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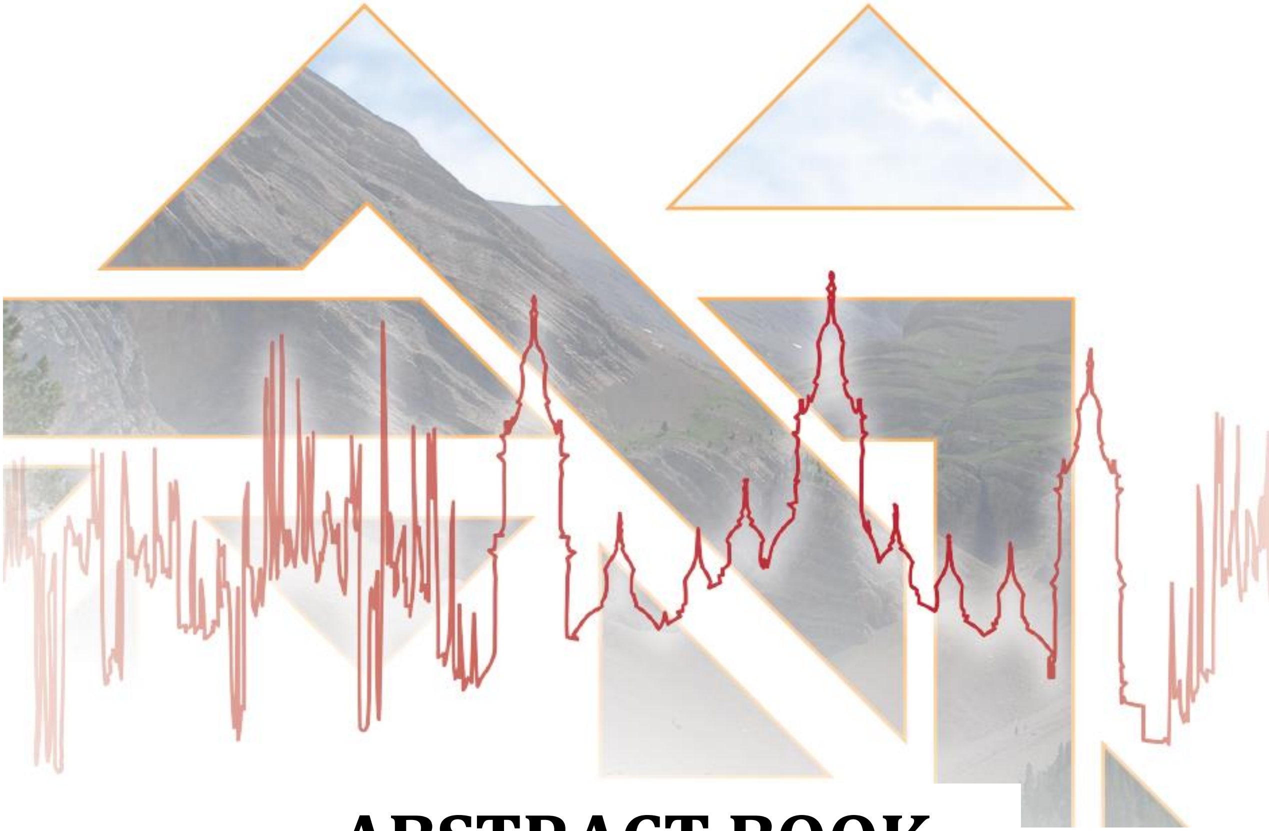
5th Open Science Meeting

Global Challenges for our Common Future:
a paleoscience perspective

9 - 13 MAY



ABSTRACT BOOK

MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD

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PLENARY TALKS

Wednesday 9:30-10:00

Early onset of industrial-era warming across the oceans and continents

Nerilie Abram[1]

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The evolution of industrial-era warming provides critical context for future climate change, and has fundamental importance for determining climate sensitivity and the processes that control regional warming over land and in the oceans. We use post-1500CE palaeoclimate records to show that sustained industrial-era warming of the tropical oceans first developed during the mid-19th Century, and was near-synchronous with Northern Hemisphere continental warming. The early onset of sustained, significant warming in palaeoclimate records and model simulations suggests greenhouse forcing of industrial-era warming commenced as early as the mid-19th Century, and included an enhanced equatorial ocean response mechanism. The development of Southern Hemisphere warming is delayed in continent-scale reconstructions, developing around the end of the 19th Century over mid-latitude continents and not yet evident at the continent scale over Antarctica. This apparent delay is not reproduced in climate simulations, but further regional analysis of an expanded array of Antarctic palaeoclimate records supports the delayed development of warming here and may be related to Southern Ocean circulation processes. Our findings imply that instrumental records are too short to comprehensively assess anthropogenic climate change, and in some regions ~180 years of industrial-era warming has already caused surface temperatures to emerge above pre-industrial variability.

Wednesday 10:00-10:30

The future of old things: geoinformatics for better paleoscience

Julien Emile-Geay[1] , Nicholas P. McKay[2] , Yolanda Gil[3] , Deborah Khider[1] , Daniel Garijo[3] , Varun Ratnakar[3]

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By some accounts, paleoscientists spend up to 80% of their time trying to access the data they need, in the form they need it. In the 21st century, we should be able to do much better.This lecture will review recent progress made by the LinkedEarth project, which relies on data standards and artificial intelligence to enable scientists to spend more time doing the science they want to do.LinkedEarth is manifesting a better future for paleoscience by creating an online platform that (1) enables the curation of a publicly-accessible database by paleoclimate experts themselves, and (2) fosters the development of community standards. In turn, these developments enable cutting-edge data-analytic tools to be built and applied to a wider array of datasets than ever possible before, supporting more rigorous assessments of the magnitude and rates of pre-industrial climate change.We will start by illustrating these principles in the context of the PAGES2k project, and outline how they may serve the PAGES community as a whole. In particular, we will illustrate how to go from spreadsheets to syntheses (PAGES2k). We will dwell on community participation in the first paleoclimate data standard. We will present GeoChronR and Pyleoclim, new open-source tools compatible with these standards and enabling cutting-edge paleoscience. We will finish by some remarks on interoperability, enabling cross-talk between scientists within a field, across fields, and between data and models.In our vision of the future, machines serve scientists, not the other way around. Yet, the process needs a lot of human input, and the participation of the PAGES community will be recognized and further encouraged.

Thursday 9:00-9:30

Determining the causes of climate change: from large scale temperatures to extreme events

Gabriele Hegerl[1] , Andrew Schurer[1] , Tim Cowan[1] , Carley Iles[1] , Juerg Luterbacher[1] , Simon Tett[1]

1) University of Edinburgh

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Attribution of climate change to causes and Attribution of changing risk of extreme events both require reliable information about climate variability and change. The grand challenge team on extreme events highlights the need to better observe, understand, attribute and simulate extreme events. A short introduction to the approach of the grand challenge is given, followed by a discussion of its relevance to palaeoclimate. Two examples are discussed: Many drought reconstructions are available and there is evidence for very significant drought events in the past. As an example, the historical dust bowl drought and associated heat waves are compared to events that occur in climate model simulations. As a mechanism, sprint moisture preconditioning appears important, while links to decadal variability connected to sea surface temperature appear unclear and model dependent for that region. When considering a possible role of external forcing in drought, it is important to consider the expected pattern of the response, which can be complex over land. Nevertheless, long streamflow data support broadly a wettening of dry regions, and drying of wet regions following volcanic eruptions. The second example focuses on extremely cold conditions also following volcanic eruptions. While overall, reconstructions tend to show a weaker response to volcanic eruptions than simulated, some of the most extreme cold conditions of Europe occurred in the 1810s. Simulations suggest that this period around the eruption of Mount Tambora was systematically colder than the preindustrial climate in general. Attribution analyses shows that the volcanic eruptions are a key driver of these cool conditions, with only a weak contribution estimated from solar forcing. However, other aspects of the cold conditions, for example, in Central Europe, appear atypical for volcanic eruptions. Attribution methods can address to what extent events such as these are random weather variability, or what fraction of the risk of cold conditions can be linked to the volcanic eruption.

Thursday 10:00-10:30

Exploring atmosphere-ocean connections in the Western Mediterranean region during past climatic transitions: last terminations, glacial inceptions and some Holocene key changes

Isabel Cacho[1] , Ana Moreno[2] , Heather Stoll[3] , OPERA team[4]

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The Mediterranean region is an exceptional sensor of climatic variability and in particular, the western Mediterranean Sea has demonstrated a tight connection with changes in the Atlantic Meridional Overturning Circulation (AMOC). Such a connection is further explored through an integrated study of cave speleothems and marine sediments reflecting climate conditions along the Iberian Peninsula. New speleothem records covering a transect from the most Atlantic to the most Mediterranean sectors across the Iberian Peninsula provide solid chronologies from Marine Isotopic Stage (MIS) 7 to 4 covering Terminations III and II and subsequent glacial inceptions. A clear picture stands out with a strong coupling between intense aridity phases and cold stadial conditions linked to AMOC weakening events and also to changes in the Mediterranean thermohaline circulation. In contrast, a high resolution Younger Dryas speleothem record breaks with this overall

stadial pattern showing an intra-event transition from extreme arid toward wetter conditions which is linked to circulation changes in the Atlantic Ocean. Temperature and humidity changes along the Holocene show a more complex pattern. A new high resolution W-Mediterranean surface temperature record supports maximum temperatures during the early Holocene while records from the north to the south of Iberia indicate limited water availability. Maximum in water availability occurred between 9-7 ka BP followed by an overall reduction in humidity, whose timing and pattern changes very much among the records, likely reflecting different proxy sensitivity, seasonality or regional diachrony. Finally, both speleothem and marine records show significant variability in temperature and humidity pattern along the last 2 kyr, particularly the Little Ice Age appears as a very unstable climatic period where two different phases can be differentiated in terms of temperature and rain patterns, the main driver of the short term variability of this period seems to be associated to the Atlantic Multi-decadal Oscillation.

Thursday 10:00-10:30

Human evolution and climate

Juan Luis Arsuaga[1]

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* Juan Luis Arsuaga, jlarfer@gmail.com

We look around and see all the animals well adapted to their respective ecological niches. They have had enough time to adapt. Natural selection, Darwin´s favorite mechanism for evolution, has done a good job with them. The unfitted were eliminated in the struggle for life, long time ago. Today natural selection should be only a normalizing force. Then, why do species evolve? Darwin was well aware of this problem and thought he had found the solution: the environment changes. The fittest today could be misfits tomorrow.In a similar way, climatic and, consequently, ecological changes haven been considered a driving force in human evolution. For the origin of the hominins in the different African East Side stories, to begin with. And for the rise and demise of the Neanderthals in the dark and freezing European Ice Ages. Neanderthal specializations have been interpreted as artic adaptations by some scholars, and yet there are colleagues who state that Neanderthals could not survive the Last Glaciation environmental challenge. They were not outcompeted by modern humans, it is said, Neandertals went extinct for just the same reason that other warm adapted European mammals. Their world vanished.In this lecture the current evidence for the role of the climate in the European Pleistocene hominin evolution is critically revised.

Friday 9:00-9:30

Warm worlds – features and lessons from the Quaternary interglacials

Eric Wolff and the PAGES Past Interglacials Working Group[1]

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Worlds that are warmer than today have a particular relevance for the future. The Pliocene had higher CO2 concentrations, comparable to those of today, but data to infer the climatic effects are rather sparse. The Holocene has a wealth of data but rather muted climate changes in many places. Some Quaternary interglacials offer a reasonable amount of data on both forcings and response, and significant differences in climate. However, interpretation is complex because the forcings and responses have a regional character that makes them only partially analogous to anything expected in the future.Interglacials are warm, low land-ice extent (high sea–level), end members of glacial cycles. Concentrating mainly on last 800,000 years, we first explore different definitions of interglacials to understand what the population of the species "interglacial" is. We use a quasi-sea level definition to identify 11 interglacials in the last 800 ka. Considering both astronomical forcing and glacial maximum ice volume, we can tentatively identify why this may be the case.Having identified the group members, we study their diversity. Marine, ice and terrestrial data compilations suggest that, despite spatial heterogeneity, Marine Isotope Stages (MIS) 5e (last interglacial) and 11c (~400 ka ago) were globally strong (warm), while MIS 13a (~500 ka ago) was cool at many locations. The onset of an interglacial (glacial termination) seems to require a reducing precession parameter (increasing northern hemisphere summer insolation), but this condition alone is insufficient. Terminations involve rapid, non-linear, reactions of ice volume, CO2 and temperature to external astronomical forcing. The precise timing of events may be modulated by millennial-scale climate change that can lead to a contrasting timing of maximum interglacial intensity in each hemisphere. This will be illustrated particularly for the case of MIS5e, and I will emphasise the implications of this interglacial for ice sheet stability.

Friday 9:30-10:00

Future Earth – vision, mission and opportunities

Hannah Moersberger[1]

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*hannah.moersberger@futureearth.org

Future Earth is a global platform for sustainability research, aiming at advancing global sustainability science, building relevant research capacities and providing an international interdisciplinary research agenda. The 10-year programme produces the knowledge and support to accelerate transformations to a sustainable world. Future Earth is built on more than three decades of international research on global environmental change carried out by projects sponsored by DIVERSITAS, IGBP and IHDP. PAGES has become one of Future Earth's global research projects in 2015.The presentation will give an overview of Future Earth's vision and mission, as well as its current activities. Our Knowledge-Action Networks as the main mechanism to connect science with society invite researchers from all kinds of disciplines and backgrounds to get engaged. Their scope covers a broad range of topics, from oceans and natural assets to transformations, the SDGs and financial and economic systems.

Saturday 17:15-17:45

New observations of past, fast changes in greenhouse gases

Edward Brook[1] , Rachael Rhodes[2] , Shaun Marcott[3] , James Lee[1] , Jon Edwards[1] , Thomas Bauska[2] , Jinho Ahn[4] , Michael Kalk[1] , Jochen Schmitt[5] , Hubertus Fischer[5]

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Advances in measurement technology and new archives now allow the resolution of ice core gas records to approach or exceed the atmospheric lifetimes of methane, carbon dioxide, and nitrous oxide. Detail at this level provides insight in to mechanisms that control natural variability and feedbacks in the climate system on time scales relevant to human impacts on the earth system. This presentation provides an overview of new carbon dioxide and methane results, primarily from the WAIS Divide ice core in Antarctica, that reveal new aspects of the relationship between abrupt climate change and greenhouse gas biogeochemistry. Continuous records of atmospheric methane from WAIS Divide fully document the well-known variations tied to the Greenlandic stadial-interstadial variability, linked by multiple lines of evidence to changes in low latitude methane emissions. This and other records also reveal a) abrupt shifts in the baseline methane concentration during some Heinrich stadials, probably tied to the impact of Heinrich events on tropical hydrology, and b) persistent but enigmatic centennial variability in the Holocene and last glacial period. Carbon dioxide variations during the last ice age and deglaciation generally correlate with Antarctic temperature, but in detail seem comprised of variability on different time scales. Coincident, abrupt increases in methane and carbon dioxide during some Heinrich stadials delineate a new type of abrupt event, probably related to southward migration of tropical rainfall belts causing increased methane emissions. The synchronous carbon dioxide variations could also have a terrestrial source, for example due to drying in the northern tropics, but there are viable mechanisms linked to changes in ocean circulation or biogeochemistry.

Saturday 17:45-18:15

Climate variability, vegetation dynamics and human-environment in continental Mediterranean Iberia during last glacial cycle

Penélope González-Sampériz[1]

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The inland areas of Mediterranean Iberia are vulnerable regions to Global Change impacts as they are characterized by extreme climate conditions in terms of both temperature and precipitation. Humans have faced abrupt environmental and climate changes in these territories through the last glacial cycle and those synergies illustrate the PAGES initiative: the climate-humans-environment interactions through time.New records have changed our understanding of the palaeoenvironmental framework for inner Iberia during the last glacial cycle. The current complex biogeographical context of the Iberian Peninsula is a reflection of a complex palaeoenvironmental history, with unexpected trends and impacts in both vegetation landscape and hydrological processes, compared with coastal areas, Atlantic and more typical Mediterranean regions. Patterns of cultural and socioeconomic evolution also show distinctive characteristics.Not surprisingly, terrestrial vegetation in continental Iberia shows a resilient behaviour during millennial – scale evolution and short periods of abrupt climate change, despite, interestingly, nearby locations respond as expected to abrupt changes with similar evolution in terms of taxa composition to Mediterranean and/or Eurosiberian sites. Besides, vegetation dynamics usually followed local, or even regional, palaeohydrological conditions but not always global millennial-scale climate variability. Asynchrony in both timing of the local last glacial maximum and humidity onset at the beginning of the Holocene are two clear examples of this complex scenario. Additionally, hunter-gathered groups likely responded to abrupt events with migration episodes, but there are too a number of examples of diverse responses to hydrological crises during deglaciation and the Holocene. Timing and intensity of first anthropogenic impact is also very variable along the whole territory.All these "apparent inconsistencies" are probably the result of an incomplete record but also illustrate the great heterogeneity inherent to Mediterranean regions. Interpretations of past human interactions with the landscape become more difficult in regions with extreme events, resilient vegetation and variable landscape dynamics. But they also provide an opportunity to improve our knowledge about Earth's past environment at local-regional scales, in order to obtain better and more detailed scenarios of human interactions with future climate and environment changes, as PAGES promotes and society demands.

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Jaume Mas, GEB, Seso Cave

ORAL PRESENTATIONS

(by alphabetical order of first author surname)

ID: 02156, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

¬Tracing Marine Cryptotephras in the North Atlantic during the Last Glacial Period

Peter Abbott[1] , Siwan Davies[2] , Adam Griggs[2] , Anna Bourne[3] 1) Institute of Geological Sciences, University of Bern, Switzerland and School of Earth and Ocean Sciences, Cardiff University, UK 2) Department of Geography, Swansea University, UK 3) Geography and Environment, University of Southampton, UK
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There is high potential to utilise tephrochronology to integrate palaeoclimatic records from the North Atlantic region to study climatic phasing, due to the high eruptive frequency of Icelandic volcanoes. However, until now North Atlantic marine records have been relatively understudied. Here we report on investigations to define a tephra framework integrating new studies of cryptotephra horizons within a wide network of marine cores with horizons identified in prior work. This framework has the potential to underpin the correlation of the marine records to the Greenland ice-core records and European terrestrial sequences.

Investigations were conducted on 13 marine sequences using cryptotephra extraction techniques to gain glass shard concentration profiles and single-shard major element geochemical analysis to characterise identified deposits. Cryptotephras were identified in many records, displaying diversity in shard concentration profiles and geochemical homo/heterogeneity. These differences reflect spatial and temporal variability in the operation of a range of transport processes, e.g. airfall, sea-ice and iceberg rafting, and post-depositional processes, e.g. bioturbation and secondary redeposition. These processes can impart a temporal delay on tephra deposition and hamper the placement of the isochron, therefore, their influence is assessed. A range of deposit types with common transport and depositional histories have been defined. Spatial patterns in the occurrence of these deposit types have been detected, the dominant controls at different sites explored and key regions preserving isochronous deposits identified.

Overall, a framework of isochronous marine cryptotephras has been defined for the last glacial period. The most widespread deposit is the rhyolitic phase of NAAZ II, identified in 9 of the marine sequences and providing a direct tie-line to the Greenland ice-cores records. The framework is dominated by horizons with a basaltic composition, predominantly sourced from the Icelandic Grímsvötn volcanic system but horizons with Katla, Hekla, Kverkfjöll, Veidivötn and Vestmannaeyjar-like compositions have also been isolated.

ID: 01945, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Indian Ocean Dipole variability during the last millennium

Nerilie Abram[1] , Bethany Ellis[1] , Bronwyn Dixon[2] , Wahyoe Hantoro[3] , Chuan-Chou Shen[4] 1) Research School of Earth Sciences and ARC Centre of Excellence for Climate System Science, Australian National University, ACT 2601, Australia 2) School of Geography, University of Melbourne, Victoria 3010, Australia 3) Research Centre of Geotechnology, Indonesian Institute of Sciences, Bandung 40135, Indonesia 4) High-precision Mass Spectrometry and Environment Change Laboratory (HISPEC), Department of Geosciences, National Taiwan University, Taipei 10617, Taiwan ROC
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The Indian Ocean Dipole (IOD) is a mode of coupled ocean-atmosphere variability that severely impacts rainfall patterns in nations surrounding the Indian Ocean. Coral-based reconstructions of IOD variability since the mid 19th Century suggest that there has been a significant increase in the frequency and magnitude of positive IOD events in recent decades. Climate model simulations also indicate that the rainfall impacts of extreme IOD events will intensify in a warming world, however confidence is limited by known biases in model representations of the IOD. Here we use an array of fossil coral records from the eastern equatorial Indian Ocean – where the signature of IOD variability is optimised – to produce a semi-continuous reconstruction of IOD variability during the last millennium. This reconstruction includes coverage during the Medieval Warm Period, Little Ice Age and pre-industrial periods, as well as following major volcanic eruptions of the last millennium. We use these records alongside ensembles of climate simulations to assess the factors that have caused changes in the frequency and characteristics of IOD variability in the past, and to provide valuable perspectives on the apparent and predicted intensification of IOD activity during the 20th and 21st Centuries.

ID: 01241, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Oral)

Late Quaternary record of changes in the planktonic foraminiferal abundance in the north to south transect of the Andaman Sea: inferences on monsoon climate

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Planetary Sciences, Brown University, Providence, RI, USA 4) CSIR-National Geophysical Research Institute, Uppal Road, Hyderabad, India 5) Department of Earth Sciences, Uppsala University, Uppsala, Sweden 6) Tandem Laboratory, Uppsala University, Uppsala, Sweden 7) National Centre for Antarctic and Ocean Research, Vasco Da Gama, Goa, India * Sijin Kumar Adukkam Veedu, sijingeo@gmail.com

Late Quaternary climate and oceanographic conditions of the Andaman Sea is rarely studied and the available paleo records are limited to oxygen isotopic and magnetic properties. We present here the downcore variations in planktonic foraminifera assemblages along with oxygen isotope and geochemical proxies of three well-dated cores collected from the north–south transect of the Andaman Sea. Age controls of the cores are based on accelerator mass spectrometry (AMS) dates on mixed planktonic foraminifera. The proxy profiles show glacial-Holocene millennial scale monsoonal climate changes and associated productivity fluctuations. Large variations in river runoff, productivity and water column stratification is seen associated with summer monsoon evolution from last glacial to Holocene. Intensification of the summer monsoon started in the early stages of the Bølling/Allerød (B/A; 15-13.5 ka) followed by slight weakening during the Younger Dryas (YD) and regained strength during early Holocene, coinciding with the highest summer insolation at 30˚N. This enhanced summer monsoon during early to mid-Holocene resulted in huge fresh water runoff that slowly muted upwelling and productivity by intense stratification. Summer monsoon was weaker during Heinrich Event 1 (H1), late Glacial (19-16 ka), Last Glacial Maximum (LGM), 38 – 34 cal ka BP and 46-41 cal ka BP. A progressive gradual decline in the total planktic foraminifera abundances from early Holocene to present suggests a gradual weakening of the summer monsoon. Our records show that monsoon variability in the last 55 ka has been controlled by variation in solar insolation, Atlantic teleconnection on Heinrich and Dansgaard-Oeschger time scale and finally shifting feedback associated with summer-winter monsoon interaction.

ID: 01715, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Late Pleistocene outburst floods of the ice-dammed lakes and climate changes in the highlands of the SW Tuva, mountains of Southern Siberia

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We present the results of our multidisciplinary investigations of the SW Tuva highlands, which is the watershed of two basins: the Arctic Ocean and the inland drainage basin of Mongolia. During Pleistocene glaciations, glaciers extended repeatedly from the mountain ranges along the major valleys and impounded extensive lakes within the depressions. Subsequent ice-dam failures led to outburst floods. All these processes were controlled by the Global climate changes and are evidenced by numerous specific landforms and sediments.In the framework of presented study generally 11 sections were studied and 15 new radiocarbon ages of deposits of different genesis were obtained.

New data suggest the existence of significantly larger lakes in the region. We also present evidences of the outbursts floods from these ice-dammed lakes and describe landforms and sediments associated with these flooding events.

Available absolute dates suggest some chronological stages of the late Pleistocene – Holocene regional hydrological system transformation controlled by climate changes. Period of prolonged climate deterioration followed by the development of spacious glaciations and related formation of ice-dammed lakes took place earlier 14000 years ago. Early Holocene climate warming accompanied by degradation of the ice sheet determined further stages of ice-dammed lakes development and draining. We can state that no later than 8000 years ago the water level in some lakes significantly declined and after their final drying approximately to the modern size there were only climatically driven oscillations of their filling.

Favorable climate conditions (more warm and humid in comparison with the modern ones) about 3000-3500 years ago was evidenced by soil formation and wide spread of forest vegetation in treeless modern landscape of the region. In 6th – 2nd centuries BC the area was widely settled by nomads associated with the Saglyn culture of Scythian epoch.

ID: 01404, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

The Pleistocene fish fauna along the eastern coast of Rhodes Island (eastern Mediterranean)

Konstantina Agiadi[1] , Angela Girone[2] , Efterpi Koskeridou[1] , Pierre Moissette[3] , Jean-Jacques Cornée[4] , Frédéric Quillévéré[3] , Vasileios Karakitsios[1] 1) National and Kapodistrian University of Athens 2) Università degli studi di Bari 3) Université Lyon 1 4) Université Montpellier 2
* Konstantina Agiadi, kagiadi@geol.uoa.grThe teleost assemblages identified in the Pleistocene sediments of the eastern part of Rhodes Island (southeastern Aegean Sea) exhibit a similar structure to the present-day eastern Mediterranean ones. Epipelagic fish include anchovies, sardines, and horse mackerels, whereas lanternfishes dominate the mesopelagic domain. The most numerous

and diverse benthic and benthopelagic families are congrids, gadids, sparids, and gobiids. A gradual replacement of pelagic tropical-subtropical species by subtropical-temperate ones, in both the neritic and the oceanic domain, took place from the Gelasian until the Ionian stage. The distribution of pelagic taxa during the Pleistocene appears to be mostly related to climate variability at local and global scale. However, the benthic neritic community did not suffer as well, since most of the species remain present in the southeastern Aegean until today. In the deep water, benthic and benthopelagic taxa have been gradually removed from this area, favoring colder-water inhabitants. The otolith assemblages identified in the Pleistocene sediments of Rhodes Island significantly enhance the eastern Mediterranean fish fauna Cenozoic record, which has so far relied only on scarce and fragmentary skeletal remains.

ID: 01296, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Frequent extreme rainstorms during late Holocene regional drought in the Dead Sea basin

Marieke Ahlborn[1], Moshe Armon[2], Yoav Ben Dor[2], Achim Brauer[1], Efrat Morin[2], Ina Neugebauer[3], Markus J. Schwab[1], Rik Tjallingii[1], Yehouda Enzel[2] 1) Section 5.2: Climate Dynamics and Landscape Evolution, GFZ German Research Centre for Geosciences, Potsdam, Germany 2) Institute of Earth Sciences, The Hebrew University, Jerusalem, Israel 3) Department of Earth Sciences, University of Geneva, Geneva, Switzerland
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Linking the frequency of extreme-flow-producing rainstorms and the long-term climate trends is essential for assessing the impacts of global and regional climate change. Our results present rare evidence of increased frequency of torrential rainstorms likely associated with the Active Red Sea Trough during a multi-century regional drought in the eastern Mediterranean.

We studied a shallow water sediment core from the Dead Sea to establish a time series of torrential rainstorms for the time interval between 3.3 and 1.8 cal ka BP. Microfacies analysis allowed the identification of 23 discrete graded layers formed by debris flows originating from the nearby steep western escarpments of the Dead Sea. Modern observations show that debris flows are triggered by exceptionally heavy torrential rainstorms over the escarpments, which exceed an estimated threshold of at least >30 mm h^{-1} for the duration of one hour. Such rainstorms are synoptically associated with the intrusion of the Active Red Sea Trough into the Dead Sea catchment. An increased frequency of torrential rainstorms during a regional drought (3.0-2.4 cal ka BP), as suggested by our data, indicates a shift in the prevailing synoptic-scale atmospheric circulation pattern. In particular, we suggest that the drought was caused by a decreased frequency of eastern Mediterranean cyclones and thereby allowed the increased frequency of the Active Red Sea Trough triggering the torrential rainstorms during generally drier conditions. Detailed analyses of present-day data from nearby gauging stations confirm that severe rainstorms become more frequent during droughts, and provide more conclusive evidences for late Holocene shifts in synoptic atmospheric circulation patterns. Our late Holocene sediment record from the Dead Sea provides a valuable record of torrential rainstorms, their causative synoptic conditions, and their linkage to the underlying long-term climate trend in the eastern Mediterranean.

ID: 01973, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Oral)

Reconstructions of winter and summer hydroclimate in western Tasmania

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Water resource availability is critical for agriculture, environmental flows, hydroelctric energy production and supply of drinking water. In Australia, short and sparse instrumental records, most of which span < 100 years, limit understanding of hydroclimatic variability. Here we present two seasonal hydroclimatic reconstructions for western Tasmania in southeastern Australia (SEA). In this region water resources are managed on a seasonal basis and there is often little relationship between the hydroclimate of different seasons. Both reconstructions are based on a mixture of ring width and wood properties chronologies (e.g. tracheid radial diameter, cell wall thickness, density, microfibil angle). The first and longest, is a 960-year December - February dam inflow reconstruction. The model explains ~37% of the variance in the calibration period and ~48.5% in the verification period. The reconstruction suggests that summer inflows since ~1900 have generally been close to or below average over the past millennium. The longest dry period occurred around 1500 CE and was accompanied by mean summer temperatures that were well above average. Greater variability is apparent between about 1550 and 1750 CE. The second reconstruction, for the winter period (July-August), is much shorter and also weaker than the summer reconstruction, but verifies back to 1731. It explains ~23% of the variance in inflows and, somewhat unusually, better captures wet rather than dry periods. According to the reconstruction, winters for the past ~150 years have been drier than for the previous ~150 years. Conditions more extreme than those in the

20th Century have occurred in the past for both seasons. Differences in the reconstructions demonstrate the relevance of highly resolved seasonal information in regions such as SEA, and temperature reconstructions for the same region and season will facilitate more detailed analyses of long-term hydroclimate than have previously been possible for this region.

ID: 02142, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Oral)

Late Pliocene-Early Pleistocene oscillations in Mediterranean Overflow water and climate in the Iberian Margin

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The Late Pliocene-Early Pleistocene transition is characterized by a climatic cooling that boosted the expansion of ice-sheets in the Northern Hemisphere and brought the alternation between glacial and interglacial periods. Several hypotheses have been put forward to explain this climate transition, and recently, changes in the production of Mediterranean deep water have been suggested to be an important factor during this transition since this deep water mass contributes high salinity water to the North Atlantic enhancing the whole Atlantic Meridional overturning circulation.

Here we investigated the oscillations in Mediterranean overflow water (MOW) throughout the Late Pliocene and Early Pleistocene using sedimentological and paleontological data from Site U1391 (37° N; 9° W; 1085 m water depth), recovered on the Southwest Iberian Margin during the Integrated Ocean Drilling Program (IODP) Expedition 339. This site is located in a plastered drift in the path of the MOW and offers high sedimentation rates to perform not only high resolution studies of past oceanographic conditions but also to reconstruct climate variability in the region across this transition. In this study, we provide the chronological framework for the bottom part of Site U1391 and combine records of XRF geochemical data (from X-ray fluorescence core scanning), grain-size analysis, benthic foraminifer $\delta^{18}O$ and $\delta^{13}C$, and benthic assemblages (ostracod and foraminifers) to evaluate changes in deep water circulation. Moreover, we reconstructed sea surface temperature conditions to assess the coherence between the regional climate and MOW. The high-resolution record of the XRF analysis (Zr/Al) indicates short-term MOW oscillations very likely related to a precessional pattern, as previously shown for the Mid-Late Pleistocene. However, the grain-size analysis shows a decreasing trend across the study interval, which indicates long-term changes in MOW. Early Pleistocene glacial-interglacial cycles appear to show a stronger coupling between MOW oscillations and sea surface conditions.

ID: 01605, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Invited Oral)

Application of HyRAD-X (a method combining reduced representation of the exome and hybridization capture applied to ancient DNA) to time series of subfossil needles unravels the early Anthropocene history of the silver fir, Abies alba, in a population from the southern Alps

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Our understanding of the evolution of several emblematic species across millenia has considerably increased in the last decade, thanks to the application of whole-genome capture, in combination with next-generation sequencing. However, to our knowledge, only anecdotical studies have made use of the application of those methods to the impressive time series of tree subfossils available in lake sendiments, to unravel the late Pleistocene and Holocene evolutionary history of forest species. One of the explanations to this gap is the lack of proper reduced genomic representation technique allowing to analyze a large number of ancient DNA samples without applying costly whole-genome capture methods.Here, we present a major update to those methods, namely *Hybridization capture from (messenger) RNA to RNA (probes) using RAD-derived probes* (HyRAD-X), a technique applying RAD-sequencing to messenger RNA from one or few fresh specimens to elaborate bench-top produced probes, i.e., a reduced representation of the exome, further used to capture homologous DNA from a samples set. As a proof of concept, we applied HyRAD-X to subfossil needles from the tree *Abies alba*, collected in lake sediments at Origlio (Switzerland) and dating back from 7200-5800 years before present (BP). More specifically we investigated genetic variation before, during, and after an anthropogenic perturbation that caused an abrupt decrease in *Abies alba* population size, 6500-6200 years BP. HyRAD-X produced a matrix encompassing 524 exome-derived SNPs. Despite a lower observed heterozygosity was found during the 6.500-6.200 years BP time slice, genetic composition was nearly identical before and after the perturbation, indicating that re-expansion of the population after the decline was driven by autochthonous specimens. This study outperforms by orders of magnitude previous studies exploring the potential of tree subfossil samples in population genomic studies.

ID: 01940, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Common Era temperature reconstructions and the response of the climate system to explosive volcanic eruptions

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Volcanic eruptions cause global-scale changes to the climate system via the direct effect of radiative forcing anomalies and the ensuing influences on and feedback to major modes of ocean-atmosphere variability. Climate model simulations suggest a larger degree of cooling following eruptions than proxy temperature reconstructions, and disagreement persists about the subsequent state of the El Nino Southern Oscillation system. Here, we use two recent temperature reconstructions to investigate the response of the climate systems to volcanic eruptions. Our new NTREND field reconstruction of Northern Hemisphere summer temperatures shows coherent, broad-scale cooling associated with large tropical eruptions: 96% of reconstructed grid points show composite mean colder temperatures and an average response across all grid points and all eruptions of -0.44C. Cooling persists in some cases for 2 or more years following eruptions and different eruptions reveal different magnitudes and spatial patterns that are not clearly associated with estimated radiative forcing. The PAGES2k Oceans2k High Resolution (HR) reconstruction of tropical sea surface temperatures shows cooling of the western Pacific and Indian Ocean in response to well-dated tropical eruptions since 1600 CE but no statistically significant response in the eastern tropical Pacific, suggesting a reduction in the tropical Pacific temperature gradient but not a canonical El Nino pattern. Climate models simulate an overall larger cooling in the western Pacific and Indian Ocean than the reconstructions and produce a variety of anomalies in the eastern Pacific. Our results here provide a new benchmark comparing proxy reconstructions and model simulations and may help identify possible sources of disagreement.

ID: 01779, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Holocene Paleoenvironmental Change in the Sierra Nevada, Southern Spain

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The Sierra Nevada region of southern Spain has a rich biological and cultural heritage. Recent paleoenvironmental research in the range includes sedimentary records from several high elevation lakes and bogs, spanning an elevational range of ca. 2500 m to over 3000 m elevation. Common research themes have centered around (1) the impact of climate change and human land use on the fragile alpine ecosystems, as well as (2) the record of more regional human impact on lower elevation landscapes surrounding the mountain range.

The longest (~ 11,500-yr) record comes from the 3020 m asl Laguna de Río Seco (LdRS), where paleobotanical, isotope geochemical and organic biomarker data suggest wet conditions prior to ~ 7.8 ka, and much drier climates after ~ 5.7 ka. These changes are confirmed from additional sites in the range. Progressive aridification of the mid- through late Holocene was periodically interrupted by wetter conditions, such as the widespread Roman Humid Period.

Signals of human activity within the region and locally within the range are evident in the cores. For example, increases in Pb in sediment occurs during the Early Bronze Age, ~ 3.9 ka. Regionally, increases in charcoal deposition ~ 4.0 ka may result from these activities, rising population levels with changing land-use, or climatic factors. Increasing *Olea* pollen after ~ 3.0 ka may signify the beginnings of olive cultivation at lowland sites, with major expansion of olive orchards during the 20th century. The periodic Holocene occurrence of the dung fungus, *Sporormiella* becomes more consistent after ~ 3.0 ka suggest more intensive pasturing. Though *Pinus* dominated during the early Holocene, it largely disappeared in the pollen record at about this time, suggesting widespread tree-cutting. Only with the establishment of *Pinus* plantations during 20th century does pine return to importance there.

ID: 01608, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

400 years of summer hydroclimate from stable isotopes in Iberian trees

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Tree rings are natural archives that annually record distinct types of past climate variability depending on the parameters measured. Here, we use ring-width and stable isotopes in cellulose of trees from the northwestern Iberian Peninsula (IP) to understand regional summer hydroclimate over the last 400 years and the associated atmospheric patterns. Correlations between tree rings and climate data demonstrate that isotope signatures in the targeted Iberian pine forests are very sensitive to water availability during the summer period, and are mainly controlled by stomatal conductance. Non-linear methods based on extreme events analysis allow for capturing distinct seasonal climatic variability recorded by tree-ring parameters and asymmetric signals of the associated atmospheric features. Moreover, years with extreme high (low) values in the tree-ring records were characterised by coherent large-scale atmospheric circulation patterns with reduced (enhanced) moisture transport onto the northwestern IP. These analyses of extremes revealed that high/low proxy values do not necessarily correspond to mirror images in the atmospheric anomaly patterns, suggesting different drivers of these patterns and the corresponding signature recorded in the proxies. Regional hydroclimate features across the broader IP and western Europe during extreme wet/dry summers detected by the northwestern IP trees compare favourably to an independent multicentury sea level pressure and drought reconstruction for Europe. Historical records also validate our findings that attribute non-linear moisture signals recorded by extreme tree-ring values to distinct large-scale atmospheric patterns and allow for 400-yr reconstructions of the frequency of occurrence of extreme conditions in summer hydroclimate. We will discuss how the results for Lillo compare with other records.

ID: 01607, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Vegetation dynamics and hydrological response to Holocene climate variability in the Iberian Range: a synthesis from lacustrine and tufa records

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The increase in chronologically well-constrained, palynological, sedimentological and geomorphological sequences obtained from lacustrine and fluvial tufa records along the Iberian Range (NE Spain) has allowed to drawn the vegetation dynamics and the hydrological variability during the Holocene. Overall, three main phases of environmental change can be established. 1) The early Holocene, chronologically comprising 11.700-8200 cal yr BP, is defined as a landscape dominated by montane pinewoods (e.g., *Pinus sylvestris/nigra* type) and steppe communities (e.g., *Artemisia*, Compositae, Chenopodiaceae), suggesting a harsh continental climate background. Palaeohydrological proxies reveal low water-stands till 9500 cal yr BP. 2) The most humid phase during

the Holocene occurred between ca. 8200-5000 cal yr BP and was characterized by the maximum spread of broadleaved elements (e.g., *Betula*, *Corylus*, *Quercus faginea* type), the expansion of a Mediterranean woodland with evergreen *Quercus* as dominant forest communities and more frequent periods of higher lake levels, resulting in the maximum frequency of tufa deposition at regional-scale. 3) The return of montane pinewoods synchronous to the depletion of broadleaved trees and the decline of tufa growing characterize the mid-late Holocene transition (ca. 5000 cal yr BP). This transition was most likely a consequence of increasing aridity that continued during the late Holocene. Human-pressure is practicably negligible until Roman-times when a rapid region-wide deforestation and the spread of agriculture occurred.

ID: 01363, 01.- Open Session on past global changes, (Oral)

Mean ocean temperature evolution in the past 40,000 years from ice core noble gas thermometry

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The amount of heat stored in the ocean is the most robust measure of the integrated energy imbalance of the Earth that accompanies glacial-interglacial climate swings. For the current anthropogenic warming, more than 90% of the excess heat stored by the Earth over the last 50 years is found in the ocean.The history of ocean heat content is thus a central parameter in the reconstruction of global climate forcing and response. Local deep water temperature has been reconstructed using sediment cores, but a truly global signal is difficult to synthesize. The novel method of ice core noble gas thermometry allows us to reconstruct global mean ocean temperature (GMOT) based on simple physics. Because noble gases are passively cycled through the atmosphere/ocean system, and because each gas species has a specific temperature dependent solubility, noble gas ratios in the atmosphere represent a direct, physical proxy for GMOT. After correcting for fractionation effects that happened in the firn column prior to the air getting trapped in the ice matrix, measurements of noble gas elemental ratios in ice cores can thus be used to estimate past GMOT.We present a record of GMOT obtained from EDC ice core samples spanning the last 40,000 years in roughly 1,000 year resolution, highlighting the warming during the deglacial transition. The Last Glacial Maximum GMOT is estimated to 2.6°C colder than present, in good agreement with sediment core oxygen isotope and pore water fluid reconstructions. The early Holocene was slightly warmer than present by approximately 0.5°C. The GMOT record shows a remarkable correlation with Antarctic temperature, suggesting that the Southern Ocean is an important driver of temperature change in the deep ocean.

ID: 02235, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Paleoflood Data and Increasing Flood Extremes

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The recent, large number of extreme flooding disasters raises questions about the possible role of climatic change. In many cases recent flood extreme magnitudes exceed decadal-scale stream gaging and century-scale historical records. Scientific understanding of extreme flooding absolutely demands real-world data on actual extreme flood events, but this type of data is not provided by either the flood-frequency analysis (FFA) or the mathematical modeling methods (MMM) that totally dominate conventional hydrological science/engineering practice. FFA methods unrealistically extrapolate from small, common floods to provide estimates for unknown, causally unrelated extremes; and MMM cannot create real-world data on the most extreme flooding. It thus follows that truly scientific flood hydrology must pay close attention both to those very rare cases when flood extremes happen and to **the existing, very extensive wealth of natural evidence of flood extremes that actually have happened.** Paleoflood hydrology provides real-world data on past flood extremes on the millennial time scales that insure representation of the most extreme flooding phenomena. Though miniscule resources have been devoted to this type of flood hydrological science (in comparison what is devoted to conventional FFA and MMM), a survey of existing global paleoflood data, collected by the world's relatively small cadre of dedicated paleoflood hydrologists, suggests the following preliminary conclusions: (1) recent extreme flood magnitudes are NOT "unprecedented" -- similar extreme flood magnitudes appear in sufficiently long paleoflood records; (2) flood information from the deep past is NOT made irrelevant because of "nonstionarity" in regard to future changes (it is FFA that needs to change, NOT nature); and (3) while future climate change may result in different levels of flood intensity and frequency in particular catchments, these will most probably result from shifts in storm tracks or patterns, evidence for which can only be found in the long-term records of the past.

ID: 02167, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Prevailing pacing of subantarctic glaciers by Southern Hemisphere Westerlies

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The accelerated loss of ice mass on the Antarctic Peninsula during the last 50 years have demonstrated that subantarctic glaciers in the Circumpolar Fringe Zone (CFZ, 65-55°S) not only are sensitive to climate change but responsive on a regional scale. Examining such variability on longer time scales has previously been difficult to assess because most records are scant and discontinuous. Here, we report with unprecedented accuracy and resolution how three cirque- and tidewater glaciers on South Georgia (SG, 54°S, 36°W) have interacted with changing climate condition during the last 14.5k years. Detailed analyses of lake- and catchment sediments combined with cosmogenic nuclide dating of multiple moraines enable us to track continuous glacier activity on centennial to multi-decadal time scales. We specifically demonstrate that glacier fluctuations on South Georgia covary with the Antarctic Peninsula and with Patagonia during the time interval in question, but with notable exceptions. We forward the idea that irregular, but consistent shifts in the Southern Hemisphere Westerlies drive the observed regional pattern of glacier vacillations. Data presented here shows how the Antarctic Cold Reversal (ACR, 14.5k-12.5k years ago) concurs with one of the largest known glacier advances on South Georgia, and also considerable changes in the ENSO. From 10.5k to 7k years ago glaciers were relative large on South Georgia compared to being small or absent in Patagonia, a period with a quiescent El Niño. A rejuvenation of glaciers starts around 4000 years ago with repeated glacier advances/retreats. This climatic mode prevails until present when glaciers start to disappear for the first time during the last 14.5k years.

ID: 01895, 01.- Open Session on past global changes, (Oral)

British-Irish ice sheet sustained by weaker Atlantic Meridional Overturning Circulation

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The strength of the Atlantic meridional overturning circulation during the Last Glacial Maximum remains a topic of considerable debate. Was the overturning stronger or weaker than today? Reconstructions and simulations of the Last Glacial Maximum climate, the overturning strength and North Atlantic oceanic heat transport are thus far inconclusive. We provide new, ice-sheet-based evidence supporting reduced oceanic heat transport into the North Atlantic region.

The British-Irish Ice Sheet was situated in a region that is critically sensitive to a poleward oceanic heat transport in the North Atlantic. We use the result of multiple global climate simulations of the Last Glacial Maximum at ~1°-resolution featuring different states of the overturning circulation. The resulting North Atlantic climate conditions are validated against paleoclimatic reconstructions and used to force ice-sheet simulations using PISM. The results show that a weakened Last Glacial Maximum overturning circulation is in agreement with extensive ice sheet cover over the British-Irish Isles as inferred from geological evidence. Our inference is therefore consistent with paleoceanographic reconstructions, which suggest a weakened overturning circulation during the LGM.

ID: 01726, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Coping with extreme events: the past flood history of Kashmir

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The recent extreme floods which took place in Kashmir valley in September 2014, March and September 2015, have revealed its high vulnerability to hydrological hazards. The bowl shaped topography of the valley, intense land-use changes and unfavourable climatic conditions are specific factors which are calling for the implementation for suitable adaptation strategies, aimed at increasing the resilience of the population of this region. This communication focuses on the analysis of past flood histories in Kashmir so as to contextualize the recent flood disasters in a long-term perspective and to contribute with a better understanding of this process in this geographical context. We apply a multiproxy approach based on historical archives, tree-ring records and a compilation of all existing flow measurements to better understand past floods variability in the valley of Kashmir. Historical sources include old records from archives of the Irrigation and Flood Control Department of Jammu-Kashmir and describe flood events which have taken place at Jhelum River. We also collected old pictures and other documents about the river system, extending back to British period (since mid-19th to mid-20th century), including information about water levels. Tree-ring records have been moreover used at the headwater catchment, as historical records used to be concentrated to the valley bottoms. Finally, more than forty flow gauge stations with records since mid-20th century have been analysed. We show that the entire Kashmir valley has severely suffered past flood events affecting the population and surroundings crops and triggering socio-economical changes in the region. The reconstructed flood dataset is one of the most complete flood records in the region, and provides information about the different trigger mechanism of extreme flood events. This information is relevant to understand flood variability, but also to improve the risk perception of different actors involved in Disaster Risk Management in this region.

ID: 01547, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Can ice sheets regrow during an interglacial?

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Within the last interglacial, one or more oscillations in mean sea level are identified at a number of sites, which potentially implies both ice sheet growth and decay within a climate which was warmer than today. A number of studies have sought to understand the mechanisms required for rapid ice sheet collapse during the interglacial, however few consider that a precursor to these high rates of sea-level rise is often a preceding phase of sea-level fall. We review the evidence for plausible mechanisms of ice-sheet growth within the last interglacial, and assess the most likely ice mass(es) which could be responsible. Due to the very limited extent, or absence, of most ice masses outside Greenland and Antarctica during the last interglacial, the polar ice sheets are the prime candidates to drive ice-mass oscillations, but there is a scarcity of geomorphological evidence. We also explore additional mechanisms, and show that solid earth deformation is potentially able to account for the presence of multiple sea-level highstands (though not the maximum rates of change). Thus, significant ocean warming, climatic changes and/or Antarctic collapse may not be required to fit the fluctuating sea-level data, suggesting relative ice-sheet stability during the Last Interglacial.

ID: 02001, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Oral)

Historical reconstructions of El Niño Southern Oscillation using data from ships' logbooks

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The meteorological information found within ships' logbooks is a unique, hand-written source of data for historical climatology. This study uses wind observations from logbooks covering the period 1815 to 1854 to reconstruct an index of El Niño Southern Oscillation (ENSO) for boreal winter (DJF). The logbook data are obtained from the Climatological Database for the World\'s Oceans (CLIWOC) and a collection of digitised English East India Company (EEIC) records, both of which contain observations from the pre-instrumental era. Statistically-based reconstructions of the Southern Oscillation Index (SOI) are obtained using two methods: Principal Component Regression (PCR) and Composite-Plus-Scale (CPS). Calibration and validation are carried out over the modern period 1979-2014, assessing the relationship between re-gridded seasonal ERA-Interim reanalysis wind data and the instrumental SOI. The reconstruction skill of both the PCR and CPS methods is found to be high with Reduction of Error skill scores of 0.80 and 0.75, respectively. The relationships derived during the fitting period are then applied to the logbook wind data to reconstruct the historical SOI. The logbook reconstructions are found to agree well with a previous SOI reconstructed from Jakarta rain day counts, 1830-1850. They provide an indication of the behaviour of ENSO during this pre-instrumental period which helps to improve our understanding of ENSO.

ID: 01345, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Persistent millennial-scale cirque-glacier fluctuations in Ireland between 24,000 and 10,000 years ago

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The abrupt climate changes of the last deglaciation are commonly associated with changes in the Atlantic meridional overturning circulation (AMOC) and associated changes in ocean heat transport. Because of its location immediately adjacent to, and downwind of, the North Atlantic Ocean, glacial records from Ireland are strategically located to monitor the full climatic effects of abrupt changes in the AMOC. Given their short response times, former Irish cirque glaciers provide a robust record of such climate variability, but dating their fluctuations remains poorly constrained. Here we report ^{10}Be ages on Irish cirque moraines that show a persistent millennial-scale signal throughout the interval from 24.5±2.1 ka to 10.8±1.0 ka. Many of our new moraine ages are associated with known climatic events driven by changes in the AMOC, suggesting a forced response. Additionally, our ages also show that a millennial-scale signal persists during the interval from ~21 to 15 ka when both AMOC and surface air temperatures are thought to be stable. This signal is consistent with modeling results that identify kilometer-scale glacier fluctuations on centennial-to-millennial timescales solely in response to high-frequency natural variability. These results demonstrate that on an individual glacier basis internal climate variability has an effective control on glacier length fluctuations and thus the moraine record. Yet, if we only consider the individual cirque basins, internal stochastic noise masks any aspect of the climate signal. To address this we ran Monte Carlo simulations of equilibrium line altitude (ELA) changes for each of the 15 moraines. When considered as a composite record the ELA changes exhibit a response to CO_2 increase ~17-18 ka. Thus, our new ^{10}Be deglacial chronology records high-frequency glacier fluctuations driven by natural internal variability overprinted on a lower-frequency climate response to increasing CO_2.

ID: 01635, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

The flagellants, the volcano and malign weather conditions of the 1250s

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The 1257 CE eruption of the Indonesian volcano Samalas and its impact on global climate has been discussed intensively by scientists since the source of the so called ‚mystery eruption' was discovered in 2013. But a historical perspective on its putative socio-economic consequences is still missing. The paper will demonstrate, mainly based on documentary data from Europe, that the phase of meteorological extreme events in the second half of the 1250s can't be simply synchronized with the Samalas eruption. Actually, years of considerable meteorological stress started as early as 1256, while the volcanic dustveil undoubtedly increased this pressure in 1258/59 CE. Furthermore, the paper will look at the potential reactions of afflicted communities, taking advantage of the particular detailed administrative and fiscal sources available for Italian city-states like Bologna, Siena and Perugia: Even if the economic pressure resulting from failed harvests is less apocalyptic than hitherto portrayed, we can find detailed practical, legal and fiscal reactions to dearth and famine provoked by malign weather conditions during the second half of the 1250s. The Italian case study explains why the economic downturn and the rise of grain prices didn't result in widespread starving of thousands of people: Hence, it underlines the importance of cultural preconditions to the vulnerabilty of societies to environmental shocks. But the origins of one of the most remarkable religious movements of the European Middle Ages, the flagellants that appeared first in Perugia in 1260 CE, can be connected to a very specific situation created by environmental factors since 1256 CE. This religious practice spread all over Italy within months, while it crossed the Alps in the following year. As these penitents have undoubtedly multiple intellectual sources, each of the flagellant's reappearences till the middle of the 14th century happen during periods of climatic stress.

ID: 02058, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Abrupt climate change events and atmospheric CO2: constraints from ice core δ13C-CO2 during the last glacial period

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Changes in atmospheric CO_2 on millennial and centennial timescales during the last glacial period and last deglaciation are key yet poorly understood components of past climate variability. Here we present the first high-precision (~0.02‰) and high-resolution (~200yr) record of the stable carbon isotopes of atmospheric CO_2 from an interval during the last glacial period. The new reconstruction spans 47,000 to 35,000 years before present, capturing multiple DO events and Heinrich Event 4.

The strongest mode of variability in atmospheric CO_2, associated with the rising and falling with Antarctic temperature, is accompanied by inversely correlated changes in $\delta^{13}C$-CO_2. Atmospheric CO_2 ranges between 195 to 215 ppm and $\delta^{13}C$-CO_2 spans -6.45 to -6.65‰, with a -0.1‰ change for every +10 ppm. The data thus suggest that the millennial-scale CO_2 variations are driven largely by changes in carbon reservoirs depleted in ^{13}C. Broadly, the data are consistent with model experiments and data that suggest millennial-scale CO_2 is controlled by changes in ocean ventilation and/or export production.

Two additional modes of centennial-scale CO_2 variability, distinguished by carbon isotope signatures, are associated with DO events and Heinrich Stadials. Similar styles of variability were recently described for the last deglaciation (Bauska et al., 2016), suggesting that drivers of both last glacial period and deglacial CO_2 are intimately linked to abrupt climate variability.

Bauska, T.K., Baggenstos, D., Brook, E.J., Mix, A.C., Marcott, S.A., Petrenko, V.V., Schaefer, H., Severinghaus, J.P., and Lee, J.E. Carbon isotopes characterize rapid changes in atmospheric carbon dioxide during the last deglaciation. Proceedings of the National Academy of Sciences, 113(13), 3465-3470 (2016).

ID: 01478, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Oral)

Shift in the glacial interglacial methane budget from dual isotope records

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Atmospheric methane records as reconstructed from polar ice cores allow a view on processes predominantly taking place in the terrestrial biogeosphere. In this study we present dual stable isotope constraints on the past natural methane sources derived from Antarctic ice cores which help to deepen our understanding. For the current and two older interglacials and their antecedent glacial maxima we show that tropical wetlands and seasonally inundated floodplains are most likely the dominating sources of atmospheric methane, steered by temperature and humidity as modulated by insolation, (local) sea level and monsoon intensity. The latter is also revealed on the basis of substantial $\delta^{13}CH_4$ signals in the course of interglacials. Based on our new $\delta D(CH_4)$ constraint, geologic emissions of methane may play a steady but minor role, and the glacial budget is certainly not dominated by these sources. Superimposed on the glacial/interglacial variations we found a marked difference in both isotope records with systematically higher values during the last 25,000 years compared to older time periods. This shift cannot be explained with climatic changes. Rather we invoke a change in fire regimes possibly due to accumulation of fuel and biome changes related to the late Pleistocene megafauna extinction which took place in the course of the last glacial.

ID: 01563, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Climate and fire-mediated terrestrial-aquatic ecosystem teleconnections: a case study from temperate Tasmania

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Fire is a powerful agent influencing cultural, ecosystem and atmospheric change. This is particularly the case for Australia, where fires have shaped the landscape. In forested high rainfall temperate regions such as Tasmania, fires are limited by climate. Thus, charcoal produced by fire is an indicator for past climate change. Whilst there is a range of literature that highlights the importance of fire in the ecology of temperate Australia, there is critical lack of understanding of how aquatic ecosystems respond to changes in fire activity. Indeed, records of long-term aquatic ecosystem dynamics are scarce in the Southern Hemisphere and there is a need for the development of coupled terrestrial-aquatic ecosystem dynamics if we are to predict, mitigate and adapt to future global environmental change. Our research intends to better understand the relationships between terrestrial and aquatic ecosystem change in a climate sensitive environment. We employ a multi-proxy approach – radiometric dating, charcoal analysis, XRF geochemistry, pollen and diatoms – to reconstruct climate and fire-driven terrestrial and aquatic ecosystem change over the last 18,000 years at Lake Vera, southwest Tasmania. Lake Vera is unique for Tasmania, having remained fire-free from ca. 10-2.4 ka. However, substantial vegetation change occurred during this fire-free period, revealing a close coupling between climatic change and rainforest community dynamics. A series of fires after ca. 2.4 ka substantially altered the catchment vegetation, facilitating the invasion of fire-promoting plant species (e.g. Eucalyptus). Critically, our data reveals a dynamic aquatic ecosystem response to both lake ontogeny (acidification) and fire-driven catchment dynamics (erosion and vegetation change). Repeated fires drove an increase in nutrient and disturbance tolerant taxa until a critical threshold was crossed and a

new diatom community state emerged. Importantly, this aquatic transition precedes the vegetation transition. We discuss the implications of these findings in terms of resilience and terrestrial-aquatic ecosystem interactions.

ID: 01893, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Glacial lake outburst floods in the Northern Patagonian icefield during the Holocene

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The Baker River drains a catchment of 27,000 km^2 and has an annual discharge of 1100 m^3s^{-1}. Since late-glacial deglaciation, the morphosedimentology of the Baker valley has been controlled by different scales of Glacial Lake Outburst Floods (GLOFs). Here we aim to reconstruct the frequency, timing and magnitude of Holocene GLOFs. We apply geomorphic mapping, stratigraphy, radiocarbon and OSL dating, and palaeoflood hydrology to reconstruct these events. Downstream of the Baker-Nef junction, slackwater flood deposits from three sedimentary benches at elevations of 23.5, 16.5 and 14 m above normal water level. The upper bench contains 28 flood units dated between 4.3 ± 0.3 ka (OSL age) to 2544 ± 34 BP (uncalibrated age), post-dating a neoglacial advance dated to 4.96 ± 0.21 ka. The lower bench is comprised of 30 flood units, dated between 2115-700 BP (uncalibrated ages), in a sequence with up to six buried soils, indicative of alternating flood-poor and flood-rich periods. The peak discharges matching the elevation of the upper bench is 10,300 m^3s^{-1}, whereas the lower bench is associated with a discharge of 5500 m^3s^{-1}. Downstream of the Baker-Colonia junction, geomorphic mapping reveals evidence of two Holocene alluvial terraces. The oldest (highest) Holocene alluvial level contains basal gravels capped by a well-developed buried Podzolic Luvisol that was radiocarbon dated to 6160 ± 40 BP. In this alluvial sequence, at least two major floods occurred between then and 5300 BP and at least eight events between 5300-2500 BP, potentially overlapping the 4.96 ka neoglacial. Dating and hydraulic modelling indicate that at least three Late Holocene (post 610±30 BP) GLOF event(s), potentially related to the Little Ice Age readvance. None of the recent 16 floods (2008-2014) from Lago Cachet II (3000-4500 m^3s^{-1}) were recorded in the upper floodplain, which required a threshold discharge of 4500-5000 m^3s^{-1} to flood.

ID: 02244, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Oral)

Deglacial sea-surface temperature change and rapid response along the western margin of the northern and southern Cordilleran ice sheet

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It is likely that sea surface temperatures played a significant role in Cordilleran ice sheet response to climate change. The relationship between the Cordilleran ice sheet and regional sea surface temperature (SST) change can be determined over the last deglaciation by detailed examination of ice-proximal marine sediments near Alaska and British Columbia (BC). Marine sediment core EW0408-85JC (59.56°N, -144.15°W; 682 m water depth) contains sediments discharged by the southeast Alaskan glacial margin along the northern Cordilleran ice sheet. Ten degrees of latitude to the south, marine sediment core MD02-2496 (48.98°N, -127.04°W; 1243 m water depth) records a southern Cordilleran ice sheet signal, which contains sediments discharged from the Puget Lobe and southeast British Columbia glacial margin. Previously published alkenone and Mg/Ca SST paleoceanographic data from these cores imply pronounced warming at the onset of the onset of the Bølling warm period and cooling during the Younger Dryas cold event, suggesting a uniform climate forcing across the western margin of the Cordilleran ice sheet. Recent research efforts using sediment discharge tracers, such as Ca/K and Ca/Sr, present a terrestrial sediment signal indicating glacier response during periods of significant SST change. Our data show concurrent rapid response of the northern and southern ice sheet to these intervals of abrupt climate change.

ID: 01312, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Controls on the evolution of the North American Monsoon since the Last Glacial Maximum

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Despite its importance to water resources in the US Southwest and northwest Mexico, the fundamental dynamics and long-term evolution of the North American Monsoon (NAM) remain poorly understood. In part, this is due to a lack of proxy records that specifically resolve summertime convection in the NAM region. We present two new records of leaf wax stable isotopes (dD of n-alkanoic acids) from the core of the NAM region to shed light on the deglacial evolution of the NAM circulation. Modern data from a suite of coretop samples suggests that dD uniquely reflects the seasonality of rainfall in the NAM region, potentially enabling reconstruction of past monsoon rainfall changes. Our results show evidence of monsoon reductions at the Last Glacial Maximum (LGM, ~18-21 ka BP), and an increase in summertime rainfall at the mid-Holocene. We complement these proxy records with analysis of transient and single-forcing GCM simulations to shed light on the dynamics responsible for the past evolution of the NAM.

ID: 01797, 18.- Human Impact on Global Aquatic Systems, (Oral)

Cultural transformation of the Swedish boreal forest over two millennia and its impact on lake-water quality

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Over the past few decades monitoring programs in N Europe have recorded increasing surface-water organic carbon (TOC) concentrations, which are hypothesized to reflect a recovery from acidification and/or response to climate warming. While monitoring programs are critical for tracking ongoing environmental and climate changes, and fundamental for assessing key processes, it can be difficult to predict future responses to ongoing changes from these data without understanding the inherent *natural* reference conditions, previously imposed changes and also underlying trajectories.

As shown previously in Sweden for lake acidification and atmospheric pollution, there have been significant long-term changes in lake-water TOC not only over the monitoring period but also over centennial to millennial timescales. Based on a suite of analytical tools (geochemistry; pollen; diatoms; FTIRS; pyrolysis-GC/MS; fecal biomarkers; VNIRS-inferred lake-water TOC and chl a) applied to several boreal lake-sediment records, we find significant changes in lake-water TOC during the Holocene. As expected, with rapid landscape development following deglaciation lake-water pH declined and TOC increased along with the build up of C and loss of exchangeable base cations in the landscape. Thereafter, lake-water chemistry (pH, TOC) changed only slightly over the next ~8000 years despite significant natural long-term changes in climate (e.g. Holocene Thermal Maximum) and forest vegetation (e.g. spruce establishment).

However, 500–1000 years ago lake-water TOC levels began an unprecedented decline by ~50%, which coincided with an increasing cultural transformation of the boreal forest landscape in central and northern Scandinavia, inferred from multiproxy evidence. Of particular importance for remote areas was the increasing use of summer forest farms, which included grazing of livestock in the forest and haymaking on mires. We hypothesize these activities reduced labile soil C pools. Increasing levels of inferred lake-water TOC over the past century and up to the present are now similar to mid-Holocene, pre-disturbance values.

ID: 01676, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Oral)

Antarctic Ice Sheet sensitivity to oceanic temperature changes

Javier Blasco Navarro[1] , Jorge Álvarez Solas[1] , Alexander Robinson[1] , Marisa Montoya[1] 1) Universidad Complutense de Madrid * Javier Blasco Navarro, jablasco@ucm.es

Different studies suggest that during the Eemian the Antarctic Ice Sheet (AIS) has contributed to a sea-level rise up to 5 meters, predominantly caused by the West Antarctic Ice Sheet (WAIS). The reason why the WAIS is the main contributor to this growth instead of the East Antarctic Ice Sheet (EAIS), which has more ice content, is due to oceanic warming. The AIS is barely subject to ablation but the WAIS lies in its major part below sea level, hence it is specially sensitive to oceanic temperature changes. Additionally it contains the two largest ice shelves of the world, whose collapse could trigger an acceleration of the ice streams and enhance sea-level rise, therefore understanding the interactions between ice and ocean seems the key factor to clarify changes in ice volume during the last glacial cycles, nevertheless those interactions are poorly understood. Here we will present a new hybrid thermo-mechanical ice sheet model capable of simulating in separate ways the slow moving grounded ice and the fast moving ice streams and ice shelves. The model includes a basal melting parametrization, for ice shelves and grounding line, dependent on present-day observed basal melting rates and computed oceanic temperature anomalies with respect to present. Our simulations will constrain possible values for the used basal melting parametrization and enlighten our understanding of the AIS evolution.

ID: 01582, 01.- Open Session on past global changes, (Oral)

Testing the analog method for reconstructing climate over the last 15000 years

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Our understanding of past climates relies on climate reconstructions based on palaeo-observations and simulations with Earth-System-Models. Both sources provide information with different characteristics and uncertainties. Confidence in our understanding requires reconciling both sources of data. Ideally we can combine both types of information in inferences about past climates. For example a number of current initiatives try to combine proxies and simulations via data-assimilation-techniques.

The analog method is a computationally cheap means of constraining simulation data by palaeo-observations. Recent applications of the method referred to its results as "proxy surrogate reconstructions". They usually concentrated on the Common Era of the last 2000 years.

In this presentation I show results of an application of the analog method to reconstructing the climate over Europe over the period from about 15ka BP to today. I discuss a pseudo-proxy approach and a reconstruction based on a previously published compilation of proxy records. The pool of simulated analogs includes a variety of transient and time-slice simulations over the last 21ka including the TraCE-21ka simulation and parts of the PMIP3 simulation archive.

I highlight the problems arising. Among these are the questions (i) how time- and proxy-uncertainty influence what can be inferred about the past from the analog method and (ii) how the requirement of a suitable and large enough pool of analog-candidates influences the result. I also show to what extent the analogs add information about past climates beyond what one directly learns from the proxies.

ID: 02251, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

The Greenland Ice-Core Tephra Record – insights into Icelandic eruptive history between 25 and 50 ka BP.

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The Greenland ice-core records provide a master record of past climate changes through the last glacial period and are also an excellent record of past volcanism with both volcanic aerosol (ice acidity and sulphate records) and tephra particulate matter (or glass shards) preserved in the ice. However, only the volcanic glass shards allow the geochemical identification of the volcanic source and their employment as isochronous marker horizons between disparate archives. Over 300 tephra deposits have been identified in NGRIP, NEEM and GRIP and contribute towards the production of a Greenland tephra framework that extends over the last 130ka. The majority of deposits are preserved in cryptotephra form and continuous sampling of the NGRIP ice-core between 25-50ka allows an initial assessment of volcanic frequency during the last glacial period. A total of 88 individual volcanic events are recorded during this time period. Basaltic composition tephras dominate the records and indicate frequent eruptions from the Grimsvötn, Katla and Kverkfjöll volcanoes in Iceland. An assessment of the frequency of eruptions from different volcanic centres will be made and links to any climatic forcing discussed.

ID: 01621, 15.- The Holocene - its climate variability and rapid transitions, (Invited Oral)

Exploring the Holocene with numerical experiments: mean climate and climate variability in the tropics

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Since the first phase of the paleoclimate modeling intercomparison in 1991 the relative role of the insolation forcing and of feedbacks from ocean, vegetation or dust is at the forefront of scientific questions. New questions concern also the linkages between the long term Holocene trends and changes in interannual variability that appears to be lower than present over most of the Holocene. The presentation will propose a rapid overview of PMIP mid-Holocene and transient simulations with a focus on monsoon and ENSO. It will highlight current successes and limitations in climate experiments and new modeling possibilities that justify the experiments proposed as part of the 4th phase of PMIP, considering mid-Holocene snap shot experiments for CMIP, as well as transient Holocene simulations. A particular focus will be put on changes in seasonality, considering how these changes in forcing and feedbacks affect interhemispheric heat and moisture fluxes, some of the teleconnections driving precipitation variability in the west Pacific and monsoon regions, and rapid changes.

ID: 01629, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Invited Oral)

Astronomical and CO2 controls on the interglacial climates of the last 800,000 years

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The climate of nine interglacials of the past 800,000 years was simulated with both snapshot and transient experiments using the models LOVECLIM and HadCM3. These simulations allow to investigate the relative contributions of insolation and CO2 to the intensity and duration of each interglacial as well as the differences between the interglacials at global and regional scales. The transient simulations cover a full range of precession, obliquity and eccentricity and we focused specifically on the response of different climate variables at different latitudes.

The results show that the relative contribution of insolation and CO2 on the warmth intensity varies from one interglacial to the next. CO2 controls the response of global annual mean temperature, southern high latitude temperature and sea ice, while the astronomical forcing controls variations of monsoon precipitation, vegetation and of the northern high latitude temperature and sea ice.

The results also show that, compared to today, the past interglacials are warmer during boreal summer and cooler during boreal winter leading to a warmer annual mean with varying length for different interglacials. The warm interval of MIS-11 is the longest, confirming its long duration as found in proxy records. The long duration of MIS-11 is related to a particular combination of eccentricity, obliquity and precession as well as to a high CO2 concentration. However, based on the analysis of the seasonal and annual distributions of temperature MIS-19 stands out as the best analogue of MIS-1 and its natural near future.

ID: 01430, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Speleothem stable isotopes reconstruction of the effects of meridional shifts in atmospheric pressure systems on South African rainfall and vegetation

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South African climate is characterized by the alternating influences of westerlies that mainly bring rainfall to the southwest during winter and the interactions of tropical low pressure systems with the westerly low pressure belt, which cause rainfall across the north, east, and interior during summer. A narrow area between these two regions receives rainfall from both influences throughout the year. High growth season temperatures favor C4 grasses in areas with summer rainfall, whereas C3 plants dominate the winter rainfall region. In the year-round rainfall region, vegetation composition gradually changes with C3 plants dominating the west and C4 grasses being more common in the east.

This study presents a paleoclimate analysis of $\delta^{18}O$ and $\delta^{13}C$ values of speleothems from Pinnacle Point in the year-round rainfall region, covering the time interval between ~330 and ~40 ka. Changes in $\delta^{18}O$ and $\delta^{13}C$ values are indicative of long-term variations in vegetation and rainfall seasonality. The $\delta^{18}O$ variations mostly follow present-day patterns: low values are associated with a southward shift of the westerlies, which restricts their influence to the winter months; higher $\delta^{18}O$ values are reached during summer when a northern position allows for frequent interactions between temperate westerly lows and tropical lows. $\delta^{13}C$ values vary in phase with southern hemisphere temperatures, thus favoring increased abundances of C4 grasses during warm phases and dominance of C3 plants during cold intervals. Deviation from this pattern is found between 75 and 60 ka, whereby high $\delta^{18}O$ values suggest that there is good connectivity between the temperate and tropical pressure systems, and a relative increase of summer rainfall on the South African south coast. Thus, despite the general cool global conditions during MIS 4, temperatures in the Pinnacle Point region remained high during the main growth season, and supported C4 grasses.

ID: 01366, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Climate dynamic of Terminations 2 and 3 in East Antarctica as inferred from the combination of water and air isotopes in Dome C and Vostok ice cores

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Ice cores are important tools to decipher the influence of different forcing on climate evolution. They are particularly adapted to depict the past variations of polar temperature and greenhouse gases. Indeed, the water isotope composition of the ice is often taken as a reference to provide a continuous and high-resolution local temperature record.

Terminations 2 and 3 are the fastest terminations of the last 800 kyrs. The only deep polar ice cores enabling description of Terminations 2 and 3 are located on the East Antarctic plateau. Still this region is characterized by very low temperature and accumulation rate (even lower during glacial periods) and climatic reconstructions from water isotopes are questioned in these regions because of strong post-deposition effects. Isotopes of inert gases trapped in ice cores are a complementary tool to document past evolution of accumulation and temperature. Indeed, $\delta^{15}N$ and $\delta^{40}Ar$ of air trapped in ice cores directly reflect the dynamic of past firn depth, itself related to surface climatic parameters through firn densification processes.

Here we provide new high resolution measurements of $\delta^{15}N$ and $\delta^{40}Ar$ over Terminations 2 and 3 on the EPICA Dome C and Vostok ice cores. While the water isotopic profiles show very similar increases over the two studied Terminations at Vostok and Dome C, air isotopes show a much smaller increase at Vostok than at Dome C. The measurements of air isotopes also permit to clearly document a 2 step temperature or accumulation rate increase over Termination 3 and over the last phase of Marine Isotopic Stage 6, an evolution that is not obvious from the water isotope profiles.

ID: 01747, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Could Humans have delayed the collapse of the African Humid Period?

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During the early Holocene, northern Africa was relatively humid and supported a large human population. Around 5,500 years ago (ka) the regional climate deteriorated and the population declined significantly. Evidence suggests these changes were coeval, but it is unclear whether or not humans influenced this ecological collapse. Using an idealised model, we forecast the length of the Holocene African Humid Period (AHP). The model shows that the end of the Holocene AHP had a low predictability in comparison with previous interglacials. It also indicates that the system was most likely to collapse between 7-6 ka, which is at least 500 years before the observed collapse. The shift from hunter-gatherer to pastoralist human societies around 7 ka may have acted to slow the regional environmental deterioration caused by orbitally-driven climate change; thus delaying the end of the most recent Humid Period. This supports the new emerging view that modern pastoralists are essential to the management of the world's dryland environments.

ID: 02068, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Fire dynamics over the last glacial cycle in South Africa

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Responses of fire activity to changes in climate are still uncertain. Biases exist by integrating this non-linear process into global modelling of the Earth system. Warming and regional drying can force fire activity in two opposite directions: an increase in fire in fuel-supported ecosystems or a fire reduction in fuel-limited ecosystems. Therefore, climate variables alone cannot be used to estimate the fire risk because vegetation variability is an important determinant of fire dynamics and responds itself to change in climate.

Southern Africa (south of 20°S) paleofire history reconstruction obtained from the analysis of microcharcoal preserved in a deep-sea core located off Namibia reveals changes of fire activity on orbital timescales in the precession band. In particular, increase in fire is observed during glacial periods, and reduction of fire during interglacials such as the Eemian and the Holocene. The Holocene was characterized by even lower level of fire activity than Eemian. Those results suggest the alternance of grass-fuelled fires during glacials driven by increase in moisture and the development of limited fuelled ecosystems during interglacial characterized by dryness. Those results question the simulated increase in the fire risk probability projected for this region under a warming and drying climate obtained by Pechony and Schindell (2010).

To get better understanding of fire variability in South Africa we compare data of a deep sea record to model results obtained by JSBACH - the land component of the Max Planck Institute Earth System Model. Fire dynamics over the last 130.000 years is simulated in an offline mode. Climate data like precipitation and temperature as well as vegetation data like soil moisture, productivity (NPP) on plant functional type level are used to explain trends and variability of fire activity over the last glacial cycle - which is driven by vegetation and climate, while vegetation itself is coupled to fire.

ID: 01658, 18.- Human Impact on Global Aquatic Systems, (Oral)

Operational assessment of regime shifts: application to the long-term ecological trajectory of a hollow lake under multiple forcings

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Large, abrupt and persistent changes have been observed in various ecosystems, and many have been referred to as regime shifts despite any explicit consideration of underlying drivers and dynamics. However, alternative mechanisms, including combination of new drivers, high environmental stochasticity, or persistence of the principal driving force, can cause abrupt changes in ecosystem states and mimic hysteresis, in absence of any regime shift. It is yet crucial, because of their serious implications on management targets, to operationally assess the actual frequency and occurrence of true regime shifts. In such purposes, we focused on the paleo-ecological trajectory of Lake Varese, a deep, hyper-eutrophicated peri-alpine lake that experienced three transitions over the last century. We combined ordination methods, changepoint analysis and general additive models, to test whether, or not, these transitions were true regime shifts triggering hysteresis. Only one transition could be qualified, based on its dynamics and the underlying drivers, as a nutrient-driven regime shift. Despite low macrophyte coverage for this hollow lake, vegetation might have had a stabilizing effect in the first stages of eutrophication and the shift was preceded by an increase in autocorrelation and variance more than two decades before. Since then, the lake trajectory has been evolving around this disturbed attractor. The most recent transition, despite sudden, was driven by current warming to which pelagic habitats have been more sensitive than littoral ones. Instead of triggering a new regime shift, climate warming has driven the lake further from its safe operating space.

ID: 01944, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

From mud to map: reconstructing Neolithic land cover dynamics at a regional scale from pollen records

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Environmental reconstructions from pollen records collected within archaeological landscapes have traditionally taken a broadly narrative approach. Pollen diagrams are interpreted in the form of a series of descriptions of changing land cover, drawing on ecological and archaeological understandings, with few attempts made at hypothesis testing or formal assessment of uncertainty. The Multiple Scenario Approach (MSA) offers a radically different way to use pollen data to reconstruct past land cover. Using ecological, topographic, geological and archaeological constraints within a GIS to produce a large number of hypothetical landscapes, the MSA simulates the pollen signal of each of these alternates then compares it statistically with an actual pollen record to identify which are possible reconstructions.As part of the ERC funded *Times of Their Lives* project, extant pollen datasets have been collated, age-depth models refined, and the Multiple Scenario Approach (MSA) to land cover reconstruction applied to create maps of possible past vegetation mosaics in two key areas of Neolithic activity in the British Isles, the Somerset Levels and Moors and the Heart of Neolithic Orkney World Heritage Site for key time slices. Analysis of these reconstructions allows us to consider the extent to which activity within and around the wetlands and in the surrounding hills might be expected to be detectable in pollen records, and to provide a context for improved understanding of the cultural reshaping of these iconic landscapes during the Neolithic.

ID: 02279, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

High-resolution sulfur isotopes in ice cores identify large stratospheric eruptions

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The record of the volcanic forcing of climate over the past 2500 years is reconstructed primarily from sulfate concentrations in ice cores. Of particular interest are stratospheric eruptions, as these afford sulfate aerosols the longest residence time and largest dispersion in the atmosphere, and thus the greatest impact on radiative forcing. Identification of stratospheric eruptions currently relies on the successful matching of the same

volcanic sulfate peak in ice cores from both the Northern and Southern hemispheres (a “bipolar event”). These are interpreted to reflect the global distribution of sulfur aerosols by the stratospheric winds. Despite its recent success, this method relies on precise and accurate dating of ice cores, in order to distinguish between a true ‘bipolar event’ and two separate eruptions that occurred in close temporal succession.

Sulfur isotopes can been used to distinguish between these two scenarios since stratospheric sulfur aerosols are exposed to UV radiation which imparts a mass independent fractionation (Baroni et al., 2007). Mass independent fractionation of sulfate in ice cores thus offers a novel method of fingerprinting stratospheric eruptions, and thus refining the historic record of explosive volcanism and its forcing of climate. Here we present new high-resolution (sub-annual) sulfur isotope data from the Tunu Ice core in Greenland over seven eruptions. Sulfur isotopes were measured by MC-ICP-MS, which substantially reduces sample size requirements and allows high temporal resolution from a single ice core. We demonstrate the efficacy of the method on recent, well-known eruptions (including Pinatubo and Katmai/Novarupta), and then apply it to unidentified sulfate peaks, allowing us to identify new stratospheric eruptions and distinguish between stratospheric and tropospheric sulphate.

Baroni, M., Thiemens, M. H., Delmas, R. J., & Savarino, J. (2007). Mass-independent sulfur isotopic compositions in stratospheric volcanic eruptions. *Science*, *315*(5808), 84–87. http://doi.org/10.1126/science.1131754

ID: 01879, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Wetter subtropics in a warmer world

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During the warm Miocene and Pliocene epochs, vast subtropical regions had enough precipitation to support rich vegetation and fauna. Only with global cooling and the onset of glacial cycles some 3 million years ago, towards the end of the Pliocene epoch, do the broad patterns of arid and semi-arid subtropical regions appear to have become fully established. However, current projections of future global warming caused by CO_2 rise suggest the intensification of such dry conditions over subtropical regions, rather than the return to a wetter state. What makes future projections so different from these past warm climates? Here, we investigate this question by comparing a typical quadrupling-of-CO_2 experiment with a simulation that closely reproduces available sea surface temperature reconstructions for the early Pliocene. Based on these two experiments, as well as a broad suite of perturbed coupled climate simulations, we argue that this puzzle can be explained by weaker atmospheric circulation in response to the different ocean surface temperature patterns of the Pliocene, specifically reduced meridional temperature gradients that required different cloud radiative forcing to be sustained. When predicting the response of the hydrological cycle within the subtropics under global warming, the warm Pliocene highlights the importance of not only predicting how global mean temperature responds to elevated CO_2 forcing (climate sensitivity) but also correctly quantifying how meridional SST patterns will change (structural climate sensitivity).

ID: 01771, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Fire in Tasmania’s endemic rainforests; recovery governed by frequency and topography

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Tasmania\'s montane temperate rainforests (MTR) contain some of Australia\'s most ancient and endemic flora, relicts from the forests that once covered the Gondwanan supercontinent. Recent landscape-scale fires have impacted a significant portion of these now restricted rainforest ecosystems. Fire facilitates the colonisation of fire-adapted species (e.g. *Eucalyptus)* into areas occupied by fire-sensitive rainforest. The complex and rugged topography of Tasmania results in a highly variable influence of fire across the landscape, rendering predictions of the landscape response to fire difficult. Highly-productive temperate ecosystems (e.g. western Tasmania) are predicted to experience an increase in fire activity driven by changing climates, raising questions about the role of fire in the ecology of these MTR ecosystems and their ability to recover from fire. This study employs charcoal, pollen and geochemical analyses from the sediments of Lake Perry, southern Tasmania, to examine how fires have influenced vegetation structure and soil dynamics in MTR ecosystems over the past 15,000 years. Infrequent fires throughout the Holocene triggered a negative response in rainforest plant taxa, yet MTR persisted at the site until ca.200 cal. yr BP. Critically, the site is located 400 m north of another study site, where repeated fires between 6500-3000 years ago resulted in a transformation from MTR to fire-adapted *Eucalyptus* forest. Topographical fire refugia within the Lake Perry catchment may have provided protection for fire-sensitive MTR species to persist. Slowing recovery of an ecosystem following disturbance has been implicated as an early warning signal for transitions between alternate stable states. The MTR taxa Cupressaceae displays a slowing down of recovery and eroded resilience after recurrent fire events. The legacy of Holocene fire eroding the resilience of MTR and the predicted increase in fire activity in highly-productive ecosystems places these systems across western Tasmania under serious threat into the future.

ID: 01587, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

New insights into the anatomy of abrupt climate changes based on high-resolution records from the Greenland NEEM and NorthGRIP ice cores

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The millennial-scale succession of Greenland Stadials (GS) and Greenland Interstadials (GI) illustrates the Greenland expression of the well-known sequence of Dansgaard-Oeschger (DO) events, within which we observe additional climate variations of decadal-to-centennial-scale duration. Various paradigms, mostly based on interactions between the cryosphere and the ocean, are proposed to explain the existence and evolution of DO events. Annual-to-decadal scale records of environmental and climatic regional changes over the rapid transitions are needed to assess whether climate model outputs based on a particular mechanism are consistent with the observed spatial pattern and temporal phasing.

We present new multiannual-scale stable water isotope measurements (ice $\delta^{18}O$ and δD) and annually-resolved ion chemistry records from the NorthGRIP and NEEM ice cores. Because these tracers imprint the signatures of different parts of the Northern Hemisphere climate system, we can map the anatomy – the spatial and temporal signature – of climate and environmental changes associated with abrupt transitions (from GS to GI and vice-versa) occurring during Marine Isotopic Stage (MIS) 4. We apply a statistical approach to determine the timing and duration of the transitions, along with the amplitude of the local and regional changes associated with each Greenland warming and cooling phase. We quantify similarities and differences in the sequences of events through a comparison with results obtained over MIS 3.

Variability in the expression of the events and methodological uncertainties prevent us from identifying systematic differences in the relative timing between the different tracers across the set of GI-GS and GS-GI transitions. However, we identify clear differences in the duration of the transition in the different tracers. We discuss the implications of our results in terms of the involved mechanisms and in particular, the possible influence of (1) the Heinrich Events and of (2) the long-term evolution of the climate system on the abrupt climate variability.

ID: 01557, 01.- Open Session on past global changes, (Oral)

Past vegetation changes in the context of land use and late Holocene expansion of the Jê pre-Columbian culture in Southern Brazil

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Palaeoecological research can provide important insights into the impacts of humans vs climate change upon ecosystems in the past, which can inform land-use and conservation planning. Our international project aims to reveal past dynamics of the iconic *Araucaria* forest in the context of land use by the pre-Columbian Jê culture in southern Brazil over the last c. 2000 years. Our palaeoecological research is based on three bog cores collected within archaeological sites representing different land uses associated with the mixed-economy Jê culture. We use modern and fossil pollen, charcoal, isotopes and geochemical analysis of the sediments to reconstruct vegetation, fire, land-use histories, as well as past agricultural practices at the sites. We also integrate this information with local archaeological and independent palaeoclimatic data to understand the relationship with climate change. Our results show varied vegetation development within the same region that seems to be related to the type of land-use. For example, we find that *Araucaria* forest expansion occurred at habitation sites but not at funerary sites. Where we do observe *Araucaria* forest expansion, it was less pronounced than the previously recorded, interpreted as climate-driven, regional-scale *Araucaria* expansion ca.

2000 yr BP. Our study therefore suggests that pre-Columbian human land-use had significant and diverse impacts on *Araucaria* forest at the local scale – through ritual practices, habitation and agriculture – nested within a long-term, regional scale trend of *Araucaria* expansion. This expansion of the forest correlates in part to the increasing rainfall, as revealed by comparison with previously published speleothem data. This case study reveals complex human-vegetation-climate dynamics, and provides key information about baseline ecological conditions relevant for conservation policy and land-use planning.

ID: 01301, 06.- Before and after - climate contrasts across the MPT, (Oral)

Pleistocene CO2 change and the MPT, from boron isotopes

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During the Mid-Pleistocene Transition (MPT; 1200–800 thousand years ago, kyrs) Earth's orbitally paced ice-age cycles intensified, lengthened from ~40 to ~100 kyrs, and became distinctly asymmetrical. Testing hypotheses that implicate changing atmospheric CO_2 levels as a driver of the MPT has proven difficult with available observations. Here we use orbitally resolved, boron-isotope CO_2 data to demonstrate that the glacial-to-interglacial CO_2 difference increased from ~43 to ~75 ppm across the MPT, mainly due to lower CO_2 levels during glacials. We observe a two-fold steepening of the relationship between sea level and CO_2-related climate forcing that is suggestive of a change in the dynamics that govern ice-sheet stability, such as that expected from the removal of subglacial regolith. We argue that neither ice-sheet dynamics nor CO_2 change in isolation can explain the MPT and that it marked a fundamental change to internal forcing. We also examine the MPT within the context of multiple lower resolution records of Pleistocene CO_2 and temperature.

ID: 02061, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Oral)

Mid-Pliocene winter temperature pattern not unlike that of recent decades: causes and implications for the 21st century

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Observations for boreal winter temperatures over recent decades show that the warming trend over the Arctic has been accompanied by a cooling trend over the surrounding continents, driven by more frequent outbreaks of extreme cold weather. This pattern has been coined "Warm Arctic, Cold Continents" and the principle causes for it remains uncertain although Arctic amplification has been argued to be significantly involved. The question as to whether should be interpreted as a transient response, or as the new steady state characteristic of the warming world is a more uncertain question. We have recently completed many thousands of years of mid-Pliocene simulations and find that the pattern of the climatological boreal winter temperature anomaly relative to modern bears a striking resemblance to the observed modern temperature trends. Prevalence of cooler temperatures over land, compared to Arctic is clearly seen in the anomaly compared to modern, despite both modern and mid-Pliocene having identical atmospheric CO2. This is the first time this pattern has been observed for the mid-Pliocene; indeed, none of the PlioMIP1 simulations show any such cooling. Are the results for the mid-Pliocene suggesting that the recently observed cooling trend over land is not just a transient feature? Because the mid-Pliocene and present share some similarity while also having important differences, the mid-Pliocene is well suited to assisting us to understand the mechanisms behind the observed present-day temperature trends and to help us understand whether the trends should be expected to persist into the future. We investigate these mechanisms using the full suite of PlioMIP2 core, and PlioMIP2 tier 2 sensitivity simulations as well as mid-Pliocene simulations that we have performed using an alternate set of boundary conditions which have been developed by ourselves.

ID: 01314, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

A combined archaeological and paleoenvironmental perspective of Holocene human-environment interactions in North America

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The ongoing development of the Comprehensive Archaeological Radiocarbon Database (CARD), the largest online open-access repository of global cultural and paleoenvironmental radiocarbon dates, is revolutionizing the study of human-environment interactions at global and regional scales. In North America alone, more than 30,000 radiocarbon dates currently exist in the CARD, and

many are associated with distinct cultural groups and regional histories. Radiocarbon data are now commonly used as a paleodemographic proxy, and when combined with records of paleofires and vegetation change, they become an invaluable source of information regarding past human-environment interactions. Continental-scale time series analyses of North American radiocarbon data show an exponential increase in population density since the Younger Dryas until the European colonization of the Americas after which population numbers rapidly decline. Similar trends are observed in South America and Australia although time series for other major world regions are more complex. This presentation emphasizes the need for regional-scale time series analyses to enable the understanding of how different population groups influenced the evolution of the North American landscape but also how past regional environments shaped human migration patterns and human-induced land use and land cover change. Preliminary analyses indicate regions can be defined based on cultural areas, cultural periods or traditions, and vegetation abundance and distribution. When dividing the continent based on cultural areas or periods, high frequency fluctuations in population density become apparent. Comparisons between regional demographic curves and paleovegetation records show correlations between human activity and vegetation change. These results confirm the utility of radiocarbon data in the study of human-vegetation-climate dynamics and highlight the potential of using these methods elsewhere in the world.

ID: 02162, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Oral)

Summer temperature and drought co-variability across Europe since 850 CE

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The increasing risk of droughts and floods is a major concern under the ongoing global warming condition. Droughts have severe and persistent negative consequences for agricultural productivity across wide areas. However, state-of-the-art climate models are not consistent in their projections of hydroclimate changes under global warming on regional scales, which hampers attempts at defining long-term mitigation strategies. A better understanding of past summer temperature and hydroclimate (or drought) co-variability will provide valuable empirical information on how increasing/decreasing temperatures will affect summer drought conditions at different time-scales over Europe. For the first time, we assess the spatio-temporal co-variability of summer temperature and summer drought across Europe since 850 CE at inter-annual to centennial time-scales. We both use instrumental data, the new gridded tree-ring-derived Old World Drought Atlas by Cook et al. (2015) and the gridded European summer temperature reconstruction by Luterbacher et al. (2016) as well as two high-resolution last millennium (850–2005 CE) climate simulations (CCSM4 and MPI-ESM-P). This allows us to i) investigate potential changes in dominating patterns of co-variability at different time scales, and ii) assess the accuracy and precision of climate models to simulate summer temperature and summer drought co-variability as found both in 20th century instrumental data and millennium-long tree-ring based climate reconstructions. Furthermore, we investigate and discuss results from cross-spectral analyses of temperature and drought co-variability in time and space over Europe.

ID: 01287, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

The dynamic relationship between temperate and tropical circulation systems across South Africa since the Last Glacial Maximum

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Perhaps the most fundamental and long-standing question of southern African palaeoclimatology is the way variability in the dynamics of tropical and temperate climate systems have influenced rainfall regimes across the subcontinent since the Last Glacial Maximum. In this paper, we analyse a selection of recently published palaeoclimate reconstructions along a southwest-northeast gradient across South Africa that span the last 22,000 years, and encompass the transition between the region's winter and summer rainfall zones. In synthesis, these records confirm broad elements of the dominant paradigm, which proposes an inverse coeval relationship between temperate and tropical systems, with increased precipitation in the winter (summer) rainfall zone during glacial (interglacial) periods. Revealed, however, is a substantially more complex dynamic, with climate change events at sub-orbital timescales being strongly – even predominantly – influenced by the *interaction and combination* of temperate and tropical systems. This synoptic forcing can create same sign anomalies across South Africa, contrary to expectations based on the classic model of phase opposition. These findings suggest a new paradigm for the interpretation of southern African palaeoenvironmental records that moves beyond simple binary or additive influences of these systems.

ID: 01367, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

Temperature range shifts for three European tree species over the last 10,000 years

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We quantified the degree to which the relationship between the geographic distribution of three major European tree species, *Abies alba, Fagus sylvatica* and *Picea abies* and January temperature (Tjan) has remained stable over the past 10,000 years.

We used an extended data-set of fossil pollen records over Europe to reconstruct spatial variation in Tjan values for each 1,000-year time slice between 10,000 and 3,000 years BP (before present). We evaluated the relationships between the occurrences of the three species at each time slice and the spatially interpolated Tjan values, and compared these to their modern temperature ranges. Our results reveal that *Fagus sylvatica* and *Picea abies* experienced Tjan ranges during the Holocene that differ from those of the present, while *Abies alba* occurred over a Tjan range that is comparable to its modern one.

Our data suggest the need for re-evaluation of the assumption of stable climate tolerances at a scale of several thousand years. The temperature range instability in our observed data independently validates similar results based exclusively on modelled Holocene temperatures. Our study complements previous studies that used modelled data by identifying variation in frequencies of occurrence of populations within the limits of suitable climate. However, substantial changes that were observed in the realized thermal niches over the Holocene tend to suggest that predicting future species distributions should not solely be based on modern realized niches, and needs to account for the past variation in the climate variables that drive species ranges.

ID: 01614, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Oral)

Deciphering detrital signatures of precipitation/weathering and wind transport related to the East Asian monsoon fluctuations: multi-proxy study of a long marine sequence from the northern part of the South China Sea

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In the South China Sea, the detrital component of marine sediment is a powerful recorder of paleoenvironmental changes linked to the monsoonal climate strongly controlled by precession. Indeed, based on the knowledge of the sedimentary signature of the potential sources for these terrigenous sediments, the composition of marine sediments can be used to decipher the different mechanisms, forcing, and transport vectors.

We report here the analysis of the magnetic properties, sortable silt and clay mineralogy of a ~51 m long sedimentary sequence retrieved from the northern South China Sea and covering the last 400 ka. Magnetic minerals with different coercivities (magnetite, pyrrhotite and hematite) are mixed. The clay mineralogical results also show variable concentrations in smectite, illite and chlorite, and kaolinite. Hematite content and smectite/(illite+chlorite) ratio present a predominant precession periodicity synchronous with the northern hemisphere summer insolation changes and therefore with that of the East Asian summer monsoon. Events of high hematite content, in phase with finer grains, coincide with precession lows, while smectite/(illite+chlorite) ratio increases during precession highs.

Knowing that smectite is mainly produced by contemporaneous chemical weathering intensity in Luzon, we use the smectite/(illite+chlorite) ratio as a tracer for increasing weathering rate in Luzon, in turn related to enhanced East Asian summer monsoon. Hematite is not produced in large amounts on lands adjacent to the northern part of the South China Sea, and the association of its content with fine-grain marine sediments suggest that the periodic supply in hematite is related to the eolian dusts transported to the studied site. Higher hematite content may therefore be used as a tracer for weak East Asian summer monsoon intensity at this latitude.

ID: 01632, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Oral)

Quantified 45,000 years-long temperature and precipitation reconstructions in southeast Africa

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In terms of our understanding of how southeast African climates have evolved since the last glacial period, a key topic of recent debate has been the extent to which direct precessional insolation forcing (the so-called Orbital Monsoon Hypothesis) and/or other factors such as Indian Ocean sea surface temperatures (SSTs) have driven regional climate change. In this paper, we present data derived from 13 fossil pollen sequences in southeast Africa using a new method based on probability density functions (pdfs) calculated from modern plant-climate relationships. This reanalysis allows for the quantification of a range of distinct climatic variables from this critical region, and provides significant insight into the nature of long-term climate change. Temperature reconstructions show strong coherency among all sites considered, and parallel southwest Indian Ocean SSTs. Reconstructions of the amount, annual distribution and effectiveness of precipitation since mid-MIS 3 indicate a dichotomy in the precipitation pattern between interior and eastern South African sites. At the millennial timescale, precipitation in eastern sites shows strong similarities with the Indian Ocean SST records as well as with records from the large East African lakes. Interior sites, while clearly being influenced by SSTs, also appear to be sensitive to additional factors, including the position of the southern westerlies, which interacts with tropical systems to create tropical-temperate troughs. Our results shed light on the complexity of the mechanisms driving South African rainfall and the heterogeneity of the 'summer rainfall zone', and clarify several key elements of the current debate, including limitations of models relying on direct insolation forcing to explain long-term climate dynamics. Finally, our reconstructions of annual aridity from the same records will shed light on the absolute necessity to differentiate between aridity and rainfall proxies when performing data-model comparisons.

ID: 01980, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Oral)

Polar Ural Mountains: A surprisingly rich flora for the past 25,000 years

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Understanding the response and resilience of the Arctic flora to past environmental change is an essential component informing ecosystem models and anticipating how plant communities may respond to future climate change. Reconstructing Arctic vegetation histories has often proved challenging due to poor taxonomic resolution and often low concentrations of pollen and/ or macrofossils preserved within Arctic lake sediments. Metabarcoding of sedimentary aDNA (*seda*DNA) is a promising tool for reconstructing past changes in vegetation and species diversity. Here, we present a *seda*DNA record of vegetation change over the past 25,000 years from Bolshoi Schuchye, a lake situated within the northernmost Polar Ural Mountains, Arctic Russia. Cosmogenic exposure dates suggest that the region remained largely ice-free during the Last Glacial Maximum (LGM), with the exception of small valley glaciers (Mangerud *et al,* 2008). The Polar Urals may therefore hold important explanations for glacial persistence and the apparently rapid dispersal of the Arctic flora at the end of the last glacial.

In total, *seda*DNA detected 167 plant taxa throughout the 24m lake sediment record. The full-glacial period is characterised as a dry Arctic tundra or polar-desert environment with a dominance of grasses such as *Puccinellia* and herbs such as *Papaver.* The Younger Dryas is seen in all geochemical proxies and a rapid decline in the s*eda*DNA of *Betula,* although this is the only taxon to show a clear response to cooling. Onset of the Holocene is marked by a rise in herbs such as *Oxyria, Pyrola* and *Alchemilla,* followed by a mixed *Picea-Larix-Betula* forest from 9500cal yrs BP. This hypsithermal phase lasted until 4800-3500cal yrs BP, after which mixed forests withdrew and allowed expansion of diverse dwarf-shrub, herb tundra. The results demonstrate a surprisingly rich flora which has shown remarkable resilience in the presence of changing environmental conditions over the past 25,000 years.

ID: 02320, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Oral)

Paleoclimate constraints on the spatio-temporal character of past and future drought in climate models

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Drought is a spatio-temporal phenomenon; however, due to limitations of traditional statistical techniques it is often analyzed solely temporally—for instance, by taking

the hydroclimate average over a spatial area to produce a timeseries. Herein, we use machine learning based Markov Random Field methods that identify drought in three-dimensional space-time. Critically, the joint space-time character of this technique allows, for the first time, both the temporal and spatial scales of drought to be analyzed. We apply these methods to climate model output from the Coupled Model Intercomparison Project phase 5 and tree-ring based reconstructions of hydroclimate over the full Northern Hemisphere for the past 1000 years. Analyzing reconstructed and simulated drought in this context provides a paleoclimate constraint on the spatio-temporal character of past and future droughts, with some surprising and important insights into future drought projections. Climate models, for instance, suggest large increases in the severity and length of future droughts but little change in their width (latitudinal and longitudinal extent). These models, however, exhibit biases in the mean width of drought over large parts of the Northern Hemisphere, which may undermine their usefulness for future projections. Despite these limitations, and in contrast to previous high profile claims, there are no fundamental differences in the spatio-temporal character of simulated and reconstructed drought during the historical interval (1850-present), with critical implications for our confidence in future projections derived from climate models.

ID: 02026, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Low latitude iceberg scours record massive deglacial outburst floods

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Outburst floods from proglacial lakes in North America have frequently been associated with a slow-down of the Atlantic meridional overturning circulation (AMOC) during deglaciation. Reconciling the magnitude of these floods is vital for quantifying the sensitivity of the AMOC to future changes in high-latitude freshwater forcing. Here, we use a high-resolution iceberg model to show that outburst floods from Hudson Bay would have transported thousands of icebergs from the subpolar North Atlantic to lower latitudes (30°N-40°N), including Bermuda Rise and the Azores, while the largest floods would have carried icebergs southwards through Florida Strait to the Gulf of Mexico. Seafloor scour marks simulated in our model by allowing grounded icebergs to plow through marine sediments correspond closely to previously identified scours along the U.S. continental margin that are found south of Cape Hatteras. Our results provide conclusive evidence that massive outburst floods from proglacial lakes would have significantly freshened the entire North Atlantic during deglaciation. Finally, we suggest that searching for iceberg scours along the continental margins of South America could provide an important new record of past fluctuations in Antarctic Ice Sheet discharge.

ID: 01720, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

A 400-year isotopic record of seabird response to eastern tropical Pacific productivity

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Seabirds play an important role in coastal environments, serving as key indicators of marine ecosystem variability. Long-term estimates of seabird populations remain rare, but lakes that support large seabird populations in their watersheds can archive a history of seabird activity in their sediment records. Here we present a seabird guano-influenced sediment record from Genovesa Crater Lake, Galápagos Islands, home to the world’s largest reported colony of red-footed boobies (*Sula sula*) and smaller populations of other species. Influx of seabird guano into Genovesa Crater Lake produces high sedimentary $\delta^{15}N$ values, and temporal variability in sediment $\delta^{15}N$ primarily reflects changes in guano influx through time. Two abrupt increases in sedimentary $\delta^{15}N$ occurred at 1835 AD and 1965 CE, and variance increased following the 1965 CE shift. The largest of these abrupt shifts at 1835 CE coincided, within age model error, with an abrupt increase in marine productivity indicators in sediment records off the coast of Perú and Chile. In the latter part of the twentieth century, $\delta^{15}N$ values increased during periods of higher landings of Peruvian anchoveta and sardines. We hypothesize that seabird presence and activity on Genovesa increased during periods of higher regional marine productivity. Enhanced variance in Genovesa $\delta^{15}N$ following the 1965 CE shift may reflect a modern population more susceptible to climate and environmental variability than at any other time in the last 400 years.

ID: 01681, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

On the frequency, seasonality and atmospheric drivers of Late Holocene heavy rainfall in Western Mediterranean

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Lake Montcortès is a small (0.14 km^2 surface area, 30 m deep) karstic lake located in the eastern Pre-Pyrenees (NE Spain). The permanent anoxic hypolimnetic conditions in this lake have favored the preservation of finely annually laminated sediments in central-distal areas of the lake basin for the last three millennia. Flood-related detrital layers are interbedded within this varve record. Annual number of these detrital layers was compared against instrumental records of extreme daily rainfalls (HR) (available since 1917) providing minimum rainfall thresholds and return periods associated to the occurrence of these detrital layers. The frequency variability of these floods allowed us to quantify temporal changes in HR events for the last 2,800 years in this region and their correlation with negative phases of the Mediterranean Oscillation (MO). Notably, scarce HR dominated by a persistent positive MO mode characterizes the so-called Migration period (CE 370-670). Large hydroclimatic variability, particularly between CE 1012 and 1164, singles out the Medieval Climatic Anomaly, whereas stationary flood conditions between CE 1537 and 1805 characterize the Little Ice Age. This exceptional paleohydrological record highlights that the present-day trend towards strengthened hydrological deficit and less HR in the western Mediterranean is neither acute nor unusual in the context of Late Holocene hydrometeorological variability at centennial to decadal time scales.

ID: 01774, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Widespread speleothem evidence for the synchronous timing of millennial-scale climate events

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Speleothems are a key tool for improving our understanding of abrupt climate changes associated with last glacial millennial-scale climate events. Precise and accurate uranium-thorium dating enables extremely high-resolution and precisely constrained chronologies of the events to be assembled. The wide geographic distribution of speleothems permits the expression of the events in various climate regions to be discerned. Numerous speleothem records have been published, yet until now, the incidence, timing or expression of millennial-scale climate events in these records has not been rigorously compared.

Here we compare the timing of the onset of interstadial conditions in over 50 speleothem records. To correct for potential inconsistencies between data sets, all records were standardised by recalculating the uranium-thorium ages using the latest decay constants and performing an optimal correction for detrital thorium. Additionally, depth-age relationships were remodelled using a Bayesian Monte Carlo based age-modelling technique to produce a revised chronology for each record. The onset of interstadial conditions were identified in an identical manner to their official definition in the NGRIP record. Statistical methods were then employed to compare the timing of the events between records.The results of this work indicate that the majority of interstadial events occur synchronously in speleothem records from Asia, Europe and South America. The few records that exist from Australasia or southern Africa do not exhibit a clear Greenland-like signal. Such generally synchronous timing implies a very rapid propagation of the events between multiple climatic regions, suggesting a strong atmospheric influence. The demonstrated ability of speleothems to precisely record these events reinforces the strength of speleothems as archives of abrupt climate change. In addition, it highlights the potential to obtain precise speleothem ages that can be used to anchor the Greenland ice-core record in radiometric time and thereby improve the chronological precision of millennial-scale climate events.

ID: 01997, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Evidence for a Holocene Climatic Optimum in the Southwest Pacific: a multiproxy study

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According to recent global compilations, the mid-latitudes (30-60°S) of the Southern Hemisphere experienced an early Holocene peak in surface temperatures, which were on average 1°C warmer than present between 11-7 ka. In the southwest Pacific the sparse published data for the early Holocene show sea surface temperature up to 3°C above present, but the timing of peak warmth appears to have varied across the region.

This new study samples a latitudinal transect of southwest Pacific sediment cores from 37-60°S across the early to middle Holocene, from subtropical waters north of New Zealand to polar waters in the Southern Ocean. Using a range of paleo-proxy data, we reconstruct the circulation and position of the main frontal systems in the southwest Pacific and Southern Ocean during the early-mid Holocene.

Our results show the early Holocene was characterised by a small warming at core sites south of the Subtropical Front. Our preferred model is for a broader, more diffuse, Subtropical Front zone waters south of New Zealand, and reduced flow of Subantarctic Surface water across the Pukaki Saddle into the Bounty Trough during this early Holocene interval. This was most likely driven by weaker westerly winds in this part of the Southern Ocean during the early Holocene, compared to the middle Holocene. An analysis of the paleo-SST data collated in this project using the Past Interpretation of Climate Tool (PICT) supports this model.

ID: 02239, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Oral)

“Mega” Green Sahara Periods? Evidence for and drivers of prolonged intervals of North African humidity in the Late Pliocene and Early Pleistocene

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The climate of North Africa during the late Neogene was punctuated by numerous “Green Sahara” periods (GSPs) when much of the region was well vegetated and cross-cut by a network of rivers and lakes. GSPs are thought to be driven by increased monsoonal precipitation during times of high summer insolation and may have played a role in the migration and evolution of hominids. ODP Site 659, located on the Cape Verde Rise, has been shown to preserve an excellent record of terrigenous input from North Africa, allowing continuous, multi-million year reconstructions of continental climate evolution. Here we present new high-resolution proxy records of dust accumulation and provenance (derived from XRF core scan data and radiogenic isotopes) coupled with multi-species foraminiferal stable isotopes to reconstruct surface ocean properties, using a 200 m-long revised Site 659 composite section extending back to 11 Ma. Our data show that strong orbitally forced alternations between humid GSP climate states and arid climate states with significant dust export persist back to the late Miocene. Most GSPs have an estimated duration of ~10 kyr. Our records, however, also indicate the presence of three unusually prolonged humid intervals or “Mega Green Sahara Periods” during the late Pliocene/early Pleistocene that correspond to intervals of low amplitude modulation of orbital forcing. During these times, Saharan/Sahelian hydroclimate became ‘stuck’ in a humid state for between 40 and 120 kyr despite intermediate levels of insolation forcing, which may have had important consequences for the evolution and dispersion of early hominids. This hysteresis behaviour implies the operation of strong positive feedback effects, possibly associated with soil moisture and vegetation.

ID: 01865, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

Abies alba in the Pyrenees: paleoenvironmental and high spatial precision studies to understand past and current distribution

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ID: 01579, 01.- Open Session on past global changes, (Oral)

Hadley Circulation extent and width in a wide range of simulated climates

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Understanding the Hadley Circulation (HC) response to global warming is crucial because it determines climatic features such as the seasonal migration of the ITCZ, the extent of subtropical arid regions, and the strength of the monsoons. In this study, we analyse the extent and the strength of the Hadley Circulation (HC) in a wide range of climate conditions covering simulations of the Last Glacial Maximum, Mid-Holocene, Pre-Industrial, the 20th century and RCP4.5 and 8.5 global warming scenarios. Including paleoclimate simulations allow us to investigate substantially larger signal than that considered in previous studies, making our results robust. Changes in the extent and strength of the southern and northern hemisphere HC are associated with changes in global-mean sea surface temperature, tropical tropopause height, subtropical static stability and meridional temperature gradient. Most changes in HC extent and strength are primarily related to the subtropical static stability, which correlates with global-mean surface temperature. Changes in the meridional temperature gradient play a less important, but not negligible role, especially in the northern hemisphere and during the Mid-Holocene. The large spread across models, in particular in the Last Glacial Maximum and RCP8.5 simulations, prevent reaching clear conclusions for the strength of the HC in the southern hemisphere winter. The multivariate regression model, built using as predictors the meridional temperature contrast, the subtropical static stability and the tropical tropopause height cannot explain about 40% and 95% of the total variance of northern HC edge and southern HC strength, leading us to argue that the theory describing HC changes is still lacking.

ID: 02007, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Comparing climatic variabilities and intensities of Quaternary Interglacials using stable isotopes in NW European calcareous tufa deposits from MIS11, MIS5 and the Holocene

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Calcareous tufas are key-deposits for palaeoclimatic reconstructions of interglacials, since they are characteristic of temperate periods and result of calcite precipitation from meteogene water. At decade scale sampling resolution, variations in the $\delta^{18}O$ of tufa calcite record variations in the $\delta^{18}O$ of regional rainfalls, depending on source or amount effects and on air temperature. Variations in the $\delta^{13}C$ indicate changes of ambient moisture (linked to biomass type/abundance) and rainfall amount.

Using our data from sites assigned to MIS11, MIS5 and the Holocene, from France, England and Luxembourg, we investigate similarities or differences between these interglacials. While warm and wet optima are clearly identified during MIS11 and MIS 5e, Holocene records have a distinct pattern. Diachronic comparisons show similar to slightly warmer conditions during MIS5e compared to the Holocene, while MIS11 interglacial appears clearly warmer. Both MIS5e and MIS11 were wetter than the Holocene, especially when comparing optima. In terms of amplitude, ambient moisture recorded during MIS5e shows little variations compared to MIS11 and the Holocene. These differences may have affected continental species distribution as observed in mollusc expansion and diversity.

ID: 01803, 26.- Data Stewardship for Paleoscience, (Oral)

“Save our Marine Annually-resolved Proxy Archives”

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Marine annually-resolved proxy archives (MARPA), including corals, mollusks, coralline algae, sclerosponges, varved sediments, etc., are critical sources of paleoclimate information. From this ever-increasing array of natural archives, the paleoclimate research endeavor has produced a critical mass of data. Those data are not only used within the paleoclimatology community but also by other communities including statisticians, modelers, data assimilators, anthropologists, ecologists, historians, and policy makers. Conducting more and more data intensive research, on various temporal and spatial scales, requires the ability to efficiently probe large sets of diverse data. This creates a need for improving standards to promote cyberinfrastructure that enables use and reuse of both our physical samples and the data derived from them. As we are moving into the era of big data in paleoclimate research, this is an important time for each geoscience community to stand up and voice their needs for shaping cyberinfrastructure in Earth Sciences. It is therefore critical for the MARPA science community to increase accessibility to data and specimens while creating a lasting legacy for future research. The MARPA project is a grassroots effort by the community, for the community and other users seeking to build consensus on data and sample archiving procedures, working with existing and new data repositories to ensure that the needs of our community are represented.

ID: 01839, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Instabilities of the SAM teleconnection and implications for SAM reconstructions over the past Millennium

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The climate of the different continents in the southern mid- and high latitudes is strongly influenced by large-scale modes of climate variability, such as the Southern Annular Mode (SAM). Climate reconstructions over the last centuries show remarkable differences between these regions, suggesting considerable variability in the strength of teleconnections. Although changing teleconnections can have severe implications for future climate projections, systematic analyses on multi-decadal and longer time scales are largely missing. In addition, non-stable teleconnections are problematic when interpreting paleoclimate data, since most reconstruction techniques are not able to capture teleconnections and climate modes which were not experienced in the calibration period.

The influence of the SAM on regional climates varies across the Southern Hemisphere's (SH) continents. Factors such as tropical variability, changing greenhouse gas concentrations or ozone depletion modulate this influence and modify its temporal stability. We use several different methods such as Kalman Filters and running correlations to assess the stability of SAM teleconnections. Preliminary results based on instrumental and reanalysis datasets show that temporal instabilities are not consistent across the SH land areas. This suggests that the influence of the SAM index is modulated by regional effects in each continent. As a consequence, proxy records from a single sub-domain may not be representative for the commonly used hemispheric SAM index. And above all, reconstructions of the SAM index, based on paleoproxy data from regions where instabilities have been detected, may have larger uncertainties than assumed. However, within key regions of relatively good proxy coverage in South America, Tasmania and New Zealand, the teleconnection is mostly stable over the instrumental period. We use high resolution climate proxies, selected based on the results of the stability analysis to perform updated SAM reconstructions. Temporal discrepancies between our new and existing reconstructions point to changing teleconnection patterns.

ID: 01868, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

Changes in prehistoric forest composition in the Upper Midwestern United States in the last 2000 years

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Terrestrial ecosystems play an important role in Earth systems processes, yet it is not well understand how they respond to changes in climate. While it has been argued that terrestrial ecosystems were fairly stable (by Quaternary standards) in the millennia before major anthropogenic disruption, others have emphasized vegetation response to environmental variability during this time. These competing perspectives are not necessarily in conflict, but argue for a quantitative assessment of forest ecosystem variability over the last several millennia.

Here we reconstruct maps of forest composition for the upper midwestern United States for the last two millenia, with uncertainty. To do this, we use a network of fossil pollen records. We link the fossil pollen records to public land survey forest composition using a Bayesian hierarchical model which accounts for key processes including pollen production and dispersal (Dawson et al., 2016; Paciorek et al., 2009). Model calibration is performed using pre-settlement data, minimizing anthropogenic impacts on the pollen-vegetation relationship. Process parameters estimated during calibration are subsequently used in prediction of relative species composition across the upper Midwestern US over the last 2000 years, with robust uncertainty estimates.

These novel estimates of forest composition and uncertainty improve our understanding of forest change in this region in both space and time. First, we see increases in hemlock composition especially along the western range boundary. Second, we find that the savannah/closed-forest ecotone has remained largely stable. Third, we see the emergence of a distinct forest community known as the Minnesota Big Woods at approximately 500 years before present. These changes are significant in both a statistical and ecological sense, but the scale of these changes is small relative to changes in the early Holocene. The developed spatio-temporal composition estimates are being used to improve the forecasting capabilities of ecosystem models.

ID: 01753, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Palaeolake Mannum – a high-resolution record of Holocene streamflow from the Murray Darling River Basin, and a proxy for Southern Hemisphere hydroclimate

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The 1.07 million km^2 Murray-Darling River Basin (MDB) drains 14% of Australia's landmass and represents one of Australia's most important and contentious environmental management and water security challenges. The Murray and Darling River catchments extend from the sub-tropics to the mid latitudes of eastern Australia (EA), with Basin precipitation driven by distinct synoptic-scale oceanic-atmospheric processes. Current palaeoclimate reconstructions draw heavily upon terrigenous sediment flux to offshore marine archives (MD03-2607, MD03-2611) as a proxy for Basin palaeodischarge and, by implication, EA's hydroclimatic variability.

Here we report the discovery of a laminated deposit at the terminus of the MDB, preserved within a previously unrecognised Holocene palaeolake, which we term Palaeolake Mannum. The deposit reflects the hydrologic regime of a large part of continental Australia, providing the first *in-situ* high-resolution archive of palaeodischarge from the MDB system, from which evidence of synoptic-scale Southern Hemisphere climate forcing may be decomposed.

We suggest that the evolution of Palaeolake Mannum is part of the global geomorphic response of incised-valleys to post-glacial eustatic sea level rise. An abrupt jump in early Holocene sea level in response to Melt Water Pulse 1C has been recorded at the mouth of the world's rivers through accelerated backstepping and rapid aggradation of incised-valley-fill systems, and as sea level stabilised, through worldwide delta initiation. It follows that sequestration of terrigenous sediment within Palaeolake Mannum would have strongly reduced sediment supply to the offshore marine record (MD03-2607, MD03-2611), confounding palaeoclimate reconstructions which draw upon the record to infer Holocene aridity. This discovery has significant implications for the widespread use of terrigenous sedimentation in offshore marine archives as robust records of climatic variability.

ID: 02023, 18.- Human Impact on Global Aquatic Systems, (Oral)

Combining subfossil Chironomidae and Cladocera remains to evaluate the effect of fish introductions on palaeolimnological records in mountain lakes

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Mountain lakes are cold and nutrient-poor ecosystems with scarce buffering capacity which are very sensitive to changes both in air temperature and large-scale nutrient transport. Also, mountain lakes have developed a significant role for the economy of human local populations during the past centuries, particularly in regards to their usage as fish suppliers. As such, not only temperature and nutrient transport, but also fish introductions, may play a significant role in shaping the ecological communities inhabiting mountain lakes. Because fish introductions in previously fishless lakes have been performed for centuries (in some cases dating back to the XIV century), it is interesting to analyse their effects on palaeolimnological records, compared to that of climate and/or nutrient enrichment. This question is relevant to adjust management strategies for mountain lakes, as well as for deciphering the effects of fish, climate, and nutrient loading on palaeolimnological records. Here, we propose the use of subfossil remains (i.e. Chironomidae and Cladocera in combination) to evaluate the effects of fish introductions on the invertebrate communities in lakes. We first evaluated the abundance and size of the ephippia of selected Cladocera species, which may vary in response to fish predation pressure. We then analysed the changes in chironomid communities that could be potentially attributed to fish introductions. We hypothesised that these changes may be triggered directly (i.e. direct predation of fish on larger and more visible chironomids) or indirectly (i.e. caused by fish predation on zooplankton, hence indirectly increasing phytoplankton and subsequently the organic matter content in sediments from in-lake productivity). We accompanied these results with estimates on the organic matter content in sediments (e.g. LOI, C/N) and further stratigraphic analyses. Results are presented for four small lakes in the Pyrenees located in the Haut Vicdessos valley, where fish introductions began during the mid XX century.

ID: 01962, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Short and late Holocene attainment of a full Atlantic Meridional Overturning circulation

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In a recent article Rahmstorf and others (Nature Climate Change 2015) document an "exceptional" reduction of the Atlantic meridional overturning (AMO) during the late 20th century, and link it to enhanced freshwater fluxes from the Greenland Ice Sheet (GIS). At the time scale of glacial/interglacial climatic changes, the production of deep to intermediate Labrador Sea Water (LSW), and thus its contribution to a robust AMO, occurred during few intervals only, in particular the present interglacial. Earlier, we have documented the unlikeness of LSW production during the previous interglacial (Hillaire-Marcel et al., Nature 2001). Here, we show that a modern-like AMO with contributions from subarctic seas, including the Labrador Sea, started quite early during the present interglacial (ca. 7 to 6.5 ka BP) in relation with enhanced penetration of more saline North Atlantic Waters into the basin. However, full production of LSW only occurred after 4 ka BP, when the Greenland ice sheet reached minimum volume (Vinther et al., Nature 2009) and Greenland/Arctic meltwaters export to the Labrador Sea reached minimum values. Therefore, we are tempted to link full LSW formation to the late Holocene "neoglacial" cooling of the northern hemisphere, which culminated during the Little Ice Age, as illustrated by several recent studies (e.g., Kelly & Long, PAGES News 2009; Briner et al., QSR 2016). A positive GIS budget during the late Holocene interval might have been critical for the reduction of GIS meltwater fluxes and the inception of a full AMO. Accordingly, a further weakening of the AMOC linked to enhanced GIS melting rates suggested by Rahmstorf and others might indeed be anticipated.

ID: 01519, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Reconstructing African Hydroclimate since the Last Glacial Maximum via integrated Climate and Proxy System Modeling

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Climate models predict Africa will warm by up to 5°C in the coming century, which will have a measureable impact on hydroclimate and severely stress African societies. Reconstructions of African paleohydrology since the Last Glacial Maximum (LGM) have made fundamental contributions to our understanding of past, present, and future climate and help constrain general circulation models (GCMs). Indeed, paleoclimate archives provide the sole testbed for GCM simulations of climate under different boundary conditions than exist today. However, the confounding effects of proxy system processes complicate our interpretations of past changes in tropical hydroclimate. These proxy-specific uncertainties require robust methodology for data-model comparison.

In this study, we build a new proxy system model (PSM) for paleolimnological proxies to facilitate data-model comparison and to fully characterize uncertainties in climate reconstructions. GCM simulations are then coupled to the PSM to simulate lake temperatures, hydrology, and associated proxy uncertainties. Using this advanced data-model comparison framework, we compare East African lake and air temperatures predicted by our PSM and the PMIP 3 simulations of the LGM, the mid-Holocene (6 kyr BP), and the pre-industrial, as well as single-forcing transient climate simulations (LGM-present) to our reconstructions. In doing so, we test the sensitivity of African climate change to orbital, greenhouse gas, and ice-sheet forcing in single-forcing simulations, and investigate dynamical hypotheses for these changes. The data-model comparison helps evaluate GCM performance and provide dynamically robust interpretations of hydroclimate records during key transitions in African climate. Through this work we provide new insight into the patterns, amplitudes, sensitivity, and mechanisms of African hydroclimate change.

ID: 01758, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Last Interglacial Decadal to Seasonal Temperature Variability in the Tropical Atlantic Warm Pool: Comparison of Model and Coral-Based Reconstructions

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The Last Interglacial (LIG; 117–128 ka), when sea level was ~5 m higher than today, serves as an analog for future climate scenarios yet only a few paleoclimatic reconstructions with seasonal to decadal resolution exist from this interval. Hispaniola is a desirable site for producing sea surface temperature (SST) reconstructions, as it is located in the northern sector of the Atlantic Warm Pool (AWP), a primary moisture source for precipitation in the Americas, and displays significant correlations with SST and precipitation anomalies for much of the tropical North Atlantic Ocean. Here we present an early LIG (128.6 ka) monthly-resolved coral Sr/Ca-SST reconstruction from a well-preserved *Siderastrea siderea* subfossil coral spanning 75 years from the northern coast of Hispaniola (19.913ºN, 70.925ºW). We compare our LIG SST reconstruction with three modern *S. siderea* microatolls, the longest spanning 84 years, recovered near Port-au Prince, Haiti (18.479070°N, 72.668659°W), as well as the CCSM3 125 ka LIG model simulation spanning 300 years. We find similar SST seasonal cycles (3.7ºC) in the LIG coral and simulation that are greater than those in the modern Haitian corals, observed SST, and CCSM3 20th century simulations. This seasonal variability is consistent with the findings of other LIG coral reconstructions in the tropical Atlantic Ocean suggest that orbital insolation changes are driving LIG SST seasonality. Furthermore, our LIG reconstruction reveals larger decadal and interannual variability (2.8 and 3.0ºC, respectively) than the modern SST records and coral reconstructions in the AWP yet similar variability is present in the LIG model simulation. This interannual and decadal variability may reflect variations in the northern extent of the AWP on these time scales, which may covary with trade wind strength, westward moisture transport to the Americas, and precipitation in the Caribbean.

ID: 02027, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Invited Oral)

A high-resolution marine record of vegetation and climate changes from Central Italy during the last five millennia

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The new high-resolution pollen record from marine core SW104_C5-C5**,** collected from the Gulf of Gaeta (Tyrrhenian Sea), provides information on the vegetation and climate changes occurred in the central Mediterranean during the last 5500 years. Our data outlines the effects of human pressure on the vegetation development, as well as oscillations in the forest canopy clearly influenced by climate changes. Between 5500 and 2500 cal. BP, the pollen record indicates that the Gulf of Gaeta borderland was characterized by a *Quercus*-dominated forested landscape. Between 2500 cal. BP and the present day, the coastal territory underwent a general process of forest reduction, related partly to an increase of human pressure on the natural woodlands, and partly to climate changes determined by the combined action of the decrease of summer insolation at the middle latitudes and the well-known cold/dry oscillations of the last two millennia. The forest vegetation development was punctuated by three major phases of forest decline that correspond to Bond events 0, 2 and 3, and suggest clear teleconnections with the North Atlantic climate. During the last two millennia, alternations of short-term warm-wet and cold-dry climatic phases are also documented in the planktonic foraminifers. Between 2000 and 1500 cal. BP, a major development of forest cover coupled with changes in the foraminifera and isotope records point to a warm and

humid phase, as also reported in many sites of southern Europe. In contrast, a major drop of forest cover between 1100 and 900 cal. BP seems linked to local effects of cold/dry climate oscillations during the Middle Age. During the Maünder Minimum, cold winters strongly affected the development of broadleaved tree populations and determined a major sea water cooling. We acknowledge the Project NEXTDATA (http://www.nextdataproject.it).

ID: 01515, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Local accidental fires during the industrialization of northern Poland revealed by fire biomarkers in varved lake sediments

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Fire is an important agent in global biogeochemical cycles by inducing feedbacks between the Earth's surface and the atmosphere, and by altering vegetation patterns. Some biomes are strongly affected by fires, while other areas, e.g. the deciduous temperate forests, are not as fire prone. Furthermore, fire has played a key role in human development. As one of the main tools for anthropogenic land cover change, fire helped to open dense forests and to increase the productivity of soils, e.g. by slash-and-burn practices.

To assess the role of forest fires in land cover change and for human societies during the last 250 years, we investigated multiple fire proxy records preserved in the varved sediments of Lake Czechowskie in the Tuchola forest, northern Poland. We present the first interannually resolved, precisely dated record of the cellulose-burning product levoglucosan and its isomers mannosan and galactosan in organic-rich, seasonally laminated lake sediments. The potential of the new molecular fire proxies is discussed by comparisons with classical records of macroscopic and microscopic sedimentary charcoal as well as with proxies for detrital input, lake productivity and regional vegetation cover. In light of analyses of historical documents and reconstructions of regional climate, we hypothesize that local accidental, low-temperature fires around AD 1850 contributed to major landscape fragmentation and initiated governmentally regulated fire suppression in this area.

ID: 01567, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

A multi-archive, multi-tiered reconstruction of southeastern Australian hydroclimate variability over the past 1200 years

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Hydroclimate variability has profound socioeconomic and environmental impacts in Australia. Therefore, it is important to understand the drivers and variability through time. Recent efforts by the PAGES Aus2k working group have identified a limited number (n=22) of high-quality, non-annually resolved palaeoclimate records covering the Australasian region over the Common Era, the majority of which are hydroclimatically sensitive. Nine of these records are situated in southeast Australia (SE Australia), which is the most populated and agriculturally intensive area of the country and has experienced a decline in winter rainfall in recent decades. The small number of records, in addition to the diversity of archives, measured proxies, resolution, and robustness of age model, emphasises the need to incorporate uncertainty estimates in any data synthesis effort. This study combines multiple novel techniques to examine inter- and intra-site coherency of climate signals within the SE Australian records. First, new Bayesian age-depth models are constructed to provide a consistent approach to age modelling and quantification of uncertainty. As with many palaeoclimate records, many of the SE Australian records have multiple proxies measured from one site. Differing sensitivities of proxies to regional versus local conditions can be overcome by data reduction techniques. Here, dominant modes of variability are extracted using data-appropriate Monte

Carlo Empirical Orthogonal Functions (MCEOF), and then combined with time series of single-proxy records into regional MCEOFs. Resulting regional modes minimise local effects and highlight regional climate variability. Identified modes show moderate agreement with a published single-archive multi-tiered regional MCEOF synthesis for the same region, as well as El Niño-Southern Oscillation and regional temperature reconstructions. This approach demonstrates the importance of incorporating age uncertainty in a consistent manner, and the utility of data reduction methods. It highlights the potential for acquiring coherent regional climate signals from a sparse network of non-annually resolved palaeoclimate archives from Australia.

ID: 01458, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Oral)

Signs of the Little Ice Age in Central Europe from AD 1500 compiled from various proxies

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The Little Ice Age (LIA) was a period of cooler climate extending approximately from the 14th to the 19th centuries between the Medieval Climatic Anomaly and the onset of the recent Global Warming. Scientific literature agrees on the fact that the start and end dates of LIA vary regionally and that clearly expressed cold intervals were separated with warmer conditions.

This contribution tries to synthetize several various temperature, precipitation and drought proxy reconstructions from the Czech Lands (recent Czech Republic) with the main aim to create more consistent description of climate variability during the past *c*. 500 years in Central Europe. First we characterize the database that comprised mostly from documentary evidence and tree ring data. Diverse documentary sources, such as narratives, economic and other records, were used to compile time series of temperature and precipitation indices, consequently used for temperature and precipitation reconstructions. Besides that, complete series of phenological observations, such as the dates of grain or vine harvest, were used to reconstruct temperature and drought patterns.

Basic features of LIA in Central Europe are represented by various time intervals of cooler and warmer climate on the one hand and wetter and drier climate on the other. Examples of such particularly warmer and drier period can be the 1530s (with extreme 1540 year) or colder and wetter conditions during the 1590s and 1690s. Outstanding extreme weather events during LIA in Central Europe are briefly mentioned and our findings are discussed with respect to climate forcings in wider European context.

ID: 01374, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

The last hunter-gatherers in western Mediterranean. Research possibilities vs. environmental constrains: the Ebro Basin case study (NE Spain)

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The last forty years have been a fructiferous time for the archaeological study of the Late Pleistocene and the Early/Middle Holocene periods in the Iberian Peninsula, and especially in long-time forgotten regions like the Ebro Basin. The almost total lack of previous fieldworks, although regrettable, has allowed the creation of a current discourse non-dependant of old clichés. Moreover, the historical reconstruction has evolved in parallel to in-depth researches in the fields of palaeoclimate and environment, which has produced great benefits to our understanding of the prehistoric past.

Since the early seventies, more than forty sites have been discovered and excavated in the Basin, offering an accurate view of the period. Our knowledge is based also in a multi-proxy approach that involves the study of lithic technology and raw materials, faunal and vegetation remains as well as geomorphological and spatial archaeology researches. Nevertheless, we are aware that our research faces almost insurmountable problems.

A number of elements difficult obtaining a more detailed perspective: first of all, the impossibility to find archaeological sites in some particular areas (e.g., precisely the Central Basin). There, massive erosive/cumulative processes from the Middle Holocene onwards have destroyed and/or buried the locations where those hunters could have settled, sometimes under several meters of sediments. Second, however much we excavate, we will never know how the sites were extensive and which the network of dwelling places profited by prehistoric groups was. Finally, the imprecision of the ^{14}C calibration curves, the bad conservation of organic materials in some areas and the incompleteness of most of the archaeological fillings are other problems that we must bear in mind when trying to reconstruct the (pre)historic environment. This

contribution, in the form of a SWOT analysis, will detail the strengths and weaknesses of our current knowledge of these crucial millennia.

ID: 02206, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Oral)

Documentary sources from Latin America: an overlooked resource to understand low frequency climate variability in the region

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The reconstruction of climate variability in the last millennia in Latin America mostly relies on natural proxies as tree-rings or ice cores which are more abundant along the Andes cordillera and documentary sources scattered in the region. Under the LOTRED-SA initiative, these data have been assembled to reconstruct temperature and precipitation at seasonal scale. However, one of the limiting factors for these past climate reconstruction efforts is the lack of instrumental data prior to 1960s in most of the region. Consequently, the overlapping period between proxies and instrumental data is usually short, which limits the calibration and validation exercises. Documentary sources can help to overcome some of these problems, since they allow extending the instrumental information with early instrumental series and observational data (weather diaries). Additionally, they are not limited to the Andean regions, thus increasing the geographical coverage.

After several years working in the region we provide three new examples of ongoing work with documentary sources with different applications to reconstruct the climate in the region:

Early Meteorological Records from Latin-America and Caribbean (EMERLAC database): more than 300.000 early instrumental observations have been rescued from 20 Latin-American countries from the 18th and 19th centuries.

Quito rogation ceremonies: we have retrieved hydrological extreme events from the Chapter Acts of Quito, mainly rogations ceremonies (pro-pluvia and pro-serenitate), during the colonial period. Extreme droughts are next identified for the last 400 years.

The Felipe Zúñiga y Ontiveros weather diary provides continuous daily meteorological information from 1st January 1775 to 31st December 1786 for Mexico City. This diary has allowed the characterization in a longer context of the “hungry year” (1785), an exceptional drought and cold year with a severe impact in the society.

ID: 01493, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Fire in northern West Africa during the Holocene

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African savannah ecosystems burn frequently and fires - natural or human laid - are important in their formation and consolidation. At the transition to forested ecosystems mesic African savannas would turn into forest if fires were excluded. While the long-term stabilizing effect of fire has been demonstrated, little is known about the effects of fire at the dry end of the savannah spectrum where the savannah might change into desert. To investigate the interaction and phasing of precipitation changes, vegetation shifts, and fire occurrence in the West African Sahelian-Saharan transition at the end of the African Humid Period, we conducted a multiproxy study combining measurements of stable isotopes of higher plant waxes with pollen and micro-charcoal counts on marine sediments retrieved offshore of Cape Blanc. We show that fires at the northern limit of the savannah occurred more frequently under wetter conditions due to higher fuel availability. Interestingly, increased fire occurrence correlated to a change in vegetation pointing towards selective burning processes conditioning the ecosystem. With declining precipitation burning aggravated the decline of the vegetation cover and accelerated desertification. Our study underlines the effect of fire as ecosystem-forming agent during the mid-Holocene aridification of northern Africa.

ID: 01709, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

“…and there came hail and fire mixed with blood”. Volcanic impacts and early medieval cultural responses

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Volcanic eruptions of high magnitudes are fascinating. Due to their ‘climate cooling’ ability they may explain periods of extreme cold. By bringing together archives of nature and written evidence cultural responses to natural impacts have been identified in the recent past. The severe winter of 939/940 CE in Europe was argued to be caused by a volcanic eruption in Iceland. At least this is what the combination of ice core data (GISP2) and medieval historiography indicate as McCormick et al. demonstrated in 2007. However, precise information about cultural responses is scarce. Historiographers mention a hard winter, an animal pestilence and famines, but there is no definite reference to a volcanic eruption in this case. Uncertainties remain. Basically, it was just cold.

This paper will examine the given winter by following both, archives of nature and culture. Taking the evidence from the ice core data as an initial point, uncertainties concerning dating volcanic eruptions in both disciplines will be discussed. The paper will then turn to an analysis of further material from the natural sciences and the humanities. It will examine historical accounts such as chronicles and normative texts as well as dendrochronological data to give a more precise overview of the natural and cultural situation during the time in question. Finally, the paper will ask for the cultural responses to a volcanic impact and discuss the socioeconomic consequences of the possible eruption in terms of vulnerability and resilience of the early medieval society in continental Europe.

ID: 02278, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Oral)

The interpretation of sedDNA records from soil samples: examples from Svalbard and Siberia

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DNA retrieved from ancient soil and sediment (sedaDNA) can provide information about local vegetation composition. Comparison of the modern sedDNA-derived taxa in Svalbard soils with vegetation composition in plots surrounding the sampling sites indicates that the DNA record is highly local, mostly reflecting plants growing within about 1.0 m. Some filtering of the data (mainly, the removal of food- plant contaminants and extremely rare sequences) is necessary to obtain taxon lists that make biogeographical sense, and some taxa that are present may be excluded, but the resultant lists show high fidelity to the local vegetation. The floristic sedaDNA information derived from sediment sequences can be used to understand past local patterns: local diversity levels, variation over small (horizontal) distances and/or temporal (vertical) periods, and dynamics of various functional groups. Larger regional compilations of samples can be examined for major shifts in plant functional types or biotic interactions in relation to major environmental change. Furthermore, under the right preservational circumstances, sedaDNA from soils and sediment related to archeological sites have the potential to yield information about human use of plant species. Records of taxa derived from sedaDNA from permanently frozen sediment sequences in Siberia illustrate some of these properties, including the composition of plant functional types in glacial-age vegetation and shifting patterns of mutualistic relationships. Data indicate higher proportions of forbs and lower plants in herbaceous glacial-age herbaceous vegetation than suggested by pollen records. Shifting patterns of the dominant types of mutualism between the last glacial and the Holocene may indicate disruptions of relationships with major environmental change, such as deglaciation or the loss of megaherbivores.

ID: 01330, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Oral)

Global foraminifera δ13C database to assess changes in the efficiency of the soft tissue pump on glacial-interglacial timescales

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The $d^{13}C$ of planktonic and benthic foraminifera over glacial-interglacial timescales represents a convolution of many processes, including the efficiency of the soft tissue pump, a major driver of past carbon cycle. Here we use a global database of more than 1000 individual records from benthic and planktonic species to derive regionally and vertically coherent signals over the last 150 kyr.

The data indicate relatively good agreement amongst planktonic and shallow-dwelling (above 1500m) benthic species at low latitudes; this signal also follows that of the atmosphere closely. The signal common to all benthic species at deep sites is in rough agreement with $d^{13}C$ of planktonic species at high latitudes. These general features are interpreted to reflect long term equilibrium between surface waters and the atmosphere, and relative isolation of the deep ocean, which intersects with surface living planktonic foraminifers only at high latitudes. At the same time, the marine soft tissue pump acts (to a greater extent in the low latitudes) to increase the vertical gradient of $d^{13}C$.

We examine the evolution of the difference between d^{13}C of low-latitude shallow and deep benthic species as a proxy for the efficiency of the soft tissue pump over the last glacial cycle. The vertical gradient of d^{13}C is highest, indicative of increased soft tissue pump efficiency, during Marine Isotope Stages (MIS) 6, 4 and 2, with smaller local maxima during MIS 5d and 5b. The agreement of this signal with previous hypotheses regarding changes in the soft tissue pump on these timescales suggests that using a geographically and species-diverse d^{13}C dataset from foraminifera may provide a reasonable proxy for this major driver of the carbon cycling on glacial-interglacial timescales.

ID: 01692, 01.- Open Session on past global changes, (Oral)

Anthroecology and Anthromes: Theoretical and Practical Tools for the Study of Anthropogenic Global Change

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Human transformation of landscapes couples social and ecological processes. By uniting the social and environmental sciences at the core of land system science, anthroecology theory and anthromes provide a useful global framework for understanding anthropogenic landscape change over millennia. Anthroecology integrates archaeological, anthropological, ecological, and evolutionary frameworks in interpreting the processes shaping long-term social-ecological changes at landscape, regional and global scales. Anthromes are useful for assessing, mapping and visualizing these changes at regional and global scales. This presentation will review the utility of anthroecology theory and anthrome mapping as tools for understanding the causes, consequences and dynamics of human transformation and use of landscapes, with the goal of highlighting new opportunities for research, applications and education.

ID: 01375, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Patterns of climate change over the Common Era

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Reconstructions of surface temperature over the past 2000 years extend our knowledge of temperature changes beyond the instrumental era, and thus allow for the characterization of climate variability on multidecadal to centennial timescales. This lends insight into exogenous and endogenous sources of climate variability. Here we reconstruct annual temperature based on the latest incarnation of the PAGES 2k global multi-proxy database and a new climate field reconstruction method, GraphEM.

We find a globally warm Medieval period, but colder than the late twentieth- century by 0.5 C. Unlike previous studies, there is no evidence for a La Niña-like pattern over this period. With high probability (87%), the 1961 – 1990 period was the warmest 40-year period of the past 2000 years almost everywhere. The probability that the rate of warming over the same period was unprecedented is more spatially variable, though a majority of locations also show the late twentieth-century as anomalous in the context of the Common Era.

Reconstructed temperature shows a robust large-scale cooling pattern shortly after a volcanic eruption; in particular, over the North Atlantic Ocean, the cooling can persist up to 3 years thereafter an eruption. The tropical Pacific response is not statistically significant. Solar irradiance forcing is found to be an important modulator of multidecadal climate variability, with the strongest solar response (0.25 C) in high latitude North America and Eurasia, and a pattern suggestive of polar amplification. These key features are echoed in multiple GCM simulations of the last millennium (PMIP3), though we find notable differences, in particular regarding the timing of the post-volcanic ENSO response, and the magnitude of the temperature response to solar irradiance forcing.

The results suggest that there is no fundamental discrepancy between simulated and reconstructed climates of the last millennium.

ID: 01593, 18.- Human Impact on Global Aquatic Systems, (Oral)

Ecosystem responses to anthropogenic changes in a tropical flood pulse wetland, Tasik Chini (Malaysia)

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Tropical areas are undergoing rapid environmental change from the combined effects of climate change and human impact on the landscape. However, understanding of tropical wetland ecosystem responses to changing environmental conditions is limited by the scarcity of well-dated palaeoenvironmental records. The flood pulse wetland ecosystem Tasik Chini (Peninsular Malaysia) is a designated UNESCO Biosphere Reserve site and heavily promoted for ecotourism. Despite this, the lake has been artificially dammed, and the catchment is heavily disturbed by bauxite mining, rubber and oil palm plantations. To investigate the effects of these different anthropogenic drivers on the lake ecosystem we retrieved sediment cores from three of the twelve interconnected basins within the wetland, and analysed them for a range of proxies. Pilot data suggest that conditions in the wetland became more eutrophic along with increases in sedimentation rates across all three basins around the mid-20th century, associated with large-scale catchment deforestation during World War 2. A second transition occurred around the 1990s probably as a result of multiple activities including the construction of a weir, and the expansion of oil palm plantations and mining. Cores from individual basins record localised impacts of mining or land use change, indicating that inter-basin comparisons are useful for differentiating responses to contrasting stressors. Whilst our results illustrate that the largest shifts in ecosystem structure of Tasik Chini occurred during the 20th century, more subtle indicators of earlier eutrophication of the wetland suggest that human impacts in aquatic ecosystems of Peninsular Malaysia may have started earlier than previously assumed.

ID: 01739, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Invited Oral)

Larch species turnovers and vegetation change in the arctic-boreal treeline ecotone during the Holocene

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The arctic-boreal treeline ecotone in Siberia is formed by monospecific stands of three species of larch, *Larix sibirica*, *Larix gmelinii* and *Larix cajanderi*. This area is currently under severe climatic pressure, and changes in forest density and extent are expected. Along with this, the respective ranges of the treeline forming species are projected to shift to the Northeast, which is only possible through migration and displacement of existing populations. Fluctuations in forest extent are known to have previously occurred during the Holocene, and investigations of these processes can aid our understanding of the dynamics of larch forests and the factors governing the distribution of the three species. While pollen records of *Larix* do not achieve a taxonomic resolution below the level of genus, this can be accomplished using genetic markers.

We used sedimentary ancient DNA to analyze lake sediment cores spanning most of the Holocene from the southern Taymyr peninsula, where the ranges of *L. sibirica* and *L. gmelinii* come together. Changes of the complete vegetation were revealed by DNA metabarcoding and pollen analyses, while diagnostic mitochondrial haplotypes traced the temporal dynamics in distribution of the two closely related larch species. Additionally, we incorporated these two species into our larch population dynamics model LAVESI to understand the influence of competition between these species. Simulations were forced with regional climate series at locations in the vicinity of the sampled lakes. These analyses offer a high degree of resolution and shed light on the complicated ecological processes leading to a change in overall vegetation.

ID: 01742, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Oral)

The tight link between oceanic meridional and zonal SST gradients: implications for the Pliocene climate and glacial cycles

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Two major characteristics define the mean climate of the tropics – pronounced zonal (east-west) and meridional (equator to mid-latitudes) gradients in sea surface temperature (SST). These gradients control the atmospheric zonal and meridional circulations and thus Earth's climate. Many studies have shown that global cooling since the early Pliocene was accompanied by the gradual strengthening of these gradients, even though the actual magnitude of the reduction has been hotly debated. An analysis of temperature trends over the past 5 million years show that changes in these gradients in the Pacific followed each other very closely, reflecting a tight one-to-one relationship between these two climatic variables. To investigate this relationship we have conducted simulations with a comprehensive climate model (CESM) wherein we systematically reduce the meridional temperature gradient by modifying cloud albedo or atmospheric CO_2 concentrations. The zonal SST gradient in the Pacific adjusts accordingly, so that the induced temperature changes along the equator match the imposed changes in the meridional gradient. In effect, the upper-ocean circulation maps the meridional temperature distribution onto the ocean vertical thermal stratification and then onto the east-west SST distribution along the equator. Consequently, the tight relationship between the two SST gradients posits a fundamental constraint that can help to resolve current debates on changes in the tropics over the past 5 Million years or so. For example, the prevalence of permanent El Nino-like conditions (El Padre) in the early Pliocene is a consequence of a significant reduction in the meridional SST gradient. In contrast, small change in the equatorial SST gradient during the LGM is consistent with the relatively uniform cooling between 30°N and S in the Pacific.

ID: 02182, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Last interglacial temperature seasonality reconstructed from tropical Atlantic corals

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Reconstructions of last interglacial (~127-117 ka) climate offer insights into the natural response and variability of the climate system. However, the seasonal temperature changes of the tropical ocean are not well known for this time interval. Here we present well preserved fossil shallow-corals recovered from the southern Caribbean island of Bonaire. These corals have been precisely dated by the ^{230}Th/U-method to between 130 and 118 ka ago. Annual banding of the coral skeleton enabled construction of eight time windows of monthly resolved Sr/Ca temperature proxy records. From these coral records, sea surface temperature (SST) seasonality in the tropical North Atlantic Ocean during the last interglacial period is reconstructed. We detect similar to modern SST seasonality of ~2.9 °C during the early (130 ka) and the late last interglacial (120-118 ka). However, within the mid-last interglacial, a significantly higher than modern SST seasonality of 4.9 °C (at 126 ka) and 4.1 °C (at 124 ka) is indicated. These findings are supported by transient and time-slice simulations with a coupled atmosphere-ocean general circulation model (COSMOS) and are consistent with the evolving amplitude of orbitally induced changes in the seasonality of insolation throughout the last interglacial, irrespective of wider climatic instabilities that characterized this period, e.g. at ~118 ka ago. The climate model simulations indicate that the SST seasonality changes documented in our last interglacial coral Sr/Ca records are representative of larger regions within the tropical North Atlantic Ocean, and suggest that the reconstructed SST seasonality increase during the mid-last interglacial is caused primarily by summer warming. Furthermore, a 124 ka old coral documents evidence of decadal SST variability in the tropical North Atlantic during the last interglacial, akin to that observed in modern instrumental records.

ID: 02274, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Natural and human-driven fire regime and land-cover changes in Central and Eastern Europe

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Fire is an important driver of terrestrial-ecosystem functioning and land-cover changes. In Europe, people have modified, or even driven fire dynamics over millennia with significant impacts on land cover. Compared to northwestern and central Europe, significant deforestation in central-eastern Europe (CEE thereafter) took place later. However, results from proxy data suggest an earlier onset of forest-cover reduction than vegetation models (LPJ-GUESS) and anthropogenic land-cover change reconstructions such as KK10 and Hyde 3.1. Determining the timing and the extent of anthropogenic fires, and whether fire was responsible for the mismatch between proxy- and models-based reconstructions may significantly advance our understanding of land-cover changes. Although the Global Charcoal Database (GCD) has allowed several sub-continental to global syntheses of biomass-burning trends, the lack of charcoal records in the relevant databases has hampered syntheses of biomass-burning changes in CEE. To fill this knowledge gap, we compiled a new charcoal dataset from CEE consisting of more than 50 sedimentary micro- and macroscopic charcoal records from published literature and yet unpublished records. We assembled the records on sub-regions and produce the first sub-regional fire syntheses covering a wide area in CEE. The sub-regional composite records will be evaluated in combination with other proxy-based and modelled datasets of past climate, vegetation, and land-cover changes to examine the patterns, drivers and consequences of biomass burning over multiple spatial and temporal scales in CEE. Specific questions to examine concern the landscape transformation over time and the role of fire in landscape management. Furthermore, the high-resolution macrocharcoal records will be used to test how has fire regimes (frequency and severity /area burnt) changed along with shifts in land-use strategies and landscape fragmentation, thereby improving knowledge on the human dimension of fire.

ID: 02013, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Oral)

The role of Middle to Late Holocene paleoclimate change in Eastern Arctic prehistory

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The eastern Canadian Arctic has been subject to significant recent warming, sea ice decline, permafrost thaw, as well as ecological and socio-cultural changes. Archaeological and paleoclimate records provide an opportunity to observe how human communities faced environmental changes of the past. This region has a complex 5000-yr prehistory, during which diverse and dynamic cultures migrated over large distances. Archaeologists ascribe these migrations, and associated cultural-technological changes, to a variety of factors, including climate. Here, we synthesize paleoclimate over the middle and late Holocene derived from biological proxies and geochemical tracers. We focus on the two largest migration episodes documented in the archaeological record: the Paleo-Inuit migration which led to the initial occupation of the region, and the later Thule migration eastward to Greenland from Alaska. Changing climate has long been considered to have influenced these aspects of Arctic pre-history. Since the 2007-2009 International Polar Year, considerable advances have been made in reconstructing Arctic paleoclimate. We integrate these new datasets to derive improved estimates of the timing and magnitude of climate change through pre-history. Our results show some correlation between the Paleo-Inuit migration and the Holocene Thermal Maximum although spatial variability in timing and magnitudes of reconstructed temperature changes over this time period, coupled with the large distances covered by the migration, indicate substantial capacity for adaptation to varying climate regimes. Further, a series of more recent radiocarbon dates have revised the eastward migration of the Thule to approximately 800 cal yr BP (13th century AD), corresponding to the terminal phase of the Medieval Warm Period (MWP). Proxy-based reconstructions indicate that the magnitude of temperature change during the MWP was small relative to the Little Ice Age. Coupled with the archaeological evidence, these results suggest significant capacity for Thule to adapt to the climate variability of the past millennium.

ID: 01402, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Response of northern hemisphere environmental and atmospheric conditions to (rapid) climate changes using Greenland aerosol records from the Eemian to the Holocene

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Climate in the northern hemisphere experienced dramatic temperature and sea level changes over the last glacial cycle with vast ice sheets expanding across North America and Eurasia and pronounced rapid climate changes occurring during the last glacial, the so called Dansgaard Oeschger (DO) events. Moreover, the last interglacial (Eemian) was warmer than today and may provide guidance for implications connected to future climate change scenarios. However, little observational evidence exists about the response of environmental parameters or atmospheric changes connected to these climate variations.

Using new high-resolution chemistry records for mineral dust, sea salt, and biogenic aerosol species from the North Greenland Eemian Ice Drilling (NEEM) project over the last 128,000 years and separating deposition from source changes we are able to quantify both glacial/interglacial and stadial/interstadial emission and transport changes and relate them to the accompanying environmental changes. This shows little influence of DO climate changes on sea salt aerosol production in the North Atlantic region and on aerosol tracer emissions from North American vegetation, however, a strong impact on dust liberation in Central Asian desert regions. For the first time our new record allows us to also compare environmental conditions in the Eemian with the early Holocene.

ID: 02304, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

Biotic response to centennial-scale climate variability in Northwest Africa: Were there Holocene analogues for current Cedrus atlantica dieback?

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Palaeoecological records can provide critical insights into the vulnerability of endangered terrestrial species to climate change. Here, we assess the sensitivity of the Northwest African endemic conifer *Cedrus atlantica* to centennial-scale climate variability during the Holocene. Based on new fossil pollen and stable isotope data from the high-resolution, robustly-dated Lake Sidi Ali archive, we assess the role of hydrological forcing in the species' postglacial trajectory of colonization, dominance and decline in the southern Middle Atlas, Morocco. While significant vegetation response to centennial-scale climate perturbation is recorded, strong aspects of historical contingency are also evident, such that the population level at any given time is a function of population growth and survival during preceding climatic perturbations. This inference is supported by a simple mechanistic population model incorporating separate thresholds for survival and regeneration (regeneration niche concept) and forced by an environmental signal with slow (orbital scale), medium (millennial) and fast (centennial) oscillating components and a small amount of random noise. Our findings suggest that anthropogenic climate change during the 21st century, and conservation responses, will have far-reaching consequences for the long-term trajectory of this endangered montane species.

ID: 01327, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Holocene rapid climate changes reflected in NE and CE European charcoal records

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The Holocene climate has undergone several marked short-term variations i.e., climate shifts occurring within centuries or even decades, known as rapid climate changes (RCCs). Evidence from multiple records indicates a wide-ranging manifestation of RCCs in Europe, with contrasting spatial characteristics and impacts. However, little is known about the spatial sensitivity of fire activity to short-term Holocene climatic variations. Here we explore the evidence of Holocene rapid climate changes in three high resolution macroscopic charcoal records from CE and NE Europe, with the purpose to examine similarities and differences in the timing and trends of fire activity. Specifically, we compare burning responses to RCC's between the more humid and more continental parts of Eastern Europe, also taking into account vegetation dynamics from published literature as a general estimation of fuel abundance.Our charcoal records show evidence for increases in fire activity at all sites, centered on 8.2 ka, 5.1 ka, 3.9 ka, 2.6 ka, 1.1 ka and last 200 yrs. However, intervals of rapid climate change are marked by high amplitude increases in the NE Europe charcoal record, whereas in the CE European records this pattern is visible with lower amplitude. Our insight in the spatial and temporal relationships between RCC's and past fire activity might contribute to a deeper understanding of the impacts of future climate changes on biomass burning.

ID: 02108, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Seasonal spatial pressure reconstructions across Antarctica since 1905

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Much research has been focused on Antarctic climate change in recent decades, with considerable focus on temperature trends across the continent. A growing body of literature however is demonstrating the relationship between the atmospheric circulation in the Southern Hemisphere and its effects on climatic change over the Antarctic continent and the Southern Ocean. Unfortunately, prior to the modern satellite era, global reanalyses are not reliable in the high-southern latitudes, given the very little *in situ* data to constrain the reanalysis model solutions across the high southern latitudes. To overcome these obstacles, spatial pressure reconstructions based on kriging over the entire Antarctic continent were performed back until 1905. The spatial reconstruction is essentially an interpolation of pressure reconstructions at key Antarctic stations. Compared to ERA-Interim reanalysis after 1979, the skill remains very high for austral summer and austral winter, following these station pressure reconstructions. Unfortunately, the skill is lowest in the Amundsen Sea, due to the high interannual variability there, and no available station data. Nonetheless, when considering the atmospheric circulation changes over the entire twentieth century, changes over Antarctica are characterized by large interannual variability, with recent persistent and unique trends only in austral summer. This highlights the strong role of natural variability in the Antarctic climate system, and continues to demonstrate the challenges in understanding and attributing recent changes without a longer historical context. Please note that the presenting author will be J Jones

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ID: 02181, 06.- Before and after - climate contrasts across the MPT, (Oral)

Detangling regional and global signals in seawater δ18O records across the mid-Pleistocene Transition

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During the Mid-Pleistocene Transition (MPT, ~900 kyrs ago), the climate system's glacial-interglacial pacing, as reflected in benthic δ^{18}O, changed from a dominant periodicity of 41,000 to one of 100,000 kyr, without a comparable change in orbital forcing. A limited number of high-resolution seawater δ^{18}O records, derived from coupled Mg/Ca and benthic δ^{18}O analyses, exist to evaluate global changes in ice volume and how this may have contributed to the MPT. However, these seawater δ^{18}O records are also influenced by regional hydrographic signals. To evaluate possible regional influences, here we reconstruct seawater δ^{18}O from coupled Mg/Ca and δ^{18}O analyses of *Uvigerina* spp., at North Pacific ODP Site 1208 (36.13°N, 158.20°W, 3350 m water depth). The Site 1208 seawater δ^{18}O record exhibits transient increases in glacial seawater δ^{18}O at Marine Isotope Stage (MIS) 22 and MIS 16, possibly indicating nonpermanent ice volume increases and/or hydrographic changes. The other existing high-resolution seawater δ^{18}O record from the South Pacific Site 1123 shows an abrupt, persistent increase in seawater δ^{18}O starting at Marine Isotope Stage (MIS) 22. This was interpreted as a large increase in ice volume in Antarctica. Yet, the 1123 benthic δ^{18}O record differs from the global LR04 benthic δ^{18}O stack in that it is ~0.3 to 0.4‰ more enriched than LR04 between glacial MIS 22 to MIS 16. Comparison of the 1208 and 1123 records indicates the MPT was not caused by an abrupt and permanent increase in ice volume but rather regional hydrography must be considered when interpreting seawater δ^{18}O records. Additionally, MIS 22 and 16 may represent critical climate and ocean circulation transitions. To disentangle hydrographic influences from global seawater δ^{18}O signals, additional records from geographically distinct areas need to be generated and compared.

ID: 02214, 18.- Human Impact on Global Aquatic Systems, (Oral)

Timing and causes of the spread of lacustrine hypoxia revealed by varved sediments

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The development of seasonal or persistent hypoxia in lakes results in the decrease of bioturbation and favours the preservation of laminated sediments once thresholds in oxygen-depleted conditions are crossed. When laminations are proved to be annual, i.e. they are varves, the timing of the onset of hypoxia in the water column can be established. The Varve Working Group compiled a worldwide database of 365 lakes known to preserve varves since CE 1700. A global analysis showed that lacustrine hypoxia started spreading before CE 1900, 70 years prior to hypoxia in coastal zones, and before the rise of temperatures and significant changes in climate. A more detailed analysis of European lakes showed that the onset of hypoxia was more frequent and synchronous in watersheds that experienced a growth of urban areas that began around CE 1850 and accelerated after CE 1900, and of larger and more intensively cultivated surface area. However, the spread of hypoxia was best explained by urban expansion and the associated intensification of anthropogenic point sources of phosphorus. To date, there have been no signs of sustained recovery of bottom-water oxygenation in lakes following the enactment of European water legislation in the 1970s to 1980s, and the subsequent decrease in domestic P consumption.

ID: 01609, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

A monthly paleo-reanalysis based on instrumental measurements, historical documents and tree-ring data for the period 1600 to 2000

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Numerical weather prediction heavily relies on the assimilation of all available observations into the model to start with a state close to the true atmosphere. Data assimilation also revolutionized climate research where reanalysis are the most investigated type of data sets in the 20th century. With the appearance of new methodologies, the assimilation of sparse and seasonally or annually averaged indirect proxy information becomes possible and reanalysis products can be pushed further back into the past, however at lower monthly to annual resolution. We present a paleo-reanalysis spanning the years 1600 to 2005. Early instrumental temperature and surface pressure observations, temperature indices derived from historical documents as well as temperature and moisture sensitive tree-ring proxies have been assimilated into an ensemble of atmospheric general circulation model using a Kalman-filtering technique. This paleo-reanalysis joins the physically consistency and three-dimensional, spatio-temporal completeness of model simulations with the best local agreement to observations, which was previously only been offered by statistical reconstructions. In contrast to traditional reconstructions, the paleo-reanalysis offers multivariate information and error estimates whereas no assumptions about stationarity are required and variability remains constant over time. We will present the resulting northern hemisphere land temperature evolution as well as spatial imprints for case studies.

ID: 02233, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Holocene global land-cover and land-use change for climate modelling studies: Achievements of the PAGES LandCover6k initiative (2015-2016)

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The envisioned product from the PAGES LandCover6k initiative (2015-2020) is quantified empirical data on past anthropogenic land-cover and land-use change that are relevant and useful for climate modelling within international programs such as CMIP and PMIP. Land-use change is one of many climate forcings and quantification of its impact on climate is still debated. Among the effects of land-use change (deforestation) on climate, the global biogeochemical effects are the most studied and best known (the effect on the CO_2 balance in particular). The biogeophysical effects are less studied, especially at the regional spatial scale at which they will be most significant. Moreover, the net effect of both effects together is difficult to quantify and still a matter of discussion. LandCover6k infers land-cover and land-use quantitative data from fossil pollen and from historical archives and archaeological data. LandCover6k focuses on regions of the world where humans have had a significant impact on land cover through deforestation and diverse agricultural practices, i.e. the Americas, Western and Eastern Africa, Europe, and Asia (China, India and Japan in particular). Pollen-based reconstructions of past land cover are achieved primarily using the Sugita's REVEALS model, and spatially continuous descriptions of pollen-based land cover are then obtained applying advanced spatial statistics. Historical and archaeological data are upscaled into maps of major land-use categories linked to quantified attributes useful for climate modellers. Anthropogenic Land-Cover Change (ALCC) modelling then integrates the information from the empirical data. Estimating pollen productivity of major plant taxa is an essential part of LandCover6k activities because it is required for REVEALS applications. Pollen productivity values are available for the northern hemisphere's major plant taxa, but are still missing for large parts of Asia and the tropics.

ID: 01281, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Long-term Climate variability in Nepal Himalaya: revealed from Tree Ring-width Chronologies

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Himalaya mountain systems are witness of diverse impacts of climate change in its ecologically sensitive and geologically fragile areas; however, climatic data are lacking for long-term trend analysis and realistically predict future. We carried out this dendroclimatological study in Nepal Himalaya with objectives to develop ring width site chronologies, identifying the response of multiple tree species to climatic variables and to reconstruct the past climate of the region. Analyzing tree core samples of *Abies spectabilis*, *Betula utilis*, *Cedrus deodara*, *Juniperus recurva*, *Picea smithiana,* and *Pinus wallichiana,* we developed a network of ring-width chronologies, some dating back to early 15th century. Depending upon the precipitation and temperature regimes prevailed in the region; growth-climate response analysis revealed that response slightly varies among different species growing in different sites, though some common responses are shared. Pre-monsoon temperature (March-May) had a negative relationship to growth for most of the species, and that tree growth was positively correlated with precipitation of pre-monsoon to monsoon (March-July) in most sites. The March–May average temperature and precipitation, and May-August average Palmar Drought Severity Index (PDSI) were reconstructed. The reconstructed spring temperature identified several of warm and cool periods with recent warming, while the reconstructed precipitation showed several wet and dry periods with recent precipitation weakening in western parts of Nepal Himalaya. The May–August PDSI reconstruction covering 1700 to 2015 AD for western Nepal Himalaya revealed several moderate to extreme multiyear drought episodes (1721-1722, 1771-1776, 1846-1884, 1899-1901, 1908-1911, 1932-1935, 1967-1969) with few short wet periods (1751-1753, 1988-1991). From the teleconnection analysis between the climatic variables from Nepal Himalaya and broader scale climatic variability indices, we found linkages with sea surface temperature of the equatorial Pacific region and extended multivariate ENSO Index.

ID: 02318, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Finding the sweet spot for abrupt change: influences of atmospheric CO2, orbital forcing and terrestrial ice sheets on AMOC stability

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Abrupt climate changes were common during some intervals of the Quaternary, but relatively rare during others. Here, a large suite of equilibrium simulations with a global coupled climate model is used to map out the interacting effects of CO2, orbital parameters and terrestrial ice sheet size on deep water formation. The results show that lower CO2 and/or a smaller tilt of Earth's rotational axis cause Southern Ocean surface waters to become much saltier by changing freshwater cycling, allowing them to dominate the deep ocean and shrinking the volumetric extent of relatively fresh North Atlantic Deep Water. With extreme Southern Ocean dominance, the model simulates unforced abrupt changes in the AMOC, or even persistent AMOC collapse. Meanwhile, a large Laurentide ice sheet steers the boreal jet so as to strengthen the AMOC, counteracting the salinity effect of low CO2 and low obliquity, but without greatly increasing the volumetric contribution of North Atlantic waters to the global ocean. These results imply a combined influence of buoyancy forcing and wind forcing in determining the sweet spot at which abrupt change is most likely to occur, largely consistent with prior works, and generally consistent with observational reconstructions. Abrupt change events could then be triggered by internal ocean-atmospheric variability, or by external forcings.

ID: 02271, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

Volcanic Eruptions as Historical Actors in Chinese Dynastic Collapse

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The need to understand human vulnerability to future climate change is driving research into the influence of climate on past societies. Capitalizing upon advances in palaeoclimatic reconstruction, prominent coincidences have been noted between climatic changes and the sudden "collapses" known or inferred from historical, archaeological and palaeoecological records. These are often associated with a reduction in socioeconomic complexity and/or political discontinuity, with climate deemed to play a role mainly through the disruption of a society's agro-ecological base. China is unique in experiencing 68 well-defined dynastic collapses during the first two millennia CE. Their frequency and precise dating affords an unparalleled opportunity to test whether climate played a role amongst the debated suite of possible causes offered to date. Here we use a state-of-the-art multi-ice-core reconstruction of volcanism to show a repeated and statistically significant association between explosive eruptions and Chinese dynastic collapses, whether of long-lived dynasties controlling large territories or shorter-lived regional dynasties in periods of instability. Collapse often occurred amidst warfare: both a contributor to and consequence of collapse. Using a 1,062 year reconstruction of warfare intensity spanning China's northernmost to southernmost extent, we further show that warfare during and following collapse scaled in intensity with the magnitude of volcanic forcing. This result is suggestive of the pathways by which explosive eruptions may trigger collapse, including intensified recourse competition under climate-induced scarcity, and opportunistic rivals exploiting reduced social cohesion alongside the material weakness and unpopularity of ruling families (associated with a perceived loss of the "mandate of heaven") during times of socioeconomic stress. These results for the first time identify a systematic role for volcanic eruptions as historical actors in the political collapse of one of the world's most populous, sophisticated, and long-lasting civilizations.

ID: 01266, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Oral)

European Hydroclimate Response to Volcanic Eruptions over the Past Nine Centuries

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The climatic aftermath of the 1815 Tambora eruption in Europe suggests large volcanic eruptions can introduce environmental and societal consequences in this region. Here, we analyze the European summer hydrological response to 31 tropical and 44 Northern Hemisphere mid-to-high latitude eruptions over the past nine centuries, using a newly published reconstruction of global volcanism and a proxy record of droughts (Old World Drought Atlas) coupled with a superposed epoch analysis. Our results show a significant wetting response (at the 95% confidence level) for year 0 and year 1 after tropical eruptions. Spatially, wetting occurs in northeast and southern Europe, while a drying response develops in central and northwest Europe. Both the wetting and drying responses increase with the eruption magnitude. Large high latitude eruptions tend to cause a drying response. Correcting for the effects of El Nino does not noticeably change the response patterns. Our results verify previous modeling studies from a longer term proxy perspective, and indicate that future stratospheric aerosol perturbations are likely to further separate modern and 20th central hydroclimate conditions in Europe during the boreal summers. Complex regional variability exists, and regions such as the Balkan Peninsula may experience intensified wetting. The results may therefore illuminate potential effects of stratospheric geoengineering in Europe.

ID: 01876, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Outburst flood erosion consistent with long-term landscape evolution models

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Existing models for the development of topography and relief over geological timescales are fundamentally based on semi-empirical laws of the erosion and sediment transport performed by rivers. The prediction power of these laws is hindered by limitations in measuring river incision and by the scant knowledge of the past hydrological conditions, specifically average water flow and its variability. Consequently, the erodability values derived from modelling long-term erosion rates in rivers are ambiguously tied not only to the lithology and nature of the bedrock but also to uncertainties in the quantification of past climate. This prevents the use of those erodabilities to predict the landscape evolution in different scenarios. Here, we apply the fundamentals of river erosion models to outburst floods triggered by overtopping lakes, for which the hydrograph is intrinsically known from the geomorphological record or from direct measures. We obtain the outlet erodability from the peak water discharge and lake area observed in 86 floods that span over 16 orders of magnitude in water volume. The obtained erodability-lithology correlation is consistent with that seen in 22 previous long-term river incision quantifications, showing that outburst floods can be used to estimate erodability values that remain valid for a wide range of hydrological regimes and for erosion timescales spanning from hours-long outburst floods to million-year-scale landscape evolution. The results also constrain the conditions leading to the runaway erosion responsible for outburst floods triggered by overtopping lakes. [Funded by CGL2014-59516].

ID: 01471, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Impact of abrupt climate changes on the coastal ecosystems of the Rías Baixas (NW Iberia) during the Lateglacial/early Holocene transition

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The *Rías Baixas* are ancient submerged river valleys located at the Atlantic margin of NW Iberia. Their associated ecosystems are very sensitive to climate and RSL changes. Pollen and dinoflagellate cyst records for the Lateglacial/early Holocene transition have been analyzed from shallow marine sediments of the Ría de Vigo (MVR-3 core) and the Ría de Arousa (A14 VC15 core). Palynology was combined with geochemical, lithological and radiocarbon data to reconstruct the local environments (marine ecosystems and vegetation) related to the relative sea-level and climate changes. The records cover the period ~14.5-8.0 ka BP and were correlated with regional vegetation and sea-level changes, as well as with other regional paleoclimatic records.

New evidence shows that cool conditions prevailed at the Ría de Arousa within the Lateglacial, with cold-tolerant especies (*Betula, Pinus*, shrubs and steppic herbs) dominating the landscape and high primary productivity prevailing in the marine environment. Sedimentary rate significantly decreased during the Younger Dryas (12.7-11.7 ka BP) and supratidal environments (coastal marshes and swamps) further developed due to RSL decrease. After the Holocene transgression the precipitation increases and coastal wetlands (moist heaths and ponds with *Isöetes*) developed in the surroundings. *Quercus* expansion started no later than 11.4 ka BP in the area, whereas other deciduous trees (*e.g. Carpinus* and *Betula*) significantly declined in the area. The new data

obtained reveals that the southern Galician rias have been sensitive to abrupt climate events during the Lateglacial and early Holocene, included the Younger Dryas, 8.2 ka, 11.4 ka, 10.5 ka and 9.3 ka and 8.2 ka. The 10.5 ka event (Bond cycle-8) has been identified here for the first time in NW Iberia.

ID: 01452, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Oral)

Hydroclimate and vegetation changes in Central Africa during the Holocene: new views from the Lake Barombi Mbo (Cameroon)

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Central Africa comprises the largest remaining contiguous expanse of humid tropical forest on the African continent, which has been strongly reduced and degraded by humans. To gain insight into the underlying processes driving changes within tropical forests of Africa, it is crucial to determine the drivers responsible for the past forest disturbances. During the Holocene those tropical forests experienced alternating periods of expansion and contraction, which are thought to be related to climate variability, although during the last ~3000 years human activity may have had a supplementary effect. However, the existence of significant episodes of human disturbances in the past remains uncertain. To resolve the drivers and mechanisms, which have affected the Central African forests during the Holocene, we analysed novel climate-proxies directly recording changes in the hydroclimate in combination with vegetation-proxies as well as indicators of anthropogenic disturbances. We used a new lake-sediment core collected in the deepest part of Lake Barombi Mbo (105-m-deep, Southwest Cameroon) during January 2014. This lake has furnished one of the few pollen records from Central Africa that goes back to the last ice age. Here, we applied molecular- and isotopic-based proxies: compound-specific hydrogen and carbon isotope ratios. Our knowledge of these proxies gained for the study area demonstrated that leaf-wax hydrogen isotopes record accurately the modern variability in the hydroclimate while leaf-wax carbon isotopes were found related to the vegetation composition, particularly to changes in the contribution of C_3 versus C_4 plants. These sedimentary molecular and isotopic data will be compared with pollen and other sedimentological data (including erosion proxies) from the same core as well as with regional archaeological syntheses to ultimately test the role of climate change and human activity on the evolution of forests in Central Africa during the Holocene.

ID: 01728, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Holocene climate variability and rapid transitions in the northern North Atlantic

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The similarity in timing, direction and magnitude of Holocene climate variability derived from multiple-proxies preserved in both glacial and non-glacial lake sediment in Iceland, and their close correlation with climate proxy records from the adjacent marine shelf, suggests that Icelandic lake records faithfully track large-scale shifts in ocean/atmosphere circulation in the northern North Atlantic. Multiple lakes studied contain numerous tephra layers of known age that constrain their age models as well as macrofossils suitable for ^{14}C dating. Paleomagnetic secular variation records from the lake sediment further aid their chronologies and provide a direct comparison with marine sediment records from around Iceland. A composite record indicates a relatively warm early Holocene, overprinted with meltwater impacts until 7.9 ka, followed by peak Holocene warmth between 7.9 and 6 ka with evidence for the disappearance of glaciers in lake catchments. Despite great variability in catchment characteristics, the high-resolution lake records capture synchronous abrupt, cold departures from the smoothly decreasing trend in Northern Hemisphere summer insolation, particularly at ~4.2 and 3.0 ka. The most significant increase in landscape instability and soil erosion occurred shortly after 2 ka likely due to a complex combination of increased impact of volcanic activity, cooling climate and increased sea ice off the coast of Iceland. Arrival of humans with grazing livestock ca 1 ka added further to the soil erosion, which culminated during the Little Ice Age.

ID: 01914, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

The post-glacial opening of Nares Strait, NW Greenland: new details on ice-sheet and sea ice dynamics.

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Together with other passages of the Canadian Arctic Archipelago, Nares Strait contributes to the export of freshwater and sea ice, as well as nutrient-rich Pacific water from the Arctic Ocean to the North Atlantic. These oceanographic transfers have a major impact on convection in the Labrador Sea and primary productivity in northern and western Baffin Bay. The precise timing and nature of events involved in the deglacial retreat of the formerly grounded Greenland and Innuitian ice-sheets leading to the opening of Nares Strait are barely known. In this study, we investigates the post-glacial paleoceanographic developments in this remote glacial setting from sedimentological (grain size, thin sections, CT-scan), geochemical (elemental, isotopic and molecular organic geochemistry) and micropaleontological (planktonic and benthic foraminiferal abundances and assemblages) records obtained from recently collected ^{14}C dated sediment cores in the north (Hall Basin), south (Trinity Fjord) and center (Kane Basin) of Nares Strait. Major changes in proxy records are associated with distinct lithologic units and suggest a succession of events related to: (1) the retreat of the Greenland and Innuitian ice-sheets, (2) subsequent throughflow of Arctic and Pacific water and (3) the response of sea ice to regional climate changes. Our best resolved record starts at 9.5 kyr cal. BP when the coalescent ice-sheets initiated breaching which eventually led to the opening of the Strait. This period of intense change sustained intervals of perennial sea ice cover which persisted until ca 7 kyr cal. BP. Soon after this series of transitional situations, a modern seasonal sea ice regime settled as Nares Strait underwent acclerated sea level change induced by the post-glacial isostatic rebound. Our results are discussed in the light of previous investigations conducted in northern Baffin Bay, downstream of Nares Strait.

ID: 01555, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

The 2000-year history of climatic change in the steppe of Ukraine, based on a high-resolution study of the varves of Lake Saki

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Bottom deposits of the saline Lake Saki (southwestern Crimea) consist of dark clay bands (the result of runoff during wet seasons) alternating with white salt layers (summer evaporates) (Shostakovich 1934). The seasonal origin of its thin lamination is now confirmed by the comparison of pollen assemblages from individual black and white bands in the lake bed with the seasonal distribution of modern pollen-fall over the lake. According to the varves count, the upper 3.06 m of deposits in the core S14, from the deepest part of the lake, correspond to the last 2000 years. It is confirmed by a 14C-date of 1800±60 from a depth of 2.76 m. The pollen study (sampling density 0.5 cm) of the uppermost lake beds, which were formed since the beginning of the Saki meteorological observation in 1870, demonstrates that the xerophytic/mesophytic pollen ratio can be directly correlated with dry phases. As the forested Crimean Mountains are located close by, arboreal pollen are also abundant in the lake deposits. The higher pollen percentages of broad-leaved taxa directly correspond to warm phases. The high-resolution pollen study of the upper 3.5 m of the core demonstrates the cyclic alternation of dry and wet phases (average duration of 100-300 years), and of warm and cool phases (average duration of 300-400 years). The correlation betwen temperature and moisture regime is not direct, but the majority of warm phases were drier than the cool phases. A pollen study at the Ak-Kaya archaeological site in the Crimean steppe (from III cent. BC to Medieval times) revealed a similar climatic cyclicity (Gerasimenko et al., 2012). The economic pattern in the drought-vulnerable steppe was strongly controlled by this climatic variability. The wet phases provided better conditions for the sedentary economies which involved plant husbandary (indicated by pollen of Cerealia, *Juglans*, *Vitis* and segetative weeds).

ID: 01809, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

Postglacial changes in the floristic latitudinal diversity gradient in Europe

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The latitudinal gradient in species diversity is one of the largest and best-known features of life on our planet, although its causes are still debated among scientists. Originations and extinctions are two major factors determining species richness and may be evaluated on deep geological time. On shorter time-scales, e.g. glacial interglacial cycles, regional diversity is influenced by immigration and emigration. The collection of pollen diagrams in the European Pollen Database (EPD) makes it possible to evaluate changes of the latitudinal diversity gradients of many plant taxa. Due to the multiplicity of authors contributing to the EPD the nomenclature of pollen types is complex; it includes many synonyms as well as identifications to different taxonomic levels, which hamper the comparisons of pollen type richness between pollen diagrams. To overcome this problem, we reviewed the nomenclature of pollen types in the EPD by identifying synonyms and amalgamating them. We constructed a hierarchical system of the pollen types on the basis of pollen morphology, and used this harmonized database to assess site-level and regional estimates of paleo-diversity. We show that there is a strong latitudinal gradient in pollen diversity in Europe, regardless the taxonomic resolution used, however the regression with latitude is strongest when taxa are combined at higher identification levels. The strength of the gradient has changed through time. It was weakest during the Younger Dryas and increased until 7000 years ago. The latitudinal gradient is always present in the regional pool of pollen types – however also here there is a peak in slope during the early Holocene, which is partially due to the disappearance of herbaceous taxa in the boreal zone. The evolution of the latitudinal gradient in pollen type diversity in Europe provides an example of climate driven changes in regional diversity due to immigration and competitive exclusion of taxa.

ID: 01554, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

New lights on human-environment interactions in the Northern French Alps provided by lake sediment DNA

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Since Prehistory, mountains have attracted human populations for hunting, gathering and agrarian activities. In the European Alps, the broad historical outline of mountain exploitation by peoples and interactions with the environment is only partially understood via palaeoenvironmental and archaeological research. Due to a lack of suitable proxies, the precise nature of agrarian activities and their temporal and spatial dynamics are poorly documented, as well as the impact of former activities on mountain environments, both in terms of landscape trajectories and legacy.We propose here a synthesis of the agrarian history from the Northern French Alps based on original results from lake sediment DNA. This emerging tool was successfully applied on Lakes Anterne, Savine and Verney located above 2000 m asl and la Thuile at 874 m asl. This altitudinal distribution reveals the story of both crops and livestock farming. Moreover, Savine, Verney and Anterne are located on or close to passes between, France and Italy or Switzerland. This allows us to assess the role of former routes networks in the development of alpine communities.Cattle herds might be present as early as 2800 BC at Anterne. Intensive use of “Alpages” with sheep and cattle is then recorded around the three lakes during the late Iron Age and/or the Roman period. A lower grazing pressure is also suggested at lower altitudes (*Plantago* sp). This development of pastoral activities led to a regionally recorded increase in soil erosion. From the Early Middle Ages (700-1000 AD) another phase of high pastoral pressure is recorded regionally (except at Savine, but the livestock were probably displaced towards more suitable pastures). Cattle dominate within the region from 1000-1400 AD. At lower altitudes, crops increase and diversify. Mountain socio-ecosystems responded differently to these agricultural and economic changes, especially in terms of erosion dynamics.

ID: 01446, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Glacial/interglacial changes of Southern Hemisphere zonal circulation from the geochemistry of South American and East Antarctic dust

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The latitudinal displacement of the southern westerlies is a key parameter for understanding the variations of Southern Hemisphere atmospheric circulation during the Late Quaternary Period. To increase understanding of past atmospheric circulation we dig deeper into dust provenance in paleo-archives of the Southern Hemisphere. We present herea Sr-Nd-Pb isotopic and rare earth element study of surface sediments collected along a ~4000 km latitudinal band from arid and semi-arid terrains in southern South America. The importance of these terrains as paleo-dust suppliers are compared with modern dust collected from monitoring stations along the same latitudinal band, thus serving as a test of how actual dust compositions compare to those of potential source areas. Moreover, the comparison is useful for understanding present-day atmospheric circulation. Revisiting the provenance of dust trapped in the Antarctic ice and sediments deposited in the Southern Ocean, the new data indicate multiple source regions in southern South America and a minor participation of the Australian potential dust sources. Although Patagonia plays an important role in contributing dust to the higher latitudes, central Western Argentina and (to a lesser extent) the southern Puna region also emerge as important dust sources during glacial times. Moreover, the southern Altiplano is as a major contributor during interglacial periods as well. Given our understanding of modern wind-dust activities, the possibility of a prominent presence of southern South America source regions other than Patagonia in east Antarctic ice is consistent with an overall equatorward displacement during glacial times of both the mid-latitude westerlies and the high altitude jet stream.

ID: 01512, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Population and Heath vulnerability

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major uncertainty concerning the 21st century climate is the ice-sheet response to global warming. Paleodata indicates rapid ice-sheet destabilizations during the last deglaciation (as for instance Heinrich Event and melt water pulses). Ice sheet destabilization could therefore modify the sea level rise and its evolution by the end of this century. This feature has already been pinpointed in recent publications. However, the impacts could not restrict to the sea level and the climate could be disturbed.To account for these potential instabilities, we explore the impact of different scenarios of abrupt Greenland ice sheet melting during the 21st century superimposed to RCP8,5. We will present the results of these freshwater housing experiments corresponding to a superimposed sea level rise varying from 0,5 to 3m. We demonstrate that such a melting induces several consequences on the West African monsoon: duration, delay and a decreasing of the precipitation. We investigate the agricultural and health impact of these abrupt climate changes on the very sensitive Sahel region.First, we quantify the agricultural area losses due to monsoon changes. Consequently, we pinpoint a large potential for migration of millions of people in the coming decades. Thus, the ice-sheet destabilization provokes not only costal damages, but also large population migration in monsoon area.Secondly, the large changes of the hydrological cycle in tropical area may also provide favorable conditions for the spread of pathogens vectors. Using IPCC scenarios several studies have already shown the impact of climate changes as Malaria on extended areas.Here we explore the potential risk due to the major atmospheric tropical reorganization due to ice sheet destabilization.

ID: 01322, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Oral)

Improving relative sea-level reconstructions in northern Greenland from marine bivalves with stable isotope data; implications for ice history and GIA models

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The Greenland Ice Sheet (GIS) holds an ice-mass equivalent to about 6 meters of eustatic sea level equivalent. Understanding its melt dynamics and placing its vulnerability within the climatic context of the Holocene is essential in order to better constrain glacio-isostatic adjustment (GIA) models and predict future GIS contributions to global sea level. Commonly, model constraints for relative sea level variations consist of limiting ages obtained from marine shells exposed on land. A key uncertainty is the water depth of shell growth, which may vary over many 10's of meters. Radiocarbon dates from bivalve samples collected on raised marine deposits during the Petermann15

Expedition (July 2015), in Hall Land, Washington Land of NW Greenland near Petermann Glacier, a major outlet of the Greenland Ice Sheet, and the Cape Baird region of Ellesmere Island constrain relative sea-level histories during the last deglacial period as well as during MIS3. Here we correct for shell depth habitats based on δ18O in each dated shells and in the modern water column, assuming that past vertical gradients in water column δ18O were roughly similar to today. We find this assumption breaks down during times of rapid relative sea level fall associated with regional ice loss, implying specific times of substantial meltwater input during glacial retreat. Both raw data and habitat-corrected data suggest a significant mismatch with previously employed GIA models, both in amplitude and rate of relative sea level change: Compared to the GIA model HUY3 we find that relative sea level during MIS 3 may have been several 10s of meters higher than predicted by the model. In addition the data suggest that the model not only underestimates the rate of sea-level change during deglaciation but also misrepresents the timing when maximum ice-loads are reached. This study may therefore provide a new view of ice load history in Northern Greenland, and points towards the importance of including marine ice dynamics in models of ice retreat, and, perhaps, better constraints on regional variations of viscosity in GIA ice-models.

ID: 01781, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Paleo-ENSO during the last glacial period inferred from tropical subandean ecosystems

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ENSO is undoubtedly the most important source of interannual variability for the hydroclimatology of the northern Andes. However, there is a clear lack of understanding of paleo-ENSO and other climatic phenomena at mid-altitudes in the tropical Andes, and its relationship to ecosystems, due to the lack of suitable paleoclimatological archives. Here, we present a multiproxy paleoenvironmental reconstruction on terrestrial sediments and extremely well preserved organic remains embedded in the Pereira-Armenia fluvio-volcanic fan (2000 m.a.s.l) located in the Central Cordillera of Colombia. Today, the study area is one of the wettest in the northern Andes with ca. 2800 mm of annual precipitation and very sensitive to ENSO variability. Radiocarbon dating, Ur-Th/He and palynological analysis suggest that the deposit dates back to the last glacial period. The overall hydroclimatic conditions in the northern Andes during the full glacial are assessed from pollen, biomarkers, and microanatomical analysis of ancient woods, suggesting colder and more seasonal climates than today. By modeling the current ecological niche of individual species and their projection for glacial conditions, we infer the prevalence of a more marked seasonality in the area. Additionally, by comparing the ultrahigh resolution δ^{13}C signal of an ancient wood identified as *Chrysochlamys* (Clusiaceae), and a modern analog of the same species, a clear difference in seasonality arises suggesting a different climatic configuration most likely related to paleo-ENSO intensity. These findings shed light on the hydroclimatological configuration of the northern Andes of intermediate altitudes and the response of tropical ecosystems to interannual climatic variability.

ID: 01535, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Cause and consequences of the '4.2 kyr event'

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The '4.2 kyr event' denotes a long-recognized and much debated cluster of striking cultural and climatic discontinuities in the last few centuries of the 5th Millennium BP, noted in widely distributed historical and natural proxy records. Familiar cultural examples include the near-simultaneous collapse of the Old Kingdom in Egypt and the Akkadian Empire in present-day Iraq, both associated with hydroclimatic stress and environmental deterioration including dust deposition. Natural proxy records clearly portray contemporaneous weakening of the North African and Asian monsoon circulations, and indicate shifts towards aridity, instances of increased dust deposition, and cooler temperatures through the Northern Hemisphere. While this evidence provides some insights, the character of the '4.2 kyr event' remains poorly understood and a plausible causal mechanism is lacking.

We synthesize the available proxy evidence and results from climate models and paleo-hydrological simulations to develop a plausible, dynamically consistent scenario for the cause and consequences of the '4.2 kyr event'. In this scenario, the event resulted most immediately from the mid-Holocene recession of Megalake Chad and the ensuing dust emissions from exposed lakebed sediments within the Bodélé Depression, today the world\'s largest single source of dust. The radiative effect of the increased dust emissions weakened the Asian and North African monsoon circulations, cooled the Northern Hemisphere extra-tropics and reduced intrusions of tropical moisture into the sub-tropics, the same distinctive suite of changes that are produced by dust-enabled global climate models when North African dust emissions are increased. Notably, a weaker North African monsoon implies a further reduction of rainfall over the Megalake Chad watershed. With respect to cause, the event occurred as the declining Megalake Chad began to expose erodible fine sediments. Hydrological modeling reveals that even modest feedback between lakebed dust emissions and rainfall can result in accelerating reductions in catchment runoff and a rapidly falling lake level, thereby increasing the area of newly exposed lakebed susceptible to dust mobilization.

ID: 02306, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Circulation control on primary productivity and CO2 in the subarctic Pacific over the last deglaciation: evidence from boron isotopes in planktonic foraminifera

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Sediments within the subarctic Pacific Ocean record a dramatic peak in biogenic fluxes (opal, $CaCO_3$, biogenic barium) during the Bølling-Allerød interval of the last deglaciation (~14.5 ka). The cause of this regional productivity maximum remains enigmatic, with macronutrient upwelling, iron fertilisation, and a reduction in light limitation all proposed as potential drivers. Distinguishing between macronutrient upwelling and iron fertilisation is important due to the different implications for the carbon cycle: macronutrient upwelling could result in a significant flux of CO_2 to the atmosphere, whereas iron fertilisation would result in a greater uptake of CO_2. Using the boron isotope ratio ($\delta^{11}B$) of planktonic foraminifera *N. pachyderma* from core MD01-2416, we demonstrate the deglacial productivity maximum was associated with a (near-)surface ocean pH minimum, a scenario only compatible with macronutrient upwelling. This pH minimum indicates a significant flux of CO_2 to the atmosphere at the onset of the Bølling-Allerød, which may have contributed to the abrupt increase in atmospheric CO_2 observed at this time. Radiocarbon depleted bottom waters at depths of < 1500 m indicate a decrease in North Pacific Intermediate Water (NPIW) formation coeval with the deglacial productivity maximum. At the same time, the presence of ice sheets over North America would have enhanced Ekman suction within the region via increased wind stress curl. We propose that the collapse in NPIW formation, coupled with enhanced Ekman suction, drove a substantial increase in the upwelling of nutrient and CO_2 rich deepwaters into the surface ocean during the Bølling-Allerød, causing the observed minimum in pH and maximum in primary productivity and CO_2. This model suggests a key role for ocean circulation in driving abrupt changes in the biochemistry of the subarctic Pacific Ocean over the last deglaciation.

ID: 02284, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Improving estimates of surface water radiocarbon reservoir ages in the northeastern Atlantic Ocean.

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Radiocarbon measurements from planktic foraminifera are widely used to constrain age models and the timing of paleoceanographic events in marine sediment cores, as well as past changes in ocean circulation and carbon cycling. However, in order to use radiocarbon for these purposes a knowledge of the surface ocean radiocarbon reservoir age and how it varies in both space and time is needed. Typically, to convert a planktic radiocarbon age into a calendar age, an assumed constant reservoir age of 400 years is applied. However, there is mounting evidence to suggest that this assumption of constant reservoir age through time is an oversimplification, particularly for the high latitude oceans during intervals of rapid climate change. Here we present new high-resolution radiocarbon reservoir age estimates from three sites in the northeast Atlantic Ocean: ODP Site 983 (60°24\'N, 23°38\'W; 1983m), Site 980 (55°29\'N, 14°42\'W; 2168m) and DAPC2 (58°58\'W, 09°36\'W; 1709m). We show that there have been large changes in surface water reservoir ages over the deglaciation, that coincide with times of abrupt climate change. These reservoir age changes have implications for both radiocarbon-based age models and our understanding of circulation and deep-water formation in the North Atlantic. Based on the new data, we present a model of

ocean overturning circulation during millennial scale climate events that is consistent with the shifts observed in radiocarbon and $\delta^{13}C$ over the deglaciation.

ID: 01700, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Holocene lowering of the Laurentide Ice Sheet weakens North Atlantic gyre circulation and affects climate

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Ice sheet topography is an important control on glacial climate. The presence of the large North American Laurentide Ice Sheet (LIS) at the Last Glacial Maximum (LGM; 21 ka) produces a stronger and more zonal jet stream, modifies surface climate and storminess over the North Atlantic and affects North Atlantic gyre circulation and the Meridional Overturning Circulation. By the start of the Holocene, 9.0 ka, the size of the LIS was much reduced, yet, it has been suggested that the demise of the LIS played a role in the 8.2 ka abrupt cooling event through its topographical influence on atmospheric circulation.

Here, for the first time, we evaluate how the demise of the LIS 9.5-7 ka directly influences atmospheric circulation through changing topography, and the wider implications for climate. We ran a series of 500 year-long equilibrium experiments using the HadCM3 ocean-atmosphere-vegetation General Circulation Model with LIS topographies and ice masks taken from a transient simulation of the ice sheet, using snapshots at 9.5, 9.0, 8.5 and 8.0 ka.

We find that the lowering of the LIS produces a dipole pattern of surface ocean and air temperature anomalies over the North Atlantic. Between 9.5 and 8.0 ka, we model a progressive 2 °C cooling south of Iceland and 1 °C warming between 40-50° N, matching sedimentary records. This is associated with a weakening of the Subtropical and Subpolar Gyres caused by a decreasing wind stress curl over the gyres as the ice sheet lowers. However, topographical changes between 8.5 ka and 8.0 ka induce minor climatic change relative to the ~160 year-long cooling pattern of the 8.2 kyr event.

ID: 01346, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Robust evidence for forced changes in ENSO: from the mid-Holocene to the 21st century

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The El Niño-Southern Oscillation (ENSO) represents the largest source of year-to year variability; however, its sensitivity to external climate forcing, whether natural or anthropogenic, is difficult to assess with available records. High-resolution paleoclimate reconstructions of ENSO provide a comprehensive view of ENSO variability through the last centuries to millennia, particularly monthly-resolved coral $d^{18}O$ records from the heart of the ENSO region, in the central tropical Pacific (Cobb et al., 2013). Here, we extend the paleo-ENSO record through the generation of 16 new fossil coral $d^{18}O$ timeseries, averaging 15yrs each, for a total of 233 years of data that greatly augment the available paleo-ENSO archive. Combining this new dataset with published data, we quantify the differences in natural variations in ENSO from the mid-Holocene to present using a variety of different null hypotheses that includes multi-millennial simulations from both statistical and dynamical models of ENSO variability. We document a significant increase in recent ENSO variance as compared to the last 7,000 years, implying a role for greenhouse gases in driving an intensification of ENSO. We also find a significant reduction in ENSO variance of roughly -20% from 3,000-5,000yr before present, relative to the preceding and subsequent intervals of data. The causes of the late mid-Holocene reduction in ENSO variance may be linked to the influence of fall and/or spring equatorial insolation forcing, which perturbs the seasonal cycle at the critical growth and decay phases of ENSO extremes, respectively. Our findings imply that ENSO is sensitive to external forcing, both natural and anthropogenic, although the precise mechanisms for such responses require further study. Our results imply that anthropogenic climate change has likely contributed to the recent record-breaking El Niño events, and that future ENSO variance is likely to remain strong under continued greenhouse forcing.

ID: 02017, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Oral)

Economic response to climate change. Poland during Little Ice Age

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In his recent *opus magnum* on the impact that the Little Ice Age had across the globe in the 17th century, Geoffrey Parker included a substantial chapter on the Polish Lithuanian-Commonwealth, that is, Central Europe. Using the data and results published by the previous generations of Polish historians, he concluded that Poland was hard hit by the warfare and economic decline that could be associated with the LIA's climate instability.More recent data, however, suggest that Poland's story was actually different. First of all, the palaeoclimate data from north-western Poland suggest that the main cooling episode occurred in this part of Europe in the middle of the 14th century, and not in the 17th c. In this later period, the climate conditions seem to be relatively stable. Secondly, pollen profiles that cluster in two key agricultural regions of the country, Greater and Lesser Poland, suggest that there occurred no drop in the spatial extent of cereal cultivation in the 17th century; this suggests that there was no major crisis in the key sector of the country's economy. On the other hand, there is a clear longer-term decline in all pollen indicators of agriculture in the 14th and 15th century. Last but not least, preliminary results of our research on documentary data from estate inventories in different parts of Poland also suggest that there was no significant crisis in agricultural productivity (or rural demography) in the 17th c. Consequently, despite its history of almost incessant warfare throughout the period, Poland seems to have escaped the real impact of the Little Ice Age, so well documented in some others parts of the world. The Little Ice Age in Poland was, in fact, the period of the country's greatest economic and political development.

ID: 01911, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Oral)

Holocene paleoenvironmental change and sea level variations in South Africa

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As part of the SPACES programme, funded by the German Federal Ministry of Education and Research (BMBF), the RAiN (Regional Archives for Integrated iNvestigations) project focuses on closely integrated investigations of terrestrial and marine environmental archives in order to assess paleoenvironmental change within the three different rainfall zones of South Africa. Here we present results from the terrestrial archives Groenvlei (vlei = lake) and Eilandvlei in the year-round rainfall zone (YRZ), and Verlorenvlei in the winter rainfall zone. Particular focus will be on a 30.5 m long sediment core recovered from Eilandvlei on the southern Cape coast. In this record, radiocarbon dating turned out to be a major issue which was solved by determining different reservoir effects over time using paired terrestrial and bulk sediment samples corroborated by paleomagnetic secular variation stratigraphy. The final chronology reveals a basal age of 8920 $^{+200}/_{-250}$ cal BP indicating an average sedimentation rate of 3.4 mm a^{-1}. Up to now, this ultra-high-resolution record of environmental change represents a unique discovery for southern Africa. Using XRF data from this core, different phases of deposition can be reconstructed. High Ca and Sr values can be linked to phases of enhanced deposition of marine sediments and reduced terrestrial sediment input, while low Ca and Sr values show the opposite. This is supported by micropaleontological (diatom, pollen, ostracod and foraminifera) investigations. Minerogenic input indicators, e.g., K reflect changing hydrological conditions in the catchment area of the lake. Results are compared to the above mentioned archives as well as previously published investigations from different archives (e.g., speleothems). Hydro-acoustic and sub-bottom profiling investigations reveal a sediment thickness of >100 m in Eilandvlei which bear the potential of extending the record further back in time.

ID: 01640, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Reconstruction of Eemian mean ocean temperature using ice core noble gas thermometry

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Oceanic heat uptake carries the lion's share of glacial/interglacial changes in the planetary heat content, and is the most integrative and representative parameter for quantifying long-term changes in the Earth's energy budget.

We are focusing on the Eemian interglacial. It is of particular interest because - similar to climate in the later 21st century - global atmospheric temperatures for this period were significantly warmer than pre-industrial, although greenhouse gas forcing was similar.

The only proxies for ocean temperatures during the Eemian are sediment cores which point to a significantly warmer sea surface temperature in many regions and an about 1.5°C warmer deep ocean compared to the present interglacial. Models in contrast struggle to produce an Eemian ocean average temperature that is significantly warmer than at present.

The novel method of ice core noble gas thermometry allows us to reconstruct global mean ocean temperature (GMOT) on the basis of physical principles. The xenon/krypton ratio in the atmosphere is a direct proxy for GMOT because of the temperature dependence of their solubility coefficients. The MOT in past times can therefore be estimated using high-precision measurements of noble gas elemental ratios from gases trapped in glacial ice after appropriate corrections for archive-specific effects.

We performed Xe/Kr analyses on the EDC, EDML, and Talos Dome ice core for the Eemian time interval (130 to 120 kyr B.P.). The measurements imply 2.3±0.5°C warmer ocean temperatures compared to the Holocene. Latest measurements on bubble ice from Taylor Glacier (Jeff Severinghaus, personal communication), however, show a smaller warming during the Eemian more in line with deep ocean temperature reconstructions. Investigations are ongoing whether this is due to a gas loss process during storage of the samples at relatively high temperatures (-25°C) related to fast relaxation of clathrate ice.

ID: 01257, 06.- Before and after - climate contrasts across the MPT, (Oral)

Simulating Mid-Pleistocene CO2 change

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Ice age cycles in the atmospheric concentration of CO2 have exerted a forcing onto the climate system that helps explain the magnitude and global reach of glacial/interglacial climate change. Moreover, the key processes thought to have caused CO2 change over recent ice age cycles are themselves sensitive to changes in climate that affect ocean circulation, biologically driven carbon sequestration and seawater acid/base chemistry. The notion of climate-carbon cycle feedbacks playing a key role in the Mid-Pleistocene Transition in the character and amplitude of ice age cycles contrasts with the widely held view of carbon cycle and CO2 change as a driver of the MPT.

In this talk I will review key ocean drivers of atmospheric CO2 change, using model simulations to frame the late Pleistocene CO2 record as the consequence of three alternating states of the climate system. Using a proxy-driven inverse modeling approach CO2 can be predicted back to 1.5 Myr, beyond the MPT. This exercise reveals that changes in both Atlantic Meridional Overturning Circulation and dust-borne fertilization of the Southern Ocean acted as positive feedbacks that intensified ice age conditions following the MPT. Detailed comparison between model-predicted CO2 and observational constraints on CO2, ice volume and temperature suggest that secular carbon cycle change was not the initial trigger for the MPT. Conversely, the intricate coupling between carbon cycle and climate across the MPT should serve as a warning of the manifold environmental impacts to be expected in a high CO2 future.

ID: 02194, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Oral)

Dry/wet change characteristics of the past 1000 years over eastern China

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Based on Chinese historical documents, local chorography and royal archives, the historical dry/wet records were divided into five grades (drought, light drought, normal, light flood, flood). Moreover, the dry/wet change characteristics on seven regions over eastern China were analyzed using 63-site yearly dry/wet grade dataset which derived from above historical records. The results show that the dry/wet variations have experienced three periods. Most regions were droughty from 960 to 1344, humid from 1345 to 1915, droughty from 1916 to 2010, respectively. Compared with temperature sequence of the past 1000 years over eastern China, the climate was droughty during three most warm periods(1370s-1450s,1500s-1580s and 1890s-2000s).By contrast, the precipitation was more than normal during little ice age (1590s-1880s). Before 1340s, the climate was droughty with lower temperature and humid with higher temperature. The spectrum analysis proved that the dry/wet variations existed 5~8a interannual period, 25-30a and 60 - 80a interdecadal period, 90-110a centennial period over eastern China. On interannual scale, the Yellow River basin was droughty in 160 El Nino years or the following years after 1525; on centennial scale, there was strong positive correlation between solar activities and dry/wet variations. In addition, the extreme drought/flood events and their high frequency periods were identified of the past 1000 years.

ID: 01307, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Human disturbance and resilience of a tropical peatland in Sumatra, Indonesia

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Pressures on peatland in Southeast (SE) Asia due to land use and conversion escalate in the past few decades, following the increase in population demand for food, settlements and resources. In order to prevent loss and to maintain the important functions of this ecosystem, management strategies are urgently required. Historical information can provide valuable knowledge on ecosystem response to disturbance and their resilience. Thus, in order to create effective management strategies on peatland under rapidly changing global environment, it is important to include a historical perspective.

Unfortunately, knowledge on past disturbance of peatland in SE Asia remains a large gap, particularly of how past human interventions controlled vegetation composition and C accumulation in peatlands. Due to lack of evidence, extensive human disturbance is considered to be novel. Thus, understanding the impact of peatland resilience to human-induced disturbance prevail to be a huge challenge.

By conducting palaeoecological study in a peatland on the coastal area of Jambi, Central Sumatra, we found strong evidence of extensive human disturbance from 1100 to 500 years ago, indicated by the openness in vegetation and decreased ecosystem ability to accumulate peat and carbon. The disturbance is noticed to be resulted from logging and grazing activities conducted by the inhabitants of Malayu Empire in the 9th to 14th century, whose temple remain is located close to the peatland. After the land abandonment as the Empire moved to the hinterland area, the record interestingly showed that ecosystem has recovered. In addition, the record suggests that socioeconomic situation was a significant indirect driver on peatland vegetation and its function.

Keywords: *peatland, long-term data, disturbance, human impact, resilience*

ID: 01417, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Tree growth and productivity during the Last Millenium: a forward modelling approach for data-model comparisons

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The derivation of Last Millennium climate reconstructions from tree-ring series is based on several assumptions including that (a) ontogenetic effects on radial growth can be removed statistically, (b) tree growth at a given site is controlled by a single climate factor and the statistical relationship between radial growth and this factor is invariant through time, (c) non-climatic factors such as changing CO_2 concentrations $[CO_2]$ have negligible impacts on growth, and (d) allocation of stem growth is a constant proportion of total productivity. Here we use a first-principles light-use efficiency model (the P model) coupled to a tree growth and allocation model (the T model) to investigate these assumptions. This forward modelling approach provides a way of explicitly accounting for ageing effects on tree growth. Comparisons of simulated productivity, driven by climate outputs from an ensemble of CMIP5-PMIP3 Last Millenium simulations, show different patterns of temporal and geographic variability from those present in individual climate variables, indicating that long-term trends in radial growth do not necessarily reflect single-factor controls. Furthermore, carbon allocation between above- and below-ground components of the tree can be affected by both climate and changes in $[CO_2]$ and could thus modulate the apparent relationship between stem growth and climate. These results suggest a way forward, by which process-based modelling – allowing the relaxation of unrealistic assumptions, and building on ecophysiological theory – could allow more soundly based interpretations of tree-ring data and comparisons with palaeoclimate simulations.

ID: 01548, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Invited Oral)

Contrasting protactinium regimes between the North Pacific and the North Atlantic

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There is a deficit in sedimentary protactinium (Pa) accumulation with respect to its production in the water column within the interior of both the North Pacific and North Atlantic Oceans. In the Pacific, this deficit has been ascribed to boundary scavenging, or transport of Pa by dispersive fluxes to areas of higher scavenging intensity at ocean margins. In the Atlantic, where dispersive fluxes have a higher advective component than in the Pacific, the interior ocean Pa deficit has been linked to the flow of North Atlantic Deep Water and furthermore to the magnitude of the Atlantic Meridional Overturning Circulation. How have recently reported water column Pa and Th distributions informed these classic, contrasting views? In the North Pacific, Pa appears to be removed more efficiently across large biogeographic provinces, rather than only at the margins, at the edges of the subtropical gyre, such as the subarctic gyre or the equatorial upwelling zone. Across the Pacific, the Pa budget appears to be roughly in balance. In the North Atlantic, there is a clear impact of ventilating water masses on seawater Pa concentrations, but the water column Pa/Th ratio is much more related to variations in scavenging intensity than to water mass origin. However, barring a yet-to-be-observed, massive Pa sink from hydrothermal scavenging along the mid-Atlantic ridge, Pa must be exported out of the North Atlantic water column, though the exact pathway is still unclear. It may be that removal of Pa from the interior North Atlantic is much more diffusive than previously thought, while still maintaining a net north-to-south transport.

ID: 01982, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Oral)

Achievements and Future Direction of the Pliocene Model Intercomparison Project

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The mid-Piacenzian (Pliocene) Warm Period (~3.3 to 3 million years ago) appears to have been a warmer and wetter world with a higher concentration of CO_2 in the atmosphere (compared to the pre-industrial era). Whilst numerical climate models have shed light on the nature of the climate system at the time, uncertainties in their predictions are only now being systematically examined. Since 2008 the Pliocene Model Intercomparison Project (PlioMIP) has quantified uncertainties in model outputs through a coordinated multi-model and multi-model/data intercomparison. Here we summarise the achievements of PlioMIP to date, derived from ~50 project publications, and present ongoing work and the future direction of the project.

So far the project has focussed on the nature of tropical circulation (both the Walker and Hadley circulations), monsoon systems (East Asian and African monsoons), modes of climate variability (i.e. ENSO), ocean circulation and heat transport (the AMOC), Arctic sea-ice behaviour and polar amplification. Additional studies have examined implications of Pliocene simulations for Climate and Earth System Sensitivity. Model performance has been assessed by comparison to available land and ocean temperature data, with lessons learned in terms of the methodological approaches towards data/model comparison.

Phase 2 of PlioMIP is currently underway and, whilst being a CMIP6 endorsed climate experiment, introduces a new focus on sensitivity experiments to inform the understanding of Pliocene climate and the nature of data/model coherence, as well as the utility of the Pliocene to better understand the nature of future climate change. This includes a new focus on a narrower time window for proxy data synthesis (Marine Isotope Stage M2 to KM5) providing the capability to include estimates of surface temperature temporal variability into Pliocene data/multi-model comparison for the first time.

ID: 01992, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

Sea-saw-like repeated extinction patterns of cold-water corals across the Strait of Gibraltar

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As ecosystem engineers, cold-water corals are at the base of impressive ecosystems found mainly in intermediate waters along many continental margins in the world. On geological time scales, the accumulation of fossil corals and other remains of these ecosystems in combination with hemipelagic sediments form impressive sea bed structures, called cold-water coral mounds. These mounds that can reach heights of >300 m can serve as paleo-archives preserving the long-term development of cold-water corals, their associated ecosystems, and the environmental setting. Applying the Bremen Seafloor Drill Rig (MeBo) to cold-water coral mounds from both sides of the Strait of Gibraltar yielded up to 70 m long sediment cores covering the last ~400,000 years. Comparing these paleo-records reveals a see-saw pattern with active coral ecosystems in the Alboran Sea being mainly restricted to warm climate settings in contrast to the Moroccan Atlantic margin, where they mainly occurred during colder climates. As immobile benthic organisms, the corals could not move to escape unfavorable environmental conditions and, obviously, rates of environmental change were too fast to adapt. Consequently, upon deteriorating environmental conditions the cold-water corals died off. Interestingly, paced by the major Late Quaternary climatic cycles, repeating cycles of on- and offset of coral prosperity can be observed on either side of the Strait of Gibraltar, most likely responding to cyclic environmental changes driven by these climatic cycles. However, it appears that rather regional oceanographic responses controlling the food supply to the corals govern their occurrences than the overall climate setting. One of the major open questions addresses the processes of the repeated re-establishment of the coral ecosystems.

ID: 01364, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Last millennium meridional shifts in hydroclimate in the central tropical Pacific

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The spatial structure of last millennium hydroclimate history in the tropical Pacific requires continuous, high temporal resolution archives of past moisture balance across spatial gradients of precipitation. To date, only one 600-year terrestrial record of hydroclimate is available for the central tropical Pacific, (CTP) limiting the ability to test hypotheses about shifts of the Intertropical Convergence Zone (ITCZ). Here we present a new lake sediment record and mineralogical modeling results from Lake 30 on Kiritimati Island (1.9° N, 157.4° W), which provide a critical test of past ITCZ migration for the CTP. We use geochemical and sedimentological data to infer centennial periods of fresher and more saline lake water during the last 2000 years. An episode of increased microbial mat development and gypsum precipitation defines 900 to 1250 C.E., coincident with the Medieval Climate Anomaly (MCA). Modeling of mineralogical evolution in this lake indicates increased evaporation, due to a period of extended aridity, drives precipitation of gypsum in Lake 30. A shift from gypsum and microbial mats to carbonate sediment at the transition between the MCA and the Little Ice Age (LIA), when a lake 3° to the north of Kiritimati shows the opposite trend, supports the hypothesis of a southward shift, rather than a contraction, of the ITCZ at this time in the CTP, leading to increased precipitation over Kiritimati.

ID: 02249, 06.- Before and after - climate contrasts across the MPT, (Oral)

A continuous 1.5-million year record of millennial climate variability from the Iberian Margin

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* David Hodell, dah73@cam.ac.ukIODP Site U1385 (“Shackleton site”) was drilled on the Iberian Margin, which is a well known source of high-fidelity records of late Pleistocene climate variability. We extended the piston core records in the region by producing a millennial-resolved record of planktic and benthic $\delta^{18}O$ for the last 1.5 Ma. The record is used to evaluate how millennial climate variability evolved across the Middle Pleistocene Transition.

Millennial-scale variability has been a strong, persistent feature of surface climate on the Iberian Margin during glacial periods for the last 1.5 Ma. Increases in planktic $\delta^{18}O$ are mirrored by decreases in benthic $\delta^{13}C$, suggesting surface water cooling was accompanied by changes in overturning circulation. For the stronger millennial events, the phasing of benthic and planktic $\delta^{18}O$ is consistent with a pattern indicative of an active bipolar seesaw. Millennial variability was enhanced during glacial stages and suppressed during interglacials and maximum glacial periods. At Site U1385, millennial variability in planktic $\delta^{18}O$ is enhanced when benthic $\delta^{18}O$ values fall between ~3.2 and 4 o/oo (uncorrected *C. wuellerstorfi*). Prior to 650 ka, millennial-scale variability was activated when obliquity dropped below 23.5°, providing evidence of obliquity modulation of the amplitude of millennial variability. Low obliquity has been associated with ice growth during glacial inceptions and the appearance of bipolar seesaw climate variability.

Prior to 1.25 Ma during the “41-kyr world”, millennial variability persisted through the glacial period as benthic $\delta^{18}O$ values always fell within the “millennial window”. After 1.25 Ma, millennial variability was most prominent during times of intermediate ice volume, and especially glacial inceptions and terminations. The style of millennial variability changed at 650 ka (MIS 16) with the growth of very large ice-sheets and introduction of additional ice sheet dynamics (e.g.,Heinrich events).

ID: 01290, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Antarctic Last Interglacial Isotope Peak in Response to Sea Ice Retreat not Ice Sheet Collapse

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Several studies have suggested that the Antarctic Ice Sheet was the primary contributor to sea level rise during the last interglacial (LIG; 130,000 to 115,000 years ago), most of which is hypothesized to have come from the unstable West Antarctic Ice Sheet (WAIS). Collapse of the WAIS would contribute ~3.5 m to the 5-9 m sea level rise reconstructed for the LIG. The prevalent hypothesis is that WAIS loss coincided with the peak Antarctic temperature and stable water isotope values from 128,000 years ago (128 ka); very early in the last interglacial. Using Bayesian multivariate linear regression and a statistical model comparison to combine isotope-enabled climate model simulations with Antarctic ice core data, we show that WAIS loss is not consistent with the isotopic evidence at 128 ka. Instead, a 65 ± 7 % retreat of Antarctic winter sea ice area best explains the 128 ka ice core evidence. This finding of a dramatic retreat of the sea ice at 128 ka demonstrates the sensitivity of Antarctic sea ice extent to climate warming. These results may also provide supporting evidence for WAIS loss and sea ice build up later during the LIG.

ID: 01855, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Invited Oral)

North African humid phases during the last 500 ka

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There have been significant changes in the palaeorainfall system of the African continent on millennial timescales, primarily driven by migration of the Intertropical Convergence Zone and its attendant monsoon belt. However, there are only scarce continental palaeoclimate data for northern Africa and the lack of well-dated time series of precipitation from the region seriously hinders understanding of underlying mechanisms as well as potential consequences for human habitats and past migration patterns. Recent work on a stalagmite from Cyrenaica, Libya, revealed previously unknown humid phases in North Africa during the last glacial period with significant implications for past human migration during that period. Here, we present new results obtained on North African speleothems. One cave is located near Gafsa (Tunisia) in a currently arid zone. The cave is dry today, but it contains stalagmites, flowstones and columns indicating previous wet conditions in the cave. We analysed drill cores taken form a suite of small stalagmites and pieces from flowstone and column formations. U-Th dating of the specimen revealed timing of past humid phases, mainly during interglacial periods in the last 500 ka, with episodic speleothem growth during marine isotope stages (MIS) 12/11, 9, 7 and 5. We also find short episodes of speleothem formation during the last glacial period. Assessing the timing and spatial extension of humid phases is complemented by analyses on a stalagmite recovered in a cave in the Djebel Serj, about 200 km north of Gafsa. We find that a ca 800 mm long stalagmite formed episodically during MIS 9, 7 and 5. We will present details on timing of humid phases across the Tunisian North African realm and also results of stable oxygen and carbon analyses on the speleothems to assess potential changes of local hydrology, vegetation or rain water source in more detail.

ID: 02130, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Dust as a tracer of, and feedback on glacial abrupt climate change

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Mineral dust is a major natural aerosol in today's climate. Changes in desert dust in the atmosphere are thought to contribute to interannual or decadal regional climate variability. During the last glacial period, atmospheric dust in Greenland and in the tropical Atlantic varied several-fold over the course of Dansgaard-Oeschger warming events. However, relatively little is known about the impact of these dust variations on climate forcing, or what they reveal about the mechanisms underlying abrupt climate change. To address these questions, we performed simulations of abrupt climate transitions using an Earth System model with interactive vegetation and aerosols (HadGEM2-ES) and ice-age boundary conditions. We evaluated two different mechanisms proposed to date. The first relies on ocean circulation changes in the North Atlantic which are modelled by prescribing an artificial freshwater flux. In the second, Arctic sea-ice fluctuations are forced using a basal sea-ice heat flux method. The two scenarios produce similar warming signals over Greenland, but with radically different climate perturbations further afield, particularly over the tropics. The resultant dust aerosol changes are also very different, with a much larger response to the freshwater forcing. We evaluate the Earth System model simulations with the available climate and dust reconstructions to compare the likely realism of the two scenarios. We also calculated the dust radiative forcing. This shows a globally averaged difference of $1Wm^{-2}$ in response to the freshwater forcing, which is equal to that simulated for glacial-interglacial difference with the same model. This raises the possibility of a role for dust changes in shaping the climatic evolution during Dansgaard-Oeschger events.

ID: 01793, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Invited Oral)

Reconstructing ocean circulation using paired measurements of Cd/Ca and Cd-isotopic compositions of deep-sea corals

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Reconstructing deep-ocean circulation requires robust proxies for ocean conditions as well as sedimentary archives that faithfully capture the tracer of interest. Analysis of the Cd (cadmium) content of sediments satisfies both of these requirements, as marine Cd distributions mimic those of the algal nutrient phosphate, and Cd readily substitutes for Ca (calcium) in carbonates. However, the Cd/Ca of some biominerals, such as scleractinian deep-sea corals, can appear unrelated to ambient nutrient inventories, leading to uncertain estimates of past ocean circulation. We hypothesized that this variability originates from physiological modulation of calcification efficiency and should result in strongly correlated Cd/Ca and Cd-isotopic ratios in precipitated aragonite. We find that skeletal Cd/Ca and Cd-isotopic compositions exhibit considerable variability, which we quantified by renormalizing our results to ambient seawater data obtained by the GEOTRACES Program. This renormalization illustrates that Cd/Ca and Cd-isotopic compositions are indeed strongly correlated across all specimens, defining a continuum bounded by corals with no discernible offsets from ambient seawater to samples significantly enriched in Cd/Ca with light Cd-isotopic compositions. The direction and maximum Cd-isotopic offset observed in the deep-sea corals is similar to that associated with inorganic carbonate precipitation, supporting a common mechanism of Cd-isotopic fractionation. We successfully modeled our results using Rayleigh- and Steady-State biomineralization models, which altogether provide strong support for the calcification efficiency hypothesis. We use these models to develop a calibration that corrects for physiological modification of ambient Cd/Ca during aragonite precipitation. This calibration enables deep-sea corals to be used as archives of ocean nutrient inventories—and thus past circulation—that we applied to a suite of fossil corals recovered from deglacial North Atlantic.

ID: 02288, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Oral)

Who came first to central Sweden, reindeers (Rangifer tarangus) or human hunters?: insights from ancient-DNA analyzes of lake sediments and archeological material

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Our understanding about reindeer *(Rangifer tarangus*) migration into the post-glacial landscape of Scandinavia currently relies on findings of macrofossils from archeological settings. This approach heavily relies on the presence and preservation of bone fossils at archaeological sites; however, rare reindeer bones have been found from archaeological sites and so the migration history of reindeers in Sweden remains unclear. Therefore, we examined the presence of reindeer ancient-DNA (a-DNA) preserved in lake sediments and compared the oldest reindeer DNA in sediment with ages inferred from fossils findings from a nearby Mesolithic settlement. At our study site, a-DNA in sediment reveals that the reindeers probably arrived to this area around 7.4 kyr BP and occurred continuously, with no apparent indications of extinction events in response to climate change, for more than seven millennia. Moreover, ^{14}C dates of burned bones suggested that human hunters arrived here around ca 7.2 kyr BP which is about the same time as reindeers did. Mitochondrial DNA from an unburned reindeer bone (ca 5.6 kyr old) from the site was phylogenetically related to haplotype cluster II which is likely originated from a population from south Sweden ~10 kyr BP. We discuss the implications of our findings in a Scandinavian context and outline a timeline for migration of a reindeer

population (cluster II) in history, as well as human hunters presumably following these reindeers, toward northern Sweden, information of importance when understanding the domestication processes in Scandinavia.

ID: 02014, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Out of Amazonia: Late-Holocene climate change and the Tupi–Guarani trans-continental expansion

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The late-Holocene expansion of the Tupi–Guarani languages from southern Amazonia to SE South America constitutes one of the largest expansions of any linguistic family in the world, spanning ~4000 km between latitudes 0°S and 35°S at about 2.5k cal. yr BP. However, the underlying reasons for thisexpansion are a matter of debate. Here, we compare continental-scale palaeoecological, palaeoclimate and archaeological datasets, to examine the role of climate change in facilitating the expansion of this forest-farming culture. Because this expansion lies within the path of the South American Low-LevelJet, the key mechanism for moisture transport across lowland South America, we were able to explore the relationship between climate change, forest expansion and the Tupi–Guarani. Our data synthesis shows broad synchrony between late-Holocene increasing precipitation and southerly expansion ofboth tropical forest and Guarani archaeological sites – the southernmost branch of the Tupi–Guarani. We conclude that climate change likely facilitated the agricultural expansion of the Guarani forest-farming culture by increasing the area of forested landscape that they could exploit, showing a primeexample of ecological opportunism.

ID: 02166, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

The Making of the Forest: Human-induced spread of Araucaria forest out of their natural range in the southern Brazilian highlands

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In this presentation, we examine the late Holocene environmental and cultural sequences of the southern Brazilian highlands that indicate that major changes in the socio-political organisation of southern proto-Je groups (increase in number and size of villages, arrival of monumental architecture and the appearance of oversized pithouses) are associated with the expansion of *Araucaria* forest around A.D. 1000. To understand the natural vs. human factors involved in this striking expansion, we model the 'natural' distribution of *Araucaria* forests and combine archaeology with stable carbon isotopes, charcoal, pollen and phytolith analyses to test the hypothesis that the spread of *Araucaria* forest beyond its natural range was human-induced. In regions devoid of archaeology the *Araucaria* forest is restricted to southern slopes, while in archaeologically rich regions the forest spreads onto northern slopes and plateaus. We discuss the implications of these findings for conservation biology.

ID: 02073, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Oral)

Pollen and spores as biological recorders of past ultraviolet irradiance

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Solar ultraviolet (UV) irradiance is a key driver of climatic and biotic change. Ultraviolet irradiance modulates stratospheric warming and ozone production, and influences the biosphere from ecosystem-level processes through to the largest scale patterns of diversification and extinction. Yet our understanding of ultraviolet irradiance is limited because no method has been validated to reconstruct its flux over timescales relevant to climatic or biotic processes. Here, we show that a recently developed proxy for ultraviolet irradiance based on spore and pollen chemistry can be used over long (10^5 years) timescales. Firstly we demonstrate that spatial variations in spore and pollen chemistry correlate with known latitudinal solar irradiance gradients. Using this relationship we provide a reconstruction of past changes in solar irradiance based on the pollen record from Lake Bosumtwi in Ghana. As anticipated, variations in the chemistry of grass pollen from the Lake Bosumtwi

record show a link to multiple orbital precessional cycles (19–21 thousand years). By providing a unique, local proxy for broad spectrum solar irradiance, the chemical analysis of spores and pollen offers unprecedented opportunities to decouple solar variability, climate and vegetation change through geologic time and a new proxy with which to probe the Earth system.

ID: 01734, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Reconstructing rates of changes in global soil erosion from lake sediment archives

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Increase in soil erosion causes soil degradation, reduces soil productivity, and compromises freshwater ecosystem services. However, global patterns of anthropogenic soil erosion and fluvial sediment transfer remain poorly understood (PAGES-GloSS). To document rates of changes in soil erosion at global scales during the last 200-500 years, we have compiled published data on sediment accumulation rates (SAR) from 500 lake sediment archives, and new highly resolved data on density (Ct-Scan), mineral chemistry (XRF) from 400 lake sediment records at the GIRAS laboratory (INRS, Canada), in collaboration with the National Lacustrine Core Facility (LacCore). Using such global network of empirical data and numerical modeling, we were able to identify hotspots of changes in soil erosion during the Anthropocene and key environmental drivers.

ID: 01714, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Oral)

GEOTRACES Intermediate Data Products: good tools for modern and paleo oceanography

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One of the main policies of the international program of geochemistry GEOTRACES (www.geotraces.org) is to regularly publish an open source data base and atlas of the different parameters acquired in the framework of the program. Data are first validated following a very strict standard and inter calibration procedure, and then loaded in the electronic atlas, for some of them even before being published (http://www.egeotraces.org/). The first Intermediate Data Product was launched in 2014 (IDP 2014). The second one will be published in summer 2017 (IDP 2017). The talk will discuss how the IDP 2014 helped to better understand of the modern fate of tracers that are currently used in paleoceanography. Three examples will be discussed: 1) data obtained along a meridianal South Atlantic section (GA02) revealed non-linearity on the global Cd-PO_4 relationship, attributed to horizontal advection of Cd-depleted low oxygen Subantarctic Mode waters (Xie et al, 2015); 2) the different affinities of Th and Pa for particulate materials propelled for years the Pa/Th ratio as efficient boundary scavenging tracer; contrastingly, it was also proposed that Pa/Th past variations along the North Atlantic Deep water was reflecting variations of the deep Atlantic water ventilation: recent data call into question this hypothesis (Hayes & Anderson, this session), although the debate is still not close; 3) the invited talk of Tachikawa et al. (this session) will already discuss the requirements for the use of Nd as paleo circulation tracer, but examples of the modern behavior of the rare earths questioning the quantification of their sources to the ocean will also be presented (Zheng et al, 2016). The consequences of these modern results for the interpretation of paleo records will be discussed, demonstrating the advantage of such open data product for the different communities.

ID: 01789, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Orbital- and millennial-scale environmental and climate changes in the Mediterranean area during the middle and late Quaternary: a new sediment record from el Padul, Sierra Nevada (S Spain)

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Long paleoenvironmental records are necessary in order to understand recurrent climatic or environmental changes occurring with a certain periodicity (i.e., glacial-interglacial cycles). In this respect, the Padul peat bog has one of the best available records of Pleistocene sediments in semiarid Southern Europe. The sedimentary sequence is more than 100 m thick and has been used to study palaeoenvironmental change for the past ca. 1 Ma. Since the 1960s several cores have already been taken from this basin showing oscillations in many proxies (pollen, organic geochemistry and sedimentation) related with paleoclimatic and paleohydrological changes. However, a more detailed and higher resolution study, using new dating and analytical techniques (AMS ^{14}C, OSL, AAR, continuous XRF-scanning, high-resolution pollen analysis and geochemistry), needs to be done in such an interesting site. Here we present preliminary paleoenvironmental data from a new sediment core, Padul-15-05, which shows significant changes in the environment and lake sedimentation, probably related with glacial-interglacial climate dynamics during the past ca. 300,000 years. These data confirm that orbital- as well as suborbital-scale variability (i.e., Heinrich events) are recorded in the studied core. This unique record thus has very high potential for paleoenvironmental and paleoclimatic reconstructions for, at least, the two last climatic cycles in this semiarid Mediterranean area.

ID: 01528, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Invited Oral)

What's so hot about the carbonate record in Lake Kivu?

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The presence or absence of calcite or aragonite ($CaCO_3$) in the sediments of many East African lakes reflects the history of past rainfall, with carbonate deposition indicating relatively arid conditions, a lake level lowered below outlet elevation, and consequent rise in lake water salinity and carbonate saturation.

Aragonite first appears in the Holocene sediments of Lake Kivu at 3,100 cal ybp (3.1 ka), around the end of the African Humid Period, consistent with a shift to more arid conditions. Aragonite has accumulated intermittently since then, at 3.1-2.2 ka, 1.9-1.5 ka, and more recently between AD 1580 and 1900, and from AD 1975 to the present day. However in the case of Lake Kivu, we find that the magnitude and timing of carbonate-rich sedimentation is not so much controlled by climate but, instead, linked strongly to hydrothermal activity in the basin. Lake Kivu, with a maximum depth of about 400 m, is unusually stratified as a result of active volcanism nearby, with warmer, more saline water holding high concentrations of methane and CO_2 underlying cooler fresh water. We find that the history of carbonate sedimentation in Lake Kivu reflects the timing and duration of past hydrothermal input to the lake. The stable isotopic composition of aragonite and the lake's calcium budget reveal the strong link between hydrothermal input and aragonite deposition. The sporadic injection of hydrothermal fluids and gases to the lake, as indicated by the carbonate record, signals the difficulty of predicting future trends and potential for catastrophic degassing, which would be potentially fatal to >2 million people living near the lake shore.

ID: 01810, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Socio-ecological trajectories and tipping-points in the making of the Cretan landscape (Greece) from Neolithic to Present day

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In order to document the complex human/natural co-evolution of the Mediterranean Landscape, multiproxy analyses were recently performed on two sedimentary cores from Crete, the largest island of Greece (Aegean Sea). The paleoenvironmental reconstruction is based on high-resolution analyses of sediments, pollen, dung fungal spores and charcoal obtained from: 1) a peat core collected in the Asi Gonia bog located in the White Mountains (790 m asl) and, 2) a core performed in the Kournas lake (20 m asl), situated some kilometers north of the bog.

The paleoecological data highlighted the human land use history in each place along time. Pastoralism was of main importance and probably mainly linked to fire use. Near Kournas lake, olive cultivation has been an important part of human land use from Late Neolithic onward as well.

Periods of intense but sustainable human activities and practices with stable landscape are recorded (eg. from Late Neolithic to the Late Minoean, 6000-3200 cal BP near Kournas lake, and during Roman and Byzantine time at Asi Gonia, 2000-1200 cal BP). Nevertheless, rapid changes between phases in vegetation development are associated with tipping-points in ecosystem dynamics. The presentation will explore the complex process involving disturbances (e.g. erosion process and flood events, fire event), as a result or as a driver, and rapid changes leading to these tipping points. Climate was obviously a favoring factor, but human activities seem to be the main driving factor.

ID: 02016, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Arctic sea ice export events as a driver of past abrupt climate change

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Abrupt periods of cooling during the last deglaciation are often attributed to the discharge of meltwater from proglacial lakes in North America weakening the strength of the Atlantic Meridional Overturning Circulation (AMOC). Here, we show an intriguing alternative to this widely cited hypothesis by discussing a set of climate model experiments that generate sea ice export events from the Arctic Ocean to the Nordic Seas with meltwater volumes and durations similar to, or larger, than those released from proglacial lakes at the onset of the Younger Dryas. Our numerical model simulations show that during deglaciation, a reduction in northward heat transport and a deeper halocline in the upper Arctic Ocean allow sea ice to become 10-30 m thick over much of the basin, storing ~15-time mores freshwater as ice than modern-day. In addition, a region of extremely thick (~50 m) immobile ice stretching ~200-km offshore develops along the entire northern edge of the Canadian Arctic that is reminiscent of an extensive *Arctic ice shelf*. We find that significant sea ice export events to the Nordic Seas are created by either flooding the Bering land bridge, enhancing the transpolar drift in the eastern Arctic, or by increasing the discharge of meltwater from the Mackenzie River. In each case, the volume of meltwater exported to the subpolar gyre as sea ice is sufficient to inhibit the production of dense waters modulating the sinking limb of the AMOC. Finally, as this mechanism does not result in any global sea level rise, it offers a tantalizing explanation as to why there was little, or no, change in sea level during the Younger Dryas.

ID: 01697, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Modulation of summer climate variability over Europe during the Common Era

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We investigate European summer climate variability and its teleconnections in reconstructions and model simulations covering the Common Era (CE). Simulations of summer temperature reproduce important features of recent reconstructions obtained by the EuroMed2k group of the PAGES2k framework. The model experiments have been carried out with the Max Planck Institute for Meteorology Earth System Model (MPI-ESM-P). Both in simulations and gridded field reconstructions, the first and second empirical orthogonal functions (EOF) of spatial variations are well separated. They exhibit a mono-polar structure in the first and a north south oriented dipole in the second EOF. The principal component of the first EOF is related to a wave-like pattern that is most prominent in the upper troposphere. The associated teleconnection pattern can explain, for example, the recently observed co-variance of temperature reconstructions from the Alps and the Altai mountains. The dominant mode of surface air temperature variability is also related to a corresponding pattern in precipitation. We discuss characteristics of the wave-like pattern with respect to that of the summer North Atlantic Oscillation.

We investigate the modulation of the wave-like pattern by air-sea interactions in the North Atlantic and the influence of external drivers (volcanic eruptions, solar modulations).

ID: 01625, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

A PAGES Floods WG core project: The Collaborative Flood Database for Multiple Archive Types

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Floods can be reconstructed from manifold archive types, such as lacustrine, sediments, tree rings, speleothems and historical documents. Each type of records have different ability to detect past flood events in different region and time epoch, and provide very different information about these events in terms of their precision of locating an event in space and time, as well as understanding the underlying meteorological causes and impacts and reaction of societies. Archives sensibility to flood often differs by the surge extension or duration. Noise driven by other parameters, such as tree-ring width from nutrients, temperatures, etc. can also affect the signal recorded in the proxy.

The challenge for a Collaborative Flood Database is to handle these different types and their degrees of accuracy while still agree on a common base of fundamental data structure. The payoff for this effort is immense. It will first offer a single interactive access point to search for these different record types and allows comparison, verification and cross correlation among them. Then, combining data from multiple proxies with mathematical methods will lead to a data set with better coverage and precision in time, space and intensity level than any single archive type could deliver alone. Yet, it enables holistic insights of causes and effects, such as weather conditions and impacts to human history.

Finally, the unified flood database could be a good starting point for expanding the general data with fundamental information very specific for each proxy type to document and store the whole chain of information measured or observed (width of tree-rings, dating of sediment layers by C14, quotes of historical documents…) and retrieve it in a sustainable and accessible way.

To achieve these goals, the database will be organized in five main thematic data clusters documenting the source, location, time, classification and reference of the records. In parallel three levels of data importance will be distinguished: i) the essential core data required for each and every archive type, ii) the optional common data available for all proxies and iii) optional data specific to each type of proxy.

ID: 02096, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Fire and land cover change during the Maori colonization of New Zealand: Hypothesis testing with model simulations and charcoal data

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The arrival of the Maori in New Zealand at about 1280 CE was followed by widespread, rapid changes in flora and fauna, including deforestation and extinction of many endemic species. The emerging consensus is that a small number of Maori, through their extensive application of fire in plant communities that were relatively sensitive to fire disturbance, were able to permanently change land cover over large regions quickly. There is no direct proof of this human impact, however. While the sedimentary charcoal record provides evidence of the timing and magnitude of fire in New Zealand, the record is spatially discontinuous and mainly limited to mid-elevation lakes on the South Island. Archaeological sites are often not co-located with charcoal records. To overcome the limitations of point-based observations and test hypotheses on the number of people, climate, and vegetation that could have led to the transformation of New Zealand's land cover, I apply a numerical model of human-environment interactions that simulates wildfire, including human and natural ignitions and impacts on vegetation. My simulations show that small numbers of highly mobile hunter gatherers, using fire to improve their mobility and hunting and foraging opportunities, could have had a large impact on the vegetation. Following an initial peak in fire for deforestation, a small increase in background fire frequency could have prevented forest vegetation from regenerating because of changes in the structure of the vegetation; mainly an increase in herbaceous fuels. My simulations also show that both the rate of deforestation and lack of recovery are sensitive to climate, and suggest that it may have taken a "perfect storm" of both human agency and the Medieval Climate Anomaly to lead to the rapid and permanent deforestation of New Zealand.

ID: 01766, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Using multi-resolution proxies to assess ENSO impacts on the mean state of the tropical Pacific

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Observations and model simulations indicate that the relationship between ENSO and the mean state of the tropical Pacific is a two-way interaction. On one hand, a strong zonal SST gradient (dSST) in the Pacific (colder cold tongue) increases the potential intensity of upcoming ENSO events and may lead to increased ENSO variance. On the other hand, in a period of increased ENSO activity, large events can warm the cold tongue at decadal scales via residual heating, and thus lead to reduced zonal SST gradient (ENSO rectification mechanism). The short length of the observational record hinders our ability to confidently evaluate which mechanism dominates in each period and whether it is sensitive to external climate forcing. This question is effectively a question of interaction between two timescales: interannual and decadal. Paleoclimate proxies of different resolutions can help elucidate this question, since they can be independent records of variability in these separate timescales. Proxies, models, and observations indicate that in periods of increased ENSO activity, dSST is negatively correlated with ENSO variance at decadal timescales, indicating that strong ENSO events affect the mean state. Using climate model simulations we attribute this effect to residual nonlinear dynamical heating, thus supporting the ENSO rectification mechanism. On the contrary, in periods without strong events, ENSO variance and dSST are positively correlated, which indicates that the primary mechanism at work is the effect of the mean state on ENSO. Our analysis also quantitatively identifies the regions where paleoclimate proxies are needed in order to reduce the existing uncertainties in ENSO-mean state interactions. Hence, this study is a synthesis of observations, model simulations and paleoclimate proxy evidence guided by the fundamental and open question of multi-scale interactions in the tropical Pacific, and illustrates the need for multi-resolution paleoclimate proxies and their potential uses.

ID: 01562, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Arctic temperature and moisture trends during the past 2000 years – Progress from multiproxy-paleoclimate data compilations

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Instrumental climate data and climate-model projections show that Arctic-wide surface temperature and precipitation are positively correlated. Higher temperatures coincide with greater moisture by: (1) expanding the duration and source area for evaporation as sea ice retracts, (2) enhancing the poleward moisture transport, and (3) increasing the water-vapor content of the atmosphere. Higher temperature also influences evaporation rate, and therefore precipitation minus evaporation (P-E), the climate variable often sensed by paleo-hydroclimate proxies. Here, we test whether Arctic temperature and moisture also correlate on centennial timescales over the Common Era (CE). We use the new PAGES2k multiproxy-temperature dataset along with a first-pass compilation of moisture-sensitive proxy records to calculate century-scale composite timeseries, with a focus on longer records that extend back through the first millennium CE. We present a new Arctic borehole temperature reconstruction as a check on the magnitude of Little Ice Age cooling inferred from the proxy records, and we investigate the spatial pattern of centennial-scale variability. Similar to previous reconstructions, v2 of the PAGES2k proxy temperature dataset shows that, prior to the 20th century, mean annual Arctic-wide temperature decreased over the CE. The millennial-scale cooling trend is most prominent in proxy records from glacier ice, but is also registered in lake and marine sediment, and trees. In contrast, the composite of moisture-sensitive (primarily P-E) records does not exhibit a millennial-scale trend. Determining whether fluctuations in the mean state of Arctic temperature and moisture were in fact decoupled is hampered by the difficulty in detecting a significant trend within the relatively small number of spatially heterogeneous multi-proxy moisture-sensitive records. A decoupling of temperature and moisture would indicate that evaporation had a strong counterbalancing effect on precipitation and/or that shifting circulation patterns overwhelmed any multi-centennial-scale co-variability.

ID: 01295, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Mapping livelihoods in West and Central Africa: changes in food-production from 1800 BC to AD 1500

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The changing land uses associated with the Iron Age transition in sub-Saharan Africa, such as increases in food-production and fuel consumption for metallurgy, may have had widespread consequences for regional climate, hydrology, biodiversity and ecosystem services that persist to the present. Quantification of these impacts and potential feedbacks is difficult however, because the archaeological and historical record is highly fragmented in time and space. We are approaching this problem from a modeling perspective by developing a classification system of subsistence and lifestyles based on a broad synthesis of archaeological, archaeobotanical, and ethnographic observations. A subset of this classification has now been mapped in timeslices across West and Central Africa where we focused primarily on several categories of agricultural land use which occurred heterogeneously in space and time. The main differences between these categories is the relative reliance on and variety of domestic species, and in turn the energy invested in them. While the particular crop or animal species utilized was partially dependent on environmental variables, diversification and intensification led to more stable agricultural results and an increase in the prevalence of farming societies. This paper presents the progress of this data synthesis and mapping process, using examples from the completed work on West and Central Africa, as well as the early stages of our work on East Africa.

ID: 01637, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Oral)

Reconstructing Greenland Ice Sheet Dynamics during the Last Deglaciation

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Sea level rise (SLR) is one of the most profound social and environmental issues facing humanity today, yet the response of polar ice sheets to future warmth remains uncertain. Disintegration of the Greenland Ice Sheet (GrIS) would raise global sea level by ~7 meters, and many Greenland outlet glaciers are already undergoing rapid retreat. The last period that saw such dramatic, sustained retreat of the GrIS was the last deglaciation, when the ice sheet retreated from its Last Glacial Maximum extent and contributed >2 m to global SLR. Thus, the deglaciation provides a unique test case for understanding the dynamics of ice- sheet retreat using a three-dimensional numerical ice-sheet model. Here we use a three-dimensional ice-sheet model at 10km resolution over Greenland to simulate the last deglaciation. Our simulations show that the GrIS grew to a maximum volume ~50% greater than present around 21,000 thousand years ago (21 ka) and reached a minimum volume ~10% smaller than present around 8 ka. We compare our simulations against data of margin retreat and show that the model captures the reconstructed progression of terrestrial deglaciation, with ice disappearing earliest in eastern sectors of the ice sheet and later in western sectors. We force the model with varied atmospheric and oceanic forcing scenarios (within the range of uncertainty of paleoclimate data) and find that the timing and rate of deglaciation in south Greenland is extremely sensitive to the magnitude and timing of oceanic warming. Our results identify the ice-sheet response to rapid oceanic and atmospheric warming, and highlight particular regions (especially Nuuk and Paamiut in southern Greenland) that were especially sensitive to past climatic changes. We demonstrate that ice-sheet history is a valuable tool for understand ice-sheet retreat dynamics and should be considered when making projections about ice-sheet response in a warming climate.

ID: 01521, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Oral)

Monsoon-induced denitrification change in the Eastern Arabian Sea during 1 Ma (IODP Exp. 355 Site U1456)

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The Arabian Sea is one of the most pronounced denitrifying pools in the world, which was reflected as δ^{15}N oscillations in response to the glacial-interglacial climate change. However, denitrification in the Eastern Arabian Sea has been investigated relatively less than its western counterpart, where the upwelling-induced denitrification occurred dominantly. In order to comprehend the denitrification history related to the monsoon activity between glacial and interglacial periods, multi-proxy paleoceanographic data were analyzed at Site U1456 (IODP Exp. 355) drilled in the Laxmi Basin (Eastern Arabian Sea), and the results were compared to ODP 722B of Oman margin. Oxygen isotope measurement of planktonic foraminifera (*G. ruber* and *G. sacculifer*) was conducted on Unit I of Site U1456, and the isotope comparison to LR04 benthic stack allows the age correlation from MIS 1 to 34. δ^{15}N values of bulk sediments ranged from 4.5‰ to 9.8‰ with a mean of 7.3‰. The δ^{15}N fluctuations follow the glacial and interglacial cycles, exhibiting high values during interglacial and low during glacial intervals. Compared with productivity proxies such as δ13C of planktonic foraminifera, total carbon, and total nitrogen, occurrence of denitrification is closely related to enhanced productivity during interglacial periods. Despite minor age difference, δ^{15}N fluctuations are consistently coherent between Site U1456 and ODP 722B. Our results indicate that monsoon-induced denitrification change was distinct in the Arabian Sea during 1.2 Ma.

ID: 02298, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

The significance of orbital forcing in Eastern Mediterranean climate during the last interglacial

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The last interglacial, marine isotope stage 5e (MIS 5e, 130-115 ka), was a relatively warm period. The peak summer insolation in the northern hemisphere (NH) was significantly higher than in the Holocene. In addition the insolation temporal variability was significantly high compared with other interglacials. In this study we combine data from the Dead Sea deep drilling project cores and climate model results to establish the climate variability in the Eastern Mediterranean. Both the sediments and the climate model show a drastic change in precipitation between MIS 5e peak NH summer insolation at 125 ka, when precipitation was high and 120 ka, which was extremely dry and when thick intervals of halite deposited in the lake. The ^{234}U/^{238}U ratio in authigenic minerals, a proxy for water sources, shifted from the typical 1.5 activity ratio (the ratio in the modern main water source to the lake) to 1.1 (the ratio in the eastern sources and floods). This indicates a hydrological shift from the typical Mediterranean climate dictated by winter storms to a regime dictated by precipitation in the currently drier regions – the north edges of the desert belt. Presently, precipitation in the arid regions is characterized by intense rainfall and flood events that occur typically in the fall. The 120 ka climate model runs show that the precipitation was overall lower but during the fall season it was higher than today. Thus, while 125 ka was a relatively wet period, 120 ka was one of the driest periods known in the region characterized by scarce but intense rainfall. 120 ka was characterized by higher winter temperatures in the Eastern Mediterranean, possibly due to increase in NH winter insolation. The relative increase in fall precipitation corresponds to a shift in the peak NH summer insolation anomaly to the fall resulting in a relative increase of the African Monsoon.

ID: 01240, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Indian Summer Monsoon variability during the Holocene in Southern India: evidence for abrupt climatic shifts from a multi-proxy lake sediment record

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A sediment core (SS-1) from Shaanthisaagara (SS) Lake in Peninsular India provides a 11,000-year paleomonsoonal record, which is the longest so far in the region. The sediment samples were analysed using environmental magnetic, organic geochemical, sedimentological and carbon isotopic techniques to reconstruct the Indian summer monsoon (ISM) variability during the Holocene. The environmental magnetic data depict variations in pedogenic magnetite production in the catchment and detrital influx to the lake, which in turn, are related to monsoonal rainfall amount. The variations in the particle size of sediments are related to the strength of the monsoon. The C/N and $\delta^{13}C$ data indicate palaeovegetational variations in the SS catchment. Periods of strong monsoon are characterised by high values of concentration-dependent magnetic parameters like χ_{lf}, χ_{fd}, χ_{ARM} and SIRM, high sand content, low C/N ratio (fully aquatic-deep water conditions), relatively depleted $\delta^{13}C$ values (more C_3 but less C_4 land plants) and *vice versa* for weak monsoon periods. The data reveal the presence of significant palaeomonsoonal events and abrupt climatic shifts in the Holocene. During 11,100-10,600 cal. yr. BP, ISM in southern India was weak. The period 10,600 - 8200 cal. yr. BP was characterized by intensified ISM, corresponding to the Early Holocene Optimum. Again, during 8200 - 4500 cal. yr. BP, the monsoon weakened, which corresponds to the global Mid-Holocene aridity event. From 4500 to 3300 cal. yr. BP fluctuating monsoonal conditions are documented. There has been a slight increasing trend in ISM from 3300 cal. yr. BP to the Present.

ID: 01760, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

Lifting the Fog of Ignorance: The Icelandic Laki Fissure Eruption of 1783

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In 1783 contemporaries in Europe gazed at the sky and witnessed a veil of dust that lasted for two to three months. In addition to the dry fog, 1783 saw extraordinary natural phenomena: heat, sulfuric odor, numerous thunderstorms, newly emerging islands, earthquakes. The summer was followed by three severely cold winters. In the spirit of the Enlightenment the contemporaries speculated about the cause of the haze and tried to explain the unusual natural phenomena of their time with reason. They were unaware a volcano produced the dry fog: It took months for the news of an Icelandic volcanic eruption to reach mainland Europe, another decade until the fissure was discovered, and more than one hundred years for the dots between the haze and the eruption to be connected. The 27 km long Laki fissure eruption only reached a 4 on the volcanic explosivity index, but it ejected the largest amount of lava in the last millennium. This paper focuses on the human experience of the Laki fissure eruption of 1783 and the eruption's aftermath (the dry fog and successive cold winters). It has an interdisciplinary approach, integrating environmental history, historical climatology, as well as geology. Sources are contemporary newspapers and scientific publications, historical maps, as well as the ephemerides of the Societas Meteorologica Palatina, data gathered by a meteorological network reaching from the Ural Mountains to North America, which existed from 1780 to 1795, its members took weather measurements at three set times every day. This paper will explore the evolution of the understanding of nature over time and the link between the unusual weather phenomena of that time and this specific volcanic eruption.

ID: 01258, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Oral)

Reconstructing East African rainfall and Indian Ocean sea surface temperatures over the last centuries using data assimilation

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The relationship between East African rainfall and Indian Ocean sea-surface temperatures (SSTs) is well established. The potential interest of this covariance to improve reconstructions of both variables over the last centuries is examined here. This is achieved through an off-line method of data assimilation based on a particle filter, using hydroclimate-related records at four East African sites (Lake Naivasha, Lake Challa, Lake Malawi and Lake Masoko) and SSTs-related records at six oceanic sites spread over the Indian Ocean to constrain the Last Millennium Ensemble of simulations performed by CESM1. Skillful reconstructions of the Indian SSTs and of East African rainfall can be obtained based on the assimilation of only one of thesevariables, when assimilating pseudo-proxy data deduced from the model CESM1. The skill of these reconstructions increases with the number of particles selected in the particle filter, although the improvement becomes modest beyond 99 particles. When considering a more realistic framework, the skill of the reconstructions is strongly deteriorated because of the model biases and the uncertainties of the realproxy-based reconstructions. However, it is still possible to obtain a skillful reconstruction of the whole Indian Ocean SSTs based only on the assimilation of the six SST-related proxy records selected, as far as a local calibration is applied at all individual sites. This underlines once more the critical role of an adequate integration of the signal inferred from proxy records into the climate models for reconstructionsbased on data assimilation.

ID: 01595, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Oral)

Sea level fall during glaciation stabilized atmospheric CO2 by enhanced volcanic degassing

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Paleo-climate records and geodynamic modelling indicate the existence of complex interactions between glacial sea level changes, volcanic degassing, and atmospheric CO2, which may have modulated the climate system's descent into the last ice age. Between ~85-70 ka, during an interval of decreasing axial tilt, the orbital component in global temperature records gradually declined, while atmospheric CO2, instead of continuing is long-term correlation with Antarctic temperature, remained relatively stable. Based on novel global geodynamic models and the joint interpretation of paleo-proxy data as well as biogeochemical simulations, we show that a sea level fall in this interval caused enhanced pressure-release melting in the uppermost mantle, which may have induced a surge in magma and CO2 fluxes from mid-ocean ridges and oceanic hotspot volcanoes. Our results reveal a hitherto unrecognised negative feedback between glaciation and atmospheric CO2 predominantly controlled by marine volcanism on multi-millennial (suborbital) timescales of ~5,000-15,000 years.

ID: 01396, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Oral)

The impact of the discovery of the Americas on the Earth System

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In the few centuries leading to the Industrial Revolution, Europeans had circumnavigated the globe, trade became global, and new scientific ideas and technologies spread. Thus some, although controversial, evidence suggests that human actions during this time drove global changes to the Earth System.Here we synthesize disparate literature and ideas, rarely combined, to produce a new synthesis of global change before the dawn of the industrial age, spanning archaeological evidence to global circulation models. We consider human impacts in Europe, Asia, Africa and the Americas during the early stages of the early modern world, before showing that the only event with hemisphere wide impact potential to cause Earth System changes was the "Columbian Exchange"following the discovery of the Americas. We show that the pre-Columbian population of the Americas had a substantial and widespread impact on their environment and that this impact effectively ceased following the spread of European epidemics. We discuss evidence for subsequent widespread reforestation and the resulting carbon uptake focusing on the largest uncertainties in the carbon uptake estimates, which arise from (i) the speed and extent numbers of people who died at that time, and how quickly, (ii) the (per capita) area used for farming pre-1492 and (iii) the carbon sequestration rate of abandoned farmland, in vegetation

and soil. We argue that the proximate driver of the observed decline in CO 2 at this time, and anomalous global cooling, was increased terrestrial carbon uptake. Identifying the ultimate drivers of the increase in carbon uptake is more complex, but likely involves uptake from reforestation following the America\'s population crash, amplified by Little Ice Age earth system feedbacks.We conclude that human actions did alter the Earth System perceptibly in short period of the early modern world, with potential ramifications for the following centuries.

ID: 02268, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Fingerprinting tropical hydroclimate change during the Last Glacial Maximum

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The cooler, lower-CO_2 conditions of the Last Glacial Maximum are often considered a "reverse analog" for 21st century climate change. However, many land-based proxy records from the tropics disagree on the sign and magnitude of glacial hydroclimate changes, making it difficult to tease apart the impact of greenhouse gases vs. other climate forcings on the tropical water cycle during the LGM. In the Indo-Pacific Warm Pool region, proxy records of surface hydrology and vegetation indicate pronounced aridity while proxy records of precipitation $\delta^{18}O$ and δD tend to indicate muted or even negative changes (sometimes interpreted as wetter conditions). Here, we present a set of single- and combined-forcing climate model experiments with the water isotope-enabled atmosphere and land components of the Community Earth System Model v1 (iCAM5 and iCLM4). In contrast to precipitation amount, which in the warm pool mainly responds to Sunda and Sahul shelf exposure under lower glacial sea level (DiNezio et al., 2016), the $\delta^{18}O$ of tropical precipitation mainly responds to greenhouse gas and ice sheet forcing. In tropical Africa and South America, $\delta^{18}O_{precip}$ excursions occur in the absence of pronounced changes in precipitation. By contrast, $\delta^{18}O_{precip}$ exhibits only minor changes in the warm pool despite large reductions in rainfall. We use water tags to determine the influence of moisture source on these findings. Model results are compared with proxy-derived changes in glacial $\delta^{18}O_{precip}$ and δD_{precip} in order to assess the stable O- and H- isotopic "fingerprint" of individual climate forcings on the tropical water cycle.

ID: 02196, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Diverse approaches to reconstructing quantitative land cover and climate changes in peninsular India

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The Indian subcontinent region is of key significance both in terms of climate and human impacts. Pivotal in the monsoon system and home to human and prehistoric cultures since several millennia, a main challenge, in the peninsular part of the subcontinent, is the preservation of organic walled proxies such as pollen. The two sides of the coin are:1) this terrain, with its diversity of climate, topography, vegetation and successions of land use since prehistoric times acts like a readymade laboratory for sustainable environments (ecosystems) both natural and human modified; 2) some constraints and challenges, among them, the limited preservation of organic matter and largely non-continuous terrestrial sedimentary sequences. Added to this is the methodological challenge posed by tropical palynology in terms of diversity and documentation. This presentation will illustrate with examples how a multi-pronged approach that combines not only multiple proxies such as pollen and phytoliths but also approaches: statistical modelling, LRA (Navya Reghu, *ongoing PhD thesis*) is helping us overcome these challenges. It will also show how an approach that combines the use of a diversity of archives – from terrestrial montane to coastal lowlands is useful in providing the environmental setting for the plethora and succession of archeological sites dotting the landscape; in turn, material evidences from archaeology, including phytoliths are able to inform on the modification of the environment. It will also put in context the pollen records from marine sediment cores in the Bay of Bengal into which a maximum of the peninsular rivers drain into. It is now quite clear that “Understanding \'human systems\' requires engaging a vast body of scholarship based on a diverse array of records” (Ellis et al, 2016) – this paper will show how the Indian subcontinent and Peninsular India in particular make a unique contribution towards this.

ID: 02129, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Post-glacial disturbance dynamics in temperate ecosystems revealed from pollen records

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During the past millenia nature encountered different disturbance regimes moderated to various extent by human impact, but also by climatic events. Research focused in the long-term perspective (Q-time) mainly on the effect of humans, but studies also emphasize natural disturbances such as windthrows, herbivory (including insect outbreaks) or fire, many of which could be a direct effect of climatic events. Pollen provides a valuable information on long-term (millenial) vegetation and environmental change. Ecological indices (e.g. Ellenberg values) represent a valuable tool to describe important environmental factors of vegetation. Newly acquired indicator values assign affinity of plants to disturbance frequency (DF) and severity (DS) for central-European species. The same region provides a high-quality database of sedimentary pollen, which we link to plant taxa with disturbance indices in order to detect postglacial disturbance dynamics and to compare it with diversity trends. In the dated pollen sequences each counted pollen was assigned a plant taxon weighted by its present-day frequency in vegetation attributed by the disturbance index. Finally a mean disturbance index was calculated for the whole pollen assemblage dated to a certain time. Similarly, rarefacted pollen richness and evenness were calculated. Generalized additive model was then fit to all pollen assemblages to show main trend at the timescale. Overall, disturbance reaches its minimum between 5000–1 BC. DF gradually decreases during the Late Glacial and starts decreasing sharply around 9000 BC, then after 1 AD sharply increases again. DS continuously decreases between 13000–5000 BC and increases again after 1 AD. Disturbance played surprisingly more important role before the arrival of agriculture (5500 BC), and after it only increased in the last 3000 years. Comparison of disturbance trend with pollen-inferred diversity indices reveals mostly independent trends suggesting that diversity might be supported by increasing disturbance only in the late Holocene.

ID: 01317, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Disturbance dynamics in montane spruce forests in Central Europe: an integration of dendrochronological and palaeoecological records

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Extensive dendrochronological studies have shown that forest composition and structure of central European mountain spruce forests are shaped by natural disturbances, such as wind throws, insect outbreaks and fires. However, there is still little knowledge of the temporal and spatial scale of natural disturbance regime and its effect on the montane forest dynamics. The frequency and severity of disturbance events will be affected by the projected climate change. Therefore better understanding of natural disturbance dynamics in these montane forests can provide important insights for sustainable forest management in an aspiration of maintaining forest biodiversity and functionality. Where dendrochronological data can cover few hundreds of years, palaeoecological records reach thousands of years back in time providing information of long-term vegetation and disturbance patterns. Comparison of data from these two disciplines can increase our understanding of the importance of different disturbance agents on forest dynamics in different temporal and spatial scales.

We employ sedimentary fossil pollen, macrofossil and charcoal records together with insect remains and geochemical signal, from lakes (lake sediments) and small forest hollows (peat layers) to reconstruct vegetation and disturbance history in Central European montane spruce forests in Czech Republic and Slovakia. Integrating this new palaeoecological data with dendrochronological data, already available from the research area, we aim to develop more precise method for reconstructing long-term disturbance regime and its effects in montane spruce forests.

Preliminary results from comparison of high resolution (up to 10 years) sedimentary data (pollen, charcoal, insect remains) and tree-ring data show common patterns between disturbance signal from tree-rings and changes in sedimentary records. More detailed description of the analysis and the results will be given in the presentation.

ID: 01488, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Oral)

A high peat and carbon accumulation event driven by changes in dust mineralogy

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It is generally accepted that mineral dusts play an important role in biological productivity, particularly in nutrient poor systems, through fertilization. We demonstrate the relationship between terrestrial ecosystem productivity and dust deposition in a northern temperate setting using a peat sequence covering the last 8900 cal yr BP from Store Mosse (N57°13’37’’, E13°55’17’’), an extensive (77 km^2) ombrotrophic bog (i.e., atmospherically fed) located in southern Sweden. While this site is typical in terms of its organic matrix (bulk density, carbon and peat accumulation rates, C/N ratios, etc), we observe a seven-fold increase in peat accumulation rates, starting 5300 cal yr BP, and reaching a maximum (291 g m^{-2} yr^{-1}) just 800 years later. The wetter climatic conditions at the time surely drove this high peat accumulation event (HPAE), but the scale of the change implies another factor must have been involved. The peat inorganic geochemistry reveals three periods of increased dust deposition, as estimated using Al mass accumulation; these do not co-occur with the HPAE. Rather, during the HPAE a distinct change in mineral character occurs. There is a rapid increase in light and middle REE enrichment starting 5300 cal yr BP, expressed by La/Lu and Gd/Lu, respectively, which is interpreted to signal the presence of primary phosphate minerals such as apatite, allanite and/or monazite. The Eu anomaly profile ($[Eu/Eu^*]_{UCC}$) follows a similar pattern and indicates that the addition of plagioclase feldspar and less weathered minerals to the bog also increased. We suggest that this resulted in an increase in P and K supply to this nutrient poor system, spiking productivity. Our work shows that dust dynamics in the temperate northern latitudes can play an important part in stimulating primary production and therefore carbon cycling and storage.

ID: 01807, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Oral)

Reconstructing Late Neolithic and Bronze Age Hinterland and Lake Shore Socio-Environmental Interactions in the Three Lake Region of Western Switzerland

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Within the scope of the project *"Beyond lake villages: Studying Neolithic environmental changes and human impact at small lakes in Switzerland, Germany and Austria"* special emphasis is put on reconstructing possible scenarios of human-environment interactions in the Neolithic and Bronze Age, ca. 4300-800 cal. BC. Our subproject focuses on the Three-Lakes-Region in Western Switzerland, which was one of the most densely settled circum-Alpine regions during the Neolithic. The extraordinary richness of (bio-) archaeological data from the lake shore villages provides us with reliable information about prehistoric subsistence economy, social organization and, in many cases, with high-resolution dendrochronological dating.

The impact of human activities on the environment is constraint by the modes of production of the studied societies. Sociocultural and technological traits are important parameters to investigate this impact of climatic and environmental changes on human societies and *vice versa*.

The “Global Land Use and technological Evolution Simulator” (GLUES) has previously been used to simulate early farming societies\' sociocultural development as well as the impact on their environment. GLUES is defined by the adaptive dynamics of the four state variables, population density, technological efficiency, subsistence economy and economic diversity, as well as by the resource utilities for each spatial unit, and by spatial interaction between the spatial units, e.g. migration and diffusion. We employ a new regionally scaled down version of GLUES to estimate population densities, land use and their temporal and spatial relations to environmental change under reconstructed modes of production in prehistoric Western Switzerland. This reconstruction extrapolated from the archaeologically well-known sites to the *Hinterland* and allows us to investigate the Late Neolithic and Bronze Age societies beyond the lake villages.

ID: 01456, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Bronze Age settlement mounds on the Colchian plain at the Black Sea coast of Georgia – a geoarchaeological perspective

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Situated between the Rivers Enguri in the north and Khobistsqali in the south, more than 30settlement mounds (local name Dikhagudzuba), identified by field survey and remote sensingtechniques, give evidence of a densely populated landscape in the coastal lowlands of westernGeorgia during the Bronze Age. While the age estimations of these mounds are based on ceramic evidence obtained during previous archaeological research, only limited information is available on their internal architecture and their palaeoenvironmental context, and the chronology of the different layers is as yet lacking.Vibracores were carried out on top of and in the direct vicinity of three mounds, situated close to the villages of Orulu and Ergeta. Based on these sediment cores, our study aimed at (i) establishing a chronostratigraphic framework for the mounds based on ^{14}C dating; (ii) reconstructing possible phases and gaps in human occupation; and (iii) identifying the environmental conditions at the time of their use. Geochemical and sedimentological analyses were undertaken to decipher the element contents (XRF) and granulometry of stratigraphic layers.The three investigated settlement mounds are similar in dimension and stratigraphy, and different settlement layers could be identified in each of them. The 14C ages indicate that their formation occurred during the first half of the 2nd millennium BC, thus confirming the archaeological interpretation of their Bronze Age origin. For two mounds, an erection within one phase could be proven, whereas the third revealed different stages of construction. Heavy metal pollution in the anthropogenic layers of the mounds indicates metallurgic activity during occupation. Based on the granulometric and geochemical data, palaeoenvironmental conditions in the vicinity of the settlements were dominated by fluvial and alluvial processes. The construction material originates from the direct vicinity of the mounds. In the case of two mounds, circular moats of eventually the same age could be identified.

ID: 01525, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Oral)

From the Last Interglacial to the Anthropocene: Modeling a Complete Glacial Cycle with Comprehensive Earth System Models (PalMod)

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The paleoclimate modeling initiative PalMod aims at filling gaps in knowledge about climate processes and climate modeling. The program, supported by the German Federal Ministry of Education and Research, is specifically designed to better understand climate system dynamics and their variability on timescales up to the multi-millennial. The target is to simulate a full glacial cycle with comprehensive Earth system models (ESMs) incorporating a detailed description of interactions between the physical and biogeochemical components of the Earth system. The approach is innovative in three respects. First, the consortium aims at simulating a full glacial cycle in transient mode and with comprehensive ESMs which allow full interactions between the physical and biogeochemical components of the Earth system, including ice sheets. Second, we shall address climate variability during the last glacial cycle on a large range of time scales, from interannual to multi-millennial, and attempt to quantify the relative contributions of external forcing and processes internal to the Earth system to climate variability at different time scales. Third, in order to achieve a higher level of understanding of natural climate variability at time scales of millennia, its governing processes and implications for the future climate, we bring together three different research communities: the Earth system modeling community, the proxy data community and the computational science community. The research is intended to be conducted over a period of 10 years. The paper describes the motivation for and preliminary results of the initiative.

ID: 01373, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Oral)

Sea-level indicators as proxy data for relative sea-level change

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Observations of sea-level variations allow the validation of numerical models used to reconstruct past and predict future sea-level change. Sea-level indicators (SLIs) are used as the main source for deriving relative sea level (RSL) variations during previous epochs for which tide-gauge and satellite measurements were yet not available. However, the leveling of an SLI relative to present sea level does not provide a direct measure of former RSL, but only an indication according to the conditions under which the sample was deposited. This information depends on the sample type and on its environment and has to be mapped to RSL by an appropriate transfer function. The respective data has to be extracted by an objective procedure from primary information usually provided in geological or paleontological literature of different primary focus, quality and detailedness. In addition to the height information, also the precision of dating varies between different indicators and in case of radiocarbon-dated material, a further calibration of the dated age has to be applied.

In order to improve the reliability of sea-level indicators for sea-level reconstructions, the visualization framework

SLIVISU is developed at GFZ-Potsdam. It allows access to a relational database system that contains compilations of sea level indicators obtained from the literature where the respective meta information is stored. First, the radiocarbon dated material is calibrated considering information from the sample\'s metadata. Then likelihood functions are derived incorporating the indicative meaning as available error information in order to evaluate model-based sea-level predictions against the respective SLI. This procedure is accompanied by applying the visual analytics tool SLIVISU.

Depending on the statistical significance, the analyzed SLIs will serve as validation data for the viscoelastic lithosphere and mantle model VILMA, part of the German Paleo-Climate Modelling Initiative PalMod.

ID: 02207, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Oral)

Linking abrupt changes in local marine radiocarbon reservoir age (ΔR) to upwelling and hunter-gatherer demographic change in coastal northern Chile during the mid-Holocene

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Shell middens are heaps of discarded human refuse, often interspersed with dwelling structures and burials. These deposits are well known features of the archaeological record in northern Chile and span most of the Holocene. Early to mid-Holocene shell middens accumulated from the discarded remains of fish, shell fish and terrestrial remains of local hunter-gatherer populations known as the Chinchorro. Some of the oldest examples of artificial mummification are among the innovations of these social groups, which settled the coastal Atacama desert before 9 ka BP. Abundant terrestrial (especially plants such as *Typha*) and shellfish remains along with very fast accumulation rates (one midden accumulated 3 m in less than 500 yr) make radiocarbon comparisons of marine and atmospheric ages feasible to estimate local marine reservoir deviations (ΔR). Such deviations result from the influence of mid-depth water masses at the surface of the coastal ocean and thus provide a proxy for the intensity of coastal upwelling. We have estimated ΔR values from three different middens that formed during the mid-Holocene from 6.7 to 4.6 ka BP. Our results show that between 6.7 – 5.5 ka BP, ΔR values were stable and averaged ~270 yrs. This period was coeval with the largest increase in the Chinchorro population during their entire history as gleaned from radiocarbon probability distributions (built from a dataset of more than 600 ^{14}C dates). In contrast, ΔR values are highly variable between 5.5 – 5.0 ka, with values exceeding 1000 yrs. This implies strong environmental fluctuations associated with variable upwelling conditions and was coeval with the largest Chinchorro population-collapse. We conclude that the strong changes in upwelling conditions driven by Holocene climate change may be one of key factors behind the large-scale demographic changes of coastal Chinchorro populations.

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ID: 02330, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

How strong are the environmental and societal impacts of major stratospheric eruptions at the local scale? Case study of the AD 1257 eruption of Samalas Volcano in Lombok, Indonesia

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The AD 1257 eruption of Samalas volcano (Lombok Island, Indonesia) is considered as one of the most powerful of the Holocene. It ejected more than 40 km^3 of pyroclastic material, including a Dense Rock Equivalent volume of inland Pyroclastic Density Currents (PDC) up to 16 km^3. The gap in the island's history during this period suggests high human loss. Local legends ("babad") indicate that the kingdom and its capital Pamatan were erased.

The objectives of our study are threefold: (i) to draw the pre-eruption shape of Lombok island; (ii) to better estimate the actual volume of the 1257 PDC deposits;

and (iii) to reconstruct the pre-eruptive settlements on the island.

Our methods include geomorphological and geological surveys on natural outcrops, wells and quarries, coring, inland and near-shore geophysical investigations, as well as exegesis of local written sources.

Preliminary results point to a strong increase of the island's area as a consequence of drastic sedimentation yield since the mid-13th Century. More than half of Mataram city was built on syn-or post-eruption soft sediments (pumice, sand, or clay). The eastern and northern coasts of Lombok also extended seaward up to several kilometers since the 13th century. Some of the present valleys already existed prior to the eruption, whereas others result from a deep incision of the rivers within PDC deposits up to 60 m thick. Although a huge volume of PDC deposits has been well-preserved from natural erosion for centuries, extensive mining activities since the 1980's have drastically reduced the former extension of these deposits. The drawing of the pre-eruptive shoreline and paleovalleys will help archaeologists to find the ancient city of Pamatan and other settlements that still lie buried beneath tephra deposits in several places of the island.

ID: 02258, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Oral)

African monsoons dynamics and marine productivity off the Congo River mouth, a model-data comparison perspective

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In this study we analyze the links between large scale atmospheric circulation, precipitation, ocean circulation and marine biogeochemistry, all related to the African monsoons in five climate simulations of the last glacial-interglacial cycle. We use the IPSL-CM5A-LR model and the PISCES biogeochemical model. Our results show that the paradigm, used to reconstruct past dynamics and based on the fact that to stronger monsoons correspond weaker trade winds, is not verified in all climates. We show that, depending on the mean climate state, the thermal or dynamical effects are more or less prominent in driving the simulated changes in precipitation and wind patterns over Africa. The stronger monsoons in our simulations are characterized by stronger westerly flows around 10°N. Since precipitation changes over Africa drive the Congo River outflow fluctuations, it is likely also modifying marine biological productivity off the river mouth. Our analyses of simulated marine productivity in the region of core KZAI-01 in the eastern south-equatorial Atlantic, shows that most of productivity occurs at the subsurface. Effects of the nutrient river supply are shown to be restricted to the surface only, whereas the coupled ocean and atmosphere dynamic is shown to be the main driver of productivity changes in the different climates. This last result points out that even though changes in river outflow and productivity happen conjointly there is not necessarily any causality between them.

ID: 01873, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

A Holocene temperature record from the Agassiz ice cap: Implications for high-Arctic climate change and Greenland ice sheet evolution

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We present a revised and extended high Arctic air temperature reconstruction from a single proxy that spans the past ~12,000 years (up to 2009 CE). Our new reconstruction, obtained from the Agassiz ice cap (Ellesmere Island, Canada), indicates an earlier and more pronounced Holocene Thermal Maximum with early Holocene temperatures 4-5 ^{o}C warmer compared to a previous reconstruction. It also shows that contemporary air temperatures are at their warmest in the past 6,800–7,800 years and that, over the last century, decadal-scale rates of temperature change in this region are unprecedented over the Holocene. We demonstrate that the more pronounced early Holocene warming inferred from the Agassiz ice core leads to a large response of the NW sector of the Greenland ice sheet with surface thinning of ~1 km during the early Holocene, which is in agreement with the surface thinning we estimate from the Camp Century ice core record. This agreement suggests that the failure of previous ice models to capture the ice thinning signal reflects inaccuracy in the adopted climate forcing. The modelled response of the ice sheet to this enhanced warming is significant, resulting in a ~25% increase in ice sheet mass loss (~1.4 m sea-level equivalent) during the last deglaciation compared to a recent model reconstruction.

ID: 01350, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Oral)

Long-term variation of clay mineral compositions in the Andaman Backarc Basin since the late Miocene

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Clay mineral studies in the Andaman Sea helped to understand the interaction between climate change and monsoon strength by revealing the erosional history of the Himalayan-Tibetan and Indo-Burman ranges during the late Quaternary. IODP Exp. 353 Site U1447 (10°47.4’N, 93°00’E), located at a water depth of 1391 m on a ridge ~45 km offshore the Little Andaman Island within the Andaman Backarc Basin, was drilled to penetrate 738 m beneath the sea floor. Chronostratigraphy of Hole U1447A was established by using shipboard biostratigraphic and paleomagnetic data, showing the late Miocene (~10.0 Ma) at the bottom of core. Seventy nine sediment samples were taken from 150 to 737 m CSF-A at Hole U1447A at ~8 m intervals for determining clay mineral compositions in order to probe the major controlling factors for their long-term variation patterns. At Site U1447, smectite (28~61%) and illite (20~40%) are the most dominant clay minerals while kaolinite (9~19%) and chlorite (5~15%) are subordinate. Variation pattern of clay mineral compositions exhibits three prominent features: (1) mostly consistent variations of all clay minerals at 750~570 m (~10.0 to 7.5 Ma) interval, (2) gradual decrease of smectite and increase of illite and chlorite at 570~400 m (~7.5 to 4.5 Ma) interval, and (3) large fluctuation of all clay minerals at 400~150 m (4.5 to 1.1 Ma) interval. Much of the terrigenous sediments from the Himalayan-Tibetan and Indo-Burman ranges mainly through the Irrawaddy and Salween rivers and additionally through the Ganges-Brahmaputra rivers discharged into the Andaman Sea. Long-term variation patterns of clay mineral compositions in the Andaman Backarc Basin may be related to various factors such as provenance shift, climate changes, monsoon strength, and tectonic/volcanic activity.

ID: 01721, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

Chemistry modulations of large volcanic events of the last millennium

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Large volcanic eruptions have long been identified as a means to perturb global climate through injection of SO_2 into the stratosphere. However, volcanoes also inject water, halogens, and ash. Here we use the NASA Goddard Institute for Space Studies ModelE-MATRIX to demonstrate how modulating these additional constituents alters the climate impact. We focus on the scale of SO_2 from Tambora (1815), Kuwae (1453), and Samalas (1258) and estimates of the other plume constituents. Previous work demonstrated that the addition of water in the injection enhances the rate which sulfate aerosols are formed and increases their size (LeGrande et al, 2016). Here we show the impact for larger magnitude events.

ID: 01467, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Palaeoenvironmental changes and Meso-Neolithic human-landscape interaction in the Caspian coast

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The south Caspian Sea coast not only underwent deep climatic changes at the Late Pleistocene-Holocene transition, but also its narrow coastal plain at the foot of the Elburz Mountains changed its width according to important water level changes. The area is known for its large biodiversity and the occurrence of glacial refugia for plants, which were also used by animals and humans. Mesolithic and early Neolithic populations are known to have lived there and their diet, according to the archaeological investigations of cave infills by McBurney in 1949-1950, changed widely according to the availability of resources alternating between more steppe–based animals and more marine-based ones. N Iran with SE Azerbaijan have a diverse environment owing to the Talysh-Elburz Range that is north facing and catches precipitation from air masses coming from the Caspian Sea. The humid area represents a pocket of life in an otherwise dry Middle-East.

This study examines palynological remains in two 17 m long sediment cores (Gharasoo and Shakileh cores) obtained in palaeo-lagoons, located between the caves (Hotu and Belt caves) and the coast and dated by radiocarbon. In particular, pollen grains and charcoal provide information on vegetation; parasite eggs and fungal spores on the presence of large herbivores and erosion; and small aquatic organisms (such as dinocysts) on water level and changes in Pontocaspian biodiversity.

Despite problems with radiocarbon dating, preliminary results indicate the continuous presence of a diverse woodland over the last 30,000 years, significant changes in the fire regime, in the climate (eg the Last Glacial

Maximum and the Younger Dryas) and in water level and quality (eg the early Holocene lowstand of the Mangyshlak). Coprophilous fungal remains indicate the continuous presence of herbivores, except during a very freshwater phase at the end of the Bølling-Allerød.

ID: 01264, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Wildfires and geochemical change in a subalpine forest over the past six millennia

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The frequency of large wildfires in western North America has been increasing in recent decades, yet the geochemical impacts of these events are poorly understood. The multidecadal timescales of both disturbance-regime variability and ecosystem responses make it challenging to study the effects of fire on terrestrial nutrient cycling. Nonetheless, disturbance-mediated changes in nutrient concentrations could ultimately limit forest productivity over centennial to millennial time scales. Here, we use a novel approach that combines quantitative elemental analysis of lake sediments using x-ray fluorescence to assess the geochemical impacts of high-severity fires in a 6200-year long sedimentary record from a small subalpine lake in Rocky Mountain National Park, Colorado, U.S.A. Immediately after 17 high-severity fires, the sedimentary concentrations of five elements increased (Ti, Ca, K, Al, and P), but returned to pre-fire levels within three decades. Multivariate analyses indicate that erosion of weathered mineral material from the catchment is a primary mechanism though which high-severity fires impact element cycling. A longer-term trend in sediment geochemistry was also identified over millennial time scales. This decrease in the concentrations of six elements (Al, Si, K, Ti, Mn, and Fe) over the past 6200 years may have been due to a decreased rate of high-severity fires, long-term ecosystem development, and changes in precipitation regime. Our results indicate that high-severity fire events can determine elemental concentrations in subalpine forests. The degree of variability in biogeochemical response across time scales suggests that shifting rates of high-severity burning can cause significant changes in key rock-derived nutrients. To our knowledge, these results are the first to reveal repeated loss of nutrients from the terrestrial ecosystem due to high-severity fires. Understanding the future of fire-prone coniferous forests requires further documentation and quantification of this important feedback mechanism between fire regimes and biogeochemical cycles.

ID: 01606, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Oral)

Holocene dust composition in the Indian Ocean inferred from Amsterdam Island peat geochemistry

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Peat bogs can produce high-resolution records of environmental and climatic changes. Because almost exclusively constituted of organic matter, peat bogs provide low uncertainty chronologies (^{14}C, ^{210}Pb, ^{137}Cs, ^{241}Am) that allow recovering high-quality paleo-information over the Holocene and beyond. Although they have been abundantly used to monitor past atmospheric pollution, less attention has been given to pre-anthropogenic signals, especially in the Southern Hemisphere and in the sub-Antarctic.

A 5-m peat core was collected from Amsterdam Island (37° 50′ 742″ S, 77° 32′ 898″ E), French Austral Territories in late 2014. It is a volcanic island displaying Sphagnum peatlands at its top, located in the middle of the Indian Ocean and at the crossroads of African, Australian and southern American dust trajectories (Lamy et al., 2014).

Chronological data and inorganic geochemistry (lithogenics, REE, Nd isotope, mercury isotope) give the first insights of sedimentation rate, dust origin as well as climate change in the middle of the Indian Ocean. In a first attempt to decipher the sources of mineral inputs, we investigated Rare Earth Elements spidergrams as well as Neodymium isotopes. The preliminary results suggest that there is a constant mix of different sources in the past ca. 6500 years. Our long-term goal is to investigate the paleodust fluxes and signatures in such remote locations in order to extend our knowledge of the dust-climate-environment interplays.

F. Lamy, R. Gersonde, G. Winckler, O. Esper, A. Jaeschke, G. Kuhn, J. Ullermann, A. Martinez-Garcia, F. Lambert, R. Kilian. "Increased Dust Deposition in the Pacific Southern Ocean During Glacial Periods." Science, Vol. 343, Issue 6169, pp. 403-407

ID: 01845, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Pollen-based land-cover change during the Holocene in temperate China for climate modelling

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Quantification of the biogeochemical and biogeophysical effects of human-induced land-cover change (land-use) on climate in the past is still a subject of debate. Progress in our understanding of the net effect of land-use change on climate greatly depends on the availability of reliable, empirical reconstructions of anthropogenic vegetation change. The PAGES working group LandCover6k has the goal to produce as reliable descriptions as possible of past vegetation for the evaluation of anthropogenic land-cover change (ALCC) scenarios and climate modelling applications at the global scale. China is one of the key regions of the world where agricultural civilizations flourished during a large part of the Holocene. However, the role of human activity in vegetation change is not yet fully understood. As a contribution to LandCover6k, we present the first pollen-based reconstruction of land-cover change, both climate-(natural) and human-induced, over the Holocene in temperate China using the REVEALS model (Sugita, 2007). The REVEALS model requires values of pollen productivity for the major plants characteristic of the study region. We performed the first evaluation of the relative pollen productivities (RPP) available from temperate China and established a tentative standard RPP dataset for 31 plant taxa. These RPP values were used together with 95 pollen records from temperate China grouped into 35 groups for the REVEALS application. The REVEALS-based values of plant cover strongly differ from the pollen percentages. As in Europe, pollen percentages generally underestimate the cover of herbs in the vegetation, except for *Artemisia* that is overrepresented by pollen. As expected, human-induced deforestation is highest in eastern China with 3 major phases of decreasing woodland cover at ca. 5.5-5k, 3.5-3k and 2k calendar years BP. Disentangling human-induced from climate-induced land-cover change requires thorough comparison of the REVEALS reconstructions with historical and archaeological data.

Sugita S (2007) *The Holocene*, 17(2): 229–241.

ID: 02009, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

The Quaternary history of non-marine molluscs in the Somme valley (northern France) during the last 1 Myr

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The Somme valley is a key area for the Human occupation of NW Europeand and has been intensively studied since the end of the XIXth century. In this region, Quaternary deposits are represented by a terrace system including ten alluvial sequences covered by slope deposits which formed during the last million year. Geomorphology and dating have been intensively studied and provide a consistent view of geometrical evolution of the landscape together with a solid chronological frame of events. Many sites have been excavated within these formations and have given opportunities to report on changes of climate and environments trough time. Non marine molluscs which are a good proxy for palaeoenvironmental reconstructions are regularly preserved in those deposits. In 1952 Breuil published a first detailed report of all the non-marine molluscan faunas from Quaternary deposits of the Somme and the Seine valleys. Sixty years later after a lot of supplementary analyses have been performed, the present contribution intends to provide a new synthesis of the history of malacological assemblages since 1 Myr. How climatic cycles influence composition of snail communities ? Is there a model of malacological evolution vs climatic and environmental changes ? What evolution of biodiversity can be reported ? Change in number of species ? Extinction of taxa ? Evolution of geographical distribution of species?

ID: 02363, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Temporal-spatial climate variations during 17th-19th centuries using Chinese chronological records

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Climate reconstruction and numerical modeling provide important information on the rate and pattern of climate responses to the forcings. But there still exists some notable limitations on the methods and proxy data to accurately depict climate anomaly and variability and their regional expressions at high temporal-spatial resolution. This research highlights a new REACHS dataset that collects primarily documented meteorological records from thousands of local chronicles in the Chinese history in more than 2000 years. The meteorological records were digitized and coded in the relational database management system in which accurate time (from yearly to diurnal), space (from province to city/county) and event (from meteorological to phonological and social) information is carefully reserved for analysis. Our present research results on the annual and seasonal temperature reconstruction during 17th-19th indicates lower temperature in the 17th century with higher occurrence frequency of summer snowfall record, correspondent to the Manuder Minimum. Precipitation reconstruction fluctuated with strong regional expressions in the Northeast, Central-east and Southeast China. Spectral analysis shows precipitation to have significant 3-5 and 8-12 years periodicity during the period, suggesting a likely interannual variability and different regional signatures. Flood was periodically happened but enduring drought was more frequently occurred in the 17th than in the following century; furthermore drought is perfectly matched with locust records, especially in the 17th century. The temporal and spatial variability of the climate reconstruction implies hierarchical and multi-scaled climate variability and a likely changing regime of monsoon: its spatial distribution, pattern and intensity. More detailed spatial-temporal analysis will be applied to analyze the dynamism.

ID: 02261, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

The Atlantic Deep Circulation During Interglacial MIS 11

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The ocean's role is crucial regarding the Earth's energy balance and thus climate state. Here, we present a new record of deep water mass provenance in the subtropical western North Atlantic during the interglacials MIS 9, 11, and 15, together with published data of MIS 1 and 5. We achieve this through the reconstruction of the authigenic neodymium isotopic composition (ε_{Nd}) of sediment core ODP Site 1063 located on the Bermuda Rise by leaching off the bulk sediment particles' ferromanganese oxy-hydroxide coatings.

While most interglacials reveal a similar pattern, MIS 11c stands out. Compared to the other interglacials, more unradiogenic ε_{Nd} values are recorded, which also lasted for the entire interglacial for almost 30 kyr. This observation agrees with the ε_{Nd} retrieved from foraminifera. Such an extreme isotopic composition has previously been documented only during rapid climate warmings of the last glacial period [Böhm et al. 2015, Nature 517]. Since the continents surrounding the Labrador Sea are an important source for unradiogenic Nd, the here traced low ε_{Nd} values are most likely indicative of a stronger influence of the Labrador Sea in the Bermuda Rise area during MIS 11c, either through enhanced Nd input from continental weathering and / or intensification of Labrador Sea deep water formation. Overall, MIS 11 stands out as a super-interglacial in terms of North Atlantic deep circulation.

ID: 01315, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Oral)

The Holocene Global Temperature Conundrum, When Models Meet Data

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State-of-the-art climate models are inconsistent with most recent data synthesis of global temperature trend in the Holocene. Surface temperature reconstruction of global annual temperature shows early Holocene warmth followed by a cooling trend through the middle to late Holocene. To the contrary, climate models show a slow warming trend, caused by the retreating ice sheets and rising atmospheric greenhouse gases (GHGs). The cause of the discrepancy remains elusive. Our preliminary re-examination of this contradiction between the reconstructed cooling and the simulated warming points to potential biases in both the seasonality of the proxy reconstruction and the climate sensitivity of current climate models. We also discuss some other conundrum on persistent model-data inconsistency and their implications.

ID: 02341, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Holocene climate variability and trends: data and models

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Data-model comparisons are hindered by uncertainties like varying reservoir ages or potential seasonality bias of the recorder systems, but also due to the models\' difficulty to represent the spatio-temporal variability patterns. For the Holocene we detect a sensitivity to horizontal resolution in the atmosphere, the representation of atmospheric dynamics, as well as the dynamics of the western boundary currents in the ocean. These features can create strong spatial heterogeneity in the North Atlantic and Pacific Oceans over long timescales unlike a diffusive spatio-temporal scale separation. Futhermore, it is shown that such non-linear mechanisms could create a non-trivial response to seasonal insolation forcing via an atmospheric bridge inducing non-uniform temperature anomalies over the northern continents on multi-millennial time scales. It is argued that some obvious biases between models and data may be linked to the missing key persistent component of the atmospheric dynamics, the North Atlantic blocking activity. It is shown that blocking is also linked to Atlantic multidecadal ocean variability and to extreme events. Interestingly, several proxies provide a measure of the frequency of extreme events, and a proper representation is a true challenge for climate models.

ID: 01436, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Fluvial dynamics in the southern Amazonian foreland basin on annual and millennial time scales

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Based on the floodplain sedimentation patterns of large rivers in the southern Amazonian foreland basin (SAFB), it has been suggested that alluvial plain sediment accumulation is primarily the result of river crevasse splays triggered by above normal precipitation events due to La Niña. Using Landsat images from 1984 to 2014, we analyse the behaviour of all the twelve tributaries of the Mamoré River with a catchment in the Andes. We show that these are very active rivers and that the frequency of crevasses is not linked to ENSO activity. Fluvial dynamics on a millennial time scale is reconstructed trough the analysis of 40 stratigraphic cores taken along a 300 km long transect across the SAFB. Based on 30 radiocarbon ages from paleosols intercalated with fluvial sediments, we reconstruct the most important Holocene changes in the SAFB's floodplain dynamics. We conclude that, on an annual to decadal time scale river sedimentation is controlled by intrabasinal processes; while the changes in river activity, which occur on a millennial scale, are controlled by climate. Fluvial activity decreases from 8k cal. yrs BP to 4k cal. yrs BP, and increases from 4k to 2k cal. yrs BP, when, once again, fluvial activity decreases and reaches its minimum after 2k cal BP.

ID: 02056, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

The record of megafloods in marine sediments: an example from the NE Pacific

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Massive inputs of freshwater into the ocean are known to disrupt climate. This has been fairly studied in the North Atlantic with freshwater inputs from the Laurentide ice sheet and glacial Lake Agassiz. The association of these discharges with deglacial warming has lead us to look for such prints in marine sediments in order to understand its paths and mechanisms. Glacial Lake Missoula "megafloods", in the North America, have been extensively studied on land. The outbursts of freshwater not only dramatically changed the landscape but also might have changed the Northeast Pacific ocean circulation, thus affecting climate. Studies showed that a ~610 m tall ice dam, holding about $2x10^3$ to 10^5 km^3 of water was confining the lake, outbursting with a $10^6 m^3/s$ to $10^7 m^3/s$ flux into ocean. Understanding the behavior and mechanism of these floods in the past help us to understand the behavior of modern glacial lakes including the Antarctica sub glacial lakes.

Here we show the records of Glacial Lake Missoula outbursts during the warming since the Last Glacial Maximum, in two marine cores off Oregon and California. The presence of diatoms that are linked to massive discharges of freshwater from the glacial lake Missoula allowed us to constrain the dynamics and timing of these north America megafloods. The consequences of such discharges of freshwater in the Northeast Pacific regional circulation remains unknown. We estimate a salinity decrease of almost 6.0 PSU more than 400 km south during the last glacial interval (from 13–30 calendar (cal) k.y. B.P.). Anomalously high abundances of freshwater diatoms in marine sediments from the region precede generally accepted dates for the existence of glacial Lake Missoula, implying that large flooding events were also common during the advance of the Cordilleran Ice Sheet.

ID: 01303, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Oral)

Simulating ENSO evolution of the last 300,000 years: precessional modulation of ENSO variance and seasonal phase-locking

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The responses of ENSO and the equatorial Pacific annual cycle to external forcing changes are studied in three 3,000-year-long NCAR-CCSM3 model simulations. The simulations represent the period from 300 ka BP to present day. The first idealized simulation is forced only with accelerated orbital variations, and the rest are conducted more realistically by further adding on the time-varying boundary conditions of GHGs and continental ice sheets.It is found that orbital forcing dominates slow ENSO vairance evolution, while the effects of GHGs and ice-sheet forcing tend to compensate each other. On the orbital time scales, ENSO variability and annual cycle amplitude change in-phase and both have pronounced precessional cycles modulated by variations of eccentricity. Orbital forced ENSO intensity is dominated linearly by the change of the coupled ocean-atmosphere instability (or its growth rate). In glacial-interglacial cycles, additionally, the weakening/strengthening of ENSO owning to a more concentrated/depleted GHGs level leaves little net signal as compensated by the effect coherent change of decaying/expanding ice sheets. Furthermore, ENSO seasonal phase locking is shifted periodically following the precessional forcing: ENSO tends to peak in boreal winter when perihelion is near vernal equinox, but in boreal summer when perihelion ranges from autumn equinox to winter solstice. The phenomenon is caused by the change of the seasonality of the growth rate of ENSO, which is associated with the mean climate and climate sensitivity response to the precessional modulation.

ID: 01819, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

A high-resolution speleothem record of the last interglacial (MIS-5e) in the Northern Alps

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Quantifying the duration and magnitude of past interglacials is of prime importance to understand ecological adaptation to a warmer world. Mountain areas such as the European Alps are particularly sensitive to even small hydroclimatic changes and thus require reliable records to unravel the complex spatial response. Here, we present a new speleothem record (7H-12) from the Sieben Hengste cave system, Switzerland, encompassing the last interglacial period. The onset into the interglacial is dated at 129.8± 0.8 ka, consistent within error with other recently published records of Termination II for the European Alps (Häuselmann et al., 2015; Moseley et al., 2015). However, in marked contrast to these speleothem records, 7H-12 shows a rapid increase in δ^{18}O, which reaches a climax at 128.4±0.8 ka and is followed by a gradual depletion until 117.5 ka. This distinct pattern, characterized by low interannual variability, suggests that 7H-12 was little affected by local processes and, thus, may represent a robust archive for the last interglacial at a regional scale. Moreover, the 7H-12 time series is well aligned with the Chinese Sanbao speleothem record (Cheng et al. 2009), suggesting a teleconnection between the North Atlantic system and the East Asian monsoon system. Overall, in combination with other speleothems from the Sieben Hengste cave system, the opportunity to quantify the amplitude of the climate signal over a full glacial cycle is provided for the first time.

References: Cheng H. et al. 2009. Science, 326, 248-252; Häuselmann A. et al., 2015. Quat. Sci. Rev., 126, 264-275; Moseley G. et al., 2015. Quat. Sci. Rev., 127, 229-239.

ID: 01718, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Oral)

Leaf wax biomarker reconstruction of Pliocene hydrological variation during Australopithecus afarensis evolution in Afar, Ethiopia

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Climate change is thought to play a critical role in human evolution. However, this hypothesis is difficult to test due to a lack of long, high-quality paleoclimate records from key hominin fossil locales. We improve the understanding of this relationship by examining Plio-Pleistocene lake sediment drill cores from East Africa that were drilled as the foundation of the Hominin Sites and Paleolakes Drilling Project, an international effort to study the environment in which our hominin ancestors evolved and dispersed. The goal of our research is to produce sedimentary records of climatic and environmental change from the basins in which early hominins lived in order to test various evolutionary and climate variation hypotheses.

We have analyzed organic geochemical signals from drill cores in paleolake Awash in the Afar region of Ethiopia where ‘Lucy’ was discovered. We present leaf wax hydrogen and carbon isotopic variation; the hydrogen isotopic compositions of these waxes record changes in regional hydrology, while complimentary carbon isotopes provide insight into the paleo-vegetation. These biomarker proxies provide a relatively straightforward indicator of past rainfall amount, which directly affects the *Australopithecus afarensis* habitat vegetation structure. The Awash drill core spans ~2.5-3.45 Ma, including part of the Pliocene Warm Period, making this study not only important for paleoanthropological research, but crucial in reconstructions of African terrestrial paleoclimate during a time dominated by precessional monsoon cycles prior to the intensification of Northern Hemisphere glaciation.

ID: 02151, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

BETWEEN- AND WITHIN-BIOME RESILIENCE AT THE FYNBOS-FOREST BOUNDARY, SOUTH AFRICA

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The fynbos biome of the Greater Cape Floristic Region (GCFR) of South Africa is a biodiversity hotspot, threatened by global change and local disturbance. Understanding of the resilience of this ecosystem is therefore critically important.

Fynbos exists in the same climatic zone as afrotemperate forests, and it is thought that these alternate stable states are maintained by fire, to which fynbos is adapted, but which afrotemperate forest cannot tolerate. In this study, palaeoecological data were used to assess the effects of changes in climate, fire and land use on vegetation at the from the fynbos – forest boundary. We hypothesised that the forest extent would increase in wetter climates with less fire, and contract in times when climate was drier and / or more fire prone. We further hypothesised that forest extent would be influenced by rainfall seasonality, with less seasonal rainfall facilitating forest expansion.

Despite known climatic changes over the past 3000 years, the fossil pollen data suggest remarkable stability of the fynbos-forest ecotone. The resistance of fynbos to forest invasion is explained by a combination of increased seasonality during cooler, wetter period, which would enhance summer drought stress, and increased fire in warmer, drier, but less seasonal periods when biomass productivity would have been higher. Furthermore, resilience of fynbos was enhanced through internal dynamics, that allowed a shift from grassy, fire prone fynbos in warmer, less seasonal time periods, to proteid fynbos during times of greater summer drought stress. Even with warming climate, proteoid fynbos was able to persist because increased herbivory, associated with the arrival of pastoralists, helped to prevent the build-up of biomass and a return to more fire-prone conditions.

These findings highlight the importance of understanding complex interactions between seasonality, ecology, fire and human land-use in predicting the responses of fynbos to changing environmental conditions.

ID: 01412, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Disentangling drivers and directions of land cover change: human and environmental interactions across East Africa from 6000 years ago to present

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Archaeological, archaeobotanical, linguistic and palaeoenvironmental data haven been compiled under the LandCover6k project to chart land cover change over the past 6000 years. Through an interdisciplinary exchange of information, we can disentangle drivers and directions of land cover change, the associated environmental history and multiple interactions with the distribution of various cultures, technologies, and subsistence strategies in time and space across the East African region. We focus on the mapping subsistence and land use transitions throughout East Africa from 6000 years BP it is clear there have been a series of quite rapid and high magnitude environmental shifts characterised by changing hydrological balance of the region. For example, a pronounced environmental shifts manifested as a marked change in the hydrological budget throughout East Africa cantered around 4000, 800 and 300 yr BP particularly as a result of decreased rainfall or seasonality.

In addition to being a pronounced period of environmental change there are numerous coeval shifts attributed to human history and interactions with the environment over the past 6000 years. From the mid Holocene anthropogenically derived land use change has increased exponentially although there have been a series of waves of land cover change associated with the arrival of new subsistence systems, crops, migrants and technologies. For example, the first large scale impacts did not occur to around 4000 yr BP associated with the arrival of pastoral communities. The first extensive forest clearances were associated with the arrival of Bantu farmers around 2500 yr BP with metallurgy and particularly focusing on the productive and easy to clear mid-altitudinal areas. Targeted areas of future research are indicated that incorporate development of ecosystem modelling and in particular combining archaeological and palaeoenvironmental investigation with a regional focus.

ID: 01483, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Tiny but powerful - the use of functional traits of testate amoebae as disturbance indicators in palaeoecological studies of peatlands

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Disturbances affecting peatlands, such as fire and peat extraction, often cause water table lowering, with long lasting effects on local microbial communities and biogeochemistry. Also, prolonged droughts can lead to changes in ecosystem functioning, shifts in vegetation structure, and influence microbial diversity and food-webs. As a result, disturbed peatlands may become carbon sources instead of natural sinks, particularly under future scenarios of land use and climate changes. A tool to monitor disturbances in peatlands may help to anticipate such risks. As shown in ecological studies, species\' functional traits might be helpful as they are closely related to ecosystem processes through evolutionary adaptation. In our study we show how functional traits of testate amoebae (TA) can be used as an “early warning” signal of ecosystem disturbance and help determine thresholds of ecosystem resilience to various disturbances. We analysed TA traits from two *Sphagnum* peatlands in Poland which had experienced both fire and peat extraction in the past 2ka. We also used structural equation modelling to test the effect of disturbances on the linkages between TA community structure, functional trait composition and functional diversity. Our results show that two traits: ‘mixotrophy’ and ‘plagiostomic apertures’ are related to disturbances over the long time-scales (decades to century). We observed loss of mixotrophic TA and an increase of TA possessing plagiostomic apertures during and post-disturbance. We suggest that those two traits can be used as proxies for peatland disturbance to support conventional microscopy analyses of TA communities.

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ID: 02099, 15.- The Holocene - its climate variability and rapid transitions, (Invited Oral)

Holocene Climate Change: A Data Perspective

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The Holocene epoch spans the entire length of human civilization and is generally considered an interval of relative climate stability. An initial global surface temperature reconstruction of the Holocene suggests that the historically documented 1.0°C global-average warming over the past century spans the full range of Holocene global-average temperature variability and reversed a long-term cooling trend that began nearly 5,000 years ago (Marcott et al., 2013). This work agrees well with other surface temperature studies for the past 2,000 years (Mann et al., 2008) and reconstructions of ocean heat content for the past last 10,000 years (Rosenthal et al., 2016). In contrast, most Holocene model simulations to date tend to exhibit a long-term global warming rather than the cooling seen in the proxy records (Marcott et al., 2013; Liu et al., 2014). This disparity raises fundamental questions: Are we misinterpreting what the proxy record tells us about past climate change? Or are models missing key physics in response to major climate forcings? Both are possibilities and as yet, have not been fully explored.

Major PAGES efforts to synthesize and analyze global paleoclimate records and model simulations of the last several hundred thousand years have already been undertaken (e.g. Liu et al., 2009; Tzedakis et al., 2012; PAGES 2k Consortium, 2013). The transient evolution of the Holocene climate, however, is still generally underrepresented in past climate reconstructions. Here we present an expanded dataset of Holocene proxy temperature records that builds on previous work (Marcott et al, 2013), and includes a more diverse network of climate proxies (e.g. pollen, d^{18}O). We will discuss our current research efforts (e.g. Marsicek et al., submitted) to characterize past climate trends of the present interglacial as well as a broad overview.

ID: 01466, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Invited Oral)

Which mechanisms led to Heinrich 1 atmospheric CO2 increase?

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During Heinrich stadial 1, atmospheric CO_2 increased by 36 ppm, while $\delta^{13}CO_2$ and $\Delta^{14}CO_2$ decreased by 0.3 permil and 115 permil, respectively. In addition, oceanic $\delta^{13}C$ data, particularly from the Pacific and Southern Ocean, indicate a decrease in $\delta^{13}C$ vertical gradient during that time. Here, transient experiments of the early part of the last deglaciation are performed with a carbon isotope-enabled Earth System Model. A model-data comparison focusing on atmospheric and oceanic changes in $\delta^{13}C$ as well as $\Delta^{14}CO_2$ provides constraints on the distinct roles of changes in iron fertilization, Southern Ocean upwelling and terrestrial carbon release in driving the atmospheric CO_2 increase during the early part of the deglaciation.

ID: 01549, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Land-ocean pre- and post-industrial climate variability in the Europe/Mediterranean paleo-archive: unique, similar or unlike the global context?

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Recent syntheses of ocean and land temperatures have estimated the timing of global anthropogenic warming around the mid-nineteenth century (Abram et al., 2016), after a cooling trend that has been explained by explosive volcanism and/or to a lesser extent by land use change (McGregor et al., 2015). A central question here is whether the Mediterranean/North Atlantic region is unique as compared to the global pattern due its continentality, human modifications and amplified sensitivity to forcings. In this study, a composite of sea surface temperature (SST) reconstructions from the Mediterranean/North Atlantic basins is compared with a stack of terrestrial records selected to describe the temperature variability in the European region over the past 2000 years. Prior to 800 CE, during the Roman and Dark Ages intervals, the scarcity of measurements prevents us from making sound inferences. From 800 to 1800 CE, both land and ocean signals present common significant cooling trends (up to −1 s. d. units/millennium), with anomalous cold temperatures registered during the Little Ice Age, standing out in both composites, particularly after 1600 CE. During the post-industrial time interval, the terrestrial synthesis registers almost +2 s. d. units warming since 1800 CE. The warming is of lower amplitude in the ocean stack, only +1 s. d. units. Sensitivity tests suggest that the 20th century ocean warming amplitude is more pronounced as more low-latitude records are taken into consideration, whereas inclusion of high-latitude and/or upwelling locations attenuates it. Inherent uncertainties in the available paleo-reconstructions and modes/mechanisms as yet to be explored bring about that for example the answer to the question whether the post-industrial period is likely the warmest climatic period of the past 2000 years appears to remain elusive in the Europe/Mediterranean archives.

ID: 01765, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Oral)

Dust deposition and soil organic carbon storage at the landscape scale: Case study of Holocene loess, central Great Plains, USA

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After dust is deposited in vegetated landscapes, OC is added to it; as the dust continues to accumulate, this OC may then be sequestered by being buried at depths where decomposition is slower. The overall effect on OC storage per unit area of the landscape depends on rates of dust deposition, post-depositional erosion, OC input from vegetation, and decomposition. Discrete OC-rich paleosols within loess sequences record periods of minimal dust deposition, but even more rapidly deposited loess can have significant OC content in some settings. We extended the analysis of Jacobs and Mason (2005, Geoderma 125:95-106) to understand how Holocene dust accumulation—producing a loess mantle ranging from < 0.5 to > 6 m thick—affected OC storage at the landscape scale in the central Great Plains, USA. We focus on carbon stocks in the column of Holocene loess that buries the Brady Soil, an OC-rich paleosol recording landscape stability during the Pleistocene-Holocene transition. Those stocks are generally greatest where the Holocene loess is thickest, but the relationship is not linear because where dust was deposited at especially high rates, little OC was added to it. Furthermore, the highest rates of Holocene loess accumulation were limited to narrow (< 1 km wide) zones on dissected tablelands just downwind of active dust sources. Much of the total volume of Holocene dust deposited in near-source areas made no contribution to upland OC storage because it was rapidly removed by water erosion in dissected, steeply sloping parts of those landscapes; some remobilization by the wind is also likely. At a regional scale, the greatest impact of Holocene dust accumulation on carbon storage is likely to be in the much more extensive, less dissected areas of relatively thin (< 0.7 m) Holocene loess.

ID: 01939, 18.- Human Impact on Global Aquatic Systems, (Oral)

The Sediment Record of human activities in Lake Enol (Picos de Europa National Park, Northern Spain)

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Lake Enol, a mountain lake in Northern Spain, is located at 1,070 m a.s.l. in Picos de Europa National Park (PENP), an emblematic area of limestone formations, Atlantic forests, mountain meadows and a varied and rich wildlife which led to its declaration as National Park (first one in Spain) in 1918. The Enol Lake is one of the most visited places in the PENP (> 600.000 visitors/year). A Fe-Mn mine (Buferrera) was exploited in the vicinity of the Lake since 1844 to 1974, which produced important hydrological modifications in the watershed. Cattle grazing has been a traditional activity during the last centuries. During the mid to late twentieth century, tourism and road traffic have greatly increased and a significant livestock population is present (cows, goats, sheep) with sporadic wild boar and deer.

In this study, the recent evolution of Lake Enol is shown by means of a multiproxy study of short sediment cores, including facies analysis, physical properties, digital imaging, XRF, geochemical analysis, C_{org}/N ratios, $\delta^{13}C_{org}$ and $d^{15}N$. The results indicate: i) a clear increase of trace metals as a result of mining and road traffic; ii) increasing soil erosion in the watershed as a consequence of local hydrological changes due to the construction of a road to access the mine; iii) increased allochthonous C_{org} in the recent sediments.

The current lake dynamics reflects the historical human impact on the aquatic system, with an increasing hypolimnetic anoxia and a change in the trophic state from oligotrophic to mesotrophic partly as a result of a higher allochthonous C_{org} contribution. The human-induced modifications in the catchment in Lake Enol are of special importance in a context of global warming, which is another factor sustaining and increasing hypolimnetic anoxia on the lake.

ID: 02263, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Oral)

Impacts of recurring extreme climatic events on societies and landscapes in Provence and Southern French Alps in the early 18th century: a comparative analysis

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Both urban and rural Mediterranean societies have always coped with specific climatic constraints (i.e. summer hot waves, persistent droughts, violent and flashy floods) causing agricultural, economical but also health disasters; these events are key factors of the dynamics of coupled human and ecological systems through history in this part of the world. In the case of the Provence area and the Southern French Alps, if various aspects of the environmental and climate history during the Little Ice Age have already been explored, especially from the 16th to mid-19th century, consequences due to unusual recurring extreme climatic events during the first decades of the 18th century in Southeastern France have been neglected notwithstanding available specific local archives (i.e. “disaster assistance registries”). Therefore, the study of the impact of these strong climate fluctuations, both on urban and rural societies, but also on landscapes, in a comparative perspective between two adjacent areas, with distinct topographies and natural resources, thus appears original and interesting. First, after describing the hydro-climatic context in Southeastern France during the late LIA (using the newly created HISTRHONE database, http://histrhone.cerege.fr/), we\'ll present major social, economic and sanitary outcomes as well as ecological crises due to these extreme climatic events which impacted this area together with their effects on urban and rural dynamics. Then, we\'ll see if there are significant differences about consequences of these events between lowlands/coastal areas and mountainous regions of the Southern Alps.

ID: 02157, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Oral)

Sea-level proxy records: Are they good enough to reconstruct small-scale jumps?

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To understand past and future sea-level variability, it is important to know if during an interglacial the eustatic sea level is constant, or oscillates by several meters around an average value. Several field sites within and outside the tropics have been interpreted to suggest such oscillations during marine isotope stage (MIS) 5e (129-116 ka). One of these sites is Hergla, where a well-exposed facies succession indicates two foreshore deposits in vertical juxtaposition, previously interpreted as sea-level highstand amplified by a second rise. Our study however shows that the upper foreshore strata coincided with the short-lived global sea-level rise during MIS 5a (85-75 ka), most likely amplified by local GIA effects. In the light of these results the challenge to robustly infer a small sea-level jump becomes apparent: The facies-based sea-level proxy suffers from both insensitivity to small-scale sea-level oscillation and inaccurate or insufficiently precise age data. The reef-based record, on the other hand, suffers from large vertical uncertainties due to hard to determine living range and growth rate of the coral investigated. In addition, the surface that should form as a result of the sea-level drop is a feature limited to outcrop scale.

Here we highlight the scale-related challenge by presenting data from outcrops, GIA model and Bayesian statistics. In an attempt to overcome the problem while recognising geological principles at the same time, we make some suggestions.

ID: 01559, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Oxygen isotope records from Patagonian lakes as recorders of past hydroclimate and southern westerlies dynamics - calibration, present achievements and future perspectives

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The belt of the Southern Hemisphere Westerlies (SHW) is considered to have played an important role for global climate change by controlling, for instance, carbon dioxide release from the Southern Ocean. However, testing such a hypothesis is hampered by inconsistencies between both models and proxy records regarding intensity and latitudinal shifts of the SHW belt in the late Quaternary. Oxygen isotope proxies from lake sediments can be used to tackle questions related to past atmospheric dynamics and associated hydrological changes in Patagonia, presently located in the SHW core region. The modern database needed for the calibration of isotope proxies from this remote region, however, is extremely poor. To overcome this lack of data, samples of surface water and precipitation from Chile and Argentina between 37 °S and 55 °S were investigated. The isotope ratios of precipitation strongly reflect spatiotemporal patterns caused by orographic, latitudinal, and continental effects. The water balance has a strong influence on the isotopic composition of lake water. Bathymetry, exposition to wind, inflows, outflows, and climatic settings influence the water balances of Patagonian lakes. Thus, the choice of adequate sites and of reliable recorders of the oxygen isotopic composition of the lake water is important. Methodologically refined isotope proxies, such as oxygen isotope ratios of aquatic cellulose and chironomid head capsules, provided promising results in our calibration studies. Combined oxygen isotope records from aquatic mosses and authigenic carbonates, continuously covering the last 26,000 years at the ICDP site Laguna Potrok Aike in the Patagonian steppe, indicated an early gradual warming starting around 18,000 years ago and extreme drought conditions in the early to mid-Holocene in the Patagonian steppe region. Future investigations will concentrate on densifying the isotopic network and comparing isotope records from multiple proxies and archives.

ID: 02324, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Pleistocene Permafrost Thawing History of the North American Arctic Cordillera from U-Th and U-Pb Dating of Cave Speleothems

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Permafrost is widespread in the Arctic and contains twice as much carbon as the atmosphere in the form of frozen organic matter. This carbon may be vulnerable to release to the atmosphere as CH_4 and CO_2 under a warming climate, making permafrost thaw a potentially significant amplifying feedback. However, because permafrost can be slow to respond to warming, the short instrumental record does not adequately capture long-term trends. Longer records are needed to constrain how sensitive permafrost is to climate change.One way to address this problem is to assess the stability of permafrost during previous interglacial periods, which provide natural experiments to examine the Arctic's sensitivity to warming. Cave speleothems in areas of the Arctic that are currently permafrost are relicts of past periods of thaw that enabled meteoric waters to seep into caves and deposit calcite (e.g., Vaks et al., 2013). We employed uranium-thorium (U-Th) dating to constrain the chronology and extent of permafrost thaw in the North American Arctic during the past 600,000 years. We sampled caves from a range of permafrost zones (continuous, discontinuous, and isolated permafrost) and latitudes (66.5°N to 49°N), in the Yukon, Alaska, Northwest Territories, and at the boundary of Alberta and British Columbia. Of the samples dated to this point (n=67), finite ages tend to cluster near MIS 11 within uncertainty, with additional samples dated to MIS 13. This dataset, coupled with a similar study in Siberia (Vaks et al., 2013), is thus suggestive of an episode of widespread thaw during the MIS 11 interglacial about 400,000 years ago when global temperature was only ~1°C warmer than pre-industrial temperatures. We will also present preliminary results from U-Pb dating of samples extending beyond the analytical limit of U-Th dating.

ID: 02342, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

External and internal origins of ENSO variability revealed by Holocene corals and climate model simulations

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El Niño-Southern Oscillation (ENSO) is the main driver of Earth's interannual climate variability. Palaeoclimate records indicate reduced ENSO variance during the middle Holocene; however, whether external forcing drives large changes in the magnitude and characteristics of ENSO variability is a matter of considerable debate. Here, we combine geochemical data from central Pacific corals with a suite of forced and unforced simulations conducted using the CSIRO Mk3L and GFDL CM2.1 climate system models. On millennial timescales, the coral data reveal a statistically significant increase in ENSO variance over the past 6,000 years. This trend is not consistent with the unforced model simulations, but can be reproduced once orbital forcing is taken into account. Analysis of the simulations reveals that increasing ENSO variance arises from a weakening of the Asian summer monsoon circulation and an associated weakening of the Pacific Walker Circulation. These results suggest that on longer time scales ENSO can exhibit a systematic response to external forcing. The picture is less clear on shorter time scales and we explore further ENSO multi-decadal variations focusing on the apparent ENSO amplitude minimum 3,000-5,000 years ago. We combine a 175-year-long coral oxygen isotope ($\delta^{18}O$) ENSO record from a 4,300-year-old coral with new $\delta^{18}O$ results from a ~300-year-long *Porites* coral microatoll. Both corals were discovered on Kiritimati (Christmas) Island, an optimal ENSO 'centre of action' in the central tropical Pacific, and radiometric dating indicates the corals have a 25-year overlap. Together, the unprecedented contiguous ~450 year-length of the combined results shows interdecadal modulation of ENSO amplitude. The results provide a robust baseline against which to quantify the response of ENSO to external forcing and to assess the degree to which variability arises from within the ENSO system itself.

ID: 01530, 26.- Data Stewardship for Paleoscience, (Oral)

Linked PaleoData: What is it and what can it do for you?

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Over the past several decades the paleoclimate community has developed a diverse and valuable set of paleoclimatic observations. These data have the geographic extent and temporal density to enable scientific inquiry into long-term and preindustrial climate dynamics; a primary aspiration of cutting edge and societally relevant research in the field. However, we still lack efficient access to these data and the critical metadata that bolster intelligent use of nuanced

observations. This bottleneck slows scientific discovery and prevents the field from fully entering a data-driven paradigm of discovery that has enabled great leaps in other scientific fields. In recognition of this, paleoclimatology is beginning a data revolution. At the heart of this revolution is the need for a structured data format that can interact with our scientific tools, and that is sufficiently flexible to span the breadth of paleoclimatology.Here we present Linked PaleoData, or LiPD, a data container flexible enough to adapt to the broad and evolving needs of the paleogeosciences, but structured enough to facilitate efficient and intelligent reuse of data and metadata. The LiPD framework accommodates measured and inferred paleoenvironmental and geochronological data, as well as any set of metadata, at any level of the dataset, from the entire collection down to individual observations. LiPD also leverages recent advances in knowledge representation, primarily through its connection to Linked Earth. LiPD has proven to be powerful in large data synthesis efforts, such as the PAGES2k Phase 2 temperature and the iso2k efforts. It is also broadly useful at the site-level, as its capacity to store expanded methodological metadata and geochronological ensembles make it the preferred data format for emerging platforms for uncertainty quantification, including CSciBox and GeoChronR. Finally, low-level interaction with the LiPD format is provided by utilities available in Matlab, Python and R.

ID: 01347, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Oral)

Stable Isotopes of Carbon Reveal a Complex Trajectory for CO2 Drawdown at Last Glacial Inception

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Roughly half of the interglacial-glacial drop in atmospheric CO_2 occurred abruptly ~70 ka ago during the marine isotope stage 5/4 transition, suggesting significant and rapid shifts in the processes controlling carbon cycling on land and in the oceans. Although ice age/ interglacial carbon cycle dynamics have been the topic of a large body of modeling and empirical research, the exact mechanisms contributing to the glacial CO_2 drawdown are not known. We use a high-resolution, high-precision record of the $\delta^{13}C$ of atmospheric CO_2 preserved in an Antarctic horizontal ice core to infer the timing and magnitude of changes in carbon cycle processes that occurred in association with global cooling and the expansion of ice sheets during the last glacial inception. The $\delta^{13}C$ of CO_2 traces carbon cycle dynamics because the stable isotopes of carbon fingerprint different processes of CO_2 addition and removal. Our measurements reveal 0.50‰ of depletion between ~71-70 ka followed by 0.75‰ of enrichment from ~70-68 ka, suggesting a complex trajectory for the glacial CO_2 drawdown with different processes dominating at different times during the transition. Qualitatively, our record is consistent with CO_2 sequestration resulting from cooling sea surface temperatures and subsequent increases in the efficiency of the ocean biological pump. Experiments employing the University of Victoria Earth System Climate Model are underway to interpret the $\delta^{13}C$ record quantitatively, the results of which are intended to constrain the likely CO_2 sequestration pathway(s). The conclusions of this study contribute to a more complete, mechanistic understanding of the relationship between the carbon cycle and global climate.

ID: 01480, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

The delayed expansion of forests in Southern Caucasus

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The nature and timing of environmental changes throughout the last glacial-interglacial transition in the South Caucasus, and more widely in Eastern Europe, are still not fully-understood. According to certain pollen records, forest expansion occurred in many areas, several millennia after what is considered world-wide as the onset of the Holocene. This delayed forest expansion, as well as its forcing factors, are still controversial. To highlight this debate, we compare five pollen records from the Southern Caucasus: the palaeolake of Nariani and the Lake Paravani, located in Georgia, and the Zarishat, Vanevan and Shenkani wetlands, located in Armenia. Since these sequences have not been collected in similar environments, the pollen records deliver different vegetation histories. However, all dynamics present a major change occurring between 9000 and 7700 cal. BP and corresponding to the end of an arid and steppic phase. The following phase is marked by the expansion of forest or hygrophilous vegetation. The origin of the delayed expansion of forests is discussed in the light of palaeoecological information provided by these five sequences and other regional records. While some palaeoclimatic regional reconstructions show a wet early Holocene (earlier than 8500 cal. BP), we interpret the delay in forest expansion as the result of reduced spring precipitation which would have limited forest development at that time. The connection of the Black Sea with the Mediterranean could have played a major role in the nature, quantity and rhythm of rainfall, but it is still challenging to draw the precipitation pattern and its influence on the forest expansion at that time.

ID: 02267, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Oral)

Hydroclimate in the Mexican Monsoon region: understanding the nature and impacts of climatic variability using different archives

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Monsoon regions are key foci for studies of hydroclimatic variability, both in the past and looking forward into the future. In many of these areas, instrumental climate records are short, so the information in different archives, such as lake and cave deposits, tree rings and in historical documents, are key in understanding the patterns of change over longer timescales and exploring the possible mechanisms behind them. They are also crucial in understanding the impacts of climate variability, with historical records offering particularly valuable insights into different responses and resilience to hydroclimatic extremes in different socio-economic contexts. Here we draw on climate records from tree rings and lake sediments (analysed using a range of methods) from across the Mexican Monsoon region to reconstruct key changes over the last 2000 years. These natural archives vary in their sensitivity and resolution and direct comparison can be problematic, but both record aspects of changes in hydroclimate (particularly drought) and can provide valuable inputs into data-model comparisons to assess the climatologies and climate forcings that can explain the observed patterns. Records from historical documents, although lacking the spatial coverage of some other archives, provide both additional information about climatic extremes and their direct impacts on settlements and people. Here we draw on data from the Mexican Drought Atlas, syntheses of lake sediment records and information from the extensive Spanish Colonial archives to reconstruct patterns of variability across the Mexican Monsoon region and consider the relative strengths and weaknesses of these different information sources. These highlight important seasonal and spatial variability in hydroclimate and the need to understand local contexts when considering climate impacts.

ID: 01863, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

High lake levels - sparse vegetation: palynological insights into the paleoenvironment of the southern Levant during MIS 2

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While the majority of eastern Mediterranean climate records agree on cold and arid conditions during the last Glacial, several southern Levantine studies suggest more humid conditions compared to today. Major lake level high stands occurred in the southern Levant and resulted in the merging of Lake Lisan, the precursor of the Dead Sea, with the Sea of Galilee (Lake Kinneret) during marine isotope stage (MIS) 2. Despite ongoing discussions about the climate causing these lake level high stands, little is known about the Levantine paleovegetation, which is an important indicator for the paleoclimate.

To investigate the paleovegetation in the southern Levant during MIS 2, we analyzed pollen assemblages of sediment cores from the Sea of Galilee and Dead Sea. The Sea of Galilee core comprises a continuous and well-dated sediment profile that deposited between ca. 28,000 and 22,500 years before present, when the lake rose above the modern lake level. The Dead Sea core was drilled at the central part of the lake and covers the whole MIS 2.

The pollen records suggest that steppe vegetation with grasses, other herbs, and dwarf shrubs predominated in the southern Levant during MIS 2. In contrast to the Holocene, there was no belt of continuous and dense Mediterranean vegetation surrounding the Sea of Galilee. Mediterranean elements such as deciduous oaks only occurred in limited amounts and were probably patchily distributed in the whole study area. The precipitation gradient was not as strong as today, and semiarid conditions prevailed.

These results apparently contradict other regional hydroclimate proxies that call for wetter conditions and disprove previous pollen-based hypotheses that assumed the spread of Mediterranean forest in the southern Levant during glacial periods. Thus, our study provides new insights into the complex connection between climate and vegetation variability in the southeastern Mediterranean.

ID: 01792, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Simulating the last glacial-interglacial transition with a coupled atmosphere-ocean-ice sheet model

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One of the major challenges in climate modeling is the simulation of glacial-interglacial transitions. A few models of intermediate complexity have been successful in simulating the last termination. Here we presents results from our first successful attempt to simulate a substantial part of the last glacial cycle with an AOGCM coupled interactively with a state-of-the-art ice sheet model.The ECHAM5/MPIOM AOGCM is interactively coupled to the dynamical ice sheet model PISM and the dynamical vegetation model LPJ. This model is integrated from the late Glacial into the Holocene using insolation and greenhouse gas concentrations as transient forcing. The land sea mask remains fixed at the LGM state. River routing and surface elevation for the atmospheric model component are calculated interactively. In a mini-ensembleT a periodical-synchronous coupling technique is applied. One simulation is run fully synchronously without acceleration in the atmosphere.The northern hemispheric deglaciation starts between 18 and 17 kyr BP, consistent with the onset of global warming. The model produces Heinrich event like variability. These rapid ice discharge events have a strong impact on the NAMOC, especially during the deglaciation..During the deglaciation the interactive river routing has a strong impact on the simulated NAMOC. The retreat of the Laurentide Ice Sheet together with the depressed topography due to the former ice load leads to a redirection of the surface runoff from the melting southwestern Laurentide from the Gulf of Mexico to the Arctic. The consequence is a rapid reduction/suppression of the formation of NADW. When the Laurentide Ice Sheet retreats from the Hudson Strait,the fresh water is released into the Labrador Sea. The NADW formation recovers within a few decades. These results show the potential importance of interactive river routing for rapid changes in NAMOC strength during the deglaciation.

ID: 02070, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Oral)

Identifying the onset and impact of the anthropocene on tropical lake systems

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The ability to recognise environmentally transformative anthropogenic impacts on ecosystems, distinct from natural variability is a key challenge in understanding the onset and nature of the “anthropocene”, especially as human-driven impacts on the environment are time-transgressive and regionally and environmentally-specific.Whilst there is clear evidence for major contemporary human impacts on the landscape of western Uganda, with large-scale clearance of land for subsistence agriculture and plantations, debate surrounds the timing of the onset of this impact. Evidence from pollen records dates human disturbance to around 2000 years ago, though this is unlikely to be the large-scale clearance observed today.Western Uganda has >80 crater lakes within four distinct districts; these systems are influenced by the same climate, underlain by similar geology, but their catchments differ in terms of their modern vegetation (from forested “natural” catchments located within National Parks, to those cleared for market garden agriculture). To assess and identify the onset and impact of human activity, we examined sediment records from multiple lakes located across this anthropogenic gradient.Diatom records from these lakes do not suggest long-term evidence of catchment disturbance, rather, diatom communities appear to respond (indirectly) to climate over much of the last millennium. A distinct switch in diatom assemblage composition and an increase in carbon flux is observed in the last 50-80 years, implying that early catchment/vegetation impact was not significant enough to alter the water quality and/or chemistry of the lakes.A major change in all lake systems occurred by 1970, suggesting a “threshold” was crossed that had previously buffered lakes against the impacts of human activity. The results provide insight into the past and future resilience of these lake ecosystems in the face of increasing anthropogenic pressures and future changes in temperature and hydrological variability.

ID: 01333, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Triple oxygen isotopes in carbonate sediments: Insights on East African water balance since 500 ka

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Carbonate oxygen isotopes ($\delta^{18}O$) are among the most powerful tools for reconstructing terrestrial hydroclimate, but the complex set of processes influencing carbonate $\delta^{18}O$ adds uncertainty to past climate interpretations. Kinetic fractionation via evaporative forcing has been particularly difficult to constrain. Triple oxygen isotopes have recently emerged as sensitive recorders of evaporation, specifically via the secondary parameter '^{17}O-excess' (e.g. Landais et al., 2010), and analytical advances allow for its precise measurement in carbonates (Passey et al., 2014). When measured in tandem with clumped isotope thermometry [$T(\Delta_{47})$] and traditional stable isotopes, carbonate ^{17}O-excess can reveal the extent of evaporative forcing and be used to estimate the isotopic composition of unevaporated source waters.

Here we apply this novel proxy approach to reconstruct local water availability and regional hydroclimate over the past 500,000 years from sediment cores recently recovered by the Olorgesailie Drilling Project from the southern Kenya Rift Valley, where local variations in water balance likely influenced human evolution and migration in eastern Africa. Carbonate $\delta^{18}O$ values average -0.4 ± 1.9‰ (n=141), while $T(\Delta_{47})$ and reconstructed parent water $\delta^{18}O$ values range from 14-32°C and -1 to 5‰, respectively (both n=28). The range of 17O-excess values is approximately 150 per meg (n = 29), exceeding that reported for freshwater sources today (≤ 80 per meg; Luz and Barkan, 2010; Li et al., 2015). We observe a strong negative correlation between 17O-excess and $\delta^{18}O$ values, consistent with evaporative enrichment of heavy isotopes in water. Together, these results suggest evaporation within the basin is an important control on the Olorgesailie carbonate $\delta^{18}O$ record. With this study, we distinguish local from regional controls on hydroclimate variability in eastern Africa since 500 ka and demonstrate the crucial insight triple oxygen isotopes provide to carbonate $\delta^{18}O$ records, particularly when evaporation is expected to play a significant role on water balance.

ID: 01397, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Boreal forests fires: climate / vegetation / human interactions during the Holocene

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As a critical ecosystem process in circumboreal forests, fire's frequency, size and severity affect vegetation patterns and dynamics. Fire also regulates the exchange of water and energy between the land surface and the atmosphere, and affects the carbon and nitrogen balance.

Due to their location at climatically sensitive high northern latitudes, boreal forests are likely to be significantly affected by global warming, with a consequent change in biomass burning, vegetation structure or composition, and a loss of terrestrial carbon linked to a rise in atmospheric CO_2 concentration.

Palaeoecological reconstructions are one of the most promising strategies for clarifying main patterns and controls of ecosystem changes over a broad range of environmental conditions and temporal scales.

Within this context, we present a new regional-scale reconstruction of boreal forests fire activity covering the Holocene based on sedimentary charcoal records. From this reconstruction, we disentangled between climate and anthropogenic drivers by means of a statistical approach, and we assessed the role played by changes in main forest composition on long-term fire dynamics. While the general patterns found in north American, and northern and southern Fennoscandian suggest the primary role of precipitation in explaining changes in biomass burning during the Holocene, in central Fennoscandia fire dynamics seem to be human-induced. When species-level traits are considered, biomass burning is related to the proportion of evergreen conifers in central Canada and in northern and southern Fennoscandia. Fire dynamics are primarily shaped by changes in boreal summer green species in Alaska and Quebec, while the proportion of cool temperate summer green trees contributes to main changes in fire in central Fennoscandia.

Addressing these questions is considerably challenging due to the complex interactions between climate, humans and vegetation in the past, the present and the future. Our results will help to better understand the processes producing the observed variability in palaeorecords in order to test ecosystem models simulations.

ID: 01998, 18.- Human Impact on Global Aquatic Systems, (Oral)

Impact of eutrophication and climate change on cyanobacterial diversity across European pre-alpine lakes over 150 years

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Human activities have impacted terrestrial and aquatic ecosystems over the last few centuries. Climate change and eutrophication have had profound effects on lakes, which stimulated phytoplankton growth and increased the frequency and strength of harmful cyanobacterial blooms. The mitigation of phosphorus loading has contributed to the return of some lakes to a lower trophic state. However, cyanobacteria often continue to dominate the phytoplankton community, impairing ecosystem functioning and water quality. Due to the scarcity of long-term lake data (both biotic and abiotic), the state of past ecosystems and the phytoplankton response to warming and rapid changes in local conditions remain poorly understood. With the aim of bridging this gap, we investigated the dynamics of cyanobacterial communities across 10 European pre-alpine lakes over the last 150 years using sedimentary records. More specifically, we used high throughput amplicon sequencing to explore temporal changes in the regional distribution and the phylogenetic diversity of cyanobacteria. Our results show that the compositional similarity increased across lake communities over recent decades, generalising possible problems related to the presence of bloom-forming and harmful cyanobacteria. This study highlights the potential of high-resolved phylogenetic data from sedimentary records for investigating planktonic community dynamics and for disentangling the roles of local and global environmental change in shaping plankton communities.

ID: 01545, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

DEEP-WATER CORAL GEOCHEMISTRY REVEALS LARGE CHANGES IN VENTILATION OF THE MEDITERRANEAN INTERMEDIATE WATERS DURING THE HOLOCENE

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Relatively little is known about the dynamics of the Mediterranean Intermediate Waters in the past, especially for the Levantine Intermediate Water (LIW), which represents up to 80% of the Mediterranean Outflow Water (MOW) to the North Atlantic and strongly contributes to the formation of the Mediterranean Deep Waters. Therefore, the investigation of the physico-chemical parameters, such as temperature and pH as well as the dynamics of the LIW beyond the instrumental period is crucial to understand the natural variability of the Mediterranean circulation and ultimately the impact of the MOW on the stability of the Atlantic Meridional Overturning circulation.

The geochemistry of the aragonite skeleton of the Mediterranean deep-water corals can provide a unique opportunity to study the evolution of the LIW in the past and its link to global climate change. Several fragments of fossil corals collected in the Central Mediterranean Sea were analysed for Li/Mg, ^{14}C, U/Th, boron and neodymium isotopes. The record spans the last 12 kyr and encompasses the transition into the sapropel S1 event. Overall, coupled radiocarbon and U/Th measurements reveal well ventilated conditions of the LIW except at the onset of the sapropel formation. This suggests a highly reduced intermediate water formation as a consequence of monsoon-related freshwater inputs to the eastern Mediterranean Sea at times of increased NH summer insolation and more stable stratification. Closer inspection of the S1 event reveals a recovery of the LIW ventilation at 8.7 ka, coincident with eNd values typical of the western Mediterranean basin. This surprising result seems to point to a collapse of the LIW formation and the presence of a well-ventilated and less radiogenic western Mediterranean intermediate water (WIW) in the Sardinian Channel during the mid-sapropel event

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ID: 01999, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Unravelling western Mediterranean vegetation and climate during a past interglacial with reduced Arctic sea ice cover (MIS 15)

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We present the results of the pollen analysis conducted on marine sediment samples from the IODP site U1385 ("Shackleton site", SW Iberian margin off Portugal) for the MIS 15. This is the first vegetation reconstruction for this interglacial in the western Mediterranean. According to palaeoclimatic simulations, MIS 15 featured a minimum in Arctic sea ice cover as it is foreseen for the next century, and consequently our data will allow us to get some insights into the likely vegetation development in this future scenario. We have then compared our pollen-based vegetation record with the available data from marine palaeoclimatic proxies for the same IODP site, quantifying the leads and lags between the changes occurred in the atmospherically-driven vegetation shifts on the one hand, and sea surface temperatures, ocean ventilation and ice volume on the other hand. Finally, this record provides a unique opportunity to empirically test the performance of vegetation simulations which predict a high development of Mediterranean vegetation for this period associated to particularly high summer insolation and enhanced seasonality, despite low levels of CO_2.

ID: 01877, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

The interplay of climate change and human activity in the central Mediterranean region during the last millennia: the varved, multiproxy record of Lake Butrint (Albania)

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Butrint is a 21 m deep lagoon located at the Ionian Sea coast of Albania. Permanent water stratification led to the deposition of varved sediments during the last millennia. Variations in the thickness and/or presence of seasonal laminae (endogenic calcite, organic matter, and clay) indicate fluctuations in water salinity, bioproductivity, and runoff, resulting from the interplay of climate and anthropogenic forcing. The multi-proxy analysis (sedimentology, geochemistry, pollen and ostracods) of a 12 m long sediment core, supported by an age model through varve counting, radiocarbon and ^{137}Cs dating, enables a precise reconstruction of environmental change in the central Mediterranean region during the last 4.5 cal kyrs BP. Additionally, the nearby archaeological site of Buthrotum, continuously populated from Greek times until the late 18th century AD, provides an exceptional record of human impact. Increasing siltation after the foundation of the city and subsequent farming and urbanization of the catchment led to the progressive isolation of the Butrint basin from an open bay to a restricted lagoon. Maximum clastic input at 500 AD likely coincides with the most intense farming during the Late Antiquity. Intervals of maximum water salinity and bioproductivity coincide with warmer conditions, such as the early Roman Warm Period (500 BC-0 AD) or the Medieval Climate Anomaly (800-1400 AD). Conversely, lower salinity, more oxic conditions, and higher runoff occurred during 1400-500 BC, Late Roman and Early Medieval times (0-800 AD), and during the Little Ice Age (1400-1800 AD). Ongoing research on microfacies and stable isotopes ($\delta^{18}O$ and $\delta^{13}C$ in authigenic calcite) allows a more precise reconstruction of the main hydrological changes in the lagoon during the last millennium. The sedimentary record of Lake Butrint demonstrates the complex interplay of climate variability and human impact in the recent evolution of coastal Mediterranean regions.

ID: 01712, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Hemispherically asymmetric trade wind changes as signatures of past ITCZ shifts

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Reconstructions of the response of the Intertropical Convergence Zone (ITCZ) and Hadley circulation to past climate changes are essential to building understanding of atmospheric and oceanic circulation changes and energy transports. Observations of the seasonal cycle, climate model simulations and fundamental angular momentum constraints demonstrate that shifts of the ITCZ and associated tropical rain belt are accompanied by a strengthening of the Hadley cell and trade winds in the colder hemisphere, with an opposite response in the warmer hemisphere. Here we demonstrate that this

pattern of hemispherically asymmetric trade wind changes is found in proxy data during Heinrich events. The signatures presented are consistent with trade winds strengthening in the North Atlantic and weakening throughout the Southern Hemisphere subtropics, and are in accord with climate model simulations. We further explore records of trade wind changes during the Last Glacial Maximum (LGM) and mid-Holocene. We find evidence of Hadley cell intensification at the LGM relative to today, but little indication of a shift in the ITCZ. Mid-Holocene trade wind reductions in the subtropical North Atlantic indicated by proxy data are more extensive than those simulated by models, suggesting that mid-Holocene simulations underestimate circulation changes associated with the Green Sahara. Our compilation of trade wind records also provides insight into past changes in subtropical gyre circulations, and offers an important complement to precipitation proxies that are more commonly used to reconstruct ITCZ changes.

ID: 01513, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Palynology and paleoecological interpretation of Core 38, Palaeo-Dneister valley, Northwestern Black Sea: initial results of pollen, dinocyst and NPP studies

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Marine palynology is a primary tool for correlating land-sea climate interactions and interpreting paleohydrological and anthropogenic changes recorded in Holocene Black Sea sediments. We present the first study of pollen, dinoflagellate cysts and other non-pollen palynomorphs in a Core 38 from the outer Paleo-Dniester Valley ca. 44.66^o N, 17.31^{o}E, at 107 m depth on the tectonically stable Ukrainian Shelf, beneath the Rim Current. An age-depth curve was derived by correlation with uncalibrated ^{14}C shell and wood AMS ages of regional cores, and one new shell age. The record extends from the Early Holocene (ca. 8.17 ka BP) to present, as marked by *Ambrosia* pollen, a recent introduction to the Ukraine. Pollen concentration is high (14,724 –43,799 grain/g) and is dominated by *Pinus* but totals increase after 4,551 yr BP (22-24 cm) when *Juglans*, *Pistacia*, *Vitis* and Cereal pollen records begin, probably reflecting land cultivation in the northern coastal plain. Increases of Filicales, Polypodiaceae and *Sphagnum* spores mark the interval <7.9 ka BP, reflecting proximity to the Paleo-Dniester Delta. Dinoflagellate cyst concentrations (126-5,430 cysts/g) are lower than pollen, especially in the deltaic interval where microforaminiferal linings are absent and presence of *Caspidinium*-*Spiniferites cruciformis* flora indicate a salinity <8 psu. *Lingulodinium machaerophorum* appears around 7 ka BP, marking increased salinity after an earlier rise of microforaminifera. Dinocyst diversity increases 3,759 yr BP when polykrikoids appear together with heterotrophic protoperidinioids, suggesting the start of eutrophication.

ID: 02365, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Oral)

Subfossils and ancient DNA shed light on the evolution of East African cichlid fishes

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In the Great Lakes of East Africa, cichlid fishes have diversified tremendously and are a well-known study system in evolutionary biology. The phylogenetic relationship of many extant lineages is known and can be used to infer rates of trait evolution or speciation. However, the environmental conditions throughout the diversification of these fishes, the colonization history of the lakes, or past extinction events are rarely considered in such analyses. This information is crucial for the inference and interpretation of evolutionary processes and can be gathered from sediment records through phenotypic identification and extraction and sequencing of ancient DNA from fish subfossils. Here, I will present findings from lakes Kivu, Challa and Victoria. Lake Victoria desiccated ˜18-15 kya and subsequently refilled. Subfossils from the period immediately after the refilling reveal if the extreme diversification of the Lake Victoria cichlid superflock was promoted by a lack of competition from other fish groups. While closely related cichlid species can sometimes be discerned by the morphology of single bones or teeth, this is difficult for most species and types of bones. Ancient DNA can be used to determine the species identity of subfossils in Lake Challa and this information then be used to corroborate or reject scarce historical records. Lake Kivu has been subject to major environmental disturbance, for example by volcanic activity, possibly explaining why its ichthyofauna is comparatively depauperate. Ancient DNA sequencing can be used to determine if fish subfossils belong to genetic lineages that went extinct during such events. The cases presented here highlight the potential and challenges ancient DNA approaches hold for the study of fish biodiversity and evolution in tropical lakes.

ID: 01960, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Oral)

Deglacial interactions between ocean circulation and the biological pump in the Nordic Seas: implications for future atmospheric CO2 variability

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Understanding the impact of ocean circulation on the global atmospheric CO_2 budget is of paramount importance for anticipating the consequences of projected future changes in Atlantic Meridional Overturning Circulation (AMOC). In particular, the efficiency of the oceanic biological pump can impact atmospheric CO_2 through changes in vertical carbon export mediated by variations in the nutrient inventory of the North Atlantic basin. However, the causal relationship between North Atlantic Ocean circulation, biological carbon sequestration, and atmospheric CO_2 is poorly understood. Here we present new high-resolution planktic-benthic ^{14}C data and biomarker records from an exceptionally well-dated marine core from the Nordic Seas spanning the last deglaciation (~15,000-10,000 years BP). The records document for the first time large and rapid atmospheric CO_2 drawdowns and increase in plankton stocks during major North Atlantic cooling events. Using transient climate simulations from a fully coupled climate-biosphere model, we show that minor perturbations of the North Atlantic biological pump resulting from surface freshening and AMOC weakening can have a major impact on the global atmospheric CO_2 budget. Furthermore, our data help clarifying the timing and magnitude of the deglacial CO_2 signal recorded in Antarctic ice cores. We conclude that the global CO_2 budget is more sensitive to perturbations in North Atlantic circulation than previously thought, which has significance in the future debate of the AMOC response to anthropogenic warming.

ID: 02113, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

The Model Intercomparison Project on the climatic response to volcanic forcing (VolMIP)

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Our understanding of the climatic response to volcanic forcing is limited as large uncertainties affect both the observational records, due to the limited number of observed events, and the non-robust dynamical responses simulated by different climate models. The lack of agreement between model results is crucially determined by differences in the model's characteristics such as resolution, complexity and implementation strategy of the forcing, and uncertainty in the eruption details including magnitude, latitude and season, input data and background climate. The multiple and varied nature of these factors prevents their contribution to uncertainty from being distinguished within existing transient simulations or non-coordinated multi-model experiments. It is therefore necessary to frame the future modeling activities within common designs that separately focus on specific aspects i.e. uncertainties in the reconstruction of radiative volcanic or associated feedback mechanisms activated in the coupled ocean-atmosphere system for one specific volcanic forcing.

The Model Intercomparison Project on the climatic response to Volcanic forcing (VolMIP) presented here focuses on the response of the coupled ocean-atmosphere system to strong volcanic forcing. VolMIP is a CMIP6 endorsed project, which defines a common protocol to subject Earth system models and coupled general circulation models to the same volcanic forcing and under a similar range of background climate conditions. By doing so, VolMIP aims at assessing to what extent simulated responses are robust across models and at identifying the causes that limit robust behavior, especially as far as different treatment of physical processes is concerned.

We will present an overview about VoLMIP and its recent activities. It will also be illustrated how VoLMIP is linked to CMIP6 and to other coordinated modeling assessments and how it will improve our understanding of past, current and future climates.

ID: 01386, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Reconstructing vegetation changes and climate from pollen from Late Pliocene to Early Pleistocene in the North Caucasus

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Pollen and spores have been analysed in deposits of the Akchagylian-Apsheronian, providing a picture of past vegetation and climate change for the late Pliocene to early Pleistocene. On the basis of pollen assemblages in sediment cores and outcrops from the North Caucasus, climatic fluctuations, and related changes in vegetation can be recognized for the time from 3.6 to 0.8 Ma. The lower Akchagylian is characterized at first by an open landscape dominated by steppe vegetation. In the middle of the lower Akchagylian, the transgression of the palaeo-Caspian spread, and the treeless landscapes of the earliest Akchagylian were replaced by forests with thermophilic relicts. During the middle-upper Akchagylian and Apsheronian periods, the vegetation cover of the North Caucasus gradually changed: forests were replaced with steppe and semi-desert vegetation in response to episodes of aridification, and changes were evident in the structure of the arboreal flora. The first significant climatic cooling occurred at around 3.6-3.4 Ma at the beginning of the Akchagylian, and corresponds with an important change in the main floral elements and was synchronous with the Gilbert/Gauss palaeomagnetic inversion. A more significant cooling at 2.6-2.3 Ma corresponds with the beginning of the upper Akchagylian and the Gauss/Matuyama palaeomagnetic inversion at the end of the Pliocene. The vegetation of the North Caucasus shows changes consistent with climatic warming at around 3.2 Ma which coincides with a period of warming in the Mediterranean and probable represents the «Mid Pliocene Warm Period». This is the first evidence for this event yet found in the Caspian region.

ID: 01931, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Past and future impact of North Atlantic teleconnection patterns on the hydroclimate of the Caspian catchment area in CESM1.2.2 and observations

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The Caspian Sea level has undergone dramatic variations of more than 3 m during the past century with important implications for the life of coastal people, economy and the ecosystem. The origin of these variations as well as future changes in the Caspian water budget are still a matter of debate. In this study, we examine the influence of the major seasonal North Atlantic teleconnection patterns, the North Atlantic Oscillation (NAO), the East Atlantic pattern (EA), the Scandinavian pattern (SCA), and the North Sea Caspian Pattern (NCP), on Caspian hydroclimate variability from 1850-2000 CE. Numerical experiments at different atmospheric grid resolutions (2° and 1°) are carried out with the coupled Community Earth System Model (CESM1.2.2). We test model skills under different resolutions through validation against observational data by various statistical methods (Empirical Orthogonal Functions, Taylor diagrams, linear regressions and Spearman rank correlation). Results reveal the strongest simulated signal in winter (DJF) with high explained variances for 1° CESM1.2.2 NAO (39%) and EA (15.7%), similar to observational data. The model is unable to reproduce the SCA pattern in the third EOF, which is found in the observations. The modelled NAO has a strong influence on winter temperature and rainfall over the Caspian catchment area. A strong winter NCP induces above-average 2-meter temperatures over north Caspian region and lower-than-normal precipitation over the eastern Caspian sea. Our study suggests that the 1° version of CESM1.2.2 (with CAM5 atmosphere physics) shows adequate performance with respect to teleconnection maps during the historical period. Lastly, 1° model climate projections (2005-2100 CE) are performed with different Representative Concentration Pathways (RCP 4.5 and RCP 8.5) to examine potential changes in the teleconnection patterns and their influence on the Caspian region

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ID: 01947, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Oral)

Documentary-based reconstruction of rainfall variability over Malawi during the late nineteenth century

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Malawi straddles an important climatic hinge-line with regards to the influence of the El Niño-Southern Oscillation (ENSO) upon precipitation. During El Niño years, northern parts of the country often receive above average rainfall, in line with adjacent areas of eastern equatorial Africa. Southern parts of the country, in contrast, may experience below average rainfall, similar to areas of south-eastern Africa. The opposite pattern occurs in La Niña years. The rainfall response, and the precise areas affected, varies with each El Niño or La Niña event. These patterns are well known from twentieth century rainfall data, but the stability of the ENSO-rainfall relationship prior to the instrumental period is poorly understood. In this study, we utilise a range of documentary sources – including letters, diaries, reports, newspapers and monographs – to reconstruct a timeline of rainfall variability during the late nineteenth century for the area occupied by present-day Malawi. Some of the earliest narrative accounts of rainfall conditions originate from members of David Livingstone's Zambezi Expedition, including Livingstone himself, which travelled along the Shire River and explored Lake Malawi between 1858 and 1864. However, greater numbers of meteorological observations, including early instrumental rainfall, temperature and pressure data, are available from 1875 onwards, following the establishment of the first Free Church of Scotland mission towards the southern end of Lake Malawi at Cape Maclear. Using information from these sources, we highlight major drier and wetter periods, examine their geographic extent, and explore the influence of historic El Niño and La Niña events upon rainfall distribution.

ID: 02216, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Coupled ocean and atmospheric changes during the Younger Dryas in Central Western Iberia

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Although the Younger Dryas (YD) has been considered for long time as a dry period on the Iberian Peninsula, increasing evidences suggest that moisture availability was a pervasive feature in some areas during this period. In particular, glacial advances in Central and North Iberia, relatively high grow rate of stalagmites in Northern Iberia and Central Pyrenees, increase of terrestrial input proxies in the Tagus shelf and inward advances of coastal dunes in SW Iberia suggests increasing winter precipitation during the YD. High resolution records off and in Iberia also show a complex pattern within the YD event marked by two or three phases. However, some proxies suggest that climate was dry while others support relatively moist or even co-existing dry and wet conditions in each of these two/three phases. Here we present an extreme high resolution multiproxy study including pollen, alkenone based-SST estimates and other independent proxies reflecting terrestrial input/river discharges from a shelf record retrieved in the mouth of Tagus River (central Iberia) and we will discuss about the possible drivers of such divergent signal within each YD phase.

ID: 01805, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Global mean temperature reconstructions over the Common Era based on the new PAGES2k proxy database

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The PAGES2k Consortium has recently assembled a global database of temperature proxy records for the Common Era. This unprecedented collection contains 692 records with subannual to centennial resolution from eleven different archive types. Using this database, we apply a range of climate reconstruction techniques to quantify global mean near-surface temperature over the past 2000 years. The reconstruction methods used range from basic compositing over regression-based techniques that have been widely used in the past (Principal Component Regression, Regularized Expectation Maximization) to newer methods, some of which can account for non-linear relations between proxy values and temperature, quantify uncertainties more explicitly, combine information from proxy data and climate models, or are otherwise based on a spatially explicit reconstruction (Optimal Information Extraction, Bayesian Hierarchical Models, Pairwise Comparison, and offline Data Assimilation).

We analyze the temperature history and validation performance of the methods and compare them to previous reconstructions. The extensive proxy temperature database and large range of reconstruction methods enables sensitivity testing of various methodological choices, including the influence of integrating low- (decadal or lower) and high- (annual or higher) resolution proxies. We also compare reconstructions based on the full proxy database with those based on subsets of records, which are culled based on their correlation with instrumental temperature.

Preliminary results indicate that the previously identified global mean cooling trend between CE 1 and 1850 is robust across methods and proxy selections. Accordingly, many reconstructions show maximum pre-industrial global mean temperatures in the first millennium CE, clearly before the medieval period. While there are substantial differences in low-frequency variability across the reconstructions from different methods and record subsets, many of the individual reconstructions are significantly correlated at interannual to multi-decadal time scales.

To help assessing drivers of regional climate, parallel temperature field reconstruction efforts are ongoing.

ID: 02259, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Oral)

Controls of 231Pa/230Th in the Atlantic Ocean both today and in the past

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Sedimentary ^{231}Pa/^{230}Th has been used as a proxy of Atlantic Meridional Overturning Circulation (AMOC) strength. However, ^{231}Pa/^{230}Th reflects signals of multiple controls associated with scavenging and oceanic transport, as demonstrated from recent GEOTRACES results. This study examines the proxy's controls by analysing ^{231}Pa/^{230}Th in paired seawater and core-top samples organised in 5 depth transects across the low-latitude North Atlantic open ocean. This study also assesses a compilation of 29 Atlantic sediment core ^{231}Pa/^{230}Th time-series back to 25ka, including 4 new records from the low-latitude North Atlantic.

Our seawater results show localised regions of enhanced ^{231}Pa and ^{230}Th scavenging at depths greater than 2.0km. However, sedimentary core-top results consistently show sedimentary ^{231}Pa/^{230}Th lower than the production ratio below 2.5km, indicating active ^{231}Pa export by North Atlantic Deep Water. In contrast, at intermediate depths (0.5–1.5km) ^{231}Pa/^{230}Th ratios higher than the production ratio (0.093) point towards enhanced ^{231}Pa scavenging especially in the eastern basin.

In our down-core sediment compilation, we identify 10 deep (>2.5km) cores that appear to be dominantly influenced by ocean circulation, rather than geochemical processes associated with scavenging. On a consistent timescale, records from the West and North-East Atlantic reveal remarkably coherent millennial-scale ^{231}Pa/^{230}Th signals which are consistent with weakened AMOC during the North Atlantic cold stadials. However, the records reveal contrasting behaviour in the eastern and western basins at lower latitudes, with indication of persistent ^{231}Pa export over the last 25 ka in the deep eastern Atlantic.

Findings from this study allow us to couple observations from the modern and the past in the same locations, and to provide a coherent in-depth basin-scale view of ^{231}Pa/^{230}Th and its controls in the present and the past.

ID: 02133, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

The onset of the temperature decline after the Holocene Thermal Maximum in the Alps

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The Holocene temperature evolution in the Alps has been investigated by analysing several climate archives that are mainly driven by summer temperatures. E.g., results from several glaciers indicate repeated, long-lasting retreats beyond approximately current extents between ca. 10 and 4 ka. Before 5 ka, advances that interrupted the general glacier retreat can only be proven for few glaciers. The megafossils-based Alpine treeline record indicates a similar pattern with above late-20th century treeline positions and with that relatively high summer temperatures from the early Holocene until about 4 ka. However, after ca. 6.5 ka the evidence for elevated treeline positions is limited. Chironomid-based July temperature reconstructions show slightly different results: On the one hand the Holocene Thermal Maximum was reconstructed for the millennium between ca. 10 and 9 ka followed by still above-today temperatures until 4 ka, on the other hand a long-lasting Thermal Maximum between 10 and 4 ka without long-term trend was suggested. However, model simulations suggest that the Holocene Thermal Maximum culminated around 7 ka in central Europe and that it was followed by a long-term decline that got the low point during the pre-industrial period.

Here we focus on the first millennium after this modelled temperature culmination around 7 ka. A glacier advance phase as well as a treeline decline has already been shown for this millennium. We use tree-ring data from temperature-sensitive sites to analyse the temperature evolution between ca. 7 and 6 ka in detail.

ID: 01468, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Oral)

Intensified aridity in northern China during the Pliocene warm periods

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Dryland areas are predicted to expand significantly due to global climate change. However, a contrasting theory is that Earth's thermal equator will move northward in a warm climate, resulting in precipitation increase and dryland shrinking. The study of past warm periods analogous to future climate can help resolve this controversy. The warm early Pliocene and the middle Piacenzian warm period during ~3.3-3 Ma are the best pre-Quaternary analogs to late 21st century climate. Here we present the first pedogenic carbonate oxygen isotope record spanning the entire Pliocene from the Chinese Loess Plateau. The record reveals intensified evaporation-induced aridity during the warm phases of the early Pliocene and the middle Piacenzian period. These records provide the first evidence demonstrating that intensified evaporation in northern China counteracted any precipitation increase associated with thermal equator migration during the warm periods. These results suggest that Asian drylands will expand with future warming.

ID: 01926, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

South American Monsoon System over the last 2000 years recorded in stalagmites from central South America

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The South American Monsoon System (SAMS) is generally considered to be highly sensitive to Northern Hemisphere (NH) temperature variations on multi-centennial timescales. The direct influence of solar forcing on moisture convergence in global monsoon systems on the other hand, while well explored in modeling studies, has hitherto not been documented in proxy data from the SAMS region. Hence little is known about the sensitivity of the SAMS to solar forcing over the past millennium and how it might compete or constructively interfere with NH temperature variations that occurred primarily in response to volcanic forcing. Here we present two new annually-resolved oxygen isotope records from stalagmites that cover the last 1500 years, recording past changes in precipitation in the hitherto unsampled core regions of the SAMS. These records details how solar variability consistently modulated the strength of the SAMS on centennial time scales during the past 1500 years and the regional differences occurred inside of SAMS domain during the Little Ice Age period. Solar forcing, besides the previously recognized influence from NH temperature changes and associated Intertropical Convergence Zone (ITCZ) shifts, appears as a major driver affecting SAMS intensity at centennial time scales.

ID: 01599, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Oral)

Archaeology and Paleo-environments of Kakapel Rock art site, western Kenya

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Kakapel rock art site is situated at the base of Chelelemuk Hills, Busia County, in western Kenya. Rock art at the site has been attributed to pastoralists and hunter-gatherers due to the unique geometric shaped components, similar to those recorded at other sites in the wider western Kenya/eastern Uganda region. Archaeological investigations so far indicated that this site would be ideal for interdisciplinary research in rock art and archaeology to understand the intra-regional cultural and environmental connections especially with neighboring eastern Ugandan sites, which have similar rock art characteristics. The current study aims at determining the authors, antiquity, cultural and environmental context of the rock art at Kakapel using material culture evidence associated with the site and similar sites in the region (both in western Kenya and eastern Uganda). A large collection of lithic artefacts, pottery and domestic and wild faunal species remains was recovered from excavations at the Kakapel rock art site. Similar, but smaller rock art sites with little sediment and cultural material scatters are recorded in the wider region, indicating that the practice of rock art painting was a widespread practice in the region mediated by similar cultural adaptations to similar environments. This paper discusses the archaeology and paleo-environments of Kakapel rock art site and assesses the contribution of Kakapel towards the understanding human adaptations to environmental change in the western Kenya/eastern Uganda region during the Later Stone Age and subsequent periods.

ID: 01615, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Unexpected weak seasonal climate in the western Mediterranean region in response to MIS 31, a high-insolation forced interglacial

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Marine Isotope Stage 31 (MIS 31) is an important analogue for ongoing and projected global warming, yet key questions remain about the regional signature of its extreme orbital forcing and intra-interglacial variability. Based on a new direct land-sea comparison in SW Iberian margin IODP Site U1385 we examine the climatic variability between 1100 and 1050 ka including the "super-interglacial" MIS 31, a period dominated by the 41-ky obliquity periodicity. Pollen and biomarker analyses at provide new insights into the regional vegetation, precipitation regime and atmospheric and oceanic temperature variability on orbital and suborbital timescales. Our study reveals that atmospheric and SST warmth during MIS 31 was not exceptional in this region highly sensitive to precession. Unexpectedly, this warm stage stands out as a prolonged interval of a temperate and humid climate regime with reduced seasonality, despite the high insolation (precession) forcing. We find that the dominant forcing on the long-term temperate forest development was obliquity, which may have induced a decrease in summer dryness and associated reduction in seasonal precipitation contrast. Moreover, this study provides first-time evidence for persistent atmospheric millennial-scale variability with multiple forest decline events reflecting repeated cooling and drying episodes in SW Iberia. Our direct land-sea comparison shows that the expression of the suborbital cooling events on SW Iberian ecosystems is modulated by the predominance of high or low-latitude forcing depending on the glacial/interglacial baseline climate states. Severe dryness and air-sea cooling is detected under the larger ice volume during glacial MIS 32 and MIS 30. The extreme episodes, which in their climatic imprint are similar to the Heinrich events, are likely related to northern latitude ice-sheet instability and a disruption of the AMOC. In contrast, forest declines during MIS 31 are associated to neither SST cooling nor high-latitude freshwater forcing. Time-series analysis reveals a dominant cyclicity of about 6 ky in the temperate forest record, which points to a potential link with the fourth harmonic of precession and thus low-latitude insolation forcing.

ID: 01891, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Antarctic climate variability at regional and continental scale over the last 2000 years

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Paleotemperature reconstructions from Antarctica mainly rely on water stable isotope records from ice cores. The key factor controlling this proxy has been mainly related to temperature variations; however this is not always straight forward and other processes acting on different spatial and temporal scales may influence the calibration between water stable isotopes and temperature. These processes can include precipitation-weighting of recorded air temperature, post-depositional movement and loss of snow, and ice flow and elevation effects. Early efforts to reconstruct the continental-scale temperature history of Antarctica over the past 2000 years indicated that at the continent-scale Antarctica is the only land region where the long-term cooling trend of the last 2000 years has not yet been reversed by recent significant warming. However, this Antarctic temperature reconstruction has large uncertainties and masks important regional-scale features of Antarctica's climate evolution over the last 2000 years. Here using a greatly expanded paleoclimate database and new reconstruction methodologies we present the results obtained from the Antarctica2k working group in the framework of the PAGES 2k initiative aiming to reconstruct the climate of the past 2000 years at both global and continental scales. This will include the compilation of ice core isotope records over 7 distinct climatic regions: the Antarctic Peninsula, the West Antarctic Ice Sheet, the East Antarctic Plateau, and four coastal domains of East Antarctica.

ID: 01924, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Oral)

Coupled Long-Term Evolution of Climate and the Greenland Ice Sheet During Past Warm Periods: A Comparison for the Last Interglacial and the Late Pliocene

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It is estimated that the Greenland Ice Sheet (GrIS) may contribute as much as one meter of global sea level rise by the end of this century, and potentially several meters in this millennium. The potential climate impact of this rapid deglaciation is debated in the literature. An instructive approach is therefore to study well-constrained warm periods in the past, from which there are abundant and well-dated proxy records: e.g. the last interglacial (LIG) warm period and the late Pliocene, as potential process analogues for centuries to come. The LIG warming is primarily attributed to high boreal summer insolation. The late Pliocene is thought to represent the long-term climate response to near-current concentrations of CO_2, though the North Atlantic region may also have been influenced by altered ocean heat transports in response to closed Arctic gateways. Here we examine the transient response of the GrIS to the late Pliocene high CO_2 and LIG high boreal summer insolation in two parallel multi-millennial experiments. We use the Community Earth System Model, version 2 (CESM2) fully coupled to the Community Ice Sheet Model, version 2 (CISM2), simulating the GrIS as an interactive component of the coupled climate system. The main focus of the analysis is on how the GrIS responds to differences in the imposed radiative forcing. Results will highlight the transient evolution of the ice sheet and how the surface mass balance (patterns of ablation and accumulation) and mass loss compare to data-based reconstructions of past climate states. We also discuss how these well studied past climate states may be informative in order to constrain the future evolution of the ice sheet.

ID: 01536, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

Spatio-temporal dynamics of bacterial communities in response to marine transgression and regressions occurred since late Pleistocene

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Marine transgressions and regressions are one of the ecological impacts of climate change. As abundant population in sediments, bacterial communities are imprinted with marine transgressions and regressions, which can be recovered through molecular tools to explain how bacterial communities respond to niche change. Three sediment layers were subsampled from a sediment core excavated from a Paleo beach ridge located 2.6km inland to south east coast of India (10.553467 N, 79.835450 E) The subsamples SSB at 24.5m bgl, SSM at 7.2m bgl, and SST at 2.8m bgl were retrieved. Formation time of subsamples was calculated as 146.64 ± 36.81 Ka BP for SSB, 6.04 ± 1.25 Ka BP for SSM and 3.36 ± 0.42 Ka BP for SST using Optically Stimulated Luminescence Dating. SST was a terrestrial environment; SSM was formed during transgression and SSB after regression. Bacterial population of the subsamples were analyzed through V3 region targeted Illumina Sequencing of 16s rDNA. Bacterial population was the highest at SSM when compared to SST and SSB. After transgression 22 new phyla appeared on SSM retaining 15 native phyla of SSB and after regression 17 phyla became virtually absent at SST. 13 phyla were commonly present in all the three samples. Nearly 56% of native bacterial species were able to adapt to the ecological changes and survived through time. Fourteen percent of native population which disappeared at SSM recolonized on SST. Marine bacterial diversity increased by 81% at SSM when compared to SSB and SST. Geochemical analysis showed higher concentration of macro elements at SSM, which correlated with the highest bacterial diversity at SSM. Bacterial community structure was altered by niche change even though, most of the bacterial communities were able to withstand niche change or recolonize when original ecological niche conditions were restored.

ID: 02356, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Climate Shifts in Arctic Norway Inferred from Past Glacier Variability

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Cirque glaciers are responsive to climate change. By reconstructing how glaciers have varied in the past we can thus make inferences about how climate have dynamically evolved over thousands of years. During the last 15 years we have targeted glaciers in Northern Norway in an effort to constrain natural glacier variability as documented in downstream basins and also from detailed mapping of moraines in glacier forelands. The result is a unique set of high-resolution, continuous glacier reconstructions covering the last 11 500 years that

allow us to assess climate trends, rapid shifts as well as regional coherence. There are, however, several caveats with glacier reconstructions based on lake sediment archives that that could hamper potential climate inferences. They include, (1) the challenge of distinguishing extra- and para-glacial sediment contributions from the 'true glacier signal', (2) securing trustworthy age-depth relationships, (3) connecting independently dated moraines, which permits for Equilibrium-Line-Altitude estimates, to corresponding variations in sediment parameters. We have taken great care in addressing these issues, but there is still work to be done and all sites are to a certain degree special. Here we uniquely present the result of a longstanding effort to constrain past climate changes based on multiple reconstructed glaciers from Arctic Norway. We observe a series of rapid climate shifts during the Holocene, which is reproduced in several of our records. Especially notable is the shift marking the onset of the Neoglacial 4000 years ago. The complete absence of many, but not all, glaciers during the Holocene Optimum document a prevailing warming which is the most consistent pattern in our records. The multidecadal and centennial variability that characterize the Neoglacial are harder to reproduce on a regional scale. Still, the records document a less stable climate, defined by high-frequency shifts hinting at large-scale atmospheric and sea ice vacillations.

ID: 01591, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

Lake Ohrid: a unique lacustrine record of vegetation and climatic history of the Early Pleistocene in SE Europe

Konstantinos Panagiotopoulos[1] , Jens Holtvoeth[2] , Adele Bertini[3] , Katerina Kouli[4] , Timme H. Donders[5] , Laura Sadori[6] , Richard D. Pancost[2] , Bernd Wagner[1] , Martin Melles[1] 1) Quaternary Geology Group, Institute for Geology and Mineralogy, University of Cologne, Germany 2) Organic Geochemistry Unit, School of Chemistry, University of Bristol, UK 3) Dipartimento di Scienze della Terra, University of Florence, Italy 4) Faculty of Geology and Geoenvironment, National and Kapodistrian University of Athens, Greece 5) Palaeoecology, Department of Physical Geography, Utrecht University, Utrecht, The Netherlands 6) Dipartimento di Biologia Ambientale, Università di Roma "La Sapienza", Italy * Konstantinos Panagiotopoulos, panagiotopoulos.k@uni-koeln.deThe response of vegetation to orbital and sub-orbital climate variability has been relatively well studied during the Late Pleistocene from marine and continental archives across the Mediterranean. However, little is known about the vegetation response in the region during the Early Pleistocene (> 1.2 million years). Marine isotope records suggest that obliquity-controlled climatic cycles are characterized by a considerably shorter duration (41 kyr) and an overall reduced global ice volume compared to Late Pleistocene cycles. Existing pollen records that encompass the interval of the Early Pleistocene are usually discontinuous and lack the temporal resolution to draw safe conclusions on centennial ecosystem dynamics. Despite their limitations, these records indicate the gradual extinction of subtropical and thermophilous tree species from the Iberian and Italian peninsulas over the course of the Mid-Pleistocene Transition. Within the frame of the ICDP drilling at Lake Ohrid, a continuous lacustrine succession spanning back to the Early Pleistocene enabled us to gain unique insights into the vegetation and climate history in the Balkan peninsula over this interval. Combined palynological and lipid biomarker analyses suggest that aquatic and terrestrial ecosystems responded sensitively to climate variability. Our results indicate the perseverance of forested landscapes and a rather stable soil organic matter pool over the Early Pleistocene. Several relict tree species such as *Carya*, *Cathaya*, *Cedrus*, *Liquidambar*, *Parrotia*, *Pterocarya* and *Tsuga* form major components of interglacial forests. Distinct succession phases can be distinguished reflecting forest dynamics and shifts in temperature and moisture availability. Pines in association with several deciduous trees dominate glacial pollen spectra. Lipid biomarker analysis indicates rather limited erosion even during glacial intervals, when persistent vegetation cover stabilized the soils in the catchment. Ongoing high-resolution analyses will improve our understanding on ecological succession and the impact of short-term climate shifts on local ecosystems.

ID: 01724, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Oral)

Holocene aeolian fluxes from northern Romania: a multiproxy approach to reconstruct the deposition of aeolian particles and their control factors

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Aeolian particles deposited in ombrogenous bogs originate from different sources ranging from regional (e.g. dust) to more local (sand). Their formation, transport and deposition can vary over time, and are mainly driven by climatic characteristics (e.g., precipitation, wind speed, the movement of air masses).Here, we have used physical (loss-on-ignition and two methods of particle size analysis), geochemical (XRF and δ13C), biological (testate amoeba, pollen) and dating measurements (AMS 14C, 210Pb) to investigate: i) changes in the aeolian particles deposited and the associated conditions in an ombrogenous bog from Romania and ii) the regional-scale relationship between our reconstruction and other records from Europe. We reconstructed a low aeolian input from 7800 to 4000 cal. years BP, which increased and fluctuated markedly over the last 4000 years. Comparison with our local climatic reconstructions reveals that at least until 200 years ago, the aeolian input was predominantly influenced by climate. We found greater aeolian fluxes at times of dry peatland surface conditions and lower dust fluxes during wet local hydroclimatic conditions. The increased dust flux over the past 200 years coincide with significant deforestation in the study region.

Our results provide new insights into the understanding of changes in wind characteristics in continental areas of CE Europe and also demonstrate that aeolian dust and sand dust are highly promising proxy of past climate variability in this region.

ID: 01952, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Invited Oral)

Shotgun ancient DNA analysis in Lateglacial lake sediments from Sweden

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The final stages of the Last Glacial in the Northern Hemisphere, between 19 and 11.7 thousand years before present, were punctuated by distinct and alternating warmer and colder climate states before Interglacial temperatures were attained, which in turn strongly influenced past vegetation. One of the best studied Lateglacial lake sedimentary record in Sweden is derived from the ancient lake of Hässeldala Port where several recent multi-proxy sediment studies and detailed chronological frameworks allowed reconstructing local and regional environmental conditions and summer temperatures between specific periods in great detail. Here we used shotgun DNA sequencing of the full metagenome preserved in the Hässeldala sedimentary record to investigate the whole diversity of taxonomic groups present in the lake sediment. We combine sedimentary aDNA, pollen and macrofossil studies and succeeded in correlating the relative abundances of plant communities to distinct climatic shifts that occurred between 14 and 10.5 ka BP.

ID: 02089, 06.- Before and after - climate contrasts across the MPT, (Oral)

Atlantic Meridional Overturning Circulation dynamics across the Mid-Pleistocene Transition

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The Mid-Pleistocene Transition (MPT, ~1.3-0.7 Ma) is recognized as a fundamental transition in glacial-interglacial periodicity as shown in deep ocean $\delta^{18}O$ records, from dominantly 41ky to 100ky cycles. During the MPT, glacial periods became more extreme and atmospheric CO_2 decreased (1). Nd isotope records in the South Atlantic indicate that the Atlantic meridional overturning circulation (AMOC) weakened drastically at this time (2). It is thus plausible that the weakening deep-ocean circulation allowed atmospheric CO_2 to be trapped in the deep ocean. We present a new basin wide compilation of Nd isotope data (ε_{Nd}) from the north Atlantic to the Southern Ocean, using FeMn encrusted foraminifera shells from ODP Sites 607, 1063, 926, 1267, 1088, 1090 and 1094. Our aim is to reconstruct the AMOC dynamics at critical points in time since ~2Ma, with a particular focus across the MPT. Our new data sets support previous findings and provide new insights on the deep ocean water mass reorganization across the MPT. A significant decline in the AMOC between 0.85-0.95Ma is seen in all the cores, confirming a widespread "AMOC crisis" in the Atlantic basin during this time. Nd isotope data are consistent with southern sourced deep waters (SSW) penetrating northward into the deep north Atlantic. Post-MPT glacial periods were characterized by weaker overturning and increased presence of SSW in all the cores presented. In addition, the site 607 Nd isotope data indicate a North Atlantic-sourced origin for the deep ocean circulation slowdown. Comparison of ε_{Nd} and benthic foraminiferal $\delta^{13}C$ and B/Ca records from different ocean basins will allow us to understand the

links between ocean circulation changes and the global carbon cycle.

(1) Hönisch, B. et al. (2009). *Science*, *1551*. (2) Pena, L., & Goldstein, S. (2014). *Science*, *345*.

ID: 01762, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

15th century C.E. urban collapse as a consequence of emergent vulnerability to climate variability

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The complex, tightly-coupled networked infrastructures upon which modern cities rely can be vulnerable to cascading failure, when relatively small perturbations cascade outward to trigger further failures in other, dependent parts of the network. This produces an important non-linearity, where the consequences of perturbation may be more significant than the perturbation itself. Here we present the results of network modelling to demonstrate that the 14th/15th century C.E. collapse of Angkor – the world's largest pre-industrial city – was a function of cascading failure in response to climatic variability. A dynamic network model indicates marked criticality in Angkor's water distribution network in response to both increased and decrease load. Cascading infrastructure failure during *extreme monsoon variability in the 14th and 15th centuries C.E. precipitated a systemic collapse of the water distribution network, and the abandonment of the city. Angkor represents an important example of the emergent properties of complex urban infrastructure in the context of regional climate variability that reflects contemporary concerns over the management of critical infrastructure.*

ID: 01541, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Climatic and environmental conditions during the neolithization of the Carpathian Mts.

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The neolithization in SE Europe was a complex process, the Carpathians acting both as a gateway for the spread of Neolithic in Central Europe, and a barrier towards Eastern Europe. In this paper we have combined palaeoclimatic (summer and winter air temperature reconstructions based on stable isotope measurements in cave ice and speleothems), palaeovegetation and floodplain fluvial processes data with the ages of early Neolithic settlements (ca. 8000-6000 cal BP) in the wider Carpathian region, to determine the possible constrains that environmental conditions put on the spread of Neolithic in SE Europe.

Our results suggest that the early Holocene experienced a rapid summer warming, while winters were rather cold until ca. 6000 cal BP. The pollen records indicate large-scale increase in temperate forests from the early Holocene onwards. However, the forests preserved a more open character in lowlands than at mid to high elevations in the Carpathians. The fraction of open landscapes was most extensive between 11700 and 8500 cal BP and decreased between 8500 and 6000 cal BP. Arable agriculture occurred from ~7500 cal BP. The rivers crossing the Carpathians responded differently to these environmental changes, some displaying a meandering behavior during the Early and Mid Holocene, while others maintained a braided character until the Late Holocene.

Our combined data suggest that once reaching the lower Danube plain and the Carpathian foothills, the Neolithic populations encountered a heavily forested area with braiding floodplains that were unsuitable for agriculture. Consequently, pressed by constantly northward moving groups from the Balkan Peninsula, local Early Neolithic populations crossed the Carpathians through the narrowest point (although unsuitable for agriculture) and moved into the loess-covered and well-suited for agriculture Pannonian Plain from where they 1) spread towards Central Europe and 2) crossed the Carpathians eastwards, once forests became less-dense and floodplains changed to meandering ones.

ID: 01459, 06.- Before and after - climate contrasts across the MPT, (Oral)

A new dataset of temperatures for the mid-Pleistocene transition via clumped isotope measurements in foraminifera at Montalbano Jonico (south of Italy) and the implication of local effect

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The mid-Pleistocene transition (MPT), also called « mid-Pleistocene revolution » is characterized by a shift of glacial/interglacial cycles from 41 ka to 100 ka and a progressive increase of the climate oscillations. The orbital forcing remained unchanged through this period that suggests another internal feedback. The paleoceanographic and terrestrials records show longer and irregular cycles with stronger glacials. This transition could be interpreted as reflecting changes in the oceanic temperatures and/or in the continental ice sheet volume, although it has not been possible to decipher these two parameters. In order to (re)solve this issue, we take advantage of clumped isotope paleothermometry, based on precise measurements of statistical anomalies (Δ_{47}) in the isotopic composition of carbonates.Clumped isotope measurements were performed on benthic foraminifera from a well stratigraphically constrained paleo-marine continental section at Montalbano Jonico (Basilicata, Southern Italy). After a methodological approach (size and species effect) on Δ_{47}, past temperatures were determined for glacial-interglacial couples through the MPT: MIS 34-31, MIS 22-21 and MIS 20-19.The data show cooler temperatures for glacials compare to interglacials. Furthermore, the first interpretations suggest stable temperatures for the interglacial periods and cooler temperatures during glacial periods at 41 ka cycles than glacials at 100 ka. The temperature amplitudes seem to be more important during the 41 ka cycles than the 100 ka cycles. But the remaining issue is to determine the importance of local effect. The paleobathymetry reconstructions show large variations from 500 m to 50 m through the MPT due to an uplift even at 0,9 Ma in the south of Italy and make the temperatures changes difficult to interpret.

ID: 01398, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

A Record of Southern Hemisphere Westerly Winds from subantarctic Marion Island

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Changes in the strength of the Southern Hemisphere westerly winds (SHW) influence Southern Ocean circulation and have the potential to alter its effectiveness as a global CO_2 sink. Despite a recent increase in the strength of the SHW, little is known about its long-term dynamics and influence on the carbon cycle. In this project, we track the variability of the SHW over the late Holocene, using diatom-salinity reconstructions and geochemical data from lake sediments on subantarctic islands.

Here, we present a multiproxy lake sediment record from La Grange Cop (LGC), on the western flank of Marion Island, which spans the last 700 years. On Marion Island, SHW dominate the regional climate (>100 days with gale force winds year^{-1}, ~2000 mm precipitation year^{-1}) and terrestrial environments on the western side of the island have elevated salinity from wind-driven sea spray, compared with the more protected leeward side. This elevated salinity forms the basis of a diatom-based conductivity transfer function with which we track salinity and wind strength back through time. XRF-based geochemistry, %C, %N, δ^{13}C, hyperspectral indices, and diatoms all track the evolution of the lake and its response to changing wind regimes over the last 700 years. Proxies in the cores document a marked shift from a drier and windier environment towards greater moisture and less wind-blown aerosols beginning 1450 CE. A period of low inferred winds prevails until c. 1900 CE, when inferred wind strength again increases until the 21st Century and to the highest values of the last 700 years. These changes mirror regional and global climate patterns (e.g. Little Ice Age) suggesting larger scale drivers of SHW strength over the last millennium.

ID: 01269, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Oral)

A terrestrial Pliocene-Pleistocene temperature record from North-Western Europe

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ID: 01653, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Oral)

Modeling land use for animal production in global change studies

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Pasture is considered the single most extensive form of land cover globally, currently comprising at least 25% of the earth's ice-free land surface. Land use for animal production influences the earth system in a variety of ways, including local-scale modification to biodiversity, soils, and nutrient cycling; regional changes in albedo and hydrology; and global changes in greenhouse gas and aerosol concentrations. Despite its importance, distinctions among different systems of animal production are effectively absent from global change studies. While recognition of land use systems is improving, the most popular global land cover inventories present only a single, usually poorly defined category of "pasture" or "rangeland" with no characterization of land use. There is a marked lack of bottom-up, evidence-based methodology, creating a pressing need to incorporate cross-disciplinary knowledge of animal production systems into global change studies. Here we present a framework, rooted in socioeconomic and ecological contexts, that defines and characterizes the range of land usage pertaining to animal production, and is suitable for application in land use inventories and scenarios, land cover modeling, and studies on sustainable land use in the past, present and future. Furthermore, we show the application of this framework in sub-Saharan Africa.

ID: 01414, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Oral)

The precarious present: Is global warming reversing an incipient Ice Age?

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Global warming associated with the steep rise in atmospheric CO_2 levels over the past century is reversing an incipient Ice Age in analyses of data for the past 10Kyr, but not in simulations of that period with climate models. This disagreement can be resolved by means of the three dominant cyclic signals in climate fluctuations over the past 3Myr: (i) the response to precession which affects the swift atmosphere strongly, the slow ocean sporadically, and the lethargic glaciers indirectly via the tropical oceans; (ii) the response to obliquity oscillations at a period of 40Kyr, which involves changes in the global atmospheric and oceanic circulations; and (iii) a signal composed of trends – a cooling trend from about 3 to 1Myr, followed by alternating warming and cooling trends, in the shape of a saw-tooth which recurs every 80 or 120Kyr, and which shares features with (ii) except that the trends, rather than forced, are sustained by feedbacks. The continually changing superposition of these three separate, recurrent signals continually changes the seasonal cycle whose simulations at different times in the past are tests for these hypotheses. These tests can reduce discrepancies between data and climate models.

ID: 01455, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Oral)

Changes in fine detrital material sources in the Eastern Tropical Pacific during the last deglaciation

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Paleo-records indicate meridional shifts of the ITCZ in the Eastern Tropical Pacific (ETP) at the millennial to Glacial/Interglacial scales. However, the amplitude and even direction of these shifts remain largely debated. We have investigated these changes by looking at variations in fine detrital material provenance. Pb and Nd isotopic compositions were measured in the <63µm fraction of two ETP sediment cores over the last 35ka.Both elements have mirror isotopic compositions patterns in both cores. In core ME0005-24JC (0°N, 86.5°W, 2941m), from MIS3 until the LGM, isotopic composition remained stable. Then, during Heinrich Stadial 1 (17.5-15.5 ka), there is a marked peak of unradiogenic Nd and more radiogenic Pb, characterizing an older source for the detrital material reaching ME24, and coinciding with higher ^{232}Th normalized flux, *i.e.* increased detrital inputs. Pb values decrease sharply to reach slightly less radiogenic values during the Holocene than during MIS2-3. In core TR163-19P (2.3°N, 91°W, 2348m), the isotopic composition patterns are different from those of ME24. Pb isotopic compositions are constant from MIS3 until *ca*. 20ka. Then, there is a sharp increase to a plateau (19-16ka), followed by a sharp decrease to reach constant values from 10ka until the late Holocene.

Based on these observations on both isotopic systems, we have determined that two common sources of detrital material contribute in various proportions through time to ME24 and TR163-19P. A third source, characterized by more radiogenic Nd, contributes significantly to TR163-19P during the Holocene. We can rule out significant dust inputs from northern Africa or Asia. Similarly, hydrothermal contributions or inputs of Papua New Guinea material transported via the Equatorial Undercurrent appear negligible. Modeling will allow us to access more precisely the sources of detrital material to the ETP and deduce the evolution of the climate in this area during the last deglaciation

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ID: 02158, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Coupling of equatorial Atlantic surface stratification to glacial shifts in the tropical rainbelt

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The modern state of the Atlantic Meridional Overturning circulation promotes a northerly maximum of tropical rainfall associated with the Intertropical Convergence Zone (ITCZ). For continental regions, abrupt millennial–scale meridional shifts of this rainbelt are well documented, but the behavior of its oceanic counterpart is unclear due the lack of a robust proxy and high temporal resolution records. Here we show that the Atlantic ITCZ leaves a distinct signature in planktonic foraminifera assemblages. We applied this proxy to investigate the history of the Atlantic ITCZ for the last 30,000 years based on two high temporal resolution records from the western Atlantic Ocean. Our reconstruction indicates that the shallowest mixed layer associated with the Atlantic ITCZ unambiguously shifted meridionally in response to changes in the strength of the Atlantic meridional overturning with a southward displacement during Heinrich Stadials 2–1 and the Younger Dryas. We conclude that the Atlantic ITCZ was located at ca. 1°S (ca. 5° to the south of its modern annual mean position) during Heinrich Stadial 1. This supports a previous hypothesis, which postulates a southern hemisphere position of the oceanic ITCZ during climatic states with reduced cross-equatorial oceanic meridional heat transport.

ID: 01344, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Oral)

Late Holocene paleo-records of atmospheric dust deposition in eastern Canada

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Atmospheric mineral dust plays an important role in the Earth's climate through parameters such as atmospheric radiation, cloud properties and biogeochemical cycles. However, the high spatial and temporal variability of mineral dust and a lack of terrestrial archives in certain regions limit our understanding of global dust-climate interactions. Ombrotrophic peatlands (bogs; atmospherically-fed only) have proven to be valuable archives of atmospheric dust deposition as their accumulation rate can provide high resolution paleo-climate reconstructions for the Holocene.

Dust deposited on three ombrotrophic peat bogs of eastern Canada was geochemically characterized using REE concentrations, Nd and Pb isotopes. Over the last 2000 years, the three cores display similar εNd values, which suggests either a common source or sources with similar signatures within the two regions. Combining Nd isotope data with REE patterns and particle size allowed for better insights into the source of deposited dust and the inference of past environmental and climatic conditions in both regions. REE elements, εNd and particle grain-size distribution suggest that, over the last 2000 years, a climatic change affected the boreal region of eastern Canada. Increase in dust deposition rates during during changes in humidity (either drier or wetter climate) suggest a link with hydroclimatic instability in two of the three studied peat bogs. Furthermore, these changes in dust deposition corresponds to documented cold periods in the region. While the dust reconstructions and regional climatic records agree relatively well, the discrepancies between paleodust records highlight an increase in the regionality of late Holocene changes in paleoclimate and more particularly past dust deposition in eastern Canada.

ID: 02327, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Oral)

Millennial to centennial evolution of the Southern Ocean CO2 store

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The carbon content of the deep Southern Ocean is widely thought to control atmospheric CO_2 on glacial-interglacial timescales, but few direct tests of this hypothesis exist. Here we present new deep sea coral boron isotope data that reflect the pH – and thus CO_2 chemistry – of the deep Southern Ocean over the last 40,000 years. At sites most influenced by deep Southern waters we find a close relationship between ocean pH and atmospheric CO_2: during intervals of low CO_2 ocean pH is low, reflecting enhanced ocean carbon storage; during intervals of CO_2 rise ocean pH rises, reflecting loss of carbon from the ocean to the atmosphere. In contrast at shallower sites we find extremely rapid (centennial-scale) pH decrease during abrupt CO_2 rise, reflecting the transfer of carbon from the deep to the upper ocean and atmosphere. The pH drop at the start of the Bolling-Allerod is centered on 14.7 ka, and is followed by a rapid pH rise, likely reflecting the advective input of high pH Northern-sourced waters. This phasing suggests that the CO_2 chemistry of the Southern Ocean can respond to rapid climate change faster than the advective timescale of NADW, and that the Southern Ocean plays a key role in governing atmospheric CO_2 on millennial to centennial timescales.

ID: 01641, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

AMOC history: subpolar Atlantic cooling linked to warming off the US coast

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Reconstructing the history of the Atlantic Meridional Overturning Circulation (AMOC) over the past century and millennium is difficult due to the limited availability of data. One approach has been to use instrumental and proxy data for sea surface temperature (SST), taking multi-decadal and longer SST variations in the subpolar gyre region as indicator for AMOC changes [*Rahmstorf et al., Nature Climate Change 2015*].

Recent high-resolution climate model results [*Saba et al., JGR Oceans 2016*] as well as dynamical theory and conceptual modelling [*Zhang and Vallis, J. Phys. Oceanorgr. 2007*] suggest that an AMOC weakening will not only cool the subpolar Atlantic but simultaneously warm the northwest Atlantic between Cape Hatteras and Nova Scotia, thus providing a characteristic SST pattern associated with AMOC variations. We investigate both instrumental and proxy data from this region to provide further evidence for past AMOC changes.

ID: 01409, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Oral)

Extratropical cyclone characteristics during the last millennium and the future – implications on wind and precipitation extremes

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Extratropical cyclones are fundamental phenomena of the day-to-day atmospheric variability, responsible for wind and precipitation extreme events. Despite the advances in better understanding the underlying processes of cyclones, there is still considerable uncertainty of how extratropical cyclones react to changes of external forcing, as there exist competing and partly canceling responses. Particularly for extreme events, understanding is limited also because of a relatively short period of reliable observations.

The purpose of this study is to present variability of different cyclone characteristics including extremes during the last millennium and the future under RCP 8.5. We use a last millennium simulation with CESM1 spanning the period AD 850 to 2099. The analysis is based on winter for the North Atlantic European region. Cyclones are detected in 12-hourly data with a Lagrangian method providing cyclone characteristics, such as cyclone intensity measured by geopotential height gradient around the center, cyclone-related precipitation, area affected by cyclones, or number of cyclones.

Results suggest that mean and extreme cyclone characteristics are dominated by internal variability during the last millennium showing pronounced low-frequency variations. Different extreme cyclone characteristics, e.g. extreme cyclone intensity and cyclone-related precipitation are not correlated among each other. We find indications that external forcing may play a role as cyclones and their characteristics behave differently in warmer periods compared to colder periods, e.g., extreme cyclone intensity is enhanced in cold periods, whereas in warm periods the cyclone-related precipitation is increased.

Changes of extratropical cyclone characteristics in the future exceed the range of the last millennium showing a decrease in the number cyclones and a decrease in extreme cyclone intensity, whereas cyclone-related precipitation and the area affected by cyclones increase in the 21st century.

ID: 02237, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

A speleothem record of MIS 9/ MIS 8 climate and environmental variability from Macedonia (F.Y.R.O.M.)

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Considerable natural variability and temporal change is a reality of the Earth System. When current changes are placed in a longer-term context, one important implication is that any human-induced change in climate is already interwoven with the natural pattern of variability. Palaeoclimate archives provide data from time periods where human activities had no or minimal impact on global-scale processes, providing the opportunity to evaluate the natural dynamics of the climate system. The Marine Isotope Stage (MIS) 9, spanning the 335-280 ka period is a valuable complement to the better studied intervals such as Holocene and MIS 5. Several Mediterranean and North Atlantic records show that it was pervaded by significant millennial-scale variability, both during full interglacial conditions and during the glacial inception. In this study, we discuss the stable isotope geochemistry and growth history of a stalagmite (OH2) from Macedonia (F.Y.R.O.M), which provides an independent, radiometrically-dated terrestrial record of hydrological and environmental variability at orbital and millennial time-scale for the MIS 9 interval. By comparison with the multiproxy record from the nearby Ohrid Lake we describe the environmental evolution at the cave site during the interglacial and the glacial inception. Then, by comparison with the regional climatic framework, and especially with the emerging speleothem record from Corchia Cave in central Italy, already recognized as strictly linked to Northern Hemisphere climate, we try to unravel how the observed variability could be linked to extra-regional climatic processes, such as variations in North Atlantic oceanic and atmospheric patterns.

ID: 01725, 01.- Open Session on past global changes, (Oral)

A global perspective on the change in climate variability from the Last Glacial Maximum to the Holocene

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Changes in climate variability are more important for society than changes in the mean state alone. A large-scale shift of the mean climate in the future is expected, but its implications for climate variability are not well constrained. Here we quantify changes in temperature variability as climate shifted from the Last Glacial cold to the Holocene warm period. Greenland ice core oxygen isotope records provide evidence of this climatic shift. A striking feature in these records is pronounced millennial variability in the Glacial, and a distinct reduction in variance in the Holocene.

We present quantitative estimates of the change in variability on 500- to 1500-year timescales based on a global compilation of high-resolution proxy records for temperature which span both the Glacial and the Holocene. The estimates are derived based on power spectral analysis, and corrected using estimates of the proxy signal-to-noise ratios.

We show that, on a global scale, variability at the Glacial maximum is five times higher than during the Holocene, with a possible range of ~3-10 times. The spatial pattern of the variability change is latitude-dependent. While the tropics show no changes in variability, mid-latitude changes are higher. A slight overall reduction in variability in the centennial to millennial range is found in Antarctica. The variability decrease in the Greenland ice core oxygen isotope records is larger than in any other proxy dataset. These results therefore contradict the view of a globally quiescent Holocene following the instable Glacial, and imply that, in terms of centennial to millennial temperature varibility, the two states may be more similar than previously thought.

ID: 02280, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Oral)

Peat record of Holocene atmospheric dust deposition on the Falkland Islands

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Records of atmospheric deposition play a key role in our quest to understand Earth System processes including changes in atmospheric circulation, impact of atmospheric sources on oceanic paleoproductivity and impact of human activities on global biogeochemical cycles.

A region of particular interest is the Southern Atlantic Ocean. To date, the lack of high-resolution records of atmospheric dust deposition is seriously limiting our progress in the understanding of the global connections between mineral dust, climate and ocean biogeochemistry in this region.

The aim of this work is to establish reference Holocene high-resolution records for atmospheric deposition of dust and trace elements to the Southern Atlantic Ocean using peat archives in a remote location outside the Antarctic ice shelf. To date, peat deposits were sampled in the Falkland Islands and peat cores were recovered covering the Holocene. The elemental and isotopic geochemical characterization of the peat will allow us to quantify the atmospheric deposition fluxes of dust and trace elements and their temporal variations during the Holocene and to identify dust sources and assess the importance of long-range transport in the western South Atlantic Ocean. We expect to reconstruct Holocene atmospheric circulation patterns associated with paleoclimatic variations but also to tackle the link between dust cycle and paleoproductivity in the Southern Atlantic Ocean. In this contribution, preliminary results on the Falkland Islands peat record will be discussed including density, ash content, trace element and REE concentration.

ID: 01829, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Sea ice as a source of sea salt aerosol to Greenland ice cores: a model-based study

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Salty blowing snow lofted from the surface of sea ice may be an important source of sea salt to the polar atmosphere. For paleoclimatologists, this is significant because it provides a mechanism by which sea salt in ice cores could record information about past sea ice extent.

To assess how Greenland ice core sea salt may be used as an Arctic sea ice proxy, we investigate the factors influencing Arctic sea salt aerosol using a chemical transport model. Our model simulations are compared to both Arctic aerosol observations and seasonally-resolved Greenland ice core records.

We find that a sea ice source of sea salt is required, in addition to an open ocean source, in order to reproduce aerosol observations, particularly winter Na concentration maxima. Furthermore, our tests indicate that sea salt emissions from multi-year sea ice must be less than emissions from annual sea ice, but not negligible.

For the first time, we are able to represent Na concentrations in the Greenland snow pack using deposited aerosol and precipitation simulated by our model. For the majority of ice cores, annual mean Na concentrations can be simulated to within a factor of 2. Sea-ice-sourced sea salt contributes to the winter sea salt peak observed in all the Greenland ice cores. A strong meridional gradient in the influence of the sea ice source is observed, with the sea ice contributing 50% of the winter sea salt at NEEM (78°N), compared to only 10% in southern Greenland (66°N).

Sensitivity tests exploring the relative influence of changing sea ice versus meteorology suggest that while meteorology is the dominant control on inter-annual variability in ice core sea salt concentrations, longer term changes in sea ice may be detectable at some Greenland locations.

ID: 01853, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Oral)

Land-ocean interactions at high latitudes during the Pliocene

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Until recently, our understanding of high latitude Pliocene (5.3-2.6 Ma) climate change has been hampered by a lack of continuous well-resolved reconstructions. New evidence from the eastern Nordic Seas ODP Hole

642B document a close correspondence between climate change on land and in the ocean on orbital to tectonic time scales between 5.1 and 3.1 Ma. Both ocean temperatures and vegetation show long intervals of warmer than Holocene conditions, and the water column structure support overall shallower ocean ventilation. One of the most striking features of the eastern Nordic Seas records is, however, that both ocean temperatures and the Northern Norwegian vegetation document conditions comparable to the Holocene between 4.3 and 4.0 Ma, at a time when global temperatures are considered to be significantly warmer than at present. At 4.0 Ma, the sea surface temperatures increased rapidly, while the transition to warmer vegetation was more gradual and also associated with gradually decreased humidity. While the eastern Nordic Seas SSTs increased at 4.0 Ma, the western Nordic Seas cooled, setting up a strong zonal temperature gradient over the Nordic Seas. In contrast, the meridional temperature gradient between the North Atlantic and the eastern Nordic Seas decreased. Mechanisms behind and implication of the results in terms of understanding the high latitude Pliocene climate development will be discussed.

ID: 01660, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Deconvolving the deglacial release of CO2 from the deep South Pacific

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It is widely understood that glacial-interglacial changes in atmospheric CO_2 are driven by changes in deep ocean carbon storage. However, the processes responsible for the transfer of CO_2 between the deep ocean and the atmosphere remain disputed. Here, we produce the first benthic boron isotope record (a proxy for seawater pH) from the deep South Pacific, and through comparison with benthic $\delta^{13}C$ and $\Delta^{14}C$, we can determine the important oceanographic changes that act to release CO_2 from the deep ocean. By combining these proxy data with model reconstructions we show that breakdown in the stratification of the Southern Ocean is responsible for the deglacial release of CO_2. In contrast, processes such as iron fertilisation of the sub-Antarctic, air-sea gas exchange and variations in the strength of Atlantic Meridional Circulation play a comparatively minor role.

ID: 01603, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Climatic change and the origins of agriculture in the Eastern Mediterranean during the last Glacial-Interglacial transition

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It has long been hypothesised that the beginnings of Neolithic agriculture in southwest Asia were connected to the major shift in climate at the end of the last Ice Age. Here we synthesise and critically evaluate the evidence for environmental change and human adaptations between 16,000 and 9000 Cal BP in this region. Stable isotope data from marine, lacustrine and cave sequences show a pattern of climatic change that was synchronous across the eastern Mediterranean basin within the limits of dating uncertainty. Changes in vegetation inferred from pollen and charcoal evidence mirror step-wise shifts between cold-dry and warm-wet climatic conditions, although with lag effects, especially in woody plant cover in upland and interior areas. We compare these environmental data against summed archaeological radiocarbon date probability distributions as a proxy for past human population. In some areas, abrupt warming transitions appear to have acted as pacemakers for demographic change, while in other regions, no such synchronism is evident.

During cold-dry time intervals (e.g. Younger Dryas), favoured regions (e.g. Levant) acted as refugia for plant and animal resources and human population. By contrast, most upland and interior regions were dominated by low-biomass resource-poor herb steppe, and there is only limited evidence of human occupation at these times. Contrasting human responses to climatic opportunities may have been set by antecedent conditions during periods of climatic adversity. Where socio-ecological continuity was maintained through the Younger Dryas, human communities were able to respond rapidly to subsequent climatic improvement. However, where there was a break in settlement at this time, a lack of pre-adaptation meant that populations were slower to react to the new opportunities provided by the interglacial world.

ID: 02221, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Can glacial precipitation changes in the Tropics be related to the global scale?

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Paleoclimate studies of tropical precipitation frequently aim to place local records into a larger, even global, scale context. Recent theoretical advances linking the energetics of the global atmosphere to the location of tropical precipitation offer an interesting framework within which to understand past changes in precipitation. We shall investigate whether it is possible to use the energetic framework to understand local precipitation records by examining output from 363 different full complexity climate model simulations of the last glacial period. We shall show that it is possible to link the position of the global mean Inter Tropical Convergence Zone (ITCZ) to changes in the global energy budget, but that the response of the ITCZ to glacial forcing is rather different to the response to the seasonal cycle. Since much of our theoretical understanding of the ITCZ is based on the behaviour of the seasonal cycle, this suggests that much work still needs to be done to understand how the ITCZ responds to glacial forcing. We shall show that although there is a relationship between the global mean ITCZ and the energy budget there is little relationship between local or continental scale precipitation and either the global mean ITCZ or the global energy budgeton glacial timescales. This suggests that the energetic framework has limited use for the interpretation of paleo-proxies and that paleoproxies should not be linked to global ITCZ shifts.

ID: 01921, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

Volcanic Eruptions as the Cause of the Little Ice Age

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Both external forcing (solar radiation, volcanic eruptions) and internal fluctuations have been proposed to explain such multi-centennial perturbations as the Little Ice Age. Confidence in these hypotheses is limited due to the limited number of proxies, as well as only one observed realization of the Last Millennium. Here, we evaluate different hypotheses on the origin of Little Ice Age-like anomalies, focusing in particular on the long-term response of North Atlantic and Arctic climate perturbations to solar and volcanic perturbations. For that, we analyze the Last Millennium Ensemble of climate model simulations carried out with the Community Earth System Model (CESM) at the National Center for Atmospheric Research, supplemented by a range of sensitivity tests performed by us using CESM, focusing in particular on the sensitivity to initial conditions and the strength of solar and volcanic forcing. By comparing the climate response to various combinations of external perturbations, we demonstrate nonlinear interactions that are necessary to explain trends observed in the fully coupled system and discuss physical mechanisms through which these external forcings can trigger multidecadal modes of the Atlantic Multidecadal Oscillation and subsequently lead to a Little-Ice-Age-like regime. For that, we capture and compare patterns of the coupled atmosphere-sea-ice-ocean response as revealed through a range of data analysis techniques. We show that the large 1257 Samalas, 1452 Kuwae, and 1600 Huaynaputina volcanic eruptions were the main causes of the multi-centennial glaciation associated with the Little Ice Age.

ID: 02264, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Oral)

Pre-Columbian raised fields in the Llanos de Moxos, Bolivian Amazon: An adaptation to the local environment

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In pre-Columbian times human have been transforming Amazonian landscapes and adapting to different environmental conditions in different ways. One impressive example are the raised fields- a pre-Columbian agricultural system found in south-eastern Amazonia – in the Llanos de Moxos, in the Bolivian Lowlands. Pre-Columbian raised fields bear evidence of human response to climatic change in the late Holocene. Our results challenge the currently most accepted theory that raised fields were a highly productive system which *per se* allowed the development of a dense population.Combining a set of pedological and sedimentological methods with radiocarbon and optically stimulated luminescence dating we show that fields were constructed to overcome flooding and were in use during time periods which coincide with anomalous wet phases. Furthermore we show that the existing different types of raised fields, occurring in different regions, are the result of a perfect adaptation to varying local environmental setting (e.g. soil types and hydrology) rather than a cultural phenomenon.

ID: 01646, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Speleothem fluid inclusions show westerly and easterly moisture advection across North East Libya during MIS 3 humid phases

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Atmospheric latent heat is a major component of global and regional climate energy budgets and changes in its amount and distribution are key aspects of the climate system to constrain. Equally, in mid- and low latitude regions, the aspect of past climate change that has had the most impact on landscapes and ecosystems is changes in the water cycle. Rainfall in semi-arid regions is also amongst the climate parameters human society is most sensitive to. Constraining past water cycle changes within the arid mid-latitudes is therefore a globally significant research priority. Here, we present speleothem-based fluid inclusion, strontium isotope and stable isotope data for a record in northeastern Libya spanning MIS 3 and demonstrating 15 newly identified humid periods during this time-period. Comparison to modern rainfall isotope data shows that fluid inclusion water is likely unmodified rainfall water, but that waters of significantly different composition are preserved in at least two families of inclusions. The whole population of measurements indicates that more than one rainfall system is represented in the fluid inclusion dataset, with moisture advection from both the west (Atlantic) and the east (Levant). We discuss different scenarios which can explain this geochemical behaviour, including changes to sources, rainfall seasonality and impact from the amount effect. Demonstration of humid periods during MIS 3 in Cyrenaica are of great significance to understanding human populations and migration through central North Africa, and we discuss the implications of the changes in the annual cycle we observe to regional human prehistory.

ID: 02229, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Oral)

Is light-absorbing particulate deposition increasing the melt of Svalbard glaciers?

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Black carbon (BC) and mineral dust are natural and anthropogenic, mainly light-absorbing particles with strong climate warming efficiency. Their climate impacts are amplified in the Arctic where their deposition on high-reflectivity surfaces decreases the surface albedo and hastens the melt of snow and ice. Globally, BC is the second most important climate warming agent after CO_2, and it is estimated to be more important to the Arctic melting and warming than greenhouse gases. BC can have an up to 100 times stronger light absorption per unit mass than mineral dust. However, dust is considerably more abundant than BC in the Arctic, and therefore the relative significance of these particles to the observed Arctic climate warming and melting is partly unresolved. Long-term observational records of Arctic BC deposition are available from Greenland and Svalbard glaciers while retrieving such data on dust has proven methodologically more challenging. Preliminary results indicate that non-elemental carbon refractory impurities (a proxy for mineral dust) may contribute to about 50 % of the light absorption caused by all impurities on a Svalbard glacier. In a 300-year Svalbard glacier record summer melt variations are better explained by the combination of BC concentration and air temperature variations than by temperatures alone. Both the BC content and melt of the glacier have increased rapidly from the 1970s to 2000s contrary to results from Greenland. The impact of dust on the increasing glacier melt is being investigated, as with growing amount of snow/ice-free rock surface on Svalbard the impact of dust on glacier melt may have increased. Furthermore, dust contains nutrients for micro-organisms, such as algae, that are suggested to affect the albedo in parts of Greenland.

ID: 01866, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Orbital-scale variations in Indo-Pacific hydroclimate during the mid- to late Pleistocene from Lake Towuti, Indonesia

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The Indo-Pacific Warm Pool plays a critical role in the Earth's climate system. Changes in local insolation, greenhouse gas concentrations, ice volume, and local sea level are all hypothesized to exert a dominant control on Indo-Pacific hydroclimate, yet existing records exhibit fundamental differences in the timing and amplitude of orbital-scale hydroclimatic changes, limiting our

understanding of the regional climate responses to orbital-scale forcings.

In 2015 we drilled over 1,000 meters of sediment core from Lake Towuti, located on the island of Sulawesi, near the equator in central Indonesia, one of the only terrestrial sedimentary archives in the region that continuously spans multiple glacial-interglacial cycles. Previously published organic geochemical reconstructions of vegetation from relatively short, ~60 kyr long piston from Lake Towuti exhibit strong drying during the Last Glacial Maximum, suggesting that central Indonesian hydroclimate is highly sensitive to forcing from high-latitude ice-sheets. New, inorganic geochemical and mineralogical reconstructions of lake level also indicate a half-precessional climate signal during the last 60 kyr in which low lake levels occur during spring and fall perihelia. This response is opposite that of nearby speleothem records from northern Borneo, suggesting strong hydroclimatic gradients over the IPWP in response to equatorial insolation changes. Comparison of these results to climate model simulations indicates that these precipitation gradients may result from seasonal changes in the Walker Circulation. However, the short length of our existing records limits our understanding of the regional hydroclimatic response to the full range of global climate boundary conditions experienced during the late Quaternary. This presentation will discuss results from the last 60 kyr and present new isotopic and geochemical reconstructions from the upper ~100 m of core from Lake Towuti, spanning the last ~500 kyr BP.

ID: 01461, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Timescale-dependent interplays of solar and temperature forcing to explain a 6-kyr record of flood frequency and intensity in the western Mediterranean Alps

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The high-resolution sedimentological and geochemical analysis of lake sediment sequence (Lake Savine) from the Western Mediterranean Alps led to the identification of 220 event layers over the last 6,000 years. 200 were triggered by flood events and 20 by underwater mass movements possibly related to earthquakes that occurred in 5 clusters of seismicity over this period. Because human activity could influence the flood chronicle, the presence of pastures was reconstructed through ancient DNA, which suggested that the flood chronicle was mainly driven by hydroclimate variability. Weather reanalysis of historical floods suggested that mesoscale precipitation events called "East Return" events were the main triggers of the floods recorded in the Savine sequence. The first part of the Savine palaeoflood record (6 to 4 kyr BP) was characterized by increases in flood frequency and intensity in phase with Northern Alpine palaeoflood records. By contrast, the second part of the record (i.e., the last 4 kyr BP) was phased with Southern Alpine palaeoflood records. These results suggest a strong palaeohydrological transition at approximately 4 kyr BP, as has been previously described in the Mediterranean region. This may have resulted in an abrupt change in the flood-prone hydro-meteorological processes, i.e., in the balance between the occurrence and intensity of local convective phenomena and the influence of Mediterranean mesoscale precipitation events in this part of the Alps. At the centennial timescale, increases in flood frequency and intensity corresponded to periods of solar minima, affecting the climate through atmospheric changes in a large European Atlantic sector.

ID: 01424, 26.- Data Stewardship for Paleoscience, (Oral)

The ACER pollen and charcoal database: a global resource to document vegetation and fire response to abrupt climate changes during the last glacial period

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Investigation of the impact of past abrupt climate changes on vegetation cover, including wetland extent, and fire activity is important for understanding the rapid and extremely large, by ca 200 ppbv, changes in last glacial atmospheric CH_4 concentrations and the potential climate feedback. The velocity and magnitude of these changes, specifically the extremely rapid warming events, are comparable to the expected magnitude and velocity of 21st century climate warming, and there is also considerable concern whether this change is too fast to allow vegetation to adapt or migrate to climatically suitable locations. Global environmental reconstructions for the last glacial period based on extensive pollen and charcoal datasets are therefore needed for a better analysis of the relationships between vegetation, fire and climate. Reconstructions published so far are based on records with independent, non-aligned chronologies, potentially leading to artificial discrepancies. Data compilations and synoptic reconstructions are also needed for evaluating model experiments simulating regional vegetation/fire/climate interactions resulting from freshwater forcing of oceanic circulation under glacial conditions. Here we present the ACER (Abrupt Climate Changes and Environmental Responses) database which is composed of 93 well-resolved pollen records (temporal resolution better than 1,000 years) distributed worldwide, 32 of which include charcoal data as well. These records cover all or part of the last glacial period, from 73 to 15 ka. Where possible a harmonized chronology was constructed based only on radiometric dating (86 records; ^{14}C, ^{234}U/^{230}Th, OSL, ^{40}Ar/^{39}Ar dated tephra layers). In some cases we were obliged to use a series of common control points based on event stratigraphy. The dataset is archived in *Microsoft Access*™ with metadata including geospatial and dating information, pollen and charcoal counts and pollen percentages of the characteristic biomes. The compiled data will be available at PANGAEA.

ID: 01581, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Historical flood analysis of river catchments in south-eastern Spain

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Although south-eastern Spain is the driest region in Europe, floods are a very destructive phenomena because of their high peak discharges, sediment transport and aggradation processes in the flood plain. Fatalities and economic losses such as damage of infrastructure and buildings were recorded during recent years (e.g. 1,500 million Euros in 2012). Despite of possible effects of increasing exposition and vulnerability, the compilation of historical floods from written and factual sources demonstrated that also during historical times, hydrological extreme events affected people and settlements in south-eastern Spain. For instance, in 1580 the town Albox were completely destroyed by catastrophic flooding.

To reconstruct floods in the Almanzora and Antas river basins (2600 and 260 km^2) during the last 500 years, data compilation from primary sources were undertaken in the municipal archives of the towns of Vera, Cuevas del Almanzora and Antas. To assess the magnitude and frequency of flood events, the following categories of flood intensities were established. Magnitude 1 (M1): ordinary floods that affected only agriculture plots; M2: extraordinary floods which produced damages of buildings and hydraulic infrastructure; M3: catastrophic floods which caused very severe damages, fatalities and partial or complete destruction of settlements. A damage intensity of +1 magnitude was added up when the event was recorded from more than one sub-basin or stretch, which were previously defined according to physiographic and topographic criteria.

According to the analysis of synoptic atmospheric situations during catastrophic events, flooding is frequently caused by heavy precipitation generated by cold drops which are Upper Level Lows that are closed cyclonically circulating eddies in the middle and upper troposphere and which generate strong rainfalls in the Mediterranean basin. This situation occurred during the floods in 1879, 1884, 1924, 1973, 1989 and 2012.

ID: 02335, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Long-term growth and establishment dynamics of high elevation Pyrenean forests

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It is expected that climate warming will enhance radial growth and establishment of high-elevation forests at cold regions. In addition, climate warming could induce altitudinal shifts of alpine treeline elevation by improving growth and establishment, either through enhanced germination rates and/or through decreased mortality rates. However, climate change could also increase the frequency of extreme climatic events as cold spells or warm-dry conditions which could negatively affect tree growth and establishment at high elevations. Despite the synergistic effects of all these climate drivers on the long-term growth and regeneration dynamics of high-elevation forests, these links have been poorly studied along long-term scales. Here, we use dendrochronology to reconstruct the centennial growth and establishment dynamics of relatively undisturbed Pyrenean high-elevation forests dominated by *Pinus uncinata* in Gerber, north-eastern Spain. We sampled and cross-dated wood disks and cores with piths to establish the germination rate of 581 trees and to reconstruct their radial growth. The establishment patterns during the best-replicated period (1270-1970) were reconstructed using 30-year long classes. Finally, we fitted a power function to these data assuming a variable mortality rate. The residuals of the power function were related with a air temperature global reconstruction based on non-dendrochronological proxies to avoid circular reasoning. We detected low establishment periods from 1550 to

1750, with drops in the 1630s, 1700s and 1850s, which coincided with cold conditions such as those observed during the late Little Ice Age. Periods with high establishment levels occurred from ca. 1400 to 1500 and in the early 14th and 19th centuries. We also observed that the establishment was positively related to reconstructed air temperatures, which indicates that the local establishment patterns of high-elevation forests respond to local and regional changes in temperatures.

ID: 02022, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Oral)

The Chew Bahir record: half a million years of environmental history from southern Ethiopia

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Chew Bahir is a deep tectonic basin and climate archive in the Southern Ethiopian Rift, close to the Lower Omo valley, site of earliest known fossil of anatomically modern humans. The Chew Bahir sedimentary deposits were cored in Nov-Dec 2014 as part of the Hominin Sites and Paleolakes Drilling Project (HSPDP) and the Collaborative Research Center (CRC806) “Our Way to Europe”. Two overlapping cores (280 m and 270 m long) of mostly clayey silts, were collected, which cover the last 550,000 years, dated by Ar/Ar on cryptotephra. The composite record presented here was constructed by using MSCL, XRF and lithologic data, providing a potential archive of environmental history during the evolution and dispersal of anatomically modern humans. Initial sedimentological and geochemical results show that the Chew Bahir deposits respond sensitively to changes in moisture by sediment influx, provenance, transport and diagenetic processes, evident from mineralogy, elemental concentration and physical properties. The potassium record for example clearly traces the African Humid Period. Therefore, the Chew Bahir record will allow us to test different hypotheses concerning the influence of environmental change on the development and dispersal of *Homo sapiens* and his technological innovations such as Middle Stone Age tools.

ID: 01491, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Invited Oral)

Stable Isotope Changes of atmospheric N2O during the last 150 kyrs: What the ice core record may tell us about terrestrial and marine N2O emissions

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* Jochen Schmitt, schmitt@climate.unibe.chN_2O and CH_4 reconstructions from ice cores show close variations to climatic shifts. For N_2O, conceivable feedbacks from a warmer world, for example by intensified nitrogen turnover in soils, are assumed to be less spectacular than for CH_4. Because bioavailable nitrogen often limits production in both terrestrial and marine ecosystems and energy is needed to fix atmospheric N_2, it is recycled and only a small fraction is lost in each cycle. As N_2O is an inevitable by-product during the mineralization of biomass, N_2O emissions scale with the carbon turnover and plant primary production. Terrestrial ecosystems under warmer conditions and higher CO_2 could speed-up global carbon turnover and thus N_2O emissions. Yet, our knowledge on the driving parameters of past N_2O emissions is very limited. Knowing the evolution of N_2O in the past as well as the lifetime of N_2O enables us to quantify the overall terrestrial and marine N_2O emissions and its temporal evolution quite well. Yet, the individual shares between terrestrial and marine emissions are less constrained and rely on basic bottom-up estimates and differences in the isotopic signature of the sources. Measurements of nitrogen and oxygen isotopes in N2O can help us to quantify this share and its temporal changes. We present an ice core record of the nitrogen and oxygen isotopic composition of N_2O over the last 150 kyr including highly resolved millennial-scale variations, the latter showing surprisingly little change in isotopic signatures. However, we find significant long-term variations in δ^{15}N-N2O, which are not reflected in accompanying changes in δ^{18}O-N2O. This decoupling shows that the isotopic variations cannot be explained by a change in the terrestrial and marine source mix alone, but could be related to changes in the isotopic source signatures or changes in the efficiency of nitrogen turnover.

ID: 01443, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Oral)

Comprehensive comparison of bottom water dissolved inorganic carbon δ13C and epibenthic foraminifer δ13C

in the global ocean: a test of the canonical one-to-one relationship

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The carbon isotope composition (δ^{13}C) of dissolved inorganic carbon (DIC) in the ocean provides valuable insight on ocean circulation changes, air-sea gas exchange, the efficiency of the biological organic carbon pump, and therefore the global carbon cycle. Seawater δ^{13}C is believed to be captured by the δ^{13}C of fossil epibenthic foraminifera in a one-to-one manner, but numerous processes are known that may bias epibenthic foraminifer δ^{13}C (e.g. phytodetritus- and microhabitat effects). We present a compilation of 1,611 δ^{13}C observations of epibenthic foraminifera of the genera *Cibicides* and *Cibicidoides* (including 30% of unpublished data) from late Holocene sediments ($\delta^{13}C_{Cibnat}$), and compare those with newly updated estimates of the natural (pre-industrial) water-column δ^{13}C of DIC ($\delta^{13}C_{DICnat}$) as part of the international Ocean Circulation and Carbon Cycling (OC3) project. Using selection criteria based on the spatial distance between samples we observe high correlation between $\delta^{13}C_{Cibnat}$ and $\delta^{13}C_{DICnat}$, confirming previous studies. We have tested several multi-variant linear regression models and find significant carbonate ion- and pressure effects. Based on these findings, we propose a new global calibration for predicting $\delta^{13}C_{DICnat}$ from $\delta^{13}C_{Cibnat}$, which reduces some uncertainties associated with an often applied one-to-one translation of $\delta^{13}C_{Cibnat}$ into $\delta^{13}C_{DICnat}$. The remaining standard error is significantly larger in the South Atlantic ($\sigma \cong 0.4$ ‰) than the global mean average ($\sigma \cong 0.25$ ‰). We discuss possible sources of this error, and emphasize that a better understanding of uncertainties associated with epibenthic δ^{13}C analyses may improve the accuracy of future seawater $\delta^{13}C_{DICnat}$-, and hence global carbon cycle, reconstructions.

ID: 02203, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

An independent record of large volcanic events over the past millennium from reconstructed summer temperatures

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Ash layers in polar ice-sheets represent the only continuous records of volcanism during the last millennium. The amount of deposited sulfate aerosols has been used widely to reconstruct volcanic forcing and to assess its climatic impact. Changes in the interpretation and composition of stacked ice-core records, however, resulted in discrepancies among different studies regarding the magnitude and timing of volcanic events. Although links to other archives, such as historic documents and tree rings, were often used to constrain the ice-core information, these resources concurrently manifest the uncertainties in the ice-core derived data. Here, we present a new record of large volcanic eruptions derived independently from hemispheric temperature estimates based on tree ring density data. An increasing network of this less common but more responsive temperature proxy stimulated a series of new large-scale temperature reconstructions, including a spatially resolved approach. We show that in one of these reconstructions our detection algorithm can distinguish the characteristic cooling subsequent to volcanic eruptions from internal variability in at least 14 cases throughout the last millennium. These cooling events mostly agree well with the latest ice-core derived reconstruction, but suggest different dates for some of the biggest events. The tree-ring derived estimates reveal a different history of volcanic forcing especially in the 1450s and 1690s. Using the detected volcanic events for evaluating the mean cooling effect indicates a stronger and more accentuated response than was previously found using ice-core based event years. Applying the detection algorithm to model simulations yields less robust results despite a likely overestimated volcanic forcing in some model runs. More insight in the agreement between the simulated and reconstructed responses to volcanic eruptions might be achieved in a spatial approach analyzing selected areas, like Arctic or monsoon regions.

ID: 01969, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

High-resolution flood history in lake sediments from SW Ecuador of the past two millennia: El Nino or not?

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ENSO is a top priority in current climate change research and globally relevant, not only for weather but also for ecosystems and society.

Rodbell et al. (1999) and Moy et al. (2002) related clastic layers in a sediment core from Lake Pallcacocha, SW Ecuador, with El Niño events. They argued that these events, which increase convection over the Pacific Ocean, lead to enhanced precipitation on the western side of the Andes (based on precipitation data from the station Guayaquil on the Pacific Ocean shore). They hypothesized that heavy precipitation events intensify river discharge and enhance watershed erosion, creating flood-event layers in Lake Pallcacocha's sediments.

However, Lake Pallcacocha lies on the eastern side of the highest Andean Ridge, and several authors showed that ENSO impacts areas on the eastern side of the Andes differently: El Niño events weaken (wet) easterly winds and strengthen (dry) westerly wind flows, ultimately leading to less precipitation. In contrast, La Niña conditions intensify easterly winds (SASM; wet) and weaken the dry westerly wind flows, which leads to increased precipitation on the eastern side of the Andes and would promote event layers in the sediments of Lake Pallcacocha.

The present study is based on non-destructive (uXRF, hyperspectral imaging) and destructive lake sediment core analysis from three different lakes (Pallcacocha, Llaviucu, Fondococha), all containing clastic layers. Is the flood history (frequency) consistent in these three lakes for the past ca. 1500 years? Can the newly available synoptic meteorological data and the new precipitation data from stations in the Cajas National Park be used to draw a conclusive picture about the atmospheric conditions producing flood layers? Do these layers really reflect variations in ENSO over the past two millennia? And if so, which events (El Niño or La Niña) caused these layers?

This study contributes to PAGES-2k-South America.

ID: 02329, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

The view from the edge: mammalian turnover and abrupt climate change during the Lateglacial in Britain

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The rapid climatic fluctuations of the Last Glacial-Interglacial transition produced a major re-ordering of the mammalian faunas of northwestern Europe, resulting in aggregations of extinct and extant taxa that are frequently referred to as 'disharmonious', by comparison to their present day biogeography. Nevertheless, the combined problems of poor resolution and chronology have hitherto made it difficult to establish whether the patterns of mammalian turnover observed are really synchronous with the climate changes recorded in long terrestrial records such as the Greenland ice cores and whether the apparent co-existence of species that are not sympatric today is genuine, or a mere artefact of the record. This has hampered our understanding of (i) the mode and tempo of faunal movement, (ii) of potential leads and lags between different parts of Europe and (iii) of regional extinction chronologies during this complex period. Using evidence from new archives based on British cave sequences, the presentation will examine the capacity of mammalian taxa to withstand abrupt climate change during the Lateglacial and evaluate the role of cryptic northern (micro)refugia at the very margins of the North Atlantic.

ID: 01811, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

A PAGES Floods WG pilot project: integration of multidisciplinary datasets to reconstruct a comprehensive paleoflood picture in the Bernese Alps

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In the context of global warming, the generation of long series of paleofloods and their transfer to relevant public agencies is crucial for an accurate flood risk assessment. However, the integration of multi-archive flood records at a regional scale is complex, not only due to statistical processing of inhomogeneous data sets (accuracy, frequencies), but also because of the nature, thresholds and sensitivity of archives and processes.

The case study in the Bernese Alps aims to (i) develop an innovative approach integrating flood data from flood plain and lake sediments, historical sources and bioindicators, (ii) model paleoclimate during flood-rich periods, and (iii) reconstruct a comprehensive picture of the flood variability and forcing in a densely populated mountain area.

Based on the combined flood data sets of the Hasli-Aare, Lütschine and Kander catchments and lakes Grimsel, Oeschinen and Thun, periods of higher paleoflood frequency and related atmospheric circulation modes were identified.

Regarding the last centuries, where calibration by historical data is performed, periods of synchronous flood activity (1320-1350, 1430-1490, 1800-1860, around 1920 AD) alternate with periods of asynchronous flood response among sites (16th to 18th c.). We attribute these patterns to differences of local hydrologic regimes influenced by (i) physiographic parameters such as size, altitude, storage and connectivity of basins, and by (ii) climatic parameters such as precipitation type, spatial distribution, duration and intensities. However, other factors as gravity processes and land-use may modify the flood signal. Despite of the difficulties to implement magnitude-frequency analysis in mountain catchments, paleo peak discharges were estimated by (i) comparison of flood damage indices with instrumental discharges and (ii) hydraulic modeling based on historical and lichenometric flood levels.

The methodological progress and outcomes of the project will stimulate other initiatives within the PAGES Floods WG and promote future studies that will cover larger spatial scales.

ID: 02197, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Importance of the Pre-Industrial Baseline in Determining the Likelihood of Breaching the Paris Limits

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During the Paris Conference of December 2015, nations of the world strengthened the United Nations Framework Convention on Climate Change by agreeing to hold “the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C”. However, neither the pre-industrial period nor baseline temperatures were defined.

Here we use last millennium model simulations to determine a global temperature baseline for “pre-industrial”. We find that values are very dependent on the period chosen and investigate the implications of different choices of this baseline for the likelihood of exceeding the two temperature thresholds under different emission pathways. In particular, we highlight that while avoiding breaching these limits is only probable in an emission scenario with strong mitigation, the probability of avoiding crossing 1.5°C and 2°C thresholds is highly dependent on how the pre-industrial baseline is chosen. For example, the probability, by the end of the century, of crossing 1.5°C under the strongest mitigation scenario, RCP2.6, varies from 55% to 82% depending on how the baseline is defined. We also find that calculations of the remaining carbon budget allowed for threshold stabilisation are also highly dependent on the pre-industrial baseline, with the current estimate allowed for stabilisation at 2°C decreasing by as much as 40%.

ID: 01835, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Oral)

The mid-Piacenzian warm period in the Asian interior: Assessing palaeoclimate variability with high-resolution pollen records from the Qaidam Basin and Kunlun Pass

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The climate of the Asian interior is controlled by the East Asian Monsoon providing warm and wet air directed north and westwards in summer, and cold and dry air directed south and eastwards in winter. During the mid-Piacenzian warm period (mPWP; 3.264 - 3.025 Ma) multiple palaeorecords indicate a strengthening of the East Asian Winter Monsoon (EAWM) whereas the response of the East Asian Summer Monsoon (EASM) is subject of controversy. Being the main source of precipitation for the Asian interior, it is of fundamental importance to understand the intensity and variability of the EASM during the warm Pliocene, which had climatic conditions similar to what climate models predict for the end of the 21st century. Our study reconstructs vegetation and climate changes during the mPWP from two sites located at the northwestern limit of the EASM (Qaidam Basin, Kunlun Pass) using high-resolution pollen records.

Preliminary results show that between 3.339 - 3.097 Ma the vegetation in the western Qaidam Basin (SG-1b drilling site) was dominated by xerophytic shrubland with Chenopodiaceae and *Artemisia* spp. usually contributing more than 50% of pollen grains. Broadleaved and coniferous trees comprise only a small fraction, however, they repeatedly reach 15-20% of the total pollen count during short intervals that represent wetter periods during the mPWP. Spectral analysis of *Artemisia*/Chenopodiaceae ratios as a relative precipitation proxy suggests that palaeoprecipitation changes are controlled by 100ka and 41ka orbital cycles. A strong increase in coniferous trees and pollen concentrations suggest a distinctly wetter phase around 3.17 Ma.

The palynogical results of the SG-1b record from the western Qaidam Basin will be compared with a new pollen record from the Kunlun Pass, allowing a high-resolution temporal and spatial reconstruction of mid-Piacenzian palaeomonsoonal changes in the Asian interior.

ID: 01951, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Oral)

Tracking Holocene genetic variability of Swiss mountain forests using ancient DNA

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With ongoing and future climate change, plant species are forced to either move, adapt or die. To test hypotheses regarding recolonization pathways and cryptic northern refugia as well as to study changes in the genetic variability of tree species in the Holocene, we propose to analyze ancient DNA (aDNA) from subfossil plant remains conserved in lake sediment from the Swiss Alps. We will apply a recently developed genetic method using exome capture and RAD sequencing (HyRAD-X) to identify single nucleotide polymorphisms (SNPs) in aDNA. We will also sample present-day tree populations around our study sites, to link the aDNA genotypes with current genetic variation. In order to identify major demographic changes in our focal species, we will also reconstruct local to regional vegetation and fire dynamics using pollen, macrofossils and charcoal analysis. We will combine these paleoecological analyses with two different, spatially explicit dynamic vegetation models (TreeMig & LandClim), to test hypotheses regarding past range expansions and simulate future vegetation dynamics. Our aims are to 1) quantify the genetic relationship between the first recorded tree species around our study sites and the present-day populations, as well as to assess changes in the allele frequency of putative adaptive alleles that would indicate genetic adaptation to environmental stressors; 2) analyze the genetic distance of the earliest macrofossils between the study sites; 3) test previously proposed recolonization pathways by identifying the timing of paleoecologically inferred population expansion; 4) compare the inferred population expansion with model simulations to identify biotic and non-biotic drivers of species dispersal and 5) quantify the impact of climate and human land-use on the vegetation dynamics in the Swiss Alps during the Holocene. This will help ecosystem managers and conservation biologists to protect multi-level biodiversity and maintain fragile alpine ecosystems and their services for future generations.

ID: 01510, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Hemispherically in-phase precipitation variability over the last 1700 years using stalagmites from Madagascar

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In recent years, the schema of north-south translation of the mean position of the Inter-Tropical Convergence Zone (ITCZ) has become key in understanding tropical monsoonal precipitation variability on orbital and millennial timescales. Yet under the boundary conditions and relatively modest climate forcing of the last two thousand years this schema is at odds with the observed pattern of southern hemisphere tropical climate variability. While the South American Summer Monsoon appears to operate under a north-south translation of the ITCZ, the East Asian/Australian monsoon domain shows a pattern of hemispheric symmetry, explained by contraction and expansion of the tropical rain belt by reduced/increased poleward motion of the ITCZ. Additionally, regional precipitation patterns at these centennial timescales resemble those of El-Niño Southern Oscillation end members, suggesting a role for zonal climate forcing. To shed light on the controls of tropical monsoon variability, additional records from the southern hemisphere are required. Here we present new results using speleothems from Madagascar in the understudied west Indian Ocean region.

Our new quasi-annual, precisely dated, 1700-year-long speleothem record from Anjohibe cave, Madagascar serves as a proxy for the strength of the northwestern Madagascan monsoon. On the multi-decadal timescale, our record is in phase with its northern hemisphere monsoon counterpart from Oman. This is surprising as north-south movement of the ITCZ should result in an antiphase relationship. Further, the Madagascan record correlates well with precipitation records from the Horn of Africa on the centennial timescale. We discuss potential causes of this regional coherency and how it could relate to either symmetrical changes in continental sensible heating, or to a low frequency sea surface temperature climate mode in the equatorial west Indian Ocean.

ID: 02224, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Invited Oral)

Biotic turnover rates during the Pleistocene-Holocene transition

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The Northern Hemisphere is currently warming at the rate which is unprecedented during the Holocene. Quantitative palaeoclimatic records show that the most recent time in the geological history with comparable warming rates was during the Pleistocene-Holocene transition (PHT) about 14000 to 11000 years ago. To better understand the biotic response to rapid temperature change, we explore the community turnover rates during the PHT by focusing on the Baltic region in the southeastern sector of the Scandinavian Ice Sheet, where an exceptionally dense network on microfossil and macrofossil data that reflect the biotic community history are available. We further use a composite chironomid-based summer temperature reconstruction compiled specifically for our study region to calculate the rate of temperature change during the PHT. The fastest biotic turnover in the terrestrial and aquatic communities occurred during the Younger Dryas-Holocene shift at 11700 years ago. This general shift in species composition was accompanied by regional extinctions, including disappearance of mammoth (*Mammuthus primigenius*) and reindeer (*Rangifer tarandus*) and many arctic-alpine plant taxa, such as *Dryas octopetala*, *Salix polaris* and *Saxifraga aizoides*, from the region. This rapid biotic turnover rate occurred when the rate of warming was 0.17°C/decade, thus slightly lower than the current Northern Hemisphere warming of 0.2°C/decade. We therefore conclude that the Younger Dryas-Holocene shift with its rapid turnover rates and associated regional extinctions represents an important palaeoanalogue to the current high latitude warming and gives insights about the probable future turnover rates and patterns of the terrestrial and aquatic ecosystem change.

ID: 02331, 01.- Open Session on past global changes, (Oral)

Hydroclimate forcing of deglacial landscape and ecosystem changes in the American southwest

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Over the past few decades, dramatic climate and ecological changes across the southwestern United States have highlighted the potential susceptibility of these systems to natural and anthropogenic disturbance. However, there continues to be a dearth of long, high-resolution records needed to understand climate-vegetation linkages across timescales and forcings. To address this here, we present a new record of vegetation and climate changes from variations in the carbon and hydrogen isotope composition of sedimentary leaf waxes in the sediments and sedimentary GDGTs in Hall's Cave, central Texas. Over the last 18,000 years, long-term trends GDGT-derived temperature and δD-inferred precipitation changes are dominated by insolation forcing, with cooler and wetter conditions during the late glacial, peak temperatures and aridity occurring during the early Holocene and a shift towards cooler and wetter conditions over the last three millennia. Superimposed on these trends are a number of millennial-scale climate shifts, the most dramatic of which were associated with the warm/wet Bølling-Allerød and the cool/dry Younger Dryas. Over the past ~14,500 yr BP, changes in δD are accompanied by variations in $\delta^{13}C$, reflecting shifts in the proportion of C_3 plants in response to changes in rainfall. These data highlight the sensitivity of grassland-shrubland ecosystems in the American southwest to changes in precipitation on millennial and longer timescales and suggest that the expansion of woody plants over the last century is not unusual. In contrast, during the late glacial, when δD suggests wetter conditions, $\delta^{13}C$ indicates that summer grasses dominate the landscape. This decoupling of precipitation and vegetation changes suggests that other factors such as the timing of precipitation or changes in atmospheric CO_2, had a greater influence on the vegetation makeup of the southwestern United States during glacial times.

ID: 02291, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Millennial and astronomically-driven changes in the speed of Mediterranean Outflow along the last 250 Kyr near the Strait of Gibraltar

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Benthic and planktic foraminifer stable isotopes and sediment sand content were analysed in IODP Hole U1389 in the gulf of Cadiz in order to investigate the evolution of the Mediterranean Outflow along the last 250 Kyr. Cyclical changes in sand content in the sediment, ranging from 0 to 60%, were recorded along the core. These fluctuations in sand content were linked to changes in the speed of Mediterranean Outflow. The elaboration of an accurate chronology based on the benthic foraminifer oxygen isotope record allowed us to relate these cyclical changes in the speed of the MOW to precession–driven changes in Mediterranean climate and tropical Monsoon . The amplitude of these changes is larger in the interval from 150 to 250 kyr were precession variability is higher.

In addition to the astronomically-driven changes, MOW variability is also affected by millennial-scale climate variability. At times of cold stadials the MOW was more intense at the depth of site U1389, whereas during warm interstadials a weak MOW was recorded. However, this pattern is not observed during the cold stadials of Heinrich events.

ID: 01832, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Global volcanism during the Holocene: Why do we care and what do we need?

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The observational record of the timing of volcanic eruptions, their location, magnitude of sulphate aerosol injection and its atmospheric life-cycle is often incomplete, with gaps in our record of past volcanic activity increasing dramatically before the Modern (pre-1800 AD) era. This shortage in observational data strongly limits our understanding of the sensitivity of the Earth system to volcanic activity and the vulnerability of social and economic systems to the climate impact of past and future volcanic eruptions.

Here we present data on the timing, magnitudes and (in cases) potential source locations of volcanic eruptions for the past 11,700 years by employing novel, precisely dated, high-time resolution aerosol measurements from ice cores, including the WAIS Divide ice-core from West Antarctica. We thereby place trends of volcanic activity observed during the most recent centuries into a multi-millennial perspective allowing firm quantification of the recurrence intervals of large volcanic eruptions such as those of Samalas 1257 AD and Tambora 1815 AD, or the unattributed event in 1458 AD, imposing a potential threat to future economies and human societies. We also discuss limitations and possibilities to extract additional important eruption parameters determining the climatic impact (e.g. injection height, season, location) from past eruptions using state-of-the-art and novel methods to analyze ice cores.

ID: 02217, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Abrupt Dansgaard-Oeschger warming events in Greenland: d18O model-data comparison

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Understanding of millennial-scale DO variability of the last ice-age remains limited, with no universally accepted theory of how these extremely rapid warming events occur. The Greenland ice core d180 records constitute the archetypal record of abrupt climate variability from the last glacial period. Considerable uncertainty about the relationship between local climate and the ice-core record of d180 remains. Both in terms of the contribution of seasonality changes and the relative importance of remote versus distant environmental controls.

Here, we use modelling of d180 as a tool to help interpret the Greenland ice core records of DO-events. We perform an ensemble of multi-century isotope-enabled simulations with a coupled general circulation model, to investigate the nature of the signal contained in the d180 records. Experiments are set up using an isotope-enabled version of the Hadley Centre HadCM3 model. The set-up of our DO-type simulation to enable emulation of a salt oscillator type DO mechanism, whereby salt is progressively lost to the North Atlantic during stadial periods, and the onset of an abrupt warming when the oscillation occurs, and salt returns to the North Atlantic from the tropical Atlantic and wider global ocean. We run a set of 24 such simulations.

Our modelled d180 increases are in agreement with the magnitude of the measured Greenland ice core abrupt rises in d180. The seasonal cycle of precipitation and d180 do both change during DO event: a substantially larger proportion of precipitation falls over the ice core sites during cold months under the warmer interstadial climate. We find however that changes in precipitation seasonality are not so important in driving the majority of the geographical variability in d180 across Greenland. We also demonstrate that DO sea ice changes have a larger impact on d180 changes, compared to site temperature control.

ID: 02098, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Palaeodata and model simulations suggest that projected subtropical drying may be a transient response to warming

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Climate projections and observations over recent decades indicate that precipitation in subtropical latitudes will decline in the near future, in response to anthropogenic warming. However, this conclusion is derived from emissions scenarios dominated by rapidly increasing radiative forcing to the year 2100, which is too short a time scale to expect to see full responses from components of Earth’s climate with high inertia, such as the oceans and ice sheets. We use U/Pb-dated Late Miocene and Pliocene speleothem palaeoclimate data (representing equilibrium precipitation responses to past climate warming) and CMIP5 climate simulations extending to 2300 CE (in which Earth\'s climate initially is far out of equilibrium with rapidly rising radiative forcing), to demonstrate the potential for a very different outcome – that Southern Hemisphere subtropical drying reverses, and precipitation begins to rise, soon after greenhouse gas emissions stabilise. Our results suggest that 21st C. Southern Hemisphere subtropical drying may partly be driven by steepening of meridional temperature gradients, rather than by warm climates *per se*, as sea surface temperatures rise more rapidly in the tropics than at southern high latitudes. Subtropical drying may therefore be a transient response to warming that will dominate during this century but may reverse in the subsequent centuries as ‘slow’ climate feedbacks equilibrate with higher temperatures. Beyond the 21st century, subtropical latitudes may increasingly experience the wetter hydroclimates that characterised past warm climate states.

ID: 02126, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Quantitative Modeling of Human-Environment Interactions in Preindustrial Time

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Quantifying human-environment interactions and anthropogenic influences on the environment prior to the Industrial revolution is essential for understanding the current state of the earth system. This is particularly true for the terrestrial biosphere, but marine ecosystems and even climate were likely modified by human activities centuries to millennia ago. Direct observations are however very sparse in space and time, especially as one considers prehistory. Numerical models are therefore essential to produce a continuous picture of human-environment interactions in the past. Agent-based approaches, while widely applied to quantifying human influence on the environment in localized studies, are unsuitable for global spatial domains and Holocene timescales because of computational demands and large parameter uncertainty. Here we outline a new paradigm for the quantitative modeling of human-environment interactions in preindustrial time that is adapted to the global Holocene. Rather than attempting to simulate agency directly, the model is informed by a suite of characteristics describing those things about society that cannot be predicted on the basis of environment, e.g., diet, presence of agriculture, or range of animals exploited. These categorical data are combined with the properties of the physical environment in coupled human-environment model. The model is, at its core, a dynamic global vegetation model with a module for simulating crop growth that is adapted for preindustrial agriculture. This allows us to simulate yield and calories for feeding both humans and their domesticated animals. We couple this basic caloric availability with a simple demographic model to calculate potential population, and, constrained by labor requirements and land limitations, we create scenarios of land use and land cover on a moderate-resolution grid. We further implement a feedback loop where anthropogenic activities lead to changes in the properties of the physical environment, e.g., through soil erosion.

ID: 01481, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Oral)

Influence of Seaway Changes during the Pliocene on Tropical Pacific Climate in the Kiel Climate Model: Mean Sate, Annual Cycle, ENSO, and their Interactions

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The El Niño/Southern Oscillation (ENSO) is the leading mode of tropical Pacific interannual variability in the present-day climate. Available proxy evidence suggests that ENSO also existed during past climates, for example during the Pliocene extending from about 5.3 million to about 2.6 million years BP. Here we investigate the influences of the Panama Seaway closing and Indonesian Passages narrowing, and also of atmospheric carbon dioxide (CO_2) on the tropical Pacific mean climate and annual cycle, and their combined impact on ENSO during the Pliocene. To this end the Kiel Climate Model (KCM), a global climate model, is employed to study the influences of the changing geometry and CO_2-concentration. We find that ENSO is sensitive to the closing of the Panama Seaway, with ENSO amplitude being reduced by about 15% - 20%. The narrowing of the Indonesian Passages enhances ENSO strength but only by about 6%. ENSO period changes are modest and the spectral ENSO peak stays rather broad.

Annual cycle changes are more prominent. An intensification of the annual cycle by about 50% is simulated in response to the closing of the Panama Seaway, which is largely attributed to the strengthening of meridional wind stress. In comparison to the closing of the Panama Seaway, the narrowing of the Indonesian Passages only drives relatively weak changes in the annual cycle. A robust relationship is found such that ENSO amplitude strengthens when the annual cycle amplitude weakens.

Reference

Song, Z., Latif, M., Park, W., Krebs-Kanzow, U. and Schneider, B. (2016). Influence of seaway changes during the Pliocene on tropical Pacific climate in the Kiel Climate Model: mean state, annual cycle, ENSO, and their interactions. *Clim. Dyn.* doi: 10.1007/s00382-016-3298-x.

ID: 01431, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Oral)

Assessing the range of hydroclimate variability in data poor regions: insights from Australia

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In recent years Australia has experienced several high impact hydrological events (droughts and floods) that have been described as the most extreme on record. As the high-quality instrumental record extends only back to 1910, the climatological significance of such events may be difficult to evaluate given the degree of natural variability in Australian hydroclimates. In other regions, extensive palaeoclimate reconstructions have been used to infer the range hydroclimatic variability on longer timescales.

Australia's proxy record is sparse bother spatially and temporally, particularly for precipitation and provides limited insight into high impact, sub decadal-scale extremes. Models can provide as basis for investigating the range of unforced hydroclimatic variability and hence the 'extremeness' of recent wet and dry climatic events. Using CMIP5 models of the historical period and Last Millennium, this study aims to determine whether the instrumental record of Australian rainfall provides a valid basis for assessing the statistical significance of observed extremes. Can models provide enhanced insights into the range of variability in data poor regions?

ID: 02250, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Southern Ocean cold-water coral records of dissolved Ba over the last 20 ka: Implications for paleoproductivity and deglacial dynamics

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Ba is a biogeochemically-cycled element in seawater and its depth profile is related to the interplay between export productivity and deep ocean circulation. Here we investigate the Ba/Ca ratio in cold-water scleractinian corals as a proxy for the concentration of dissolved barium in seawater ($[Ba]_{sw}$), using solution-based single collector inductively coupled plasma mass spectrometry. We find that coral Ba/Ca is linearly related to $[Ba]_{sw}$. We use this relationship to reconstruct $[Ba]_{sw}$ in the Drake Passage over the last 20 thousand years (ka). We find that during the deglaciation, $[Ba]_{sw}$ gradients were substantially enhanced relative to the Holocene, suggesting that export productivity was increased. This productivity increase was likely linked to increased Southern Ocean ventilation and upwelling during Heinrich Stadial 1 (HS1) and the late Younger Dryas (YD), as a result of an increase in the overturning circulation. During the mid-late Antarctic Cold Reversal, a combined increase in shallow $[Ba]_{sw}$ and radiocarbon reservoir age and a collapse in coral growth suggest strong shallow ocean stratification. The Southern Ocean appears to have changed to modern-like conditions during the late YD, when the deep gradient in $[Ba]_{sw}$ was mixed away.

ID: 01908, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Oral)

What to expect when you're expecting decadal variability in hydroclimatic proxies

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Prolonged episodes of persistently dry or wet conditions are common features of most proxy-based reconstructions of past hydroclimatic variability. These so-called "Joseph" events might be due to external forcings that push sea-surface temperatures into warm or cold states, and thereby increase the likelihood of widespread megadroughts or megapluvials. Alternatively, internal ocean-atmosphere variability alone might be able to produce long-lasting and spatially extensive wet or dry intervals, even in the absence of any exotic external influences. In this study, we use a simple statistical emulator to establish benchmarks for decadal or multidecadal patterns in the western United States. We constructed a linear inverse model that included three key aspects of the El Niño-Southern Oscillation (monthly sea-surface temperatures, zonal surface wind stress, and sea-surface height), and restricted the spatial domain of each field to include only the tropical Pacific. By also including western United States hydroclimate information in the LIM, we are able to test whether ENSO variability and stochastic weather 'noise' could be sufficient to create low-frequency coherence within proxy networks. More broadly, if simulated drought patterns generated by the LIM are able to match the frequency, intensity, or spatial extent of droughts reconstructed by proxies, that implies that neither exotic forcings nor climate variability outside the tropical Pacific are required to produce widespread megadroughts in this region. If prolonged departures from the mean are indeed emergent but unremarkable features of western North America's hydroclimate, we might be able to estimate their future occurrence as a linear combination of changes in the mean state and the linear dynamics that have governed their behavior in the past.

ID: 01864, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Climate and human influences on the Holocene fire and vegetation history of western Tasmania, Australia

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On centennial to millennial timescales, fire regimes are driven by climate changes, vegetation composition and human activities, but disentangling the relative influences of these drivers is rarely straightforward at the regional scale. High-resolution fire and vegetation history information from the subalpine zone of northwest Tasmania provides an opportunity to examine potential climate and anthropogenic drivers of environmental change over the last 13 kyr. The data suggest that climate has been dominant driver of environmental change. The warmest interval of the Holocene 11.8-9.8 ka, as evidenced by independent paleoclimatic proxy, was a period of maximum fire, high vegetation heterogeneity and an increase in sclerophyll plants, *Leptospermum-Baeckea* and Proteaceae. In the mid-Holocene, high effective moisture allowed cool temperate rainforest taxa, dominated by *Nothofagus* tree species, to expand at 8.5-5.8 ka and fire activity to decrease. In the late Holocene, climate was more arid and variable than earlier times resulting in a large increase in fire activity at 4.8-3.2 ka. Sharply increasing abundances of sclerophyll taxa and declining rainforest and subalpine taxa were associated with peaks of high biomass burning. The present mosaic of sclerophyll, temperate rainforest, shrubland, moorland, and alpine communities was established between ca. 5.0-3.6 ka, but was also a feature of the early Holocene landscape. In contrast, the mid-Holocene vegetation was more homogeneous. The archeological evidence indicates people were present at the beginning of the Holocene and in late Holocene, but missing during the intervening wet period. We suggest that past changes in vegetation and fire activity were primarily driven by climate, but that changes in the vegetation mosaic may have influenced human occupation.

ID: 01938, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Temperature field reconstructions and method intercomparison over the past 2000 years

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There exist many spatial reconstructions of hemispheric or global temperature covering the past few centuries. Yet most of these reconstruction products are based on different proxy collections, reconstruction techniques, and methodological assumptions. We therefore lack a systematic and fair comparison of these diverse temperature reconstructions. Here, we use a range of climate field reconstruction (CFR) methods to derive global temperature histories over the last 2000 years using a common dataset of proxy records. This allows us to investigate the coherence between different products and assess the uncertainty arising from the choice of reconstruction method. Here, we consider a wide range of reconstruction techniques, from basic proxy composites, to widely used linear temperature--proxy covariance methods (Principal Component Regression, Canonical Correlation Analysis), to more recent techniques (GraphEM, Offline Data Assimilation, and an Analog Method). As common input data for the reconstructions, we use the annual proxies from the newly updated PAGES2k database. We find that many regions of the globe, particularly in the Southern Hemisphere, still suffer from relatively poor reconstruction quality due to sparse proxy coverage. Contrary to what could be expected, some of the areas most densely covered by proxy records in the PAGES2k database also display a reduced reconstruction skill. This is likely due to the large number of spatially clustered proxies that apparently introduce noise without providing an independent source of useful information. Thus, balancing the number and quality of proxy data remains a key challenge for statistical climate reconstructions. The agreement across reconstruction methods is highest on decadal, and lowest on centennial time-scales. The best agreement is found over western North America, the southwest North Pacific and parts of the North Atlantic.

ID: 02292, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Constraining El Nino Properties Throughout the Last Millennium Using Improved Forward Models

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The large internal variability in the ENSO system makes it extremely difficult to assess the degree to which anthropogenic and/or natural forcings have influenced the properties of El Nino/La Nina events. To extend the record, isotopic time series (coral $\delta^{18}O$) from coral reefs in the equatorial Pacific are often used, but these proxies are influenced by multiple processes during the ENSO cycle, making them hard to interpret quantitatively. The isotope-enabled Regional Ocean Modeling System (isoROMS) was developed in order to enable the direct simulation of the relationship between ENSO and isotopic variations local to individual proxy sites. isoROMS can provide characterization of the reef environment at an arbitrary location at any desired spatial resolution; here, new \'forward modeling\' relationships derived from 20th century isoROMS simulations are presented, which are used to infer ENSO properties based on $\delta^{18}O$ at various locations. The relative importance of temperature and the $\delta^{18}O$ of seawater varies dramatically with both space and time, as does the relationship between seawater $\delta^{18}O$ and salinity. Results from isoROMS are used to identify isotopic signatures of both extreme \'Eastern Pacific\' and more moderate \'Central Pacific\' El Nino events, and are validated based on monitoring data from a 2014-16 field campaign at two members of the Line Islands chain: Palmyra Atoll (5.9N, 162.1W) and Christmas Island (1.9N, 157.4W). Implications for our ability to quantitatively reconstruct both ENSO amplitude and the relative strength and importance of extreme El Nino events are discussed.

ID: 02176, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Integrating lake sediment paleoflood reconstructions in Norwegian flood frequency scenarios

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Floods are among the most severe natural hazards, causing devastation both in terms of human suffering and in terms of economic cost in all corners of the world. During the last couple of years, Norway has experienced two flooding events classified as floods with a 200-year recurrence interval. Based on this it is clear, at least in Norway, that there are challenges with estimates of recurrence intervals that are based solely on relatively short time periods with instrumental measurements.

Extending modern observations with lake sediment paleoflood reconstructions is one way to overcome this challenge, but combining data of different quality and resolution there are considerations to take. A priori to integration of paleodata in flood modelling tools there is a need to understand: 1) How to identify and quantify the footprint left by floods in lake sedimentary archives; 2) How to relate the sedimentary imprint of paleofloods to magnitude, or at best to actual discharge values; and 3) How to utilize statistical methods that are able to implement observations of paleofloods in a reliable way including how to relate this to modern observations as well as model output.

Here we aim to address these points, by exploring how high-resolution sedimentary quantitative techniques (e.g. XRF) combined with image analyses (CT-scanning) using state-of-the-art instrumentation at the newly established National Infrastructure in Norway, Earth Surface Sediment Laboratory (EARTHLAB), can be utilized to delineate the information that can be extracted from soft sediment records. Moreover we exemplify how to incorporate such data in a non-stationary flood frequency model within a Bayesian framework, with the goal of testing how the model can be used for flood frequency estimation under current and future climates.

ID: 01580, 06.- Before and after - climate contrasts across the MPT, (Oral)

Mid-Pleistocene monsoon transition from 23- to 100-kyr cycles

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The mid-Pleistocene transition (MPT) is widely recognized as a climate shift from 41- to 100-kyr cycles from marine-based proxies that largely reflect changes in ice volume, sea level, and ocean temperature. However, monsoon-induced vegetation variability across the mid-Pleistocene on the land remains poorly constrained. Here, we present a 1.7-million-year d^{13}C record of loess carbonates from the Chinese Loess Plateau, demonstrating a remarkable transition from dominant 23-kyr periodicity before 1.2 Ma to combined 100- and 23-kyr cycles afterwards. Model simulations show that astronomical, ice, and CO_2 forcing all can affect precipitation and temperature changes in the East Asian monsoon domain, and the MPT of the monsoon-vegetation variability was induced by competing effects between precession and coupled ice/CO_2 forcing. Our proxy-model comparison suggests that different sensitivity of the temperature and precipitation to astronomical and ice/CO_2 forcing can result in diverse MPT manifestations depending on proxies and regions.

ID: 01675, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

Sensitivity of the Greenland Ice Sheet to oceanic changes in the last 150 kyrs

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For many years the scientific community mainly focused on the sensitivity of the Greenland Ice Sheet (GrIS) to surface air temperature variations. However, several works have recently investigated the present-day and future influence of the ocean on the submarine melting of the GrIS outlet glaciers, motivated by the thinning and grounding-line retreat of their marine-terminating parts. It has been estimated that the mass loss triggered by this huge ice discharge contributed to a sea-level rise of 7.5 mm over the last two decades. However very little has been done in order to understand how the past GrIS has dynamically evolved under the influence of the oceanic forcing over the last few glacial cycles. Here we simulate the GrIS evolution over the last 150 kyrs driven by the surface air as well as ocean temperature changes, using a three-dimensional thermomechanical hybrid ice-sheet/ice-shelf model. Inland ice masses that flow through deformation are modelled by the Shallow Ice Approximation (SIA), while fast-flowing outlet glaciers and floating tongues are described by the Shallow Shelf Approximation (SSA). Ice-ocean interactions are considered by including a time-dependent parametrization of the marine basal melting rate.

Simulations of the last glacial cycles suggest that the GrIS is very sensitive to the ocean-triggered submarine melting, indicating that mild changes in the ocean temperatures may lead to significant variations in the distribution of Greenland ice mass. Our results definitely suggest that to properly simulate the past and the future evolution of the GrIS ice-sheet models should consider the ocean as an active forcing at the ice-ocean interface.

ID: 02087, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Oral)

Understanding δ18O Variability in Monsoon Regions Using an Earth System Model

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Long-term $\delta^{18}O$ records show large variability in monsoon regions during the Quaternary. Determining what these $\delta^{18}O$ signals represent remains difficult given the influences from many different climate forcings. We can use model simulations to get a quantitative understanding of the mechanisms responsible for monsoonal variability and how this variability translates into $\delta^{18}O$. Here, we use the Community Earth System Model (CESM) with water isotopologue tracking functions to explore the climate responses to end-member forcings of orbit, CO2, and land ice from the Quaternary. With equilibrium snapshot simulations, we are able to compare the contributions to changes in $\delta^{18}O$ of monsoon regions from different forcings and determine how these $\delta^{18}O$ changes reflect variations in temperature, precipitation, and atmospheric circulation.

While seasonal insolation changes often have the strongest control on monsoon intensity, our model results suggest that $\delta^{18}O$ shifts rarely reflect just local climatological changes in temperature or precipitation. Instead, circulation changes tend to contribute significantly to $\delta^{18}O$ variability in the monsoon regions. The relationships between $\delta^{18}O$ and local temperature or precipitation in monsoon regions are further complicated by the forcing dependency of the responses, which can be different in sign. When combined, the various different relationships between forcing and response make simple correlations rarely viable. Our results highlight both the need for careful consideration of the various influences when trying to interpret long-term $\delta^{18}O$ records and the potential for $\delta^{18}O$ from monsoonal regions to act as paleo-circulation proxies.

ID: 01984, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Invited Oral)

The large-scale evolution of neodymium isotopic composition in the global modern and Holocene ocean revealed from seawater and archive data

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Neodymium isotopic compositions ($^{143}Nd/^{144}Nd$ or ε_{Nd}) have been used as a tracer of water masses and lithogenic inputs to the ocean. To further evaluate the faithfulness of this tracer, we have updated a global seawater ε_{Nd} database and combined it with hydrography parameters (temperature, salinity, nutrients and oxygen concentrations), carbon isotopic ratio and radiocarbon of dissolved inorganic carbon. Archive ε_{Nd} data are compiled for leachates, foraminiferal tests, deep-sea corals and fish teeth/debris from the Holocene period.

At water depths ≥ 1500m, property-property plots show clear correlations between seawater ε_{Nd} and the other variables, suggesting that large-scale water mass mixing is a primary control of deepwater ε_{Nd} distribution. At ≥ 200m, basin-scale seawater T-S-ε_{Nd} diagrams demonstrate the isotopic evolution of different water masses. Seawater and archive ε_{Nd} values are compared using property-property plots and T-S-ε_{Nd} diagrams. Archive values generally agree with corresponding seawater values although they tend to be at the upper limit in the Pacific. Both positive and negative offsets exist in the northern North Atlantic. Applying multiple regression analysis to deep (≥ 1500m) seawater data, we established empirical equations that predict the main, large-scale, deepwater ε_{Nd} trends from hydrography parameters. Large offsets from the predicted values are interpreted as a sign of significant local/regional influence. Dominant continental influence on seawater and archive ε_{Nd} is observed mainly within 1,000 km from the continents. Generally, seawater and archive ε_{Nd} values form gradual latitudinal trend in the Atlantic and Pacific at depths ≥ 600m, consistent with the idea that Nd isotopes help distinguish between northern/southern sourced water contributions at intermediate and deep water depths.

Participants : T. Arsouze, G. Bayon, A. Bory, C. Colin, J.-C. Dutay, N. Frank, X. Giraud, A. T Gourlan, C. Jeandel, F. Lacan, L. Meynadier, P. Montagna, A. M. Piotrowski, Y. Plancherel, E. Pucéat, M. Roy-Barman, C. Waelbroeck

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ID: 02345, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Quantifying abrupt changes of bottom water oxygenation in the northeastern Pacific Ocean using new benthic foraminiferal tools.

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Over the past thousands of years, rapid global climate changes (e.g. Dansgaard-Oeschger events) led to strong fluctuations in the intensity and spatial expansion of oxygen minimum zones (OMZs). Benthic foraminifera are sensitive tracers of oxygen conditions at the bottom of the water column in such oxygen-depleted environments. We successfully developed three independent benthic-foraminiferal based methods to estimate short-time scale changes of bottom water oxygen concentration off the Northeast Pacific margin during the late Quaternary.

A micropaleontological method, based on the relative abundance of several foraminiferal assemblages (characteristic of dysoxic, suboxic, or oxic conditions), is used to provide an accurate past dissolved oxygen reconstruction. We combined this approach to two new morphometrical methods: (i) an automated pore morphometric analysis was performed with an optical microscope on benthic species *Bolivina seminuda*, as, for this species, test porosity is likely to respond to water oxygen content; (ii) a further approach relies on semi-automatically computed morphometric analysis of taxon-free complete assemblages for each sample.

These three independent approaches provide similar oxygen estimates that mirror the NGRIP $\delta^{18}O$ record, further evidencing already reported global climate connections between the Northeast Pacific and high latitudes of the Northern Hemisphere. Over the last 80 kyr, every warm interstadials (corresponding to Dansgaard-Oeschger events) is represented in our oxygenation signals and exhibit conditions almost depleted in oxygen (~ 0.05 $ml.L^{-1}$) while cold stadials show higher values (~ 0.5 $ml.L^{-1}$) reaching ~ 1 $ml.L^{-1}$ during stadials associated with Heinrich events.

ID: 01844, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Antarctic snow accumulation over the past 2000 years

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Here we examine regional Antarctic snow accumulation variability over the past 2000 years. Seventy nine ice core records, collected as part of the PAGES Antarctica 2k working group, are divided into geographical regions that separate high accumulation coastal regions from lower accumulation continental sites. The spatial representativeness of each regional composite is evaluated against reanalysis derived precipitation and surface mass balance from the Regional Atmospheric Climate Model (RACMO2.3). We review the dominant drivers of regional snow accumulation variability and explore how these influence the observed trends. The past 200 years has seen an increase in snow accumulation in all regions, however the late 20th century trends differ in both sign and magnitude. The most dramatic change is observed in the Antarctic Peninsula, where snow accumulation has increased dramatically in recent decades, with recent trends considered exceptional in the context of the past 2000 years.

ID: 02177, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

A shift to a modern weaker state of Labrador Sea convection and AMOC at the onset of Industrial Era

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Several proxy and modelling studies suggest that there may have been considerable change in the operation of the Atlantic Meridional Overturning Circulation (AMOC) during the last two millennia. Yet despite its importance for regional and global climate, the recent history of the AMOC is poorly constrained and comprehensive observational records only extend back a few decades at most. Observational data suggest that the export of large volumes of sea-ice and freshwater from the Arctic during the Great Salinity Anomaly of the late 1960s to early 1970s impacted North Atlantic circulation, and perhaps the strength of the AMOC, thus raising the possibility that more extreme events may have affected the AMOC during the pre-instrumental era.

We present a suite of AMOC related proxies from high resolution marine sediment cores from the North Atlantic, spanning the last ~2000 years, including proxies for both deep ocean circulation and surface ocean climate. Our results suggest that there was an exceptional shift to a weaker mode of Labrador Sea Water (LSW) formation during the late 19th century, which persisted up to the present day, notwithstanding strong decadal-scale LSW production events such as during the 1990s. Using a compilation of sites that allow the sea-surface temperature fingerprint of AMOC change to be identified, we show that the shift to weaker LSW formation was accompanied by a weakening of the combined AMOC. Based on their timing, we infer that the weakening of LSW and AMOC may have been caused by the export of sea-ice and freshwater from the Arctic during the termination of the Little Ice Age. These results have significant implications for the sensitivity of the AMOC to climate forcing, and the cause of late Holocene climate events.

ID: 01399, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Oral)

Reassessing Pliocene temperature gradients

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With CO2 levels similar to present, the Pliocene Warm Period (PWP) is one of our most salient analogs to climate change in the near future. Paleoclimate data from this time period describe dramatically reduced zonal and meridional temperature gradients, implying large changes in ocean heat transport and/or atmospheric circulation. Such conditions have proved difficult to reproduce with climate model simulations.Recently, debate has emerged regarding the interpretation of the proxies used to infer Pliocene temperature gradients; these interpretations affect the magnitude of inferred change and the degree of inconsistency with existing climate model simulations of the PWP. Here, I revisit the issue using Bayesian proxy forward modeling and prediction that propagates known uncertainties in the Mg/Ca-d18O, UK37, and TEX86 proxy systems. These new spatiotemporal predictions are quantitatively compared to PWP simulations to assess agreement probabilistically and determine whether the Pliocene climate state requires the existence of exotic physical mechanisms.

ID: 01808, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

Sensitivity of simulated 19th century climate to volcanic forcing uncertainties

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The early 19th century was the coldest period of the past 500 years and therefore of special interest in the study of inter-decadal climate variability. It encompasses a cluster of strong volcanic eruptions, which included the 1809 eruption of unknown location, the 1815 eruption of Tambora and the 1835 Cosigüina eruption. It is, however, still unclear whether the episodic extreme cold temperature anomalies reconstructed around these volcanic eruptions can be solely attributed to volcanic forcing, or, more generally, to what extent volcanic forcing has shaped decadal-scale variability in the early 19th century. The early 19th century is a period of focus in the CMIP6 activities VolMIP and PMIP where dedicated experiments are carried out to address uncertainties related to volcanic forcing. These experiments use the same volcanic forcing input dataset based on state-of-the-art estimates from ice cores. Yet, the reconstruction process currently brings large uncertainties in the volcanic forcing itself, particularly related to the magnitude of the stratospheric sulfur load. In this study we have tested the sensitivity of the climate response simulated by the MPI Earth system model to a range of volcanic forcings for the early 19th century constructed using estimated uncertainties in volcanic stratospheric injections and the Easy Volcanic Aerosol (EVA) forcing generator Ensemble simulations have been performed and compared to climate reconstructions for the time period considered. In this contribution, we will present and discuss first results with respect to surface temperature and precipitation.

ID: 01814, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

eVolv2k: A new reconstruction of major volcanic stratospheric sulfur injections and associated aerosol optical depth perturbations, 500 BCE-1900 CE

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The injection of sulfur into the stratosphere by explosive volcanic eruptions is the cause of significant climate variability. Based on sulfate records from a suite of ice cores from Greenland and Antarctica, the eVolv2k database includes estimates of the magnitudes and approximate source latitudes of major volcanic stratospheric sulfur injection (SSI) events, updating prior estimates from 501 CE and extending estimates back to 500 BCE. The SSI estimates incorporate improvements to the ice core records, in terms of synchronization and dating, and refinements to the methods used to estimate SSI from ice core records. SSI estimates for many of the largest eruptions, including Samalas (1257), Tambora (1815) and Laki (1783) are within 10% of prior estimates. The long-term average annual SSI between 501-1900 is, however, 68% greater than prior estimates, due to the identification of more events and an increase in the magnitude of many intermediate events. A number of strong events are included in eVolv2k which appear to be missing or largely underestimated in earlier SSI reconstructions, including the 540, 682 and 574 unknown eruptions. A long-term, latitudinally and monthly resolved aerosol optical depth (AOD) time series is reconstructed from the eVolv2k SSI estimates, and found to be similar to a prior reconstruction in terms of the estimated magnitude of the largest eruptions. The long-term average global mean AOD estimated from the eVolv2k SSI estimates is 37% greater than prior estimates, due to the identification of new events and the inclusion of a non-zero background AOD based on recent observations. The evolv2k volcanic forcing dataset has been provided for use in the Paleo-Modeling Intercomparison Project (PMIP), and VolMIP experiments within CMIP6. Here, we describe the construction of the eVolv2k data set, compare with prior forcing sets, and show initial simulation results.

ID: 01880, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Oral)

A meridional shift of the tropical rain belt across the Red Sea during MIS5e

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The Red Sea is an elongated, semi enclosed oligotrophic water body surrounded by hyper-arid deserts. As such, it receives negligible direct input of water and fluvial material from its margins, while being exposed to significant dust fluxes originating from the nearby Sahara-Arabian desert belt.

We present new results describing the history of the Red Sea since the last interglacial from a series of downcore records spanning >2000 km between the Gulf of Aden in the south and the Gulf of Aqaba in the north. In each core we report major and trace element concentrations of the bulk and terrigenous fractions, together with the organic carbon content and $d^{13}C$, and the detrital εNd composition.

The results show that the two recent glacial cycles (Marine Isotopes Stages (MIS) 6 and 2) are characterized by εNd values associated with Sahara dust (~-10), while Mg/Ca ratios suggest that significant fractions of Arabian dust are delivered during late MIS2.

By contrast, MIS5e sediments are characterized by an abrupt, basin wide shift of εNd values towards the local Arabian Nubian Shield end member (~ -2) surrounding the Red Sea. This shift stems from intense fluvial events whose impact reached as far north as the north Red Sea. These are coeval with the appearance of cave deposits across the Arabian Peninsula, development of wetlands in East Sahara, and an abrupt fluvial event in the Dead Sea, all pointing to an extensive northward shift of precipitation from the tropics during MIS5e, most likely driven by the African monsoon or tropical plumes. Although general circulation models indicate corresponding northward migration of the African monsoon during MIS5e, the evidence suggests that they considerably under-estimate the intensity and possibly spatial extent of precipitation in the northern Red Sea. We find little evidence supporting similar climate system migration patterns during the Holocene.

ID: 02358, 18.- Human Impact on Global Aquatic Systems, (Oral)

An Integrated Habitat and Land Cover Change Approach for the Lake Victoria Watershed in Eastern Africa

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Assessing the status and monitoring the trends of land cover dynamics in watersheds of aquatic ecosystems and protected areas is of utmost importance for the integrated watershed management and decision making. The information on land cover dynamics is required to support the Convention on Biological Diversity (CBD)'s Strategic Action Plan including the Aichi Biodiversity Targets. These efforts are necessary to set a framework to reach the agreed national, regional or global targets. The integration of land use/cover change (LULCC) data with information on habitats and population dynamics provides the means to assess potential degradation and disturbance resulting from anthropogenic activities such as agriculture, urban area expansion and industrialization. This study assesses the LULCC over a 115 year (1900–2015) period using Landsat imagery and vegetation maps. Habitat data gathered from the Digital Observatory for Protected Areas (DOPA)'s eHabitat+Web service were used to perform ecological stratification of the study area and to develop similarity maps of the potential presence of comparable habitat types outside the wetlands in the Lake Victoria watershed. Integration of the habitat similarity maps with the LULCC data was applied in order to evaluate potential pressures on the different habitats within the watershed and on the linking corridors between the different wetlands and other protected areas in the context of wildlife movement and migration. The results show that the Lake Victoria watershed has suffered from relevant human activities during the last 100 years. The natural vegetation area has continuously declined as a result of the anthropogenic impact which has been strong.

ID: 02366, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

The nature and causes of 'megadroughts' in south-eastern Australia: evidence from the Holocene sediments of West Basin, Victoria

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Documenting and understanding centennial scale hydroclimatic variability in Australia is significant both to global climate science and to regional efforts to predict and manage water resources. In particular, multidecadal to centennial periods of low rainfall – 'megadroughts' – have been observed in semi-arid climates worldwide, however they are poorly constrained in Australia. Here, we present a sub-decadally resolved record of hydrological change at West Basin, Victoria, which spans the last 10,000 years. Using a variety of evidence, including µXRF inferred mineralogy, high resolution image analysis, diatom species analysis and the isotope geochemistry of carbonates, organic matter and aquatic cellulose, we document both sub-centennial and millennial scale variability in lake water depth and salinity, reflecting regional scale changes in precipitation/evaporation. We focus on two periods: (a) the transition toward more arid conditions during the mid-late Holocene, linked to the intensification of the El Nino Southern Oscillation (ENSO); and (b) decadal scale hydroclimate variability and the occurrence of megadroughts during the last 1000 years. These data will be discussed in the context of the causes of hydroclimate variability in south-eastern Australia, the implications for future management of water resources and considerations for future research in the region.

ID: 02008, 06.- Before and after - climate contrasts across the MPT, (Oral)

A simple rule to determine which insolation cycles lead to interglacials

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The pacing of glacial-interglacial cycles of the Quaternary (last 2.6 million years) is attributed to astronomically-driven changes in high-latitude insolation. An enduring puzzle, however, has been how astronomical forcing translates into the observed sequence of interglacials. Here we show that before ~1 million years ago, interglacials occurred when caloric summer insolation exceeded a simple threshold, about every 41,000 years. After 1 million years ago, insolation peaks were skipped more frequently and glacials became longer. We also find that the propensity for deglaciation increases with time elapsed since the previous interglacial onset. A statistical model combining these observations correctly predicts every complete deglaciation of the last million years and also indicates what alternative histories might have arisen. It accounts for the early dominance of obliquity cycles and the change in frequency of glacial-interglacial cycles during the Mid-Pleistocene Transition. The larger ice-sheets of the last million years should be viewed as a consequence of a rise in the deglaciation threshold and the skipping of obliquity cycles.

ID: 01435, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Looking for new territories. What Levantine Rock Art can bring to the climate question

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The Levantine rock art style is supposedly linked with the Early Holocene climatic transitional moment, being associated to the Geometric Mesolithic or Neolithic phases.

So, if we focus on the four main styles for Levantine human motifs) we can observe that only the so-called "pachypodes" appear dressed, which maybe points out that those people could live in a cold period. The themes are always the same: people appear marching. All of the painted figures are oriented to inland, to the Maestrazgo. This could be related to the quest for new territories, less arid than the Bajo Aragón, where there could be environmental constrains at the beginning of the 8.2 event.

Furthermore, these motifs seem to be the first painted on the shelters (occupying the central spaces), reaching large dimensions. Their bad conservation could have been caused by abrupt changes in temperature, maybe aggravated with cryoclastia effects in cold environments.

Some authors (M. Bader) suggest that the representation of paquipodes would designate the mobility of some people who depart from the Maestrazgo looking for Evaporitic chert in Bajo Aragón during Early Copper Age. This idea lies on the distribution of several contemporary sites around rock art shelters but also highlights that this kind of chert was needed to make leaf-shaped arrowheads. On the contrary, we demonstrate that the change on the use of non-local raw materials occurs much earlier, in the Geometric Mesolithic, growing strongly from the ancient Neolithic period, with the appearance of the double-bevelled microliths.

From these analyses we could point out to socio-ecological responses to climatic instability during a critical phase of human development. In this way, it can be possible to look for human responses to aridity and hydrological stress relating rock art sites (as those already mentioned) and dated archaeological levels on the studied area.

ID: 02050, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

The role of resolution in simulating past hydrological cycle

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The hydrological cycle has considerable spatial variability and is a major challenge to simulate with climate models. The majority of palaeoclimate simulations (in PMIP1, 2 and 3) used relatively coarse resolution models, using grids typically several 100 km wide. These models poorly represent the mean precipitation in hilly regions, near coastlines, and other areas of strong surface variations. Low resolution models also have difficulty representing extreme precipitation events and will have a tendency towards "drizzling" everywhere.

To investigate how resolution improves the simulation of mean and extreme precipitation events, we perform a unique set of 6 global simulations ranging from those typical of PMIP2 and PMIP3 (3.75^{o} x 2.5^{o}) to much higher resolution (maximum of 0.56^{o} x 0.38^{o}). The latter resolution is the resolution often used in regional models. All simulations are global and use the same basic model (Hadley Centre Atmosphere model, HadAM3) so that changes in the results can largely be attributed only to resolution. We focus on the classic PMIP time periods of the Last Glacial Maximum (LGM; 21 kyr BP) and the mid-Holocene (6 kyr BP).

The results show that increased resolution improves the simulation of modern precipitation patterns by better representing the detailed orographic and coastal processes, but that palaeo changes in large scale precipitation are relatively robust and insensitive to spatial scale. The exception to this is at the LGM, when the flow direction changes (causing a shift in rain shadows etc.) and when land area expands with the reduced sea level.

The effects of resolution on the changes in extreme events will also be discussed. Furthermore, we will present analyses of the simulations with respect to "the wet gets wetter" paradigm. Initial work suggests that this is not especially effective at explaining the modelled changes.

ID: 01623, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

Determinants of savanna ecosystem dynamics in the Kenya Rift Valley

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Savanna ecosystem dynamics are determined by multiple environmental drivers. Most important to savanna spatial distribution are fire regime, precipitation, and human impact. To help understand these complex fire-human-vegetation interactions we analysed a sediment record from Lake Bogoria, a hypersaline lake located in the Kenya Rift Valley at the base of the Marmanet-Laikipia Escarpment. Climate in the region is semi-arid, with an annual rainfall of 500-1000 mm. The region experiences high amplitude inter-annual precipitation changes. The vegetation is categorized as Somalia-Masai as described by White (1983), with *Tarchonanthus* woodland, *Acacia* wooded grassland, open *Dodonaea* woodland and upland dry coniferous forest. To ascertain the relative importance of the different drivers we compared the pollen record with independent climate reconstructions and the charcoal record. We analyzed sub-fossil pollen from a 3 m core from the southern basin, reconstructing the vegetation dynamics over the last 1300 years. The record shows a relatively open savanna vegetation with the relative percentages of Poaceae pollen between 40-60%. Two major vegetation changes have occurred, the first from 1180–1335 AD, the second from 1910-2014 AD. During these periods the record shows an expansion of Afromontane forest and to a lesser extent woodland, and lower percentages for Poaceae. Our analysis shows that these changes in vegetation are likely caused by changes in precipitation. Species that are indicative of disturbances, such as Asteraceae, and cultivated species such as *Pinus* suggest that human impact on the landscape played an important role in vegetation dynamics during the period 1910–2014 AD. Increasing human impact will likely continue to be an important driver of vegetation changes. Future trends in biomass burning in the region will depend on the regional precipitation regime and co-determined by land-use changes.

ID: 02091, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Oral)

Using sedaDNA alongside palaeoenvironmental proxies for understanding wetland archaeological sites

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Wetland sites, including settlements on lakeshores and artificial islands, often provide a wealth of well-preserved archaeological material, but are generally difficult and expensive to excavate conventionally. An alternative or complimentary approach can be the retrieval archaeological data from lake sediment cores, which can under certain conditions contain a continuous record of the archaeological site, the lake and its surrounding catchment.

We present early data from a study of three crannogs (artificial island settlement) and an Iron Age lakeshore village in Scotland where sedaDNA data is analysed from proximal sediment cores. The sedaDNA provides detailed information about the plants and mammals that lived, died, or were kept on the sites in different periods of site use. This information is compared with a range of palaeolimnological proxies that allow us to differentiate between (i) changes that happened regionally in the lake catchment (based on pollen, x-ray fluorescence scanning, stable carbon and nitrogen isotopes, n-alkanes), (ii) changes that happened in the lake ecosystem (based on loss-on-ignition, diatoms, biogenic silica, invertebrates, C/N ratios), and (iii) changes that occurred very locally at the sites (based on invertebrates, sterols, PAHs, and sedaDNA).

Our sedaDNA results complement data from both archaeological excavation and traditional palaeenvironmental proxies to provide a more detailed and robust assessment of the environment in which our ancestors were operating. We also show that different proxies in the same sediment core provide insights in past environments at different spatial scales.

ID: 01743, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Oral)

The Global Paleofire Working Group (GPWG2) & Global Charcoal Database (GCD)

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Understanding fire disturbance and its influences on the biosphere is key in light of the major environmental changes that are occurring on most continents. In the past decade, the GPWG analyzed fire history using the GCD and advanced our understanding of the controls and impacts of fire on a wide range of spatial and temporal scales. Climate variability had a strong, persistent influence on Late Quaternary trends in fire through its direct impacts on the number and timing of ignitions and fire weather, and through its indirect impacts on vegetation changes and productivity. The complexities of vegetation change and its influences on fire, especially at regional scales and on multi-decadal to centennial timescales, however, remain poorly understood, as do the varied roles of humans. The GPWG is therefore running a new phase – the GPWG$_2$ – to more deeply examine the linkages between fires, climate-driven fuel changes, traditional human land uses, modern landscape management, and biodiversity conservation.

The objectives of this communication is to disseminate on the GCD updates and the GPWG work:

- increased standardization in paleofire data collection and storage;
- paleofire data-model integration and links with other databases to support data-model integration and multiproxy comparisons;
- develop a modern Global Charcoal Database (mGCD), containing surface samples to improve calibration of fire history records;
- open source tools development to get easier access by international community and non-experts;
- connect modelers, practitioners and stakeholders with a community of "data producers" that could help to manage paleofire disturbance in the best way;
- geographic data development for Central Eastern Europe, Asia and Africa, which is critical for human livelihoods and the future sustainability of ecosystem services there.

Further details on the Global Charcoal Data Base, the organization of the working group, and future activities can be found on the website: www.paleofire.org

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ID: 01906, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Oral)

Reconstructing oxygen isotope heterogeneity of Laurentide Ice Sheet meltwater during Termination I

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Oxygen isotope values in continental ice sheets are controlled by Rayleigh fractionation during ice sheet evolution, yielding geochemically heterogeneous ice sheets. Modern continental ice sheets exhibit dynamic processes and highly variable melting, and the resulting meltwater is isotopically heterogeneous. As a result, the history of past meltwater oxygen isotope variability is potentially a powerful tool for exploring ice sheet behavior during glacial terminations. Here we investigate a record of Laurentide Ice Sheet (LIS) meltwater entering the Gulf of Mexico during Termination I (18–11 ka) and present a series of "snapshot" reconstructions of meltwater $\delta^{18}O$ values from discrete time slices. We employ a novel technique, pairing oxygen isotope and trace element analyses (Mg/Ca, Ba/Ca) of individual *Orbulina universa* planktonic foraminifera to reconstruct temperature, $\delta^{18}O_{seawater}$, and salinity for each specimen. For each core interval, we reconstruct $\delta^{18}O_{seawater}$-salinity relationships and instantaneous meltwater $\delta^{18}O$ values.

During the Bølling-Allerød (15.5–13 ka), our reconstructions of LIS meltwater $\delta^{18}O$ values range from -20‰ to -49‰ (VSMOW). This range suggests a dynamic melting history for the LIS, including contributions from both the low-elevation southern margin and high-elevation, high-latitude interior domes, alternating on decadal timescales. Prior to Bølling-Allerød warming, Mississippi River outflow $\delta^{18}O$ values were dominated by regional precipitation, and LIS meltwater did not significantly affect salinity variations in the Gulf of Mexico. After ~13 ka, our data show no evidence of Mississippi River outflow, which is likely due to the location of this Orca Basin sediment core. The interpretation that LIS meltwater had multiple distinct geographic sources is supported by independent records of continental runoff in the Gulf of Mexico. Our results suggest that high-resolution oceanic records of ice sheet meltwater can be directly linked to variable ice sheet behavior.

ID: 01935, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Provenance and dispersal of terrigenous sediments in the Bering Sea slope: Implications for late glacial land-ocean linkages

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Clay mineralogy and grain-size properties from two well-dated, high resolution sediment cores recovered from the western Alaskan continental are used to decipher millennial-scale changes in sediment provenance and sedimentary transport during the last 32 kyrs. During the last glacial maximum, the depositional environment was characterized by hemipelagic background sedimentation with overregional sediment sources. Maximum values of fluvial suspensions and kaolinite concentration occur during the late Heinrich event 1 (H1), which point to the sudden influx of clay-laden meltwaters from Northern Alaska. For the subsequent deglacial Bølling-Allerød (BA) interval, meltwater supply changed from glacial-fluvial to more fluvial, caused by warming that probably led to increased snow melt and permafrost thaw. The fresh-water lid might have eased local overturning ventilation in the Bering Sea water that promoted the deposition of laminated sediments. During Holocene sea-level rise the shore line moved far away from the site and reduced terrigenous sediment influx. Strong contour currents possibly led to the winnowing of sediments and caused residual sand enrichment.

ID: 01502, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Regional seesaw between North Atlantci and Nordic Seas during the last glacial abrupt climatic events

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The last glacial period has been punctuated by millennial abrupt climatic variations strongly imprinted in Greenland ice core records, where cold phases are associated with pan-North Atlantic ice-sheet collapses and iceberg delivery. These variations are thought to be linked to changes in the North Atlantic meridional overturning circulation, potentially in response to iceberg-derived freshwater injections in the North Atlantic. Indirect marine proxy records and sensitivity tests performed with atmospheric models have also suggested that the expansion of sea ice in the Nordic Seas during cold phases could be a key amplifier, explaining the large 5-16 °C magnitude of Greenland cooling. Here we provide direct and quantitative evidence of a regional paradoxical seesaw pattern: cold Greenland and North Atlantic phases coincide with warmer sea-surface conditions and shorter seasonal sea-ice cover durations in the Norwegian Sea as compared to warm phases. Our results are based on dinocyst analyses conducted in four sediment cores from the northern Northeast Atlantic and southern Norwegian Sea, for Marine Isotopic Stage 3 (48- 30 ka BP). Such regional seesaw is also simulated in freshwater hosing experiments from five state-of-the-art climate models. These simulations and reconstructions suggest that during cold Greenland and North Atlantic phases, reduced Atlantic overturning and cold North Atlantic sea-surface conditions were accompanied by the subsurface propagation of warm Atlantic waters that re-emerged at the entrance of the Nordic Seas, warming the topmost layer, limiting sea-ice extent, and providing high deuterium excess moisture towards Greenland summit. This mechanism potentially enhanced iceberg discharges from the bordering ice sheets. This new scheme of variability, with complex regional hydrological reorganizations, can be regarded as a new case study for ocean – cryosphere – atmosphere interactions.

ID: 01392, 16.- Multidisciplinary reconstruction of paleofloods, (Oral)

Reconstruction of magnitude and seasonality of pre instrumental floods based on documentary evidence

Oliver Wetter[1] 1) Oeschger Center for Climate Change Research 2) Economic Social and Environmental History * Oliver Wetter, oliver.wetter@hist.unibe.chFlood water levels and flooding areas of pre instrumental floods can be reconstructed by combining different documentary and instrumental sources , retaining relevant flood information. Preliminary results of reconstructed 700 to 800 year long flood series for several Swiss rivers will be presented and discussed. The inclusion of so called institutional sources (i.e. accounting books of cities) furthermore enables us to detect also "small" and "normal" pre instrumental flood events in terms of seasonality as well as in terms of river contribution or non contribution to single pre instrumental flood events.

ID: 02353, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Oral)

Human resilience and adaptation of early agricultural societies

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Concepts of resilience have been developed within the ecological sphere to examine how animal and plant species, communities and ecosystems respond to disturbance and recovery following a period of environmental perturbation. As a concept, resilience has also become an increasing preoccupation within social science, examining the adaptability of human populations and societies to change – whether internally or externally derived. The archaeological record offers the opportunity of linking social and ecological resilience to provide a long-term perspective of how communities adapt (or not) to change and the traits associated with such communities. Such long-term perspectives allow a more nuanced understanding of human-environment relationships and the adaptability and resilience of small-scale societies and communities.

These ideas will be examined with reference to the early Neolithic in Ireland and Britain, focusing on agricultural activities, the use of cultivated and wild plant foods, connections to the wider ecological landscape, settlement patterns and associations to the mortuary monuments and ceremonial enclosures that characterise much of the archaeological record of this period. What advantages did agricultural systems bring to small scale-societies? How did these deal with food risk and uncertainty and variable climatic conditions? What where the ecological impacts of these activities on the surrounding landscapes which people were dependent upon? These issues are examined drawing on archaeobotanical, archaeological, radiocarbon data, palaeoecological and palaeoclimatic data from the Neolithic to better understand how early agricultural societies achieved resilience and the lessons these offer our own world.

ID: 01763, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Postglacial vegetation-fire linkages in western Patagonia and western Tasmania as a response to large-scale climate controls

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The postglacial vegetation and fire history of Patagonia (41-50S) and western Tasmania (41-42S) is largely governed by variations in the broad-scale controls of regional climate, including shifts in the strength/position of the Southern Westerlies (SW) and ENSO variability. In contrast, pre-European human influences on vegetation in both regions were relative weak and localized. Pollen data from a network of sites along the eastern Andes suggest that forests developed as early as 16.5 ka north of lat 44S, whereas trees did not expand in regions south of that latitude until 7 ka. The time-transgressive pattern is attributed to a gradual southward shift in the SW as a result of deglaciation and increasing annual insolation. Present-day vegetation developed at all latitudes in Patagonia during the middle to late Holocene when the core of the SW reached its modern position (50S) (e.g., establishment of *Austrocedrus* north of lat 43S and eastward advance of lower treeline in the south). Asynchronous forest expansion between 5 and 3 ka is ascribed to latitudinal variations in seasonal precipitation caused by shifts in the SW strength and location. Decreased forest cover and high fire activity between 2.5

and 1.5 ka occurred during strengthened La Nina-like conditions and high solar irradiance. In western Tasmania, warming is evidenced after 19 ka by an initial spread of cold-tolerant woody shrubs and a subsequent expansion of early-successional rainforest taxa. Between 12.5 and 9.5 ka, decreased forest cover and increased grassland and buttongrass were associated with rising fire activity. The warmest interval, 11 and 9.5 ka, was a time of highest fire. After 9 ka, strengthened SW led to wetter conditions and rainforest expansion; rainforests were most extensive between 8.5-6.5 ka and sclerophyll taxa became abundant afterwards. Large fires after 4 ka are attributed to increased human activity and heightened interannual variability.

ID: 01411, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Oral)

Transient modelling of Pliocene climate variability over glacial-interglacial timescales

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The Pliocene was a period of relatively warm and stable climate and has been proposed as an analog for future climate warming. However, recent studies suggest that the Pliocene was characterized by substantial variability on orbital time scales. These orbitally-forced glacial-interglacial variations have to be quantified in order to properly interpret reconstructions of Pliocene environmental conditions.

In this study we perform transient simulations with the Earth system model of intermediate complexity CLIMBER-2 to estimate the orbitally induced variations in climate, ice sheets and atmospheric CO_2 from 4 to 3 million years ago. CLIMBER-2 is a comprehensive model and includes atmosphere, ocean, land surface, northern hemisphere ice sheets, interactive carbon cycle and aeolian dust cycle. The only prescribed external radiative forcing applied to the model is from changes in orbital configuration of the Earth. The model has been optimally tuned to reproduce climate, ice volume and CO_2 variability of the last 500 thousand years.

The results show glacial-interglacial global annual temperature variations of up to 1.5-2°C, Northern Hemisphere ice sheet volume variations equivalent to ~50 m of sea level change and CO_2 variations of up to ~50 ppm. The model results are in agreement with the reconstructed benthic $\delta^{18}O$ record.

ID: 01755, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

New evidence for persistent drying in the tropics linked to natural forcing

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Climate projections for the future indicate a regional contrast in tropical hydrologic trends between areas that are slated to dry and those that may become wet. While much of the tropical ocean under the Intertropical Convergence Zone (ITCZ) is projected to see an increase in rainfall, a wide area of Central America and surrounding oceans is expected to experience severe drying. Approximately half the world\'s population lives in the tropics, and future changes in the hydrological cycle will impact not just freshwater supplies but also energy production in areas dependent upon hydroelectric power. It is vital that we understand tropical forcing mechanisms and the eventual hydrological response in order to better assess projected future regional precipitation trends and variability. Paleoclimate proxies are a valuable source of information for this purpose as they provide long time series that pre-date and complement the present, often short instrumental observations. Here we present paleo-precipitation data from a speleothem located on the western side of the Caribbean (Mesoamerica), and new data from a speleothem from the eastern side of the Caribbean (Puerto Rico) that both reveal large multi-decadal declines in regional precipitation whose onset coincides with clusters of large volcanic eruptions during the 19th and 20th centuries. This reconstruction provides new independent evidence of robust long-lasting volcanic effects on climate and elucidates key aspects of the causal chain of physical processes determining the tropical climate response to global radiative forcing.

ID: 01598, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Pollen-inferred Mediterranean landscape change and human population dynamics since the advent of Neolithic farming

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The vegetation of the Mediterranean region is the product of a distinctive climate and natural environment that has been transformed by human activities over many millennia. The *"Changing the Face of the Mediterranean"* project is a Leverhulme-funded

Plymouth-UCL collaboration, which aims to reconstruct long-term trends in vegetation change and population dynamics across the Mediterranean since the advent of Neolithic farming in order to explore the impacts of human activity on landscape change. Data from 159 fossil pollen records and 1798 modern pollen surface samples have been harmonised and analysed to identify major land-cover types in terms of their taxa associations and in relation to human-induced landscape modification. Pollen count data have been summed into 200 year time windows on a common timescale from 11,000 BP to present. Cluster analysis and community classification of pollen percentage data have been used to identify both closed forest land-cover types (e.g. evergreen and deciduous oak woods) and open or scrub land-cover types (sclerophyllous scrub, parkland/heath, olive groves and grassland/arable). Understanding the complexity of these land-cover classes and their trajectories of change through time will allow the extent to which the Mediterranean is naturally perpetually changing or a human-modified landscape to be explored. Radiocarbon dated archaeological sites and survey data are being compared with synthesised pollen records to analyse long-term relationships between human demography and vegetation/land cover change.

ID: 01620, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Oral)

Medieval written sources of volcanic eruptions, A.D. 600-1100

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The early and high medieval epoch has seen some large volcanic eruptions like the 536/540/542-event, or the 934/938/940-Eldgjá-event.

Some researchers suggest a strong climatic forcing due to six or more volcanic eruptions between 750 and 950 as suggested by ice-core data. So far it is believed, that the climate forcing from a large eruption like the Eldgjá would have had direct and indirect consequences on the contemporaries and that it is only a question of looking very closely into the annals and chronicles to find such after effects. But a closer look into the historical sources shows that the medieval chroniclers didn’t only write about their observations.

Instead they composed texts for a mainly clerical audience which was expecting the Apocalypse in the way John mentioned it in the New Testament. So the writer often didn’t write about everything happened, but about the types of events that were useful for their narrative. In doing so, they even changed the chronological order of events to fit them into the pattern of John`s revelation.

On the other hand some sources do contain direct observations of volcanic activity. They concern mainly Mediterranean volcanoes like the Vesuvius and Etna in Italy or the Santorino in Greece. Some of these volcanoes were suspected for centuries of being entrances to the hell. After the famous eruption of the Hekla in 1104 the suspected entrance to hell first was transferred to the Icelandic volcanoes.

This paper aims to look at the medieval annals and chronicles to gather direct descriptions of volcanic activity, and to give new interpretations of the patterns and tropes used by medieval writers to give indirect information on natural events, especially on volcanic ones.

ID: 01780, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Oral)

A Critical Test of Neodymium Isotopes as a Paleocirculation Proxy in the Southwest Atlantic

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The application of neodymium isotopes as a paleo-ocean circulation tracer assumes that Nd isotope ratios (εNd) effectively fingerprint different water masses and approximate expected values from water mass mixing. The Southwest Atlantic, with the major water masses involved in the Atlantic Meridional Ocean Circulation (southward flowing North Atlantic Deep Water, northward flowing Antarctic Intermediate Water and Antarctic Bottom Water), is one of the best places on Earth to evaluate how well Nd isotope ratios act like a conservative water mass tracer in the modern ocean.

Seawater profiles and core-top sediments from 17 stations were sampled in the Southwest Atlantic in the South Atlantic Meridional GEOTRACES cruise (GA02 Leg 3; RRS James Cook 057) between Tierra del Fuego and the Equator. Along the cruise track, along with the possibility of “boundary exchange”, there are several additional potential sources that could add external Nd to seawater and disturb the “quasi-conservative” behavior of εNd. For example, it transects the continental shelf in the far south, the Rio Grande Rise, volcanic seamounts, and the major geological age boundaries of South America. It also crosses the major Southern Hemisphere wind zones, allowing us to test the impacts of eolian dust input, as well as inputs from major rivers.

Our results on seawater εNd show strikingly that the Southwest Atlantic transect confirms "quasi-conservative" behavior of εNd in intermediate and deep water. From the depth of AAIW to bottom, εNd values covary systematically with salinity and potential temperature and show systematic changes from southern to northern stations. To a first order, samples reflect mixtures of the main water masses. Shallow depths show local impacts from South American detritus but these are not transferred to intermediate and deep water.

ID: 01496, 03.- Regional and transregional climate variability over the last 2000 years, (Oral)

Late Holocene sea ice dynamics and potential forcing mechanisms off East Antarctica

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Antarctic sea ice exerts a strong control on Southern Hemisphere climate system. However, Antarctic sea-ice regional trends over the last 200 years, reconstructed from historical and instrumental data, cannot be unambiguously attributed to forced or natural climate variability. Therefore, high resolution investigations of past Antarctic sea-ice conditions over the last 2000 years are essential to better assess changes in ocean surface conditions and their natural climate forcing mechanisms. Here, we present a new well-dated sea-ice record from the Integrated Ocean Discovery Program (IODP) Site U1357B, retrieved on the continental shelf off Adélie Land, East Antarctica. Our work constitutes the first complete sub-decadal marine-based paleoclimate records covering the last 2,000 years. Diatom assemblages and diatom-specific lipid biomarkers allow to distinct four multi-centennial intervals with mean climatic conditions inversed to the known Northern Hemisphere phases but in agreement with air temperatures inferred from nearby ice cores indicating coherent regional past climate changes. We suggest that spring and autumn sea-ice conditions mainly responded to the long-term expression of ENSO and SAM, respectively. Centennial variations in sea-ice seasonality and regional polynya activity continuously roamed each period. We attribute centennial to multi-centennial sea-ice variations to changes in synoptic and regional atmospheric circulation as a response to external forcing and dominant climate modes of the SH. For example, we show that clusters of volcanic eruptions were congruent to warming events off East Antarctica over the past 2000 years while Total Solar Irradiance might have had a more direct and positive impact on sea-ice cover.

ID: 02038, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Invited Oral)

Correlation of the paleogeographic events of the Caspian Sea and Russian Plain during the last climatic macrocycle

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The problem of correlation between transgressive-regressive oscillations in the Caspian and glacial events on the Russian Plain is of great importance in Pleistocene paleogeography. At the present moment, there is no unequivocal opinion on the problem. According to the view of the present authors, many factors (neotectonic movements, sedimentation in the basin, the restructuring of the hydrographic network) have affected the transgressive-regressive rhythm of the Caspian Sea, chief of which is the global climate rhythm. This work presents the data obtained by the authors during the last years. They allow us to specify relationships and synchronization of events in the Caspian Sea and on the Russian Plain.

1). The event scheme of the Caspian Sea includes the two phases (Late Khazarian and Girkanian) of Khazarian transgression that developed during the MIS 5 epoch: stages. The each peak of warming of MIS 5 in the Lower Volga area led to an interval of soil formation. 2). OSL and ^{14}C dating confirm the development of the Atelian regression of the Caspian Sea during the epoch of MIS 4 glaciations on Russian Plain, and they fix its end during an epoch of interstadial warming MIS 3. 3) The first stage of the Khvalynian transgression took place during the second half of the interstadial warming of MIS 3. 4) The LGM in Eastern Europe was reflected in the development of a falling sea level in the Caspian Sea. 5). The epoch of degradation of the Late Valdai glacial stage (MIS 2) corresponded to the time of sea-level rise in the Caspian Sea and the accumulation of the thickness of Khvalynian chocolate clays. During the late Pleistocene epoch, the Manych threshold was breached three times resulting in overflow into the Pontian Basin.

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ID: 01584, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Oral)

Late Pleistocene-Holocene dynamics in the Caspian and Black seas: data synthesis and paradoxical interpretations

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Different multidisciplinary data within the framework of projects IGCP 521 and 610 are controversial in some aspects. For example, records indicate that the Black Sea level fluctuated in an oscillating manner (Balabanov, 2007; Yanko-Hombach, 2007; Yanko-Hombach et al., 2014), while some authors (Aksu et al., 2016) claim a large water discharge from the Black Sea into the Sea of Marmara via the Bosphorus Strait at the beginning of the Holocene. These interpretations cannot co-exist simultaneously (Esin and Esin, 2014; Kislov, 2016), yet such contradictions are paradoxical.According to geological data, there were large and irregular fluctuations of the Caspian Sea level (explained by the mathematic theory of Brownian motion (Kislov, 2016)), including the huge Khvalynian transgressions during which the Caspian Sea level rose so high that its water spilled into the Black Sea. Despite uncertainty about the source of the additional water that filled the Caspian basin, the overflow is clearly indicated by the presence of Caspian fauna in the form of mollusks (Yanina, 2012) and foraminifera (Yanko, 1990) in the Black Sea. The spectrum of fluctuations also comprises deep regressions of both the Caspian and Black sea levels corresponding to the Last Glacial Maximum (Kislov and Toropov, 2011).

Do these extremes in Caspian Sea conditions reflect bifurcation transitions? Recently-developed methods predict that as a system nears a tipping point, both the variance and autocorrelation should increase (Scheffer et al., 2009). Taking into consideration the Caspian Sea level and area changes, and accompanying river runoff changes, we evaluate that the above-mentioned statistical parameters describing sea-level fluctuations do not principally change. Therefore, even extreme transgressive/regressive stages were not signatures of a system's loss of stability.

ID: 01439, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Invited Oral)

Investigation of past nutrient and carbon cycles using benthic foraminiferal proxies

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Marine nutrient cycle is tightly linked to the carbon storage in the ocean with critical implications for past atmospheric CO_2 and climate changes. Benthic foraminiferal Cd/Ca and B/Ca have been respectively used as proxies for deep water phosphate and carbonate ion concentrations, but the two proxies haven't been employed jointly to investigate past oceanic nutrient and carbon cycles. Here, we first revisit the partition coefficient of Cd (D_{Cd}) into core-top benthic foraminfiera shells, taking account of the recent Cd-PO_4 data from GEOTRACES. We then apply the obtained empirical DCd to reconstruct deep water phosphate concentrations during the last ~25 ka at several locations in the Atlantic. Finally, we combine Cd/Ca-derived phosphate and B/Ca-derived carbonate ion to investigate air-sea exchange component carbon changes since the Last Glacial Maximum. Our data suggest that both poles, North Atlantic and Southern Ocean, have played important roles in controlling past atmospheric CO_2 variations.

ID: 02283, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Late Holocene Climate Changes Across the Antarctic Peninsula Induced by Atmosphere-Ocean-Ice Interactions

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Increasing number of Holocene paleo records from the Southern Hemisphere (SH) high and mid-latitude regions show major changes in regional climate, often interpreted as responding to shifts in the SH westerlies. In particular, emerging evidence suggests intensified westerlies about 2000-1000 years ago, possibly induced by positive shifts in the Southern Annular Mode (SAM). However, climate responses have been highly variable throughout the region, suggesting feedbacks from ice and ocean dynamics at regional scales. Here we review records from around the Antarctic Peninsula (AP) to discuss possible mechanisms. Our recently published peat-based record from the coastal area of the western AP at ~65°S shows a substantial warming at 2300-1200 cal BP. Such a large magnitude warming appears to be restricted to the western AP, suggesting a strong role of the wind-driven incursions of warm Circumpolar Deep Water onto the continental shelves and consequent warming effect from increased sea-surface temperature and reduced sea-ice extent. On the other hand, records from regions further east, including James Ross Island,

Elephant Island and South Georgia, seem to show climate cooling after 2000 cal BP. We speculate that the cooling was induced by the reduction in ocean deep convection, especially around the Weddell Sea -- through increasing ice melt, freshening of polar surface water and strong density gradient during positive SAM -- that would limit the heat transfer from warm deep water to the atmosphere. Furthermore, abundant ice pack along the Iceberg Alley would be transported further north to cool regions downstream from the Weddell Gyre. This suggests that documenting spatial pattern of regional climate changes will provide invaluable clues in understanding forcing mechanisms.

ID: 01348, 23.- Regional syntheses of human-climate-environment interactions, (Oral)

Abrupt ecological transition in China's aquatic systems during the last two centuries

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Dealing with grant challenges of Anthropocene needs rigorous understanding of linked social-ecological system, which are complex, adaptive system characterized by historical dependency, nonlinear dynamics and uncertainty. Examining regime shifts occurred in the past could offer rich opportunities to increase understanding of patterns and process of governing regime shift, and impact on ecosystem services and society. China's unprecedented environment degradation under social-economic transition provide a unique case to explore how ecological system changed in the Anthropocene, which could not only increase new understanding of ecosystem regime shift, but also generate valuable information for environment restoration and management, not only for China, but also for other developing countries facing similar challenges.

Here, we synthesis and examine paleoecological records across multiple trophic levels, in 20 different typical aquatic ecosystems in China that include shallow lakes, deep lake and coastal marine ecosystems. Comprehensive tests of nonlinear change across species, community and ecosystem types during the past 200 years were undertaken by employing multiple statistic approaches. Significant ecological nonlinear transition were identified at regional scale during 1960-1980s. However, close examination indicate that these ecological nonlinear change show different temporal and spatial patterns. We also find time-lag between different community shifts and ecosystem level shift. These spatial and temporal heterogeneities argue against a synchronous regime shift of ecological community from one well-defined regime to another. Accumulating drivers interact with each other reduce system resilience, and finally leading to critical transition. A combination of empirical, modeling, and theoretical approaches is required to better understand how ecological system shift are caused by social transition.

ID: 01794, 17.- Abrupt climate change: Challenges for Earth system understanding, (Oral)

Atmospheric CO2 controlled stability of glacial climate

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Millennial-scale Dansgaard-Oeschger (DO) events, as recorded in Greenland, are a ubiquitous characteristic of Late Pleistocene glacials. Changes in the stability of the Atlantic Meridional Overturning Circulation (AMOC) caused by both freshwater perturbations and changes in Northern Hemisphere ice sheet geometry have been identified as potentially important controls on abrupt glacial climate changes associated with these events. However, substantial problems remain in explaining the dynamics of transitions into and out of North Atlantic cold conditions. Here we show, using a fully coupled atmosphere-ocean model, that atmospheric CO_2 provides a critical control on AMOC stability through changes in the freshwater budget of the Atlantic basin associated with atmospheric moisture transport from the Atlantic to Pacific. Specifically, gradual CO_2 changes can trigger abrupt AMOC shifts within a regime of AMOC bi-stability while global climate is in an intermediate state (between full glacial and interglacial conditions). The CO_2 range of ~15 ppm required to trigger instability is of comparable magnitude to observations. Therefore, the integration of atmospheric CO_2 changes with other control factors can explain a broad spectrum of millennial-scale variability, including abrupt climate transitions. Furthermore, because millennial-scale CO_2 variability is thought to be driven by AMOC changes, our results indicate that CO_2 might represent an internal feedback agent by promoting spontaneous transitions between climate states.

ID: 01336, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Oral)

Impact of millennial-scale Atlantic meridional overturning circulation changes on tropical South American climate

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During the last glacial period, a succession of millennial-scale cold intervals was documented in Greenland ice cores, termed Heinrich stadials (HS) and Dansgaard-Oeschger (DO) stadials. Through substantial reductions in strength of the Atlantic Meridional Overturning Circulation (AMOC), these stadials affected tropical South American precipitation due to reorganizations of both the South American monsoon system and the Intertropical Convergence Zone (ITCZ). Detailed knowledge about changes of South American precipitation in response to such cold intervals may provide important insights into the reaction of Amazon biodiversity under future AMOC slowdown, e.g., about 20-40% over the 21st century. Here, we combined geochemical proxies in numerous paleorecords (e.g., new sediment cores from the western tropical Atlantic and previously published terrestrial hydroclimate records from tropical South America) and a set of sensitivity climate model experiments. We used the HS1 (18-15 ka ago) as a specific case to address: (i) the simulated reversal of the North Brazil Current (NBC); and (ii) the mechanism connecting a weakened AMOC and tropical South American climatic anomalies. Our results suggested that: (i) the NBC was very unlikely to have been reversed; and (ii) the eastern equatorial Pacific forcing was crucial to cause anomalous wet conditions over the Amazonian Andes. In addition, we also investigated the spatial patterns of South American precipitation across HS and DO stadials. We found decreased precipitation over northernmost South America and increased precipitation over the Andes during stadials. In contrast, northeastern Brazilian precipitation exhibited significant increases during HS, but small changes during DO stadials. Regarding moderate AMOC slowdown associated with DO stadials relative to HS, we propose that the ITCZ mean position during DO stadials did not shift as far south as during HS.

ID: 01824, 15.- The Holocene - its climate variability and rapid transitions, (Oral)

Millennial shifts in Saharan dust supply across the decline of the African Humid Period

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The Sahara is the world\'s largest and dominant dust source with significant impacts on trans-Atlantic terrestrial and large-scale marine ecosystems. Controversial views about a gradual or abrupt onset of Saharan aridity at the end of the African Humid Period dominates the current scientific debate about the Holocene Saharan desiccation. In this study we present a 19.63 m core sequence from Lake Sidi Ali (Middle Atlas) at the North African desert margin. With a multi-proxy approach based on core-scanning and quantitative XRF and stable isotopes of ostracod shells, we reconstruct the interaction between Saharan dust supply and Western Mediterranean hydro-climatic variability during the last 12,000 yr. A robust chronological model based on AMS 14C dated pollen concentrates supports our high-resolution multi-proxy study. At orbital-scale there is an overall increase in southern dust from the Early Holocene to the Late Holocene. However, our Northern Saharan dust record indicates that the Saharan desiccation does not reveal a gradual pattern but is characterized by multiple dust advances before the \'southern dust mode\' was finally established at 4.7 cal ka BP. Here, the Sidi Ali record features millennial-scale peaks in Saharan dust supply at 10.1, 8.2, 7.3, 6.6, 5.0, 4.7, 4.2, 3.6, 3.1, 2.4 and 1.4 cal ka BP. Early Holocene Saharan dust supplies coincide with Western Mediterranean winter rain minima and North Atlantic cooling events. In contrast, Late Holocene dust supplies correspond mostly with positive stages of the North Atlantic Oscillation. Intriguingly, the catastrophic 4.2 ka drying event that is well-known from East African and Indian monsoon domains is also detectable in our Northen Saharan dust record although the Western Mediterranean climate was humid at that time.

ID: 02236, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Oral)

Sedimentary ancient DNA offers new insights into the vegetation history of western Beringia since the Eemian

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Past climatic changes led to the migration of plant species and even whole plant communities, e.g. the replacement of arctic tundra by boreal taiga and vice versa. Sedimentary ancient DNA from natural archives is a valuable proxy to track such changes. Bol'shoy Lyakhovsky is an island within the Laptev Sea but it was part of Western Beringia during the last glacial due to the marine regression. There deposits can be found dating back to the Eemian (Krest Yuryakh Suite, ~125 kyr BP). Paleobotanical records based on macrofossils and pollen are available, but limited in their temporal resolution. Since sedimentary ancient DNA has proven to reveal complementary information not captured by traditional paleobotanical proxies, our aim was to provide a paleobotanical record in high resolution spanning from the Eemian to the present. We collected four terrestrial permafrost sediment cores from dated coastal localities and applied a DNA metabarcoding approach using the universal plant barcode of the *trnL* P6 loop. In total we recovered 325 taxa of which 244 (75%) were identified to species or genus level. The dataset is dominated by Saliceae, Anthemidae and Agrostidinae. In twelve samples from three different cores we detected sequences of *Larix*, which has not been detected before by macrofossil analyses and only sporadically by pollen analyses of coastal outcrops at the island. This suggests that the northern extent of the Siberian treeline was further north than previously assumed, and that *Larix* was indeed present at Bol'shoy Lyakhovsky Island.

ID: 01601, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Oral)

Position and strength of the Southern Hemispheric Westerlies – a multiproxy reconstruction from southern Patagonia (Laguna Azul, Argentina)

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Temperature, precipitation and wind intensity of South America respond to the air-pressure gradient between polar and subtropical latitudes as well as to sea-surface temperatures of adjacent oceans, the extent of sea-ice and continental ice masses and to the pathway of the Southern Hemispheric Westerlies (SHW). The resulting variations of the regional hydrological balance are recorded in sediments of closed lakes, like e.g. Laguna Azul.

Multiproxy investigations of Holocene sediments from Laguna Azul at 52°S in Argentinean Patagonia document a superior climatic control. Position and strength of SHW control the semiarid conditions in southeastern Patagonia and overprint the ontogeny of this lacustrine system. SHW influence local evaporation, precipitation and insolation with impacts on the type of water-column stratification and lake-level fluctuations. Both lead to internal feedbacks on wave erosion along the lakeshore, algal communities and trophic conditions as well as authigenic mineral formation.

Based on multiproxy analyses (sedimentology, geochemistry, stable isotopes, pollen, diatoms), we present a detailed radiocarbon-dated environmental reconstruction documenting a millennial-scale hydrological variability for the Holocene. According to this multiproxy dataset, lake internal and external processes characterize hydrological fluctuations. These include influences of the shrinking and expanding littoral zone as well as changes in lacustrine productivity, salinity and patterns of water circulation. Driest conditions of the record correspond to high wind speeds and a low lake level related to higher salinity that caused an ectogenic meromixis in the lake's water body. Together with anoxic conditions in the hypolimnion, methanogenesis and high salinity were recognized for the early Holocene between 10,300 and 8,500 cal. BP. We relate this period to highest SHW intensities occurring at the latitude of Laguna Azul (52°S). Only during the past two centuries human impact obscured the climatic signal, as evidenced by eutrophication, increased precipitation of authigenic calcite and spreading of neophytic species like *Rumex*.

ID: 02025, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Oral)

Indian monsoon variations during three contrasting climatic periods: the Holocene, Heinrich Stadial 2 and the last interglacial-glacial transition

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Pollen analysis from two marine cores (NGHP-01-16A and NGHP-01-19B2) collected off shore of Godavari and Mahanadi basins, both located in the Core Monsoon Zone, reveal changes in Indian summer monsoon variability and intensity during three contrasting climatic periods: the Holocene, the Heinrich Stadial (HS) 2 and the Marine Isotopic Stage (MIS) 5/4 during the ice sheet growth transition. The Holocene record reveals two long climate trends on which rapid shifts of Indian monsoon are superimposed. During the first part of the Holocene between 11,300 and 4,200 cal years BP, the extension of moist ecological communities reflects high monsoon rainfall which contrasts with the second phase of the Holocene, from 4,200 cal years BP to the present, marked by the development of drier vegetation. The historical period in India is characterized by an alternation of strong and weak monsoon centennial phases synchronous with the Medieval Climate Anomaly and the Little Ice Age, respectively. During the HS 2, vegetation was dominated by grassland and dry vegetation indicating a pronounced aridity as the result of a weak Indian summer monsoon whereas the MIS 5/4 glaciation was characterized by a weaker reduction of the Indian summer monsoon and a decrease of seasonal contrast as recorded by the expansion of dry vegetation and the development of *Artemisia*, respectively. Our results support model predictions suggesting that insolation changes control Indian monsoon long trend variability, but not its intensity, distribution or rapid climate variations. The long and short-term Indian monsoon intensity is modulated by atmospheric teleconnections involving several feedback mechanisms such as snow cover in the Himalaya, iceberg discharges in the North Atlantic Ocean, and SSTgradient in the Indian Ocean and at inter-hemispheric scale.

ID: 02230, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Oral)

Influence of CO2, the Antarctic Ice Sheet and Asian Topography on the Asian Monsoon and Regional Moisture Availability

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Asia is the most densely populated continent on Earth and has a varied climate with environmental conditions in East and South Asia dominated by the monsoons, whilst central Asia is characterized as arid. Studies examining the onset of aridity and the intensification of the monsoons controlling Asian climate have generated significant debate. Researchers have identified the major drivers of Asian aridity being the Himalayan and Tibetan Plateau uplift, the retreat of the Paratethys Sea, and the global cooling after the Eocene/Oligocene transition. Here, using results derived from 7 climate simulations of a fully coupled ocean-atmosphere climate model (HadCM3L), we investigate the effect of Antarctic ice-sheet formation, CO_2 decline and Himalayan elevation changes on the moisture supply in inland Asia and on the Asian monsoon circulation. Overall simulated precipitation changes in Central Asia are modest, with the most pronounced response being confined in the regions associated with the South Asian Monsoon and East Asian Monsoon. However, changes in Himalayan elevation alter the flow of the westerlies, which are considered to be the main moisture source for inland Asia. With no Antarctic ice Sheet the westerlies are strengthened and displaced northward. Decreasing atmospheric CO_2 concentration displaces the position of the Intertropical Convergence Zone to the south. Overall, these result indicate a complex interplay of forcings and climate responses driving regional changes in hydrology over the last 33 million years.

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POSTER PRESENTATIONS

(by alphabetical order of first author surname)

ID: 02015, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Modern pollen, diatom, and chironomid assemblages as quantitative indicators for the reconstruction of past environmental conditions in the south-central Chile

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Quantitative reconstructions from biological proxies have revolutionized paleolimnology and paleoclimatology to allow us understand and compare different trends, magnitudes and timing during the Quaternary. Pollen, diatom, and chironomid assemblages were studied in the surface sediments of 62 small lakes and swamps along an altitudinal gradient from sea level to 1800 m in south-central Chile (37-42°S). In addition, 27 environmental variables relating to the physical limnology, geography, climate, and water chemistry were recorded for each site. The explanatory power of each variable for the different biological data-sets was estimated by canonical correspondence analyses (CCA). A minimal set of environmental variables was found preliminary for each biological data-set by a forward-selection procedure within CCA. As the first step, inference models for austral winter air temperature (July) were developed for modern pollen data-set using weighted-averaging partial least squares. This model was applied to the 26,000 yr BP time window addressed by the high resolution Lago Espejo pollen record (39°S, 400 m asl). The winter temperature reconstruction suggests 3-4°C during the LGM until 18,000 yr BP, when winter temperatures increase abruptly to10.5°C at 14,000 yr BP. Pleistocene–Holocene transition (12,500–11,500 yr BP) is marked by warm winter temperatures up to 11°C and high fire activity under warm conditions. Although, YDC is observed as the decrease of winter temperature on 1°C between 13,000 to 11,500 yr BP. Early and mid-Holocene had winter temperatures between 10 to 8°C, until 3000 yr BP when winter temperatures drops to 5°C, close to the modern values. These results will be contrasted to different biological data-sets to integrate the paleolimnological and paleoclimatological reconstructions in south-central Chile, and their relationship with regional, inter-hemispheric, and global climate trends.

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ID: 01874, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

The Pacific Centennial Oscillation

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El Niño Southern Oscilation (ENSO) is the principal mode of interannual variability on global climate, and has been related with profound impacts beyond the weather, as the collapse of fisheries and forest fires. Understanding the low frequency variability of ENSO beyond interannual timescales is a major goal, and large efforts has been dedicated to reconstruct the ENSO low frequency variability during the Holocene. Some authors have reported a centennial ENSO mode of variability from documentary archives and tree rings chronologies. Carbonate paleoproductivity records from San Lazaro Basin, in the southern domain of the California Current System (CCS), show a consistent variability in the centennial band periodicity (~100-120 yr) that broadly coincides with the sea surface temperature record from Makassar Strait and the Drought Area Index from Western North America, which suggest an ocean-atmosphere coupled system similar to ENSO. Here, we present an ensamble of marine and terrestrial records to better understand the spatial extent of this mode of variability, the Pacific Centennial Oscillation (PCO).

During the last century, more frequent *El Niño* events apparently occurred during a warm mode of the PCO, in a similar fashion to the positive mode of the Pacific Decadal Oscillation. This result is further observed in the historically documented *El Niño* events reconstruction of the last four centuries from the city of Trujillo, North coast of Perú. In contrast, the Pallcacocha ENSO precipitation record does not show significant variability in the centennial band, in spite of a significant coherence in this band with the CCS carbonate record. However, other records that share this centennial variability do not support the interpretation of a low frequency mode of the ENSO system. PCO have large effects in monsoonal precipitation from North to South America, with important effects during the Medieval Climate Anomaly.

ID: 02374, 18.- Human Impact on Global Aquatic Systems, (Poster)

20th century human impact on the sediment transfer from the upper Rhone River basin to Lake Geneva (Switzerland/France)

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Sediment production and transfer processes in Alpine environments are mainly controlled by climate. Changes produced by climatic changes can be recorded in peri-Alpine lakes sediments. In the last ~200 years anthropogenic activities begun to have a great impact in these watersheds, producing measurable changes in the sediment record in lakes.

During the 20th century the upper Rhone River watershed has been subject to climate changes and various anthropogenic impacts (e.g. dam construction). Under the scope of the SEDFATE project (Swiss National Science Foundation CRSII2_147689) we address human and climatic impact on the sediment transfer from the Rhone River watershed to Lake Geneva (Switzerland/France).

Sediment cores collected in the Rhone River sublacustrine delta were analyzed to determine mass accumulation rates (MAR) and patterns and sediments characteristics.

Radiodating (^{137}Cs and ^{210}Pb) results show that from 1964 to 1986 MARs decreased. After 1986 MARs increased again. Geochemical proxies for detrital input (e.g. Si, Ti) follow the variations and trends of MARs. Geochemical data (ICP-MS) on the fine sediment fraction (<63µm) don't show any significant change in the geochemical signal, implying that the observed elemental changes must be related to the coarser sediment fraction.

Preliminary mineralogical data (Qemscan) on bulk sediment samples show variations in their mineralogical content. Quartz and epidote content decrease coevally with the decrease of the detrital signal while calcite, dolomite, and illite increase. Post-1986, most of these minerals percentage increase again together with the increase in MARs but albite and titanite stay low.

We hypothesize that coarse sediment was abstracted from the transporting system after the major dam constructions in the 1950's and that, since 1986, an opposite trend is due to increased sediment loads, possibly owed to glacial melting resulting from climate change. Future analysis will focus on sediment fingerprinting and identification of the sources changes in the watershed.

ID: 01717, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Climate changes over the last 2000 years recorded in various proxy archives in the SE Altai, mountains of Southern Siberia

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We present the results of our multidisciplinary investigations of the SE Altai, which represents a combination of landscapes and ecosystems of alpine highlands, vast plateau-topped watersheds and intermountain depressions with unique archeological heritage. A number of different nature archives provide information about climatically driven landscape evolution in the region during the last 2000 years. In our researches we summarize the results of studying glacier advances, upper timber limit fluctuations, paleosols archives, tree-ring analysis and geoarchaeological data.

Mountain glaciers are potentially good climatic indicators. Numerous radiocarbon dates including more than 50 new ones indicate two stages of glacier advances during the last 3000 years. Generally, the reduction of glacial activity in every subsequent Holocene glacial stage is expressed in topography, and the decreasing magnitudes of these expansions argue for progressive aridity intensification, especially noticeable in the last 2000 years. This conclusion is supported by the fact that thermal minimum in the middle of the nineteenth century, the greatest in the last millennium, did not positively influence the mass balance of the glaciers. The trend of aridity intensification is also supported by pedosedimentological analysis and newly obtained radiocarbon dates of paleo and contemporary soils in mountain valleys and intermountain depressions. Besides the chronological issues, the studied contemporary soils and paleosols provided climatic and environmental characteristics of their formation. Tree-ring analysis of numerous finds of Larix sibirica in the region, utilized for wooden burial constructions, argues for considerable timber usage by ancient nomads and implies more humid and warm climate conditions (in comparison with the modern ones) favorable for forest growth, even in the arid and desert eastern part of the Chuya depression. Archaeological site distribution generally marks favorable for living areas. Using them as spatial-temporal markers allows reconstructions to be specified based only on geological data.

ID: 02254, 01.- Open Session on past global changes, (Poster)

Linking Climate Change and Altitudinal Variation of the Andean Vegetation during the last three decades in South-Central Chile.

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The spatial distribution of vegetation is strongly related to favourable climatic conditions for its development. Hence, changes in temperature and precipitation regimes are expected to alter the distribution of species at their latitudinal or altitudinal extremes. In the Northern hemisphere there is important evidence of vegetation altitudinal variation in response to climate change. The shift is larger for species restricted to mountain habitats and for grassy species, which are characterized by faster population turnover. Studies of climatic variability report a notorious tendency towards the increase of the temperature and ascent of the 0° C isotherm for south-central Chile since 1980. These trends are expected to favor the advancement of high Andean vegetation beyond its present position by increasing its altitudinal level. In this context, we evaluated the altitudinal redistribution of high Andean vegetation using a Multi-Temporal series of satellite imagery Landsat between 36º40 \'- 38º30\' LS during the last three decades. The NDVI (Normalized Difference Vegetation Index) and SAVI (Soil-Adjusted Vegetation) vegetation indices were analyzed to detect changes in plant development on the treeline. The results show a slight increase of the treeline and progressive increase of vegetational development in areas that historically were clear of vegetation or permanently covered by snow. Using meteorological data from Andean stations closest to the study area, we detected a positive correlation between temperature variations and altitudinal vegetation changes. Partially funding by FONDECYT Project N 1160719

ID: 01305, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Speleothem δ18O record of multidecadal Atlantic oscillations during the last millennium in Morocco

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The climate processes in Morocco are poorly understood, making the investigation of paleoclimate changes during the last millennium highly requested. Here, we present the first well-dated high resolution stable oxygen isotope δ18O speleothem record from southwestern Morocco, covering the last 1200 years. Our record reveals substantial decadal to multidecadal fluctuations between dry and humid periods, consistent with regional paleorecords, with prevailing dry conditions during the MCA, wetter conditions during the LIA, and a trend towards dry conditions during the current warm period. Statistical analyses indicate that the climate in Morocco remained under the combined influence of both the AMO and NAO over the last millennium. The generally warmer MCA and colder LIA at longer multidecadal timescales probably influenced the regional climate in North Africa through the influence on Sahara Low, which weakened and strengthened the mean moisture inflow from the Atlantic Ocean during the MCA and LIA respectively.

ID: 02051, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Trace element characterisation of Japanese tephrostratigraphic markers: elucidating eruptive histories and facilitating the synchronisation of palaeoclimate archives

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The volcanic glasses of visible tephra layers recorded in the key East Asian palaeoclimate archive of Lake Suigetsu (SG06), Japan, have been subject to detailed trace element geochemical characterisation (using LA-ICP-MS). Trace element glass compositions from proximally investigated pyroclastic deposits allow us to chemically distinguish tephra units erupted from volcanic sources situated along the two volcanic arcs of southern Japan. These data indicated that Yttrium, Zirconium and Thorium concentrations in the glasses are particularly useful for discriminating the different volcanic sources. Consistent with prevailing winds in the region, our trace element data verify that at least twenty of the twenty-two distal tephra layers investigated from the SG06 record derive from volcanic sources south-west of Lake Suigetsu. These include the calderas of Kyushu Island situated along the Ryukyu-Kyushu arc (RKA), and also Daisen and Sambe stratovolcanoes of southern Honshu, associated with the south-west Japan arc (SWJA). The prevalence of tephra layers from Daisen and Sambe enables the construction of a detailed event stratigraphy for the SWJA with an unrivalled temporal resolution owing to the integrated varve and ^{14}C chronology of the SG06 record. Precise geochemical fingerprinting of widespread Japanese tephra layers is key to both unlocking the chronological potential of the Lake Suigetsu archive and facilitating the accurate synchronisation of palaeoclimate archives throughout Japan and beyond.

ID: 02040, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Neanderthal landscape south of the Ebro river. First results from the Late Pleistocene (MIS3) site of Aguilón P5 cave (Zaragoza, Spain)

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The cave of Aguilón P5 is a small opening in the Iberian Range (south of the Ebro river, Zaragoza, NE Iberia). The sediments that fill up the cave has provided archaeological and paleontological remains The fieldwork developed since 2010 has excavated the sediments of the top of the stratigraphic sequence only. The presence of animal bone remains, charred plant remains, hearth structures and lithic artefacts has been found during excavations (Mazo and Alcolea, 2016)[1]. Due to tool assemblage and radiocarbon dating (>50.0-41.9 kyr BP) the attribution to the Middle Palaeolithic is clear, contemporary with other important Mousterian sites in the Ebro Basin.

In this work we focus in the preliminary results provided by archaeobiological records. Wood charcoal analysis reveals that the surroundings of the cave would be dominated by pinewoods (*Pinus* tp. *sylvestris*) accompanied by some shrubby taxa characteristic of the forest edges (fam. Rosaceae). Archaeozoological study reveals that small and medium size ungulates such as deer (*Cervus elaphus*) or wild goat (*Capra pyrenaica*) and rabbit (*Oryctolagus cuniculus*) are present in the faunal spectrum. This fits with the data obtained in the neighbouring palaeontological cave-site Aguilón P7 with the relict presence of other cool-climate, atlantic, animal taxa (Nuñez-Lahuerta et al., 2016)[2].

In summary, we can state the following preliminary conclusions: i) the surroundings of the cave was composed by a relatively open-landscape dominated by conifers with an alternation of woodland environments characterized by mountain pinewoods and rocky areas, ii) climate conditions were more atlantic-influenced, colder and high water supply than nowadays in contrast to the Mediterranean climate that now prevails in Aguilón, iii) future studies in this site can provide valuable palaeoenvironmental information to understand human-landscape interactions in the Late Pleistocene and Neanderthal history.

[1] In J.M. Rodanés & J.I. Lorenzo (Eds.) Actas del I Congreso de Arqueología y Patrimonio aragonés. Zaragoza. pp. 21-31.

[2] Historical Biology, 28(6), 774-786.

ID: 01703, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Human-forest interactions in Central Pre-Pyrenees (NE Spain) during Early-Mid Holocene transition. Charcoal analysys in archaeological contexts

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The central part of the Pre-Pyrenees southern slope (NE Spain) constitutes the present-day limit between the Athlantic and Mediterranean climate boundary in the Iberian Peninsula. The Early-Mid Holocene transition period (ca. 9000-7000 cal yr BP) is a period of environmental and cultural change. Firstly, from 8200 cal yr BP a change in precipitation regime and the increase in winter temperatures favored the vegetation belts rise in altiude, leading to the establishment of a well-developed Mediterranean forest in the lowlands (González-Sampériz et al., 2017[1]). Secondly, an increase in human activities and a subsequent modification on forest exploitation ocurred at the end of Mesolithic period (ca. 7500 cal yr BP), occurs in different forms and rhythms and implies significant evolutions concerning environmental management and occupation of space (García-Marínez de Lagrán, 2015[2]). Although wood charcoal in archaeological contexts do not accumulate randomly, a synthesis effect of the surroundings vegetation can be recognized as a consequence of the prehistoric populations daily fuel collecting activities. These deposits seem to constitute a reliable source for local vegetation reconstruction and they are considered synthetic type deposits with a statistical consistency (Scott and Damblon, 2010[3]). Charcoal analysis in archaeological contexts emerges as a valuable small-scale environmental tool. Five charcoal-sequences from archaeological sites were studied in this work: Arba de Biel (Biel, Zaragoza), Chaves (Bastarás, Huesca), Espantalobos (Quicena, Huesca), Esplugón (Sabinñanigo, Huesca) and Forcas II (Graus, Huesca). All of them are located in mid-mountain areas (ca. 800-500 masl). A total of 20 different plant taxa were documented among a total of 4183 charcoal fragments analyzed. Archaeobotanical data provided in this work fill a relevant gap in this region and allows an approach to the evolution of the Atlantic- and Mediterranean-taxa related to climatic transitions and anthropic factors. [1]Palaeogeography, Palaeoclimatology, Palaeoecology 291, 1-10. [2] Catena 149, 668-688. [3] European Journal of Archaeology 18(3), 429-453.

ID: 01735, 21.- Sediment Flux: Past Peaks and Troughs, (Poster)

Lake sedimentation rates over the Anthropocene: A quantitative synthesis

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Sediment and mass accumulation rates represent key metrics of lake functioning and have a wide range of physical and chemical implications, ranging from lake infilling to carbon sequestration. Lake sediment records and the rates at which they accumulate are also highly informative as they reflect the complex changes in hydrological and anthropogenic processes occurring throughout a watershed. With knowledge about the past, we are also better equipped to envisage scenarios of future Earth system trajectories. For this study, we have compiled data published in the Journal of Paleolimnology between 2008 – 2015 and amassed records from over 250 sites. In particular, we have digitized data on sedimentation rates (measured as mm/year and g/cm^2.year) over the past ~ 150 years. We are also extracting key watershed data including landuse/landcover, climate conditions, watershed size and slope to quantify the relative importance of these metric in terms of defining lake sedimentation rates. We will apply additive mixed effect models and regression tree approaches to define sedimentation rate patterns and identify key predictors. Overall, this work will advance our understanding of how lake sedimentation rates vary across different regions, how they have varied over the past 150 years and what are key environmental variables that can explain differences across the landscape and through time.

ID: 01652, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Bottom sediments of the Lake Donguz-Orun (Central Caucasus) as a chronicle of the climate change in the region

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Bottom sediments of the Lake Donguz-Orun (Central Caucasus, Elbrus region), first retrieved in 2012, revealed regular laminae typical for proglacial varved lakes. In order to confirm the annual lamination we used several geochemical markers. The sediment core was scanned for elemental analysis using XRF-SR (synchrotron) technology in the Institute of Nuclear Physics SB RAS at the resolution of 200 µm and ultra-high resolution of 30 µm for the upper 20 mm. The ratio Rb/Sr was selected as an indicator of an annual cycle of sedimentation due to different mobility of the two elements depending on the sediment grain-size. Indeed, the Rb/Sr curve revealed a strong pattern of annual variability with lower values corresponding to the spring snowmelt (with a near-perfect fit with the visible layers). Subsequent use of the other indicators, namely Zr/Rb and others, provided an independent calculation of the annual layers. Together with the Cs-137 dating, all the results agree on the sedimentation rate around 1.7 mm/yr for the period 1910-2010.

Distinguishing the separate annual layers enabled the comparison of the sedimentary geochemical data with the annually resolved data, such as the local meteorological observations and tree-ring series. The concentration of bromine – often considered as a temperature-sensitive biophile element – revealed a significant correlation with the local annual temperature (r2=+0.48). The concentrations of terrigenous elements – K, Ti, Fe, Zn, As, Rb – show a correspondence with the annual atmospheric precipitation, which seems logical considering that the lake is glacier-fed. On a shorter timescale, certain elements were able to record precisely abrupt changes in the instrumental records.

Thus, varved sediments of the lake Donguz-Orun revealed a great potential in terms of creating regional reconstructions of climatic parameters, which are still scarce in the Caucasus. Currently, the work on a longer sediment core is undertaken with an estimated timespan of 350-400 years.

ID: 02006, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Reconstructing Holocene hydrographic variability in the Northeast Atlantic using bivalves

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The bivalves Arctica islandica and Glycymeris glycymeris are highly resolved archives of past marine climate in the North Atlantic. The annual growth patterns of the shell reflect the environment the animals live in and by cross-matching these growth patterns it is possible to construct multi-centennial, replicated, and annually resolved chronologies that form a temporal template for isotope sampling. The aim of this study is to assess differences through time in marine climate and growth rates in isolated A. islandica and G. glycymeris populations in the northeast Atlantic Ocean. In May 2014 and April 2016, we collected dead valves and live specimens of both species from St Kilda, Outer Hebrides, Scotland. This area is of particular interest as it is close to the Scottish shelf margin, has negligible freshwater input and is thought to represent open-ocean North Atlantic signals well. We here compare inter-annual and seasonal growth in modern specimens with growth in two floating chronologies, each spanning >200 years, built from dead-collected shells. All the shells in the floating chronologies were found to have radiocarbon ages between 3700-3300 cal yr BP. The radiocarbon ages confirm our findings by grouping the shells into two distinct age bands consistent with our two floating chronologies. We present annual and sub-annual $\delta^{18}O$ data of these floating chronologies as well as of modern specimens from St Kilda to compare changes in mean state and seasonality between the present and the fourth millennium BP. Sub-annual $\delta^{18}O$ data from the floating chronologies and from the modern specimens show a strong seasonal signal and multi-year trends. We calibrate the $\delta^{18}O$ results from the modern specimens with instrumental data, which enables us (assuming that there has been no change in $\delta^{18}O$water) to compare mean and seasonal seawater temperatures between the present day and the fourth millennium BP.

ID: 01751, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Lake Urmia (NW Iran) environmental and climate changes during the Holocene inferred from the lake deposits; preliminary results

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The ongoing changes affecting the Lake Urmia are revealed by a considerable lake water level decrease (7 m in the last 15 years), desertification and formation of dust storms in its area. This environmental and ecological disaster has become a major preoccupation for Iran\'s government in recent years. Water level drop was attributed to the decrease of the rainfall and to the anthropogenic causes, principally the construction of numerous dams on rivers supplying the lake. Nevertheless, even if the overexploitation of water is evident, the role of individual natural and anthropogenic factors influencing the state of the lake is still not well identified. Indeed, the lack of the detailed record of environmental evolution in the past, limits the understanding of actual processes and the capability to develop an integrated management of the water resources.

The French-Iranian project that started in 2016, aims to obtain high temporal resolution records on past environmental and climate changes in the Lake Urmia area for the whole Holocene. The process integrates geophysical, hydrogeological, hydrological and lake sediments studies. During the fieldwork in May 2016, two sediment cores have been obtained from recently dried out part of the lake close to the city of Urmia, and preliminary sampling of the lake water and groundwater has been done. Sediment obtained from cores (~12 m thick) is not yet dated; nevertheless, according to previous works it most probably presents the latest Pleistocene and Holocene. The sequence consists on sandy and clayish/silty deposits characterised by different magnetic susceptibility values. That indicates changes in detrital material sources and/or lake water level. At the bottom, a crust of evaporites similar to that from the top, indicates the state of the lake as low as that of today. The conductivity of sampled lake- and groundwater shows values indicating its very high mineralisation.

ID: 01750, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Clay minerals in Late Quaternary Caspian Sea sediments

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We present results of clay mineral analyses applied to sediments from the Caspian Sea. Analyses were performed on two ~10 m long sediment cores that were collected (middle basin SR-9418 GS20, water depth of 479m and south basin: SR-9402 GS05, water depth of 519m) during a cruise that took place in 1994 as a part of the multidisciplinary study of the Caspian Sea, conducted by a Russian-French team. Sediments were already studied for sedimentological, magnetic, geochemical and biological parameters (Chalié et al. 1997; Jelinowska et al., 1998,1999; Boomer et al., 2005; Leroy et al., 2000,2007,2010,2013,2014; Pierret et al., 2012; Tudryn et al. 2013,2014;2016). Both cores present Late Pleistocene and Early-Mid Holocene sediments. Late Pleistocene part of both cores consists on detrital rich and carbonate poor material while Holocene sediments are dominated by carbonaceous mud.

Our results show that during the last deglaciation, the Caspian basin collected meltwater and fine-grained sediment from the southern margin of the Scandinavian Ice Sheet via the Volga River. It induced the deposition of characteristic chocolate-coloured illite-rich sediments (Chocolate Clays) that originated from the Baltic Shield area according to Nd data (Tudryn et al., 2016). This supply started probably at ~22 cal kyr BP, led to the Early Khvalynian transgressive stage(s) and Chocolate Clays deposition in the now-emerged northern flat part of the Caspian Sea and in its middle basin, and it stopped at ~13.8 cal kyr BP. After the Chocolate Clays deposition and until 3.0 cal kyr BP, smectite originating from the East European Plain became the dominant clay mineral in the sediment from the middle basin of the sea. In the south basin, until ~11.0 cal kyr BP, smectite and illite present equal values, showing different pattern from that in the middle basin. During the Holocene, smectite became dominant, as in the middle basin.

ID: 01262, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Belgian speleothem records Holocene cold events?

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Speleothem is now regarded as valuable archives of climatic conditions on the continents, offering a number of advantages relative to other continental climate proxy recorders such as lake sediments and peat cores. High spatial resolution measurements of Mg, Al, Sr, Ba were realized by using laser-ablation inductively coupled plasma mass spectrometry in the Belgian Pere Noel cave. A stalagmite from the Pere Noel (PN) cave representing 12000 years dated by U/Th method. Trace element variations in speleothem are a reflection of hydrochemical conditions. These changes were interpreted as indications on changes in climate in the Han-sur-Lesse region. The similar patterns found in δ ^{18}O, δ ^{13}C and chemical composition along the Pere Noel stalagmite suggests that trace elements in speleothems have the potential to provide the high resolution insights into palaeoclimatic variability during the Holocene. The interpretation reveals several periods of significant rapid climate change during the Holocene periods (10.7-9.2 ka, 8.2-7.9 ka, 7.2-6.2 ka, 4.8-4.5 ka, and 3000-2.4 ka BP. These periods are similar to the cold events detected from different natural paleoclimate archivers (Wanner et al., 2011). A comparison between geochemical analysis of Père Noël speleothem and solar activity (sunspot number) reveals a significant correlation. The spectral analysis methods reveal common solar periodicities (Gleissberg cycle, de Vries cycle, unnamed 500 year, Eddy cycles, and Hallstatt cycle). The geochemical analyses have the potential to improve that PN speleothem is sensitive to changes in solar activity on centennial and millennial timescale during the Holocene.

ID: 02135, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Spatial and temporal heterogeneity of Holocene ocean and climate conditions in the Antarctic Peninsula: evidence from a suite of marine diatom records.

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Diatom-based paleoceanographic reconstructions on a suite of marine sediment cores from the east and west Antarctic Peninsula (E/W-AP) reveal the spatial and temporal heterogeneity of Holocene climate in the AP. Five statistically defined ecological groupings characterise 80.2 ±4.7 % (mean ± 1s.d.) of all the diatom assemblages and together with diatom concentrations and accumulation rates, describe the principal oceanic settings of the AP. Early Holocene ocean conditions along the WAP are characterised by high glacier discharge, likely reflecting accelerated glacier thinning and grounding line retreat in response to the elevated atmospheric temperatures recorded in ice cores and frequent incursions of \'warm\' upper circumpolar deep water (UCDW). The mid-Holocene is characterised by declining glacial discharge with varying patterns of UCDW influence across the WAP. On the EAP, UCDW is absent from the inner shelf throughout the Holocene, as such, ice thinning and retreat and intervals of ice shelf absence are inferred to have been driven primarily by elevated atmospheric temperatures. Our study highlights the complexity of the AP ocean and climate system and illustrates that no single record can adequately represent regional paleoclimate.

ID: 01698, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Trace element proxies for surface ocean conditions: A synthesis of culture calibrations with planktic foraminifera

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We have assembled the results of culture experiments for three species of symbiont-bearing planktic foraminifera, *Globigerinoides ruber, Globigerinoides sacculifer*, and *Orbulina universa*, and one symbiont-barren species, *Globigerina bulloides*, to evaluate their responses to temperature, salinity, pH, carbonate ion, and dissolved inorganic carbon (DIC) growth conditions. Trace element ratios (Li/Ca, B/Ca, Mg/Ca, Sr/Ca, Mn/Ca, Cd/Ca, Ba/Ca, Na/Ca, and U/Ca) were measured simultaneously on samples grown with the same culture techniques, which provides robust, relatable calibrations that may be used together in multi-proxy paleoceanographic studies. Our data confirm that temperature is the dominant control on foraminiferal Mg/Ca under the ranges of conditions studied and that the potential effects of salinity and CO_3^{2-} on Mg/Ca of these tropical species across late Pleistocene glacial cycles are relatively small. Carbonate system experiments suggest that Sr/Ca may be useful for reconstructing large DIC changes. Na/Ca increases with salinity in *G. ruber* (pink), but not in *G. sacculifer*. As these emerging proxy relationships become more firmly established, the synthesis of multiple trace element ratios may help paleoceanographers isolate the effects of different environmental parameters in paleo records. Calcification rates (µg/day) vary among species and do not respond consistently to any experimental parameter. Comparison of our calcification rates with those observed in inorganic calcite precipitation experiments suggest that foraminifera calcify ~100x more slowly than inorganic calcites grown in similar solutions. We suggest that calcification rate does not typically exert a dominant control on trace element partitioning in planktic foraminiferal calcite, though it may play a role for some elements under certain circumstances. Differences in average growth rate cannot explain composition differences among species, pointing to alternative controls that may be biological in origin.

ID: 01520, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

A high quality millennial-length summer temperature reconstruction for southeastern Australia

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An evolving understanding of past climate variability and changes observed over the 20th Century requires integration of high quality palaeoclimate records into analyses. To this end, we have developed a nested 950-year mean temperature record for the Austral summer (December – February) based on a network of *Lagarostrobos franklinii* sites in southeastern Australia. The calibrated model explains ~ 66% of the variance and the Coefficient of Efficiency (CE) that is commonly used to assess reconstruction quality is positive (interval estimate) back to 1050 CE. Unlike the previous Mt Read *L. franklinii* reconstruction for the November-April period, our reconstruction depends not only on the ring widths of high elevation sites, but also, crucially, on low elevation wood properties such as density, tracheid radial diameter and cell wall thickness. Although our smoothed reconstruction is somewhat similar to the previous Mt Read reconstruction, there are some important differences, especially around the start of the 20th Century and around 1150 CE, two periods during which a number of very narrow rings occurred at Mt Read. In addition, there are important differences between our reconstruction and the recent Aus2k Australasian reconstruction, notably over the ~1500 – 1900 CE period in which our reconstruction suggests temperatures were warmer than shown by the Aus2k reconstruction. Further, 20th Century warming for our region has been less extreme than shown in the Aus2k reconstruction. Different seasonal windows and target domains are two prominent reasons why the reconstructions will differ from one another. Notably, the signal of our reconstruction is largely limited to part of southeastern Australia and has an interesting similarity to the relationship between Australian temperatures and SAM for the Austral summer. The strength of our reconstruction and its spatial signature highlight the potential for high quality sub-regional reconstructions where multiple large-scale ocean-atmosphere processes drive climate over broader regions.

ID: 02232, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

A new proxy for reconstructing past wind strength in the Amundsen-Bellingshausen Sea

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Winds in the Southern Ocean drive exchanges of heat and carbon dioxide between the ocean and atmosphere. Winds also explain the dominant patterns of both basal and surface melting of glaciers and the collapse of ice shelves in the Amundsen and Bellingshausen Seas. However, long records of past wind strength and atmospheric circulation are needed to assess the significance of these recent changes. Despite evidence in the literature showing that wind-transported diatoms may provide a proxy for atmospheric circulation, this potential has not been fully exploited in Antarctic ice core studies. Here we present evidence for a novel proxy for past wind strength and atmospheric circulation patterns in the Amundsen-Bellingshausen Seas, based on diatoms entrained in the Ferrigno ice core. Taxonomic identification of diatoms recovered from the ice core are used to determine the ecological affinities of the assemblage and infer the potential source regions. The potential for entrainment and transport of diatom specimens is then assessed using back-trajectories of air masses to the Ferrigno site. Good agreement between diatom assemblage composition and air mass trajectories for the 1980 to 2010 period, suggest that Ferrigno-diatoms may provide a novel proxy for winds in the Amundsen-Bellingshausen Sea sector.

ID: 02150, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Poster)

Late Pleistocene climatic and oceanographic variability in the Indian Ocean revealed by the Maldives Sea record of IODP Site U1467

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The Maldives Inner Sea is a natural sediment trap within the Indian Ocean, providing a sedimentary record of changes in ocean circulation patterns and regional climate variability. The Maldives Sea is influenced by the South Asian Monsoon (SAM), driving modern currents in the north and central Indian Ocean, which are linked to the seasonal reversing wind pattern. Winds are directed westward in the winter and eastward in the summer, with direction changes reflected in the sedimentary record of the Maldives Inner Sea. Additionally, in the northern Indian Ocean oceanic productivity and the oxygen minimum zone (OMZ) in the water column are intimately related to the SAM. Therefore, the Maldives Sea is a perfect location to study past changes in the monsoon dynamics and its associated effects.

IODP Site U1467 was drilled in the Inner Sea of the Maldives at a water depth of 487 m during IODP Expedition 359, and recovered a 630 m thick Miocene to Pleistocene carbonate drift succession. Well preserved microfossils in the Plio-Pleistocene sequence offer the opportunity to establish a good chronological framework and study changes in benthic communities as a proxy for bottom water oxygenation and changes in the OMZ. This study will reconstruct sea surface temperature variability in the Indian Ocean (based on alkenones), as well as changes in the bottom water conditions during Mid to Late Pleistocene in order to understand monsoon dynamics in the Indian Ocean across glacial-interglacial cycles.

ID: 02364, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

The LGM ice-free Andøya island – did local favourable condition combined with distinct long-distance dispersal routes cause non-analogue vegetation?

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At the LGM, Andøya refugia on the NW coast of Norway was isolated by glaciers 2000 km to the south and 1200 km to the east. Controversy has arisen concerning the bioclimatic conditions, especially concerning finds of ancient DNA from pine (*Pinus*) and spruce (*Picea*) as well as a megafossil of birch (*Betula pubescens*). We reviewed the existing data as well as analysed ancient sedimentary DNA, pollen, macrofossils, geochemistry and stable isotopes in three new cores from lake Øvre Æråsvatnet. The presence of conifer DNA in LGM/MIS2 sediments was confirmed, validating the authenticity of previous finds. The LGM/MIS2 levels in the new cores have very high organic matter probaly derived from a high-trophic source. This, along with earlier finds of bones, suggests that the lake received guano from an adjacent little auk (*Alle alle*) colony, which might have produced local conditions beneficial for plants. The pollen and macrofossil assemblages are strongly dominated by Poaceae, *Papaver* and Brassicaceae, which is in accordance with other LGM records from Andøya, and have been interpreted as Arctic conditions (July temperature 1–5°C). Finds of few but indicative thermophilous species, together with high pollen accumulation and macrofossil concentration, seemingly contradict this by indicating low- to sub-Arctic conditions (July temperature up to c. 10°C). The presence of conifer DNA in LGM/MIS2 sediments was confirmed, validating the authenticity of previous finds. We conclude that climatic conditions during the LGM (here 24 – 18 ka cal. BP) could periodically have supported local conifer growth. We contribute this unusual vegetation assembly to a combination of highly variable local climatic conditions (primarily determined by the strength of the Norwegian current), the presence of bird manure, nutrient rich habitats, and glacial age long-distance ice-rafting dispersal from the east, most likely Siberian rivers.

ID: 02172, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Holocene hydrological variability in Northern Chile using δ18O signal on freshwater ostracods and mollusks

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Different climatic scenarios have been set by several studies during the mid-Holocene in northern Chile (central Andes), which have been attributed to: different proxies used, space variations, and temporal resolution. $\delta^{18}O$ signal can be interpreted as variations in hydrological balance, lake level, temperature or atmospheric circulation, and thus been a reliable method to understand past climatic variability. The objective of this study is to reconstruct the hydrological balance of a lake from the central Pre-Andes combining the $\delta^{18}O$ signal of ostracods and mollusks, and establish their timing with the previous records during the Holocene. Inca-Coya is a lake located at the central Pre-Andes, where the precipitation is lower than 200 mm/yr. A sediment core was retrieved in the deepest part of this lake where biogenic carbonates were identified. The age model was performed combining ^{210}Pb data and ^{14}C of amphibian bones. $\delta^{18}O$ analyses were performed in *Limnocythere elongate* (ostracods) and *Heleobia sp.* (gastropod). In addition, sedimentological analyses (LOI_{550}, LOI_{950}, and magnetic susceptibility) were included. The results showed that both species presented a roughly similar trend of $\delta^{18}O$ ranging between 1.31‰ and 3.89‰, where ostracods had higher amplitude of values. A period of positive hydrological balance was identifying during the early Holocene, extended until 9 kyr BP. During mid-Holocene the $\delta^{18}O$ in mollusks tended to rapid increase coinciding with several more positive peaks $\delta^{18}O$ in ostracods and high LOI_{950} values, which evidence a negative hydrological balance. The $\delta^{18}O$ decreased during the last 2000 years, suggesting more humid conditions but not as humid as the conditions of the early Holocene. In conclusion, our results are in agreement with the records from the Altiplano and represent a regional hydrological variability.

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ID: 02287, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Temperature variability in lakes in different altitude in Central Chile during the last millennium.

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Meteorological records in Chile has shown different behaviour in air temperature during the last three decades, observing a cooling tendency in the coastal zone and warming towards the Andes. Due to the lack of long-term meteorological data is not possible to know if this pattern has been repeated in the past because instrumental measurements of temperature are only available for the last hundred years. Hence the "calibration in time" approach in lake sediments permits to reconstruct past temperatures with high temporal resolution (annual or decadal) using sensitive proxies to this variable. According to this, the objective of this study was determined is the observed air temperature pattern has occurred in the last thousand years in different altitude in Central Chile. To achieve this goal the temperature estimated by calibration in time, using in situ reflectance spectrometry of three lakes, were compared: Laguna Chica de San Pedro - LCSP (43 m a.s.l), Laguna Amargo (730 m a.s.l) and Laguna Aculeo (Von Gunten et al. 2009). Preliminary results, evidenced temperature fluctuations during the last millennium, showing high temperature (similar to today) between 1000 - 1320 AD and a decreasing between 1370 - 1690 AD, coinciding with MCA and LIA, respectively. During 20th century, the temperatures tended to increase rapidly, with higher amplitude (~2°C) in lakes located in the Central Valley and in the Andes Mountain Range (above 300 m a.s.l.) in comparison with the coastal lake (<50 m a.s.l), where the temperature variation was near to 1°C. The incorporation of new lakes will allows enhancing the knowledge of spatial behaviour of temperature during the last millennium, which has implications in the biological diversity and their distribution. This research was supported by CRHIAM/Fondap 15130015.

ID: 01310, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Late Holocene vegetation dynamics and disturbance regime in north Patagonia

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The transition from the temperate rain forest to the Patagonian steppe of the southern Andes in Argentina is one of the most remarkable vegetation gradients. The vegetation changes correspond to a west-to-east precipitation gradient, documenting that climate is the main control on the regional-scale variability in vegetation composition. We collected sediment cores from two lakes: Lake Bruja (40°14'S, 71°30´W; 1069m) and Lake Avutarda (40°23'S, 71°25´W; 1610m). Core Bruja was dated to 3600 years ago and core Avutarda dated to 2800 years ago. Preliminary results show the presence of several tephra deposits in both cores suggest high volcanic activity. Both cores show fluctuations in the percentages of *Nothogafus dombeyi*-type, with the increase of pollen from herbaceous taxa at the decline of *N. dombeyi*–type. Both lakes are within and or close to the distribution of *Nothogafus obliqua* and *Nothofagus alpine*. At around 1000 years ago the pollen diagram from Bruja shows an increase in the abundance of the *N. obliqua* pollen type, which includes *N. alpina*. Avutarda record shows the pollen type for the last 2000 years with an increase around 1000 years ago. Thus, both diagrams documents that *N. obliqua* and potentially also *N. alpina* have become more abundant in the region during the last millennia.

Human impact is possible to recognize in both records in the presences and increased abundance of *Rumex acetosella*, *Plantago lanceolata* related to severe overgrazing by sheep and cattle during the first three or four decades of this century, documented for this zone. Pollen of *Pinus spp* is another indicator of human land use documenting the initiation of plantations for timer production. The appearance of these indicator taxa coincides with the decrease in the percentage of *Nothofagus dombeyi*-type.

ID: 01328, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Differential response of Holocene climate variability observed from lake records along an elevational gradient in the intermediate latitudes of the Southern Hemisphere.

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We present a temporal analysis of high-resolution geochemical data series obtained from Holocene sediment cores recovered from two lakes in central Chile (Laguna del Maule [LdM: 36ºS, 2200 m] located in an active volcanic field the Andes, and Laguna Vichuquén [VIC: 34°S, 72º 05'W, 4 m] on the coast) to study the existence of cycles associated with climatic forcing. Temporal dynamics were established using a spectral analysis (Morlet wavelet power spectrum or MWPS and Lomb-Scargle Fourier Transform or LSFT) and break points methods for quantifying major climate transitions present in the geochemical proxies. Both sequences reveal high periodicity. The MWPS analysis for the LdM sequence shows two periods of minimum variability between ~13 - 9 ka and 7 - 5 ka, which occurred during lower lake levels. The wavelet and LSFT analysis show significant peaks at ca. 5000, 200 (De Vries/Suess oscillation), 80 (Gleissberg cycle), and 60-yrs cycles for LdM and at 1500, 650, 300, 13, ~10.5 (11-yr Schwabe cycle), and ~5.5-yrs (ENSO) cycles for VIC. During the mid-Holocene, the VIC record shows low-frequency cycles in productivity, clastic input and paleoredox indicators that appear to be driven by the Southern Westerlies (SW) variability at centennial scales. Both records are underlain by a period of minimum variability between ~7 - 4/3 ka that was coeval with aridity at the regional scale prior to 3-4 ka. Bioproductivity began to increase ~4 - 3 ka in both records as evidenced by the MWPS analysis, which could reflect the onset of modern ENSO dynamics. These cycles are related to the ENSO/PDO though changes in the dynamics of the SW and Hadley Cell circulation. Also, the dominance frequencies in the spectra with similar periodicities as solar activity suggest that this could have been a dominant forcing of paleoclimate during the Holocene in the Central Chile.

ID: 01454, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Variations in near-bottom flow of ACC during past glacial cycle in SW Indian Ocean

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The meridional overturning circulation of the ocean plays a key role in global climate variability by storing and redistributing heat, fresh water, carbon and nutrients. In the North Atlantic surface water sinks to the abyss, but a major part of this cycle is the return path from the ocean's interior through upwelling in the Southern Ocean. This upwelling is largely regulated by the latitudinal position of the Southern westerly winds associated with the deep-reaching Antarctic Circumpolar Current (ACC).

Climate model studies show progressively poleward intensifying winds, related to increased ACC transport and southward shifting of its mean position and increased upwelling. However, a number of recent numerical studies have shown that the sensitivity of the large-scale circulation in the Southern Ocean may be reduced by eddy-effects.

As there remains significant uncertainty regarding the degree of sensitivity of the Southern Ocean circulation to wind stress and the response of the Antarctic circumpolar transport, our aim is to investigate the temporal and latitudinal evolution of the ACC dynamics over the last glacial cycle.

Previous studies suggested a stronger ACC during glacials in the Indian Ocean, but more recent studies in the Drake Passage and Scotia Sea indicate less throughflow during glacials and lateral differences in current speeds. Here we present the sortable silt mean-size of a series of cores across the ACC in the SW Indian Ocean, the mean-size of the re-deposited silt fraction being proportional to the near-bottom flow velocity.

ID: 01271, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Poster)

Dust records during 38-15 kyr BP in arid Central Asia and its connection with abrupt climate events in the Northern Hemisphere

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Little is known about dust history in arid Central Asia during the last Glacial. Here we demonstrate that grain-size changes in the sediment of two lakes, which are located at the core area of arid central Asia, document the dust deposition during 38-15 cal kyr BP. We find that periods 30.5-35, 23.8-25, and 15-16.5 cal kyr BP are characterized by intensive dust storm deposition in the study area. The peaks of dust variation in arid Central Asia are correlated with dust variations seen in Greenland ice core during glacial time, suggesting a correlation with abrupt climate change such as Heinrich events recorded therein. Dust originated from arid central Asia are transported to northern China mainly by winter monsoon, but are transported to far depositional areas such as Greenland by westerlies. So dust records in Chinese loess and Greenland represent different wind systems, and that dust records from Chinese Loess Plateau or Greenland can not completely represent dust variations in arid central Asia. Arid Central Asia may be considered as a pacemaker of climate change in the Northern Hemisphere.

ID: 01941, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Past Asian Monsoon circulation from tree-ring isotopes and proxy system models

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The Asian monsoon can be characterized in terms of both precipitation variability and atmospheric circulation across a range of spatial and temporal scales. While multicentury time series of tree-ring widths at hundreds of sites across Asia provide estimates of past rainfall, the oxygen isotope ratios of annual rings at some of these sites may reveal broader regional hydroclimate and atmosphere-ocean dynamics. Here we present a replicated multicentury stable isotope series from Vietnam that integrates the influence of monsoon circulation on water isotopes. Stronger (weaker) monsoon flow over Indochina is associated with lower (higher) oxygen isotope values in our long-lived tropical conifers. Ring width and isotopes show coherence at multidecadal time scales, and together allow past precipitation amount and circulation strength to be disentangled. Combining these data with proxy systems models using simulations from isotope-enabled circulation models allows us to assess the mechanisms responsible for proxy formation.

ID: 01236, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Impacts of Climate Change and Variability on Food Security in Kenya.

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The economies and livelihoods of people in Kenya is dependent on rain-fed agriculture that is highly sensitive to extremities in weather climate variabilities. Despite progress made in reducing extreme poverty and food insecurity in Kenya, climate continues to pose significant threats. It is therefore critical to address these risks, and focus efforts in building resilience among the most vulnerable populations.

In order to identify policies to support the most vulnerable people in the region, it is important to understand what the climate impacts are on livelihoods and food security so that such credible information can inform on the most vulnerable and why prioritize interventions. The Kenya's Vision 2030 advocates for a secure and wealthy Nation anchored by an innovative, commercially oriented and competitive agricultural sector. This can't be attained if the impacts of extreme climatic events on agriculture and food security are not well understood. This study documents past and current climate trends, identifies geographic patterns of variability, seeks to understand how previous climate shocks and stressors align with trends in food production outcomes so as to help identify priority areas that are particularly vulnerable. This will be useful to a wide range of stakeholders in targeting priority areas for intervention.

The methodology adopted includes an estimation of the annual economical exposition to drought based on Standardized Precipitation Index (SPI), key food security variables for analysis include crop production, area under harvest, yields, and nutrition. The results showed areas vulnerable communities to be highly impacted by climate change and variability.

Key Words: Climate change, food security, Adaptation, Standardized Precipitation Index

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ID: 01775, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Pollen, NPP, Charcoal and Historical Documents Record Late-Holocene and Historical Change at Coastal Wetlands Along the Central California Coast, USA

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Late Holocene pollen, Non-Pollen Palynomorphs (NPP) and charcoal records from small ponds along the south central coast of California, USA, detail the relative impacts on the environment of different cultural traditions, first by Native Americans, followed during the 18th and 19th centuries by Spanish, Mexican and American settlers. Matching this multi-proxy, high-resolution paleoecological study with historical records allows us to characterize the development of colonial transported landscapes following Euro-American settlement along the coast, from Santa Barbara to

north of San Francisco. We coupled radionuclide dating, Spheroidal Carbonaceous Particles and stratigraphic changes of paleoecological markers indicative of land-usage to build historic chronologies.

Pollen records from Mod and Dune Ponds suggest that vegetation has remained a mosaic of sage scrub on lowlands and oak woodland on uplands for most of the late Holocene. Recurrent fire was intimately linked with such dominating mosaic vegetation and native populations used it as a tool to keep an open coastal landscape attractive to hunting wildlife despite climatic variability. Minor changes in the proxies at several sites record the Medieval Climatic Anomaly and LIA climatic fluctuations.

Evidence of Euro-American local impact begins with the first Spanish expeditions in the 1760-70s. In the Santa Barbara region, the introduction of livestock grazing by Spanish colonists after settling the area in the 1780s favored erosive processes and the introduction of fecalborne parasites in freshwater bodies; negatively impacted coastal marshes; and promoted the invasion of alien grasses and ruderals. Deposition of coprophilous fungi show local grazing impacts during this time. Local burning by native populations was banned by Spanish proclamation in 1793, being noted also in the charcoal stratigraphy. This agro-pastoral landscape was consolidated during this American period, with a greater role for cultivation, woodland clearance, the development of industrial activities and increased population.

ID: 01540, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Factors that affect sedimentary 231Pa/230Th ratios

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Sedimentary ^{231}Pa/^{230}Th ratios have been used extensively in the paleoceanographic literature as a proxy for the rate of deepwater ventilation, especially in the Atlantic Ocean where the rate of formation of North Atlantic Deep Water has been invoked as the principal factor that regulates the unsupported ^{231}Pa/^{230}Th ratio archived in the sediments. This application relies on two assumptions: 1) that the dissolved ^{231}Pa/^{230}Th ratio in deep water is affected primarily by the rate of deepwater ventilation, and 2) that the sedimentary ^{231}Pa/^{230}Th ratio responds to changes in the dissolved ^{231}Pa/^{230}Th ratio in a simple and predictable manner. Here we test the first assumption using data from the GEOTRACES GA03 section between North America and North Africa. In the western North Atlantic, where near-bottom turbulence maintains persistent and intense nepheloid layers, we find that the enhanced preferential scavenging of Th relative to Pa elevates the dissolved ^{231}Pa/^{230}Th ratio relative to surrounding waters. In the eastern North Atlantic a similar effect is found in the region of most intense deposition of dust from North Africa, where we find some of the highest dissolved ^{231}Pa/^{230}Th ratios anywhere in the ocean. In both cases, the relatively high dissolved ^{231}Pa/^{230}Th ratios are attributed to the preferential scavenging and removal of Th by lithogenic particle phases. The fate of these deep water masses imprinted with high dissolved ^{231}Pa/^{230}Th ratios, their impact on sedimentary ^{231}Pa/^{230}Th ratios elsewhere in the North Atlantic, and the overall sensitivity of sedimentary records used to infer past changes in deep water ventilation to variable supply of lithogenic material, whether from continental erosion, resuspended bottom sediments or dust, remain unexplored.

ID: 01434, 01.- Open Session on past global changes, (Poster)

Paleolakes reconstruction in the southeastern Scandinavian ice sheet edge

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The study of glacier erosion processes, paleolake dynamics and topographical changes, together give us insight into both localized and broader landscape evolution patterns while also assisting human exploration.

Objective: reconstruction of glacial lakes based on lithostratigraphic and geomorphic analysis using GIS technology. The GIS was used as a means to categorize published, time mapped data and thereby fuse and unify the changes into a single, integrated prototype. Publications on limnologo-glaciological and geomorphological reconstructions of paleotopography and paleolakes north of the Russian plain, along with additional copyrighted and grant-funded GIS studies, together served as resources to authenticate the paleolake contour modeling.

Based upon preliminary results from publication summaries, and initial data collected when analyzing the maps (quaternary sediments, geomorphological, topographical), the contours and maximum glacial lake rise levels in the southeastern Scandinavian ice sheet periphery, including the levels and contours of their coastline, have been duly identified.

The model reflects drain reconstruction and primary watershed migration within the territory in question. Paleobasins undergoing deglaciation processes repeatedly cooperated with one-another other to form lake systems, and then eventually collapsed or broke up into separate lakes.

The highest raised beach level terrace formations were recorded at the Molovo-Sheksninskoy (150 m), at the Vozhe-Lachensk (150 m), and at the Belozersk (145 m) lakes. The lowest levels (below 70 m) but with the greatest number of raised beach terrace formations (6-7) were found at the Onega and Nizhnesuhonskovo lakes. Of the larger glacial lakes studied, two have completely disappeared (Nizhnesuhonskoy, Vazhskoy), four have been preserved as primordial (Vozhe, Beloye, Kubenskoe, Onega). The Molovo-Sheksninskoy and Srednesheksninskoy paleolakes also have an interesting history where back in the 20th century, after the Volga-Baltic Waterway reconstruction project took place, their levels were elevated by 18 m; and thus, the Late Pleistocene paleobasins were reengineered through human intervention to become what became known as the Sheksna and Rybinsk freshwater reservoirs.

ID: 01597, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Deglaciation and Holocene climate change in the Tore Seamount

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The Tore Seamount has a 5500 m water depth deep basin in the middle - isolated from the open ocean, and providing a singular palaeoclimatic record in the North Atlantic Ocean. It is located about 300 km west off the Iberian margin, and we predict acts as a giant sediment trap of subtropical gyre productivity.

Core MD13-3473 was recovered using a Calypso giant piston corer during cruise Gateways Tore Eurofleets [MD194], in 2013, onboard the R/V *Marion Dufresne*. Although the 24 m long sediment record covers the last 430 thousand years (from Marine Isotopic Stage 11 (MIS 11) to the Holocene), this study focus on the last deglaciation period.

To establish the best chronostratigraphy for this time interval (6 ky–21 ky BP.) and assess temperature and productivity changes in the Tore Seamount record, different analyses have been carried out at high-resolution: color intensities, physical properties, geochemical composition, organic carbon, microscopical and compositional analysis of lithic particles (ice-rafted debris) and planktonic foraminiferal assemblages.

By combining these records, we were able to approach glacial to interglacial changes in temperature and productivity, and identify Heinrich event 1 (HE1), which altogether reveals specific lithological, biological, and physical characteristics.

An age model has been developed for the deglaciation based on five AMS radiocarbon ages, and correlation with the GISP2 ice core and d^{18}O *G.bulloides* curves from other nearby marine cores of the North Atlantic Ocean. Two AMS radiocarbon ages gave anomalous data, due to the presence of reworked material in these samples and pointing to a turbidite deposit in the middle of hemipelagic sediment, whose emplacement was just after HE1.

A thorough study of all these data is necessary to prove the singularity and exceptional paleoceanographic capacity of the Tore Seamount as a sediment trap in the North Atlantic.

ID: 02295, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

A Late-Pleistocene chironomid record from Northern Patagonia: does it reflects similar trends than classical proxies?

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Important climatic changes have occurred since the Late-Pleistocene in Northern Patagonia due to millennial-scale changes in southern westerly winds. While wetter conditions are recorded between 11,800 and 16,000 yr BP, a dryer period is recognized between 9,800 and 11,800 yr BP. Most of those paleoclimate studies in the area have been based in pollen and stable isotopes analyses. Chironomids are non-bitting midges that have been broadly used to infer past temperatures, however its application in Northern Patagonia is very limited. Hence the objective of this work was to reconstruct climate since 15,600 cal. yr. BP in Lago Cisnes, Northern Patagonia (~47° S), using chironomids for corroborating other proxies trends. Three different zones were identified by CONISS analysis. Zone I, between 15,600 and 12,000 cal. yr. BP have low abundances and includes *Tanytarsini* type-B, *Dicrotendipes*, and *Ablasbemyia.* The number of head capsules increase in Zone II (12,000-8,000 cal yr BP), Tanytarsini and *Parapsectrocladius* increase at 10,000 cal. yr. BP and *Ablasbesmyia* decreases. Head capsules increases again in Zone III (8,000-2,200 cal. yr. BP), appearing in this period *Polypedilum*, *Alotanypus*, and *Cricotopus*. The maximum abundance in head capsules occurs at 5,000 cal. yr. BP while *Parapsectrocladius* disappears in this zone. After 2,200 cal. yr. BP, total head capsules decreases, disappearing *Macropelopia* and *Polypedilum* while *Chironomus* and *Tanytarsini* type-B, taxa typical of higher trophic state, increases. Chironomid assemblage of Lake Cisnes suggest lake level fluctuation is one of the most important variable in to determine changes in the aquatic ecosystem which in turn is associated to changes in other variables. Disentangle such association is a challenging issue to determine the effects of temperature forcing itself. Partially funded by Fondecyt 1160719.

ID: 01318, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Late Holocene human-environment interactions in New Zealand: a biomarker approach

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The recent colonization history of New Zealand makes it an excellent test site for investigating the early impact of human activities on natural ecosystems. The arrival of humans around 700-800 yr BP is marked by a neat increase in fire activity and land clearance, as documented by charcoal and pollen records. Here, the validity of biomarkers was tested in a multi-proxy study including three different categories of organic molecular markers. Results were compared with existing paleoecological data.

Samples from a small alpine lake in the South Island of New Zealand (Lake Kirkpatrick, Otago), covering a time span of about 800 years (~AD 1153-1961), were analyzed for polycyclic aromatic hydrocarbons (PAHs) as combustion tracers, monosaccharide anhydrides (levoglucosan and its isomers, MAs) as specific markers of biomass burning and fecal sterols (FeSt) for the reconstruction of human/animal presence, organic matter input and chemical conditions of the basin. All tracers peak sharply and abruptly in a brief period centered at about AD 1350, which corresponds to the first increase in fire activity and decline in arboreal species in the South Island. Values decrease to background after ~AD 1400, until the beginning of the 19th century, when a huge increase is registered in FeSt after the European arrival.

Results are confirmed also by the FeSt record from Lake Diamond, not far from Lake Kirkpatrick, that is coherent with significant human presence and increased erosion and sedimentation during the 14th century. Such changes are consistent with the so-called "AD 1300 event", a short period of increased precipitation and erosion observed in many records from Pacific Islands. Whether natural changes affected human settlement and land use or vice-versa is matter of debate, and multi-proxy studies look promising in the reconstruction of such complex interactions and feedbacks.

ID: 02086, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Reduced Earth system resilience across the Palaeocene-Eocene Thermal Maximum

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Several past episodes of rapid carbon cycle and climate change are hypothesised to be the result of the Earth system reaching a tipping point beyond which an abrupt transition to a new state occurs. At the Palaeocene-Eocene Thermal Maximum (PETM) ~55.5 Ma hypothesised tipping points involve the abrupt transfer of carbon from surface reservoirs to the atmosphere. Theory suggests that tipping points in complex dynamical systems should be preceded by early warning signals (EWS) due to critical slowing down of their dynamics, including increasing temporal autocorrelation and variability. However, detecting EWS in palaeorecords is challenging, with issues of data quality, false positives, and parameter selection potentially affecting reliability. Here we show that in the highest-resolution palaeorecord currently available, there is consistent evidence of destabilisation of the carbon cycle prior to the PETM, elevated carbon cycle instability after the PETM in the lead up to Eocene Thermal Maximum 2 (ETM2), and further instability thereafter. This may reflect gradual forcing of the carbon cycle due to the North Atlantic Volcanic Province eruptions. Whilst our results do not prove the existence of a tipping point, they do indicate a loss of 'resilience' in the carbon-climate system with weakened stabilising negative feedbacks.

ID: 01790, 26.- Data Stewardship for Paleoscience, (Poster)

From core referencing to data re-use: two French national initiatives to reinforce paleodata stewardship (National Cyber Core Repository and LTER France Retro-Observatory)

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Managing paleoscience data is highly challenging due to multiplicity of actors, types of sampling, analysis, post-analysis treatments. However, a well-structured data curation would permit innovative developments based on data and/or sample re-use, as meta-analysis or development of new proxies on previously studied cores. In this paper, we present two initiatives that allowed us tackling this objective at a French national level: “National Cyber Core Repository” (NCCR) and “LTER-France retro-observatory” (ROZA).

NCCR was developed under the umbrella of the French National Center fo Coring and Drilling (C2FN) thanks to the national excellence equipment project CLIMCOR. It aims at gathering on a unique website the locations and metadata of any scientific coring/drilling performed by French teams or using French facilities, whatever the type of archive it is (lake/marine sediment; ice etc.). It uses international standard, notably IGSN (for samples), ORCID (for persons) and DOI (for campaigns). NCC follows the INSPIRE ISO 19115 standard in order to catalogue the data. For continental sediment, NCCR may be fed directly on the field through a specifically developed mobile application.Based on NCCR, further initiatives may be led. In particular, under the umbrella of LTER-France (Long Term Ecological Research), we developed ROZA in order to facilitate the re-use of data and samples. Here the idea is to capitalise the knowledge on a given lake from which several sediment cores can be taken through time. In that aim we selected at least one lake from each of the 13 areas composing the network LTER-France. To enter the database, a set of mandatory data must be provided under a pre-determined format. In that case, the insertion of ROZA within the network LTER will favor to use of paleodata by non-paleodata scientists, in particular ecologists.

ID: 02248, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Developing the use of mammalian tooth crown height to quantify precipitation in the Late Pleistocene

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The Late Pleistocene is a period characterised by abrupt shifts in climate in Europe, driven by a range of forcing factors. There is evidence of semi-arid environments spreading through the Late Pleistocene, highlighted by the westward migrations of arid-adapted mammals. However, relating these faunal migrations to the wider unstable climatic regime is hampered by a current lack of quantitative precipitation estimates at a representative spatial scale and within a robust dating framework.

Recent work on both modern herbivores and Neogene fossils has revealed the utility of large herbivore hypsodonty (tooth crown height) as a method of quantifying past and present precipitation. Fortunately, the abundance of Late Pleistocene mammal assemblages provides excellent spatial coverage and have often had robust dating methods applied.

Preliminary analysis of the existing hypsodonty-precipitation models and datasets indicates generalisation of the relationship between hypsodonty and precipitation across large spatial areas as well as suppression of natural variations in hypsodonty. Here, we attempt to improve existing models by creating a large modern training set using well-provenanced museum specimens. Thus far it appears that the relationship between hypsodonty and mean annual precipitation that is shown in the previous models appears not to be present in our dataset, whereas a stronger relationship with seasonality is shown. After the development of our improved model we aim to use it to quantify precipitation at Late Pleistocene sites. This will provide the first quantitative reconstructions of past precipitation. Existing radiocarbon based chronologies will be used to deliver a robust chronology of past precipitation values at a high temporal resolution. This will permit us to assess the control of abrupt climate changes on aridity and the effects of this upon faunal migration and hominins.

ID: 01311, 01.- Open Session on past global changes, (Poster)

The Batagay mega thaw slump reveals the Late Pleistocene history of inland West Beringia

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Beringia is a well known land bridge between Asia and America that numerously appeared during the

Pleistocene low sea level stands. The Arctic Seas shore line was shifted by 800 km to the north of its current position, which caused an increase of climatic continentality compared to the modern conditions. Beringia has been subject of scientific research for several decades and is believed to be a main refuge area of Arctic flora and fauna and also the last asylum for woolly mammoth. Nowadays, mammoth-steppe or tundra steppe vegetation occupy only sparse areas in landscapes of Northeast Siberia; during the Pleistocene in this unique biome coexisted animals, some of which are extinct now and others live in different climate zones. Material available for palaeoreconstructions is available from permafrost exposures. A lot of data is published about the outcrops that are located in nowaday\'s coastal zone. We would like to report the material from the inland permafrost exposure, that never experienced maritime influence, located in the Yana Uplands. This is the region in Northern Yakutia, Russia, where the Pole of Cold of the northern Hemisphere, Verkhoyansk, is found. In conditions perfect for permafrost preservation, 50 km from Verkhoyansk, forms the Batagay mega thaw slump. This is a 800 meter in diameter and 73 m deep permafrost exposure, where syngenetic deposits preserve organism remains. We provide a detailed stratigraphic description of this profile and present results of cryolithological and geochemical analyses to deduce the genesis of the permafrost sequence. Radiocarbon and OSL dating results set the temporal frame of accumulation of the studied material from the Middle Pleistocene age till today. Results of carpological, palynological, entomological analyses allow us to reconstruct vegetation patterns of Eemian Interstadial (120-127 ka BP) and Sartan Stadial (26 ka BP).

ID: 01568, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Palynological records of the Labrador Sea during the intensification of the North Hemisphere glaciation

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The Pliocene-Pleistocene transition (2.58 Ma) was marked by global changes, including a significant reduction in the concentration of atmospheric CO^2 (~ 400 ppm to 180-280 ppm vs. Pliocene to Pleistocene), and an intensification of the Northern Hemisphere glaciation that led to the establishment of the Greenland ice sheet. If the Greenland ice sheet is the only one in the northern hemisphere have persisted during the Pleistocene interglacial (unlike the Laurentide ice sheet or Innuitian for example), it is currently threatened by the recent climatic changes.

We investigate the marine and terrestrial palynological record from marine core sediment collected in the Labrador Sea southwest Greenland (Site IODP U1307) in order to assess on the vegetation over southern Greenland from pollen and spore and oceanic surface condition from dinocysts during the Pliocene to Pleistocene transition (from 3.3 to 2.3 Ma).

The pollen assemblages of Pliocene climatic optimum suggest input from boreal-type forests located in a relatively proximal source, likely the southwest Greenland. In contrast, the assemblages of the early Pleistocene characterized by low pollen concentrations together with higher proportion of herb taxa may indicate that more open tundra-like vegetation established in the source area. The dinocyst assembages of the Pliocene are more variable but suggest cool, low saline environment and stratified surface water mass, not unlike those prevailing presently along the the southeastern Canadian margins. The palynological assemblage also contains abundant acritarchs, which probably belong to green algae and are often associated with epicontinental marine environments and high primary productivity in the fossil records.

ID: 01683, 01.- Open Session on past global changes, (Poster)

A new Holocene record of geomagnetic secular variation from Windermere, UK, and a new northern North Atlantic geomagnetic reference curve

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Palaeomagnetic secular variation (PSV) records serve as valuable independent stratigraphic correlation and dating tools for marine and terrestrial sediment sequences, and enhance knowledge of geomagnetic field dynamics. We present a new radiocarbon-dated record (WINPSV-12K) of Holocene geomagnetic secular variation from Windermere, updating the UK master PSV curve.

Our analyses used continuous u-channel samples taken from the center of four sediment cores retrieved from Windermere in 2012. The natural remnant magnetization (NRM) of each U-channel was measured before and after stepwise alternating field (AF) demagnetization on a superconducting rock magnetometer at every 0.5-cm or 1-cm interval resolution. The NRM data reveal a stable and well-defined primary magnetization.

Component declinations and inclinations estimated using Principal Component Analysis (PCA) of NRM data from the four Windermere cores correlate well on their independent radiocarbon age models. The four records were stacked using a sliding window bootstrap method. On centennial timescales WINPSV-12K correlates well with other records from western Europe and the northern North Atlantic to a resolution of a few centuries, given age uncertainties and spatial variability between records.

The WINPSV-12K curves were then stacked against six other records from the north Atlantic geomagnetic region, resulting in a new regional PSV reference curve (NATPSV-12K) which contains characteristic features including a declination peak at 2.3 cal ka BP and an inclination trough at 5.15 cal ka BP. NATPSV-12K provides a regional PSV reference curve whose prominent features may serve as stratigraphic markers for north Atlantic palaeorecords.

ID: 01708, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

A new high resolution deglacial record from Windermere, UK

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A new deglacial sediment record is presented from Windermere, UK, including the first glaciolacustrine varve record from a currently active British or Irish lake. The cores, recovered in 2012, have undergone extensive electron microscope analysis of resin-embedded thin sections to identify sub-mm scale varve boundaries and other micro-scale features, augmented by X-radiography, ITRAX XRF geochemical analysis, and other complementary techniques.

Annual laminations form a major part of the sequence, documenting the overall deglaciation of the catchment as well as interannual to centennial-scale climate variability. Varves from prior to the Lateglacial Interstadial (~GI-1) indicate that ice retreated up the catchment rapidly enough for a transition from glacial to nival varves in just two to three decades. Organic-rich, intermittently laminated muds with diatom laminae from the Lateglacial Interstadial record increases in lake productivity during climatic amelioration. The succeeding Loch Lomond Stadial (~GS-1) is represented by varves from a nival-dominated catchment and shows the potential for the development of a precise varve-dated chronology. The excellent resolution and location of the Windermere varve records will enable new constraints to be placed on the nature and timing of deglacial and Lateglacial climate changes with respect to Greenland and Northern Europe, and allow the identification of leads and lags in the climate system of the region.

ID: 01369, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Response of Sandy Lake in Schirmacher Oasis, East Antarctica to the glacial-interglacial climate shift

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Freshwater lakes in Antarctica fluctuate from ice-free state (during austral summer) to ice-cover state (during austral winter). Hence the lake respond instantly to the seasonal climate of the region. The Antarctic seasons respond sharply to the glacial and interglacial climates and these signatures are archived in the lake sediments. A sediment core from Sandy Lake, a periglacial-lake located in Schirmacher Oasis of East Antarctica records distinct changes in grain-size, C, N, C/N ratios (atomic), $\delta^{13}C_{OM}$ and $\delta^{15}N_{OM}$ contents during the last 36 ky. The contents of the sedimentary organic matter (OM) proxies (C_{org} ~0.3 ± 0.2 %, C/N ratios ~9 ± 5 and $d^{13}C_{OM}$ ~ -18 ± 6 ‰) indicate that the OM in this lake sediment is a product of mixing of terrestrial and lacustrine biomass. Distinctly lower contents of C_{org} (~0.2 %) and sand (~50 %), low C/N ratios (~8) and depleted $d^{13}C_{OM}$ (~ -20 ‰) during the Last Glacial Maximum (LGM: 32-17 ky BP based on Vostok Temperatures) suggest greater internal (autochthonous) provenance of organic matter and limited terrestrial (allochthonous) inputs probably due to long and intense winters in the Antarctic. Such intense winters might have resulted the lake surface to be ice-covered for most part of the year when the temperatures remained consistently colder than the Holocene temperatures. The denitrification within the lake evident by enriched $d^{15}N_{OM}$ (>10 ‰) during Antarctic LGM might have resulted from oxygen-limitation within the lake environment caused by insulated lake surface. The gradual increases in $d^{13}C_{OM}$, C/N and sand content starting at ~11 ky BP and attaining high values (~−11 ‰, ~10 and ~80 % respectively) at ~ 6 ky BP together suggest a subtle change in the balance of sources of organic matter between algal and macrophyte/bryophyte nearly 8-9 ky later to the beginning of the deglaciation. Thus the seasonal opening-up of the Sandy Lake similar to the modern pattern started with the establishment of the optimum temperature conditions (i.e., 0 °C anomaly) in the Antarctic, prior to which the lake environment might have remained mostly insulated or closed.

ID: 01993, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Baery knolls - unusual landforms in the Northern Caspian Plain

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Keywords: Northern Caspian Plain, bottom accumulative forms, morphology, lithology, lamination, ‘sheet’ stream.

There are many such forms on the North Caspian lowland, where the author and colleagues conducted detailed geologic and geomorphologic field surveys. On the south, the range of altitudes of Baer knolls (BK) reaches 10-12 m, and the hills have a general southwest orientation. The described landforms are the same BK as those developed along the Volga delta. The sediments composing the BK consist of alternations of clay, silt and sand. They contain a rich complex of brackish water ostracods, detritus and even whole shells, which indicate their subaqueous genesis. During the Late Khvalyn, currents dominated in a large lagoon. Chocolate clay (CC) deposited in it. These currents were not linked to the littoral zone with wave activity, as granular composition of the deposits, their sorting and type of lamination are not peculiar to sediments of a coastal marine zone. They are characteristic of unidirectional currents with frequently changing velocities. Water from the lagoon flowed through the Manych passage into the Black Sea in the Late Khvalyn. Hence, last connection of the Caspian Black and Black Sea was at the end of the Late Khvalynian time (Early Holocene). At first, the water overflowed through the Manych passage (minimal width of 2 km) from the Caspian to the Black Sea; then, it reversed and flowed from the Black Sea to the Caspian Sea. At this time, when the most recent alluvial dam had not yet formed yet in Manych, there was infiltration of *Cerastoderma glaucum* to the Caspian Sea. Discusses the landforms similar to BK, in particular, the long ridges in the south of Western Siberia.

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ID: 01526, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Precipitation, temperature, and teleconnection signals across the combined North American, Monsoon Asia, and Old World Drought Atlases

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The tree-ring-based North American Drought Atlas (NADA), Monsoon Asia Drought Atlas (MADA), and Old World Drought Atlas (OWDA) collectively yield a near-hemispheric gridded reconstruction of hydroclimate variability over the last millennium. To test the robustness of the large-scale representation of hydroclimate variability across the drought atlases, the joint expression of seasonal climate variability and teleconnections in the NADA, MADA, and OWDA are compared against two global, observation-based PDSI products. Dominantly positive (negative) correlations are determined between seasonal precipitation (surface air temperature) and collocated tree-ring-based PDSI, with average Pearson’s correlation coefficients increasing in magnitude from boreal winter to summer. Precipitation correlations tend to be stronger in the boreal winter and summer when calculated for the observed PDSI record, while temperature correlations remain similar between tree-ring PDSI and observed PDSI. Notwithstanding these differences, the drought atlases robustly express teleconnection patterns associated with the El Niño-Southern Oscillation, North Atlantic Oscillation, Pacific Decadal Oscillation, and Atlantic Multidecadal Oscillation. These robust expressions in boreal summer PDSI reconstructions are despite the fact that the modes of climate variability have the largest hydroclimatic impacts in the Northern Hemisphere during the boreal winter, with the exception of the Atlantic Multidecadal Oscillation, which has the largest hydroclimatic signal during the boreal summer. Our findings confirm that the joint Northern Hemisphere drought atlases combine to robustly reflect large-scale patterns of hydroclimate variability on seasonal to multidecadal timescales over the 20th century and are likely to provide similarly robust estimates of hydroclimate variability prior to the existence of widespread instrumental data.

ID: 01723, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Pedological response to the dynamics alteration in environment of the Lover Volga region in the last macrocycle.

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Buried soils, that keep environmental information in their features, provide an excellent opportunity to reconstruct paleoenvironments preceding burial. Numerous horizons of buried soils have been recorded in sedimentary sequences of Lower Volga region and has been used for paleogeographic and geomorphological studies, stratigraphic correlations in the area. However, paleopedological work in the region have been starting for the first time. The Srednyaya Akhtuba site is a marine terrace, located on the left bank of the Akhtuba River, the upper part of Lower Volga region. The site represented by 6 pedogenetic levels, including 7 soils (MIS1-MIS5) separated by sediments of different structure and genesis. The upper part of the section (0-150 cm) presented by a typical soil Kastanzem (MIS1). Parent rock material is a great pack (>1m) of the Caspian marine sediments, represented by a series of layers of «chocolate clays» (MIS2) with interbedding sand layers. Lower parts, is represented by a sequence (520-670 cm), formed during Atelian regression of the Caspian Sea (MIS3-MIS4), presented by one well-developed soil with truncated humus horizon and two loessic layers with signs of soil formation (rhizolithes, manganese nodule, cryogenesis structure and etc.) in MIS3 stage. From a depth of 1530 cm begins thick layer of loess-soil series, presented by MIS5a-e Mezin pedocomplex (Eemian), correlating to the Late Khazarian and Girkanian transgressions, with three well-preserved soils. Three paleosols have common features: semi terrestrial genesis with gleyic features due to long-term seasonal overflooding; well developed humus horizons and complex assemblage of carbonate neoformations, formed under steppe environment. Pedogenetic horizons serve as good stratigraphic markers that will help to correlate late Pleistocene soil-sedimentary sequences of the whole Caspian-Azov-Black sea region, East European Plain and link it with global stratigraphic schemes.

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ID: 01575, 01.- Open Session on past global changes, (Poster)

Seasonal variability of biomarker flux in the Chukchi Sea (Western Arctic) and their relevance for sea-ice cover reconstruction

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Assessment of spatial and temporal changes of sea ice in the Arctic Ocean is of importance for understanding causes for the recent decrease in Arctic sea ice cover. In this context, the emerging biomarkers Highly Branched Isopronoids (HBIs) biosynthesized exclusively by sea-ice dwelling diatoms have proven to be useful for reconstructing past sea ice distributions. We report on the export of HBIs, phytosterols and n-alkanes determined in sinking material collected in the Chukchi Sea plateau, an area where data are still very scarce. Vertical fluxes of $IP_{25,}$ HBI III and brassicasterol acquired over one year were combined to improve the use of these seasonal sea ice proxies.

Sediment traps were deployed at a water depth of 870 m from August 2008 to September 2009. Highest mass flux values occured from mid-July 2009 to September 2009. During all other months (i.e. December 2008 to June 2009) fluxes were fairly low. The absence of IP_{25} from November 2008 to June 2009 is consistent with predominantly sea ice covered conditions and limited export. Summer 2009 was characterized by higher sea ice algae and pelagic phytoplankton production compatible with ice edge conditions ending with the onset of new-ice formation late September. In contrast, end of summer 2008 high flux values of IP_{25} and HBI triene (HBI III) are suggestive of a complete melting of sea ice in the mooring area as attested by remote sensing data.

Surface sediments were also collected to examine the spatial sea-ice distribution in the Western Arctic. Surface sediments show higher IP_{25} values in the South-East Chukchi Sea decreasing westwards due to less severe sea ice conditions. The spatial sedimentary phytosterol distribution shows enhanced primary productivity in the seasonally ice free zone in the Southern Chukchi Sea (<70°N).

ID: 01834, 06.- Before and after - climate contrasts across the MPT, (Poster)

Radiometric dating of glacial terminations through the MPT

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The mechanisms that force glacial terminations constitute an ongoing debate in palaeoclimatology. A key to resolving this debate is the assembly of precisely dated proxy records that can be tied to marine sediments, where the expression of these events is best preserved but poorly anchored in time. Speleothems provide one means by which to achieve this. Over the past decade, speleothems have been used to shed light on the timing of terminations, and currently there appears to be a consensus that favours Northern Hemisphere summer insolation as the driving force, at least back to about 600 ka. The period 1.2 Ma to 0.6 Ma, which includes the Middle Pleistocene Transition (MPT), thus stands out as absolutely crucial for determining exactly when the pacing shifted from an obliquity-driven 40-kyr world.

We present speleothem data from an Italian cave system spanning multiple terminations across the MPT (1.1 Ma to 0.8 Ma), and tie these to marine records from the North Atlantic. The speleothem time series is anchored radiometrically by over 100 uranium-lead age determinations. Synchronising the oxygen isotope data to the ocean record allows us to fix the benthic oxygen isotope ice-volume proxy to an absolute time scale, thus allowing us to constrain the timing of ice-sheet collapse and to explore the potential astronomical parameters responsible. The most significant findings thus far are the pacing of Terminations XII and X, which are separated by two obliquity cycles, and the poor expression of T-XI, arguably a 'failed termination', which together appear to spell the demise of the 40-kyr world.

ID: 02192, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Late Holocene glacier activity on the Kerguelen Island, South Indian Ocean - reconstructed from distal glacier-fed lake sediments

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The Southern Hemisphere`s westerly winds play a vital role in regulating Earth`s climate by shielding Antarctic ice from low-latitude heat, driving global ocean circulation and storing vast amounts of CO2. Both strength and position of this globally significant atmospheric pattern are rapidly shifting in the face of ongoing warming. A string of recent studies links these developments to dramatic changes in temperature, precipitation, sea-ice extent and cryosphere stability unfolding throughout the Southern Ocean region. Critically, a lack of baseline information restricts our ability to understand the causes and patterns of these shifts and represent them in the future projections that underpin climate policies. Especially in the Southern Ocean, there are few time series recording past climate due to few suitable land areas and the few Sub-Antarctic Islands is remote and has cumbersome logistics. Kerguelen Island is located within the Antarctic Circumpolar Current and the Southern Westerly wind belt and contains several glaciers and smaller ice caps. Terrestrial archives recording past history of the glaciers at Kerguelen thus have a unique potential to record past changes in oceanic and atmospheric circulation patterns from southern mid-latitudes. Here we present results from the first distal glacier-fed lake study at the Kerguelen Island. A 2.8 m long sediment core was obtained from Lac Guynemer (121masl.), a lake that receives glacial meltwater from Glacier Guynemer at the Pic Guynemer (1188masl.), located at the Peninsule Loranchet at the northern part of Kerguelen Island. The sediment core has been analyzed with high-resolution core scanning X-ray fluorescence (XRF), CT scanning, magnetic parameters, loss-on-ignition and dry bulk density, to reconstruct past glacier variability of Glacier Guynemer. The sediment record covers an interval over c. 1000-3500 cal. yr BP and show dynamic glacier variability during the Neoglacial time-period, in phase with other glaciers reconstructed from the Southern Hemisphere.

ID: 01896, 01.- Open Session on past global changes, (Poster)

Centennial-scale Holocene climate variations amplified by Antarctic Ice Sheet discharge

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Interactions between the Antarctic Ice Sheet and the rest of the climate system are known to have affected centennial- to orbital-scale climate variability during past glaciations and are likely to be important in future climate change. However, here we show that they were also potentially important in driving centennial to multi-millennial climate variations during the Holocene, a period for which the Antarctic Ice Sheet is generally considered a static entity. We analyzed high-temporal-resolution records of iceberg-rafted debris derived from the Antarctic Ice Sheet, and performed both high-spatial-resolution ice-sheet modeling of the Antarctic Ice Sheet and multi-millennial global climate model simulations. Fluctuations in Antarctic Ice Sheet discharge caused by relatively small changes in subsurface ocean temperatures can amplify multi-centennial climate variability regionally and globally and suggest that the Antarctic Ice Sheet may have been more dynamic during the Holocene then previously anticipated. Newly performed high-resolution climate simulations with the CESM global climate model, suggest that Antarctic Ice Sheet discharge fluctuations also cause low latitude climate change through oceanic and atmospheric teleconnections.

ID: 02143, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Non-stationarity in the evolution of major floods in the Ebro River (NE Iberian Peninsula)

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Flood frequency analysis is a required step when determining the flood risk of a given location. It uses series of annual maximum instantaneous flows (Qci), which are frequently too short (50-100 years) to calculate long return periods (around 500 years). To lengthen these series, information about non-instrumental historical floods is used by means a reconstructed peak flow or only the occurrence of an over-bank flooding. However, when using this information, the stationarity hypothesis is no longer fulfilled (Milly et al., 2008).

In this study we analyzed the evolution of major floods in the final stretch of Ebro River (at the town of Xerta) in the last 400 years. Besides the 20th century measured peak flow series, 9 reconstructed peak flows and the knowledge of the occurrence of every flood above 4500 $m^3 \cdot s^{-1}$ are included in the dataset. The obtained series is not stationary according to Lang test (Lang et al., 2005), so we applied a flood frequency method that includes covariates to account for the variability of flood frequency. These covariates include two climatic indices (NAO and WeMO), a reservoir index, meteorological variables (temperature, pressure) and an astronomical one (sunspots). The statistical method used is GAMLSS (generalized additive models for location, scale and shape).

Several probability functions have been fitted to the series with the GAMLSS method and the covariates. In the case of the Gumbel function, for a return period of 20 years (95% percentile), the expected peak flow continuously increases since the year 1600 (4100 $m^3 \cdot s^{-1}$) until reaching a maximum around 1850 (4500 $m^3 \cdot s^{-1}$), then it stays approximately constant for 100 years, and diminishes abruptly to 3700 $m^3 \cdot s^{-1}$ since 1950 because of the generalized dam construction. In contrast, a stationary analysis would have overestimated it (4250 $m^3 \cdot s^{-1}$).

ID: 02144, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Indirect estimation from paleoflood evidences of the liquid and solid loads of the November 2015 and 2016 flash floods in the Sió River (NE Iberian Peninsula)

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Flash floods in the rural catchments of the Catalan Central Depression (NE Iberian Peninsula) usually have a great sediment load, with its source in the agricultural soils. This high sediment load can even alter the hydraulic behavior of the flow, turning them into actual mudflows.

The night of 2-3 November 2015 torrential rains (up to 146 mm in ten hours) fell on the headwaters of the Sió River catchment (512 km^2), generating a flood that claimed four lives in the town of Agramunt and caused many damages along the stream banks. The night of 23-24 November 2016, a slightly more moderate rain event (46 mm), also cause a flash flood, but with much less catastrophic consequences. In order to gain a better insight on the characteristics of the major historical floods in the Sió River catchment, the hydrological, hydraulic and sedimentary characteristics of these recent floods have been analyzed using paleoflood evidence, water samples and flood reconstruction methods.

The peak flow of the 2015 flood in the headwaters (Oluges) was 150 $m^3·s^{-1}$ (that is, a specific peak flow near 4.2 $m^3·s^{-1}·km^{-2}$) and it diminished downstream: 45 $m^3·s^{-1}$ in the centre of the catchment (Oluges + 27 km) and 8 $m^3·s^{-1}$ in the outlet (Oluges + 63 km). The suspended sediment load was 10-15% in volume in the headwaters and it increased as the flow moved downstream. This concentration gain was most probably caused by the flood wave's water loss due to the dryness of the riverbed and translated in an increased viscosity that ultimately altered the hydraulic behaviour of the flow, slowing it down. The source of the sediment is located in the agricultural soils, which showed evidence of intense erosion by Hortonian overland flow in their superficial layer (Ap1; 10 cm).

ID: 02362, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Preliminary evidences of ancient wetter episodes in the Theban Mountains (Egypt)

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Field survey along the Theban Mountains revealed the existence of two weathering formations whose development must be related to wetter than present climatic conditions, and their relative chronology is tentatively stated. A first episode of humidity is evidenced by an extensive iron coating development on scree deposits associated to an ancient erosional surface previous to the present fluvial incision. Water is necessary to the chemical weathering of hostrock and dusts, leading to the mobilization of iron and manganese ions. Subsequent deposition of these ions leads to the formation of rock coatings. Coatings can be formed as moisture from rain, fog, and dew interacts with detrital materials on rock surfaces under favorable redox conditions. The age of this formation is set at the middle – late Pleistocene since it is affecting early Pleistocene fluvial deposits.

The second evidence of former humid conditions is a reddish soil also extensively developed along the foothills of the Theban Mountains, what cannot have been developed under the present hyper-arid conditions. Precisely, the high iron content of these edaphic materials may come from the ferruginous coatings cited above. Relative chronology of this soil allows us to correlate it provisionally with the African Humid Period (early-mid Holocene). Preliminary analytical results of both weathering formations are presented here.

Besides these weathering formations, at least two gravitational collapse events have been identified, helping in the reconstruction of the climatic-geomorphological history of the area since the early Pleistocene.

ID: 01427, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Climatic variability in western Mediterranean during the last glacial cycle (ca.130-14kyBP): evidences from an island setting (Formentera, Balearic Is., Spain).

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The changing climatic and sea level history along the last glacial cycle (ca. 130 - 14 ky BP) in Formentera (Balearic Islands) is approached. Geomorphological, sedimentological, palaeontological and geochemical studies have been used in the reconstruction of the evolution of the coastal system. Luminescence dating supports chronology, and phytolith content has been determined and applied in the vegetation cover reconstruction. The sedimentary succession outcropping along the southwestern coast of the island is continuous and complete enough to investigate the sea-level and climatic changes occurred in this part of the Western Mediterranean along the late Pleistocene. The sequence starts with three marine units separated by erosional surfaces with evidences of small-scale sea level oscillations occurred during MIS 5. Up to six terrestrial units, mainly formed by aeolian and alluvial deposits, complete the sequence. Environmental reconstruction shows the occurrence of different phases of wind intensification with changes in wind patterns, and phases of alluvial deposition, soil development and vegetation changes. All these phases are correlated with the climatic variability reported for the North Atlantic region, which is manifested in the Western Mediterranean by paleoceanographic changes and rapid vegetation response in inland settings, however no complete and continuous sedimentary sequence recording this time span has been reported up to now in theses islands. A tentative correlation of the sedimentary sequence with Dansgaard – Oescher cycles and Heinrich events is proposed. Supported by CGL15-69919-R, CGL2015-67169-P, CGL2013-42847R.

ID: 01979, 18.- Human Impact on Global Aquatic Systems, (Poster)

Assessing salinity variations in brackish Chilika Lake – a multiproxy approach

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Chilika, the largest coastal brackish water lake of Holocene period, is connected to the Bay of Bengal through narrow channels allowing saline water into the lake during the high tide. On the other hand, the Lake also receives a huge amount of fresh water and terrestrial sediments from the rivers flowing into it on the northern sector. On account of its rich biodiversity and socio-economic importance, it was designated as a 'Ramsar site' on Oct. 1, 1981.

In this study, one representative sediment core of 75 cm depth was obtained from the northern sector of the lake which is in proximity to the fresh water source. These sediments spanning over few centuries time period are taken into consideration to evaluate fluvial interaction in the lake using Sedimentological, Micropaleontological and Geochemical proxies. The upper portions (0-30 cm) of the cores consist of medium size sand particles and mud content is found increasing with depth. Brackish shallow water benthic foraminifera were picked, identified and counted up to the species level at every 5 cm interval. *Ammonia sp.* was the most dominated species and found to have weak and fragile test at all depths and their population showed sharp increase from 30 cm depth onwards. The increase in foraminifer's population and high mud content in 30-75 cm suggests high salinity whereas low to negligible presence of foraminifera and medium sand size from surface to 30 cm depth indicates low salinity in the lake. Incorporation of Fe, Mn and few other elements were found during SEM-EDS analysis on the calcareous test of foraminifera. The presence of pyritised foraminifera indicate anoxic conditions at depth below 30cm. Multivariate variate analysis of foraminifera and elemental data on its test and grain size analysis indicate increased fluvial impact and low salinity during the deposition of upper 30cm sediments.

ID: 01546, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Poster)

Relative sea-level variability during the late Middle Pleistocene: new evidence from eastern England

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Understanding relative sea-level changes during previous interglacials enhances our understanding of ice sheet response to changing climate. Temperate-latitude estuarine environments have the potential to preserve continuous records of relative sea level from previous interglacial (warm) periods. This is important because, currently, we typically only have snapshots of sea-level highstands from low-latitude sediment archives. Here, we focus on the Nar Valley in eastern England, in which, is preserved evidence of a late middle-Pleistocene marine transgression of greater than 20 vertical metres. By applying a 'Holocene-type' approach to reconstructing relative sea-level change in estuarine settings, using models of coastal succession and sea-level tendencies, we assess the mode (abrupt versus gradual), of sea-level change recorded by the interglacial Nar Valley sequences. Compiled palaeo-stratigraphic evidence comprising foraminifera, pollen and amino acid racemization dating, suggests that the mode of sea-level change in the Nar Valley interglacial sequence was gradual, with potentially two phases of regional transgression occurring at two separate times: the first phase during the Late Temperate phase of Marine Oxygen Isotope stage (MIS) 11 from ~8 to 18 m OD; and, the second phase potentially from the Early Temperate period of MIS 9 from ~-3 to 3 m OD, although we cannot conclusively preclude an alternative MIS 11 age for these lower sediments. The absence of one or more sea-level oscillations in, the (albeit limited) datasets, does not suggest catastrophic decay of the ice sheets during the MIS 11 and 9 highstands, instead implying steady melt during both of these interglacials.

ID: 01308, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Poster)

Salt-marsh testate amoebae as a novel tool for reconstructing regional sea-level changes in eastern Canada

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Salt-marsh sediments and coastal deposits are routinely used to reconstruct relative sea-level (RSL) changes over the past few millennia at decadal and decimetre scale resolutions. Recently, progress has been made on the development of salt-marsh testate amoebae as a widely applicable and precise sea-level indicator. This contribution demonstrates the cosmopolitan vertical zonation of salt-marsh testate amoebae across the North Atlantic and presents results from the development of an applied regional training set of surface assemblage data. Recent and original late Holocene RSL reconstructions have been produced from eastern Canada using salt-marsh testate amoebae alongside foraminifera and other sea-level indicators. These reconstructions document differences in rates of RSL rise as a result of: i) local environmental dynamics; ii) isostatic uplift gradients and associated geophysical mechanisms; iii) regional processes governing ocean volume changes (e.g., ice-sheet dynamics and thermal expansion), and iv) drivers forcing ocean mass redistribution (e.g., ocean-atmosphere circulation patterns). The records show accelerations in the rates of RSL rise towards the end of the 19th century and during the early 20th century. Similar signals have been recorded from palaeo-evidence at several locations across the globe. These inflexions coincide with the increase in global temperature seen since the onset of industrialisation and with a downturn in the strength of the Atlantic Meridional Overturning Circulation. Improving multi-proxy reconstructions, their chronologies, and their spatial coverage will be necessary for teasing apart the different mechanisms that drive RSL changes at local to regional scales. Mechanisms such as land-based ice-melt and ocean circulation changes currently contribute to rapid RSL rise during the 21st century but are yet to be accurately and precisely constrained for our recent past.

ID: 01772, 01.- Open Session on past global changes, (Poster)

A 7500 year history of El Niño-Southern Oscillation variability derived from a quantitative Australian precipitation record

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The opposing El Niño and La Niña phases of the El Niño-Southern Oscillation (ENSO) have major impacts on regional rainfall patterns that affect billions of people worldwide. It is, therefore, critical to understand how these phases will change under future climates. Palaeoclimate proxy data can help to refine our understanding, but this requires a broad spatial distribution of long records that span differing background conditions and forcings, such as was evident during the Holocene. However, the current suite of Holocene proxy ENSO records are generally discontinuous, low resolution, spatially biased to the eastern Pacific or document only the El Niño phase. As such, the scale and timing of Holocene ENSO variability remains unclear.

Here we present a quantitative rainfall reconstruction from sub-tropical Australia, derived from the $\delta^{13}C$ of sub-fossil *Melaleuca quinquenervia* leaves preserved in lake sediments, that records El Niño and La Niña conditions over the past 7500 years. Capturing both phases enables the characterisation of mid- and late-Holocene ENSO variability, while tight chronological control facilitates precise timing of regime shifts. The mid-Holocene is characterised by more La Niña-like background conditions, before a significant shift towards increased variability and more frequent El Niño conditions is evident ca. 3200 cal yr BP. These conditions prevailed until the Little Ice Age, in which persistently wet conditions are evident.

In addition to being the first quantitative rainfall record of its type from Australia, the record also provides insight into the evolution of ENSO over the mid- to late-Holocene and the influence of forcing mechanisms external to the Pacific region.

ID: 01736, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Quantifying sediment delivery during floods in Mediterranean mountain watersheds using lake sediment records (Iberian Range, Spain)

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Long-term records in sediment yield beyond monitoring data from experimental catchments are particularly important in Mediterranean areas where land degradation and soil erosion are key environmental problems underlain by both a long history of human occupation and strong seasonality of hydrological regimes. Integrating time-series from lake sequences based on robust age models and detailed bathymetric maps and seismic surveys provide the needed long perspective of erosion processes in Mediterranean mountain watersheds.

We applied multi-proxy sedimentological and geochemical analyses to the sedimentary record of four karstic lakes in the Iberian Range (Central Spain) to identify and quantify periods and events of higher sediment input to the lake and indirectly, the sedimentary yield evolution of their watersheds. We evaluate the response to human impacts and climate forcings during the last 2000 years by comparing with regional climate reconstructions and documentary and historical records.

Sediment yield data during flood events show similar ranges both in lake sequences and in monitored catchments (7-110 T km^{-2} y^{-1}). In both settings, most sediment delivery at annual and multiannual scales occurs during flooding events, underlying the punctuated nature of sediment dynamics in Mediterranean landscapes. The most significant periods of increased sediment delivery in the Iberian Ranges during last two millennia took place during the 6th-8th, 10th-12th, 15th-17th and 19th-early 20th centuries. Increased flood frequency and synergistic effects associated to increasing human pressure led to enhanced erosion during some periods of the Little Ice Age. Although changes in flood frequency and intensity cannot be ruled out, reduced human pressure since the mid 20th century in rural areas seems to be the major forcing to explain current decrease in sediment yields.

ID: 01738, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Paleohydrology, climate and land-use changes during the last two millennia in the Iberian Peninsula

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High-resolution, multi-proxy lake records from Iberian Mediterranean mountains with robust chronologies have allowed the identification of centennial to decadal scale paleohydrological fluctuations during the last 2000 years within the Iberian Peninsula. The dataset illustrates sharp regional gradients and timing differences when compared to climate changes recorded in Northern European records. Furthermore, these fluctuations show a large internal variability both in terms of timing and paleohydrological history in the Iberian Peninsula.

Several factors may be responsible for this variability, mainly the interplay between Atlantic (NAO fluctuations) and Mediterranean influences and geographic factors as latitudinal and altitudinal gradients which imply a complex mosaic.

In spite of some uncertainties, the main paleohydrological phases in Iberian Peninsula during the last two millennia appear in most records: a humid Iberian-Roman period (IRHP, 650 BCE – CE 350) particularly wetter between CE 300 – 350, relatively colder and wet conditions during the Dark Ages (CE 500 – 900), a well characterized Medieval Climate Anomaly (MCA, CE 900 – 1300) with lower water levels but variable flood frequency, and a contrasting relatively wet Little Ice Age (LIA, CE 1300 – 1850) with forest spread in the mountains, stationary flood conditions and increased sediment delivery to the lacustrine basins. Periods of increased human pressure in the landscape occurred both during warmer phases (IRHP and MCA) and colder periods (LIA) with diverse environmental and human adaptive strategies.

ID: 01907, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

PALEOSTRAT: PALEOmodelization from a STRATospheric perspective

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Last Millennium (LM) simulations are crucial to asses the relative roles of internal versus forced variability, the responses to natural and anthropogenic forcings, and the climate sensitivity of the Earth system. However, many open questions still remain regarding the ability of these models to reproduce the LM, since reconstructions suggest more complex patterns than those obtained from LM simulations. Among other factors, these discrepancies could be due to uncertainties in the forcings and/or in model physics. In particular, recent studies have demonstrated the influence of the stratosphere on the surface with important implications in future climate projections. However, most models employed in PMIP3 did not have a well-resolved stratosphere, thus neglecting its potential contribution to explain anomalous periods before the industrial era.

PALEOSTRAT is a project funded by the Spanish government which investigates the impact of the stratosphere on the climate of the LM (850-1850 CE). This is addressed by means of a suite of LM simulations with the CESM model which only differ in the representation of the stratosphere, so that their comparisons will provide insights into the impact of the middle-atmosphere on the surface climate. Uncertainties related to external forcings will also be assessed by comparing business-as-usual LM model simulations with LM runs forced with novel external forcing histories and model implementations. This talk will summarize the influence of the stratosphere on the surface climate, its potential role in explaining past changes, the main objectives of PALEOSTRAT and its experimental design.

Acknowlegdements: PALEOSTRAT (CGL2015-69699-R) is funded by the Spanish Ministry of Economy and Competitiveness (MINECO)

ID: 02064, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Climate variability inferred from several speleothems in Central Pyrenees during MIS 3, Lateglacial and Holocene (Las Gloces Cave)

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Las Gloces Cave is located close to Ordesa and Monte Perdido National Park (Central Pyrenees, Iberian Peninsula) at 1300 m a.s.l. Four speleothems, three of them from the Holocene and one from the Lateglacial and MIS 3, reveal important changes during these periods. During the MIS 3, $d^{13}C$ and $d^{18}O$ values show a variation of -1.89 to -6.03 ‰ and -7.63 to -8.78 ‰ respectively while a hiatus is recognized during Heinrich Event 5 (~45 kyr BP). A similar isotopic pattern between $d^{18}O$ and $d^{13}C$ points out that during the MIS 3, the oxygen was controlled mainly by the amount effect, although punctually also by temperature changes. Another import hiatus appears between 31-21 kyr BP in coherence with other speleothems from Southwest France (Genty et al., 2006). During the Lateglacial the heaviest $d^{13}C$ values (-0.79 to -0.46 ‰) took place from 20 kyr to 17.8 kyr coinciding with Heinrich Event 1, characterized as a cold and dry period in this area throughout the study of lacustrine deposits (González-Sampériz et al., 2006; Moreno et al., 2012). A rapid depletion of $d^{13}C$ values can be associated with a climatic amelioration until ~8.7 kyr BP when the values reach to -8.13‰. On the other hand, $d^{18}O$ shows heavy values during 20-17.8 kyr BP, associated with the low rainfall amount. An important depletion occurs afterwards, at the same time as $d^{13}C$ values decrease , responding to the humidity increase in the area. From 12 kyr BP onwards, the $d^{18}O$ record appears less influenced by the amount effect and temperature and changes in the ice volume play a dominant role. The Early Holocene is characterized by still cold and dry conditions, in agreement with previous lacustrine and palynological Pyrenean records.

ID: 02065, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Is the climate signal adequately recorded in the □18O isotope composition from ice cave deposits? Climate variations during the Little Ice Age and the Industrial Era inferred from Pyrenean ice deposits and stalagmites

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Well-date ice deposits hosted in caves represent important new local-regional climate records of the past. Changes in ice accumulation rates are commonly used it to infer changes in the snow precipitation in winter or indicators of important melting processes associated with warm periods. We present preliminary record from Sarrios 1 Ice Cave, representing the first $d^{18}O$ record from an ice cave in the Pyrenees (2790 m asl, Monte Perdido Massif). In Sarrios 1 sequence, seven ^{14}C ages on organic macrorests allow to build a solid chronology where two important phases of ice accumulation are clearly discriminated. First phase took place between 6500 to 5200 years cal BP and is formed by transformation ice. Differently, second phase, separated by a hiatus of 4500 years, started to accumulate 670 years BP ago and is formed by ice resulting from dripwater congelation, providing an excellent archive of past climate variability during the LIA and the last decades. 121 ice samples were extracted from the second phase and the isotopic record (with $d^{18}O$ values varying between -21.14‰ to -6.06‰) is compared with previous data from Seso Cave located nearby but at lower elevation. $d^{18}O$ profile obtained from the ice shows a very similar pattern that the one recorded in the stalagmites, indicating a regional climate variation in terms of amount of rainfall or temperature, moreover, depleted $d^{18}O$ values in ice appears related with Spörer, Maunder and Dalton solar minima. Interestingly, the fact that Mg/Ca in the stalagmites presents a striking similarity with the $d^{18}O$ during the LIA, points out that this last record could be mostly influenced by the "amount effect", resulting in an excellent indicator of hydrological variability. On the contrary, both proxies (Mg/Ca and $d^{18}O$) are very different during the IE signaling the temperature as the dominant control during that period.

ID: 01682, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Contextualizing drought in Medieval Italy: A case-study of the 1302-04 CE events in Siena

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Documentary data on hydroclimate variability in the second millenium can a lot in comparison to the perspective of scientific data. Hence, the proposed case study on a multi-annual drought hitting Italy and neighbouring regions in the years 1302-1304 CE is meant to demonstrate what historians can contribute with their specific sources of climate-historical information:

Taking existing drought reconstructions from dendrochronological data, a comparison with dense information retrieved from chronicles and administrative sources shows that especially for the Italian peninsula the picture retrieved from man-made proxy data is far more nuanced. Beyond that, written sources provide a high spatial resolution to reconstruct the territories afflicted by drought, while the temporal resolution is higher than the annual scale available from scientific data.

Furthermore documentary data allows to review in detail the socio-economic impact of multi annual droughts on pre-modern societies. In the case of Siena and early 14th century Italy, this includes not only reduced harvests, dearth and partially famine, but also a remarkable increase in the number of city fires. In addition, the city's industrial production came to a standstill as water mills went out of work. The necessary remuneration of their owners by the comune added to the fiscal pressure created by grain imports to mitigate the increasing dearth. Most interesting is the long-term context of these events: In the case of Siena, the drought-induced dearth lead to large investments like a newly acquired sea port in late 1304, that should guarantee the city's access to long-distance grain trade. If the temporal perspective is widened to the 1290s, one can realize that the drought accelerated pre-existing legal and administrative measures that should provide Siena resilience against food scarcities. During the next meteorological crisis in the 1310s, Siena showed considerable less vulnerabilty to food shortages than other comparable Italian cities.

ID: 02226, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Impacts of the Last Glacial Cycle on Ground Surface Temperature Reconstructions over the Last Millennium

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Borehole temperature profiles provide robust estimates of past ground surface temperature changes, in agreement with meteorological data. Nevertheless, past climatic changes such as the Last Glacial Cycle (LGC) generated thermal effects in the subsurface that affect estimates of recent climatic change from geothermal data. We use an ensemble of ice sheet simulations spanning the last 120ka to assess the impact of the Laurentide ice sheet on recent ground surface temperature histories reconstructed from borehole temperature profiles over North America. When the thermal remnants of the LGC are removed, we find larger amounts of subsurface heat storage [2.8 times] and an increased warming of the ground surface over North America by 0.75 K, both relative to uncorrected borehole estimates.

ID: 01358, 18.- Human Impact on Global Aquatic Systems, (Poster)

Natural and anthropogenic changes in a Mediterranean delta as reconstructed from benthic foraminifera

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Deltas are highly dynamic ecosystems of great ecological and economical importance. Global change consequences, such as sea-level rise and sediment deficit, put these systems at risk. Sediments beneath deltas are the only archive for generating an understand of their formation and dynamics through time, also providing scientific knowledge for informing future adaptation strategies. We conducted a palaeoenvironmental study in the Ebro Delta (NW Mediterranean) using benthic foraminifera (unicellular protists) and their present-day environmental requirements. The benthic foraminiferal content of seven dated sedimentary records with ^{14}C and ^{210}Pb were analyzed at two different temporal scales: 1) Millennial scale reflecting a long enough temporal window for capturing large-scale natural changes in the Delta, such as delta-lobe switching and/ or sea-level fluctuations, and 2) Decadal-centennial scale to evaluate the anthropogenic impacts relative to pre-disturbance conditions in the Delta. Water depth appeared as the most important factor structuring living foraminiferal assemblages. We then developed and applied a water-depth transfer function and analogue matching to the fossil foraminiferal record with the aim of reconstructing palaeodepths and habitats. First, down-core assemblages indicated the existence of deltaic habitats (e.g. coastal lagoons) for the last *c.* 7500 yr BP. Second, recent reconstructions revealed distinct habitat shifts since the late 1800's, likely showing the effect of the intensive human alteration of the Delta due to agricultural activities (mainly rice cultivation). Finally, we hypothesize that foraminiferal proxies should be able to establish reference conditions in these Mediterranean wetland habitats before significant human intervention.

ID: 02161, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Sources of organic matter to Lago Castor (Chile, 45°S) during the late Quaternary: implications for the evolution of vegetation and the southern westerlies

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Lago Castor (45°S; 72°W) is located on the leeside of the Patagonian Andes, near the forest-steppe ecotone. It contains a continuous sediment record of the last 20 kyr, which we recently interpreted in terms of past changes in westerly wind strength, based on sediment physical properties and seismic data. Here, we use the bulk elemental and isotopic composition of the organic matter preserved in Lago Castor sediments to reconstruct changes in terrestrial vegetation composition and aquatic productivity through time. To constrain the sources, we analyzed samples of present-day terrestrial vegetation, lake plankton, river sediment, and soils. Results demonstrate that the lake sedimentary organic matter is composed of variable proportions of aquatic plankton and C3 and C4 terrestrial plants. The proportions of each component were estimated using a three end-member mixing model that takes into account the alteration of the isotopic values during incorporation of plant material in soils prior to transport by rivers. Results show that before 17.8 cal kyr BP, terrestrial vegetation was sparse and dominated by C4 plants (shrubs and some grasses), likely due to the increased rain-shadow effect of the Patagonian Ice Sheet. After 17.8 cal kyr BP, accumulation of organic matter of aquatic and terrestrial C3 origin increased, reflecting the progressive evolution of the regional climate towards temperate conditions. From 9.3 cal kyr BP onwards, the proportions of C4 and C3 plants resembled the present-day values, while accumulation rates of terrestrial organic matter peaked between 7.5 and 2 cal kyr BP. The latter is interpreted as a period of increased precipitation, and is in excellent agreement with the grain-size results previously obtained on the same sediment core. These results, which are broadly compatible with regional pollen records, highlight the potential of bulk organic geochemistry to reconstruct climate-driven variations in local vegetation composition.

ID: 01970, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Reconstructing the frequency of Glacial Lake Outburst Floods in Patagonia: Introducing the Paleo-GLOFs project

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Glacial Lake Outburst Floods (GLOFs) constitute a major threat in glacierized regions. They cause considerable damage to infrastructure and frequently result in the loss of livestock and human lives. Although the frequency and magnitude of GLOFs seem to have increased worldwide in the last decades, there is currently no reliable scientific evidence supporting this claim, largely due to a lack of flood records on timescales that extend beyond gauged river-flow datasets. This issue is particularly pronounced in Patagonia, where 15 GLOFs were documented between 2008 and 2014. During these events, the discharge of Baker river, which drains most of the eastern side of the Northern Patagonian Icefield, increases from 500–1000 to >3000 m3/sec, and river water level rises by 4–6 m. To investigate changes in GLOF frequency during the late Holocene we recently started investigating the flood deposits preserved in the sediments of Baker fjord, and in elevated lakes and peatbogs along Baker river. In addition, we mapped the bathymetry of the Baker fjord delta area and we deployed a mooring equipped with a sequential sediment trap and a turbidity logger to improve our understanding of how GLOFs are recorded in fjord sediments. Multibeam mapping results revealed the presence of channels deeply incised in the subaqueatic delta of Baker river, suggesting the existence of episodic turbidity currents, likely occurring during GLOFs. Preliminary results on the floodplain sediment cores indicate several flood-rich intervals alternating with periods of quiescence. In the near future, the cores will be dated using radiocarbon and radiogenic nuclides and the results will be compared to historical chronicles and glacier variability reconstructions to assess the possible relationships between GLOF frequency and climate change. We will also be testing the feasibility of REE and Nd, Pb and Hf isotopes to trace changes in GLOF provenance.

ID: 02141, 18.- Human Impact on Global Aquatic Systems, (Poster)

Holocene diatom community changes in a Pyrenean high altitude lake in relation to climate changes and local human impacts.

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Mountain lakes are very sensitive to climate changes and local human impacts. However, both types of forcing may act simultaneously on lake functioning, which can make sedimetary records difficult to interpret. Inthis study, we aimed at disentangling both effects using diatom community changes in a Pyrenean lake subjected to pastoralism fo millenia (Lake Gentau, Pyrénées-Atlantiques, France). We took a sediment core in the lake to reconstruct its paleoenvironmental conditions for the last 12,000 years, providing the first continuous record in the northern slope of the Pyrenees. Diatoms were analysed in combination with sediment inputs, lake productivity, loss-of-ignition and magnetic susceptibility. Nine diatom assemblage zone could be identified. Most transitions could be attributed to climate shifts, mainly at 9400-9100 and 7200-7100 cal BP. These affect ice-cover duration and summer stratification as well as spring and autumn overturns, with strong consequences for planctonic diatoms. However, we also identified two transitions which can be associated to changes in land use, at 1700 and 200 cal BP. These affect nutrient content, the littoral development of macrophytes, or acidity which in turn affect diatom assemblages compostion. Furthermore, one brief event at 2800 cal BP was likely the consequence of reduced solar activity, with strong climatic consequences, and the land abandonment, following cold conditions. Finally, we observed a recent (200 cal BP) increase of the in-lake productivity (decreasing C:N ratio) which should indicate increased algal productivity. Nevertheless, we simultaneously observed a rapid decrease of small planctonic Cyclotella species giving room to littoral species. This suggests a potential role of land use forcing, in contrast to previous studies associating climate warming to the increase of planctonic species during the same period. Our results provide new insights into the combined effects of climate change and local human impacts on lakes.

ID: 01524, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Sulfur Isotopes as a Tracer of Sea level variability

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Sulphur isotopes ($\delta^{34}S$) has played a crucial role in constraining the biogeochemical cycle in modern environment and proven to be a valuable tool in unravelling the early history of earth surface oxidation. Presence of high sea water sulphate yields to high reduced sulphur concentration in presence of high sedimentary organic carbon which stimulates the Bacterial Sulphate Reduction (BSR). BSR results in depleted $\delta^{34}S$ in sedimentary organic carbon compared to coexisting sulphate. Relict and active mudflats of Saurashtra coast, Gujarat from western India were investigated to decipher mid-late Holocene sea level variability based on sulphur isotopic variation. Saurashtra coast is an ideal platform for the study of Quaternary land-sea level interactions.

Saurashtra coast being tectonically active experiences sea regression which can be a function of local sea lowering, tectonic activity or both. Earlier studies from this region on sea level changes were mostly based on fragmentary records, however, present study provides continuous record of sea level changes during mid-late Holocene. Two major shifts in sea regressions at ~3500 and ~1500 cal yr BP have been observed, which appear to have transformed the studied site from coastal lagoon to mudflat with shift in $\delta^{34}S$ from -30 ‰ to 11 ‰. The present study for the first time demonstrates variation in sea level during mid-late Holocene from Saurashtra Coast deciphered as a function of sulphur isotopic composition and entails exploitation of sedimentary $\delta^{34}S$ as a potential tracer for past sea level changes.

ID: 01812, 01.- Open Session on past global changes, (Poster)

The influence of high-density layering on firn air transport in a 2D model

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Ancient air trapped in ice core bubbles has been paramount to developing our understanding of past climates and atmospheric compositions. However, before air bubbles become isolated in ice the atmospheric signal may be altered in the firn column above by processes that are not yet fully understood. Here we present a 2D trace gas advection-diffusion model that allows us to account for discontinuous horizontal layers of reduced permeability and diffusivity that are thought to occur in the firn. These regions force extensive horizontal transport to occur, effectively diminishing gravitational separation of isotopes near the lock-in depth because the driving force for gravitational settling is zero in the horizontal direction. Thus the layered 2D model reproduces the observed lock-in zone more realistically than previous 1D models. Furthermore, we show that, as in 1D models, the downward advection of air with near atmospheric composition prevents slow-diffusing gases from reaching concentrations expected from gravitational separation. A suggestion is made to correct for this kinetic isotope fractionation using noble gas isotopes in future high precision ice core studies.

ID: 01299, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

The evolution of deep water circulation in the subpolar North Atlantic during the last glacial termination

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Authigenic neodymium (Nd) isotopes have become a valuable proxy for the reconstruction of past ocean water mass provenance. For an accurate interpretation of Nd isotope palaeo records, however, a precise knowledge of the Nd isotope signatures of possibly prevailing water masses is imperative. While there is evidence that the Nd isotope composition of North Atlantic Deep Water and its glacial pendant remained constant during the last glacial cycles, there is also data that conflicts with such constancy in deeper waters. The subpolar North Atlantic is both the source region of North Atlantic Deep Waters as well as a very dynamic region that reacts sensitively to climatic changes like ice cover and surface temperatures. Furthermore, it is a region with vastly variable input in terms of Nd isotope composition. We reconstructed the deep water Nd isotope composition from several sites across the deep subpolar North Atlantic during the last transition from glacial to warm climate. While these reconstructions are complicated by variable inputs of easily weathered material from the continents, we are confident that they mainly react to changes in deep ocean circulation. They show that water exchange between the deep eastern and western basins was limited during the last glacial maximum, probably due to the weakening of the overflow waters from the North-East. During the early Holocene, a vigorous exchange between the two basins was established, evident through a homogenised Nd isotope signature across East and West. However, it further changes towards more radiogenic isotope signatures in both basins during the later Holocene. This continued change could indicate a strengthening of overflows exporting more radiogenic Nd from Iceland and would present a possible source for

variations in the Nd isotope signature of North Atlantic Deep Water.

ID: 02399, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Molluscan sclerochronological-derived paleo proxy records and their potential to obtain a better

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In this study we apply sclerochronological techniques to obtain closer insights into climatic and paleoceanographic conditions of the Faroe Current. The Faroe Current is one of the main inflow branches of warmer water masses into Northern Europe and is therefore of great importance for the climate development in this region. The shells of the bivalve species Arctica islandica provide annually resolved paleo proxy records because it forms annual growth increments, which can be analyzed similarly to tree rings and their geochemical compositions can be used for temperature reconstructions. Here we present the first multi-centennial absolutely dated chronology (AD 1642-2013) from the Faroe Shelf. The growth increment variability seems to be strongly influenced by local year-toyear phytoplankton dynamics and to a lesser extent by air and sea surface temperatures. ?18O values from several samples per increment reveal a seasonal temperature signal, which can be translated to a main growing season from March – September. ?18O-based temperature reconstructions from all single growth increments of the chronology suggest an overall warming trend from the end of the Little Ice Age towards present times with several fluctuations on decadal time scales. Correlations of the RBAR, which is an indicator for the signal strength throughout the chronology, with reconstructions of the AMO suggest an inverse relationship between these time series indicating that periods of higher AMO-index result in weakened signal strengths. In conclusion, our results suggest that the growth increment variability in shells of A. islandica from the Faroe Shelf reflects local environmental and ecological on-shelf dynamics and the ?18O measurements of the growth increments can serve as a tool for temperature estimations on multi-decadal time scales. Furthermore, the variability of the RBAR may provide information about the variability of the AMO on multi-decadal time scales.

ID: 02208, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Poster)

Trade wind and monsoon regimes over West Africa during Terminations I, II and V

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The terrigenous fraction of sediments found off West Africa consists for a large part of eolian deposits originating from the Saharan region. These Saharan dust deposits therefore provide a testimony of West African aridity as well as a record of wind regimes, ever since the region became dry and that eolian activity begun. Here we report data from core MD03-2705 collected ~500km off Mauritania (18°05N-21°09W, 3085m). This 37m-long archive provides a unique record of paleoclimate changes over West Africa throughout the last million years [Malaizé et al., 2012]. Initial investigations over the last 25kyrs of the core showed that important changes in the dust grain size occurred, revealing periods of trade wind intensification over West Africa such as during the Younger Dryas [Skonieczny et al., in prep.]. The last termination was also accompanied by significant modification in the clay mineral assemblages off Africa, implying major changes in provenance and possibly also in transport mode (fluvial/oceanic versus eolian) during the so-called African Humid Period. Comparison between Termination I and V reveal striking similarities between the two periods, supporting the idea that AHP and YD events are recurrent patterns over the late Quaternary. Results from Termination II, however, show that West African climate may not always follow the same pattern during terminations. These results - which will be discussed in the light of knowledge we are currently gaining on the dust proxies in the present climate through our monitoring of the mineral dust deposits on the West African margin [Skonieczny et al., 2011; 2013]- provide new vistas regarding the interplay between high- and low-latitude forcing in the making of monsoonal regimes over West Africa throughout the late Quaternary.

ID: 01801, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

A new concept for paleohydrological evolution of the Younger Dryas in NE Brazil

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The late deglacial interval from approximately 13 to 11 kyr BP contains some of the best documented abrupt climate changes in the Past, the Younger Dryas (YD). It is also an interval when the bipolar climatic signature of millennial-scale changes in the Atlantic meridional overturning circulation (AMOC) is well expressed. Here we present a high-resolution palynological record from core GeoB16205-4 (121.11’N, 4305.80’W), retrieved off the Parnaíba River mouth, southeast of the Amazon River (~1955 m water depth). Pollen and organic-walled dinoflagellate cyst assemblages indicate a predominantly wet climate during the YD in the nowadays semi-arid Nordeste, whereby a second phase between ~12.3 and 11.7 kyr BP is wetter than the period before. This is recordedby a strong increase in the concentrations of river plume dinoflagellate cyst assemblages indicative of a stratified surface water column and reduced salinity environments, as well as a drop in grass pollen and microcharcoal particle concentrations along with strong fluctuations in the representation of rain forest, gallery forest and tree ferns suggesting year-round humid conditions. This shift from a relatively wet first phase to a much wetter second phase is in agreement with the transient TRACE-21k coupled climate model simulation which shows a first pluvial Parnaíba stage from ~12.8 to 12.3 kyr BP and a second stronger pluvial stage between ~12.3 and 11.7 kyr BP to be related to a very weak AMOC due to meltwater pulses in the North Atlantic. The AMOC variation induces a steep temperature gradient between the Southern and the Northern Hemisphere which forces a southward shift of the Intertropical Convergence Zone (ITCZ) and its associated rainfall. The two-step hydroclimatic and environmental evolution during the Younger Dryas has not been documented previously in this region.

ID: 02311, 01.- Open Session on past global changes, (Poster)

The PMIP4 contribution to CMIP6

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The goal of the Paleoclimate Modelling Intercomparison Project (PMIP) is to understand the response of the climate system to different climate forcings and feedbacks. Through comparison with observations of the environmental impact of these climate changes, or with climate reconstructions based on physical, chemical or biological records, PMIP also addresses the issue of how well state-of-the-art numerical models simulate climate change. Paleoclimate states can be radically different from those of the recent past documented by the instrumental record, and thus provide an out-of-sample test of the models used for future climate projections and a way to assess whether they have the correct sensitivity to forcings and feedbacks. The poster will present the rationale behind the choice of the five different periods that have been designed to contribute to the objectives of the sixth phase of the Coupled Model Intercomparison Project(CMIP6): the millennium prior to the industrial epoch (past1000), the mid-Holocene, 6,000 years ago (midHolocene); the Last Glacial Maximum, 21,000 years ago (lgm); the Last Interglacial, 127,000 years ago (lig127k) and mPWP, the mid-Pliocene Warm Period, 3.2 million years ago (midPliocene-eoi400). These climatic periods are well documented by paleoclimatic and paleoenvironmental records, with climate and environmental changes relevant for the study and projections of future climate changes. The focus will be on the novel features of these experiments compared to the experiments performed in previous phases of PMIP and CMIP. It will also provide an overview of analyses plans of the individual periods, across all the periods and comparisons with other CMIP6 simulations. The examination of relationships between forcings of different nature and amplitude and climate responses, and comparison of the processes involved in these responses are central aspects of the project. The evolution of interannual variability in the past is also expected to provide some clues on the linkages between mean climate and climate variability. This poster would provide an umbrella for companion posters showing in more details the experimental protocols, the PMIP database, new datasets for model-data comparisons and the needed documentation.

ID: 02057, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Late Holocene palaeoclimate variability in south-western Asia highlighted by the Lake Maharlou sediments (Iran) and potential implications for human adaptive strategies

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During the last decade, numerous endorheic lakes of the semi-arid Iranian plateau have critically dried up (e.g. Lake Urmia, Lake Parishan, Lake Maharlou), questioning long-term sustainability of water resource to economic development. It is manifest that dam construction and irrigation preclude water from flowing into lake affecting water deficit. However, which role play climate changes in current lake water deficit? Retrospective studies using fossil archives allow investigating environmental variability over time which is the first step toward recognizing forcing factors and rate of change. The sediment core extracted from the Lake Maharlou (Zagros Mountains, close to the city of Chiraz), covering the last 3500 years, has been investigated through sedimentological (µ-facies characterisation on thin-slides, XRD analyses, layer counting, dry density) and geochemical analyses (major element measured on XRF Core scanner). Two main sedimentological and geochemical components have been distinguished: a chemical component made of evaporates (halite, gypsum) and endogenic carbonates (aragonite, calcite), and a clastic component comprising quartz and clay. These two components occurred in the sediment core by distinct alternating beds (halite coarse crystal beds; gypsum dominated silt clay beds; aragonite/calcite/clay dominated silt clay beds; and homogeneous clay bed). Bed thickness and frequencies obtained from layer counting will inform on the last millennia hydrological changes. These results will help to put present-day lake drying in a range of "natural" variability and to discuss on implication of past climate changes on historic human trajectories.

ID: 02060, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

The overlooked human influence in the Late Holocene great acceleration of floods in the European Alps

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Accelerated erosion processes are a major environmental concern because they result from a combination of factors that include climate, geomorphology, and human pressure, particularly when landscape disturbances occur at watershed scales and cause a shift to a regime with mean levels and variances higher than those prior to disturbances. In mountain areas, accelerated erosion is expected to exacerbate torrential floods through mobilization of large amounts of sediments during high-intensity rainfalls. We used the sedimentary archive of Lake Allos (southeastern France), a mountain lake in the European Alps, to characterize mountain flood deposits and vegetation dynamics over the past 7000 yr. Our results support the interpretation of a critical threshold in catchment sensitivity to erosion at 1700 calibrated (cal.) yr B.P. (AD. 250) concomitant to maximal vegetation disturbances related to agro-pastoral human activities. Thus, threshold in sensitivity to erosion probably resulted from long-term, uninterrupted impacts of human activity. The frequency and severity of floods increased dramatically after this date. These results demonstrate that underestimation of human impacts over the Holocene may pose a challenge to a clear understanding of past climate changes because paleorecords are highly likely to have been affected by geomorphic thresholds. Natural reforestation since the end of the 19th century does not appear to be sufficient to induce a flood regime comparable to that which occurred prior to 1700 cal. yr B.P. This poses the question as to whether forest restoration in high-altitude environments is liable to foster a return to a low-erosion regime over the next decades, or whether the overall severity of soil degradation has been such as to preclude a return to previous conditions. Further details are available in Brisset et al., GEOLOGY.

ID: 01773, 01.- Open Session on past global changes, (Poster)

MexiDrill, the Basin of Mexico Drilling Project: Exploring a lacustrine record of climate, volcanism and environmental change in subtropical North America since the mid-Pleistocene

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In February to April 2016 the MexiDrill field expedition recovered over 1000m of sediment from the Basin of Mexico at the Lake Chalco drilling site on the outskirts of Mexico City. Three holes were drilled, reaching a maximum depth of 520m. The upper ~300m of the sequence is composed of lacustrine mud punctuated with discrete tephra layers, underlain by a volcaniclastic sequence with basalt intercalations to approximately 512m depth. The deepest hole penetrated a colluvial breccia unit below the volcaniclastic-basalt. Triple core recovery with offset core intervals in the lacustrine unit provided core overlap that allowed us to create a composite sequence for continuous paleoenvironmental reconstructions for the past several hundred kyr. The Chalco record is thus among the longest continuous climate records from tropical North America, and it will help to understand millennial scale variability, the climate during past interglacials and the relationships between rates of climate change, ecosystem response, and biodiversity.

We observe repeated sedimentary sequences that have recorded transitions from laminated sediments deposited in a deep lake, to massive sediments characteristic of shallower environments, to carbonate-rich sediments that suggest shallow water. In addition to these broad changes, we expect that scale variability recorded in Chalco may be linked to strength of the Mexican Monsoon, which in turn was impacted by ITCZ migration. Southward excursions of the ITCZ are associated with enhanced aridity in central Mexico and a weakening of the Mexican Monsoon.

MexiDrill cores will also provide a long record of volcanic events, allowing determination of the magnitude and frequency relationships of the area's explosive volcanic eruptions and improving risk assessment for future activity. These anticipated results are directly relevant to the >25 million people living in the Mexico City region, and area that is subject to a wide range of volcanic hazards.

ID: 01665, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Did large lakes' ecology react to Medieval warming?

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Studies focusing on the past 1500-2000 years present a great interest as this time window covers a high natural climate variability in Europe, including the Medieval Warm Period (MWP), as a useful analogue for recent warming, but also the Little Ice Age. As atmospheric temperature is a primary driver of sea and lake surface temperatures (ST), oceanic and continental sediments are expected to record climatic variability. However, recent findings showed that, counter-intuitively, sea ST have displayed a millennial-long cooling trend before the industrial era due to repeated clusters of volcanic eruptions (McGregor *et al*, 2015). In this study, we questioned the thermal behaviour of large inland waters bodies over the last millennium, testing how strongly they were tied to atmospheric temperatures.

Lake Geneva is a large and deep water system in the perialpine area. Our study relies on a well-dated (historical events, radio-elements, ^{14}C, paleomagnetism) sediment sequence covering the past

1500 years. Geochemical and biological (diatoms, cladocera) proxies are measured. During the preindustrial period, no variations in geochemical proxies and diatoms assemblage are observed. A small shift from sediment-associated species (e.g. *Monospilus dispar*, *Alona affinis)* to macrophyte-associated species (*Sida crystallina*) is observed around 1000AD in the zooplanktonic littoral communities.

If the ecological responses to recent climate warming are quite obvious on the top-most part of the core, none of the studied proxies supported a warming in Lake Geneva during the MWP. Three hypotheses are considered to explain this lack of relationships:

1. Under lower local human impacts, the ecology of Lake Geneva was less sensitive to climatic variability,
2. Lake Geneva thermal dynamics were more strongly responding to other climate components (radiative forcing, hydrology) than atmospheric temperatures during the MWP,
3. Low regional signal of the MWP in the western part of the Alps.

ID: 02317, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

A new Holocene δ13C-CO2 record from the South Pole ice core

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The carbon isotopic composition of CO_2 trapped in ice cores can help constrain past variability in the global carbon cycle as it can be diagnostic of changes in the strength of CO_2 sources and sinks. Previous work has revealed broad trends in $\delta^{13}C$-CO_2 over the Holocene, but detailed study of centennial-scale variability has been restricted to the most recent ~2 ka. Here, we present high-precision $\delta^{13}C$ as well as CO_2 and N_2O concentration measurements covering the past 7+ ka from a new South Pole ice core that allow sub-millennial changes in the isotopic record to be observed. The general trend in CO_2 concentration over the Holocene is punctuated by several transient increases coinciding with negative $\delta^{13}C$ excursions that may reflect the release of carbon from the terrestrial biosphere. The most notable feature of the record is a previously undocumented increase in $\delta^{13}C$ between ~5.2 and 4.5 ka that coincides with a gradual rise in CO_2 concentration, followed by an abrupt decrease in $\delta^{13}C$. We also confirm earlier observations, with greater precision, that increasing CO_2 in the early Holocene is not accompanied by a decrease in $\delta^{13}C$ that would be indicative of a previously hypothesized release of carbon from the terrestrial biosphere.

ID: 01884, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Interhemispheric climate coupling via atmospheric and oceanic teleconnections during abrupt climate change of the last ice age

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During the Dangaard-Oeschger cycle, the climate of both hemispheres is linked via inter-hemispheric heat exchange driven by AMOC variations. A recent study finds that the Antarctic climate response lags Greenland by ~200 years, consistent with a climatic coupling via ocean currents. However, Antarctic temperature variations during Heinrich stadials appear to contradict this simple oceanic seesaw model. Moreover, WAIS Divide Deuterium excess shows evidence for latitudinal shifts in the moisture source origin synchronous with NH climate, but it is unclear at present whether this behavior is confined to the Pacific sector, and what the impact of atmospheric teleconnections is on Antarctic climate.

Here we investigate the interhemispheric climate coupling using high-resolution water isotope records from five volcanically-synchronized Antarctic ice cores. Using principal component analysis, we show that the Antarctic temperature response can be understood as the superposition of two distinct modes. The first mode is the spatially homogeneous, ocean-driven bipolar seesaw response that lags NH abrupt climate by about 200 years. The second mode is a spatially

inhomogeneous, atmospheric mode that is in phase with NH abrupt climate change.

The spatial pattern associated with the atmospheric mode resembles modern-day surface temperature variations associated with the Southern Annular Mode (SAM), suggesting it may be linked to latitudinal movement of the SH westerlies and eddy-driven jet. Using both deuterium excess data and climate models, we provide further evidence for a zonally coherent shift in the position of the SH westerlies. Last, we show that the Antarctic warming response to Heinrich events resembles the aforementioned atmospheric climate change pattern, suggesting it may be explained via an extremely southern position of the SH westerlies.

Our analysis shows both atmospheric and oceanic teleconnections couple both polar regions during DO events. Both modes are needed to explain the observed patterns of Antarctic climate change.

ID: 01885, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

Dispersion in deep polar firn driven by synoptic-scale surface pressure variability

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Understanding firn air transport is critical for the correct interpretation of atmospheric trace gas reconstructions from ice cores and firn air. Commonly, three mechanisms of firn air transport are distinguished: molecular diffusion, advection, and nearsurface convective mixing. Here we identify and describe a fourth mechanism, namely dispersion driven by synopticscale surface pressure variability (or barometric pumping). We use published gas chromatography experiments on firn samples to derive the along-flow dispersivity of firn, and combine this dispersivity with a dynamical air pressure propagation model forced by surface air pressure time series to estimate the magnitude of dispersive mixing in the firn. We show that dispersion dominates mixing within the firn lock-in zone. Trace gas concentrations measured in firn air samples from various polar sites confirm that dispersive mixing occurs. Including dispersive mixing in a firn air transport model suggests that our theoretical estimates have the correct order of magnitude, yet may overestimate the true dispersion. We further show that strong barometric pumping, such as at the Law Dome site, may reduce the gravitational enrichment of $\delta^{15}N–N_2$ and other tracers below gravitational equilibrium, questioning the traditional definition of the lock-in depth as the depth where $\delta^{15}N$ enrichment ceases. Last, we propose that ^{86}Kr excess may act as a proxy for past synoptic activity (or paleo-storminess) at the site.

ID: 01943, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Palynological visibility – establishing detection limits for pollen records of range change in different landscape systems in southern Amazonia

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Palaeoecological datasets can potentially make important contributions to discussions of range change and community dynamics, but this potential can only be realised if both the strengths and weaknesses of the records available are understood, ensuring that methods chosen are appropriate for the specific research problem. Before using any palaeoecological method to reconstruct changes in species distribution, it is important to understand the limitations of that method, and determine its sensitivity to the underlying ecological processes and expected changes. Simulations allow experiments which are not possible in the real world, and therefore once a model of a palaeoecological signal-forming system is available it can be used to improve our understanding of the limitations of the method.

Pollen records are one of the most abundant types of palaeoecological data, and have been used to create maps of vegetation change in space and time which have shaped scientific understanding of species response to environmental change. However, not all changes in vegetation distribution will be 'palynologically visible', that is, will be recorded in the contemporary pollen assemblages accumulating in sedimentary systems by a clearly distinguishable change in the proportions or abundance of different pollen types.

This paper will demonstrate how models of pollen dispersal and deposition can be used to establish the potential limits of visibility of changes in community abundance and ecotonal position in pollen records from large lakes in southern Amazonia. By simulating the pollen signal from many different land cover scenarios, including a wide range of both ecotonal position and level of tree cover, it is possible to assess the sensitivity of the pollen record to changes in one or both factors, and therefore make clear statements about both the usefulness and the limitations of pollen analysis for reconstruction of past shifts in community distribution.

ID: 01867, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Poster)

The emergence of the Pacific meridional overturning circulation paced by obliquity cycles during the Pliocene

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Deep water formation in northern high latitudes, as part of the Atlantic meridional overturning circulation (AMOC), is a critical element of modern ocean circulation and climate. For the warm Pliocene, roughly 4 to 2.8 million years ago, we present measurements and modeling evidence that deep water formation also occurred in the North Pacific, supporting another overturning cell – the Pacific meridional overturning circulation (PMOC). The evidence includes calcium carbonate accumulation in Pliocene subarctic Pacific sediments rivaling that of the modern North Atlantic, with pigment and total organic carbon measurements supporting deep ocean ventilation as the driver of the enhanced calcium carbonate preservation. Together with high accumulation rates of biogenic opal, this implies a bi-directional communication between surface waters and the waters overlying the deep seafloor, and hence deep convection. Similarly, redox-sensitive trace metal data provide supporting evidence of higher Pliocene deep ocean ventilation prior to the 2.73 Ma transition. A Pliocene-like climate simulation reproduces this deep water formation, with co-occurring Atlantic and Pacific overturning cells. The PMOC emerges as a result of the less intense hydrological cycle under Pliocene conditions characterized by a reduced meridional SST gradient. This weaker hydrological cycle leads to the erosion of the North Pacific halocline, allowing deep convection.

Examining the data in more detail shows that, while the opal accumulation rate was continuously high, maxima in calcium carbonate accumulation rate were sharp and orbitally paced. These maxima most likely occurred during Northern Hemisphere summer insolation maxima when, as supported by the modeling results, mid-latitude SSTs in the Northern Hemisphere were at a maximum and the meridional SST gradient was particularly weak. These findings suggest that the climate system fluctuated between periods of strong and weak PMOC during the Pliocene. Such fluctuations appear to be a crucial part of Pliocene climate variability on orbital timescales.

ID: 02328, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

An annually resolved marine proxy record for the 8.2K cold event from the northern Noth Sea

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The so-called 8.2K cold event is a rapid cooling of about 6° +/- 2° recorded in the Greenland ice core record and thought to be a consequence of a freshwater pulse from the Laurentide ice sheet which reduced deepwater formation in the North Atlantic. In the Greenland ice cores the event is characterized by a maximum extent of 159 years and a central event lasting for 70 years. As discussed by Thomas et al (QSR, 2007), the low resolution and dating uncertainty of much palaeoclimate data makes it difficult to determine the rates of change and causal sequence that characterise the event at different locations.

We present here a bivalve shell chronology based on four shells of *Arctica islandica* from the northern North Sea which (within radiocarbon uncertainty) is coeval with the 8.2K event recorded in the Greenland ice cores. The year of death of each shell based on radiocarbon analysis and crossmatching is 8094, 8134, 8147, and 8208 yrs BP (where “present” = AD1950), with an associated radiocarbon uncertainty of +/-80 yrs, and their longevities are 106, 122, 112 and 79 years respectively. The total length of the chronology is 192 years (8286 to 8094 BP +/- 80 yrs).

The most noticeable feature of the chronology is an ~60-year period of increasing growth which may correspond to a similar period of decreasing ice accumulation in the GRIP (central Greenland) ice core record. We tentatively suggest that this reflects increasing food supply to the benthos as summer stratification is weakened by colder seawater temperatures. Stable isotope analyses (results should be available when this abstract is presented) will show changes at annual and seasonal resolution, potentially giving a very detailed insight into the causal factors associated with the 8.2K event and its impact in the northern North Sea.

ID: 02273, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

The influence of snow cover distribution on alpine floods. An image-satellite snow distribution analysis related with the severest flood episodes of the Hasli-Aare river basin, Berner Oberland (1987-2012)

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Regarding the hydrological hazards in the Hasli-Aare river over the last century, documentary and instrumental data show that flood frequency and magnitude increased since the late 70s until now. One of the main water inputs contributing to peak discharges is given by the thaw of the stored snow that changes depending on its exposure, height and other factors. Therefore, the knowledge of the evolution and distribution of snow cover is considered essential for the assessment of alpine floods.

Snow cover studies can be made by different methods such as the analysis of data provided by nivometeorological stations or the one obtained by doing field work. However, these methods are expensive and do not present adequate spatial or temporal coverage data. For this reason, satellite images with different spatial and temporal resolution are an interesting source for the understanding of the snow cover dynamics.

The aim of the paper is to study the distribution of the snow cover during years of severe floods that occurred in the upper Aare basin from 1987 to 2012. Different satellite images have been selected for each of the 9 studied events: one corresponding to the maximum snow cover during winter, and 2 other related with the moment of the flood. Each image has been processed with the ArcGIS software and the result of this processing has provided data of spatial quantification and variation of the snow cover in the studied catchment.

It has been observed that the heritage of the snow cover is not a key factor for flooding whereas higher temperatures (higher snowline) and a minimum of snow cover eases surface runoff and higher discharges. For this reason, the snowpack distribution and properties must be also considered and included in our study to be used as information for a snow melting analysis. Finally, the temporal distance between images and events may introduce an important range of uncertainty that will be considered in future works.

ID: 01786, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

A multi-proxy assessment of 100,000 years of environmental change in sub-tropical Australia.

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Terrestrial records that detail environmental and hydroclimate variability from mainland Australia that extend beyond the Last Glacial Maximum (LGM) are rare. This paucity of terrestrial archives is further hampered by poor age constraints and low sample resolution, with reconstructions frequently relying on extrapolation from glacial-interglacial patterns identified in ice and marine cores. Here we present a high-resolution, well-dated, multi-proxy sedimentary record covering the past ca.100,000 years from Welsby Lagoon, North Stradbroke Island, south-eastern Queensland. Welsby Lagoon is a perched, internally draining, closed permanent wetland system, with no fluvial input. The Welsby Lagoon chronology has been developed from 21 OSL ages and 20 ^{14}C dates and spans the regionally significant periods of Marine Isotope Stage (MIS) 3 and the LGM. Centennial-scale variations in total organic carbon (TOC), total nitrogen (TN) and sediment charcoal are reconstructed via infrared (IR) spectroscopy and a newly developed quantitative calibration. Carbon and nitrogen isotope composition of sediment organic matter were analysed to determine organic matter sources and reconstruct past productive rates. Pollen-based vegetation reconstructions together with high-resolution XRF elemental profiles are used to assess broader landscape scale environmental change. This record has the potential to provide an advancement in our understanding of millennial to centennial-scale climate and ecological variability during significant time periods in subtropical Australia.

ID: 01492, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Agulhas leakage over the last 3 million years

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Heat and salt transfer from the Indian Ocean to the Atlantic Ocean (Agulhas leakage) has an important effect on the global thermohaline circulation and climate. Previous studies based on planktonic foraminifera counts highlight the significant role of the

Agulhas leakage on climate changes over the last 600 ka and 1.3 Ma (Peeters et al., 2004; Caley et al., 2012; Caley et al., 2014). The dynamic of the Agulhas leakage prior to 1.3 Ma is unknown and could have contributed to the evolution in the Plio-Pleistocene climates.

We will present preliminary results of long term Agulhas leakage over the last 3 Ma based on planktonic foraminifera assemblages and sea surface temperature reconstruction from the unique sedimentary material retrieved during the IODP expedition 361 (South African Climates) in the cape basin region (site U1479) (Hall, I.R., Hemming, S.R., LeVay, L.J., and the Expedition 361 Scientists, 2016). Agulhas leakage changes will be discussed and compared to the onset of Plio-Pleistocene ice ages (2-3 Ma).

ID: 01340, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Fire and vegetation changes during Holocene recorded in Tibetan lacustrine sediments

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How land use changes have been influencing Holocene's climate is a hotly debated topic. Increasing awareness of "The Early Anthropocene Hypothesis" led to chemical and physical investigations of natural archives such as sediments, peat bogs, ice cores. Lacustrine sedimentary cores provide continuous records of large-scale and local environmental modifications, intelligible thanks to specific biomarkers that accumulated in these archives during past millennia. The Asiatic region is one of the centers of the advent of agriculture and pastoralism, and it is a strategic area to explore biomarker distributions. In order to study the interactions between human, environmental changes and fire during the Holocene in Asia, we selected a small moraine lake called Paru Co, located in the South-Eastern Tibetan Plateau. We extracted 72 Paru Co sediment samples by Accelerated Solvent Extraction and analysed different organic molecular proxies by GC-MS and IC-MS. Firstly we aimed to reconstruct past fire history using a group of molecules called monosaccharide anhydrides (MAs). Furthermore, we analysed polycyclic aromatic hydrocarbons (PAHs) as additional combustion proxies. To better understand the changes in vegetation and human presence at the lake shore we analysed n-alkanes and faecal sterols. The information obtained from these organic geochemical data needs to be complemented with archaeological findings, meteorological data and charcoal data. In this way we can contextualize in a regional setting the biomass burning events occurred in the Tibetan Plateau. Moreover, the association of past climate fluctuations with vegetation changes and possible human disturbances is allowed. From the MAs results we can see that the very high intensity of biomass burning recorded in the Early Holocene samples is parallel with the drier climate of the same period, following the deglaciation. The promptest results show that the local ecosystem and vegetation changes are in agreement with intensity's variations in the Indian Summer Monsoon rainfall.

ID: 01902, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Ocean productivity across the Subtropical Front over the last deglaciation

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The Subtropical Front (STF) separates warm and saltier subtropical waters from the cold, less saline and nutrient-rich subantarctic waters of the Southern Ocean. Determining its past north-south movements is crucial, for instance, to understand the role of such frontal systems on ocean productivity of the subantarctic region, as opposed to increased Fe availability. Three marine cores were recovered south of New Zealand, along a latitudinal transect crossing the modern STF. We have analysed long chain alkenones, as markers of coccolithophore productivity and past sea surface temperatures, *n*-alkanes and *n*-alcohols, as proxies for continental input and dust-derived iron and long chain diols as tracers of diatom productivity. Reconstructed SST changes show a 3-4°C temperature gradient during the Holocene between the core locations, while during the last glacial period no temperature gradient existed, with 8-9°C recorded at all three sites. This suggests a northward displacement of the STF during the cold glacial climate and the prevalence of subantarctic waters at the core sites, between 47 and 50.5°S. An increased productivity and continental input during the glacial and early deglaciation suggest that both Fe fertilization and equatorward migration of fronts likely drove the biological productivity of the region. The SST evolution will also be complemented with a temperature reconstruction based on the relative distribution of isoprenoid GDGTs, the TEX^{H}_{86} index, which in this region, we believe may record deeper temperatures than coccolithophores.

ID: 01963, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Wildfires and desiccated fountains: Heat and drought in 1473

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In the spring of 1473 an extraordinary hot spell in Europe began. This heatwave favoured a fast phenological development in the spring. In the summer and autumn of the same year temperatures were outstandingly hot and furthermore it was very dry. At many places the harvest was brought in remarkably early and there was abundant wine of good quality. Moreover, reports even exist of fruit trees starting to blossom a second time in autumn.

Nevertheless, the heat and drought also had a considerable impact on the natural environment and damage to agriculture and society, such as the desiccation of fountains, wildfires at uncommon places, cattle suffering of hunger, and losses in grain, fruit and vegetable production.

This paper aims to analyse the weather conditions of 1473 in Europe as well as their consequences for society by answering the following questions: What were the magnitude and the sequence of the heat and drought in 1473? Were there differences between several regions in Europe? To what extent were European societies vulnerable to extreme drought events in the second half of the fifteenth century? What kind of weather impacts occurred in Europe during the examined year? Are regional differences traceable?

In order to answer these questions a large number of historical sources, such as chronicles, annals and account books, mainly from France, the Low Countries, the Holy Roman Empire and England, will be examined and compared to the results of tree ring and speleothem analyses.

ID: 02373, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

A speleothem record of climate of the last millennium in Southeast Spain

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We report a paleo-climatological study of Southern Spain using an actively growing stalagmite (“Zerolin”) collected in the Cave of Ardales (Málaga) in 2007. U-Th dates indicate that the spleothem began forming ±1000 years ago with an average growth rate of ±200 microns per year. Clear annual laminae couplets composed of porous white layer and denser darker layer are present in portions of the stalagmite. The thickest laminae couplets reflect times when the stalagmite had the highest growth rate and coincide with the beginning of the Little Ice Age; we interpret these as periods of more humid climates which maintained active dripping and stalagmite growth in both the winter and summer seasons. During dry periods, the dry season laminae is condensed or suppressed.

The stalagmite is fed by fracture flow in the dolomitic bedrock. In times of drought, the drip interval can be longer than 20 minutes which would be expected to produce extensive prior calcite precipitation on the cave ceiling. Low Sr/Ca ratios between 1200 and 1700 AD coincide with thickest laminae and may reflect low PCP and more humid conditions. Mg/Ca ratios are more complex to interpret because LA-ICPMS data reveal high contribution of Mg from detrital phases, which may be transported preferentially through the fracture during high flow periods. The magnitude of annual Mg/Ca variation clearly exceeds that which could be attributed to PCP. Although the stalagmite does not have annual laminations during the last two centuries, within the precision of existing U/Th dates we conduct an evaluation of the multidecadal scale proxy response during the period of instrumental climate observations of the region to more carefully establish the best proxies for aridity and humidity.

ID: 01501, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Molecular traces of Anthropogenic and Climatic impact in Remote Oceania (MACRO)

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Island ecosystems in remote Oceania have mostly evolved and developed without (long-standing) human presence and are consequently vulnerable to even minor anthropogenic pressures. Here we present the outline of the recently started MACRO project (Molecular traces of Anthropogenic and Climatic impact in Remote Oceania) where we will retrieve data on past environmental changes related with the first human settlements. This objective will be achieved through a multi-proxy analysis of sediments collected in lakes and swamps. We warmly welcome discussions and inputs useful for the progress of the project.

We will especially focus on the development of agriculture and the related environmental consequences that land use change triggered in different islands of remote Oceania (*e.g.* extinctions, soil loss, arrival of invasive species, changes in water quality). The use of faecal biomarkers such as coprostanol and bile acid will allow us to reconstruct the arrival of humans and the changes in human population size. New biomarkers will be identified to trace the introduction of allochtonous species. The main innovative approach of the project will be the use of compound-specific radiocarbon as a tool to assess soil degradation accompanying human settlements. The age of terrestrial biomarkers deposited in sedimentary basins - that provides information on soil carbon cycling in the catchment - coupled with conventional indicators of soil erosion will allow us evaluate prehistoric human impact.

Using an interdisciplinary approach, we will trace the history of human pressure through time and the consequent environmental changes. Overall, our aim is to draw a baseline that will help addressing the necessary trade-offs of current conservation challenges in light of a human-environment sustainable interaction.

ID: 01655, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

High-resolution multiproxy study of the Last Glacial Maximum (LGM) and deglaciation from the Padul peat bog (southern Iberian Peninsula)

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The Mediterranean region and specially, the southern Iberian Peninsula, is a very sensitive area for palaeoenvironmental studies due to its location, between arid and temperate climates. The Padul peat bog, located in Granada province (southern Spain), has one of the largest and continuous record of southern Europe, with more than 100m thick peat and lacustrine sediments deposited over the last ca. 0.8-1 Ma. In 2015, a 42 m long core was taken from the Padul peat bog, providing with an excellent sediment record to identify and understand past environments and climate changes. This study focused on the paleoenvironmental and climatic reconstruction of the Late Pleistocene and the Early Holocene (ca. from 50,000 to 9,500 cal yrs BP), in particular the LGM (Last Glacial Maximum) and different Heinrich Stadials, with special attention to the Heinrich Stadial 1, the Bølling-Allerød and the Younger Dryas event (final Pleistocene-Holocene transition). High-resolution pollen analysis, lithology, X-ray fluorescence, X-ray diffraction, magnetic susceptibility and organic geochemistry are used for the identification of these events. Different proxies give us information not only about the regional environmental changes (given by pollen analysis), but also about local changes in the conditions of the Padul peat bog/lake because of variations in water temperature, oxygenation, pH and/or nutrients.

ID: 02084, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

PEOPLE 2K (PalEOclimate and the PeopLing of the Earth): Investigating tipping points generated by the Climate-Human Demography-Institutional nexus

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One of the least understood aspects of paleoscience is the role of climate in controlling long-term changes in human population, and, in turn, how changes in population influence the strategies that individuals use to manage resources. Understanding the nexus between climate, human population and the management of resources is important in a world where climate change is accelerating; populations are growing; and biological diversity is in decline, stressing systems of resource management. We propose the creation of PEOPLE 2K, a research network to study trade-offs inherent to the climate-human population-institutional adaptation dynamic, and to describe threshold changes in social-ecological systems (SES) over the last ~2000 years. We propose that investments in strategies that reduce variation in food production and institutions for protecting those investments generate ever more complex SES. The growth of such complexity, where accompanied by a loss of diverse social and subsistence strategies, can result in major reorganizations due to external or internal changes that drive a SES across a critical threshold. We begin to evaluate this proposition using three case-studies: the Great Basin; northern Chile; and western Argentina. We compare the summed probability distribution of radiocarbon dates (a proxy for population change) with records of palaeoecological and climatic change, and changes in the diversity of subsistence and social strategies documented archaeologically. The results illustrate that population increased from 2000 to 800 BP in all three locations, and, coincident with the transition to the Little Ice Age (700-100 BP), populations declined and societies reorganized between 700-550 BP. Variability in population decline and reorganization among our cases relates to the maintenance of diverse social and subsistence systems. Our analysis reveals possible trade-offs associated with simultaneous adaptation to population growth and climate change and provides a more informed position to understand relationships between social-ecological parameters and threshold changes in modern SES.

ID: 01499, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

The contribution of Palaeoecology to assess legacy of pre-historic human land-use and climate change on modern vegetation

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Across Latin America the uncovering of impressive archaeological sites, often underlying dense forest, show evidence of past human impact within what are often viewed as pristine ecosystems. Intercontinental comparison of studies shows that anthropogenic impacts were spatially heterogeneous and it is often argued that modern floristic composition in areas of past human occupation espouses a legacy effect in terms of an abundance of economically useful species. In the face of future climate change and biodiversity loss, seems important then to consider indigenous knowledge as a tool for management and conservation strategies. This challenges us to take into account how vegetation diversity and composition in human impacted areas has responded and changed according to different prehistoric land use strategies. Palaeoecology can offer unique insights into legacy impacts on forest composition and biodiversity because it affords a long temporal perspective, and in most cases, pre-date complex societies, so they can provide an ecological baseline. Here we review four case studies from lowland Belize, Southern Brazil Highlands, Llanos de Moxos, Bolivia and the lowland savannas of Bolivia that demonstrate how palaeoecology attempts to address the question of legacy effects on ecosystems that experienced varied pre-historic land-use and climatic changes during the last c.3,000 years. The comparison of pollen and physical characteristics of sediment cores and archaeological data of the four cases of Pre-Columbian impact on ecosystem composition provides evidence of variable effect for legacies of past land use. The intensity and type of past management, combined with ecosystem type as well as climate, might be key in controlling and whether or not anthropogenic modifications create long-term changes to ecosystems composition and biodiversity. The complexity illustrated by these studies highlights the challenges ahead for palaeoecology in disentangling the natural and human determinants of composition and biodiversity in tropical ecosystems.

ID: 01401, 01.- Open Session on past global changes, (Poster)

Paleo-hydrologicInterpretation of a Late Pleistocene/Holocene ssdiment-core archive in Nizzanim, Israel

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A 20 meter long sediment core, reaching to the top of the water table, was collected in the southern coastal plain of Israel at Nizzanim. The alternation of the core mineralogy of quartz sand, clay, and carbonate reflected climate changes. Radiocarbon dating of the organic carbon showed two age groups. Ages of *in situ* carbon showed the time of deposition increased linearly with depth (r^2 =0.99). A smaller group of younger, *ex situ* ages, are due to intrusion of plant roots which have penetrated 8.6±2.6m beneath the extant surface. It was possible to attribute geologic information to different depths: The Little Ice age, the flooding of the Black Sea, the Younger Dryas. Also suggested is important local paleo- hydrologic information. A radiocarbon age of 14Ky, when the global sea level was approximately 100m below the present, is measured at 12m when the sediment surface was about 11m lower than today (rising approximately 0.8 mm/y). The coastal plain aquifer is phreatic, draining into the sea. With lowering of sea level it extended westwards (seawards) and aquifer discharge increased due the increased gradient. The sea level lowering caused streams draining to the sea to incise their water courses. Increased groundwater discharge to the sea lowered the water table, which had a profound effect on human settlement; for digging of inordinately deep wells would have been required to reach fresh water. At approximately 8K BP the rise in sea level with the concomitant water table rise would have made the digging of fresh water wells feasible. Continuous sea level rise would have at first led to increasing salinization of these wells followed by full sea water flooding, causing human migration eastwards.

ID: 01898, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Seasonal sea ice in the Iceland Sea during the Late Pliocene

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Sea ice is a crucial component in Arctic and global climate, but there is limited knowledge about Arctic sea-ice extent throughout the geological past. There is geochemical evidence that a seasonal sea ice cover already occurred during the Miocene in the Arctic Ocean, and a modern winter maximum extent first appeared around the Pliocene/Quaternary transition. We reconstructed sea ice variability in the Iceland Sea during the Late Pliocene to Early Quaternary (3.5–2.4 Ma) using the sea-ice proxy IP_{25}, biomarkers for palaeoproductivity (brassicasterol, dinosterol), alkenone-based sea surface temperatures and dinoflagellate cysts. Our preliminary results from ODP Site 907 suggest that prior to 3.0 Ma a seasonal sea-ice cover frequently occurred, with occasionally sea ice-free intervals. After 3.0 Ma, the Iceland Sea was mainly sea ice-free with an occasional seasonal sea-ice cover. The extent of Late Pliocene seasonal sea ice in the Iceland Sea was thus not unlike modern historical and satellite observations for the region, even during the so-called mid-Piacenzian Warm Period (~3.3–3.0 Ma).

ID: 01695, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Refinement of stable isotope palaeoclimate proxies from southern African rock hyrax middens

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Rock hyrax middens – the communal latrines of the gregarious herbivore *Procavia capensis* – are increasingly utilised as palaeoenenvironmental archives in southern Africa. While long-recognised to preserve pollen and microfossils, recent work has emphasized the use of stable isotope analyses, particularly isotopes of carbon (^{13}C) and nitrogen (^{15}N), which has facilitated high temporal resolution climatic reconstructions. Here we report work to refine interpretations of these proxies and to develop additional (cellulose δ^{18}O and leaf wax deuterium) isotope proxies, with a goal of maximizing the paleoecological-palaeoclimatic insights gleaned from middens. Analysis of the stable N, C and O isotope compositions of hyrax faecal pellets and food sources (plants) support interpretations of mixed feeding and the occurrence of grazing only when palatable grasses are available (early wet season in the savanna biome). This is consistent with interpretations of midden δ^{13}C in such mixed C_3/C_4 ecosystems. Recent analyses have shown strong correlations between faecal and hyraceum (midden) δ^{15}N, as well as correlations between foliar δ^{15}N and aridity/mean annual precipitation across several sites. Building on this we present a new and more extensive analysis of the wider relations between soil δ^{15}N, foliar δ^{15}N and climate. Both soil and foliar δ^{15}N track climate in a manner previously described (for a more limited dataset) for this region, and while the specific underlying mechanisms in the desert soil N cycle remain to be elucidated, the findings support previous interpretations of midden δ^{15}N signals. To consider this further the relationship between faecal cellulose δ^{18}O with climate and faecal d^{15}N is also presented. Finally, we present new data pertaining to leaf wax δD records extracted from middens. This approach represents a key opportunity to establish a high-resolution palaeohydrological proxy for southern African drylands and initial results from several sites are promising.

ID: 01425, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Human-driven fire regimes in the Cantabrian region. A comparison of three peat bog sediment records

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The study of sedimentary charcoals and pollen data of three paleobotanical sequences at different altitudes (Cueto de la Avellanosa, 1320 m; Sertal, 940 m and La Molina, 484 m) allows us to discuss the historical role of fire in the configuration of the forest landscape in Cantabria for the last 6,000 years.

Two types of fire have been distinguished: those burning woody vegetation, with great capacity of transformation of the landscape, and those others that have been used to maintain the open spaces.

Sedimentary charcoal records of wood burning since Neolithic times have been synthesized taking into account the frequency and the intensity of fires. The beginning of the Neolithic, the Age of Metals and the beginning of the Middle Ages have been defined as the moments with more fire episodes. In addition, the different causes of fires throughout the Holocene have been analyzed. In a natural regime the climate cycles seem to explain those of fires. However, from the Neolithic period the fire regime changes according to cultural patterns, exhibiting differences in the different historical periods.

There is a great abundance of charcoal particles at lower altitudes (La Molina) where a high frequency of fires has been identified between 6740 and 3500 cal yr BP and a low fire frequency over the past 3500 cal yr BP. At higher altitudes (Cueto de la Avellanosa and Sertal) the number of fire events is lower due to the existence of opened spaces since the beginning of the sequences. The number of fire events is in inverse proportion to the relative importance of grasses and other pollen indicators of open spaces.

ID: 01365, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Sahel rainfall negatively linked to global temperature during the past 1600 years

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As climate model uncertainties remain very large for future rainfall in the Sahel, a multi-centennial perspective is required to assess the relationship between global warming and the Sahel hydroclimate. We present here a new record of hydrologic conditions over the past 1600 years in Senegal, obtained from stable oxygen isotope analyses ($\delta^{18}O$) in archaeological shell middens in the Saloum Delta. During the preindustrial period, the Sahel was relatively humid, particularly from AD 1500 to AD 1800, during the coolest period of the last two millennia, referred to as the Little Ice Age. A strong negative link is observed at the centennial scale between global temperature and humidity in the Sahel, in direct contrast with the relationship observed elsewhere in the northern tropics, which shows that the processes linking the Intertropical Convergence Zone (ITCZ) and the West African Monsoon (WAM) are more complex than previously thought. The relationships between changes in the annual mean state and seasonal to interannual variability are explored using monthly resolved shell isotope records. In the context of the past 1600 years, the Western Sahel appears to be experiencing unprecedented drought conditions, resulting from a rapid aridification since AD 1800 that points to local and global anthropogenic forcings. This new long-term perspective suggests that under future global warming the potential for severe Sahel droughts may increase significantly.

ID: 02095, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Unprecedented diatoms records show late Quaternary paleolake environments along the hyperarid Atacama Desert, northern Chile

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Atacama Desert is pictured by salt flats and plantless environments. Late Pleistocene (< 26-15 ka BP) subfossil diatom stratigraphic records and geomorphological evidence, however, show that shallow lakes existed. Here we describe 18 different diatom taxa from laminated lake sediments (13 samples from ~15cm profile) in the salt-encrusted Salar de Bellavista (section BV-01). Most of taxa are planktonic, *Cyclotella*, *Discostella stelligera* and *D. stelligera* var. *stelligera* dominate, and few benthic (*Gomphonema angustum* mainly) The mean ratio of benthic/planktonic (B/P) taxa fluctuates ~0.7 (highest values: 10-11cm, 20%-planktonic, B/P: 3). Three "zones" occur based on functional groups (benthic, epiphytic, planktonic, aerophilic). Basal Zone3 (14.5–13.5cm) is most abundant in *Cyclotella* and *D. stelligera* indicating high freshwater levels, although some epiphytic and benthic diatoms are also present. *D. stelligera* is linked to thermal stratification and warmer conditions. Zone2 (13.5–1.5cm) shows an increasing of *G. angustum*. The presence of epiphytic *Epithemia adnata* and *Staurosirella* from littoral macrophyte, imply more shallow water and *Aulacoseira* taxa (big surface-volume rate, indicative of enhanced mixing needed to afford flotation; consequently high turbidity and low light conditions). Increased wind intensities could explain turbulence. More vegetated landscapes and the presence of *Aulacoseira distans* suggest a wetland with more littoral development. *N. borealis* (aerophilic) may indicate it ability to move to more humid area when soil gets dryer. In the uppermost 1.5cm (Zone1) *D. stelligera* var. *stelligera* dominates indicative of higher water prior to top drier conditions. This sequence shows a lake transgression and freshwater conditions followed by a trend towards drier conditions typical of wetlands. A short-lived phase of relatively more humid conditions ensued, then abruptly terminated. Our data reveal different hydroclimate during last glacial–interglacial transition, coincident with *Homo sapiens* introduction in these pristine ecosystems.

ID: 01354, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Drivers of vegetation change from the Sumava Region, central Europe in association with the 8.2 ka event.

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The 8.2 ka event was a short-lived, cold climate anomaly that caused a wide range of both abiotic and biotic responses, such as changes in precipitation regimes, advances in glaciers, and changes in vegetation composition. Within central Europe, abrupt changes in vegetation composition may have been caused by cooler summertime temperatures resulting from less summer drought stress. However, at Prasilske Lake, Czech Republic, vegetation composition may have already been changing prior to the 8.2 ka event as a result of several large-scale landscape disturbances. A high-resolution pollen analysis was conducted between depths 1600-1650 cm, which corresponds to 6000-9000 cal yr BP in order to document the prior-to, during, and after ecological responses of the 8.2 ka event. Pollen analysis suggests a decrease in *Picea* pollen, and increase in *Pinus* pollen beginning around the 8,500 cal yr BP with a minimum of *Picea* pollen occurring around 8,200 cal yr BP. By using a multi-proxy approach using elemental XRF data, macroscopic charcoal and macrofossil analyses, preliminary results suggest disturbances may have helped facilitate vegetation change between 8000 and 9000 cal yr BP. For example, identification of several bark beetle remains suggests the presence of host specific *Picea* disturbance agents, which could have also helped facilitate the decline in *Picea* pollen. This study aims to investigate the main driver(s) associated with the change in vegetation composition at Prasilske Lake in order to understand both the local-scale and regional-scale drivers of vegetation change associated with the 8.2 ka event.

ID: 02289, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Pleistocene sediments in the NE of Ebro Basin. An example of coarse deposits produced by flash floods

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The term flash flood has been used widely to describe sudden increases in discharge in streams with intermittent or perennial flow regime. This case includes those river courses with a Mediterranean-type climate. But it is also important to consider the geomorphological setting in order to have better comprehension of sedimentary structures and textures generated.

Deposits generated by flash floods are the effect of short time and turbulent transport due to high energy and density currents. It is difficult to observe internal sedimentary structures and textures in present time flash flood deposits, and therefore make a thorough analysis of the generating processes. Therefore, it is interesting to search Pleistocene deposits in prone areas to allow observation of such sedimentary structures and textures, while observing the geographical situation where they have been formed.

The divide between the Ebro and the Catalan Internal Drainage Basins, in NE of Iberian Peninsula, is a good area to analyze two different types of drainage basins subjected to the same climate and providing different flash flood processes because of their geomorphological setting. The divide is formed by a gentle escarpment crest separating a set of dip stream drainage basins (Sió, d'Ondara, Corb) from another set of anti-dip stream drainage basins (Anoia, Gaià, Francolí).

The scarp face of the divide is oriented parallel to the coast line. This favors local atmospheric dynamics; humid air masses from the east undergo orographic lift that have resulted, both historically and in the longer term, in extreme events. Storm results have been different depending on the affected basin. Headwaters of anti-dip stream basins are steeper than those of dip streams, and therefore resulting deposits have different sedimentary structures and textures.

ID: 02127, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Holocene marine-atmosphere linkages in the western Mediterranean Sea

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Marine and atmosphere patterns in the western Mediterranean Sea are explored in base to a high-resolution multiproxy study from the marine sediment core ALB-02 from the Alboran Sea. Here we present XRF core scanner record statistically treated by principal components in order to identify those related elements and explore their relationship with rainfall changes over land. In addition, marine surface temperatures have been obtained through Mg/Ca ratio measured on the planktonic foraminifera *Globigerina bulloides*. Both marine and terrestrial source proxies are combined to identify those similar and different patterns along the Holocene. In base to our results, the early-Holocene display the warmest temperatures and the more humid conditions during the Holocene. Mid-Holocene is characterised by a transition towards the coldest temperatures and driest conditions established in the late-Holocene. However, the high-resolution data allow us to observe centennial-scale oscillations in both proxies. Early-Holocene display a good parallelism between warm periods with an aridity increase, while during the late-Holocene warm periods become linked with a humidity increases. The mid-Holocene (6 to 4 cal. kyr BP) appears as a transition period between these two described patterns. These results are discussed in the framework of independent marine and terrestrial pollen records and flooding reconstruction from the region providing a compressive regional picture. Moreover this comparison provides a further insight in the rapid climate variability of our current interglacial period.

ID: 01341, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

A Late Pleistocene Meltwater Routing Record from the Gulf of Mexico

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Marine sediment cores in the Gulf of Mexico contain an archive of terrigenous sediment from the Mississippi River over time. The sediments also maintain a unique geochemical signature of their primary source location and can be used to fingerprint where water is being derived within the Mississippi drainage. During the last glacial period, routing of freshwater from the Laurentide Ice Sheet was primarily restricted to four primary drainage areas and largely influenced by the location of the southernmost extent at ~45°N. Which drainage the water discharged had a profound influence on North Atlantic Deep Water formation, and therefore determining the timing and location of the freshwater routing out these drainages provides a better understanding past ice-sheet influenced climate changes.

To shed light on the routing of ice sheet meltwater to the Mississippi River drainage, sediment cores from 50 sites in a network across the Gulf of Mexico have been analyzed for geochemical composition using XRF core scanners (ITRAX and Avaatech). XRF core scanners offer a fast, non-destructive method to capture relative elemental counts and elemental ratios. The sediment cores extend from present into the last glacial, and preliminary age-depth models for each core are created by cross-correlation based on sediment density, magnetic susceptibility, and biostratigraphy. XRF data show discrete packages of sediment heavy in lithic fragments and Ti and Si, characterizing meltwater plumes of freshwater discharged from the Mississippi River, thinning in thickness from the mouth of the Mississippi River. Cores located ~1000 km from the Mississippi River record several glacial cycles and show the extent of the meltwater plumes. Combining XRF data with an extensive network of cores allows the geochemical signature of the Mississippi River to be identified, and maps its attenuation across the Gulf of Mexico in three dimensions.

ID: 01872, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Geochemical investigation of the Mediterranean red coral (Corallium rubrum) for paleotemperature reconstructions

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A geochemical investigation of the elemental (Mg, Sr, Li, Mn, Ba, B and P) and oxygen isotopic and stable carbon isotopic ($\delta^{13}C$, $\delta^{18}O$) compositions has been carried out on living colonies of the calcitic red coral *Corallium rubrum* collected from different localities and depths (15 to 50 m) in the NW Mediterranean Sea. Laser ablation ICP-MS transects across the solid axial calcareous skeleton of the red coral showed a large elemental variability with a significant difference between the inner medullar and the outer annular portions. A positive correlation was observed between the high resolution seawater temperature time series (from 2003 to 2008) and the *C. rubrum* Mg/Ca ratios in the annually banded skeleton. Our Mg/Ca-derived T reconstruction was tested for Riou Island against T-Logger data and nicely reproduced the seasonal cycle at the sampling location. A significant correlation was also found between the coral $\delta^{18}O$ and the mean annual seawater temperature. As $\delta^{18}O$ of the *C. rubrum* is shifted from expected equilibrium, we used the $\delta^{13}C$ measured on the same coral samples to correct the oxygen isotope values, following the “lines technique” approach developed by Smith et al. (2000) for aragonitic corals. The corrected $\delta^{18}O$ values were then used to extend the previous calibrations (from 2 to 11.2°C) obtained in the open ocean for calcitic corals for the temperature range from 14 to 17°C (Chaabane et al., 2016). Our results suggest that Mg/Ca, $\delta^{18}O$ and $\delta^{13}C$ in *C. rubrum* can be used to reliably reconstruct paleotemperatures in the Mediterranean Sea.

ID: 02059, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Poster)

Reconciliation of the Orangeburg Scarp Record for the Influences of an Accurate Pleistocene GIA Correction and Tectonic Uplift

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The Orangeburg scarp is an extensive palaeo-shoreline along the US Atlantic Coastal Plain and was formed during the mid-Pliocene (MP) epoch (~2.9-3.5 Ma) when sea level is thought to have been significantly higher than present. In the absence of post-formation disturbance, the scarp’s elevation with respect to present sea level should be constant throughout its length and would reflect MP relative sea level throughout the latitudinal range of its location. However, the scarp is not at a constant elevation with respect to present sea level and the elevation is too large to be attributable exclusively to a MP sea level high-stand. In this study, the latest field measurements of the scarp’s length dependent elevation profile, together with the VM6 mantle viscosity depth profile, a seismic tomography initialized mantle convection model, a version of the ICE6G_C loading history extended to 1 Ma and a gravitationally self-consistent model of the deformation of the Earth by ice-age related surface mass loads are employed to investigate the mix of geodynamic influences required to satisfactorily explain the scarp’s present elevation. We show it is possible to explain the elevation profile entirely in terms of the influence of mantle convection induced dynamic topography (DT), as the contribution due to incomplete glacial isostatic adjustment (GIA) is found to be insignificant - a conclusion which contrasts significantly with a previous analysis. Correcting the present scarp elevation for post-formation deformation due to DT and GIA, whilst considering various sources of uncertainty, leads us to argue that the MP sea level was likely 15 ± 7 m higher than present. The mean value of our estimate is considerably lower than those that are being employed (~25 m) to produce land-sea boundary conditions for use in coupled climate simulations of the MP.

ID: 02183, 21.- Sediment Flux: Past Peaks and Troughs, (Poster)

Missing the coastal deposits from 3-6 ka along the macrotidal shore, west coast of Korea (eastern Yellow Sea)

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The beach-dune system fronted by an extensive tidal flat is a typical coastal landform found both in embayments and along the open macrotidal west coast of Korea. About 10 km wide and approx. 50 m thick coastal deposit extends from the tidal shore to the broad continental shelf with abundant sediment supply from large rivers. Here a variety of sedimentary records were formed during the Holocene period, in association with postglacial sea-level rise. The shelf-coastal sedimentary systems thus have unique characteristics in terms of sptial distribution, sediment composition, deposition rate and the timing of deposition, all of which are related to physical processes such as tides, waves, and shelf ciruculations. Interesting feature is the general lack of sedimentary deposits from 3-6 ka not only on the shelves, but on the Korean west coast. Geochemical and sedimentary facies analyses of numerous borehole cores, supplimented with ^{14}C-AMS and OSL age dates, reveal that stratigraphically, the beach-dune deposits are underlain by muddy tidal flat deposits, which results in a clear upward coarsening grain-size trend and thus intimates transgressive deposition associated with sea-level rise over the past 7-8 ka. A time gap of about 4 ka between them, i.e., an age of 7-8 ka for the underlying tidal flat deposits and just over 2-3 ka for the basal beach-dune sand was documented. A similar hiatus was also recognized from the mud belts on the tide-dominated shelf off southwestern Korea. An explanation would be that the region was experienced under nondeposition since 7 ka possibly by a sudden decrease in sediment supply, high sediment supply however being resumed after 3 ka. The direct cause of the ca. 4,000 year stratigraphic break remains still obscure and requires clarification in the future.

ID: 01767, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Poster)

Instant responses of Indian Ocean monsoon to high-latitude northern Atlantic during the Younger Dryas

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During the last decade, the multiple devastating flood events and droughts in Thailand have drawn attention to the importance of understanding long-term climate dynamics of the region. However, the spatial and temporal pattern of monsoon variability and its impact on land cover in Southeast Asia are still unresolved. This shortcoming stems from the fact that temporally well-resolved paleoenvironmental studies are missing for large parts of Mainland Southeast Asia. This research project aims to develop a high-resolution paleoenvironmental/paleohydroclimatic data based on stalagmites derived from Thailand. Southern Thailand's limestone bedrock and karst formations make it an ideal target for stalagmites study in this project. Here we combine a new hydroclimate record from southern Thailand west coast, to highlight instant responses of Indian Ocean summer monsoon to high-latitude northern Atlantic since the last 16 Kyrs. Although the onset and termination are synchronous across the records, the Atlantic temperature records clearly show that the Younger Dryas was an abrupt climate change event during the last deglaciation. Current publication suggests no direct evidence of boreal summer monsoon changes in the Western tropical Pacific to date. The new hydroclimate record from southern Thailand suggests that Mainland Southeast Asia may reflect isotopic changes in precipitation over India via atmospheric moisture transport indicating a reduction in the boreal summer monsoon.

ID: 01254, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Climate change since the last glacial period in Lebanon and the persistence of Mediterranean species

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In this study, we quantified the mean January temperature (Tjan) and both winter (Pw) and summer (Ps) precipitation from three fossil pollen records from Lebanon. Tjan showed a strong correlation with the global temperature changes retrieved in the NGRIP Greenland ice core. However, its amplitude of ca. 8°C between the Younger Dryas (YD) period and the Holocene is much lower than that reconstructed from European and other Mediterranean climate proxy records.

The overall amount of precipitation was also lower during the YD than during the Holocene but the contrast between Pw and Ps was much more reduced (less than 2 times) during the YD than during the Holocene (up to 8 times). Such different seasonal contrast compare to the present day is coherent with the climate proxies that tend to indicate the presence of moisture during the last glacial period in the Levant. In effect, the low Pw during the YD reflects the replacement of the forest ecosystem by a more shrubby or herbaceous vegetation. Concomitantly, the occurrence of an amount of precipitation higher than the current one during the summer season, along with a reduced evaporation, due to lower temperature, may have contributed to some observed high lake levels in the area.

During the last glacial period, Lebanon was not under a typical Mediterranean climate such as the one we know today, i.e. with a strong precipitation and temperature contrast between summer and winter seasons, but rather under a less contrasted climate. Mediterranean species persisted in this area due to the low amplitude of temperature change between the last glacial period and the Holocene as well as to an availability of moisture throughout the year instead of an occurrence mainly during the winter season as is the case today.

ID: 01937, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

A U/Th age model for the continuous, >600-kyr-long lacustrine sediment record of Lake Junín, Perú

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We present a >600-kyr-long age model for the ~100-m-long sediment core extracted from the depocenter of Lake Junín, Perú. By virtue of the successful application of U/Th dating to carbonate marls throughout the core, the record represents the first continuous, absolute-dated record of Quaternary climate change from the tropical Andes.

The sediment core is characterized by alternating packages of glaciogenic siliciclastic sediment and authigenic carbonate marl deposited at a high rate (0.1-0.4 mm/yr). We applied U-series geochemistry to ~150 bulk samples of carbonate marls spanning the upper 75 m of the core. Our results show that the marls have high uranium concentrations (0.3-4 ppm) and low detrital content, with ratios of radiogenic ^{230}Th to initial ^{230}Th that are 10-20 times greater than sediments from Lake Titicaca (Fritz et al., 2007) and the Great Salt Lake (Balch et al., 2005). These qualities allow us to date these sediments to within ±200-800 years in the Holocene and ±6000-8000 years between 280 and 400 kyr ago. The core\'s dependence on U/Th ages throughout its length is unprecedented amongst deep lacustrine records.

Through examination of all our analyses, we are able to devise a set of geochemical (e.g., ^{230}Th/^{232}Th ratio, δ^{234}Uinitial) and sedimentological (e.g., facies type) criteria for evaluating the robustness of the U/Th age for any given sample. Consequently, we also demonstrate the influence of detrital carbonate (eroded marine limestone bedrock) on U/Th dating.

Furthermore, radiocarbon data from the upper 6 m are consistent with U/Th ages. Paleomagnetic secular variation data are compared to globally distributed records of magnetic field variability.

Ultimately, our results indicate that the Lake Junín record spans ~7 glacial-interglacial cycles. Due to its independent and absolute age constraints, this record is well-positioned to yield critical insights on past climate changes in South America, complementing the long records from Sabana de Bogotá, Lake Titicaca, and local speleothems.

ID: 01733, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Reconstructions of late Pleistocene precipitation from paleoshorelines of high-altitude, closed-basin lakes in the central Andes

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Speleothem-based oxygen isotope records provide strong evidence of anti-phased behavior of Northern and Southern hemisphere summer monsoons during Heinrich events, but we lack rigorous constraints on the amount of wetting or drying occurring in monsoon regions. Studies centered on shoreline deposits of closed-basin lakes are well-suited for establishing such quantitative bounds on water balance changes, providing unequivocal evidence for variations in lake area.

We present new dating constraints on lake level variations in a series of closed-basin, high-altitude paleolakes along a north-south transect on the Altiplano-Puna plateau of the central Andes (21-27°S, 3800--4400 masl). This region is home to several small (<40 km3) lakes and salt pans surrounded by well-preserved paleoshorelines that indicate previous intervals of much wetter conditions. Reconstruction of the timing of these wet periods is made possible by the presence of abundant calcium carbonate tufa deposits in association with these abandoned shorelines. Initial U/Th dating of these tufas and other lake carbonates reveal that these deposits are dateable to within ±50 to 300 years due to high U concentrations and low initial Th content. Our initial U/Th ages suggest that these lakes were higher than present levels during three periods: 15.5-14.5 kyr BP, coincident with Heinrich Event 1; >23.5 kyrs BP, possibly coincident with Heinrich Event 2; and at some point before 100 kyr BP. These lake expansions correspond to 4- to 19-fold increases in lake surface area relative to modern.

Because of their location at the modern-day southwestern edge of the summer monsoon, intact shoreline preservation, and precise age control, these lakes may uniquely enable us to reconstruct water balance (precipitation minus evaporation) changes associated with Heinrich events. We explore the physical mechanisms linking Heinrich events and the hydroclimate of the central Andes by comparing results of several freshwater hosing experiments.

ID: 01821, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Dead Sea pollen reveal last interglacial environment of the southern Levant from Paleobotanical perspective

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The southern Levant is controlled by the Mediterranean climate in the north and the Saharo-Arabian desert climate in the south. The regional climate is hence linked to both mid-latitude and sub-tropical atmospheric-oceanic systems. Previous paleoclimatic studies of of cave and lacustrine sediments have refined our knowledge of the last interglacial conditions. Yet, the pattern and trigger of the climatic change remain elusive due to the inconsistences implied by different records. The Dead Sea is an invaluable archive hosting a long history of the regional environment. In 2010, Dead Sea deep drilling cores were retrieved under the auspice of ICDP and allow high-resolution multi-proxy analyses for the past c. 220 ka. Here we present palynological results for the last interglacial period, as well as the transitions in and out of it.

The transition into last interglacial was marked by extensive desert expansion and increased amounts of pistachio trees, suggesting an increased temperature accompanied by prevailing aridity. The last interglacial witnessed a typical vegetation succession process that has also been observed from the southern European pollen records. Relatively high contents of arboreal pollen point to enhanced humidity during the last interglacial, whereas its early phase was characterized by summer drought as indicated by the expansion of sclerophyllous communities. The transition into the early glacial mirrors slightly cooler but still mild climatic conditions due to the occurrence of some pine pollen and moderate amounts of deciduous oak pollen.

Our results add information to the current observations and fill the gap of the last interglacial vegetation history in the mid- and low-latitude Mediterranean region. Given the existing controversies on the relative impact of climatic variables (e.g., precipitation and evaporation) in southern Levant, our investigation highlights the role of insolation-induced seasonality and relative humidity on vegetation changes.

ID: 01628, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Poster)

Long term plant community changes in two lake catchments in the Western Alps: a study based on lake sediment DNA

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Understanding biodiversity changes under the impact of human activities over large timescales is a key challenge in paleoecology. To reconstruct past community changes, Sedimentary ancient DNA (*Sed*aDNA) in lake is an effective tool alongside pollen and macroremains. Here we present an analysis on *sed*aDNA combined with other sedimentary records to investigate the plant community evolution in two Western alps lake areas over the last 10000 years (Lake Verney at 2093m a.s.l and Lake Savine at 2447m a.s.l.).

In the Lake Verney area, the plant community evolution is characterized by a compositional change from conifer forests and tall-herb communities to grazed lands at started at around 3000 cal. BP, accompanied by intensive sheep and cattle farming and rapid increase of soil erosion. A similar expansion of grazed land species (e.g. *Plantago* spp.) replacing tall herbs is recorded in the Lake Savine area during the same period. This study highlight the impacts of livestock farming and potentially other human activities on alpine plant communities in different altitudinal contexts.

ID: 01633, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

CREST – Climate REconstruction SofTware

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Several methods currently exist to quantitatively reconstruct palaeoclimatic variables from fossil botanical data. Of these, methods using probability density functions (*pdfs*) have proven particularly valuable in certain cases as they can be applied to a wide range of plants assemblages. Most commonly applied to fossil pollen data, their performance, however, can be limited by the taxonomic resolution of the pollen data, as many species may belong to a given pollen-type. Consequently, the climate information associated with different species cannot always be precisely identified, resulting in less accurate reconstructions. This can become particularly problematic in regions of high biodiversity, such as southern Africa.

In this paper, we propose a novel *pdf*-based method that takes into account the different climatic requirements of each species constituting the broader pollen-type. *Pdf*s are fitted in two successive steps, with parametric *pdf*s fitted first for each species, and then a combination of those individual species *pdf*s into a broader single *pdf* to represent the pollen-type as a unit. A climate value for the pollen assemblage is estimated from the likelihood function obtained after the multiplication of the pollen-type *pdf*s, with each being weighted according to its pollen percentage.

To make this method accessible to the wider community we have developed a point-and-click software package entitled CREST. Written in Python (fast computing), CREST is compatible with all operating systems. Besides facilitating the use of the method, CREST also generates a series of useful graphical and numerical outputs to help understand the results and refine the reconstructions. Finally, we have also included a module dedicated to the study of plant/climate relationships. Statistics can be derived to identify the environmental factors that drive the distribution of a (group of) plant species.

ID: 01787, 01.- Open Session on past global changes, (Poster)

A high-resolution geological model for central Sundaland : Quaternary Stratigraphy of the Kallang River Basin, Singapore

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This synthesis reviews the current understanding of Quaternary deposits in the Kallang River Basin on the island of Singapore, located in the core of the Sunda Shelf. We selected 151 boreholes from approximately 4000 borehole logs to create 14 cross-sections covering the distribution of the Quaternary deposits in the Kallang River Basin. Analysis of the cross-sections and 3D geologic model shows various palaeo-features (e.g. Palaeochannels, swamps etc) showing the geomorphic and facies evolution of the basin. The oldest of the Quaternary deposits are fluvial deposits of postulated, but not proven, Plio-Pleistocene age called Old Alluvium, which was subsequently unconformably overlain by a sequence of unlithified sediments of late Quaternary age – collectively called the Kallang Formation, which were deposited predominantly in the Kallang River Basin and up incised valleys and palaeochannels from MIS 5e to present. The Lower Marine clay was deposited about 120,000 years ago atop transgressive sands and muds and was subsequently exposed and desiccated during the last interglacial forming a ‘stiff clay’ layer. This was later overlain by younger transgressive sands and nearshore peats during the last interglacial, followed by the Upper Marine Clay which was deposited ~10,000 years ago. Sequence stratigraphy of the marine clays and other Kallang Formation facies has been instrumental in understanding the sea-level change and associated geomorphology and facies evolution from the penultimate interglacial to present times in the farfield Sunda shelf.

ID: 01278, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

The last 2.7 kyr in the central western Mediterranean: climate evolution from speleothems and marine sediments

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Atmospheric and surface-deep ocean interactions reconstruction are here presented for the last 2.7 kyr in the central western Mediterranean taking the advantage of the high sensibility of this region to climate variability.

Speleothem records from a Mallorca-Cave have been used to evaluated atmospheric conditions and, sediment multicores from the North Minorca drift to reconstruct ocean-conditions. Instrumental measurements of deep-sea currents from moorings have also been evaluated. Hydrological fluctuations on land are interpreted from stable isotopes and trace elements records from four U-Th dated speleothems. Sea surface temperatures (SST) were derived from Mg/Ca-*Globigerina bulloides*-ratios. Deep-current intensity-changes associated to the main core of the Western Mediterranean Deep Water (WMDW) are evaluated by means of grain-size analysis (UP10-fraction). The strongest WMDW flow occurred during warm intervals as the Roman Period, but also took place during colder intervals like the Little Ice Age. This observation suggests different triggers for the WMDW-convection. On land hydrology, SST and deep-water fluctuations present a significant centennial-scale variability coupling in the study area. However, atmospheric and ocean conditions do not present a simple-connection. Warmest conditions dominated mostly during the Roman Period and part of the Medieval Climate Anomaly but, according to the speleothem records, wet/dry conditions dominated on land and, deep convection patterns were also very different between these two periods. The comparison between our WMDW-record and other convection record from the Levantine Basin in the Eastern Mediterranean also supports distinct climatic forcings. Taking into account available reconstructions of different modes of climate variability such the NAO and other Mediterranean and North Atlantic climate records, the climate variability in the region was most likely caused by a combination of distinct climate modes that should have occurred during the last 2.7 kyr.

ID: 01722, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Sources of inter-model variability in the VolMIP-Tambora experiment

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The Model Intercomparison Project on the climatic response to Volcanic forcing (VolMIP) included a pre-study of an idealized tropical eruption resembling the 1815 Mt Tambora event. The pre-study was composed of an ensemble of simulations performed with multiple climate models with interactive stratospheric aerosols under coordinated climatological and injection parameters. The experimental protocol designated an emission of 60Tg of sulfur dioxide into the stratosphere, approximately 5-10 times the amount emitted by the 1991 Pinatubo eruption. Results showed large disparities between models in the volcanic radiative forcing parameter of global-average aerosol optical depth (AOD) in the visible band, urging the need to understand the sources of inter-model disagreement. Here, work is presented on inter-model differences in size, spatial and chemical evolution of injected sulfur species. Results from this analysis will assist in the identification of the simulated chemical and physical model processes that currently limit the ability of state-of-the-art climate models to robustly simulate the radiative forcing generated by very large volcanic eruptions, detect areas for model improvement, and eventually advance our understanding of volcanic impacts on the climate system.

ID: 01531, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Modern and Holocene hydrological variations of the NE Atlantic inferred from Nd isotopic composition analyzed on seawater and deep-sea corals

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The North Atlantic plays a major role in the European climate via the Atlantic Meridional Overturning Circulation (AMOC) that is intimately tied to the salt and heat budget in the north Atlantic gyres. The strength of the subpolar gyre as well as the northern limit of MOW and subtropical waters are important components of mid-latitude Atlantic climate variability that are in turn linked to the atmospheric circulation and freshwater fluxes from the Arctic. However, little is known about the sensitivity of the gyres and boundary currents to wind stress and freshwater perturbations over long time-scale such as the Holocene. Because the AMOC has a significant impact on the precipitation patterns over Europe, North America as well as the Atlantic tropical areas, it is important to improve our knowledge of the low frequency ocean variability. HAMOC (Holocene North Atlantic Gyres and Mediterranean Overturning dynamic through Climate Changes) is an integrated multidisciplinary climate research project that take up the challenges of improving present knowledge of the AMOC variability and links with the Mediterranean outflow during the Holocene (abrupt or not, e.g. Medieval Warm Anomaly, Little Ice Age, 8,200 yrs cold event…). Here, we present a new set of εNd data obtained on seawater and precisely dated cold-water corals (U/Th dating) collected in the NE Atlantic to reconstruct the re-circulation of water occurs through basin scale gyres and boundary currents at surface and at mid-depth. More particularly, we will show the interest to use εNd proxy to reconstruct the eastward extension and strength of the subpolar gyre water as well as the northern limit of Mediterranean Sea Waters (MSW) and subtropical gyre waters in the NE Atlantic.

ID: 01988, 01.- Open Session on past global changes, (Poster)

SISAL: A community-driven initiative to create a global database of speleothem data for model evaluation

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Speleothems can provide extremely high-resolution records of changes in both climate and atmospheric composition. These records have the potential to be used to document regional changes in mean climate and climate variability on annual to centennial timescales. They can also be used to refine our understanding of regional changes in climate forcings, such as dust and volcanic aerosols, through time. Many climate models now explicitly include isotopic tracers, and thus the isotopic records from speleothems can be used directly for model evaluation. There are more than 400 published speleothem records providing information covering part or all of the last 21,000 years and a large number of these records extend much further back in time. Previous attempts to compile speleothem data have not provided a globally-comprehensive synthesis, nor have they provided assessments of measurement, chronological or interpretation uncertainties. SISAL (Speleothem Isotopes Synthesis and Analysis) is a new community-based working group sponsored by Past Global Changes (PAGES) to synthesise speleothem data globally and develop a public-access data base, that can be used both to explore past climate changes and in model evaluation. SISAL will rigorously evaluate and document the sources of uncertainty in speleothem records to produce standardised and fully-documented reconsructions. The working group will bring together speleothem scientists, speleothem-process modellers, statisticians and climate modellers, to ensure that the database serves the needs of these communities. This presentation will explain the motivation for SISAL, outline the philosophy behind the data synthesis, and present preliminay results from the SISAL working group.

ID: 01716, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

The primacy of internal variability over late Holocene forced change of the Asian monsoon on the southern Tibetan Plateau

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The nature of multidecadal to centennial variability of the Asian monsoon remains largely unknown. Here we use the sediment record from a closed-basin lake in southern Tibet, Ngamring Tso, to assess summer monsoon precipitation from 4100 cal yr BP to present. The first principal component of the Ngamring Tso grain size record correlates significantly with observed June-September precipitation. From CE 1940-2007, grain size decreased with increasing summer precipitation and increased with decreasing summer precipitation. Satellite images of Ngamring Tso suggest precipitation-induced changes in lake depth or area likely govern grain size variability. Prolonged periods of weak summer monsoon precipitation occurred from 2800-2600 cal yr BP, 2500-2300 cal yr BP, and 1600-400 cal yr BP. A trend toward increased summer precipitation began around 1000 cal yr BP, with above-average summer precipitation from 400 cal yr BP to present, peaking between 200-100 cal yr BP. Dry and wet periods are coincident with dry and wet periods in other south-central Tibetan lake sediment records and with regional proxies of the ISM and EASM, indicating south-central Tibet is influenced by both monsoon subsystems. 20th century precipitation variability in southern Tibet falls within the range of natural variability in the last 4100 years, and does not show a clear trend of increasing precipitation as projected by models. Instead, it appears that poorly understood internal modes of monsoon variability remained influential throughout the last 4100 years. Substantial multidecadal to centennial-scale variability will thus complicate our ability to project future anthropogenic changes in the region\'s monsoon precipitation.

ID: 02119, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Variability of Sahel rainfall and Lake Chad extent during the Pliocene reconstructed by a chain of models

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In order to understand the paleo-variability of Saharo-Sahelian paleoprecipitation, which is recorded in the sediments of Lake Chad situated in central Sahel, we use a modelling chain going from global climate to basin-scale hydrological model. Namely, climate model outputs available from the IPSL-CM5 global climate model are statistically downscaled with the General Additive Model approach (Levavasseur et al., 2011), then used to feed the LPJmL model (Bondeau et al., 2007) which calculates the equilibrium vegetation and runoff. Climate and runoff are then given to the dynamic routing scheme HYDRA (Coe et al., 2000) in order to calculate the paleo river network and paleo extent of Lake Chad. The method is first tested for the mid-Holocene, for which several paleo-precipation estimates and precise Lake Chad extent reconstruction are available. For the mid-Holocene, the downscaled precipitation matches very well precipitation estimations derived from lacustrine pollen data. The simulated extent of Megalake Chad for the mid-Holocene closely matches the paleoshoreline. The method is then applied for different orbital configurations of the Pliocene warm period in order to assess the variability of paleo-precipitation and paleo-lake extent during that period, and inform the potentiality of Lake Chad as a continuous recorder of the African monsoon during that time.

ID: 01799, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

Atmospheric carbon invasion in the meridional border of California Current: the last three decades

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Eastern Boundary Upwelling Systems (EBUS), as the California Current System (CCS), alternate seasonally between more acidic surface waters than most of the surface ocean due to the vertical mixing of carbon rich subsurface waters driven by the intensification of equatorward winds during spring to early summer. These processes make EBUS especially sensitive to ocean acidification and play an important role in the ocean carbon exchange. Recent observations show a considerable increase in the chemistry of carbon driving surface ocean acidification.

Three different cores were retrieved from San Lázaro basin (25° 10’ N and 112° 44’ W), a 540 m deep enclosed in the west by a 100 m deep uplifted fault system that is broken in the southwest by a narrow sill of 350 m depth. The constriction on circulation imposed by this sill coupled with the oxygen poor waters entering through this depth, and the relatively high export productivity of organic carbon control to suboxic conditions of the bottom waters. These conditions inhibit biological bioturbation processes and allows for the well preserved laminated sediments. The basin is further located in the transition zone of the CCS and the Tropical waters, location highly sensitive to interannual and decadal variability from the high latitudes and the equatorial and tropical Pacific.

We present the d^{13}C isotopic records of organic fraction and inorganic carbon (calcitic from planktic foraminifera) for the last century, that show the direction and magnitude of the atmospheric carbon invasion in the surface waters for the last three decades. Preliminary results show similar trend toward lighter isotopic compositions of both, calcitic and organic carbon that mimic the atmospheric record, but with different slopes. We discuss the physical, chemical, and biological processes that could influence this behavior and their relative importance with implications on the dynamics that control the CCS.

ID: 01684, 18.- Human Impact on Global Aquatic Systems, (Poster)

Seven centuries of mercury and lead atmospheric deposition recorded in a varved lake record from the Pyrenees

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Geochemical analyses in varved lake sediment cores (Lake Montcortès, Pre-Pyrenees) allowed reconstruction of mercury (Hg) and lead (Pb) atmospheric deposition over the past seven centuries in the Pyrenees (NE Spain). Accumulation Rates (AR) from the Middle Ages to the Industrial Period ranged from 2500 to 26130 µg.m^{2}.y^{-1} and 15 to 152 µg.m^{2}.y^{-1} for Pb and Hg respectively. Significant metal pollution started ca CE 1550 during a period of increased exploitation of ore resources in Spain. Colder and humid conditions in the Pyrenees during the Little Ice Age may have also favoured Hg and Pb atmospheric deposition in the lake. Therefore, the interplay between increased rainfall (wet deposition) and mining activities in the Iberian Peninsula has driven Hg and Pb AR during the Pre-industrial Period. More recently, the use of leaded gasoline in Europe in the mid-20th century may explain the highest Pb AR between CE 1953 and 1971. The highest Hg AR occurred in CE 1940 synchronously with the highest Hg production peak in Almadén mining district (southern Spain) and the Second World War. Hg enrichment evolution in Lake Montcortès shows a decrease during the last decades in Western Europe similar to other regional records and global emission models. This study highlights the exceptional quality of varved sequences to tease apart pollutants depositional mechanisms, identify historical periods of increased atmospheric pollution and reconstruct the evolution of aquatic ecosystems to make correct assessments of recent (atmospheric) pollution in lake ecosystems.

ID: 01470, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Circulation changes in eastern Mediterranean Sea over the past 23,000 years inferred from authigenic Nd isotopic ratios

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Eastern Mediterranean Sea (EMS) is a key site to study circulation change because of its own thermohaline circulation induced by convection processes. The sensitivity of the EMS circulation has been associated to different climate backgrounds, inducing strong modifications in salinity gradients. Additional

knowledge about Mediterranean circulation sensitivity can be gained through paleoclimate studies using appropriate proxy for paleocirculation reconstructions**.** In this study, we focused on intermediate/deep waters circulation during the Last Glacial Maximum (LGM), the following deglaciation including the sapropel (S1) deposition. Two cores from the Levantine Sea and the Strait of Sicily, respectively collected at 1,780 m and 771 m, were selected. Combined geochemical data (ε□Nd, $\delta^{13}C$, $\delta^{18}O$) and a box model allowed us to determine 1) various contribution of North Atlantic waters to Mediterranean basin, 2) the water exchange at the Strait of Sicily, and 3) variations in the Nile River contribution. During the LGM, high benthic foraminiferal $\delta^{13}C$ values indicate well-ventilated intermediate and deep water conditions in the EMS. More radiogenic ε□Nd values than present at both sites reflect a smaller contribution of the unradiogenic North Atlantic water to the EMS due to restricted exchange at the Strait of Sicily and/or a change in convection zone. At the end of HE1, synchronous decrease of ε□Nd and $\delta^{13}C$ values is linked to an increased contribution of North Atlantic freshwaters in the Mediterranean basin, which impacted the water column stratification and thus ventilation of intermediate and deep waters in the EMS. Increased Nile River freshwater at 15 ka BP and during the AHP (including S1) further strengthened the sluggish circulation whereas partial dissolution of high εNd Nile river particles increased Nd isotopic signature in the EMS. During S1, a large εNd difference between EMS and WMS suggests that both basins could have a distinct circulation mode. After S1, enhanced exchange between WMS and EMS led to decreasing εNd values at the strait of Sicily before establishment of the modern circulation pattern in the Mediterranean.

ID: 01776, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

A precise chronology of millennial-scale climate events from French speleothems

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The development of precise and accurate chronologies of millennial-scale climate events is essential for improving our understanding of these rapid climate changes. Many aspects of millennial-scale climate events remain unresolved, including their propagation mechanisms and underlying cause. A major limitation to furthering our understanding of the events is the chronological uncertainty associated with the Greenland ice-core record, which despite concerted effort, remains relatively large with respect to the duration of these events. It is therefore necessary to turn to new dating methods or other archives in order to improve this chronology.

Speleothems can be dated extremely accurately and precisely using uranium-thorium dating and have been widely shown to record millennial-scale climate events in their stable oxygen and carbon isotope signatures. Speleothems thus present the potential to provide precise age-anchor points to tie the Greenland ice core chronology to radiometric time. Speleothem records from south-west Europe are ideal for this task due to the region's climatic connectivity with the North Atlantic, and thus to Greenland. However, there is currently an absence of high-resolution, precisely dated and continuous records from this region.

In this project we aim to produce a speleothem-based palaeoclimate reconstruction of millennial-scale climate events from French caves, including Saint-Marcel, Villars and Orgnac. Here we present the preliminary results capturing events in the early last glacial. Following the identification of millennial-scale events we endeavour to date the record at a high resolution over individual interstadial events to optimally constrain the chronology over the event transitions.

ID: 02334, 06.- Before and after - climate contrasts across the MPT, (Poster)

Bipolar climate seesawing along the last 800,000 years

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Temperature measurements in Greenland and Antarctica ice cores showed a linear correlation between amplitudes of South warm episodes and duration of concurrent North cold events during the age span covered by Greenland ice (last 110,000 years). This bipolar seasaw documented the South-North heat transport by the Atlantic Meridional Overturning Circulation (AMOC). A study of alkenone sea surface temperatures from ODP977 sediment core now provides a Northern Hemisphere submillennial scale climate record for the last 800,000 years. The abrupt cold episodes show good equivalences with Antarctic warm events and linear correlations. The regresion slopes of the last four glacial cycles are the same as observed in the Greenland-Antarctic records. These results indicate that the AMOC driven bipolar seasaw operated with the same intensity during the last 800,000 years.

ID: 01928, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Deciphering 231Pa/230Th in hydrothermally influenced sediments from the Juan de Fuca Ridge

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^{231}Pa/^{230}Th is a widely utilized proxy that can provide valuable insight into circulation, particle fluxes, surface productivity, and hydrothermal activity in the modern and past ocean. Its multifunctionality derives from the constant global production of ^{231}Pa and ^{230}Th from U decay in seawater combined with the substantially different residence times of the two nuclides in the water column. Application of ^{231}Pa/^{230}Th is generally focused in regions with a single dominant influence on the distribution of the two nuclides, but confounding interpretations are sometimes unavoidable. The Juan de Fuca Ridge is one region where both surface productivity and hydrothermal activity may be influencing sedimentary ^{231}Pa/^{230}Th. We generated a high-resolution ^{231}Pa/^{230}Th record covering the last 180ka using sediments in core AT26-19-09PC recovered from 2678 m water depth on the western flank of the Juan de Fuca Ridge, where hydrothermal metal deposition has previously been found to be high throughout the sedimentary record. The reconstructed burial ratios range from the seawater production ratio (0.093) during the last glacial maximum to more than double the production ratio (0.200) during the Holocene. Generally, high ^{231}Pa/^{230}Th correspond to interglacial periods, with a secondary 40kyr cycle in which high ^{231}Pa/^{230}Th occurs during high obliquity. Despite relatively high Mn concentrations (up to 1.9wt%), there is little covariation between metal deposition and ^{231}Pa/^{230}Th, perhaps suggesting that a primary relationship between Mn and ^{231}Pa/^{230}Th has been decoupled by post-depositional redox mobilization of Mn. Alternatively, hydrothermal particles may impose only weak scavenging of ^{231}Pa/^{230}Th. We also consider the potential influences of variable intermediate-water ventilation and changes in biological, particularly opal, productivity on sedimentary ^{231}Pa/^{230}Th in the northeast Pacific Ocean.

ID: 01840, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

The 8.2 ka event recorded at high resolution by a speleothem from the Northern French Alps

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Continental records of Holocene climate variability in the Alps are scarce and they rarely document the “8.2 ka event”. Several reasons have been proposed: records do not have sufficient resolution, are not precisely dated or the proxies are not sufficiently sensitive to climate variations associated with this event. The European records of adequate resolution generally allow the identification of an anomaly but its characterisation is unclear: it seems that the event has triggered significant impacts only for a few decades and mainly expressed in winter (whereas most archives are more sensitive to summer conditions). Thus, the detailed characterisation of the impacts of this event requires records with sub-annual resolution and preferably sensitive to winter conditions.

Here we present a multi-proxy, high-resolution analysis of this event, as recorded by a stalagmite of the Bauges massif (Northern French Alps), at ~1400 m a.s.l. The most prominent feature of the oxygen isotope record for the Holocene is the ~1 per mille depletion centred on 8.2 ka. The structure and duration of this excursion, as constrained by U-Th dating, are identical to those observed in the Greenland composite ice-core record. Interestingly, other proxy data from the speleothem show no obvious hydrological or thermal response during this event, suggesting that the oxygen isotope shift reflects mainly a change in rainwater composition. We compared our record with other high-resolution oxygen isotope records from western European terrestrial archives whose rainfall source is also the North Atlantic. This comparison reveals similar structure for the isotopic event, indicating that meltwater-driven change in surface ocean composition was likely responsible. The result of this work calls into question the magnitude of the climate change associated with this event in western Europe.

ID: 01892, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Was a cold/arid spell driving the collapse of the Terramare culture in the late Bronze Age of Northern Italy?

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A geoarchaeological and archaeobotanical investigation on the Terramara Santa Rosa di Poviglio archaeological site in the central Po Plain (Northern Italy) suggested a possible nexus between the societal collapse of the Terramare culture of the Bronze Age and a rapid climate change (RCC). The Terramare are archaeological remains of banked and moated villages, located in the central alluvial plain of the Po River. The sedimentary infilling of the moat surrounding the site of Santa Rosa di Poviglio was analysed in order to obtain palaeoenvironmental inferences from sediments and pollen assemblage. The relationships between Late Holocene regional environmental vicissitudes and land-use changes were investigated focussing on adaptive strategies of the Terramare people during the Middle/Recent Bronze ages (1550–1170 yr. BC). Pedosedimentary features and biological records from the moat demonstrate that, at the beginning of the formation of the sedimentary sequence, shallow water was permanent, and its level dropped during the last phase of life of the site. Pollen showed continuous transformation in flora composition and communities, suggesting a dynamic agricultural economy, based on wood management and crop fields. At the top of the sequence, in correspondence with the drying of the moat system, a dramatic decrease of woods may have had twofold causation: aridity and intensive land-use might have played a fairly synchronous action on vegetation. Data suggest a scenario of an impoverished plant landscape at the end of the life of the Poviglio Santa Rosa village, and connected with the collapse of the Terramare culture. The cold/dry RCC is also evident in regional and global climatic records and has been now identified also in the speleothems-based reconstruction (Rio Martino Cave) for climate changes in the Po Plain.

ID: 01631, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Poster)

ENSO and tropical monsoon variability througouh the ice ages

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This contribution documents the sensitivity of tropical interannual variability in HadCM3 over ice ages, based on two series of 60 experiments with HadCM3. The output of these experiments is synthesised under the form of statistical meta-models (Gaussian process emulators) with the following objectives : (a) detect which aspects of tropical variability is actually sensitive to changes in the level of glaciation, CO2 concentration and astronomical forcing (b) explore relationships between variability in sea-surface temperature and atmosphere dynamics (c) determine whether the well-known relationship between ENSO events and the weakening of sub-tropical monsoon westerlies in the Northern Hemisphere is maintained across the glacial cycle.

We find that climate precession is generally the main causes of changes in tropical variability in the Pacific, with maximum interannual variability with the perihelion is reached between December and March, followed by the level of glaciation. Precession and glaciation have different signatures on wind stress. Furthermore the glaciation effect itself combines two opposite effects: the ice sheet albedo increases wind stress and reduces tropical variability ; the topographic growth does the opposite. Finally, the negative correlation between NINO3.4 temperatures and tropical monsoon is maintained throughout the ice age and is not significantly alterned.

ID: 02055, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

CO2 drawdown via Southern Ocean stratification at the onset of the last glacial period

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The magnitude and pacing of CO_2 change during glacial cycles over the past 800,000 years suggests a major role for the deep ocean. The Southern Ocean has been a focal point for research in this area as 1) it is an important region of deep water ventilation and 2) CO_2 change is tightly coupled with Antarctic air temperature. In the modern Southern Ocean, the upwelling of carbon-rich deep waters coupled with incomplete nutrient consumption at the surface results in a leak of CO_2 to the atmosphere. Stemming this leak by imposing a physical barrier to the upwelling and outgassing of CO_2-rich deep water offers a potential mechanism to lower glacial pCO_2. Both greater sea-ice cover and enhanced surface stratification in the

Antarctic zone of the Southern Ocean have been suggested as barrier mechanisms. Greater sea-ice cover would impose a disequilibrium between the surface ocean and atmosphere and result in a lower sea-surface pH. Conversely, enhanced stratification would reduce the upwelling of CO_2-rich waters, causing a relatively higher sea-surface pH. To determine which mechanism is dominant, we have applied the boron isotope pH-proxy to samples of the planktic foraminifera *N. pachyderma* from a Weddell Sea sediment core spanning the last glacial cycle. We find low $d^{11}B$/pH during the penultimate deglaciation and last interglacial, followed by a switch to high $d^{11}B$/pH during the onset of the last glacial period. Our results provide evidence for the upwelling of carbon-rich deep waters at the penultimate deglaciation, which likely contributed to deglacial CO_2 rise. The subsequent increase in $d^{11}B$ indicates the early establishment of surface stratification and associated CO_2 drawdown during the glacial period, suggesting that Southern Ocean stratification plays an important role in the transition into glacial conditions.

ID: 01886, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Long-term ground surface temperature from geothermal data in North America as a complement for GCM control simulations

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Control climate simulations aim to provide a stationary state to General Circulation Models (GCMs) under constant preindustrial conditions (piControl simulations). This stationary state is then used as initial conditions in GCM simulations to provide a stable and realistic climatology, reducing the potential bias in such simulations. However, it is difficult to provide a reference to assess the climatology of piControl simulations due to the lack of long-term preindustrial observations. We explore the use of long-term ground surface temperature estimates from borehole temperature profiles as an additional reference that may be useful for the initialization procedure of GCM simulations. We compare estimates of long-term preindustrial ground surface temperatures from 514 borehole temperature profiles over North America against five Last Millennium (LM) simulations and five preindustrial control simulations from the third phase of the Palaeoclimate Modelling Intercomparison Project (PMIP3) and the fifth phase of the Coupled Model Intercomparison Project (CMIP5) archive. Our results suggest that the ground surface temperature estimates from borehole data could be employed as a reference within piControl simulations to enhance the quality of the initial conditions in GCM climate simulations.

ID: 02164, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

The “Ills”: Long-Term Climatic Context for the 1690s Scottish Famine Inferred from Tree Rings

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One of the coldest decades of the past millennium, the 1690s, overlaps with the so-called Scottish “Ills”, considered the worst period of widespread late harvests, crop failures and associated famine in Scottish history. This climatic episode, along with a failing economy, partly led to the decision by Scottish investors to launch the ill-fated expedition to colonize Darien, on the Isthmus of Panama, to boost Scottish morale and welfare. The expedition ultimately failed, finally bankrupting Scotland and helped lead to the eventual unification of Scotland with England in the early 1700s. Here we use an 800-year long summer (July-August) temperature reconstruction for northern Scotland based on Scots pine tree-ring width and Blue Intensity data to place the severe cold of the 1690s into a historical perspective. This extreme event coincided with the peak of the Little Ice Age, the late Maunder Minimum of solar activity, and anomalous features of the atmosphere-ocean circulation in the northeast North Atlantic sector. Volcanic cooling has been suggested as another contributing factor. Here we show, using both tree-ring and climate model results, that this decade was exceptionally cold elsewhere across Eurasia and North America, arguing for volcanism as the primary cause of this event.

ID: 01356, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Herbivore and fire interactions in grassland dynamics at wetland key resource use area at millennial timescales

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Large mammalian herbivores (LMH) are one of the major drivers of directional vegetation change in grass-dominated terrestrial ecosystems. Areas where LMHs aggregate are often associated with switches from tallgrasses to shortgrasses and this is followed by changes in soil properties. However, the relationship between LMHs and vegetation is complicated by interactions with fire and rainfall which results in dynamic vegetation patterns in landscapes dependent upon the susceptibility and tolerance of vegetation to herbivory over time. Compared to woody plants, grasses have shorter lifespans which make them ideal for the investigation of vegetation dynamics at millennial timescales as they are likely to be vulnerable. A multiple-proxy palaeoecological study was conducted to investigate long-term changes of local herbaceous biomass in response to LMHs and climate at a wetland key resource area (KRA) that attracts many LMHs. Herbaceous community structure, LMH activity, soil disturbance and fire were investigated using grass silica short cell (GSSC) phytoliths, dung spores, elemental analyses, and charcoal respectively from a wetland sedimentary core obtained in a mesic grassland-savanna matrix in Vryheid, South Africa. The dynamic 1300-year multiple proxy record suggested that grass composition was driven by LMHs as the correspondence analysis primary axis which accounted for c.46% of variation in GSSC grass tribe phytoliths was dominated by the overgrazing indicator, Aristidoideae. LMHs were present throughout the sequence but increased local activity from ca. 620 cal BP as indicated by *Sporormiella* dung spores, which coincided with increased fire as suggested by charcoal abundance. Increased local presence of herbivores was in response to moist local conditions indicated by Fe^{2+}, and this led to unstable vegetation associations which ceased from ca. 450 cal BP when *Phragmites* represented by Arundinoideae GSSC phytoliths dominated. The resilience of KRA and their role in the sustenance of LMHs are discussed using a novel approach.

ID: 02128, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Reconstructing climate during Late Holocene: Decline of Pre-Historic site in Western Kachchh

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Major climatic transformation in Western India is affected by variation in Indian Summer Monsoon (ISM). During last millennial scale, Indian sub-continent has observed varied climatic oscillations due to temperature variations. People and society are the most affected lot due to this climate changes, which leads towards migration or colonization of people. This study focuses on the Late Holocene monsoonal changes from the sediment record of Western Kachchh. The field of study is at the mount of Kali River, a 45 km long river originating from the hills of Western Mainland Kachchh and debouching into Kori Creek. The exposed cross-section along the river bank has a fluvial unit (Unit 1) at the base followed by human settlement marked as Unit-2 culminating with eolian deposits (unit 3) at the top. The sediments were analyzed sedimentologically, optically and geochemically to ascertain the climatic fluctuation in the region. The lower Unit 1 which range in age from 6-5 Ka shows declining monsoon. The above exposed sediments with anthropogenic activity (Unit 2) cover a time span of 3-2.5 ka indicates monsoonal stability with declining trends. The general weakening of monsoon may be a major factor towards the ending or migration of the human settlement leading to the absence of archeological activity above 2.5ka in the area. The eolian sands sitting above the Unit 2 fall between 450 to 230 yrs represent the Little Ice Age. Sediment record from the opposite bank of the river reveals an age of 1100 yrs supports wet condition which is co relatable with the global Medieval Warm Period (MWP). Based on detail study it can be interpreted that the area has been highly affected by ISM variability since last 5ka and the pre-historic human occupation has been affected by the climatic changes.

ID: 01368, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Salinity effect on Globigerinoides ruber (white) Mg/Ca: A revisit of Atlantic core-tops

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A salinity effect on *Globigerinoides ruber* (white) Mg/Ca complicates the application of *G. ruber* (w) Mg/Ca as a proxy for sea surface temperature. Despite various attempts, the effect of salinity on *G. ruber* (w) Mg/Ca remains an unresolved debate over the last decade. To pin down the extent to which salinity affects *G. ruber* (w) Mg/Ca, we have analyzed *G. ruber* (w) Mg/Ca from an Atlantic meridional core-top sample set. These core-

tops have been previously used to argue for a large salinity effect based on a strong salinity-“excess Mg/Ca” correlation, where excess Mg/Ca represents the Mg/Ca offset between measurements and expected values at isotopic temperatures (T_{iso}) derived from foraminifera-seawater $\delta^{18}O$ offset. Our new Mg/Ca results are on average 12% lower than the published data. Without invoking a salinity effect, our *G. ruber* (w) Mg/Ca temperature estimates match well with hydrological temperatures at the calcification depths during the seasons preferred by *G. ruber* (w). We show that the salinity effect previously suggested by excess Mg/Ca is probably an artifact resulting from the covariation between T_{iso} and salinity in the modern Atlantic Ocean. When this covariation is taken into account, we demonstrate, for the first time, that the salinity effect on *G. ruber* (w) Mg/Ca is negligible for the Atlantic core-tops. By reconciling *G. ruber* (w) Mg/Ca-derived temperatures with those based on hydrological and foraminifera-seawater $\delta^{18}O$ data, we conclude that *G. ruber* (w) Mg/Ca is marginally affected by salinity changes and thus mainly reflects calcification temperatures, enhancing our confidence to use planktonic Mg/Ca for past sea surface temperature reconstruction.

ID: 01362, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Age and inferred paleoclimate from Pleistocene-aged deposits in the Hudson Bay Lowlands, Northern Canada

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Earth System Models, which are used to simulate past climates and project future conditions, require an accurate understanding of the dynamics of Pleistocene ice sheets. While we have a relatively good understanding of the most recent deglaciation, large knowledge gaps exist for periods prior to the Last Glacial Maximum (LGM), in particular the dynamics of the Laurentide Ice Sheet (LIS). The paleo-history of the Hudson Bay Lowlands (HBL), an extensive peatland spanning >370,000 km^2 in central Canada, may be able to resolve this issue. Since the HBL lies near the center of many Pleistocene ice sheets, non-glacial deposits signal large-scale deglaciation over North America. Various non-glacial records (marine, fluvial, organic, lacustrine) have been found in this region, all of which are overlain by tills. However these records are highly fragmented and disparate, making the glacial history of this region a topic of ongoing research. Our review of existing (n=88) and new (n=39) age determinations from these sites suggests an ice-free interval during Marine Isotope Stage 3 (ca. 57,000 to ca. 29,000 yr BP; Dalton *et al.* 2016, QSR). Glacial modelling suggests that the LIS may have been close to its maximum extent during MIS 3, therefore, these data suggest a significantly different configuration of the ice sheet than previously believed. Efforts to improve these age determinations are underway. Non-glacial records from the HBL also offer rare insights into Pleistocene paleoclimate. For example, the Ridge Site, provisionally dated to MIS 3, contains a pollen and macrofossil record suggestive of peatlands and a climate slightly cooler/drier than today (Dalton *et al.* 201x, Boreas, *accepted*). Thus, these records also enable estimates of pre-LGM peatland extent and carbon pools, and new insights into the global carbon cycle during the Pleistocene.

ID: 01495, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Precession and obliquity controls on South Africa monsoon and fire

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Subtropical southern Africa is dominated today by grass-fuelled fires which are controlled by marked rainfall seasonality, with wet austral summers during which fuel accumulates, and dry winters that increase fuel flammability. Microcharcoal (micro-particle produced during vegetation fire), a tracer of fire activity, was analysed from a deep-sea core off Namibia covering the past 180,000 years to study sensitivity of fires to changing climate and therefore to gain insights into fire activity for the near future. We observe clear cycles in fire activity during this period. Spectral analysis of the fire signal shows three distinct periodicities of 12.9, 23 and 54 kyrs. Maxima in fire activity occur during maxima of local summer insolation and maxima of precession (maxima of seasonality). We interpret changes in fire activity as a record of South African monsoon changes (strength and/or intensity) in agreement with results from a set of five simulations from a General Circulation climate model integrated for different key orbital configurations. Although fire activity and South Africa monsoon appear to be paced by orbital forcing through precession, observation of a 54 kyr period suggests a modulation of the response by the obliquity, or a non-linear response of the fire and monsoon to precession and obliquity. We finally propose a simple conceptual model to illustrate such a potential non-linearity, explaining the presence of 12.9, 23 and 54 kyrs periods in the fire record.

ID: 01353, 01.- Open Session on past global changes, (Poster)

Spatio-temporal variability of the SPCZ fresh pool eastern front from coral-derived surface salinity data

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The South Pacific Convergence Zone (SPCZ) is a major atmospheric feature of the southern hemisphere. It is a low atmospheric convergence band associated with intense precipitations. Its position and intensity responds to global changes but also modulates regional weather patterns. Interannual to long-term SPCZ modifications result in extreme events such as severe droughts or flooding with profound socio-economic consequences. The SPCZ oceanic counterpart is a large body of fresh water (SSS<34.5 pss) extending southeast from the Maritime Continent to the dateline. This freshpool is separated from the high-salinity waters of the South Pacific gyre to the west by a steep salinity front.

Various studies have shown a freshening of the freshpool and its south-eastward expansion since the 1970s, modulated by interannual to interdecadal variability (Cravatte et al., 2009). The scarcity of traditional SSS measurements limits our ability to describe accurately this variability. This study validates the use of coral d18O as a proxy for the reconstruction of SSS over the last 200 years. Derived SSS is validated against insitu data at 3 different locations along the SSS front (Fiji, Tonga and Rarotonga Islands). This new dataset enables us to investigate the spatio-temporal variations of the SSS front prior to the instrumental data.

Two robust modes of variability are present in the reconstructed SSS datasets: interannual variability and a secular trend. The reconstructed SSS variability follows El Niño Southern Oscillation index. The three sites present secular trends toward fresher conditions, but do not present similar variability, neither in timing nor strength over their total length. Furthermore, the role of atmospheric freshwater fluxes on SSS variability is evaluated by comparing reconstructed SSS to available historical rain gauge data. Results highlight the role of both atmospheric freshwater fluxes and ocean dynamics on SSS variability.

ID: 01996, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Grazing the ‘wet desert’: a comparison of pollen and coprophilic fungal spores as grazing indicators in peatland ecosystems

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In 1999 Bradshaw and Mitchell commented on the need for better information on herbivore abundance to understand the interactions between grazing and vegetation structure, composition and dynamics over long timescales. Pollen analysis remains the most widely used proxy for this, even though using pollen to reconstruct both vegetation dynamics and herbivory introduces circularity into arguments about cause and effect. Coprophilous fungal spores (CFS) have emerged as a powerful independent proxy for assessing changes in herbivore abundance, but this method has yet to be tested in peat- and moorland habitats. Peat systems are sensitive to disturbance, and consequently the ecological impact of grazing is a long-standing interest in palaeoecology and contemporary landscape management. However, pollen may be relatively insensitive to grazing on peatlands since the mineral soils required by ‘grazing indicator’ pollen taxa are largely absent. If CFS can be demonstrated to provide a more reliable proxy for grazing than pollen, they could provide a more sensitive proxy for reconstructing local disturbance dynamics. New surface sample and short peat core data are being collected from experimental and managed grazing sites to determine whether CFS can correctly predict treatment type (grazed vs ungrazed) and to assess whether pollen indicators and CFS show comparable trends. Early results will be presented from a site in northern England which has been experimentally grazed with sheep for the last 40-60 years. Further sampling is planned for peatlands that support wild native herbivores (primarily red deer). This study provides a novel way of connecting long-term ecological monitoring with palaeodata to assess the role of animals in ecosystem form and function and add trophic diversity to palaeoecological studies.

ID: 02210, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Connecting the records: exploiting tephra deposits to help understand abrupt climate change

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The causal mechanism of abrupt climate change during the last glacial period remains a key challenge. Although these events are well-documented in a wide range of proxy records, the triggers and drivers remain poorly understood, largely due to the dating uncertainties that prevent the integration of different archives. Unravelling the lead/lag responses (hence cause and effect) between the Earth's climate components is limited by the challenges of synchronising palaeoclimate records on a common timescale. Here we present the potential and the challenges of optimising the use of cryptotephra deposits to precisely correlate the Greenland ice-cores with North Atlantic marine records. A series of new cryptotephra deposits have been identified in Greenland, increasing the scope of identifying coeval isochrons in the marine environment. This new framework, however, brings new challenges in the search for unique and robust geochemical fingerprints for unequivocal tephra correlations. As such, some tephra deposits are proposed to be more valuable than others and underpin key snapshots in time during the last glacial period. The North Atlantic Ash Zone II, for instance, represents the most widespread isochron and constrains the cooling of GI-15. Some tephra deposits in the ice-core record originate from ultra-distal sources beyond the North Atlantic region and this recurrent pattern of long-range ash dispersal continues into the Holocene. We also explore the potential for establishing North Pacific linkages.

ID: 02202, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

The lost season: winter temperature change during the Holocene

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Future warming is expected to be greatest in winter over higher latitudes of the Northern Hemisphere, but our understanding of winter temperature change in the past has been limited by a climate record dominated by summer and annual temperature sensitive proxies. This is important because the climate system operates very differently over higher latitudes in winter when atmospheric heat transport dominates, compared to summer when solar insolation dominates. Differentiating the relative role of summer and winter seasons on the annual energy budget therefore allows us to reveal something of the mechanisms underlying past warming.

During the Holocene, coincident increases in summer and annual temperatures during the early-mid Holocene 'thermal optimum' over Northern Hemisphere high latitudes has led to a common assumption that summer drives mean annual temperature, and that the mechanisms that drive summer warming are therefore the most important. But this ignores the 'lost season' of winter, whose contribution has not generally been visible and therefore has been largely ignored. Pollen data provides one of the few proxies that can provide winter temperature data, since winter temperatures have a significant control on plant distribution through frost tolerance and chilling requirements for dormancy, budburst and regeneration. Here we use a spatially explicit pollen-based reconstruction of changes in winter/summer temperatures during the Holocene over the Northern Hemisphere to show that the winter season may have not only been important, but perhaps even the dominant source of warming. Furthermore, the spatial pattern of warming is shown to be entirely consistent with that expected from a strong zonal atmospheric circulation (+NAO or high index AO) which also generates the greatest winter warming over the Northern Hemisphere today. We conclude that the observed importance of winter over summer in driving interglacial warming is at odds with conventional Milankovitch theory and is poorly reproduced in climate model simulations, indicating that we may have overlooked the important role of atmospheric dynamics in the climate system in the past, and a key factor in determining the regional impact of future climate change.

ID: 01309, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

d13C decreases in the upper western South Atlantic during Heinrich Stadials 3 and 2

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Abrupt millennial–scale climate change events of the last deglaciation (i.e., Heinrich Stadial 1 and the Younger Dryas) were accompanied by marked increases in atmospheric CO_2 (CO_{2atm}) and decreases of its stable carbon isotopic ratios ($d^{13}CO_{2atm}$), presumably due to outgassing from the ocean. However, information on the preceding Heinrich Stadials during the last glacial period is scarce. Here we present $d^{13}C$ records from two species of planktonic foraminifera from the western South Atlantic that reveal major decreases (up to 1‰) during Heinrich Stadials 3 and 2. These $d^{13}C$ decreases are most likely related to millennial–scale periods of weakening of the Atlantic meridional overturning circulation and consequent increase in CO_{2atm} and decrease of $d^{13}CO_{2atm}$. We hypothesise two main mechanisms that could account for the $d^{13}C$ decreases observed in our records, namely strengthening of Southern Ocean deep water ventilation and weakening of the biological pump. Air–sea gas exchange could have acted as secondary modifier and contributed to the decreases. Our data are consistent with the hypothesis that the CO_2 added to the atmosphere during abrupt millennial–scale climate change events of the last glacial period also originated in the ocean and reached the atmosphere by outgassing. The temporal evolution of $d^{13}C$ during Heinrich Stadials in our records is characterized by two relative minima separated by a relative maximum. This “w–structure” is also found in North Atlantic and South American records, giving us confidence that such structure is a pervasive feature of Heinrich Stadial 2 and, possibly, also Heinrich Stadial 3.

ID: 01662, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

A 1,300-year moisture-balance reconstruction from the dry eastern rift valley of East Africa: the sediment record of hypersaline Lake Bogoria

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High-quality paleoclimate records are rare in the dry eastern branch of the East African Rift System, due to frequent desiccation of lakes which form the major source of paleoenvironmental information in the region. In this study, we present a 1,300-year history of hydrological change at hypersaline, alkaline Lake Bogoria (Central Rift Valley, Kenya), which has survived more recent destructive episodes of drought. Multi-proxy analyses on sediment cores from five key positions resulted in a detailed characterization of lacustrine deposits in Lake Bogoria’s three basins and on the two sills separating them. These core data were supplemented with information on present-day conditions through seasonal sampling of settling particles and physicochemical water-column measurements. A set of chronologically equivalent tie points between the five sequences allowed inter-basin comparison of sedimentation dynamics through time. The resulting quantitative reconstruction of historical fluctuations in lake level, supported by a robust age model, demonstrates considerable moisture-balance variability over the past 1,300 years. Between *ca.* AD 690 and 950, Lake Bogoria’s central and southern basins were reduced to shallow and separated brine pools. In the former, occasional near-complete desiccation triggered massive trona precipitation. Between *ca.* 950 and 1100 AD, slightly higher water levels allowed the build-up of high pCO_2, leading to precipitation of nahcolite. Lake Bogoria experienced a pronounced highstand between *ca.* AD 1100 and 1350, only to recede again afterwards. For most of the time until *ca.* 1800 AD, the northern basin was disconnected from the joint central and southern basins. During the last two centuries, lake level has uninterruptedly been relatively high. Additionally, evidence for increased terrestrial sediment supply in recent decades due to anthropogenic soil erosion in the wider Bogoria catchment is reason for concern about this unique ecosystem.

ID: 01820, 01.- Open Session on past global changes, (Poster)

Biogeochemical fingerprints of marine carbon pump variability in the glacial ocean

Maria de la Fuente[1] , Luke Skinner[1] , Aleksey Sadekov[1] , Emma Freeman[1] , Adam Scrivner[1] , Salima Souanef-Ureta[1] 1) University of Cambridge * Maria De La Fuente, md717@cam.ac.uk What causes atmospheric CO_2 to vary between glacial-interglacial cycles remains a puzzle for the palaeoclimatic community. Changes in the efficiency of the marine biological carbon pump due to variations in both its ‘strength’ (i.e. export production) and its ‘leakiness’ (i.e. ocean overturning) emerge as plausible mechanisms to account for a large part of the observed CO_2 drop in the atmosphere over glacial periods. To isolate and quantify the potential effects of any of these mechanisms is not straightforward. However, by comparing observed changes in the radiocarbon ventilation state of the deep ocean, which is not affected by remineralization processes, with carbonate system and sedimentary redox reconstructions over time, it may be possible to identify their respective 'biogeochemical fingerprints'. Here we use a 'geochemical tool box' based on the analysis of radiocarbon, $[CO_3^{2-}]_{(B/Ca\text{-}based)}$ (derived from LA-ICPMS analyses), $\delta^{13}C$ and $[O_2]_{(U/Ca\ auth)}$ measured in sediment cores from several locations and depths in the global ocean, in order to make a 'map' of the potential processes responsible for changes in the carbon cycle and to try to account for the amount of carbon stored in the ocean interior over the last glacial maximum (LGM). Our results show an overall poorly ventilated deep glacial ocean with lower $[CO_3^{2-}]$, $\delta^{13}C$ and $[O_2]$ supporting the general idea of deep ocean carbon sequestration over the glacial. However, qualitative/quantitative differences are found between areas, which may reflect regional differences in seafloor carbonate dissolution and/or export production that have affected the relationships between radiocarbon ventilation, carbonate saturation and oxygenation.

ID: 02315, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

DISENTANGLING THE LATE PLEISTOCENE TROPICAL-EXTRATROPICAL RAINFALL SYSTEMS INTERACTION IN THE SOUTHERN ATACAMA DESERT

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The southernmost part of the Atacama Desert (24-27°S; AD) lies in the transitional area between the tropical (summer) and extra-tropical (winter) rainfall systems so it provides a unique chance to trace their past interactions in the past. It has been largely hypothesized about the source of the rainfall associated to the different wet phases recorded in the AD since 17ka mainly based on the temporal and spatial patterns recorded in the different kind of archives. However, even when the modern rainfall $\delta^{18}O$ average values reveals that tropical and extra-tropical water have a significantly different isotopic signature (-6 and -12, respectively) which allows distinguish one from the other, isotopic analysis were not applied until now. This study aims to therefore to trace the past palaeoenvironmental and palaeoclimatic dynamics at southern Atacama Desert (24°-27°S) since the Late Pleistocene focusing on the interaction of summer/winter rainfalls by analyzing changes in the fossil midden pollen assemblages at different altitude and latitude complementarily supported by ^{18}O isotopes in fossil plant macro-remains cellulose. In order to achieve the latter, modern calibration sets (pollen-climate and $\delta^{18}O$ water-plants) were developed to provide the basis for robust interpretations of the fossil pollen and isotopic records. The first results show that the modern pollen assemblages from rodent middens along the W-E transects (24°, 24.5°, 25.5° and 27°S) resembles vegetation patterns showing the Pre-Puna, Puna and High Andean steppe in the north and the transition to different *Adesmia*-dominated communities to the south. On the other hand, modern water from (summer/winter) rainfall, rivers and salt lakes as well as plants *(Jarava frigida*) samples were collected at 32 sites at different altitude and latitude and are currently being isotopically ($\delta^{18}O$) analyzed to establish the modern isotopes relationships. FONDECYT #11150089

ID: 01897, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Poster)

Exploring ancient DNA as a sea ice proxy

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Environmental ancient DNA (aDNA) as a paleoceanographic proxy is still in its infancy and its potential is not yet fully explored. However, emerging multidisciplinary studies suggest that, through its geochemical link with biological diversity, aDNA can become a valuable tool to deepen our understanding of palaeoceanography and sea ice history. We investigated a sediment core off East Greenland for aDNA, dinoflagellate cysts and the sea ice biomarker IP_{25}. All samples yielded aDNA, with a long-linear decreasing trend in the total amount of aDNA recovered from the youngest (~14 ka) to the oldest sample (~100,000 ka). The aDNA sequences in the sample dated to ~34 ka are unique in the study interval with nearly-absent diatoms and a dominance of dinoflagellates, cercozoans and unclassified sequences. The same sample also yielded the sea-ice-associated dinoflagellate cyst *Islandinium* and the organic biomarker IP_{25}, both indicating a seasonal sea ice cover. Our preliminary aDNA work demonstrates (1) the presence of amplifiable aDNA back to ~100,000 years ago in the Greenland Sea and (2) the potential of aDNA to complement traditional microfossil analyses in order to strengthen estimates of past seasonal sea ice cover.

This new approach provides additional depth beyond the traditional proxies for palaeoceanography and specifically sea ice reconstructions.

ID: 02110, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Abrupt Shifts in Elemental Dust Proxies and their Ratios across Stadial-Interstadial Transitions in Greenland Ice Cores via Cryo-cell Laser-ablation ICPMS

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Greenland ice cores preserve seasonal to millennial scale variability of atmospheric dust transport through several proxies deposited in the ice. Among these, elemental concentrations are particularly relevant. Using cryo-cell laser-ablation-ICPMS, we analysed several species representative of dust (Na, Mg, Al, Ca, Fe) across six different climatic transitions of the Greenland Stadial Phases 20, 21.2 and 22 at a resolution of ~200 µm (0.2 mm). At these NGRIP ice core depths, this nominally represents 0.5 months and is achievable only by cryo-cell laser-ablation. Calibrated elemental concentrations record an increase of about an order of magnitude for most elements across interstadial/stadial transitions and vice versa, showing that most ions often complete the switch from cold to warm conditions within one to a few years only. These changes are accompanied by a relative decrease in elemental ratios (Fe/Al, Mg/Al and Ca/Al) at the onset of the stadial phase and vice versa, suggesting that the location of the dust source changes between warm and cold phases. This indicates rapid atmospheric reorganization, consistent with East Asian dust sources and transport mechanisms changing abruptly and sustainably (with one year) between stadial and interstadial phases, as a result of a variation in the westerly jet path and strength over East Asia induced by a southward shift of the polar front.

ID: 01511, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Walthère Victor Spring, a forerunner in the study of the greenhouse effect, at the University of Liège, Belgium

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Walthère Victor Spring, a forerunner in the study of the greenhouse effect, at the University of Liège, Belgium

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In 1886, an article by Walthère Spring and Léon Roland, two scientists from the University of Liège, dealing with the carbon dioxide content in the atmosphere in Liège, appeared in the *Memoires couronnés* of the Royal Academy of Belgium. In this context, Spring and Roland set up a one-year long observational time-series of daily measurements of various climatological variables and of the atmospheric CO_2 content at the site of the University of Liège. In order to explain the difference between the temperatures in Liège and the ones observed in the environment of this city, the authors involved the high level of atmospheric CO_2. The authors explained the high content of atmospheric CO_2 by the massive use of coal for heating homes and in the steel industry. A second reason was that the soil of Liège contains coal and its slowly burning was thought to be responsible for the high soil temperatures. The main component of this burning process is methane (CH_4), a prevalent greenhouse gas. Spring used the speaking image that "*the atmosphere charged with water vapor and CO_2 protects the earth against a cooling as does a greenhouse*". Although the climatological data used by Spring were rather weak, the arguments advanced to invoke a local impact of the greenhouse effect are correct. It is obvious that Spring can be viewed as a precursor of Svante Arrhenius who, in 1896, foresaw a global warming. Therefore, Spring merits to take his place, for a too long time forgotten and unnoticed, in the histories of the greenhouse effect and of the global climate change.

ID: 02352, 28.- Climate variability signals in groundwater (and unsaturated zone) archives, (Poster)

Recharge and Paleorecharge of Saharan and Sahelian Aquifers: the 36Cl perspective

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Large sedimentary aquifer systems are widely distributed in Sahelian and Saharan parts of Africa. The recharge of these large systems occurred during past, intermittent humid periods paced by the quaternary climatic cycles. Due to the scarcity of long-term continental archives in these areas, this groundwater may provide unique information on past hydrological and environmental changes, provided that they were sufficiently well dated.

Because the residence time of groundwater in these systems is often in the order of 100 000 years to 1 million years, geochemical tracers providing insights on time transfer of water at the Quaternary timescale are required. Although the potential of the long-lived radionuclide ^{36}Cl ($T_{1/2}$= 301 ka) as a powerful tracer in groundwater studies has been recognized since 80\'s, its widespread use has been limited by the few accelerator mass spectrometry (AMS) facilities capable of detecting and quantifying natural ^{36}Cl levels. For 5 years, the CEREGE group has launched several ^{36}Cl investigations of aquifer systems of Northern Africa by using a recently set up facility, the 5 MV ASTER AMS. We will present some key results acquired in the frame of these studies: from the classical use of ^{36}Cl as a chronometer for dating old groundwater, to its more innovative employment as a tracer of recent recharge of aquifer system. Examples will be taken from the North Western Saharan Aquifer System, Nubian Sandstone Aquifer System or the Deep Aquifer System from Lake Chad Basin.

ID: 02123, 06.- Before and after - climate contrasts across the MPT, (Poster)

Sea ice dynamics across the Mid-Pleistocene: Insights from the Bering Sea

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The Mid-Pleistocene Climate transition (MPT, 1.2-0.7 Ma) marks a fundamental shift in the frequency and amplitude of northern hemisphere glaciations from 41-ka to 100-ka accompanied by an intensification of the typical sawtooth shape seen in late Pleistocene glacial/interglacial cycles. No apparent change in external forcing parameters indicates a shift in the response of the climate system to orbital forcing caused by mechanisms internal to the climate system. A coupled ocean, atmosphere, sea ice, land ice model, the so-called sea ice switch model, proposes increased northern hemisphere sea ice cover as the underlying cause for MPT climate change. Sea ice influences the transfer of heat, gas, and moisture from the surface ocean to the atmosphere and determines the energy budget at the Earth's surface due to its high albedo. For the first time we present orbitally resolved sea ice reconstructions based on the novel biomarker proxy IP_{25} to elucidate sea ice dynamics across the MPT and shed light on the possible role of sea ice in forcing late Pleistocene climate cycles. Records from IODP sediment core U1343 in the eastern Bering Sea (57°33.4'N, 176°49.0'W, water depth 1950m) demonstrate a twofold change in sea ice across the MPT. Seasonal sea ice duration increases from 1 Ma onwards and increased sea ice extent is observed from 0.95 Ma. Together with the evolution of a deglacial sea ice peak from 1 Ma this demonstrates the importance of sea ice for the timing and rate of late Pleistocene terminations. Thus sea ice change is a necessary precursor for rapid terminations and increased asymmetry of post-MPT climate cycles.

ID: 01816, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Hydroclimate history of the last 7500 years in the northern Carpathians, Romania

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As natural and anthropogenic ecosystems are dependent on the local water availability, understanding past hydroclimate changes is a priority area in the research of climate variability. For this purpose, it is well establish that ombrotrophic bogs are most suited for hydroclimate reconstruction as they are entirely dependent on water from precipitations.

We used radiocarbon dating, testate amoebae (TA) and chironomids analysis on 2 sediment profiles from an ombrotrophic raised bog (Tăul Muced, northern Carpathians, Romania) to quantitatively determine major hydrological changes and July air temperature over the last 7500 years.

The water table depth reconstruction based on the TA highlights six wet-dry stages in the mire surface conditions. Wet surface conditions were recorded between 4500-2700 and 1300-400 cal. yr BP by the testate amoebae assemblages dominated by *Archerella flavum*, *Amphitrema wrightianum* and *Hyalosphenia papilio*. Dry mire surface conditions were inferred between 7550-4500, 2750-1300 and 0-50 cal. yr BP by dominance of *Nebela militaris*, *Difflugia pulex* and

Phryganella acropodia, whilst a rapid shift from dry to wet conditions characterized period 400 and (-50) cal. yr BP. The quantitative reconstruction of the July air temperature based on the chironomids show six climatic changes. Slightly cooler summer temperatures were recorded between 6500-5600, 4500-3150 and 1550-410 cal yr. BP, while periods of increased summer temperatures were observed between 5600-4500, 3150-1550 and 410 cal BP-present. Generally, there is a good correlation between drier phases of the peat surface conditions and warmer July temperatures, making summer temperature an important factor controlling water table fluctuation in this region.

The most important aspects of our approach are that i) provides valuable information on changes in local hydrology and the potential effect of the mean summer temperature over these changes and ii) strengthens the reconstruction of hydrological variability in an understudied region.

ID: 02160, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Quaternary palaeo-environmental reconstruction of the southwestern Chad Basin: the invaluable legacy of soil relics

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Climatic variations directly influence the water budget at the continental surface, and in turn the ecosystem dynamics of landscapes, in both aquatic (rivers, lakes) and terrestrial (vegetation, soils) environments. Environmental changes can be recorded in various continental sedimentary sequences, i.e. lacustrine, alluvial, palustrine or peatlands. However, a geosystem like soil may also record such changes relevant for palaeoenvironmental reconstructions.

Soil relics were investigated in Far North Cameroon. They are (i) clay-rich, (ii) enriched in pedogenic carbonate nodules, and (iii) display mound morphologies, termed mima-like mounds, within stream networks. They were interpreted as Vertisol relics resulting from past pedogenesis and subsequent erosion. To constrain their genesis and evolution, a numerical chronology coupling OSL and radiocarbon dating was developed. Four phases of formation were found to occur in the last 20 ka cal BP: 1) soil parent material deposition, 2) pedogenesis, 3) carbonate nodule precipitation, and 4) erosion. These phases are linked to the succession of sedimentary and pedogenic processes, controlled by P/PET (aridity index) conditions and/or tipping-points. *In fine*, this succession of processes through time can be related to the evolution of the African monsoon.

Soil relics were thus found to be relevant pedo-sedimentary terrestrial archives, registering specific events, four in this case, rather than a continuous sedimentary sequence. They record processes related to water balance changes, controlled by climatic variations, occurring during the Late Pleistocene-Holocene in West Africa.

ID: 02044, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Calcium transfer over the last 20ky: from a granitic source to carbonate nodule sinks (northern Cameroon)

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Calcium (Ca) is a key element of the Earth system and closely related to the carbon (C) cycle. Weathering of terrestrial silicate releases Ca, which is exported and sequestered into the oceans. However, a second Ca-trapping pathway, that has received little attention, exists: pedogenic carbonate.

This study explores the Ca biogeochemical cycle in a Sahelian carbonate-free watershed located at Far North Cameroon (Diamaré piedmont). It provides an example of outstanding accumulations of pedogenic Ca-carbonate nodules. These nodules are associated with a clay-rich parent material inherited from a mixture of an aeolian deposit and a saprolite, formed between 18 and 12 ka BP. ^{14}C analyses indicated that these nodules developed in (paleo)-Vertisols precipitated during the African Humid Period. Strontium isotopic signatures demonstrated that the main Ca source of the nodules is the local granite. These results were not expected as Ca is easily leached during weathering, especially in subtropical settings.

This study highlights processes involving in the transfer of Ca from source (granite) to sink (carbonate nodules). A comprehensive investigation of the geochemical compositions of the granite, the transient compartments, and the carbonate nodules provide insights on Ca pathways in this system: 1) Ca is leached from the weathered bedrock; 2) Ca is stored in the soil system, and 3) Ca is sequestered as carbonate nodules.

Consequently, Vertisols have acted as C and Ca sinks at the end of the African Humid Period. Therefore, climate changes in Far North Cameroon had a direct impact on Ca dynamics.

ID: 01517, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Holocene fire history of the Central European lowlands driven by interactions of climate, vegetation and land use change

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The Central European Lowlands (CEL) south of the Baltic Sea show contrasts in modern climate and land cover, but share a similar geological history as an area that has largely been formed during the Weichselian glaciation. Regional climate is characterized by an increase in continentality from the west to the east. Holocene land use and vegetation history differ in a more complex pattern as regional palynological records have revealed. However, many open questions remain, e.g. about intensity of past human land use and interaction with natural climate change. Lakes and peat bogs archive palaeoecological and sedimentological proxies that can be used to reconstruct past environmental conditions. A rarely interpreted proxy in this region is sedimentary charcoal representing past fire activity this humid temperate region with prevailing deciduous forests. Today, forest fires are restricted to pine forests on poor soils and occur seldom due to forest management. Biomass burning has probably been much more important in the past and is mainly attributed to human activity. Fire has been used, for example, to clear forests, to fertilize agricultural land or to drive technological advances. However, little is known about past interactions of human activity, climate, fire and vegetation.

We will present the first synthesis of Holocene fire history along a spatial gradient from northern Germany to the Baltic countries, which is based on >30 sedimentary charcoal records. By providing and comparing composites of sites from three subregions (N-Germany, N-Poland, NE-Poland/Baltic countries), we fill a gap in knowledge and discuss past relationships of land cover, land use, fire and climate. We will compare our composite records with modelled Holocene climate data and anthropogenic land cover change, with quantitative vegetation reconstructions (REVEALS transformed pollen records) as well as with independent reconstructions of past hydrological dynamics of the CEL.

ID: 01770, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Rainfall Variability in the North-Central Mediterranean during MIS7 and MIS5 : New insights for sapropel deposition

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The Mediterranean Sea is characterized by organic rich layers or sapropels that punctuate the Neogene-Quaternary sedimentary series. These sapropels deposited during anoxic conditions caused by periods of reduced deep water ventilation owing to increased surface buoyancy. Although previously associated mainly with massive freshwater input from the Nile and other north African rivers during increased summer monsoon rainfall, the rainfall on the northern Mediterranean borders is also suggested to have played a role. However, lack of evidence for hydroclimate variability from the northern Mediterranean restricts our understanding of its contribution. Marine sediment core GDEC-4-2, collected at the mouth of the Golo river off Corsica records the past five glacial-interglacial cycles and partly fills this gap. A striking feature in this record is high terrigenous flux from the Golo river during highstand, interglacial conditions, including Marine Isotope Stage (MIS) 5 and MIS 7. Here we use rainfall proxy results from GDEC-4-2 across MIS 7 and MIS 5, to test the hypothesis of high rainfall during the warm interglaicals on the north-central Mediterranean. Our results show sharp increase in Ba/Ca ratio, a proxy for riverine discharge, during MISS7c (~210 to 220 ka BP) and MIS5e (~120 to 125 ka BP), precisely at time of Sapropel 8 and 5 deposition, due to increased winter rainfall and high riverine discharge . These periods of high rainfall could suggest an orbital forcing, for example relatively higher discharge is observed during

MIS 7 than MIS 5 following the eccentricity. The results validate that the rainfall over the northern Mediterranean borderland could possibly exert a control on the formation of sapropel deposit *via* surface buoyancy changes and organic matter input.

ID: 01981, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Sources of Uncertainty in Modelling mid-Pliocene Arctic Amplification

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The mid-Pliocene Warm Period (mPWP) is an interval between 3.264 and 3.205 million years ago, which has globally warmer temperatures (Haywood et al., 2013) accompanied by levels of CO_2 above pre-Industrial (~400 ppmv; e.g. Bartoli et al. 2011; Badger et al., 2013). Arctic amplification of temperatures is a major characteristic of all proxy-based reconstructions of the mPWP in terms of both oceanic (Dowsett et al., 2010) and land warming (Salzmann et al., 2013). Nevertheless, results from the first phase of the Pliocene Model Intercomparison Project (PlioMIP) suggest that climate models may underestimate the degree of Arctic amplification suggested by proxy records (Haywood et al., 2013).

Here we use a large ensemble of experiments performed with the HadCM3 climate model to explore relative sources of uncertainty in the simulations of Arctic amplification. Within this suite of over 50 simulations, we consider; (i) a range of mPWP-specific orbital configurations to quantify the influence of temporal variability, (ii) a range of CO_2 scenarios to take into account uncertainties in this particular greenhouse gas forcing, (iii) a perturbed physics ensemble to investigate parametric uncertainty within the HadCM3 climate model, and also (iv) a number of experiments with altered palaeogeographies (including changes to topography and ice sheets) to assess the impact of different boundary condition realisations on our simulation of Arctic amplification. We also incorporate results from the PlioMIP project to allude to the effect of structural uncertainty on Arctic warming.

Following methods used in Yoshimori et al. (2013) and Laine et al. (2016), we identify the largest sources of uncertainty over both the land and the ocean in simulating the degree of amplification suggested by available proxy data.

ID: 02118, 01.- Open Session on past global changes, (Poster)

Climatic signal inferred from multiple tree-ring parameters of Scots Pine (Pinus sylvestris L.) in the central sector of Russian Plain.

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Here we present 4 chronologies based on tree-ring width (RW), earlywood width (EW), latewood width (LW) and minimum blue intensity (BI) of Scots pine from Kaluga region (European Russia). Comparison of the EW, LW and RW of pine for 2002 and 2010, i.e. the years characterized by drought conditions on the European part of Russia (Mokhov, 2011), shows the difference between the response of each parameter. The lowering of the LW occurs during the same year as the heat wave, whereas for the EW and RW a more significant reduction in growth occurs in the next year. Thus, the use of all three types of chronologies allows diagnosing the anomalous droughts in the second half of the summer according to the scheme mentioned above: the maximum reduction of the LW in the current year and the reduction in the EW and RW in the year following the drought. BI chronology reflects mainly the May-September air temperature variability, and not the parameters dryness. According to our reconstruction, in the Kaluga region allocated relatively warm periods of 1830-1890, 1900-1970, 1990-2013 ss. and cold - in 1890-1895, 1970-1990 ss. Supported by RSF Grant №14-17-00645.

Our analysis showed that the BI chronology reflects mainly the May-September air temperature variability, and not the parameters dryness. This conclusion is fundamentally changes the attitude to the possibilities of reconstructions of summer temperatures in temperate regions, where there is a weak and ambiguous dependence of the width of the rings on weather conditions. According to our reconstruction, in the period from 1831 to 2013. in the Kaluga region allocated relatively warm periods of 1830-1890, 1900-1970, 1990-2013 ss. and cold - in 1890-1895, 1970-1990 ss.

ID: 01955, 01.- Open Session on past global changes, (Poster)

Quantifying uncertainty in sediment-archived climate proxies over decadal to millennial timescales using proxy system modelling.

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Climate models can simulate global and local temperatures at arbitrarily fine temporal resolutions and assist in our understanding of climate variability over a broad range of timescales. For the recent past we have the instrumental record against which to compare model output, but to validate climate models on millennial scales, or for the more distant past, we have to turn to climate proxy records archived in ice sheets and sediments.

Comparing climate models and proxy reconstructions is challenging because, in addition to their low temporal resolution, many sources of bias and noise are introduced on the way from climate - to proxy - to proxy-based climate reconstruction. The (bio)chemical processes that encode climate signals, e.g. into elemental ratios in the shells of marine organisms, are influenced by multiple environmental and biological factors, making temperature calibrations uncertain. For sediment-archived biological proxies, seasonal patterns bias recorded conditions towards those found during peak development and export of biomass, and bioturbation can mix this signal over a large number of years. The process of picking, cleaning and measuring samples inevitably introduces other sources of error, and for proxies measured on a relatively small number of individuals, stochastic sampling of seasonal climate variation adds further noise to the proxy record.

Here we present a forward modelling analysis where we take a transient climate model simulation of the last 21000 years (TraCE-21ka) and simulate the encoding of the climate signal into, and climate reconstruction from, sediment-archived proxies such as foraminiferal Mg/Ca ratios and the Uk'37 alkenone unsaturation index. We examine the signal to noise ratio of the simulated proxies over a range of temporal resolutions and decompose the noise into components originating during the creation and reading of the archive.

ID: 01298, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Automatization of an inverse surface temperature modelling procedure for Greenland ice cores, developed and evaluated using nitrogen and argon isotope data measured on the Gisp2 ice core

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In order to study Northern Hemisphere climate interactions and variability during the Holocene, access to high resolution surface temperature records of the Greenland ice sheet is an integral condition. Surface temperature reconstruction relies on firn densification combined with gas and heat diffusion (Severinghaus et al., 1998). In this study we use the model developed by Schwander et al. (1997). A theoretical $\delta^{15}N$ record is generated for different temperature scenarios and compared with measurements by minimizing the mean squared error (MSE). The goal of the presented study is an automatization of this inverse modelling procedure. To solve the inverse problem, the Holocene temperature reconstruction is implemented in three steps. First a rough first guess temperature input (prior) is constructed which serves as the starting point for the optimization. Second, a smooth solution which transects the $\delta^{15}N$ measurement data is generated following a Monte Carlo approach. It is assumed that the smooth solution contains all long term temperature trends and (together with the accumulation rate input) drives changes in firn column height, which generate the gravitational background signal in $\delta^{15}N$. Finally, the smooth solution is superimposed with high frequency information directly extracted from the $\delta^{15}N$ measurement data. Following the approach, a high resolution Holocene temperature history for the Gisp2 site was extracted (posteriori), which leads to modelled $\delta^{15}N$ data that fits the measurements in the low permeg level (MSE) and shows excellent agreement in timing and strength of the measurement variability. To evaluate the reconstruction procedure different synthetic data experiments were conducted underlining the quality of the method. Additionally, a second firn model [Goujon et al. (2003)] was used, which leads to very similar results, which shows the robustness of the presented approach.

ID: 02005, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Poster)

3D numerical simulation of a dust storm past Downtown Dubai (United Arab Emirates, UAE)

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We studied dust storms investing Downtown Dubai (UAE) with wind velocity higher than 20 m/s. In such case, the storms can heavily impact the urban visibility even below 50 m, and accumulate dust in the streets. This also occurs to other cities in the Arabian Peninsula (e.g. Salmiya, Kuwait), as the source of dust is the neighboring desert or the Mesopotamian flood plain. The goal of our study is to analyze the evolution and effect of a dust storm past a metropolis, by means of computational fluid dynamics to calculate flow velocity and pressure, and dust particle trajectory during flow-building interaction. We run different numerical cases using the actual 3D geometry of Downtown Dubai, creating the computational mesh above the geometry, and solving the incompressible Navier-Stokes equations + particle motion equation + turbulence closure in the Eulerian-Lagrangian fashion. The physical scheme consisted of solving the interaction between the buildings and an atmospheric air-dust particle mixture, by applying various wind directions and using irregularly-shaped particles for the different runs. Results show that the dust storm strongly interacts with the buildings, generating zones of flow separation and recirculation in the rear of the impacted structure. The intensity of the interaction depends not only on the initial storm velocity, particle concentration and mineralogy, but also on the geometry and size of each building with respect to the wind direction. Higher accumulation of dust occurs close to the first buildings impacted by the storm, while some accumulation and atmospheric fog occur in the streets and building rears. Lastly, the storm duration can play a role in the flow-building interaction.

ID: 02012, 21.- Sediment Flux: Past Peaks and Troughs, (Poster)

Holocene sediment fluxes by running water in central Europe

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The flux of sediment associated with Holocene erosion in central Europe is reviewed in the paper. The focus is set on the scales of slopes and lake catchment areas. The first gives information about the intensity and type of erosion due to its high spatial resolution. The second allows a precise dating and the calculation of fluxes, in particular if annually laminated lake sediments are used. A combination of both approaches within lake catchment areas results in high resolution data sets enabling to disentangle trigger mechanisms that control Holocene sediment transfer on the lake catchment scale.

A bisection of Holocene erosion is recorded in central Europe. Pulses of early Holocene slope erosion were probably associated with climatic variability. Since the onset of sedentary life style increased human impact on the landscape system stepwise lowered its thresholds, resulted in increased long term erosion rates during lower and lower intensities of precipitation or snowmelt events. Some aberrations from this general trend occurred, most pronounced during the migration period and phases of the Bronze Age with distinct erosion minima.

The Holocene centennial sediment flux data from central Europe show large differences between water-eroded sediment stored at the slopes (usually 1-1,000 $t*ha^{-1}*a^{-1}$) and deposited in lakes (usually < 1 $t*ha^{-1}*a^{-1}$). This indicates a high storage capacity of the slopes and a limited transfer of sediments across the hydrological path into lakes, rivers, and the sea. Exceptions occurred during events of extraordinary high runoff intensity, where thresholds within the landscape system were surpassed which resulted in hydro-sedimentary connectivity. Such events occurred during Roman Times (ca. 2000-2200 before present day), and the medieval (14th century) and modern (18th century) periods. A general increase of the baseline sediment flux was associated with increased anthropogenic impact, too.

ID: 01837, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

A cross-hemispheric comparison of Last Interglacial climate variability using Italian and NZ speleothem records

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We compare precisely dated, high-resolution speleothem stable isotope records of the Last Interglacial (LIG) from Corchia Cave (Italy) and Nettlebed Cave (NZ). Post-termination warming first occurred in NZ, after which there was a period of synchronous bipolar warming of several thousand years. From 127 ka, we see bipolar cooling, which first appears in NZ. This cooling heralds the beginning of a series of anti-phased, millennial-scale cooling/warming events through the remainder of the LIG.

It appears that peak warming during the early LIG, which was warmer than present, may have triggered bi-polar ice-sheet melting, resulting in cooling penetrating to (at least) the mid latitudes of both hemispheres. This seems to have paved the way for a resumption of a weak \'interglacial version\' of the bipolar seesaw. This appears to have been too weak to have triggered a temperature response in East Antarctic ice cores.

ID: 01440, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Molecular biomarkers of anthropic impacts in natural archives

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Molecular fossils are becoming increasingly important tools in paleoenvironmental research, and over recent years, some were shown to be useful indicators of human activities. Common indicators of past human impacts include pollen, charcoal, sedimentation rates, and magnetic susceptibility, each of which has its limitations.

Thus the advent of novel molecular markers of human activities provides an additional set of tools to make the difficult distinction between anthropogenic and natural factors that have influenced the environment in the past. Fossil biomarkers preserved in natural archives provide valuable temporal and spatial insights on land use such as cultivation practices and pastoral activities, post-harvesting activities (e.g. retting), and their consequences on the environment and ecosystems.

Here we will present a review of the progress that has been made in developing novel biomarkers of human activities, differentiating those indicating environmental changes that can be related to human activities from those unambiguously attributable to human activities.

ID: 02053, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

Radioactive and Stable Paleoatmospheric Methane Isotopes across the Oldest Dryas-Bølling Transition from Taylor Glacier, Antarctica

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Methane (CH_4) is an important greenhouse gas with both natural and anthropogenic sources. Understanding how the natural CH_4 budget has changed in response to changing climate in the past can provide insights on the sensitivity of the natural CH_4 emissions to the current anthropogenic warming. Both radioactive and stable CH_4 isotopes ($\Delta^{14}C\text{-}CH_4$, $\delta^{13}C\text{-}CH_4$, and $\delta D\text{-}CH_{4)}$ from ice cores in Greenland and Antarctica have been used to constrain the past CH_4 budget. Among the CH_4 isotopes, $^{14}CH_4$ is unique in its ability to unambiguously distinguish between "old" CH_4 sources (e.g. marine clathrate, geologic sources, old permafrost) and "modern" CH_4 sources (e.g. tropical and boreal wetlands). During the 2013-2014 field seasons at Taylor Glacier, Antarctica, we have successfully extracted 7 large volume (1000kg) ice samples across the Oldest Dryas-Bølling transition (~14.5ka). All samples have been successfully measured for CH_4 mole fraction ([CH_4]), $\Delta^{14}C\text{-}^{14}CH_4$, $\delta^{13}C\text{-}CH_4$, and $\delta D\text{-}CH_{4.}$ The [CH_4], $\delta^{13}C\text{-}CH_4$, and $\delta D\text{-}CH_4$ measurements in our samples are consistent with existing $\delta^{13}C\text{-}CH_4$, and $\delta D\text{-}CH_4$ datasets from other deep ice cores, confirming the integrity of CH_4 in Taylor Glacier ice. $^{14}CH_4$ results across the Oldest Dryas – Bølling (OD-BO) CH_4 transition suggest that the ~150 ppb [CH_4] increase during the transition was caused by increased wetland emissions.

ID: 02369, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

Determining the imprint of Heinrich Stadials 4 and 5 on the latitudinal distribution of methane sources using the inter-polar methane difference from the WAIS Divide and GISP2 ice-cores

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Ice core records of atmospheric methane show that on orbital and millennial timescales methane closely follows changes in Greenland temperature, presumably driven by variations in tropical precipitation/hydrology. Over glacial-interglacial cycles methane mole fractions can range from 350ppb up to 750ppb. Over the last 110,000 years, warm events referred to as Greenland Interstadials (GI), noted in Greenland ice core δ18O records and other global climate archives, are characterized by a coeval rise in atmospheric methane. At the onset of these events methane rises by 50 to 300ppb from Greenland Stadial (GS) concentrations. In addition to the GI/GS methane variations, there are distinct, though smaller, increases in methane during Heinrich Stadials (HS) 1, 2, 4 and 5 (Rhodes, Brook et al. 2015). These HS features in the methane record are unique as there is no coeval change in Greenland water isotopes.

Using the Inter-Polar Difference (IPD) of methane mole fractions, we investigate these periods and test the hypothesis that the Inter-Tropical Convergence Zone (ITCZ), normally positioned north of the equator, shifted southward during Heinrich Stadials, causing an intensification of monsoons and tropical wetland methanogenesis in the southern hemisphere and drying in the northern hemisphere. We obtained a high-resolution, high-precision record of IPD from the WAIS Divide and GISP2 ice cores covering GS 10 through GI 8 and GI 13 through GI 11. Because methane is sufficiently well mixed in the atmosphere to allow synchronization of gas chronologies between Greenland and Antarctic ice cores, yet has a short enough lifetime to preserve an inter-hemispheric gradient, a change in the latitudinal distribution of sources can be inferred from the difference between these two records.

ID: 01497, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Sr isotope composition of modern molluscs shells: Are they a truthful proxy of seawater composition?

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The strontium isotope ratio ($^{87}Sr/^{86}Sr$) of modern seawater is generally considered as homogeneous at global scale because the residence time of this element is longer than the global ocean mixing duration. However, temporal variations in the relative contribution of main geochemical sources (i.e., continental weathering or hydrothermal inputs) modulate this isotopic ratio through geological times. Reconstructing the long-term fluctuations of seawater $^{87}Sr/^{86}Sr$ ratios is thus of prime importance for: 1) understanding the evolution of geochemical cycles in regard to global geodynamic or climate events, and 2) producing chimiostratigraphical reference curves allowing relative dating of any biological samples. Owing to their large spatio-temporal distribution and their relatively good preservation, shells of fossil molluscs and brachiopods have been widely investigated for their strontium isotope composition in a perspective of stratigraphic application. Nevertheless, these relative temporal calibrations are based on the postulate that the calcitic or aragonitic shells record the global $^{87}Sr/^{86}Sr$ oceanic composition without any isotopic fractionation process. Moreover, most molluscs live in marine environments influenced by detrital and freshwater inputs, which could modify the isotopic composition of proximal marine water. The aim of this study is to test if mollusc shells record the global $^{87}Sr/^{86}Sr$ signature of oceans or a local signal specific to the site studied. Thirty shells of modern bivalves, gastropods and cephalopods living in various environments (e.g. open shelf, lagoon) have been collected at different localities (Europe, Pacific, Northern Africa) in order to discriminate the main factor controlling the Sr isotopic composition. Our first analyses performed on worldwide oyster shells show heterogeneous $^{87}Sr/^{86}Sr$ values below and above 0,709160 ratio of seawater, which could suggest local influences related to freshwater.

ID: 02092, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Indian Ocean Dipole variability from Indonesian corals during the Little Ice Age

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The Indian Ocean Dipole (IOD) is an ocean-atmosphere climate oscillation within the Indian Ocean basin, and one of Australasia's key climate drivers that influences the distribution of rainfall across the region. Future projections of the activity of the IOD suggest that positive IOD events may become more frequent with greenhouse warming. However, the short duration of instrumental records and biases in model representations of the IOD make it difficult to confidently separate anthropogenic-related trends from natural variability. To better understand natural IOD variability, high-resolution reconstructions of the Indian Ocean sea surface temperature (SST) are needed to provide a comprehensive view of IOD upwelling activity prior to the 20th Century.

In this research, a fossil *Porites* coral from the Little Ice Age have been used reconstruct past SST from the Sunda Strait, between the Indonesian islands of Java and Sumatra. Tectonic and volcanic activity in this region has preserved fossil coral material of various ages along the Sunda Strait coast. The southern Sunda Strait (6.5ºS, 105.5ºE) area is a key area for measuring IOD activity, as the cold upwelling waters in the eastern Indian Ocean, associated with a positive IOD event have a clear signature here that is captured by geochemical changes in coral skeletal material. The focus of this project is on a new 170 year, ~monthly resolution $\partial^{18}O$ record from a Krakatoa coral tsunami block dated to 1883 BP. This coral-based SST reconstruction reveals insights into the frequency and intensity of positive IOD events prior to anthropogenic climate change that gives context to the intensification of positive IOD events since the 1960s.

ID: 01594, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Chironomids as proxy-indicators of spatiotemporal changes in biodiversity

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Anthropogenic changes to the environment are leading to dramatic changes in the structure and composition of biological communities – from the local to the global scale. In many natural settings it has been impossible to disentangle natural variability from the effects of human-induced ecosystem change, partly because of the short time scales typically used in ecological studies on trends in biodiversity. Palaeoecological data can provide new insights into the relationship between biodiversity and ecosystem functioning as such records can predate the period of human impact.

Subfossil larval chironomid assemblages preserved in lake sediments represent a local biodiversity signal, integrating millennial-scale changes in the fauna within a lake. As such, they add a unique perspective on (past) biodiversity change. However, (palaeo-) ecological datasets of spatiotemporal changes in chironomid biodiversity are understudied. Here we use modern-day distribution patterns of chironomids as described in chironomid-environment calibration datasets, as well as fossil chironomid records, to assess patterns in biodiversity change in both space and time.

Species diversity linearly increases with temperature in a Norwegian calibration dataset, whereas a Canadian calibration dataset shows a strong relationship between diversity and DOC. Eight late-glacial records from Europe show higher species richness during the late-glacial interstadial and the early Holocene, and lower diversity during the Younger Dryas stadial. However, three other sites illustrate that this general trend is not consistent across Europe, and that local settings and factors other than temperature must have played a role as well. Finally, a Holocene record from Canada shows temporary decreases in diversity associated with cold events such as the 8.2 ka event. Our combined results illustrate the potential of using chironomids as indicators of spatiotemporal changes in biodiversity and highlight the unique perspective that this source of data can provide in order to test ecological theory about diversity response to global change.

ID: 01838, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Morphosedimentary evolution of the Middle Martín Valley (NE Spain) during the Late Pleistocene-Holocene and its relation to climate changes.

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Two stages of sedimentary aggradation separated by an intermediate river incision phase are interpreted for the middle course of the Martín River in the Iberian Range (Spain). Radiometric ages (^{14}C y U/Th) provide a Late Pleistocene-Holocene age for the studied deposits. Five lithofacies have been identified: polygenic gravels, monogenic gravels, sands, marls and tufas, with different relative proportion of each one if the two sedimentary stages are compared. Coarse terrigenous facies predominated during the first stage (Late Pleistocene) whereas during the second one (Holocene) sands, marls and tufa did. This features permit to interpret a fluvial system with the main channel flowing towards the north, as nowadays, with lateral alluvial supplies and local development of tufa, although the sedimentary model and sedimentary dynamics changed through time. During the Late Pleistocene an aggradation stage related to a coarse-grained dominated system took place, with local development of tufa towards the end of the stage. After a subsequent incision phase, a second aggradation period is deduced for the middle part of the Holocene. Although coarse terrigenous supplies characterize the lower part of the succession, the Holocene deposits reveal a predominance of fine carbonate sedimentation and tufa growth that we correlate with a warm and humid climate. Common flooding and scarce lateral supplies were due to slope stabilization by vegetation cover. Facies during the Holocene stage show great mineralogical homogeneity, with high calcite content, lesser amounts of quartz, phyllosilicates, and sparse gypsum. The <2mm fraction contains, in order of abundance, illite, kaolinite, I/Sm and, occasionally, gypsum and lepidocrocite, the latter frequently as framboids. Isotopic data evince hydrologically closed conditions for the Holocene system related with the existence of tufa damming. Subsequently the fluvial system experienced a new incision stage during which the system reached its recent position.

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ID: 01701, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Limited early Holocene northward shift of the ITCZ and rain belt over Arabia: The Lakes vs. wetlands debate regarding how wet is wet.

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Lake levels in basins bordering northern Arabian Sea have been used to reconstruct regional paleohydrology through lake-level statuses. For the early-middle Holocene, dramatic increase in regional rainfall have been proposed. Commonly, these increases are associated with intensified Indian summer monsoon (ISM) and a northward latitudinal shift of the boreal summer ITCZ over the Indian Ocean; this shift was proposed to reach latitudes as far north as the Levant. Currently, however, the Indian summer monsoon forces large-scale air subsidence and total summer drought not rains in the Levant and neighboring deserts, including Arabia. This dries the region except in southernmost Arabia, where topography lifts air and produces orographic rain. This is assisted by increased upwelling that limits rainfall inland. These observations raise questions of how large the actual changes in paleohydrology were in Arabia, and what the real causes, if not the ISM, of these changes were. We summarize paleohydrologic information from Arabia and specifically revisit the published paleolake status, the sedimentology of lacustrine-like deposits and fauna, and their basins. We conclude that these basins were occupied by shallow marsh environments, not by lakes, as none presents shorelines. Arabia was slightly wetter, but required paleohydrologic changes to support restricted wetland are were much smaller than proposed. The spatio-temporal distribution of pollen and speleothems indicate that (a) rainfall changes were very small in the heart of Arabia, and (b) changes occurred primarily at elevated edges of southwestern, southern, and southeastern Arabia, where it rains at present due to increased moisture supply and orographic effects. Latitudinal and inland impact expansion of the North African summer monsoon rains across the Red Sea. This uplifted air to southwestern Arabia highlands, rather than rains associated with intensification of ISM, increased the rains producing the modest paleowetlands in downstream hyperarid basins.

ID: 02312, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Poster)

Sedimentary ancient DNA in paleoecology across climate zones

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Sedimentary ancient DNA is becoming more widely used in paleoecology, as methods for sampling of sediments, as well as for extraction and sequencing of sedimentary ancient DNA have become more efficient. To date, investigations of ancient DNA have concentrated on sites with low temperatures, as these display optimal preservation conditions. Remote, high latitude sites are ideal to track environmental changes that are not directly induced by human activity. Current climate changes are causing strong ecosystem perturbations in the Arctic, and sedimentary archives allow a comparison of the current situation with past changes from the Late Pleistocene and throughout the Holocene. Sites from temperate and tropical regions have been studied to a lesser extent, but are important for the analysis of human history and anthropogenic ecosystem modifications.

Given good preservation conditions coupled with adequate precautions to ensure clean subsampling of the inside of sediment cores and for work with ancient DNA, a high diversity of authentic taxa can be retrieved. Plant DNA metabarcoding of Arctic lake sediment cores and ancient permafrost from Siberia can yield, for example, up to over 90 or 100 plant taxa from single samples, including both terrestrial and aquatic taxa, as well as bryophytes. Inferences of spatial and temporal vegetation change correspond very well to those from pollen, and DNA can potentially offer a higher degree of resolution. Using the same approaches as for Arctic samples, we are currently investigating a sediment core from Lake Barombi Mbo in Cameroon, concentrating on samples spanning the Holocene. Here, we give an overview of our approaches and comparatively assess the potential of sedimentary DNA as a paleoecological tool in different settings.

ID: 01768, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Climate and drought over the past 1000 years in the Last Millennium Reanalysis

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The North American Drought Atlas shows large variability in droughts over the past 2000 years. Because drought frequency and severity over the coming century is an area of vital interest, better understanding the causes of these historic droughts is crucial. A variety of research has suggested that a La Niña state was important for producing past droughts, and other work has indicated the potential roles of the Atlantic Multidecadal Oscillation and internal atmospheric variability. Correlations between drought and large-scale climate patterns also exist in the instrumental record, but understanding these relationships is far from complete.

To investigate these relationships further, a data assimilation approach is employed. Proxy records – including tree rings, corals, and ice cores – are used to constrain climate states over the Common Era. By using general circulation model (GCM) output to quantify the covariances in the climate system, climate can be constrained not just at proxy sites but for all covarying locations and climate fields. This “Last Millennium Reanalysis” is used to quantify relationships between North American droughts and SST patterns in the Atlantic and Pacific. Results suggest that the association between a positive Southern Oscillation index (La Niña conditions) and drought in the southwest United States is robust through time. However, not all drought events conform to this relationship, indicating that the Southern Oscillation alone is not enough to fully explain drought in this region.

ID: 01429, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Dynamics of vertical tectonic movements during the Holocene

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Our work is a complex theoretical and modeling studies of dynamics of the coast and shelf vertical movements. Current satellite altimetry methods allow to measure present (average over several years) velocities of the vertical tectonic movements in locations on the Earth\'s surface with quite good accuracy. There more and more information in the scientific literature that the velocities of vertical crustal movements on the shores of the seas often exceed the velocity of eustatic sea level change. Hence, the study of crustal movements and their spatiotemporal variability and their impact on coastal processes is an important aspect for the economy of the coastal countries. Current crustal movements velocities can be measured, but how to look into the past of this process, how do we know the dynamics of this process? We propose a solution to this issue. The solution lies in the fact that the coastline is the intersection of two dynamic surfaces - surface of the water and the land surface. Hypsometric position of the ancient coastline is mainly determined by changes in the position of the two surfaces. Current geological methods allow reconstructing the curves of local sea level changes in the past. If we know the curve of eustatic sea level change then we can to reveal data about vertical movements of the coastal areas from the local sea level curves.

We developed a method for the separation of the local sea level curves to the eustatic and tectonics components. The method allows to reveal absolutely previously not studied the dynamics of the vertical movements of the crustal blocks in the past. By using the proposed method, we carried out the calculations for several dozens of coastal and shelf areas of the Mediterranean and Black seas. Performed calculations have shown that the velocities and even directions of vertical movements of the individual crustal blocks substantially change over time.

ID: 02247, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Annually resolved water temperature over the northern North Sea for the past 500 years associated with Northern Hemisphere volcanism

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Given their importance for planetary climate modulation, the high latitudes exemplify a blind spot in high resolution palaeoceanography. Since local marine conditions are unsuitable for the development of natural archives like corals and varved sediments much of the published literature consists of records with, at best, decadal resolution. Here we present an annually resolved and absolutely dated marine $\delta^{18}O$ series derived from the shells of the longevous bivalve *Arctica islandica* from the Fladen Ground in the northern North Sea for the second half of the last millennium and analyse its relation with the North Atlantic Oscillation (NAO), the Scandinavian Pattern (SCAND) and volcanic forcing. We interpret the $\delta^{18}O$ series as a measure of water density which is mainly controlled by temperature is our area of study. Initial results suggest that there is a non-stationary coupling of the extended winter NAO (December to March) and the shell δ^{18}O with an approximate periodicity of 30 years with an uninterrupted 36-year period that shows a mean 11-year running correlation of -0.58 starting on 1826 CE. The coupling between the SCAND and the δ^{18}O is similarly non-stationary but with significant frequencies equivalent of periods of 40, 20, 18 and 8 years showing on the red-noise analysis. Periods of strong negative correlation between the SCAND and the δ^{18}O series are near-synchronous with periods of high SO4 fluxes in the northern hemisphere due to volcanic eruptions. We conclude that strong volcanic eruptions forces the SCAND into a negative phase which in turn dominate the water column density over the North Sea. The link between volcanic forcing and the coupling between the NAO and the δ18O is less clear.

ID: 01477, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Bayesian MCMC flood frequency analysis integrating paleoflood data

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The choice of an acceptable and cost-effective solution for the design of hydraulic structures depends upon the estimation of quantiles for different characteristics of floods, usually peak flows. However, series of observed floods have a limited length, and quantile estimates associated to high return periods are subject to large uncertainties. In this study, we propose a novel and complementary approach which aims at combining reconstructed peak flows of the Rhône River with the series of observations. This reconstruction is based on estimations of flood-sediment volumes deposited in the Lake Le Bourget (Aix-les-Bains, France) over the last 350 years.

A Bayesian approach is adopted in order to properly treat the non-systematic nature of the reconstructed flow data, as well as the uncertainty related to the reconstruction method. While this methodology has already been applied to historical floods, similar applications to paleofloods are absent and promising. We first estimate extreme quantiles using direct measurements of peak flows (1853-2004). Direct observations are then combined to the sedimentary information (1650-2013). The comparison of the resulting estimates demonstrates the added value of the sedimentary information, and its impact on the associated uncertainties. In particular, 4 major floods which have occurred during the 18th century are very unlikely in comparison to the floods observed during the last 150 years.

ID: 01856, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Palaeo Data Assimilation of Pseudo-Tree-Ring-Width Chronologies in a Climate Model

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Using the Time-Averaged Ensemble Kalman Filter (EnKF) and a forward model, we assimilate the pseudo Tree-Ring-Width (TRW) chronologies into an Atmospheric Global Circulation model. This study investigates several aspects of Palaeo-Data Assimilation (PDA) within a perfect-model set-up: *(i)* we test the performance of several forward operators in the framework of a PDA-based climate reconstruction, *(ii)* compare the PDA-based simulations\' skill against the free ensemble runs and *(iii)* inverstigate the skill of the "online" (with cycling) DA and the "off-line" (no-cycling) DA. In our experiments, the "online" (with cycling) PDA approach did not outperform the "off-line" (no-cycling) one, despite its considerable additional implementation complexity. On the other hand, it was observed that the error reduction achieved by assimilating a particular pseudo-TRW chronology is modulated by the strength of the yearly internal variability of the model at the chronology site. This result might help the dendrochronology community to optimize their sampling efforts.

ID: 01270, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Coherent millennial-scale hydroclimate variability in southern Australasia during the Last Glacial Period

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Drivers of long-term climate variability in the Southern Hemisphere (SH) are not well understood. The instrumental record does not extend far enough to encompass the full range of possible climate variability in the SH, including changes that may occur in the future. The Last Glacial Period (LGP; 30,000-10,000 yr. BP) was characterised by large, rapid climate fluctuations beyond what is preserved in the instrumental record, and in many cases without a clear external forcing. The LGP is therefore an ideal period in which to investigate the earth system response to external forcing and internal variability. LGP climate change in the high latitudes of the Northern and Southern hemispheres is well constrained, however LGP climate change on the continents of the SH mid-latitudes is poorly understood. Australasian climate proxy records are particularly sparse, and often confounded by local effects, coarse resolution, or poorly resolved chronologies. Coherent signals are consequently lacking in Australasian climate proxy datasets.

Here we present a new well-dated, high-resolution record of LGP hydroclimate variability inferred from the sediments of Lake Surprise in south-eastern Australia. Hydrological changes are interpreted from δ13C analysis of organic matter, and XRF-derived dust concentration. Both tracers indicate abrupt changes coeval with other sites across southern Australasia. We use a Monte Carlo Empirical Orthogonal Function approach to assess the shared response of these sites to internal and external forcings, and observe coherent millennial-scale variability in precipitation in these and several other Australasian sites. The MCEOF also identifies a ca. 2500 year oscillation that is not clearly aligned with Heinrich Events or Dansgaard-Oeschger cycles. The combined proxy evidence suggests that Antarctic temperature and Southern Ocean sea surface temperature are strongly correlated with precipitation at the south-east Australasian sites during the LGP, providing an important constraint on climate model simulations for the LGP.

ID: 01306, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Some appear, some adapt, some die – stratigraphy by means of quaternary guide assemblages of land snails.

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To establish a robust stratigraphy in dune-paleosol-sequences is not an easy undertaking. This is due to the complex formation process of these dune-paleosol-sequences that were studied on Fuerteventura (Canary Islands). By means of a malacological approach we can now assure our first stratigraphic findings. In our study we were able to identify land snail species, that were only present in special layers within a mighty Pleistocene sequence that contain more than 6 paleosols spanning about 400ka. These findings enable us to do precise stratigraphic assignment, an approach that normally is used for long geologic time scales (the principle of guide fossils in paleontology). For stratigraphic purposes we use *Obelus pumilio, Cochlicella sp., Pomatias lanzarotensis, Rumina decollata* and *Theba sp.*. Some of them are on the one hand guide fossils and on the other hand form part of guide assemblages for paleoenvironmental reconstruction. We think that this kind of precise stratigraphic assignment was only possible because of the island situation. On small islands such as Fuerteventura climate change will favor extinction of species more easily. In consequence we observe various snail assemblages (with different species) in a comparatively short time span.

ID: 01740, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Poster)

Robust ENSO in a broad range of climates

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El Niño–Southern Oscillation (ENSO) is a pronounced mode of climate variability that originates in the tropical Pacific and affects weather patterns worldwide. Growing evidence suggests that despite extensive changes in tropical climate, this climate mode was active over vast geological epochs stretching millions of years from the late Cretaceous to the Holocene. In particular, ENSO persisted during the Pliocene, when a reduction occurred in the mean east–west temperature gradient in the equatorial Pacific (the state sometimes referred to as permanent El Niño conditions or El Padre). The mechanisms for sustained ENSO in such climates are poorly understood. Here a comprehensive climate model is used to simulate ENSO for a broad range of tropical Pacific mean climates characterized by different climatological SST gradients. It is found that the simulated ENSO remains surprisingly robust: when the east–west gradient is reduced from 6 to 1°C, the amplitude of ENSO decreases only by 30-40%, its dominant period stays close to 3–4 years, and the spectral peak remains statistically significant. To explain these results, the magnitude of ocean–atmosphere feedbacks that control the stability of the tropical ocean-atmosphere system (the Bjerknes stability index) is evaluated. It is found that as a result of reorganization of the atmospheric Walker circulation in response to changes in the mean surface temperature gradient, the growth/decay rates of the ENSO mode stay nearly constant throughout different climates. These results explain the persistence of ENSO in the past and, in particular, reconcile the seemingly contradictory findings of ENSO occurrence and the reduced mean east–west temperature gradient during the Pliocene.

ID: 02147, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Evidence for environmental change at around the Hekla 4 eruption from laminated lake sediments in Northern Germany

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Laminated lake sediments are occasionally found in deep lakes of the younger moraine area of Northern Germany and provide the base for well dated multi-proxy studies of past environmental change. Unfortunately the laminated sequences are generally interrupted in younger prehistoric times and absolute dating is based on ^{14}C wiggle match dating. Therefore detailed high-resolution decadal inter-site comparison is hampered by uncertainties involved in radiocarbon dating. Cryptotephra layers in these records however provide not only well constrained age estimates for prehistoric volcanic eruptions but further allow for temporal synchronization of the different records. The comparison of such synchronized time series allows the identification of short-termed over-regional environmental change which offers the possibility to investigate the local environmental impact of volcanic eruptions and their effect on human activity.

We will present and compare data from multiple sites and discuss the evidence for regional environmental change and human impact in the aftermath of the Hekla 4 eruption (ca. 4400 cal BP).

ID: 01654, 06.- Before and after - climate contrasts across the MPT, (Poster)

The mid-Pleistocene transition in a marginal sea: A high resolution, multi-proxy study in the southern Sea of Japan (IODP Exp. 346, Site U1427)

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The amplitude and frequency of global climate cyclicity shifted from 41 to 100 ka during the mid-Pleistocene transition (MPT, ~1.2-0.6 Ma), crucially without changes in orbital parameters. This suggests internal feedback mechanisms must have caused the change in the Earth’s climate dynamic. While no agreement has been reached on what these feedbacks are, multiple drivers have been proposed, including variations in the Asian monsoon intensity. Nevertheless, long-term records across the MPT at a resolution high enough to record variations in the Asian monsoon are few. However, newly recovered sediments from IODP Site U1427, located in the southern part of the Sea of Japan/ East Sea, now offer a chance to examine monsoon variations.

The site experienced high and constant sedimentation rates, has good foraminifera preservation, and lies underneath the main branch of the Tsushima Warm Current (TWC), a current whose strength is closely linked to freshwater input via the Yangtze River. Fluctuations in Asian monsoon intensity control the river runoff and, in turn, the strength of the TWC and the amount of freshwater and nutrients entering the Sea of Japan.

We present geochemical records across the MPT at Site U1427, including δ^{18}O and δ^{13}C of benthic foraminifera (*Uvigerina spp.*), and organic and inorganic carbon content and compare these to shipboard data. The proxies show a distinct pattern prior and post the MPT: From 1.2 to 0.91 Ma there is little correlation between our proxies, while between 0.91 and 0.7 Ma our proxy data show close correlation with each other. These data suggest a change in the behaviour or in sensitivity to regional climatic and oceanographic changes. The shift in this relationship is concomitant with the “900 ka event” identified by Elderfield et al. (2012), who suggest this was a global cooling event possibly with enhanced terrigenous input.

ID: 02163, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Extreme aridity and mild temperatures in the Middle East during the late Little Ice Age

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Throughout the global deserts, annually resolved reconstructions of temperature that extend the short instrumental record are virtually absent, and proxy records of aridity are difficult to obtain. The Little Ice Age (~1450-1850) is thought to have been characterized by generally cold conditions in many regions of the globe with little commonality regarding the hydroclimate. However, due to a lack of annually resolved natural archives in the Sahara and Arabian Desert, the precise characteristics of Middle Eastern climate during the Little Ice Age are unknown. Here we show, based on subseasonally resolved proxy records using paired Sr/Ca and oxygen isotopes in a northern Red Sea coral that the Middle East did not experience pronounced cooling during the late Little Ice Age (1751-1850). Instead, Middle Eastern climate was characterized by an even more arid climate than today. From our coral records and early instrumental sea level pressure data we conclude that Middle Eastern aridity resulted from a blocking-like atmospheric circulation over central Europe that weakened the moist Mediterranean westerlies and favoured the meridional advection of dry continental air from Eurasia towards the Middle East. We find that this extreme aridity terminated abruptly between 1850 and 1855 due to an atmospheric circulation change over the European-Middle East area at the end of the Little Ice Age with profound impacts on regional hydroclimate. Our results provide a hydroclimatic perspective on the resettlement of abandoned areas of the historical Fertile Crescent following the Little Ice Age. Furthermore, we speculate such an atmospheric blocking could have prevailed during other Little-Ice-Age-type North Atlantic-European cold events of the Holocene epoch, and may contribute to a better understanding of the northern Mesopotamian aridification at 4,200 years ago that is thought to have led to the collapse of ancient civilizations.

ID: 02088, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Late Pliocene climate sensitivity estimated with the Community Earth System Model version 2

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Equilibrium climate sensitivity (ECS) is a fundamental metric to quantify responses of climate system to radiative forcings from changes in atmospheric concentration of CO2 (pCO2). ECS measures equilibrium responses of surface temperature to a doubling of pCO2, which is mainly influenced by responses of water vapor, clouds, snow and sea ice. Observational constraints of ECS are unavailable due to limited length of instrumental observations. Proxy data and paleoclimate modeling, therefore, are useful tools to constrain ECS. Published studies generally suggest high ECS during the Quaternary and similar to present-day ECS during the late Pliocene (3.6 – 2.6 Ma). The accuracy of both proxy and model estimates of ECS is limited by the uncertainty in estimating polar amplification of temperature responses to CO2 forcing. For the late Pliocene, earth system models consistently overestimate Arctic sea ice amount and underestimate northern high latitude warmth among simulations of Pliocene Model Intercomparison Project Phase 1 (PlioMIP 1). Using the new Community Earth System Model version 2, we update estimates of late Pliocene ECS using boundary conditions provided by PlioMIP phase 2. Previous updates of CESM have increased model ECS from 3.2 in CCSM4 to 4.0 K in CESM1. Newer versions of the model also feature more realistic simulation of Arctic sea ice by correcting the previous overestimation bias in CCSM4. In addition, our results using CCSM4 suggest that, in comparison to CCSM4 PlioMIP1, simulated surface temperatures are warmer in the North Atlantic due to closure of the Arctic gateways in PlioMIP2 and across the northern high latitudes due to updates in vegetation mapping. These results point to a potentially higher late Pliocene ECS using CESM2 due to enhanced polar amplification as a result of updates in model and boundary conditions.

ID: 02090, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Contributions to Pliocene Arctic warmth from a clean atmosphere and enhanced forest fire emissions

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Changing atmosphere chemistry in the past has been hypothesized to have altered the earth's radiation budget, and hence the climate. Here, we use an advanced climate model to test whether this hypothesis can help explain the amplified warming in the northern high latitudes during the mid-Pliocene warm period (mPWP, 3.0 – 3.3 Ma). This amplified warming, suggested by terrestrial proxy records of the northern high latitudes, is underestimated by previous climate simulations. This model-proxy data mismatch may be partially attributable to proxy uncertainties, but also to insufficient model sensitivity, or incomplete knowledge of mPWP climate forcings. To explore the latter aspect, we have conducted three coupled simulations using the same mPWP geography and topography, vegetation and CO2 level according to the reconstructions from Pliocene Research, Interpretation, Synoptic Mapping project, but alternating emission scenarios among clean, polluted, and clean plus forest fire case. In the clean and polluted case, year-1850 emission and year-1850 natural plus year-2000 industrial emission are prescribed respectively. For the clean-plus-forest fire case, emissions from mPWP forest fire are estimated with a process-based prognostic fire model using fixed mPWP proxy SSTs. Preliminary results suggest that mPWP Arctic warmth is likely attributable to the removal of anthropogenic aerosols and enhanced deposition of black carbon emitted from northern high latitude forest fires on snow and ice. Cloud radiative responses are shown to accelerate the summer sea ice melting from the continental margins, triggering the positive surface albedo and water vapor feedback that maintain a low perennial sea ice state in the Arctic Ocean. These results identify the important role that changes in aerosol chemistry may play in amplifying the mPWP and potentially future surface warming of the Arctic region.

ID: 01719, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

The tephra deposits of the large 4.2 ka BP Cerro Blanco eruption in the southern Puna, Central Volcanic Zone, Andes

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We present stratigraphical and geomorphological data, physical volcanology, radiocarbon dating, and tephra petrography and geochemistry data which provide evidence for a major explosive eruption -spreading □140 km3 ashes over 440,000 km2- from the southern Puna in NW Argentina. This eruption occurred around 4100-4410 years ago in the Cerro Blanco Volcanic Complex. Ash fallout deposits mantled the region up to hundreds of kilometres from the volcano and thick pyroclastic flow deposits ponded the neighbouring valleys at distances up to 35 km from source. This eruption is the biggest documented during the past five millennia in the Central Volcanic Zone of the Andes, and possibly one of the largest Holocene explosive eruptions around the world. Furthermore, we have identified two additional eruptions in the region, one during the Early-Holocene and other in the Late-Holocene. The recognition of these significant volcanic events sheds new light on interpretations of the Holocene geological and archaeological records, and offers an excellent, extensive regional chronostratigraphic marker for reconstructing Holocene geological history over a wide geographical area of South America.

ID: 02222, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Preliminary results on the glacio-chemical investigation of firn cores from the central Chilean Andes

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Many major cities close to the Andes rely on water resources from the mountains and their glaciers. Principal economic incomes for countries like Chile are dependent on commodities such as minerals and agriculture, which are competing for water resources for human consumption. Presently, there is a general state of concern as regions along the Andes suffer from prolonged drought, increased temperatures at higher altitudes and cooling of the ocean surface. All these factors contribute to diminished precipitation and accelerated melting of glaciers. Here we present the preliminary results of a glacio-chemical investigation of shallow firn cores from the central region of Chile. In February 2016 two 5m cores were retrieved from the glaciers Juncal-Sur (~4700m a.s.l; 33°03’57’’S/70°06’17.3’’W) and Bologna (5169m a.s.l; 33°07’55.5’’S/70°03’38.4’’W). The cores were analyzed for their stable water isotope content, as well as major ions and compounds including Black Carbon. Contrary to expectations, the stable isotope analysis shows no clear seasonality on the δ-profiles. Visual inspection of both cores shows the presence of moderated (< 1 cm) ice layers, revealing that they are undergoing water melting and percolation. Refreezing is especially marked on the core from the lower location, but much less so in higher located core, a finding also supported by geochemical analysis. An important difference on the accumulation rates was detected between both sites, ranging from ~0.6m w.eq. at the lower site and ~1.2m w.eq. at the highest location. This supports the idea of increasing mass loss at the lower location. We relate higher concentrations of crustal elements to the more pronounced negative ENSO events (La Niña phenomenon). During negative ENSO, the precipitation in winter is diminished with respect to neutral conditions, implying that continental dust can be transported with ease. Based on this assumption, the Bologna core could yield contamination time-series of the past 5-10 years.

ID: 01323, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

A regional synthesis of climate and fire-driven land cover changes from western Tasmania

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In Australia, climate and human-driven fire activity play a pivotal role in shaping vegetation patterns. Parts of the continent, such as Tasmania, have hyper-fire-sensitive ecosystems juxtaposed against highly flammable vegetation. The paradoxical coexistence of fire-promoted and fire-sensitive vegetation highlights a need to understand the role of fire in shaping this landscape in order to best manage this unique region under a changing climate. The use of fire by Tasmanian people throughout the last 35,000 years has had a profound influence over the island’s vegetation, particularly in the wet west where fire constrained the postglacial expansion of rainforest. The fire history of western Tasmania over the last 12,000 years is well documented and is interpreted as reflecting the influence of long-term climatic change over both human and natural fire regimes. While the number of coupled pollen and charcoal records is increasing in this region, affording greater insight into how climate and fire have shaped the vegetation landscape, biases in the pollen record toward wind-pollinated forest species render the region’s dominant vegetation type, treeless moorland, virtually invisible in the pollen record, limiting our capacity to understand past land-cover dynamics. Here we use recently developed pollen-dispersal models to reconstruct actual land cover changes from multiple pollen records located across western Tasmania. We seek to understand how long-term climatic change and fire activity have shaped actual vegetation cover in this region. Our results reveal (1) that treeless plant communities have dominated the landscape over the last 12,000 years and (2) that fire-driven changes in forest cover through this period correspond to known shifts in regional climate.

ID: 02083, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Southeast Pacific subtropical anticyclone and southerly winds variability over the Last Millennium and historical period from climate models and high-resolution proxy records

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In this work we studied the Southeast Pacific subtropical anticyclone (SPSA) behavior, and the related southerly winds, during the Last Millennium (850-1850 CE) and historical period (1850-2000 CE) from CMIP5 climate simulations.

In particular, we analyzed the SPSA variability during two of the most important global climate events: the Little Ice Age (LIA) and the Current Warm Period (CWP, 1970-2000). To do that we studied different meteorological variables (sea level pressure maximum value and position, stream function at 925 hPa, geopotential height at 850 hPa and meridional winds intensity at 850 and 925 hPa) from seven climate models ((1) bcc-csm1-1, (2) CCSM4, (3) FGOALS-gl, (4) IPSL-CM5A-LR, (5) MPI-ESM-P, (6) MRI-CGCM3, (7) HadCM3).

Our results indicate that a general reinforcement of the SPSA, represented by a southward expansion of its southern boundary, occurs during the warm period (CWP). This migration is accompanied by a southward shift of the westerlies wind belt. The opposite situation is observed during the cold period (LIA).

These results are in great agreement with several climate reconstructions from high-resolution proxies of the region.

ID: 01643, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Analyzing the origin of the southerly wind variability along the eastern edge of the South Pacific Subtropical Anticyclone

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The climate of southwestern South America is mainly influenced by the semi-permanent presence of the Southeastern Pacific Subtropical Anticyclone (SPSA).

It has been largely assumed that this high pressure center is responsible of producing relatively strong southerly winds, and intense coastal upwelling-related events in most of the southwestern continental margin of South America. This assumption has been widely used in paleoclimate reconstructions. However, the influence of SPSA on southerly winds dynamics over millennial timescales remains unclear. In this work, we analyze (1979-2010) NCEP/NCAR CFSR reanalysis of sea level pressure and meridional wind data and, radiosonde wind data in order to determine the origin of southerly wind intensity variability and its relation with the SPSA. The results of this work indicate that the correlation between the maximum values of sea level pressure and wind intensity is not significant along the central-northern coast of Chile, particularly in austral spring and summer, as expected. In addition, the strongest southerly winds show to be related to a weakened anticyclone. These results suggest that, contrary to what is commonly assumed, the strong southerly winds seem to be more related to synoptic activity than the SPSA influence.

ID: 02124, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Heterogenous pattern in fire activity in a homogenous climate: test using Holocene charcoal records from Northern Carpathians, Romania

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Fire activity at smaller spatial scales generally shows high temporal variability. However, the long-term role of local controls on burning and site-specific histories, the relationships between different charcoal sizes and types of depositional environment are poorly understood because of the lack of relevant palaeoecological and historical information. Here we compiled seven sedimentary charcoal records located in a confined (1500 km^2), high elevation area (930-1920 m asl), in the northern Carpathians, Romania, covering the last 11 ka, to examine three main research questions: i) spatial and temporal pattern in charcoal records in relation to regional and local drivers at centennial to millennial time-scales; ii) the source area for microscopic and macroscopic charcoal at given depositional locations; iii) how charcoal deposition in different environments i.e., lakes and bogs compares. We found that at the local scale, Holocene fire histories were largely heterogeneous, particularly over the last 3000 years, with marked differences between treeline-subalpine environments and the boreal forest. This likely resulted from variability in fuel availability, associated to elevational vegetation gradient, and the response of vegetation to climate shifts and anthropogenic impact i.e., clearance and burning. The increased divergence in trends of fire activity over the past 3 ka was likely human derived.

We found that the 150-300 µm macrocharcoal size-class has the highest proportion at all analyzed sites. Its correlation with microcharcoal, and the weak correlation between microcharcoal and the largest macrocharcoal classes (>500 µm) suggests that most 150-300 µm particles are likely a combination of local and regional fires. Lakes provide an overall higher charcoal influx and larger sizes of charcoal particles than peat. This suggests that peat-lake sediment lythological transitions within the same record likely contribute to an artificial change in charcoal deposition.

ID: 02348, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Processes and patterns of vegetation change during the Holocene at the forest-steppe ecotone in northern Patagonia, Argentina

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Northern Patagonia is characterized by unique landscape with the presence of *Araucaria araucana* and *Austrocedrus chilensis*. Climate change, volcanic eruptions, earthquakes, fires and human activities have controlled the recent environmental history of the region. Strong climate gradients determine the vegetation distribution which is most distinct at the forest-steppe boundary. This investigation looks at the vegetation composition along climate gradients in space as well as through time in order to gain insights into the dynamics of the ecotone and past climate change studying the vegetation internal processes and responses to disturbance events. The study focuses on the forest-steppe ecotone in the eastern side of the Andean Cordillera in Argentina, at around 39 degrees south. Pollen and charcoal are analysed from sediment cores in two sites across the forest-steppe ecotone. Lake Torta (39°06’S, 71°21’W; 1090masl) and Lake Tonkol (39°08\'S; 71°14\'W; 1060masl). The 10m sediment cores recovered at both sites span the Holocene. Sediments are intercalated with numerous tephra layers of varying thickness (up to 70cm tick). Pollen data indicates that the forest-steppe ecotone has gradually shifted towards the east over the Holocene. Changes in species abundances occurred rapidly during the first few hundred years. Afterwards, vegetation changed gradually from open *Austrocedrus* woodland to *Araucaria* woodland and then, to a more dense forest dominated by *Nothofagus*. The increase in *Nothofagus obliqua* pollen towards the top of the sequences is consistent with a more humid second half of the Holocene. Individual tephra layers are not associated with sudden vegetation change. However, maximum values of *Araucaria* pollen were encountered at times with a low frequency of tephras, suggesting that the tree benefits from reduced disturbance frequency. Clearance of natural vegetation for timber and plantations of exotic trees occurred during the last ca. 100 years.

ID: 02184, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Pliocene estimates of tropical Pacific temperature sensitivity to radiative greenhouse gas forcing

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The Western Equatorial Pacific (WEP) warm pool, with surface temperatures >28 °C and a relatively deep thermocline, is an important source of latent and sensible heat for the global climate system. Understanding the WEP’s response to radiative forcing is key to constraining a minimum estimate of Earth system sensitivity because the tropics are not sensitive to ice-albedo feedbacks. To investigate the warm pool’s long-term response to radiative forcing, individual surface and subsurface dwelling foraminifera were analyzed from glacial-interglacial (G-IG) pairs from four time slices over the last four million years. We predict no change in temperature distribution between populations of foraminifera if temperatures primarily respond to $p\mathrm{CO_2}$-radiative forcing. Our results show the SST and subsurface temperature distributions of single foraminifera from G-IG pairs are similar. In comparison to the Holocene, SST distributions are similar while subsurface distributions are not. This suggests surface temperatures over the last four million years and subsurface temperatures within G-IG pairs respond to $p\mathrm{CO_2}$-radiative forcing and associated feedbacks. In contrast, subsurface temperatures over the last four million years respond to dynamic forcing, such as changes in thermocline structure or depth. We estimate tropical temperature sensitivity at ~3 Ma using our single foraminifera SST dataset and a previously published high-resolution boron isotope based $\mathrm{pCO_2}$ reconstruction. Additionally, we correct our SST dataset for possible changes in the Mg/Ca of seawater for the Pliocene. We find tropical temperature sensitivity was equal to, or less than that of the Late Pleistocene.

ID: 01890, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Full glacial vegetation history in high-elevation Sierra Nevada from Southern Spain.

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Future projections reflect Mediterranean region as especially vulnerable to Global Change impact, and mountain ranges concretely, as most fragile and sensitive ecosystems. In this sense, the Sierra Nevada range (Southern Iberia) contains the Western Europe´s highest peak (Mulhacén (3479 m a.s.l.), being a well-known biodiversity hot spot in the Western Mediterranean.

We present a multiproxy analyses of pollen, plant microfossils and geochemistry carried out on a 4.5 metre sedimentary sequence from Laguna Seca, (2260 m a.s.l., Sierra Nevada, Spain) which spans the last phase of the last glacial period, covering an interesting and poorly known period between 41,700 – 16,100 cal. yr BP (MIS3 – MIS2). Taking into account that the last glacial palaeoecological history of the southEuropean mountain ranges is almost completely unknown, results from this high-altitude, ephemeral lake reveal a unique and sensitive vegetation history which demonstrates that the landscape of the Sierra Nevada during the late full glacial was different to what has conventionally been believed.

The early record (37,100 – 30,910 cal. BP) is dominated by high *Pinus* percentages with cryoxeric taxa such as Chenopodiaceae and *Artemisia* throughout much of the sequence. After ca. 15,500 BP, there is a warm, more humid pulse, with high percentages of wetland pollen types and a reduction of *Pinus* besides a significant increase of *Quercus* and other mesophilous taxa, indicating that tree taxa were growing in the area. Thus, it is suggested that arboreal species persisted throughout the last glacial in small, mid-altitude refugia in the Sierra Nevada, limited not by temperature but by available moisture. Towards the top of the record the area was sparsely vegetated and an extensive Mediterranean montane pastureland developed (borreguiles). This sequence is noticeable because it provides, up to now, the oldest upland vegetation sequence from southern Iberia with a securely dated vegetation history for the last glacial, showing the presence of nearby glacial refugia in a current biodiversity hotspot which must be specially considered in future conservation strategies.

ID: 01978, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Reconstructing Past Ocean Circulation and Water Mass Mixing with Radiogenic Neodymium Isotopes and Rare Earth Elements: Potential and Pitfalls

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Over the past two decades radiogenic neodymium isotope compositions have been increasingly used as a proxy to reconstruct past ocean circulation and water mass mixing. This application is based on the quasi conservative behavior of Nd isotopes and Rare Earth Elements (REEs) in the open ocean water column and on the ability of Nd isotope compositions to fingerprint the contributions from distinct continental sources introduced through weathering inputs and exchange with shelf sediments at the last contact of water masses with land. In addition, the precise and accurate measurement of Nd isotopes in waters and sediments is comparably easy given the widely available TIMS or MC-ICPMS instruments, accepted standard values, and internationally intercalibrated techniques, in the frame of the GEOTRACES programme for water samples. The wealth of seawater data that have now become available allows a detailed picture of the present day Nd isotope distribution and relationship to water masses, to which the sedimentary records can be directly compared.

I will discuss examples for tracing past mass water mixing but will focus on the pitfalls that may arise either from problems with the extraction of the seawater Nd isotope and REE element patterns from marine sedimentary archives or from non-conservative behavior of Nd isotopes and REEs in the water column of particular areas of the ocean. This will include the effects of particle inputs and dissolution, exchange with reactive margin sediments, as well as contributions from pore waters. It is evident that the Nd isotope and REE methods will deliver the most reliable records in areas where water mass exchange is rapid and which are not located close to reactive continental margins and to the associated detrital particle fluxes, which should guide the choice of locations to apply these proxies.

ID: 02168, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Dynamical anomalies in North Atlantic climate variability during the last 2 ka as revealed by visibility graph analysis of terrestrial proxies

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Recent work has provided ample evidence that the utilization of nonlinear methods of time series analysis provides a fruitful tool for detecting periods of anomalous dynamics in paleoclimate proxy records that can be hidden to classical statistical analysis techniques. Following upon these findings, we systematically test a set of Late Holocene terrestrial paleoclimate records from Northern Europe for indications of intermittent periods of time-irreversible dynamics, implying that climate variations cannot be described by a stationary linear-stochastic process. Our analysis reveals that most of the well-known Late Holocene climate periods, including the Little Ice Age, Medieval Climate Anomaly, Late Antique Little Ice Age and Roman Warm Period, have indeed been characterized by such dynamical anomalies, commonly dominating in their initiation and/or termination periods. The identified episodes of time-irreversibility indicate qualitative changes in the dynamical regime of interannual variations of the North Atlantic atmospheric circulation during boreal summer, which could have resulted from both time-dependent internal (e.g. oceanic) and external (solar, volcanic) forcing. In order to discriminate between both types of behavior, we perform a similar analysis of established reconstructions of solar and volcanic forcing, providing a first step towards attributing observed dynamical anomalies of multiple proxies to either (possibly linear) responses to anomalous forcing or anomalous (possibly nonlinear) responses to "normal" (possibly linear-stochastic) forcing.

ID: 01822, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Reconstructing the leading mode of multi-decadal North Atlantic variability over the last two millenia using functional paleoclimate networks

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The increasing availability of high-resolution North Atlantic paleoclimate proxies allows to not only study local climate variations in time, but also temporal changes in spatial variability patterns across the entire region possibly controlled by large-scale coherent variability modes such as the North Atlantic Oscillation (NAO) and Atlantic Multidecadal Oscillation. In this study, we use functional paleoclimate network analysis [1] to investigate changes in the statistical similarity patterns among an ensemble of high-resolution terrestrial paleoclimate records from Europe and Greenland. We construct complex networks capturing the mutual statistical similarity of inter-annual temperature variability for multidecadal time windows covering the last two millenia. The observed patterns of co-variability are connected to the North Atlantic atmospheric circulation and most prominently to multi-decadal variations of the NAO. Based on the inferred networks, we study the dynamical similarity between regional clusters of archives and identify those time-dependent inter-regional linkages that are most informative about the leading-order North Atlantic climate variability according to a recent NAO reconstruction for the last millenium [2]. Based on these linkages, we extend the existing reconstruction to obtain qualitative information on multi-decadal to centennial scale North Atlantic climate variability over the last two millenia. In general, we find a tendency towards a dominating positive NAO phase interrupted by pronounced and extended intervals of negative NAO. Relatively rapid transitions between both types of behavior are present during distinct periods including the Little Ice Age, the Medieval Climate Anomaly and for the Late Antique Little Ice Age. [1] K. Rehfeld et al: Late Holocene Asian summer monsoon dynamics from small but complex networks of paleoclimate data. Climate Dynamics, 2013 [2] P. Ortega et al: A model-tested North Atlantic Oscillation reconstruction for the past millenium. Nature, 2015

ID: 01942, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Climate change detection and attribution using high resolution paleoclimate observations

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Paleoclimate change detection and attribution (D&A) studies have the advantage of looking past the overwhelming GHG forcing of the 20th century, and are generally based on linear regression of hemispherically averaged temperature reconstructions on forced response patterns estimated from climate change simulations driven by single and cumulative combinations of external radiative forcings: well-mixed greenhouse gases, solar variations, orbital mechanics, volcanic aerosols, and land use change. However, these studies have ignored spatial information and incorporated uncertainties arising from the inversion of sparse observational networks of paleoclimate observations that may not be univariate and linearly ascribed to temperature variation. To improve upon these efforts, we use the VS-Lite tree-ring width model to map realistically forced climate change simulations to the observed variable. We use CRU TS3.23 gridded temperature and precipitation data, a recent global compilation of 2761 uniformly processed tree ring width chronologies, and a Bayesian estimation scheme to estimate and validate parameters for the VS-Lite model for each chronology. Then, bias corrected temperature and precipitation data from HadCM3 simulations with single and cumulative external radiative forcings serve as inputs for VS-Lite. First results suggest that valid parameter estimates may be uniformly, normally or bimodally distributed over realistic a priori ranges of plausible VS-Lite parameter values. However, the resulting TRW chronologies are not particularly sensitive to parameter estimates. At the meeting, we will report on the progress in the actual D&A exercises.

ID: 02107, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Productivity in the Iberian Upwelling System since the late 18th century using the annually-resolved sclerochronology of the bivalve Glycymeris glycymeris

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Eastern Boundary Upwelling Systems (EBUS) are among the most diverse and productive marine systems, with significant environmental, climatic and economic relevance. Knowledge of past upwelling variability is essential to correctly predict and model the environmental and economic impacts of EBUS's in future climate change scenarios. The seasonally variable Iberian Upwelling System (IUS), the northern section of the Canary Current Eastern Boundary Upwelling Ecosystem, lacks well-dated high-resolution proxy records of past environmental variability before the existence of instrumental records. Bivalve shells contain annually- and sub annually-resolved records of shell growth (sclerochronology) that provide robust high-resolution archives of oceanographic and climatic data variability. In this study, the potential of the long-lived (> 100 years) bivalve *Glycymeris glycymeris* as a novel marine palaeoenvironmental archive for IUS variability is assessed.

An annually-resolved growth chronology from the 1790's to 2014 (CE) was constructed by cross-matching growth increment series from live- and dead-collected shells. *G. glycymeris* growth mainly reflected conditions during the low-upwelling season (October to February), likely through a control on the duration of the annual growth reduction period. In particular, sub-decadal variability in the *G. glycymeris* chronology was synchronous with low-upwelling season chlorophyll concentration, i.e. phytoplankton abundance/productivity, and to a lesser extent with upwelling intensity variability. The bivalve *Glycymeris glycymeris* thus provides a novel high-resolution, annually-resolved archive of variability in the IUS for the period before instrumental records.

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ID: 01349, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

ENSO flavours- Spatial dynamics of ENSO during the pre- industrial period

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El Niño-Southern Oscillation (ENSO) is the largest driver of interannual variability in the global climate system. Recent studies carry out major changes in frequency and intensity of canonical ENSO events. Under greenhouse warming scenarios an increase in frequency of extreme El Nino and La Nina events is being projected. Recent work has identified different 'flavours' of ENSO, for example, classical cold-tongue ENSO events and non-conventional El Niño definitions like the Central Pacific, Modoki and warm pool El Niño events.

A central question is to understand the dynamical aspects of the variety of ENSO events in a changing climate prior to the instrumental period. Different ENSO dynamics arise out of complex ocean-atmosphere interactions on various space and time-scales.

We present the first sub-seasonally resolved reconstruction of El Niño Southern Oscillation (ENSO) events based on a multi-century seasonally resolved network of tropical coral records.

The comparison with instrumental observations and existing ENSO reconstructions exhibits high agreement on interannual timescales but importantly highlights the merit of seasonally resolved proxies in studying ENSO dynamics.

The reconstructions are used to explore seasonal to multi-decadal time scale variability and trends in frequency, duration and propagation direction of ENSO events

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ID: 01319, 18.- Human Impact on Global Aquatic Systems, (Poster)

Tracking recent watershed changes in Vichuquén Lake (Central Chile) through δ15N signatures

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Stable isotope analyses of lacustrine organic matter are often used to reflect past environmental changes in aquatic ecosystems. Isotopic fractionation and variable sources of organic matter, however, hinder straightforward environmental interpretations of isotope signatures. To evaluate how stable isotopic values in surface lake sediments reflect modern isotope values in the lake – watershed system and to assess the role of organic matter sources, limnological and diagenetic process we analysed δ^{15}N and δ^{13}C values from soil and vegetation from watershed, particulate organic matter (POM) in water column and lake sediments from Lake Vichuquén (costal central Chile). Water samples from several different depths were collected and filtered for POM during summer and winter. Soil, watershed vegetation and surface lake sediments were also obtained. The main results show higher δ^{15}N values from riparian vegetation (mean 8.1‰) and POM (mean 12.4‰) compared to surface lake sediments (mean 2.3‰). This may be due to shifting sources that contribute to lacustrine organic matter (watershed vegetation, soil, lacustrine). Recent changes in N cycling inferred from a short core (spanning the last ca. 600 yrs), include an upcore decreasing δ^{15}N trend, perhaps caused by large-scale agricultural development and deforestation along with other anthropogenic activities.

ID: 01989, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

A 970 year-long summer temperature reconstruction from Rogen, west central Sweden, based on Blue Intensity from tree rings

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To better understand local to regional climate variability in west-central Scandinavia, a new 972 year-long temperature reconstruction based on adjusted delta blue intensity (ΔBI_{adj}) was created. Presently, it is the longest blue intensity chronology in Fennoscandia and the second longest in the northern hemisphere. Maximum blue intensity (MBI) measurements were obtained from 120 Scots pine (*Pinus sylvestris L.*) samples from a tree line environment in central Scandinavia. The MBI values were adjusted to maximum latewood density (MXD) measurements from the same species and region, and all individual series were d-trended using a signal-free regional curve standardization method (RSFi) to minimize the biological noise and maximize low frequency climate information. The presented ΔBI_{adj} chronology showed similar strength as that of MXD with warm-season temperature at interannual timescales and were much stronger than those of tree-ring width (RW), achieving an outstanding spatial correlation with gridded temperature data. Following, a ΔBI_{adj} based temperature reconstruction is presented, extending back to 1038 CE, exhibiting three warm periods in 1040-1190; 1370-1570s and the 20th century, and one major cold period between 1570 and 1920. Regional summer temperature anomalies are associated with a Scandinavian-Greenland dipole sea level pressure pattern, an association which was stable for the last several centuries. Our results prove that blue intensity from *Pinus sylvestris* in Scandinavia can be used to assess temperature information at various frequencies providing reliable reconstructions. Nevertheless, long-term trend differences with the RW version imply that further research is needed to fully understand the application of this technique in dendroclimatology.

ID: 01990, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

On the large scale controls of tree growth from the southernmost forest in the world

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Understanding the relationship between local climate, large-scale atmospheric circulation patterns and tree growth at high latitudes in the southern hemisphere is of crucial importance to place present climate change into a historical context. Patterns of common variability of eight *Pilgerodendron uviferum* and six *Nothofagus betuloides* tree-ring width chronologies were extracted by means of Principal Component Analyses and investigated regarding their climatic (temperature and precipitation), atmospheric (Southern Annual Mode, SAM), Oceanic and atmospheric (Southern oscillation index, SOI) sea level pressure and dominant modes of zonal wind flow at 850 mb (geopotential height) and oceanic (sea surface temperature, SST) signals. Additionally, 850 mb geopotential height was assessed for the extremes years of tree growth captured in the principal components through composite maps. The common signal of these species is modulated by large scale atmospheric variability (SAM) were southern Pacific SST and synoptic patterns over Amundsen, Bellingshausen and Weddell seas are of importance for the main modes of tree-growth variability regardless the species. Mechanisms of how these factors relate to tree growth are discussed suggesting the potential of tree rings to provide information of these factors determining southern climate variability further back in time.

ID: 01679, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Improving quantitative reconstructions of climate parameters and long-term Holocene pattern in an high-alpine peat bog subjected to heavy oceanic outbursts (outer Italian Alps)

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Temperature and precipitation are the main environmental factors influencing vegetation and pollen production. Knowing the modern climate optima and tolerances of those plants represented in fossil assemblages and assuming that the relationships between plants and climate in the past are not dissimilar from the modern ones, fossil pollen records offer many descriptors to reconstruct past climate variables. The aim of our work is to investigate the potential of a high-altitude site in the outer Italian Alps (Armentarga peat bog, 2345 m a.s.l.) for quantitative reconstructions of climate parameters in the last 11000 years. The so-called Orobian range is characterized by an extremely oceanic climate with high rainfall, snowfall and cloudiness significantly influencing ecological gradients.

234 alpine sites subsampled from the EMPD-European Modern Pollen Database joined to locally sampled altitudinal training set were used as modern calibration set to be compared to our high-altitude fossil site. Regression and calibration method (LWWA) and MAT (Modern Analogue Technique) were applied to our fossil site to infer temperature of the coldest (T_{jan}) and warmest (T_{jul}) months and the total annual precipitation (P_{ann}).

Our results show a persistent trend from Early Holocene warm and continental conditions towards Late Holocene oceanic conditions. Overimposed on this main figure, a number of short-lasting centennial events can be detected, including a marked sedimentary and plant record testifying the impact of the Little Ice Age on the persistence of snow and melting floods.

Our tests underline the need to integrate the EMPD database with local modern training sets to calibrate the relationships between pollen rain - modern vegetation - climate parameters in high-altitude environments.

This research is promoted by the CNR-DTA NextData Project.

ID: 02228, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Internal variability in North Atlantic summer storm tracks over Europe over the past millennium.

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Certain large, sustained anomalies in European temperatures in the past millennium are probably the result of internal variation. Such internal variations can modulate regional temperatures away from the expected response to greenhouse gas forcing. We assessed the causes of European summer temperature variability over the past millennium from temperature observations, simulations and tree-ring based reconstructions. We found multidecadal-mean summer temperatures to have varied within a span of 1K, largely controlled by external forcing. By contrast, we found that subcontinental variations, described by the temperature contrast between northern and southern Europe (the meridional temperature gradient) to have varied with a span of 2K, and to be more likely controlled by internal processes. The variations in the meridional temperature gradient are the result of redistributions of precipitation and cloud cover linked to oscillations in the position of the European and North Atlantic sector summer storm track. In contrast to recent twentieth-century winter-time trends, variations of the summer storm track over the past millennium showed a weak response to external forcing, and instead are dominated by stochastic internal variability. We argue that the response of European summer temperatures to anthropogenic greenhouse forcing is likely to be spatially modulated by the same stochastic internal processes that have caused periods of cool, wet summers in northern Europe over the last millennium.

ID: 01385, 06.- Before and after - climate contrasts across the MPT, (Poster)

Simulation of glacial cycles before, across and after MPT

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In spite of significant progress achieved in recent decades in understanding of Quaternary climate dynamics, there are still a number of important questions remained to be answered. Among them is the cause of the mid-Pleistocene Transition (MPT). To address this questions we used the Earth system model of intermediate complexity CLIMBER-2 which incorporates all major components of the Earth system – atmosphere, ocean, land surface, northern hemisphere ice sheets, terrestrial biota and soil carbon, aeolian dust and marine biogeochemistry. We performed a set of simulations covering the entire Quaternary using as the forcing variations in Earth orbital parameters and prescribed gradually evolving in time land-ocean distribution and terrestrial sediment cover. We found that a gradual removal of terrestrial sediments from Northern Hemisphere continents by glacial processes is sufficient to explain the transition from 40-ka to 100-ka worlds. The role of different processes (aeolian dust, permafrost, ice sheet and carbon cycle dynamics) in shaping of glacial cycles will be also discussed.

ID: 01267, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Climate Aftermath of the 1815 Tambora Eruption in China, and the Role of Eruption Season

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The April, 1815 CE eruption of the Tambora volcano led to the " Year Without a Summer" and caused serious crop failure and famines in 1816 CE across Europe and North America. However, few reports were available on Tambora\'s influence in China despite the region\'s susceptible to monsoonal volcanic perturbation. This study presents a systemic analysis of the climatic and related social responses to the Tambora perturbation in China, by using two independent lines of proxy records and projecting the responses on top of the impacts averaged over all tropical eruptions of the past millennium. Both the tree ring and Chinese documentary proxies show that Tambora induced a cold excursion, which caused severe frost damage, snow and ice accumulations that are uncommonly seen in southern China. Cold temperature tends to cause drought by suppressing evaporation and monsoon circulation, a hydroclimate response that\'s evident in the tree ring based Monsoon Asia Drought Atlas and to a less degree in the multiproxy precipitation reconstruction.

Outside southern China, both of the climatic and social responses are fairly mild, in contradictory to the vast climatic and social consequences seen in Europe and North America. Modeling study with vary seasonality of eruption months suggesting that, an April eruption causes less cooling in the Asian continent and stronger poleward migration of the Intertropical Convergence Zone than a summer or fall eruption. This, together with the cold background climate setup by the low solar insolation of the coincident Dalton Minimum and the preceding 1809 CE unknown eruption, may contributed to the relatively insignificant responses in China. These results allow new insights into the spatial extension and characteristic of the Tambora purturbation, by providing a systematic evaluation of the climatic aftermaths in China in parallel to that in Europe and North America. They also argue for the integral use of multiple proxies from different regions of world to gain better understanding of the climatic impacts for individual volcanic eruption.

ID: 01277, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Palaeoenvironmental changes in Bassa Nera pond during the last millennium (Central Pyrenees)

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Under the actual climate warming scenario, it is decisive to predict how future changes will affect the ecosystems and apply proper management measures. Palaeoenvironmental reconstructions of high mountain lakes provide an accurate knowledge to understand the environmental change patterns and discern between their climatic or anthropic causes. With this aim we performed a multiproxy study combining pollen and diatom analysis from recovered sediments of Bassa Nera, a pond located in the montane-subalpine boundary in central Pyrenees (42º 38\' 18.5\' N, 0º 55\' 27.6\' E, 1891 m). The present study has reconstructed the history of the surrounding vegetation and the peat bog development at a multidecadal resolution for the last millennium. This allowed to cover and identify the responses of a high mountain ecosystem to different climatic phases such as the Medieval Climate Anomaly and the Little Ice Age. A montane-subalpine ratio based on modern pollen assemblages was calculated to infer altitudinal shifts of the montane-subalpine ecotonal boundary. Results show that the vegetation of Bassa Nera catchment strongly responded to climate with altitudinal shifts of deciduous vegetation, especially during the Medieval Climate Anomaly, and indicate that montane-subalpine ratio has the potential to be used as a palaeoecological tool for quantitative paleoenvironmental reconstructions. Regarding the aquatic scenario, diatom communities, macrophytes and aquatic taxa allowed to show changes in the pond and the establishment of the peat bog in the sampling site by 1565 AD. Our palaeoenvironmental results have also allowed to identify anthropic pressure in Bassa Nera, which in general has been of low-intensity pressure. Along the last millennium, the natural resources management has varied from farming to cattle raising. Consistent shifts in vegetation, fire activity and aquatic communities throughout the sequence are clearly related to climatic signals such as the Medieval Climate Anomaly and the Little Ice Age phases.

ID: 02212, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Air and ground temperature coupling in the CMIP5 historical and future simulations

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Past temperature reconstructions from geothermal data assume a stable relationship between air and ground temperatures. The representation of the air and ground temperature coupling, its stability and the influence of land-surface processes on it are evaluated across North America within the historical and future projection simulations from 32 General Circulation Models (GCMs) included in the fifth phase of the Coupled Model Intercomparison Project (CMIP5). The thermal coupling between the lower atmosphere and the ground surface is related to snow cover, vegetation cover, soil moisture and precipitation at the surface. At high latitudes, the differences between air and ground surface temperatures, for all CMIP5 simulations, are mediated by the insulating effect of snow cover. At low latitudes, the difference between the two temperatures, for the majority of simulations, is inversely proportional to leaf area index, soil moisture, and precipitation, likely due to induced-changes in latent and sensible heat fluxes. The temporal evolution of the air-ground temperatures shows a stable relationship from 1850 to 2005 across North America. However, results show a change in the air-ground relationship at high latitudes within the future experiments under both medium-level and high-level emission scenarios. Additionally, our results show that the transport of energy across the air-ground interface differs from observations and among GCM simulations, by amounts that depend on the components of the land-surface model used. The large variability among GCMs and the marked dependency of the results on the choice of the land-surface model, illustrate the need for improving the representation of processes controlling the coupling of the lower atmosphere and the land surface in GCMs as a means of reducing the variability in their representation of near-surface processes, with potentially important implications for positive climate feedbacks such as permafrost and soil carbon stability.

ID: 02219, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Ground Heat Flux within the PMIP3/CMIP5 Last Millennium Simulations and Estimates from Geothermal Data

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The proper simulation of the energy partitioning at the surface, both as storage within the ground and energy fluxes from the surface, is crucial for the accurate representation of land-surface processes and related climate feedback mechanisms (e.g. permafrost thaw and soil carbon stability). We analyze the changes in ground heat flux over the last millennium as simulated by the PMIP3/CMIP5 General Circulation Models (GCMs). The following three methods were used to estimate ground heat flux: 1) using the surface energy balance, that is from the difference between net-radiation, latent and sensible heat fluxes, 2) calculations based on Surface Air Temperature (SAT), Surface Temperature (ST) and Ground Surface Temperature at 0.5m and at 1m (GST), and 3) inferences from temperature at two soil depths (GST at 0.5m and GST at 1m). Results show large regional variability among models and methods. Global estimates of ground heat flux from the surface energy balance differ significantly from values obtained from geothermal data over the second half of the last century. Such disagreement may be indicative of a change in the partitioning of the energy within historical simulations of the PMIP3/CMIP5 GCMs. The lack of observational data and the challenges of measuring soil fluxes highlight the value of geothermal database as a potentially valuable source of information for evaluating long-term models performance.

ID: 01691, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Increased sensitivity in S Spain alpine bogs after the Industrial Revolution: natural vs human-induced environmental change

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The geochemical study of two nearby alpine bogs (~3000 m asl) in the protected Sierra Nevada National Park (southern Spain) has revealed unexpected and opposite local environmental responses during the late Holocene. These ecosystem responses are even more complex during the last century as opposite and amplified “environmental responses” were recorded, agreeing with an increase in human-induced heavy metal atmospheric pollution in the studied area. This indirect anthropogenic impact on the natural trends in the studied sites gave rise to highly vulnerable (more sensitive) ecosystems, which exceeded the natural tolerance threshold of this endangered area at the beginning of the 20th century, at the same time that the last glaciers in the area, the southernmost ones in Europe after the Litte Ice Age, disappeared. Present day ecosystems were formed just during the last century under an anthropogenic influence that also appears to moderate the influence of the solar and atmospheric cycles over these environments. European glaciers have been suffering major retreats during the 20th century, and even several can disappear. So, the outcomes of this work are really valuable for these present glaciated areas, as well as they will be useful to manage the National Park, adding a historical perspective to conservative actions.

ID: 01690, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Global warming evidence from a long chain diol record of an alpine lake in southern Iberia

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The natural and human-induced causes of the global warming are beginning to be understood, but longer high-resolution temperature records overlapping both the instrumental and non-instrumental climate records are needed to fully understand the precise causes of global warming, possible future evolution of tempeatures, and its consequences. Marine records usually extend back into the past farther than lacustrine records, but it is difficult to get high-resolution records of the last hundred years. In addition, temperature-dependant biomarkers, such as those produced by algae (alkenones and diols) or archaea and bacteria (GDGTs) are commonly used in marine records as temperature proxies. However, the importance of these proxies in lake environments has increased during the last decades due to their common identification in lake sediments, but additional high-resolution studies are needed to test their reliability and get proper temperature calibrations to reconstruct high-quality temperature estimates for the past. Long chain diols are algae-derived compounds. Although there are no clear producers in lacustrine environments, the relative abundance of the most dominant diols (Long Chain Diol Index (LDI)=FC_{30}1,15-diol/(FC_{28}1,13-diol+FC_{30}1,13-diol+FC_{30}1,15-diol)) is directly related to surface temperature in both marine and lacustrine environments. However, there is no an existing calibration between lacustrine diols and temperature instrumental records thus far. This work describes the ~200-year high-resolution diol record of an alpine lake in South Spain. The correlations between the LDI record and the long available series of mean annual temperature anomalies in Spain, such as that from Seville or Madrid, or even with the global land and sea surface temperature anomaly, have shown very high correlations, i.e. R^2= 0.82, 0.83, and 0.79, respectively, allowing an accurate Holocene temperature anomaly reconstruction for this site.

ID: 02275, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Development of a precise age–depth model for the varved record of Lake Butrint (Albania): a reconstruction of environmental change in the central Mediterranean region during the last millennium

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Lake Butrint is a lagoon of tectonic origin located on the southern Ionian Sea coast of Albania. Its relatively high water depth (ca. 21 m) and progressive isolation from the sea has led to permanent water stratification, allowing the deposition of varved sediments formed by seasonal laminae (endogenic calcite, organic matter, and clay) during the last millennia. Variations in the presence and/or thickness of different laminae indicate fluctuations in water salinity, bioproductivity, and runoff, resulting from the interplay of climate variability and fluctuating human activity. The varve counting of the uppermost 3 m of a 12 m long sediment core, through the petrographic analysis of thin sections, enables the construction of an annually-resolved age-depth model for the last millennium, supported by radiocarbon and ^{137}Cs dating, as well as the location of homogenites formed by mass-wasting activity associated to well-dated, historical earthquakes. According to this model, the sedimentation rate was lower (2.4 mm/yr) between 1000 and 1500 AD, coinciding with the continuous presence and relatively high thickness of endogenic calcite laminae. Accordingly, this interval is interpreted as being characterized by a warmer climate (maximum water salinity and higher bioproductivity), occurring during the Medieval Climate Anomaly (800-1400 AD). Conversely, the sedimentation rate was higher (4.5 mm/yr) between 1500 and 2000 AD, when thicker clay-rich and thinner endogenic calcite laminae were deposited during the Little Ice Age (1400-1800 AD), characterized by lower salinity and higher runoff. Increasing human activity in the area may explain the high sedimentation rates (4.7 mm/yr) after 1800 AD. Ongoing research on microfacies and stable isotopes (d^{18}O and d^{13}C in endogenic calcite) allows correlating variations in sedimentation rate with the main hydrological changes occurred in the lagoon during the last millennium. Hence, Lake Butrint sedimentary record provides a detailed reconstruction of the recent environmental evolution of coastal Mediterranean regions.

ID: 01875, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Numerical modeling of lake overtopping: the Bonneville flood

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Lake overtopping is one of the main mechanisms responsible for outburst flooding, with abundant examples occurring worldwide during the Late Pleistocene. Numerical modeling of such floods has focused mainly on estimating flood discharge from erosional and depositional features along the spillway and downstream. Those models focusing on the outflow sill have assumed either an instantaneous collapse of the barrier or its erosion at a constant rate. Here we first use a fluvial erosion model to develop a power-based relationship between the gradual deepening of the outlet, outflow, erosional resistance, and changing lake stage. We test this 0-D model with a dataset of lake overtopping floods and show that the predicted flow is consistent with previous peak discharge estimates and with the lithology of the lake outlets. We then compare this 0-D with a 2D (vertically-averaged 3D) hydrodynamic model of the flooding triggered by the overtopping of Lake Bonneville ca. 17 ky ago, with a peak discharge of about one million cubic meters per second estimated from the elevation of flood features along the spillway and from step-backwater calculations. The hydrodynamic model is based on two-dimensional, non-linear, depth-averaged flow constrained with known lake geometry and previous flood discharge estimates. This modeling, based on numerical solution of the mass and momentum conservation equations, enables understanding of the effects of 3D hydrodynamics in the lake basin on flood evolution. The results are visualized by depth-averaged water-velocity vectors and water surface elevations. Thy show unforeseen effects of the lake basin geometry on the timing of the outburst flood resulting from overtopping and points out areas of potential erosion within the lake as a result of its rapid emptying.

ID: 01442, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Poster)

Dust deposition forecasts at the Barcelona Dust Forecast Center

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The Barcelona Dust Forecast Center was designated by WMO to operationally distribute dust forecasts for Northern Africa, Middle East and Europe. The Center releases daily predictions of surface concentration and extinction, dust load and optical depth (DOD), dry and wet deposition based on the NMMB/BSC-Dust model. The evaluation of dust predictions presents serious difficulties. Firstly, due to the scarcity of appropriate observations and secondly because most of the measurements integrate particles of different origins. In addition, the location of the main dust sources in sparsely populated regions complicates the establishment of observing networks. Nonetheless, DOD predictions are routinely compared with values retrieved from AERONET measurements and from the MODIS spectrometer traveling aboard NASA\'s Terra and Aqua satellites. As for surface concentration, no systematic evaluations are carried out, but comparisons are sporadically made with PM measurements from selected dust-prone regions. Before addressing the evaluation of deposition predictions, a statistical analysis has been performed to determine the geographic distribution of dry and wet deposition, as well as the ratio between them according to the model on annual and seasonal scales. It has also been intended to deal with inter-annual variation, although only a 32-month data series is currently available, so the validity of any conclusion is very limited. Finally, the time-averaged predictions have been compared with different data available in the literature. The deposition measurements used here are not coincident with the model simulations. We consider them as a first approximation to climatological values, although sometimes they do not cover a period as long as would be necessary. Datasets of deposition over land include the compilations of Ginoux and Mahowald, as well as data from the AMMA Sahelian Dust Transect. On the other hand, for deposition over ocean we use deposition fluxes measured at sediment traps being part of the DIRTMAP database.

ID: 01754, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Mollusc shell Mg/Ca ratios measured by Laser-Induced Breakdown Spectroscopy (LIBS) as a future palaeoclimatic proxy

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Reconstruction of past environmental conditions is an important geological and archaeological research topic. The chemical composition of marine mollusc shells offers information on climate conditions during the organism's lifespan. A correlation between seawater temperature and the quantity of some elements (magnesium, strontium, etc.) substituted for calcium in the calcium carbonate shells has been found for certain species. Here, we propose use of the Laser-Induced Breakdown Spectroscopy (LIBS) technique to estimate Mg/Ca ratios within the common limpet *Patella vulgata* Linnaeus, 1758. To validate this technique in palaeoclimate investigations different experiments have been developed: 1) Diverse LIBS instrumental setup were employed (including two spectrometers in parallel and multiple experiments on the same sample) to determine repeatability of the measurements. 2) Reference materials were measured to confirm the accuracy of the Mg/Ca ratios obtained by LIBS. 3) Intra-shell Mg/Ca profiles measured by LIBS were compared with results obtained by Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES), a traditional spectrometry methodology more frequently used for trace element analyses. 4) LIBS derived Mg/Ca time series (along the axis of mollusc shell growth) were compared with instrumental records of seawater temperature for the period of growth of the specimens analysed, to test whether the quantity of magnesium incorporated into the mollusc shell is dependent of seawater temperature. The results obtained demonstrate that LIBS is a reliable methodology to measure Mg/Ca variations within *P. vulgata* limpet shell, with great potential for palaeoclimate and archaeological studies. However, method development is required to improve this technique, especially as a proxy to decipher past environmental conditions.

ID: 01933, 01.- Open Session on past global changes, (Poster)

Looking for the 8.2ka event: environmental conditions derived from oxygen stable isotopes on mollusc shells during the Early Holocene in northern Iberia

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The relatively homogeneous climate of the Holocene is punctuated by a number of short climatic events, that had significant impacts on past societies. The most prominent of these is the 8.2ka event, a short period generally accepted as being characterised by relatively cold conditions. How this event affected to hunter-fisher-gatherer societies in southern Europe is still unclear. The Mesolithic in northern Iberia (ca. 10.8 - 6.8 ka cal BP) is characterised by the formation of shell middens in coastal locations. Archaeological shells found in these middens can not only provide information on human subsistence strategies, but also on environmental conditions. Molluscs form their shells by precipitating calcium carbonate in isotopic equilibrium with the surrounding environment, and so they become environmental archives. In the case of marine molluscs, stable oxygen isotope ($\delta^{18}O$) are mainly dependent on seawater temperature (ST), and $\delta^{18}O$ values can be safelly used to establish accurate ST. This paper aims to improve our knowledge on climate variability in northern Iberia during the Early Holocene. To achieve this, $\delta^{18}O$ values were obtained from ancient shells of *Phorcus lineatus* (da Costa, 1778) recovered from five stratigraphic units at the Mesolithic shell midden site of El Mazo cave (Asturias, Spain). Results showed cooler winter temperatures at the start of the archaeological sequence (ca. 8.9 ka). Temperatures increased between 8.5 and 7.5 ka, suggesting the existence of warmer conditions than today, mainly in winter. However, shells from units dated to around 8.2 ka recorded slightly cooler summers and smaller ranges of annual temperatures than the rest of the sequence.

ID: 02355, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Rare Earth Elements and Nd isotopes as tracers of modern circulation in the central Mediterranean Sea

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The western Mediterranean Sea has been recognized as one of the best natural laboratories for studying physical processes behind climate variability. Atmospheric changes are transferred into Mediterranean intermediate and deep water properties that ultimately exit into the Atlantic through the Strait of Gibraltar. Tracing the different Mediterranean water masses, their paths and properties, is critical to characterize Mediterranean thermohaline circulation and became a powerful tool to understand the sensitivity of this system to past climatic changes. In this context, the central Mediterranean, from the Ionian to the Tyrrhenian Sea is particularly relevant since this is the place where intermediate and deep waters of the western and eastern basin origin converge, and are modified to form the Tyrrhenian Deep Water (TDW), before spreading further westward and exiting from the Strait of Gibraltar.

This study is based on the analysis of dissolved Rare Earth Elements (REE) and Nd isotopes in seawater samples from a series of stations around the Tyrrhenian Sea, Strait of Sicily and the Ionian Sea (NextData 2016 Cruise). Preliminary results show significant enrichments of light REE in surface waters (30-40% with respect to underneath waters) in the closest stations to the continent implying active margins in terms of geochemical exchange. This indicates that the shallow overturning of MAW gets imprinted by terrigenous sources along its cyclonic circulation in the Tyrrhenian Sea. Further from land, well-developed oceanic REE patterns are found displaying negative cerium anomalies (from 0.20 to 0.30) and enrichment of heavy REE (relative to light REE). From intermediate to deep-waters REE concentrations show rather constant values with depth supporting previous findings of significant downward mixing of Levantine Intermediate Waters (LIW) due to their higher density. We will provide with a better evaluation of water mass interactions and pathways when all REE and also the Nd isotopic data are available.

ID: 01744, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Postglacial interactions between climate, vegetation, land use and fire dynamics in Northern Greece

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The spread of Neolithisation from the Fertile Crescent via Anatolia to the Balkans and across Europe had dramatic impacts on ecosystems and vegetation. The dynamics and processes of Neolithisation in the Southern Balkans are of special interest, since they provide the basis for the expansion into Central, Western and Northern Europe. The focus of paleoecological and archaeological research has been mainly on the bigger lakes, located near the border of Albania and the Macedonian Republic, that provide exceptionally long records of regional environmental changes. Here we present a new pollen, macrofossil and charcoal record from Zazari, a small lake located in the Eordea basin in Northern Greece, which provides new insights into local vegetation and land use responses to disturbance (e.g. fire). Our results complement archaeological evidence in the region and present additional information on the Neolithisation process in Europe, for instance, on humanization of vegetation and the use of fire as a primary tool to shape landscapes in prehistorical periods. We reconstruct the natural vegetation of the area before the onset of large-scale farming activities and briefly discuss the relevance of our results for modern day nature protection, ecosystem management and in regard to future ecosystem trajectories.

ID: 01570, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Human-climate-environment interactions in the Murray River catchment: the case for a multi-faceted approach to waterway restoration

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The Murray Darling Basin is Australia's largest river catchment. Palaeoecological records attest to considerable resilience in the system's wetlands to climate variability over millennia. However, the condition of most wetlands changed considerably after European settlement, but particularly since the acceleration of river regulation and water abstraction from the 1920s. In most instances the wetlands have transitioned from macrophyte-dominated systems, as revealed by macrofossils and the predominance of benthic and epiphytic diatoms and invertebrates, to turbid phytoplankton-rich systems. This is attributed to substantial increases in the flux of sediments, salts and nutrients to the wetlands from the floodplain, and the rivers. In many instances the changes in state occurred very early after European settlement and so the full richness of the original biodiversity, and the services it provided, is poorly recognised. The aquatic systems of the Basin are recognised as being under stress, and the ongoing drying of the climate has brought great contest in the allocation of water resources for an intensive agricultural industry and the environment. While much is to be gained from government programs to rehabilitate the waterways of the system through allocations of environmental water, the long term record highlights the importance of a simultaneous focus on catchment management approaches to maximise the outcomes to be returned from the investment.

ID: 01432, 18.- Human Impact on Global Aquatic Systems, (Poster)

Human Impact on coastal aquatic systems in south-east Australia: a synthesis

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The coastline of south-east Australia hosts the nation's greatest density of people and so the aquatic systems have been subjected to considerable human impact. The region was the first settled and many coastal flowing catchments were developed for agriculture and industry soon after. Many estuaries and coastal lagoons have been analysed paleolimnologically and these attest to considerable ecological change following settlement. Early, abrupt change is associated with the construction of barriers to tidal inflow to secure freshwater resources for settlement, or the construction of permanent openings to permit navigation from coastal ports. Diversion of water inland has seen the salinization of many lakes, while others receiving the diverted water have turned fresh. The widespread increase in the release of diffuse pollutants as seen substantial increases in sedimentation rates, increased nutrient loads and the accumulation of metal pollutants. Many ecological changes have occurred gradually and this masks the wider understanding of the natural character of the estuarine systems. This moving baseline creates challenges in the identification of target condition for the management of these systems, particularly those that are covered under international treaties.

ID: 01930, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Differential sensitivity to volcanic forcing of black spruce ring widths and stable isotopes from the northern Quebec taiga

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Northeastern North America has very few millennium-long, high-resolution climate proxy records. However, recently in the northern Quebec taiga, six millennium-long ring width chronologies were developed with 1782 subfossil and 150 living black spruce trees. Subfossil logs were sampled from the water and sediments of the littoral zone of six boreal lakes. From one of the six sites, 60 subfossil logs and 5 living trees were further analyzed to extract two millennium-long chronologies of stable isotope ratios (δ^{18}O and δ^{13}C) in tree-ring cellulose. All our proxies (ring widths and stable isotopes) are sensitive to the summer temperature of the study area and, when they are used together with a multiproxy approach within a Bayesian framework, they significantly improve the millennium-long temperature reconstruction (997-2006 CE). However, a methodological sensitivity analysis indicates that each proxy has a different response to abrupt forcings linked to strong volcanic eruptions of the last millennium. Ring width shows a larger response to single eruptions and a larger cumulative impact of multiple eruptions during active volcanic periods, δ^{18}O shows intermediate responses, and δ^{13}C is mostly insensitive to volcanic eruptions. Our results highlight that all reconstructions based on a single proxy can be misleading because of the possible reduced or amplified responses to specific forcing agents. Possible causes of the proxy differential sensitivity to volcanic forcing will also be discussed.

ID: 01869, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Spatio-temporal dynamics of vegetational communities in Late Pleistocene pollen records from Ukraine

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Maps of vegetational communities of Ukraine, based on pollen data, are compiled for 28 time windows within the Late Pleistocene. The key regions include the Carpathians with the adjacent Tyssa Lowland and the Middle Dniester region (in the west), the dissected Dnieper Upland and the flat Dnieper Lowland (northern and central Ukraine), the dissected Donetsk Upland (in the east) and the Crimean Mountains. On the plains, steppe spread more extensively than in Central Europe and, in the southeast, it even existed during some phases of the Last Interglacial. During some stadials and interstadials, forest zones existed only on mountain slopes, and in the plains, trees survived only in gullies (being particularly sparse in the Dnieper Lowland). Nevertheless, during the majority of the interglacial and in some interstadials, a steppe zone was practically absent in Ukraine. The northern plains were never occupied by steppe. There existed forest-steppe or parkland during interstadials, and tundra-forest-steppe during stadials. The composition of dendroflora and steppe plants showed great variability in different parts of Ukraine, being more mesophytic in the west and north. *Juglans* occurred in Crimea during the interglacial. During the Last Glacial, an admixture of broad-leaved trees was always present in the Crimean forests, though their pollination was reduced during the stadials. Few broad-leaved trees (as indicated by presence of their pollen and macrofossils) grew during the stadials in the valleys of Dniester and Tyssa. The northernmost occurence of *Tilia cordata* was revealed in the Dnieper Upland (50°N) between 27 and 23 14C kyr, but the atypical morphology of its palynomorphs indicates harsh conditions affecting pollen production. During the Late Glacial, broad-leaved trees first occupied the foothills of Crimean Mountains, strated to spread in the Dniester valley and the Donetsk Upland (arriving from the southern Carpathians and Caucasus, respectivelty, or from local refugia).

ID: 02029, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Abrupt changes in the south China Sea mixed layer depth during the last 20 ka

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Asian Monsoon System paleorecords have shown some abrupt climatic centennial-scale oscillations similar to the North Hemisphere high latitudes at North Atlantic. This results suggest climate teleconnections between high and low latitudes. Here we investigate these rapid climate-oscillations in the South China Sea (SCS) by reconstructing mixed layer depth (MLD) since the Last Glacial Maximum (LGM). The MLD was chosen as it responds to the atmospheric patterns driven by the East Asian Monsoon (EAM). We reconstructed the MLD changes by using the percentage of deep-dwelling planktonic foraminifera species of 12 published census records from cores retrieved from the SCS (5°N - 20°N; 110°W -119°W). A generalized additive model (GAM) was used to generate the MLD stack curve. Each GAM was fitted using the 'mgcv' package in R with a Gaussian error structure. Our reconstructions suggest a deeper MLD during the LGM is followed by a progressive shoaling towards the Present with three abrupt changes: (i) at 14 ka with a rapid shoaling of the MLD; (ii) at 8.2 ka MLD experiences an abrupt deepening; and (iii) at approximately 5 ka a new shoaling of the MLD. These intervals were associated with the Younger Dryas (YD), 8.2 ka and the Holocene Warm Period (HWP) events, respectively. A deeper (shallower) MLD reflects the strong (weak) wind mixing of surface waters promoted by an intensified (weakened) winter EAM during the colder (warmer) H1 and the 8,2 ka (YD and HWM) events. This scenario suggests the presence of communication between high and low latitudes, including in the HWM. Thus, in these periods the winter EAM strengthening (weakening) is dynamically influenced by both the cooling (warming) of the North Hemisphere and the intensification (decrease) of the Siberian high-pressure system and the westerly winds.

ID: 01764, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Constraining the North Atlantic Summer Climate during the Early Last Interglacial

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Early reconstructions of the Last Interglacial (LIG), such as those provided by the (CAPE Last Interglacial Project (2006), have been constrained to reproducing only a single snapshot of the entire climate period. More recently, new work by Capron et al. (2014) has been able to differentiate the climate into distinct periods. The early LIG features a remarkable cooling, which has not been reproduced in climate modelling efforts. To rectify this, Stone et al. (2016) hypothesized that freshwater forcing may be required, and when applied, this appeared to assist in eliminating the model-data mismatch. Here we use a novel approach with a stable-water isotope enabled climate model to demonstrate that such a freshwater forcing not only is not required to reproduce the cooling seen in the proxy cores, but instead would generate δ18O values in calcite that would be unable to match with Plaktic Foraminifera. As the North Atlantic is influenced by changes in the Atlantic Meridional Overturning Circulation (AMOC), we use this to suggest that the AMOC may have been slightly reduced during the early LIG, however such a slight reduction is likely only due to changed orbital and greenhouse gas forcings. This highlights the importance of new, multi-model comparisons including freshwater forcing in upcoming PMIP experiments in order to further our understanding of how AMOC-in past warm climate states as well as a likely warmer future.

ID: 02307, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Quantitative paleo-aridity record from Karsandi paleolake (NW India) over the Holocene inferred from triple oxygen isotopes in gypsum hydration water

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Stable isotopes in gypsum hydration water can be used to reconstruct the stable isotopes of paleolake waters at the time of gypsum formation, and describe the hydrologic budget of the lake. In addition, the coupled measurements of $d^{17}O$ and $d^{18}O$, along with dD and derived ^{17}O-excess and D-excess, provide a rich source of information about past atmospheric relative humidity. Karsandi paleolake is located in the Thar Desert of northwestern India, and preserves a unique 2.5 m sequence of evaporitic gypsum deposits dated between ~4-13kyrs BP. Karsandi's gypsum hydration water was analyzed for $d^{17}O$, $d^{18}O$, and dD. The $d^{18}O$ and dD records suggest a dry period coincident with the 4.2k event, and a relative humidity model based on $d^{17}O$ and $d^{18}O$ also points to lower relative humidity levels of ~50%. This timing is significant because of the site's proximity to large population centers of the Harappan Indus civilization, which collapsed and experienced large population declines just after 4kyrs BP. The triple isotope record of Karsandi's gypsum hydration water furthermore points to a humid period

with a relative humidity ~75% between 5.2 and 4.4kyrs BP, which chronologically corresponds to the Mature Harappan phase and the peak of Harappan urbanization. Karsandi's gypsum deposits appear to be a proxy for regional monsoon strength.

ID: 02255, 18.- Human Impact on Global Aquatic Systems, (Poster)

New perspectives on lake ecosystem state trajectories from lake sediment DNA as a proxy of anthropogenic factors (Mundic Lagoon, South eastern Australia)

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The Murray Darling Basin, representing 14% of the Australian territory, provides a lot of services to the population, especially water provisioning to sustain agricultural activities. The Murray River has also an important cultural value. For instance, it is widely present in the mythology of Aboriginal communities. However, the waters suffer from salinization and high turbidity triggering the loss of aquatic plants and eutrophication. With the ongoing drying conditions due to the global warming, the degradation of these ecosystems by crossing a "tipping point" is expected, leading to a loss of ecosystems services, too. Thus, there is an urgent need to identify the causes of the poor state of these ecosystems.

Lake sediments are widely recognised as good archives of past environmental changes. Previous studies on sediments from over 50 billabongs and lagoons along the River's floodplain reveal a huge increase in sediment fluxes (80% of sites), after European settlement. The determination of the origin(s) of this change remains challenging. Here, we propose to analyse *seda*DNA to test the assumptions of sediment increasing due to sheep farming and/or the introduction of European carp. A core was taken in Mundic Lagoon to apply this emerging tool. Physico-chemical and biological lake ecosystem trajectories were also assessed using sedimentological approaches and diatoms. Moreover, pollen and macrofossils studies were integrated as indicators of landscape changes.

Preliminary X-Ray fluorescence core scanner results show a progressive change in the lake ecological state since European settlement. It is mostly characterised by an increase in detrital elements and a shift in redox dependant elements suggesting an improvement of oxygenation conditions in the hypolimnion. Diatoms also reflect a recent increase in river plankton since regulation while the pollen and macrophyte records attest to the decline in submerged macrophytes and the increase in floating and emergent forms.

ID: 01830, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

The impact of land-use changes on palaeoflood and recent floods magnitude and frequency: Portainé (Eastern Pyrenees, Iberian Peninsula)

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This work presents the changes in the hydrological response of the high mountain watershed of the Portainé stream (Eastern Pyrenees) due to the installation in 1986 of the Port-Ainé ski resort and the related land-use changes produced since then.

A detailed mapping of the land uses at several years was carried out, based on vertical aerial photographs and ortophotos (from 1956 to 2014; available at www.icgc.cat). From these maps and DTMs, selected basin models were created.

Due to the lack of long enough local rainfall data series, synthetic hyetographs for specific return periods were generated (software MAXIN 2.0). These synthetic rainfalls were transformed to hydrographs for different land-use scenarios (software HEC-HMS). The results show, from 1956 to 2011, a significant increase of 26% of the peak discharge at the exit of the ski resort and of 15% downstream, for short return period rainfalls (Tr 10 years). These results were compared to other studies in the area performed with the software CAUMAX, in order to check their coherence. The local rainfalls available since 2011 and recorded during the flood events are compared to the results of the hydrometeorological models to better characterize the system behaviour.

Since 2006 nine debris floods and flows occurred in the Portainé stream and its tributary Reguerals stream, which damaged the ski resort access road. The major event occurred in 2008 caused the overcoming of a geomorphological equilibrium threshold and since then the hydrological behaviour of these streams dramatically changed, inducing severe erosion and deposition processes.

The overcoming of the geomorphological threshold and the processes change was clearly enhanced by the increase in peak discharges demonstrated in this work.

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ID: 02121, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Exploring the Quaternary palaeoecological potential of Portuguese Macaronesian archipelagos: examples from Madeira and Faial Islands

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In the early 15th century, when the Portuguese Madeira and Azores archipelagos were settled, the islands were described as presenting luxurious and pristine forests. Since then the vegetation suffered overexploitation, area loss, degradation, extirpation and extinction, while numerous new species were introduced from all over the world. Anthropic impact in the flora of these archipelagos, although evident from historical and present studies, continues understudied. The addition of a palaeoecological perspective is imperative as it provides clues about past vegetation diversity and dynamics at time-scales of hundreds to millions of years. Moreover, although plant fossils are known in both archipelagos since the early 19th century these were never studied in detail. Here we report a preliminary study of the palaeobotanical and palynological record from two Portuguese Macaronesian islands: Madeira and Faial. In Madeira Island (Madeira archipelago), we are currently studying fossiliferous localities ranging from at least 1.5 Ma to present: 1. Porto da Cruz (≥1.5 Ma), a sedimentary deposit rich in adpressions of stems, leafs, seeds, fruits, and pollen; 2. Holo-Pleistocene crater lakes revealing the presence of a pollen archive from the last millennia; and 3. a paleosol dating from 6000-7000 yr BP containing charcoal and pollen. In Faial Island (Azores archipelago), a record of 12 sub-plinian and phreatomagmatic trachyte eruptions younger than 16 ka BP is known to have buried and preserved paleosols and vegetation. Field work provided charred and unaltered wood specimens and leaf fossils preserved in volcanic ash-tuffs, while paleosols and sediments were sampled for palynological study. Preliminary results show that several paleosols preserve a pollen content and leaf fossils indicate a laurel forest leaf-litter buried by ash. Although our results are still preliminary, further investigation will contribute decisively to elucidate palaeoecological key-questions about these two Macaronesian Islands.

ID: 02030, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Diatoms from Mozambique: a tool for palaeoenvironmental reconstructions and to understand human evolution

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In the framework of the project "Stone Age Vilankulos: Modern Human Origins Research South of the Rio Save, Mozambique" a geoarchaeological survey was conducted in 2016 aiming to better understand the environmental history and landscape evolution of the study area including the environmental context of human occupation. During the survey, 23 sediment surface samples were collected across a variety of environments, namely: freshwater environment - Elephant River basin in Southwestern Mozambique - and brackish and marine tidal environments - Inhambane coastal area, Southeastern Mozambique. These samples will be used as modern analogues to interpret the sedimentological and paleontological record of 4 cores collected in a mangrove area of the Inhambane estuary and then reconstruct its palaeoenvironmental evolution. All the sampling points were georeferenced and the study area was overflown with a drone to collect photogrammetric data. Both surface and core samples were used for diatom, texture and geochemical analysis. Diatoms will be used as the main palaeontological proxy, because they are unicellular algae with a short-live cycle and largely sensible to environmental variables such as salinity, sediment texture and duration of the tidal inundation. Thus, diatoms are valuable tools for paleoenvironmental reconstructions in estuarine zones, which are influenced by both continental (e.g. precipitation) and marine variation (e.g. mean sea-level). Preliminary data on the modern diatoms analysis showed that diatom diversity is high and the equitability is low in all environments. Cores sedimentological description and dating are also presented. The work was supported by the project PTDC/EPHARQ/4168/2014, funded by the Portuguese Foundation for Science and Technology.

ID: 01977, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Testing the analog method in reconstructing the global mean annual temperature during the Common Era

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This study addresses the possibility to carry out global gridded mean annual temperature reconstructions using a worldwide network of proxy records and a method based on the search of analogs (AM-CFR). Several variants of the method are evaluated, and their performance is analysed. As test bed for the reconstruction, the PAGES2K proxy database (version 1.9.0) is employed as predictor, the HadCRUT4 dataset is the set of observations used as predictand and target, and a set of simulations from the PMIP3 are used as pool to draw analogs and carry out Pseudo Proxy Experiments (PPE). The performance of the variants of the analog method is evaluated through a series of PPEs in growing complexity, from a perfect scenario to a realistic one where the pseudo-proxy records are contaminated with noise and missing values mimicking the limitations of actual proxies. From all the tests carried out, we can conclude that the analog pool provided by PMIP3 ensemble is large enough to reconstruct global annual temperatures during the Common Era. Further, the search of analogs based on a metric that minimises the RMSE outperforms other evaluated metrics, including the search of analogs in the range-reduced space expanded by the leading EOFs. We show how the method is able to extrapolate the information of the proxy network to produce a homogeneous gap-free climate field reconstruction with valuable information in areas barely covered by proxies. Finally, the method is applied to reconstruct the HadCRUT4 observed temperature based on the calibration of the proxies. The reconstructed fields reproduce the observed decadal temperature variability. The AM-CFR is a suitable tool which is able to deliver valuable climate field reconstructions for the Common Era.

ID: 01788, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Coherent changes of the Atlantic Meridional Overturning Circulation and North Pacific Intermediate water during Mid-to-late Holocene transition

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Paleoceanographic evidences have identified temporal slow-down of the Atlantic meridional overturning circulation (AMOC) during the mid Holocene (around 7 to 4 ka B.P.) In accompany, recent marine proxies have suggested deepened North Pacific Intermediate water (NPIW) of also stronger export out of the south Okhotsk Sea at around 6.5 to 5 ka, compared to the Present. Previous mechanism studies have attributed the Mid-Holocene, reduced AMOC to the weaker North Atlantic deep-water convection due to either negative phase of the North Atlantic Oscillation or stronger freshwater outflow out of the Arctic Ocean. At the Pacific side, the Mid-Holocene transition of the NPIW has been hypothesized under the consequence of regional sea ice expansion in the Okhotsk Sea, probably related to shifts of the Aleutian low system. However, the dynamical linkage behind the coherent AMOC and NPIW changes remains to be discussed. By applying an Earth System model, we conducted the transit simulations through the Holocene interval forced by the changes in greenhouse gas concentrations and solar insolation. Our modeling results characterize the Mid-Holocene AMOC and NPIW transitions by the resembled patterns as revealed in marine proxies. Therefore, our results allow us to discuss the cross-basin scale dynamics in controlling the coherent AMOC and NPIW changes during the Mid Holocene. Since the solar insolation and CO_2 are two key factors driving the Holocene climate evolution, we have additional experiments to diagnose their specific roles in leading the Mid-to-late Holocene ocean circulation changes.

ID: 01836, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

CLIMATE-HUMAN-ENVIRONMENT INTERACTIONS AS TRIGGER OF THE CURRENT CENTRAL PYRENEES LANDSCAPE: A HISTORY FROM LAKE RECORDS

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The Central Spanish Pyrenees is a region where the interplay of climate and human interaction on the landscape has always been difficult to detangle. Furthermore, this area, as the whole of the Mediterranean mountains, stands out as one of the most vulnerable areas to Global Change both in current day studies and in future projections.

We present eight Central Pyrenean and Pre-Pyrenean multiproxy lacustrine sequences providing essential information on this region\'s environmental history. These are, from lowlands to high altitude areas: Estanya, Marcelino, Montcortés, Tramacastilla, El Portalet, Basa de la Mora, Redón and Marboré lakes. According to its location each sequence shows additional information related to glacier retreats, lake level and depositional evolution, duration of ice-cover period in lake surfaces, forest development and dominant taxa, evolution of moisture gradients from western to eastern areas, movements of the tree-line through the Holocene and identification of different timing for first human action impact (deforestation, pasture, agriculture presence) and its persistence and extension.

A comprehensive analysis of these data have allowed us a detailed palaeoenvironmental landscape reconstruction which has both completed and changed the previously established history about climate and human land-use interactions in the region. Now, we can affirm that landscape dynamics in the Pyrenees has been greatly controlled by both long term and abrupt climate variability, including recent periods in spite of anthropogenic activities, which however emerge as an important trigger of threshold responses during the last centuries or few millennia, depending on altitude.

Available data from lake record inform us on common temporal trends and also particularities at different time scales since the Last Glacial Maximum, with a special focus at the Holocene. Specifically, variations in intensity, nature and evolution of both regional and local vegetation changes as well as hydrological variability.

Thus, the long-term climate-human-environmental interactions at the Central Pyrenees shape an interesting and diverse case study which can help to evaluate the possible impact of current and future Global Change in an especially vulnerable region in projections such as Mediterranean mountain areas.

ID: 01243, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Reconstructed and simulated temperature asymmetry between continents in both hemispheres over the last centuries

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Available proxy-based temperature reconstructions covering the past millennium display contrasted evolutions between the continents. When driven by realistic natural and anthropogenic forcings, climate models tend to simulate a more spatially homogenous temperature response. This is associated with a relatively good agreement between model results and reconstructions in the Northern Hemisphere but a low consistency in the Southern Hemisphere. Here, simulations with data assimilations are performed to analyse the causes of this apparent disagreement. It shows that, when the uncertainties are taken into account, states of the climate system compatible with the forcing estimates, the reconstructions and the model physics can be obtained over the past millennium, except for the 20th century in Antarctica where the simulated warming is always much larger than in the reconstructions. Such states consistent with all sources of information can be achieved even if the uncertainties of the reconstructions are underestimated. Although, well within the range of the proxy-based reconstructions, the temperatures obtained after data assimilation display more similar developments between the hemispheres than in those reconstructions. Ensuring the compatibility does not require to systematically reduce the model response to the forcing or to strongly enhance the model internal variability. From those results, there is thus no reason to suspect that the model is strongly biased in one aspect or another. The constraint imposed by the data assimilation is too low to unambiguously identify the origin of each feature displayed in the reconstructions but, as expected, changes in atmospheric circulation likely played a role in many of them. Furthermore, ocean heat uptake and release as well as oceanic heat transport are key elements to understand the delayed response of the Southern Hemisphere compared to the northern one during some transitions from warmer to colder states or from colder to warmer ones.

ID: 01441, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Deglacial ventilation history of the deep South Indian Ocean: new insights from radiocarbon analyses of ultra-small foraminifer samples with an accelerator mass spectrometer (AMS) Mini-CArbon DAting System (MICADAS)

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The deglacial radiocarbon (^{14}C) history of the ocean and the atmosphere gives valuable insights into the mechanism that control atmospheric CO_2 ($CO_{2,atm}$) levels, and hence global climate. Ocean ^{14}C ventilation ages largely reflect the efficiency of the air-sea exchange of CO_2, the residence time of carbon and vertical mixing in the ocean, and therefore indicate the degree of oceanic carbon sequestration. A full picture on the magnitude and impact of changes in ocean carbon sequestration on deglacial $CO_{2,atm}$ levels may ultimately emerge from high-resolution and widely distributed ^{14}C-based ocean ventilation age records, but some regions, such as the Indian Ocean, are highly undersampled. We present a new suite of paired benthic and planktonic foraminifer ^{14}C ages from the sub-Antarctic Indian Ocean (sediment core MD12-3396CQ: 47°43.88'S, 86°41.71'E, 3615 m water depth) obtained by small-sample analyses (300 to 1,000 µg $CaCO_3$) with the MICADAS at the University of Bern that allow circumventing previous limitations of very low foraminifer abundances in this region. (Sub-)surface ocean temperature estimates allow stratigraphic alignments to Antarctic (ice core) temperature variations, thereby providing independent, robust chronological control. ^{230}Th flux analyses provide further information on accumulation rate changes at the core site. Our new data indicate that glacial deep-ocean ^{14}C ventilation ages were increased compared to mean Holocene levels. The transition from a poorly ventilated glacial ocean to a well ventilated Holocene ocean in the sub-Antarctic Indian region coincided with a rapid change in $CO_{2,atm}$ associated with the Bølling-Allerod stadial-interstadial transition. Our findings may indicate the importance of ocean dynamics in the Indian Ocean in driving $CO_{2,atm}$, and further point at a major link between Northern-Hemisphere climate change and increased CO_2 outgassing from the sub-Antarctic Indian Ocean.

ID: 01529, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Assessing nudged atmospheric model performance using Antarctic ice core water stable isotope data for the period 1960-2013

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Polar ice cores provide exceptional archives of past climate change. Past temperatures can be inferred from ice core water isotope records, if the relationship between $\delta^{18}O$ and temperature can be quantified. Simulations performed by atmospheric general circulation models are commonly used to investigate the various processes affecting Antarctic precipitation isotopic composition. Here, we evaluate the skills of a highly resolved water-isotope-enabled atmospheric general circulation model ECHAM5-wiso, nudged to ECMWF reanalyses over he period 1960-2013, with a focus on Antarctica.

To this aim, we compare model outputs with 1) near surface temperature from weather station data (https://legacy.bas.ac.uk/met/READER/, Turner et al., 2004), 2) a new accumulation dataset (GLACIOCLIM, Favier et al., 2013), and 3) an updated dataset of water stable isotope measurements from precipitation and ice core samples encompassing the same period.

ECHAM5-wiso produces a large Antarctic surface warming after 1979. We suggest that this feature may arise from a discontinuity in the ERA reanalyses following the start of assimilation of remote sensing data. The comparison with accumulation and water stable isotope data is thus restricted to the period 1979-2013. We identify some systematic regional biases but report an overall remarkable coherency between model outputs and data for mean values, seasonal patterns, amplitudes, spatial distribution and amplitude of inter-annual variability. We further assess the model skills for the average seasonal lags between $\delta^{18}O$ and deuterium excess, as well as for the relationships between $\delta^{18}O$ and temperature at spatial, and inter-annual scales.

This analysis builds trust in the use of ECHAM5-wiso outputs to investigate $\delta^{18}O$ and temperature relationships for past climates. The model framework has allowed us to develop methods to calibrate regional $\delta^{18}O$ time series to temperature, as one methodological option for the Antarctic 2k temperature reconstruction.

ID: 01407, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Last Interglacial variability of the deep North Atlantic circulation

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Although most climate models simulate a future reduction in the deep North Atlantic circulation in response to increased atmospheric greenhouse gas concentrations, the rate and magnitude of simulated weakening remain highly uncertain. With strong orbital forcing and sea levels higher than nowadays due enhanced ice sheet melting, the Last Interglacial period (LIG, ~129-116 ka) represents an excellent case study to investigate the response of the deep Atlantic circulation to a climate warmer than present-day. However, most existing records documenting LIG changes in the deep North Atlantic circulation are based on “passive” tracers and do not provide any information on the dynamics of deep water currents. Here we will present high-resolution paleomagnetic records from several North Atlantic sediment cores collected at water-depths ranging between 1800 and 3400 m, in order to document the detailed dynamical evolution of bottom North Atlantic currents throughout the Last Interglacial. Preliminary results indicate active deep currents between 1800 and 3400 m, and the decreasing intensity of currents at 3900 m, throughout the LIG, in line with the concept of a deep and intense North Atlantic circulation during the LIG. The early LIG may also be characterized by a slightly shallower North Atlantic circulation than the LIG climatic optimum, suggesting the potential influence of ice sheet melting on the early LIG deep circulation.

ID: 01329, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Role of sediments in controlling the dynamics of paleo-ice sheets

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The motion of glacial ice is predominantly controlled by basal conditions, which include a variety of parameters such as ice rheology, temperature, water content, the presence of sediments, and topography. Soft sediment deformation has long been hypothesized to be a dominant control on the size and dynamics of temperate ice sheets such as the Laurentide Ice Sheet. The transition from hard-bedded regions (areas that lack significant sediment cover) to soft sediment areas put a limit on the maximum volume of these ice sheets. When the ice sheet margin reached soft sediment cover, it may have caused the ice sheet to surge, with global-scale climatic impacts. Current generation ice sheet models only have limited control on how sediments modify the behavior of an ice sheet. We present a model of sediment deformation that can take into account the thickness, lithology and hydrology at the base of the ice sheet using the Parallel Ice Sheet Model (PISM). We assess how changes in sediment properties affect the advance and retreat of the ice sheet, including standstills in the margin when the ice sheet becomes restricted to the hard-bedded interior areas. We apply this model to the Wisconsin Glaciation (~85-11 kyrs ago) of the Laurentide ice sheet. We show how the distribution of sediments affect its growth and retreat. We specifically focus on how the soft bedded Hudson Bay impeded the growth of the ice sheet, up to the lead up to the Last Glacial Maximum. We also investigate the relationship between Dansgaard–Oeschger and Heinrich events and the basal dynamics of the ice sheets.

ID: 01569, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Hydrological simulations of the mid-Holocene drying of Megalake Chad

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Hydrological simulations of the mid-Holocene drying of Megalake Chad

During the mid-Holocene, Megalake Chad (MLC) was larger than today’s ten largest freshwater lakes combined, spanning 8° of latitude and more than 150 m deep. Sediment-based reconstructions suggest that MLC receded slowly ~6.5-5.0 ka BP followed by rapid decline and split into two connected lakes with Lake Chad spilling northward into Lake Bodélé. The latter continued to fall, to a minimum ~4.4-4.0 ka BP which exposed vast areas of long-submerged lakebed. It recovered somewhat in subsequent centuries, but fell dry by ~2.4 ka BP. Today, these dry northern lakebeds form the Bodélé Depression, the world's largest single source of dust (~10-20% of global emissions), their productivity owing to extensive diatomaceous deposits accumulated under mid-Holocene megalake conditions.

We examine MLC's remarkable mid-Holocene evolution using a realistic coupled hydrology / lake water balance model with simple parameterizations of lakebed dust production and of the feedback between dust and catchment rainfall seen in climate models. The results are of three-fold interest. First, they support quantitative inferences concerning the pace of changes in mid-Holocene regional rainfall. Second, the timing of changes in lake geometry places important constraints on the interpretation of paleo-records from different settings within the basin. Third, dust-rainfall-runoff feedbacks using plausible sensitivities and deflation rates produce intense coupled 'events' of 200-300 years duration during which both catchment rainfall and lake level plummet in response to heavy dust production from the newly exposed bottom sediments. Simulated dust emissions during these events reach the estimated total magnitude of modern North African production.

The 5th Millennium lowstand of Lake Bodélé coincides with the much-debated '4.2-kyr event'. We discuss whether dust emissions towards the end of its rapid mid-Holocene recession plausibly played a role in both enabling the event and producing global climatic impacts.

ID: 02346, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Unravelling the exceptional El Niño-driven mudflows and catastrophic floodings of march 2015 at the hyperaryd Atacama Desert

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In March 2015, extreme precipitations in northern Chile triggered debris-flows and floods over the Atacama Desert. One of the most affected zones was the Salado river basin, especially the city of Chañaral. The damages in this city and upstream locations were exceptional, but it's not the first time this kind of events happened in Chañaral. Unravelling the factors that generated this catastrophic event, associated with particular climatic conditions influenced by ENSO, is key to understand the happening and recurrence of these extreme events over the past two centuries and into the future.

The data observed from the mudflow showed us that it was an unprecedented event in the recent history of Chañaral, in terms of magnitude and triggering factors. Three previous extreme precipitation events in the zone (1991, 1983 and 1972) were studied through re-analysis, showing that the mechanisms vary, but certain conditions must be met to trigger a debris-flow: high zero isotherm, high water availability and higher concentration of rainfall in high areas. In a broader sense, records of rainfalls that triggered floods and debris-flows over the last two centuries (1877, 1918, 1940, 1972, 1983, 1991 and 2015) show us that peaks of negative SOI and high SST at NIÑO3.4 zone correlates directly with the occurrence of these extreme events (except 1972), and that it's getting more and more recurrent to the present, probably associated with the increasing force of recent El Niño periods, without discarding possible effects of climate change.

We propose that the 2015 event has no precedents in the recent years, but events of similar magnitude can be traced over 200 years ago. Also, it's most likely that the recurrence of these kind of extreme events will increase in the future, and that the effects will be equally or more catastrophic.

ID: 01285, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Pliocene vegetation and hydrology changes in western equatorial South America

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During the Pliocene, two major tectonic events triggered a profound reorganization of ocean and atmospheric circulation in the Eastern Equatorial Pacific (EEP), the Caribbean Sea, and on adjacent land masses: the progressive closure of the Central American Seaway (CAS) and the uplift of the northern Andes. These events presumably lead to a shift in the mean latitudinal position of the Intertropical Convergence Zone (ITCZ), which would have affected the continental climate. The direction of an ITCZ shift however is still debated, because numerical modelling results and paleoceanographic data indicate shifts in opposite directions. To resolve this contradiction, an independent hydrological record of the region is needed. A study site in the EEP (ODP 1239A) was chosen to reconstruct the vegetation and climatic history of western Ecuador with palynological techniques, focusing on two time windows: 4.7-4.2 Ma and 3.6-3.1 Ma. The presented pollen record comprises representatives from five vegetation types: lowland rainforest, lower montane forest, upper montane forest, páramo, and broad range taxa. The main finding is the persistence of a broad tropical rainforest coverage in the whole study area throughout the early Pliocene. From 4.7 to 4.44 Ma and around 4.2 Ma, the record reveals increasing humidity. This is reflected through increasing percentages of lowland rainforest and lower montane forest, a high spore content and high linear sedimentation rates. The development of the different vegetation types reveals stable, permanently humid conditions. This finding would rather be in agreement with paleoceanographic data indicating a southward ITCZ shift in response to CAS closure. However, the very stable conditions suggest that the critical thresholds of surface water restriction of the CAS and of Andean uplift were reached even earlier. Therefore, the exact timing of an ITCZ shift and the question whether it was a direct response to CAS closure or not remains unclear.

ID: 02252, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Paleoecological reconstruction of a marine-terrestrial linkage in the Falkland Islands

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Nutrient transport from the marine ecosystem to island ecosystems is a basic supporting service to a system that receives very little nutrient input otherwise. Marine nutrient subsidies are essential to maintain biodiversity of isolated terrestrial environments. Endemic seabirds and some of the world's most important seabird rookeries in the Falkland Islands face the threat of extinction from the impacts of a rapidly changing climate. Changes in temperature and precipitation are expected to influence top predators of the marine food web breeding in the ecologically important coastal tussac grasslands. Subsequent declines in marine fauna populations are expected to influence nutrient input via guano into low productivity oceanic islands. Specifically, marine-derived nutrients are especially important for primary productivity of tussac grasslands on oceanic islands that provide breeding habitat and shelter from perpetually intense southwesterly winds in the Southern Hemisphere. Primary productivity of tussac grasslands, which are now in a perilous state, is driven by the interaction of the climate system and fluctuations in nutrient input. The natural range of vulnerability in marine fauana populations in response to interactions of the climate system and the resulting impact on the marine-terrestrial linkage was investigated using paleoecological reconstructions. Tussac grass (*Poa flabellata*) peat cores were used to reconstruct Holocene environmental changes to test the sensitivity of this terrestrial-marine linkage and its impacts on island plant and animal communities. Results indicate that an abrupt decline in the relative abundance of seabird and marine mammal populations occurred in sync with changes in island plant communities providing important breeding habitat, and that fire is a frequent component of tussac grasslands. These results improve our understanding of how the climate system and specifically changes in the position and strength of the southwesterly winds influenced tussac grasslands and nutrient input through fluctuations in populations of marine fauna.

ID: 02303, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

The last 600 cal yr BP ecosystems dynamics at Serra da Bocaina National Park, Southeastern Brazil

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The Serra da Bocaina National Park is located at the border between São Paulo and Rio de Janeiro states in Southeastern Brazil, one of the first areas occupied by European during Brazilian colonization. Originally, the vegetation was composed by Montane Atlantic Forest, Araucaria Forest and High Elevation Grasslands. However, more or less 400 years of land use changed the landscape, ecosystems and species composition. The immigrants prepared the land basically cutting the vegetation and putting fire, first for coffee plantation and afterward for cattle. Nowadays, exotic species are also found. The National Park embraces a large gradient of elevation, from the sea level to more than 2.000 m. As a result of several geomorphological domains, it presents different reliefs, microclimates, hydrography, soils, ecosystems and landscapes, as well as ecologic refugees, endemic and endangered species; increasing its importance for conservation. A 228 cm-long record, representing the last 600 cal yr BP from a contact area between Araucaria Forest and Grassland, was analyzed to study past vegetation dynamics and humans changes in the vegetation (1.539 m asl and S 22°44\'02.0"/ W 044°38'39.4"). The record provides important information on mountain vegetation dynamics, human impacts and climate change. The tree pollen types found are characteristics of the Upper Montane Araucaria Forest, such as *Podocarpus*, *Weinmannia*, *Myrsine* and Myrtaceae. However, *Araucaria* pollen is very low represented. Most of this tree pollen types describes secondary vegetation. Also, Poaceae and Cyperaceae are quite abundant, indicating human activities. The pollen record with taxa of Araucaria Forest, Atlantic Forest and Grassland are discussed in the light of the past, current and future scenarios enabling the planning of strategic actions of management for conservation the ecosystems and their biodiversity.

ID: 02185, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

A century of limnimetric shifts in central Argentina: floods, droughts and climate change linkages

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Extreme hydro-climate changes recognized in southeastern South America (SESA) for the last 200 years have affected water resources and thus the ecosystems and human population depending on them. For instance, important precipitation increases were recorded between the 1970s and 2003 and between 2013 and the present in SESA (i.e. central and northeastern and central Argentina, Uruguay, Paraguay and southern Brazil). In contrast, severe droughts reducing water availability were documented through historical and paleoclimatic archives for early 19th century. In the Pampean Plains from central Argentina, rainfall conditions interplay with a flat terrain geomorphology, ruling the environmental response of the hydrological systems. Pampean lakes and wetlands are mostly closed systems, where vertical water interaction dominates the hydrological balance (i.e. rainfall and evaporation) and they are extremely sensitive to water balance changes. The Melincué Lake (33°S/61°W), situated in this geographical context, has suffered large surface variability with severe floods during wet climates affecting agriculture and grazing lands, roads and the Melincué town, followed by important lake-surface reductions during dry periods. In this contribution we present an analysis of the limnimetric shifts of Melincué Lake linked to the regional rainfall variability of the last 100 years, and compare both variables with historical and limnogeological records. Instrumental information provides direct data of the recent climatic variation setting the base of calibration of paleoclimatic proxies. Statistical analyses applied on the data indicate different periodicities of the hydro-climate variation. The lake-level oscillations show superposed signals, with a stronger variability associated to the Pacific Decadal Oscillation, with wetter periods registered as organic-rich sedimentary deposits. Understanding how the lake reacts to variable precipitation in the region will permit vulnerable societies dependent on the water resource to plan strategies for extreme drought or floods situations of future climate changes.

ID: 02187, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

The limnogeological record of Melincué Lake (central argentina) through the last millennium in the South American hydro-climate context

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Regional paleoclimatic reconstructions are fundamental to emplace the present-day climate in a long-term context. The reconstruction of climate in the region of southeastern South America (SESA) can supply information to validate the paleoclimate models at a continental level and to understand the past patterns of atmospheric circulation. The South American Monsoon (SAM) system controls the precipitations in the tropics and subtropics of South America at the east of the Andes. Recently, an increasing number of climate reconstructions from SESA has been developing for the Common Era, using multiple continental proxies, including paleolimnological records. Melincué Lake, located in central Argentina (33°S/61°W), is shallow and closed system, highly sensitive to changes in regional water-budget and has a record of the last 1000 years climate variability. In this contribution, the sedimentary record from Melincué Lake is compared with different paleolimnological records from central Argentina and eastern Uruguay during contrasting climatic periods comprising the Medieval Climate Anomaly (MCA), the Little Ice Age (LIA) and the 20th century. These reconstructions are also compared with available paleoclimatic archives from different sites of South America, which are also under the SAM domain, including glacial, lacustrine records and speleothemes. Sedimentological and chemical analyses from Melincué indicate significant wet periods during the MCA-LIA transition and after the LIA, with increasing humidity during the last part of the century. Conversely, part of the MCA and the LIA periods are represented by very low lake-level records. The regional and sub-continental comparison depicts regional hydro-climatic differences during warm and cold periods along South America, which reflect the past dynamics of the SAM. Future research taking part in the eastern part of the Andes in northwestern Argentina will provide further information to complete the latitudinal climate variability in the SESA region associated to the monsoon.

ID: 01505, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Reassessing the climatic impacts of the 1257 eruption in Europe and in the Northern Hemisphere using historical archives and tree rings

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Polar ice cores attest to the CE 1257 Samalas as the largest sulphur signal of the two millennia, and suggest that this eruption was approximately two times greater than the Tambora event in 1815. Stratigraphic and sedimentological analyses of deposits confirm the exceptional magnitude (me 7, VEI 7) of the Samalas eruption that expelled a minimum of 40 km3 of dense magma at an estimated altitude of 43 km2. Reconstructing the climatic anomalies and the spatial cooling extent associated with such high-magnitude eruptions has proven very challenging and generated vivid debate in the scientific community. Scarcity of annually resolved proxy records extending back to the 13th century has so far prevented robust documentation of climatic perturbations induced by the AD 1257 Samalas eruption in terms of its severity, spatial extent and duration. The recent development of new tree-ring chronologies in poorly studied regions of the Northern Hemisphere, as well as the discovery of new historical evidence from Europe and Japan now allow to shed a new light on the climatic aftermath of one of the largest explosive volcanic events of the Holocene.

ID: 01378, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Equilibrium simulations of Marine Isotope Stage 3 interstadial climate

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Marine Isotope Stage 3 (MIS3) was a period between approximately 60 ka to 30 ka BP that is characterised by abrupt climate transitions between cold, stadial and mild, interstadial climate conditions. The fluctuations are known as Dansgaard–Oeschger (D-O) events featured by a rapid warming from stadial to interstadial in a matter of a few decades, followed by a gradual cooling to stadial. We present fully coupled climate simulations of a pre-industrial control run and a MIS3 experiment at 38 ka, both integrated for 2000 years using the Norwegian Earth System Model (NorESM). With the recent model developments in the Bjerknes Centre for Climate Research (Norway), a new and efficient NorESM version (BCCR fast version) with 2 degrees atmosphere and 1 degree ocean is configured for paleo-modelling. BCCR fast version is capable of simulating Arctic sea ice and North Atlantic inflow well. We will present the large scale climate features in the MIS3 interstadial relative to today, such as the Atlantic Meridional Overturning Circulation, surface air temperature, etc. We also focus on the climate conditions in the Arctic and discuss the ocean circulations and sea ice conditions. In addition, sensitivity experiments with freshwater input into different regions (e.g., along the Norwegian coast, in the Nordic Seas, in the Labrador Sea, and in the region between 50 and 70 N) are performed; we will show the response of Arctic sea ice and Greenland temperature change from the freshwater perturbations and their implications for D-O events.

ID: 02077, 28.- Climate variability signals in groundwater (and unsaturated zone) archives, (Poster)

Climate variability signals in groundwater from U.S. agroecosystems

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Natural climate variability on interannual to multidecadal timescales affects spatiotemporal patterns of precipitation, evapotranspiration, soil moisture, plant function, infiltration flux, and augments or diminishes human stresses on water resources. Understanding the physical processes in the vadose zone that link climate variability with transient recharge fluxes has particular relevance for the sustainability of groundwater-supported irrigated agriculture and other groundwater-

dependent ecosystems. Findings are presented from major agroecosystems of the United States (U.S.), including the High Plains, Central Valley, California Coastal Basin, and Mississippi Embayment aquifer systems. Singular spectrum analysis (SSA) is used to identify quasi-periodic signals in precipitation and groundwater time series that are coincident with the Arctic Oscillation (AO) (6–12 mo cycle), Pacific/North American oscillation (PNA) (<1–4 yr cycle), El Niño/Southern Oscillation (ENSO) (2–7 yr cycle), North Atlantic Oscillation (NAO) (3–6 yr cycle), Pacific Decadal Oscillation (PDO) (15–30 yr cycle), and Atlantic Multidecadal Oscillation (AMO) (50–70 yr cycle). SSA results indicate that nearly all of the quasi-periodic signals in the precipitation and groundwater levels have a statistically significant lag correlation (95% confidence interval) with the AO, PNA, ENSO, NAO, PDO, and AMO indices. The spatial patterns of correlations between the modes of climate variability and the lagged responses between precipitation variability and groundwater level fluctuations are presented. Results from HYDRUS-1D simulations indicate that transient water flux through the vadose zone are controlled by highly nonlinear interactions between mean infiltration flux and infiltration period related to the modes of climate variability and the local soil textures, layering, and depth to the water table. Findings from this study improve understanding of how vadose zone properties influences transient recharge flux and damp climate variability signals in groundwater systems, and have important implications for sustainable management of groundwater resources and coupled agroecosystems under future climate variability and change.

ID: 01657, 18.- Human Impact on Global Aquatic Systems, (Poster)

Of Pile Dwellers, Roman and Medieval Farmers – Early Human Impact on Lake Murten, Switzerland

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Besides the climate system, it has long been proven that human activities can also affect aquatic ecosystems to a great extent, by modifying the nutrient and hydrological regimes. However, our knowledge of the timing of the first detectable human perturbation, often linked to the historical evolution of land-use changes, is rather limited. This study seeks to address this problem by investigating the sedimentary record from Lake Murten (Swiss Foreland Basin), whose region witnessed several phases of human occupation starting already thousands of years ago during the Neolithic Period.

We applied a multi proxy approach including several geophysical, geochemical and biological methods on a 10 m sediment core from the deepest part of the lake. Our paleolimnological data show that human impact only started to be recorded in the sediments during Roman times. Although Pile dwellers occupied Lake Murten for almost 3000 years, the Romans were the first who left visible traces in the sedimentary record, the deposition of varves being the most obvious one. During this period, slightly decreasing C/N ratios, but raising magnetic susceptibility, grainsizes and amount of detrital elements (Ti) were detected. At the same time, radiocarbon ages of the total organic carbon (TOC) fraction are increasing compared to the sediment ages, indicating a rapid flushing of old soil carbon from the surrounding catchment. Analyses of plant derived leaf waxes, such as *n*-alkanes, revealed a rough vegetation change from a tree to a grass dominated landscape.

These findings are consistent with the development of first large-scale farming practices and the growing influence of the Roman city “Aventicum” 2000 years ago. Deforestation and soil cultivation led to increased runoff of nutrient-rich material resulting in eutrophication of Lake Murten and the deposition of varves. Similar trends can be recognized from the medieval period until today.

ID: 01659, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

How politics shape agricultural landscapes: The plant wax record of Lake Lavijärvi, Russia Karelia

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Agricultural soil erosion has a strong influence on the global carbon cycle, however, the historical evolution of its extent and rate is poorly known. This study seeks to address this issue by investigating lacustrine sediments from Lake Lavijärvi (Russia Karelia) to reconstruct past soil loss and soil degradation in the catchment, with a focus on soil carbon dynamics.

The region of Sortavala in the Russian Republic of Karelia has witnessed severe changes in land-use in the last century. During World War II, intensive field cultivation with regular plowing occurred in the catchment of Lake Lavijärvi, initiating soil erosion and consequently lake eutrophication. In the post-war period, the arable fields were mostly converted to pastures as the land was ceded to the Soviet Union by Finland. Shifts in pollen and diatom assemblages revealed that the lake became eutrophic in the 1920s-30s, with the mechanization of agriculture, and oligotrophic following the relaxation of human pressure in the post-war-period.

In this study we test whether rapid changes in intensities of human land-use, such as the transition from ploughing to grazing, can be detected on a molecular level by analyzing the distribution of leaf wax biomarkers, such as *n*-alkanes and *n*-carboxylic acids, in lacustrine sediments. Investigations of the soil derived plant waxes in the sediments allow us to evaluate the influence of different agricultural practices on soil degradation. In this regard, compound-specific radiocarbon dating of the fossil molecules, will be key to trace changes in the organic carbon pool.

We will present preliminary results of the *n*-alkane and *n*-carboxylic acid homologue patterns in comparison with the grainsize distribution, magnetic susceptibility, concentration of detrital elements (i.e. Ti, Fe, Mn) as well as the $CaCO_3$, total organic carbon (TOC), and total nitrogen (TN) content.

ID: 01242, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Hydroclimatic changes in Middle Atlas (Morocco, Western Mediterranean region), during the lateglacial-early Holocene transition based on multiproxy data.

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In the Moroccan Middle Atlas Mountains (Western Mediterranean region), Ifrah Lake (33.33°N, 04.56°W, 1610m a.s.l.) was used to characterize climate variability during the lateglacial-early Holocene Transition. The methodology is based on sedimentological, geochemical, and mineralogical analysis of lacustrine sediments.

Lake Ifrah is a natural lake located in an endorheic catchment dominated by *Aok* and *Cedar* forest. Waters are calc-magnesian, relatively very alkaline and oxygenated. It is of karst origin covering an area of 250 ha, with maximum depth around 6 m which varying continuously.

We present a multiproxy analysis data from a 9m lacustrine record providing a reconstruction of hydroclimatic and fire history during the lateglacial - early Holocene transition. Paleohydrological combined with microcharcoal analysis of the Ifrah core record the paleohydrology, the fire history allowing a high climatic reconstruction of Morocco during the last 30,000 cal yr BP inferred from lacustrine record. This record provides evidence for a different periods with variable lake level and paleofire activity. This periods are divided to three intervals : **(i)** Pleistocene/late Holocene transition with a cold and dry period marked by a very low fire activity; **(ii)** an Early-mid Holocene interval, when climate was warmer and drier under interconnected forcing factors acting at globally, regionally and local scales; **(iii)** a Late Holocene interval, when climate approached that of present and human influences start acting. This study allows us to deduce that the lake level and fire occurrence seem therefore directly influenced by climatic forcing.

ID: 01644, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Legacy of iron mining in central Sweden: pervasive impact of mining and land use over 1000 years

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In the public consciousness Sweden is often viewed as a largely natural landscape. However, many parts of the landscape have undergone substantial changes. In the historically and culturally important Bergslagen region in central Sweden agriculture and mining have transformed the landscape over the past 1000 years. In this project we have studied the sediment record from five lakes and two peat bogs in the Norberg iron-mining district, which covers 1000 km^2 and is the oldest of Sweden's 23 mining districts. One of these sediment records is annually laminated, giving us a precise chronology of environmental changes. Our analyses include mercury and multi-element analyses using XRF, which provides data on lithogenic elements (e.g. Ca, K, Mg, Na, Rb, Sr, Zr), ferrous metals (Fe, Mn) and trace elements (e.g. As, Cu, Pb, Ti, U, Zn) as well as analyses of pollen and total-carbon/nitrogen. The earliest evidence of human impact in the area is c. AD 950, with diffuse signs of forest grazing and a small source of locally derived Pb. From 1250 evidence for an increasing scale of forest clearance (loss of pine, increased charcoal particles) and cultivation (rye) and mining begin, and by 1300 – along with the establishment of a blast furnace – the alteration of the landscape was comprehensive. About AD 1500 the concentrations of many metals increased by 2–10-fold (Zn 2x; Cu 3–5x; As 5x; Hg 10x). Despite declines in mining and metallurgy since 1800 and complete cessation of activities since the mid-20th century, metal concentrations in most cases have remained consistently elevated over the past 500 years, occasionally even overshadowing any modern pollution signal. It is therefore clear that legacy pollution can still influence and impact our contemporary environment.

ID: 01686, 18.- Human Impact on Global Aquatic Systems, (Poster)

Old sins in new fins – Tracing the effect of ancient mining on contemporary high-altitude aquatic food-chains using Pb-isotopes.

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Although we largely associate impacts from mining on surrounding environment with the industrial era, historical mining has a millennial scale history leaving a long-lasting imprint on the environment. Due to their geological features mountain environments have been exploited since the beginning of metallurgy and the French Pyrenees is no exception. Results on trace metal concentrations in the Central Pyrenees, where extensive mining (Ag, Fe) occurred from the Antiquity to the 19th century, indicates that ≥600 tons of anthropogenic lead (Pb) is stored in peat and organic soils in the Haut-Vicdessos area. The Pb-isotopic signature measured in soils, peat bogs and sediments indicates various sources of Pb deposition; i.e. both natural sources and from mining activities during the Antiquity, medieval and recent periods, but also Pb lead derived from industrial and vehicle/transportation sources. The effects of this legacy pollution can also be seen in the contemporary freshwater aquatic food chain. Based on geochemical data, i.e. total concentration and isotopic signatures of lead in brown trout (*Salmo Trutta*) and common minnow (*Phoxinus phoxinus*) caught at five sites and in three different adjacent valleys, we found that although mining in the area ceased over 100 years ago, trout and their prey still show a large range of Pb isotopic signatures including both modern deposition and mining related Pb. This reflects the long human-environment interaction in this mountain environment and that legacy pollution have a long-lasting impact even after activities have ceased.

ID: 02094, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Extra-long interglacial in Northern Hemisphere during MISs 15-13 and its influence on the second major dispersal of African hominins

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In the MIS sequence, MIS 14 (563−533 kyr BP) stands out as a short and mild glacial epoch in many records of the last 700kyr. Confirming the extent of Northern Hemisphere (NH) ice sheets during MIS 14 can provide new insight into the 100-kyr climate cycles and improve our understanding of the forcing mechanism of the Pleistocene glacial and interglacial cycles.

Here, based on the demonstrable link between changes in Chinese loess grain-size and NH ice-sheet extent, we use loess grain-size records to confirm that northern ice-sheets were restricted during MIS 14. This is in accordance with the marine and continental records in the NH. Thus, an unusually long NH interglacial climate of over 100 kyr persisted during MISs 15−13, much longer than expected from marine oxygen isotope records. However, the evidence from many middle-high latitude records from the Southern Hemisphere suggests typical glacial-like climate conditions in middle-high southern latitudes, and we tentatively attribute the cooing of MIS 14 as indicated by the marine $\delta^{18}O$ record to South Pole processes.

The extra-long and warm, predominantly interglacial style climate in the Northern Hemisphere during MISs 15−13 may have had a profound influence on the migration of early humans within the context of alternating glacial and interglacial climates. The evidence from genetic analysis and archaeological investigations suggest that hominins of African origin dispersed, and similar forms of hominins and Acheulean bifacial handaxes occurred in regions on both sides of the Mediterranean about 600 kyrs ago. Therefore, we propose that the extra-long duration of interglacial/mild stadial climates during MIS 15−13 may have provided favorable conditions over 100 kyr for the second major dispersal of African hominins into the Eurasia region during the middle Pleistocene.

ID: 01304, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Volcanic Forcing: New Initiatives to Establish its Impacts on Climates of the Southern Hemisphere

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In the northern hemisphere (NH), 1816 is well known as ‘the year without a summer’. But what happened in the southern hemisphere (SH) in 1816, or following other major tropical or SH volcanic eruptions? Whilst recent work has taken on an increasingly global focus on volcanic forcing as a driving mechanism influencing climate, the emphasis has largely been on the NH. The SH continues to remain in the shadows; hence our initiative to investigate past impacts of major volcanic eruptions on SH climate, environment and society, and to model the climatic impacts of such eruptions on specific SH landmasses.

Given the scarcity of SH instrumental records covering major historical volcanic events, little is known about their impact in southerly latitudes. Here we use a variety of proxies including historical documentary sources, and tree ring and speleothem data to demonstrate that major tropical or SH volcanic eruptions are usually followed by extreme climatic events across much of the SH. For instance, in southern Africa, such events may be followed by exceptionally hot summers and severe winters (with unusually early and/or late frosts and heavy snowfall events). In addition, data thus far suggest that one or two years following such a major eruption have a very high probability of experiencing flooding or drought conditions.

Finally, we present our current work and future aims to model the climatic impacts of major volcanic eruptions across various spatial and temporal scales in the SH using the Variable-Resolution Earth System Model and its atmospheric component the Conformal Cubic Atmospheric Model. The models will be integrated to simulate volcanic events ranging in size from Toba to Pinatubo and will test the associations between geographic location (longitude/latitude) and event magnitude to establish spatial, temporal and type/magnitude of climatic impacts in the SH.

ID: 02360, 06.- Before and after - climate contrasts across the MPT, (Poster)

Evolution of Antarctic Ocean stratification through the glacials of the MPT

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Despite the wealth of data covering the past 1.5 Myr, the causes of the mid-Pleistocene transition (MPT; ~1.2–0.7 Ma) remain elusive. In the absence of substantial changes in orbital forcing, internal feedback mechanisms must have been in play. Most of the causes that have been put forward to potentially trigger an amplification or a threshold response of Earth\'s climate system during the MPT call for a decline in glacial atmospheric CO_2 (pCO_2). Indeed, indirect pCO_2 estimates suggest that the glacial pCO_2 level was higher by ~30 ppm before the MPT. Previous results have indicated that the Southern Ocean provides a coherent two-part mechanism for the timing and amplitude of the glacial-interglacial pCO_2 variations. Whereas evidence suggests that iron ferilization in the Subantarctic Zone increased at the beginning of the MPT, there is still much uncertainty regarding the response of the Antarctic Zone (AZ) stratification to changes invoked for the MPT, and its contribution to the proposed pCO_2 variations. Here, we have investigated the density gradient of the Antarctic Southern Ocean by producing surface and deep-sea temperature and salinity proxy records over the past 1.5 Myr from ODP Site 1094 located south of the Polar Front in the Atlantic Sector of the AZ. The combination of paired foraminiferal Mg/Ca and $\delta^{18}O$ measurements on planktonic and benthic foraminifera allowed us to estimate the temperature and $\delta^{18}O$ of the surface and deep waters, the latter of which is closely related to salinity. Our results indicate that there was a shift from thermally to salinity controlled stratification at around MIS 16, consistent with the emergence of the high-amplitude 100 kyr glacial cycles. The glacial stratification in the late MPT might have contributed to maintain the low pCO_2 levels observed for the past 800 ka.

ID: 02093, 06.- Before and after - climate contrasts across the MPT, (Poster)

Deep Equatorial Atlantic Carbon Storage Across the Mid-Pleistocene Transition

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The Mid-Pleistocene Transition (MPT) was a profound reorganization of the climate system between ~0.8 to 1.2 million years ago (Ma) that led to the establishment of ~100 thousand year (kyr)-paced glacial cycles. While the mechanism for the transition remains elusive, recent evidence suggests that an increase in the volume of southern-source deep waters occurred in the Atlantic during glacial periods around ~900 ka, coincident with a rapid decrease in atmospheric pCO_2 of glacial periods and enhanced CO_2 storage in deep North Atlantic. We use the B/Ca proxy for carbonate ion saturation (ΔCO_3^{2-}) in the benthic foraminifer *C. wuellerstorfi* to investigate changes in deep ocean carbonate chemistry across this key transition along the deep ocean conveyor in the Western Equatorial Atlantic. Data from 0.5-1.3 Ma at ODP Sites 926 & 925 (3600 and and 3040 m water depth, respectively) indicate that reconstructed deep $[CO_3^{2-}]$ covaries with benthic $\delta^{18}O$ and $\delta^{13}C$, suggesting a strong link between changes in global climate, ocean circulation and deep ocean saturation state. In addition, covariance of reconstructed $[CO_3^{2-}]$ and $\delta^{13}C$ follows the slope anticipated from Redfield relationships, indicating that $[CO_3^{2-}]$ is controlled by glacial-interglacial oscillations in respired CO_2 content. Comparison with previously published B/Ca data from further north at DSDP site 607 shows a similar decrease in deep Atlantic $[CO_3^{2-}]$ during glacial periods across the MPT, also likely driven by changes to ocean circulation. Quantitative comparison between northern and equatorial sites, as well as with ε_{Nd} data, provides insight into the evolution of the deep Atlantic $[CO_3^{2-}]$ gradient, ocean circulation shifts, and CO_2 storage across the MPT.

ID: 01857, 01.- Open Session on past global changes, (Poster)

Tracers of sea ice, primary production and terrigenous inputs: distribution of biogenic proxies in a High Arctic fjord system, Northeast Greenland

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The coastal Northeast Greenland serves as a filter for terrigenous inputs into the Arctic Ocean. While ecosystems and ocean circulation in this region are particularly vulnerable to the enhanced melt of continental and sea ice as a result ongoing climate warming, little is known of past ecosystem changes. Here, we present the modern distribution of an array biogenic proxies (dinoflagellate and ciliate cysts, pollen, diatoms, biogenic silica, TOC, C/N, $\delta^{13}C$, $\delta^{15}N$, IP_{25}, HBI III) from a transect of 13 surface-sediment samples from Young Sound-Tyrolerfjord, NE Greenland (74°N), in order to assess their relevance as tracers of past changes in sea ice, primary production and terrigenous inputs. The Young Sound-Tyrolerfjord presents a well-suited study arena, as the Greenland Ecosystem Monitoring (GEM) program provides a unique high arctic time-series of hydrological, atmospheric and biological measurements since the mid-1990s, against which the sediment signatures can be compared. The sedimentary proxy data show an overall good agreement with the monitoring data. Organic carbon contents, diatom production, HBI III and heterotrophic dinoflagellate cyst abundance were higher in the outer Young Sound, where turbidity is lower, salinity higher and waters more nutrient-rich compared to the inner fjord. Conversely, in the Tyrolerfjord and inner Young Sound, these production proxies follow an opposite pattern. The seasonal sea-ice proxy IP_{25} and sea-ice-dwelling taxa (e.g. *Polarella glacialis*) are present in varying abundances, which reflects the seasonal character of the sea-ice cycle together with species-specific habitat preferences of these taxa. Our results support the notion that future warming and freshening will likely have a negative impact on primary productivity and organic matter sequestration in the fjord. This implication may be assessed by reconstructing changes during past warm periods using the new sediment core records from the area.

ID: 01590, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Poster)

Modern and ancient sedimentary DNA from Lake Karakul, Pamir Mountains – investigating aquatic and terrestrial taxa

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Lake Karakul (3929 m asl) is a 380 km² large, endorheic, brackish lake located in a tectonic basin in the eastern Pamir Mountains (Tajikistan). The catchment is comprised of high alpine steppe to desert with partially snow-covered mountain peaks, which reach up to 6000 m height. In order to investigate the lake's history and compare the historical vegetation record to the modern lake, we used DNA metabarcoding to analyse a sediment core from 12 m water depth, reaching back approximately 29 cal kyr BP, as well as 8 surface sediment samples from different depths, retrieved from the shallower eastern basin.

Along the core we detected 2 macrophyte as well as 47 terrestrial taxa. The main taxa recovered in the core sediment samples were the submerged aquatic taxa Potamogetonaceae and *Chara*. The modern surface sediment samples are also dominated by aquatic macrophytes, however only represented by Potamogetonaceae. Although terrestrial taxa were recovered both from the core and the surface samples, their sequence reads are rather low, which can assumingly be ascribed to the sparse vegetation at the study site, which is nonetheless represented in the DNA, and to the size and features of the lake. Our findings furthermore suggest that the sedimentation of DNA of terrestrial plants was likely suppressed by the occurrence of a relatively dense macrophyte cover within the lake during the last 29 cal kyr BP. Thus the core *sed*aDNA data rather reflects changes in macrophyte populations within the lake than vegetation changes in the vicinity of the lake. Our study shows that even in the non-optimal conditions presented by a large lake with alkaline pH, sedimentary ancient DNA can provide valuable additional data for paleoecological inferences.

ID: 01656, 01.- Open Session on past global changes, (Poster)

WARM SUMMERS AND RICH BIOTIC COMMUNITIES DURING N-HEMISPHERE DEGLACIATION

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Environmental and climate conditions right at the moment of deglaciation remain largely unknown. Glacial lake deposits are a persistent element in the geological record and former extents of glacial lakes have been mapped in detail in different parts of the world. Glacial lake sediments have being widely used for geochronology (varve chronology), however, these sediments have been rarely used for paleo-environmental studies through analysis of biotic content. The lack of proxy analysis on glacial lake sediments is in part due low fossil contents, and often broken and corroded nature of fossil remains, making the analysis particularly time-consuming. We here compare multi-proxy data (diatoms, phytoliths, chironomids, pollen/spores, NPP's, macrofossils) from three deglacial phases of the Fennoscandian Ice Sheet (early Holocene, early MIS 3 and early MIS 5a) preserved at Sokli in northern Finland. Our study reveals marked compositional shifts in fossil assemblages and indicates that biotic taxa have responded sensitively to environmental changes during deglaciation. The availability of nutrient-rich glacial silts, leaching of carbonates and other soluble minerals from surface soils, and climate resulted in the establishment of rich aquatic and wetland communities. Furthermore, there is overwhelming evidence for warm summers, with higher than today July temperatures, during the three deglacial periods, most probably in response to high summer insolation.Terrestrial vegetation on land was pioneer birch vegetation and open birch forest established during the early Holocene and possibly early MIS 3. Our study shows that glacial lake sediments can provide invaluable paleo-environmental data and reveals that the ice-marginal environment during N-Hemisphere deglaciation can have been very productive both in the aquatic and terrestrial spheres.

ID: 02198, 01.- Open Session on past global changes, (Poster)

A new Western Pacific radiolarian-based transfer function for reconstructing winter sea surface temperatures in East Asian marginal seas

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Radiolarian modern assemblages from the Equator to the north subtropics in the Western Pacific region are used to develop a new transfer function for the reconstruction of sea surface temperatures. Although modern radiolarian training sets exist for whole Pacific Ocean, no studies exploring quantitatively the use of radiolarians as paleoenvironmental indicators in the marginal seas of the Western Pacific have been undertaken. This region is dominated by the East Asian monsoon (EAM), which drives seasonal climatological variability, playing an important role for the short- and long-term hydrological, chemical, and sedimentological cycles. Original and published radiolarian counts from surface sediment samples in the South China Sea (SCS) (n=56) and East China Sea (ECS) (n=66) marginal basins, and open Pacific Ocean (n=39) are included in the calibration set. Data for annual and seasonal environmental variables (temperature, salinity, oxygen and nutrients) at different depths were included in the analyses. Multivariate numerical analyses (DCA, CCA) on environmental and radiolarian data revealed that winter sea surface temperature (wSST) was the most important variable for the radiolarian assemblages. A transfer function based on Locally-Weighted Weighted-Averaging (LWWA) regression was developed for wSST (R2cross = 0.88, RMSEP= 1.6 ºC). The resulting transfer function was applied to two cores located in the ECS (Okinawa Through), covering the last 20 ka. Diagnostics of analogue quality indicate that fossil assemblages from the ECS have high similarity with the modern assemblages from the marginal seas.

ID: 02281, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Shifting and tilting of the westerly axis induced regionally contrasting Holocene rainfall pattern in China

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Proxy-based reconstructions suggest a spatially shifting Holocene moisture optimum in China which could not yet be reproduced by modelling studies. The ongoing debate indicates that the basic mechanism of the East Asian Summer Monsoon are still not understood and do thus not deliver a reliable base for predictions. Here we present pollen-based quantitative precipitation reconstructions from 79 sites in China that agree with respect to trends and absolute change with simulations from a minimal numerical model. We found that precipitation in southern China increased throughout the Holocene while rain successively declined in northwestern China and a mid-Holocene precipitation optimum was inferred for north-eastern China. By analogy to the modern meteorology we infer that the westerly wind axis over Asia was strongly southwest-northeast tilted during Early Holocene summers which yielded contrasting moisture developments in the northeast and northwest of the study area. Since the mid-Holocene a continuously southward translocation of a meridionally-located westerly axes as a result of a continuously decreasing summer insolation let to a see-saw moisture between northern and southern China. Our results imply that irrespective of the time-scale and related forcing mechanism a correct simulation of the location and tilting of the westerly wind axis is crucial to reliably predict moisture pattern in China.

ID: 01489, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Hydroclimatic variations from the Last Glacial to historical times in the eastern Lesotho Highlands, southern Africa

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Southern Africa is considered one of the most climate sensitive regions in the world. Slight variations in ocean temperatures and pressure systems regularly lead to droughts or flooding. Such water-stress in combination with poor climate adaptation may have devastating consequences, particularly given that most people in the region are dependent on subsistence agriculture. A better understanding of the complex mechanisms driving hydrological variability can be gained studying proxies linked to past climates during the last few millennia.

Sekhokong is an alpine wetland site in eastern Lesotho (>2900m asl) where previous work identified fossil pollen and diatoms sediment records to reconstruct past variations in vegetation, relative temperatures and wetland water tables over the last ~16 ka. These data revealed eight climatic periods varying in temporal duration from a few decades to more than 5000 years. High-resolution XRF, conventional XRF and FTIR methods are used to compliment this original dataset, revealing details of paleo- earth processes such as weathering, sediment movement and transport, biological productivity, degradation and changes of material sources. When multiple proxies are used parallel, it is possible to distinguish these climate forced processes, which is important for establishing large-scale migrations of circulation systems and the controlling mechanisms. This study spans the Late Glacial to present, a period for which the paleoclimate is not yet resolved for southern Africa, addressing an important gap in this climate data-poor region.

ID: 02152, 06.- Before and after - climate contrasts across the MPT, (Poster)

Biomarkers reflecting terrestrial ecosystem response to pre-MPT climate change in the Western Balkans (Ohrid Basin; Albania, Macedonia)

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Lake Ohrid dates back ~1.2 million years, representing an outstanding archive of continental environmental change that spans across the mid-Pleistocene transition (MPT). Due to the scarcity of terrestrial climate archives predating the MPT, little is known about terrestrial ecosystem response to climate change under an obliquity-controlled climate regime. We present first results from lipid biomarker analyses of Lake Ohrid sediments from climate cycles before and after the MPT. While glacial-interglacial cyclicity is clearly illustrated by the profile of total inorganic carbon (TIC), the adaption of vegetation and soil stocks to climatic changes is reflected in the distributions of lipids from plant waxes and root material. The ratio of leaf wax-derived C_{26} over C_{28} *n*-alcohol shows the strongest correlation with TIC, with dominance of the C_{26} *n*-alcohol in low-TIC samples (glacial) and the C_{28} *n*-alcohol in high-TIC samples (interglacial). This pattern most likely results from changes in dominant plant species distribution in the catchment. Palynological data confirms this assumption, revealing shifts in the dominant tree species from cedar and hemlock during interglacials towards pine during glacials. The differences in biomarker distributions between glacials and interglacials prior to the MPT are less pronounced than in post-MPT sediments covering the transition from marine isotope stage (MIS) 6 to 5 and much of MIS 5. There, the glacial-interglacial transition and short-term climate fluctuations led to the destabilisation of soils and soil erosion as indicated by the supply of root-derived lipids and degraded soil organic matter. In the pre-MPT sediments, there is currently no evidence for such severe disturbances, suggesting more stable terrestrial habitats. The hydrogen isotope composition of the plant-derived lipids provides further insights into glacial-interglacial hydrology changes as it reflects the isotopic composition of meteoric water.

ID: 02138, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Reduced cooling in response to future volcanic eruptions

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Following large volcanic eruptions, the formation of a stratospheric aerosol layer causes climatic cooling and altered circulation patterns. These perturbations may persist for several years and are an important driver of climate variability on an interannual timescale. Several feedbacks in the Earth System contribute to the observed climate response to a volcanic eruption. In a future climate state these feedback processes may be altered by ongoing anthropogenic warming. We quantify this influence by performing a series of Earth System model simulations (using HadGEM2-ES) of a Tambora 1815-like eruption under pre-industrial and future (Representative Concentration Pathway 6) background climatic conditions. We found that the cooling after the eruption is reduced in a warmer future climate. This is caused by three main processes. Firstly, the altitude of the tropopause (the boundary between the troposphere and stratosphere) is projected to rise with climatic warming over coming decades. A higher tropopause reduces the effective radiative forcing from stratospheric volcanic aerosols. In a warmer state the model also predicts a more muted temperature response over polar regions because of reduced sea-ice coverage and albedo feedbacks. The model also predicted a more significant winter warming effect in a warmer climate state. As the change in both tropopause elevation and sea-ice coverage are robust features of climate change simulations, these findings point to a previously underappreciated coupling between volcanic eruptions and climate state, whereby the cooling effect from large eruptions is enhanced in cold periods and reduced in warm states.

ID: 01748, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Poster)

An ultra-long speleothem record shows that orbital forcing alters the amplitude, but not period, of interannual variability

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The past behaviour of interannual variability and its response in future climate projections are important, yet open, questions. A first step to answering them, would be the creation of long, high-resolution palaeoclimate proxy records. Here we present an annually-resolved 91,000 year Early Pleistocene record of hydroclimate from the early hominin-bearing Makapansgat Valley, South Africa; novel confocal microscopy methods were used to image and measure annual laminae in a flowstone. Changes in speleothem annual band thickness are dominated by precession over four consecutive orbital cycles with strong millennial-scale periodicity. The frequency of interannual variability (2.0-6.5 year oscillations) does not change systematically, yet its amplitude is modulated by the orbital forcing. These long-term characteristics of interannual variability are reproduced with transient climate model simulations of water balance for South Africa from the Late Pleistocene to Recent. Based on these results, we suggest that the frequency of interannual variations in tropical net rainfall is likely to be stable under anthropogenic warming, but that the size of year-to-year variations may change. We see an orbitally-forced increase in the amplitude of interannual climate variability between 1.8 Ma and 1.7 Ma coincident with the first evidence for the Acheulean stone tool technology.

ID: 02262, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Barium in deep-sea bamboo corals: Phase relationships, stable isotopic distributions, and prospects for paleoceanography

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The response of bathypelagic (1,000—4,000 m) circulation to changes in ocean ventilation, nutrient cycling, and export productivity are uncertain because of insufficient instrumental and geochemical records. Deep-sea bamboo corals are uniquely poised to document decadal to centennial changes in the depth structure and trajectory of bathypelagic circulation due to their longevity, widespread occurrence within this zone, and propensity to record ambient geochemical signals in their calcite skeletons. However, reconstruction of ocean circulation from geochemical proxies, such as Ba (barium), requires that the controls on Ba incorporation into bamboo coral skeletons are known and that corals faithfully capture ambient seawater. To understand how Ba is incorporated into bamboo corals, we performed a series of stepped chemical cleaning experiments to isolate the probable Ba host phases. We additionally screened corals for evidence of extraneous Ba phases—in particular, micron-sized barite crystals—using scanning electron microscopy and micro-scanning computed tomography. Taken together, these tests indicate that essentially all Ba is hosted in the calcite lattice with negligible contamination from extraneous phases such as barite. To understand if corals faithfully record ambient seawater compositions, we analyzed Ba/Ca and stable Ba-isotopic compositions in a suite of modern bamboo corals collected between 870 and 2,100 m from the northeast Pacific and compared against ambient seawater. We find that all specimens record depth-dependent changes in Ba/Ca and Ba-isotopic compositions, which can be converted to ambient seawater values by means of a constant Ba partition coefficient and stable isotopic offset, respectively. We will apply this calibration to a suite of time-resolved specimens to examine bathypelagic circulation in the northeast Pacific over the past ~100 years.

ID: 02407, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Land use in Classical Antiquity: How good are the global datasets? A case study in Roman Switzerland (1st century B.C.E. – 3rd century C.E.)

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The impact of humans on the landscapes of Europe in Classical Antiquity has been poorly quantified to date. Most global scenarios of Anthropogenic Land Cover Change (ALCC), e.g., HYDE and KK10, suggest that humans had relatively little influence on land cover during the Roman Empire, while documentary sources and archaeological data imply that many European regions were severely impacted by human activities by this period. In order to address this discrepancy between models and observations, we synthesized the archaeological evidence of ancient agriculture and land use, primarily based on archaeobotany, zooarchaeology, and palynology, from the 1st century B.C.E. until the 3rd century C.E. for the area covering contemporary Switzerland. Using these data, we reconstruct per capita land use in the principal regions of Switzerland: the Alps, the Plateau and the Jura, and the diversity evident between different occupation types, coloniae, civitas capitals, military forts, villae and rural settlements. Where the archaeological record does not record necessary information, such as productivity and fertility, the literary record, ethnographic and modern scientific studies are used to develop a holistic view of ancient land usage. Our data synthesis is used to inform a quantitative model of human-environment interactions that allows us to test hypotheses and assumptions about land use in the ancient world. The major urbanities of Augusta Raurica and Aventicum would have had the largest total impact due to their scale and diverse diets and inhabitants, though present a lower per capita requirement. Due to topographical and lifestyle differences between the three zones of Switzerland, there are also different land use impacts with the Jura showing the highest per capita while the Plateau the lowest overall. By grounding land use models in the archaeological record, we can evaluate models, while also providing a practical and flexible tool for estimating ALCC over larger landscapes.

ID: 02371, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

STUDY OF THE INSTRUMENTAL PERIOD USING GEOCHEMICAL HIGH-RESOLVED DATA OF A 600YR SPELEOTHEM OF THE NORTHWEST IBERIAN PENYNSULA

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In meteorology and climatology, the instrumental period is the period where we have measured directly by instrumentation, different meteorological data along the surface which allow us to determinate the evolution of the climate during the last 150 years over the world. At the beginning, the density of this data were very low, so we have to wait until the last 75-100 years to have a good network in most of the parts of the surface. This time period is very small if we want to analyze the relationship between geochemical and instrumental variability in any speleothem. So a very high resolution data is needed to determinate the connection between both of them in the instrumental period, to try to determinate de evolution of climate in the last 600 years. Here we present a high resolution speleothem record from a cave located in the middle of the Cantabrian Mountains without any anthropologic influence and with no CO_2 seasonal variability. This 600yr stalagmite, dated with U/Th method with a growth rate from 100 to 200 mm/yr calculated with Bchron model, provide us accurate information of the climate conditions near the cave. Trace elements are analyzed at 8 mm intervals by Laser Ablation ICP-MS which resolves even monthly resolution during the last 600 years with special attention with Sr, Mg, Al and Si. As well, we have trace elements data with spatial resolution of 0.2mm analyzed with ICP-AES which allow us to compare the geochemical variability with both technics. We also analyze stable isotope $d^{13}C$ and $d^{18}O$ with a spatial resolution of 0.2mm, so we are able to identify variations and all possible correlations between them, trace elements and instrumental records from the different weather stations located near the cave.

ID: 01673, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Holocene drowning of the Late Pleistocene lake in Pirovac Bay and the formation of Lake Vrana

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Two nearby depositional systems, Lake Vrana near Biograd and Pirovac Bay, were analyzed and correlated to reconstruct paleoenvironmental evolution of the area in relation to climate variability and the sea-level fluctuations during the Late Pleistocene and Holocene in the central part of the Eastern Adriatic coast. They are elongated karst depressions with numerous springs in and around the lake and bay, which gives an evidence of their connection through permeable underground. High-resolution seismic study was coupled with multyproxy (geochemical, grain-size, mineralogical and paleontological) sediment core analysis. Marine sediments in Pirovac Bay have variable thickness rangeing from bare rock to more than 4 m. The 7.2 m long sediment core was extracted and it covers the last 14.000 years, while in Lake Vrana the 11 m sediment core covers the last 12.000 cal yr BP. Geochemical and ostracod analysis from Pirovac Bay showed that the lake sediments preceded marine deposits. The „karst lake" Pirovac Bay existed from 14.000 cal yr BP until 8.000 cal yr BP when the sea water entered in the depression. Early Holocene is characterized by floodplain environment in Lake Vrana, increased erosion and higher concentrations of siliciclastic material. The lake was formed at around 9.100 cal yr BP, with dominant carbonate sedimentation. The marine influence on the Lake Vrana sediments is evident after 6.1 ka BP, so as gradually increase of siliciclastic material as a result of deforestation. The evolution of the Pirovac Bay had strong influence on the formation of the Lake Vrana, and the two lakes coexisted for about 1000 years in the Early Holocene, before the drowning of the „karst lake" Pirovac Bay with the climate change and the rising sea.

ID: 02122, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Integrating Holocene RCC geochemical proxies and archaeological cultural changes in the northern Plateau of the Iberian Peninsula: the Villafáfila lagoon and Sierra de Atapuerca speleothems

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Environmental impacts of Holocene Rapid Climate Changes (RCCs), including vegetation dynamics, hydrological fluctuations and geomorphological activity, potentially conditioned the human subsistence strategies and migrations. The interaction between these processes could only be detected and characterized from the interdisciplinary integration of archaeosedimentary records. In this work we characterize and integrate the RCCs-related palaeoenvironmental changes and their impact in the archaeological record in two case studies in the northern Plateau of the Iberian Peninsula (Spain). Sedimentological, geochemical and palynological records from a core recovered in the Villafáfila lagoon (Tierra de Campos, Zamora) and the associated prehistoric to medieval salt exploitation activity, were compared with the stalagmite geochemical record and an archaeological sequence from the Cueva Mayor karst system in the Sierra de Atapuerca (Burgos). The obtained results show both contrasting and common interactions between human populations and environmental change processes pointing to the high plasticity character of the human-environment interactions during the Holocene.

ID: 02125, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

The youngest Holocene volcanic eruptions in the Iberian Peninsula: palaeoenvironmental context and possible impacts on early Holocene populations in the Garrotxa region (NE Iberian Peninsula)

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Volcanic eruptions are key drivers of climate variability, with complex environmental consequences at regional and local scale. In this work we present the first results of a 15 m deep paleolake core (Pla de las Preses core, Vall d´en Bas, Girona) covering the Late Pleistocene-Holocene transition. The ongoing multiproxy analyses from chronostratigraphy, sedimentology, tephrostratigraphy, XRF geochemistry and fire and vegetation history are used to reconstruct the palaeoenvironmental framework of the Late Pleistocene-Holocene transition, and allow the detection of the youngest volcanic eruptions in the Garrotxa volcanic region. One of the specific aims of this research consists of reconstructing the palaeoenvironmental dynamic of the Vall d'en Bas valley in order to gain better insights into the configuration of the environments where the last hunter-gatherers and the first farming communities developed, thereby allowing the evaluation of human impact and possible environmental constraints on cultural development. The period comprised in our study was punctuated by several rapid climatic changes. These may have influenced the development of the last hunter-gatherer and first farming societies, which, in this area characterized by volcanism, represent a peculiar environmental constraint for the distribution of settlements and for human activities. The work shows the precise timing and an example of rapid local-scale environmental effects of volcanic eruptions and, therefore, represents a powerful case study in environmental impacts, vulnerability and resilience in past societies.

ID: 01592, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Late Quaternary sedimentary environmental change in the Bonaparte Gulf, northwestern Australia

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The Bonaparte Gulf, northwestern Australian continental shelf, is among the widest in the world, ranging to 500 km, with shallow carbonate terraces and platforms that were exposed during lowered sea level. The dominant sediments type switches between carbonate and siliciclastic over a sea-level cycle. However, the mechanism of sedimentary environmental change in the Bonaparte Gulf is not clearly understood. Here we present a record of sedimentary environmental change from ca. 35 to 24 cal kyr BP that is related to sea-level variability and exposure of carbonate terraces and platforms. Multi-proxy data from a marine sediment core shows a sea-level change induced switch in sedimentary environment from siliciclastic to carbonate-dominated sedimentation during the last glaciation. Radiocarbon ages constrain the timing of this switch to ca. 26 ka, associated with a local sea-level fall of -90 m.

Reference: Ishiwa, T., Yokoyama, Y., Miyairi, Y., Ikehara, M., Obrochta, S. 2016. Sedimentary environmental change induced from late Quaternary sea-level change in the Bonaparte Gulf, northwestern Australia. Geoscience Letters, 3, 33.

ID: 01678, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Collapse of the North American ice saddle 14,500 years ago caused widespread cooling and reduced ocean overturning circulation

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Collapse of ice sheets can cause significant sea-level rise and widespread climate change. We examine the climatic response to meltwater generated by the collapse of the Cordilleran-Laurentide ice saddle (North America) ~14.5 thousand years ago (ka) using a high-resolution drainage model coupled to an ocean-atmosphere-vegetation General Circulation Model. Equivalent to 7.26 m global mean sea-level rise in 340 years, the meltwater caused a 6 Sv weakening of Atlantic Meridional Overturning Circulation (AMOC) and widespread Northern Hemisphere cooling of 1-5 °C. The greatest cooling is in the Atlantic-sector high latitudes during Boreal winter (by 5-10 °C), but there is also strong summer warming of 1-3 °C over eastern North America. Following recent suggestions that the Saddle Collapse was triggered by the Bølling Warming event ~14.7-14.5 ka, we conclude that this robust sub-millennial mechanism may have initiated the end of the warming and/or the Older Dryas cooling through a forced AMOC weakening.

ID: 01693, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Transient climate simulations of the deglaciation 21-9 thousand years before present (version 1); PMIP4 Core experiment design and boundary conditions

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The last deglaciation, which marked the transition between the last glacial and present interglacial periods, was punctuated by a series of rapid (centennial and decadal) climate changes. Numerical climate models are useful for investigating mechanisms that underpin the climate change events, especially now that some of the complex models can be run for multiple millennia. We have set up a Paleoclimate Modelling Intercomparison Project (PMIP) working group to coordinate efforts to run transient simulations of the last deglaciation, and to facilitate the dissemination of expertise between modellers and those engaged with reconstructing the climate of the last 21 000 years. Here, we present the design of a coordinated Core experiment over the period 21–9 thousand years before present (ka) with time-varying orbital forcing, greenhouse gases, ice sheets and other geographical changes. A choice of two ice sheet reconstructions is given, and we make recommendations for prescribing ice meltwater (or not) in the Core experiment. Additional focussed simulations will also be coordinated on an ad hoc basis by the working group, for example to investigate more thoroughly the effect of ice meltwater on climate system evolution, and to examine the uncertainty in other forcings. Some of these focussed simulations will target shorter durations around specific events in order to understand them in more detail and allow for the more computationally expensive models to take part.

ID: 01680, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Heinrich Stadial 1 caused by acceleration of Eurasian deglaciation ~18.5 ka

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Heinrich Stadial 1 (~18-15 ka) is characterised by slow Atlantic Meridional Overturning Circulation (AMOC) and relatively cold Northern Hemisphere temperatures. Until recently, such conditions were largely attributed to the effect of North Atlantic surface freshening from enhanced iceberg calving (Heinrich Event 1). However, climate models have repeatedly struggled to simulate Heinrich Stadial 1 using realistic iceberg-derived freshwater fluxes, and it has recently been shown that Heinrich Event 1 began well after the onset of the AMOC slow down and northern cooling, and thus could not have caused it.

We ran the ICE-6G_C (VM5a) global ice sheet reconstruction through a high resolution drainage network routing model to produce fully-distributed meltwater discharge for the period spanning 21-17 ka. We then used the resultant global, transient meltwater flux to force the coupled ocean-atmosphere-vegetation General Circulation Model HadCM3, which was otherwise set up according to conditions at 21 ka.

The model simulates a 20% reduction in maximum AMOC strength in response to accelerated Eurasian ice sheet melt delivered to the Arctic Ocean, starting ~18.5 ka. This in turn drives North Atlantic sea surface and surface air temperature cooling of 2-5 °C, with even greater cooling occurring over regions with increased sea ice cover. More widely, Eurasia generally cools by 1-3 °C, and the Southern Hemisphere undergoes weak warming of under +1 °C. Notably, there is a sharp 12% fall in AMOC strength ~18 ka (causing a 3 °C drop in central Greenland temperatures), indicative of ocean threshold behaviour in response to a more gradual rise in Eurasian ice melt.

ID: 01854, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

large-scale Climate And VegetatIon Changes OveR the last Deglaciation (CLAVICHORD)

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The last deglaciation (from 21,000 to 9,000 years ago), during which the huge ice sheets over the North America and Scandinavia melted, is a period of tremendous climate and environmental changes, including Heinrich Event 1 (abrupt cooling over and round the North Atlantic), Bølling Warming (BW) and Younger Dryas Cooling. These changes are documented by physically based paleoenvironmental indicators (such as oxygen or carbon isotopes in ice cores and marine cores), and by biologically based data (such as paleo-vegetation). This study aims, for this period of the last deglaciation, at 1) building a comprehensive documentation of climate changes over terrestrial areas from widely available pollen data, 2) assessing the impact of both climate and atmospheric CO_2 changes on vegetation change, and 3) investigating the changes in large-scale atmosphere circulation and the hydrological cycle responsible for these surface climate and vegetation changes. This study will provide new benchmarking data for understanding environmental changes and evaluating climate models that are used for climate projections. Then, these results will contribute to quantifying the range of possible changes in these circulations in the future.

Here, we develop pollen/biome-based global climate reconstructions with an inverse (equilibrium) vegetation modeling approach over the last deglaciation. The approach is implemented by searching for a set of climate values which, when input to a vegetation model, simulates vegetation that is consistent with the paleovegetation reconstructed from fossil pollen data. The approach allows us to avoid both no-analog and wrong-analog problems and to assess the potential bias in reconstructions that may result from varying atmospheric CO_2 concentrations.

ID: 02036, 01.- Open Session on past global changes, (Poster)

The Study of Glacio-paleoflood slack water deposits and landforms in Shehezar River, Iran

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The aim of this paper is to compare flood sediments and landforms with different mechanics. Based on recent and modern glacio-paleoflood events during the last decades, we analyzed physical characteristics of flood sediments and flood effects on the main channel stream. The study area with 462km2 is situated on the northern slopes of central Alborz Mountain Range. These mountains are the highest topographical units in the Middle East and only active mountainous glaciers are located in these areas. The river under study originates from an ice reservoir with 4500 meters elevation which drains into Caspian Sea in the -28 meters. Over the last years during the summer in sunny weather, flash floods have flowed from glacier bursts and affected the river channel with unique landforms and slack water deposits. During a fieldwork in July 2016 we have collected 24 sediment samples in a river reach with 30 km length, starting from downstream and drawing into upstream. The samples concluded that slack water deposits of floods originate from glacial bursts and rainstorms. We analyzed the physical characteristics of sediment samples in the sedimentology laboratory of Ferdowsi University of Mashhad. The results showed many differences between flood sediments from two triggering….

The glacio-flood sediments basically have a light gray color ranging from muddy sand to gravel, very poorly sorted, high hardening, and very weak roundness. Distribution of the glacio-flood sediments over the bed stream creates a different landscape in compression of fluvial geomorphology.

ID: 01384, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

High-resolution Holocene climate and hydrological variability from the two major Mediterranean deltas (Nile and Rhone)

Bassem Jalali[1] , Marie-Alexandrine Sicre[2] , Nejib Kallel[1] , Julien Azuara[3] , Nathalie Combourieu-Nebout[3] , Maria-Angela Bassetti[4] , Vincent Klein[2] 1) GEOGLOB, Université de Sfax, Faculté des Sciences de Sfax, route de Soukra km 4-BP.802, 3038, Sfax, Tunisia. 2) Sorbonne Universités (UPMC, Univ Paris 06)-CNRS-IRD-MNHN, LOCEAN Laboratory, 4 place Jussieu, F-75005 Paris, France 3) Histoire naturelle de l'Homme Préhistorique, Département de Préhistoire, Muséum national d'Histoire naturelle, Institut de Paléontologie humaine, 1 rue René Panhard, F-75005 Paris, France 4) CEFREM-UMR5110 CNRS, Université de Perpignan, 52 Avenue P. Alduy, 66860 Perpignan, France * Marie-alexadrine Sicre, malslod@locean-ipsl.upmc.fr Deltaic sediments were used to generate high-resolution paleoclimatic records of the western (KSGC-31_Gol-Ho1B; Gulf of Lion) and Eastern Mediterranean (MD04-2726_MS27PT; Nile delta) basins during the Holocene. The same marine and land-derived biomarkers were analyzed in the two cores. Alkenones were used as a sea surface temperature proxy (SST) while n-alkanes, pollen and logTi/Ca were used to infer river discharge and paleoenvironmental changes in their watershed. Data from the Nile sediments indicate wetter conditions during the early Holocene culminating between 8800-8400 yr BP due to enhanced monsoon precipitations and northernmost position of the ITCZ prevailing during the African Humid Period (AHP). The n-alkanes and pollen data also show a temporary weakening of the monsoon during the AHP (around 9200 yr BP) most probably triggered by high latitudes North Atlantic cooling. From mid- to late Holocene, our data highlight progressive dryness. SSTs show large amplitude oscillations during the early Holocene followed by long-term warming from the mid-Holocene interrupted by recurrent cold intervals. Comparison with the same proxy records acquired from the Rhone River sediments reveal common features such as a humid early Holocene and subsequent dryness as the Mediterranean vegetation established. Furthermore, the western Mediterranean records also display millennial climate variability (humid/dry alternation) during the second half of the Holocene. Warm SSTs in the early Holocene start cooling from ~ 7000 yr BP till the post-industrial warming. Superimposed millennial-scale fluctuations are also detected and appear to be of opposite sign as compared to those of the Nile delta. This finding is consistent with the East-West seesaw pattern evidenced from paleolimnological data over the Holocene and the last millennia. We further investigate the sub-millennial oscillatory component of the climate signals and discuss the possible role of ENSO and the tropical North Atlantic SSTs.

ID: 02021, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Deltaic and coastal sediments as recorders of Mediterranean regional climate and human impact

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Deltaic and coastal sediments represent unique natural archives to study mutually past climate and environmental regional changes along the land / sea continuum at high temporal resolution. Here, we present new records from the Western and Central Mediterranean obtained from four marine cores, resolving decadal time scale variability over the past 3000 years. The reconstructions for sea surface temperature proxy (SST) are based on alkenone distribution while n-alkanes are used as indicators of regional environmental changes in relation with hydrological activity of the Rhone and Var River on the one hand, and of the main river streams discharging into the SW Adriatic Sea, on the other hand.

SST records generally indicate a cooling till 1000 AD but different signal thereafter. SSTs from Gulf of Lion and open southern Adriatic Sea both distant sites from deltas and located in convection regions reveal similarities. They show lower SST values in agreement with enhanced heat loss caused by strong Mistral and Bora winds respectively. However, they differ in the rate of post-industrial warming with a steep SST rise in the Gulf of Lion.

Higher-plant n-alkane concentrations in the NW Mediterranean Rhone and Var delta sediments show a small degree of resemblance that reflects differences in the latitudinal extension of the drainage basins, also seen in the vegetation index values (ACL; average chain length). Furthermore, in the Adriatic Sea, the last 500 years increase in n-alkane delivery suggests enhanced erosion most probably induced by land use changes. Indeed, the SW Adriatic records do not reveal any change in vegetation type that could account for this change. Instead, the Adriatic ACL signals are similar to those of the Var River delta sediments, a result that is further supported by palynological studies.

ID: 02347, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Reconstruction of precipitation regime since 1600 AD in Santiago de Chile (33° S) using documentary records as proxy.

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Climatic records from instrumental data were inexistent or rare in Chile during the Spanish Colonial period (16th–18th centuries) and at the beginning of the Republic (19th century). In this situation, documentary records provide a high temporal resolution climate reconstruction. The objective of this work is to understand climate regime since 1600 AD in central Chile stablishing an index from documentary records. The documentary evidence was obtained from Vicuña Mackenna (1877) due to He registered climatic events that altered the daily life of community (e.g.: droughts, floods, epidemics, alteration in agriculture production). The index values from documentary evidence were obtained by transforming the basic data into simple annual precipitation index on an ordinal scale. Climatic indicators for droughts and high precipitation were sought. Indicators of droughts were epidemics, alteration in agriculture production, and rogations “pro pluvia”, among others. Indicators of high precipitation were floods, infrastructural damages, rogations “pro sereniatate”. Finally, the index used a three-term classification scale were 0 for normal years, 1 for wet years, 2 for very wet years, -1 for dry years and -2 for very dry years. The index record shows a mark centennial tendency. The 17th century was wet, and no written records of droughts were found. At the contrary, the 18th century had a high frequency of droughts. During this period long and strong droughts were described followed by short wet periods which could be related with El Niño Southern Oscillation (ENSO) phenomenon. Finally, during the 19th century few years were wet and dry, but the records were not complete due to the political instability during this century. In conclusion, our records show a strong centennial tendency and during the 18th there was a dry/wet dynamic that could be related with ENSO phenomenon.

ID: 01372, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Evidences for submerged ancient river courses in Sri Lanka

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Sri Lanka is an Island in the Indian Ocean. The total land area measures 65,610 square kilometers. Physiographically Sri Lanka consists as a central mountainous mass with radial drainage pattern surrounded by a low, flat plain on all sides and extending to the sea. The shelf around Sri Lanka is narrower and shallower. The objective of this paper is to describe the changes of ancient sea levels around Sri Lanka. Inland coral deposits, shell beds, raised beaches, gravel deposits and submarine canyons etc. are the direct evidences to indicate the sea level rise and fluctuation during Pleistocene. The present live coral reefs in shallow sea indicate the sea level rise again in Holocene. At present, the submarine contour lines in the wide continental self area show some valley shape submarine surface changes along the existing rivers in NW part of Sri Lanka. These submarine valleys connected to the rivers are assumed as submerged river courses. Seven canyons have been recognized in the continental shelf and continental slope around the coastal zone. The distances to the canyon heads from the shore vary from 200m to 16km and those are situated opposite of some major river outfalls. Occurrence of submarine canyons shows higher erosion of rocks during the lower sea levels in later periods. 75m thick alluvial deposit at the largest canyon head in the sea along Mahaweli river path indicates the level of ancient river course which is submerged now. It can be assumed that the canyons have been formed as a result of bedrock erosion by these rivers during low sea level period (glaciation). Now these eroded features exist as canyons under the sea levels with the submerged ancient river paths.

ID: 01297, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

Glacial-Interglacial Variations in the Carboncycle

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The understanding of mechanisms governing glacial-interglacial variations in atmospheric CO_2 remains limited. Recent ice core studies on $\delta^{13}CO_2$, covering the period from 155 kyrBP to present, reveal an offset in the $\delta^{13}CO_2$ record between MIS6 (~155 kyrBP) and the LGM (~21 kyrBP) (Eggleston et al., 2016, Paleoceanography). A similar offset is also found in marine sediment records. What is the reason for this offset in $\delta^{13}C$ in the atmosphere-ocean system?

This question is addressed by performing novel 100kyr long carbon isotope-enabled simulations with the Bern3D-LPX Earth System Model of Intermediate Complexity. Potential mechanisms such as changes in land carbon inventory, the weathering rate of organic matter by erosion, or Neogene ocean cooling are changed in a step-like manner. Evolution of climate, different physical and biogeochemical tracers, and their fluxes through the atmosphere, ocean, ocean-sediment, and land biosphere model components is monitored. Characteristic spatio-temporal patterns are extracted by Principal Component Analysis.

Results suggest that differences in land biosphere carbon inventory are hardly responsible for the $\delta^{13}CO_2$ offset, but rather long-term imbalances in the weathering-burial fluxes.

The $\delta^{13}CO_2$ signal from the release of isotopically-light land carbon evolves differently than that of CO_2. Initially, the $\delta^{13}CO_2$ perturbation is removed much faster than the CO_2 perturbation as gross exchange with the land biosphere and the ocean dilute the isotopic signal. On millennial to 100kyr timescales, the ^{13}C perturbation is removed by dissolution of isotopically-enriched $CaCO_3$ from sediments and the burial of biogenic particles with perturbed $\delta^{13}C$ signature.

Comparison of model results with a multitude of proxy data, including for example marine CO_3^{-2} concentrations (Yu et al., 2013 – Quaternary Science Reviews), $\delta^{13}C$ from ice and ocean sediments, or atmospheric oxygen (Stolper et al., 2016 - Science) will further help to constrain mechanisms of climate-biogeochemical changes and feedbacks.

ID: 01343, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

A spatio-temporal reconstruction of North Atlantic sea-surface temperatures during Dansgaard-Oeschger events 5-8

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Proxy data suggests a large variability in the North Atlantic sea-surface temperatures (SST) during the Dansgaard Oeschger (DO) events of the last glacial. However, as the SST records are limited by suitable sites for marine sediment cores, a full-spatial picture of the SSTs can't be obtained with proxy data alone. Here, we combine fully coupled, general circulation models (GCM) with SST reconstructions using planktic foraminifera data to attain a broader spatial picture of the ocean state during DO events 5-8. GCM simulations are treated as a pool of possible ocean states from which the closest match to the observations is selected based on an objective cost function. The original model chronology is replaced by that of the proxy record. Repeating this algorithm for each proxy time step yields a comprehensive four-dimensional dataset that is consistent with reconstructed data. In addition, the solution also includes variables for which no reconstructions exist.

Our results show a tripole pattern of SST variability in the North Atlantic between the subtropical gyre, subpolar gyre, and the Nordic Seas, concurrent with the DO variability on Greenland. Warm periods on Greenland tend to coincide with a stronger overturning circulation and a warmer subpolar gyre, while a colder subtropical gyre and Nordic Seas. The opposite is true for cold periods on Greenland. Interestingly, even the pre-industrial control climates include the tripole pattern of surface temperature variability, but glacial boundary conditions are needed to capture the strength of the variability. Our results are robust to uncertainties in the age models of the proxy data, the number of available temperature reconstructions, and over a range of climate models.

ID: 01677, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Assessing recent trends in high-latitude Southern Hemisphere surface climate

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Understanding the causes of recent climatic trends and variability in the high-latitude Southern Hemisphere is hampered by a short instrumental record. Here, we analyse recent atmosphere, surface ocean and sea-ice observations in this region and assess their trends in the context of palaeoclimate records and climate model simulations. Over the 36-year satellite era, significant linear trends in annual mean sea-ice extent, surface temperature and sea-level pressure are superimposed on large interannual to decadal variability. However, most observed trends are not unusual when compared with Antarctic paleoclimate records of the past two centuries. With the exception of the positive trend in the Southern Annular Mode, climate model simulations that include anthropogenic forcing are not compatible with the observed trends. This suggests that natural variability likely overwhelms the forced response in the observations, but the models may not fully represent this natural variability or may overestimate the magnitude of the forced response. (Additional authors Leela M. Frankcombe, Gareth J. Marshall, Valérie Masson-Delmotte, Adele K. Morrison, Anaïs J. Orsi, Marilyn N. Raphael, James A. Renwick, David P. Schneider, Graham R. Simpkins, Eric J. Steig[18], Barbara Stenni, Didier Swingedouw and Tessa R. Vance).

ID: 02002, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Epipalaeolithic human-climate-environment interactions in eastern Jordan: can local noise inform a regional signal?

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The Epipalaeolithic Foragers in Azraq Project (EFAP) has spent the last decade investigating human – climate – environment relationships in eastern Jordan between c. 23,000 cal BP and the beginning of the Holocene. On- and off- archaeological site environmental archives from three sites within the Azraq Basin (Ayn Qasiyya, Kharaneh IV and Shubayqa) are used to here to relate Epipalaeolithic human behaviour to local, and then regional, records of palaeoenvironmental change. Human occupation of the basin was more-or-less continuous throughout the Epipalaeolithic, but shifted from locality to locality, varying in density and type. The environmental data suggest this was, at least in part, due to a complex landscape of changing local environments. The wider south-west Asia region has seen much interest in the Epipalaeolithic and the correlation of societal change, namely the emergence of sedentary farming villages, with hemispheric patterns of post-glacial climate transition. However, any suggestion that these correlations have a causal link remain only hypotheses to test. Local work such as in the Azraq basin, and in the wider region from both archaeological and palaeoenvironmental perspectives, are needed to provide evidence to do this. We use the examples from Azraq here to discuss issues of scale in developing a nuanced understanding of human – climate – environment relationships. We need models, conceptual and mathematical, that can bring together continuous records of palaeoenvironmental and paleoclimate change with the more scattered records of human occupation and palaeoenvironment, at scales, temporal and spatial, relevant to fully understanding these relationships.

ID: 02003, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Early Holocene Desertification of Eastern Jordan

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The Early Holocene was a key time in south west Asia with new Neolithic farming strategies and associated, substantial, permanent settlements developing. Here we present data from two sites in eastern Jordan that suggest the early Holocene was a substantially different environment to that observed today, at least in this part of the region, prior to a significant desertification event sometime in the early- to mid-Holocene. Basalt buildings at the sites of Wisad (c. 8,500 cal BP) and Shubayqa (c. 15,000 – 11,000 cal BP) sit directly above a poorly developed red 'soil' that is not observed on the landscape today. Similar sediments, dated by OSL and radiocarbon to postdate these structures, are found in qa (ephemeral lake) basins near to the sites. The geomorphological evidence, alongside plant remains from the archaeological sites and preliminary pollen analysis of the qa sediments, suggest the early Holocene of eastern Jordan was characterised by more vegetated landscapes than are seen today, with qa basins that could hold more water than they can at present. The relationships between climate (particularly precipitation amount, seasonality and intensity), vegetation, landscape stability and human activity are complex and potentially difficult to tease apart. Here we discuss the data from eastern Jordan and hypotheses for desertification against a background of changing regional climate and early agricultural activity.

ID: 01689, 26.- Data Stewardship for Paleoscience, (Poster)

The PalMod paleoclimate data synthesis: curated database of paleoceanographic records over the last glacial cycle

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Within the framework of the German climate modelling initiative PalMod, we are assembling a global database of paleoclimate records spanning the last glacial cycle. The data will serve to produce time series of changes in multiple compartments of the Earth system with comprehensive and transparent error estimates. Compilation of raw data and extensive metadata will allow a consistent re-analysis and provide transparent uncertainty estimates that include chronological uncertainty. Here we report on the approach chosen to assemble paleoceanographic data and process them to facilitate such synthesis. We first identified key parameters to synthesize and then translated these into search strings for querying of online repositories. The parameters that are compiled include surface and bottom ocean temperature, stable oxygen and carbon isotopes of planktonic and benthic foraminifera, sea-ice extent and concentration proxies, radiocarbon, sedimentary biogenic carbonate and silica as well as organic carbon. The database querying has been implemented in an R code allowing automated merging of data retrievals to unique sites and subsequent identification of key parameters of the data series. These parameters allow prioritisation of the retrieved data by length and time resolution. Initial search of NGDC and PANGAEA for six of the synthesized parameters yielded 1840 sites with at least one reported age within the last glacial cycle and at least 50 data points. The next step is a sequential curation of this reduced dataset and collection of metadata for records that will be retained. The analyses of the data will take place within a stand-alone visualisation and analysis tool, that is being developed within the PalMod project. The standardisation of the records and their implementation into a common software environment will enable fast, objective and consistent estimates of proxy and chronological uncertainties and provide machine-readable output of synthesis products in netcdf format.

ID: 01403, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

A palaeoenvironmental perspective of prehistoric salt exploitation in the Villafáfila wetlands (Tierra de Campos, Zamora, Northern Iberia)

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Salt exploitation in the Villafáfila lagoon complex (Tierra de Campos, Zamora) is one of the most important events since Prehistory in the Northern Plateau of the Iberian Peninsula. Salt production is documented from the Bell Beaker (*ca.* 2450 cal BC). In 2013, a core drilling was performed in the salty swamp of the Laguna de las Salinas. The analysis of pollen and non-pollen palynomorphs of this record suggests the origin of the lagoon 8 thousand years ago linked to the 8.2 ky cal BP climatic event, a very anthropized environment from the beginning of the Chalcolithic period *ca.* 3300 cal BC and the subsequent exploitation of salt, the gradual and definitive degradation of the holm oak forest from the Bronze Age onwards, and, in general, a wide climatic variability, with alternate humid and arid phases throughout the paleoenvironmental sequence.

ID: 01671, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Recent hydrological variability of the Moroccan Middle-Atlas Mountains inferred from sedimentological and geochemical analyses of lake sediments

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The frequency and/or intensity of extreme precipitation events and droughts is expected to increase in the Mediterranean basin in the XXI century (Giorgi and Lionello, 2008). Future adaptation to water availability in Moroccan regions will require a precise knowledge of its response to hydrological variability over the past century. The Moroccan Middle-Atlas Mountains is considered as the “Moroccan water tower” and contains several natural lake systems of tectono-karstic origin functioning as “pluviometer”. This region suffers from scarcity of observational data that prevent a coherent management of water resources. In this context, the precise study of the lacustrine sedimentary infill can provide some key information about past hydrological changes. In this work, we focused on the micro-scale analysis of well-dated sedimentary deposits of Lake Azigza (32°58’N, 5°26’W, 1,470 meters a.s.l.). A combined approach based on elemental, mineralogical and geochemical measurements coupled to microfacies characterization of the sediments was conducted. We were able to provide proxies of runoff intensity and lake level changes calibrated to hydro-climate observations available for the last 50 years. These proxies were then applied to the entire sedimentary sequences covering the last 150 years providing a record of local hydrological changes for the pre-instrumental period in a vulnerable area. Finally, the detected microstructures, i.e. very thin laminations composed of biological and detrital materials coming from the shoreline, could be related to increased superficial runoff or extreme events.

ID: 01699, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

The PMIP4/CMIP6 Past1000 Simulations

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Climate has varied considerably during the Common Era (roughly the last 2000 years) and these changes have left their traces in history (e.g., Medieval Climate Optimum, Little Ice Age). However, the relative magnitude of natural fluctuations due to internal variability of the Earth’s climate system and to variations in the external forcing and the present global warming, attributed to anthropogenic greenhouse gases, is still under debate. Investigating the response to (mainly) natural forcing under climatic background conditions not too different from today is crucial for an improved understanding of climate variability, circulation, and regional connectivity. Simulations over the pre-industrial millennia allow assessing climate variability on decadal and longer scales and provide information on predictability under forced and unforced conditions.

PMIP4 Tier-1 includes the standard LM simulation covering 850 to 1849 CE and a subsequent "historical" (1850 – 2010 CE) experiment as a minimum requirement. In addition to changes in Earth's orbit and greenhouse gas concentrations, the models are forced by variations in solar irradiance, volcanic aerosol load, and anthropogenic land-cover. As part of Tier-2, the modeling groups are asked to provide additional simulations in the form of ensembles, single forcing experiments, as well as sensitivity runs using alternative forcing combinations. The extension of the simulations to cover the complete last two millennia (0 CE to present) is also part of Tier-2.

We describe the experimental design of the LM simulations and discuss the protocol on new forcing and boundary conditions.

The PMIP LM working group (WG Past2K) is closely cooperating with the PAGES initiative PAGES2k promoting regional reconstructions of climate variables and variability modes. We suggest common analyses for integrated assessment of reconstructions and simulations leading to progress in model evaluation and process understanding.

ID: 02231, 01.- Open Session on past global changes, (Poster)

The PMIP4 Last Glacial Maximum experiments

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The Last Glacial Maximum (LGM, 21ka) is one of the suite of paleoclimate simulations included in the current phase of the Coupled Model Intercomparison Project (CMIP6). The LGM has been a focus for the Palaeoclimate Modelling Intercomparison Project (PMIP) since its inception, and thus many of the problems that might be associated with simulating such a radically different climate, with huge ice sheets in the northern hemisphere and low concentrations of atmospheric greenhouse gases, are well documented. The LGM state provides an ideal case study for evaluating climate model performance. The changes in forcing and temperature between the LGM and pre-industrial are of the same order of magnitude as projected for the end of the 21st century. Thus, the CMIP6 LGM experiment has the potential to provide additional information that can be used to constrain estimates of climate sensitivity. The design of the Tier 1 LGM experiment (lgm) includes an assessment of uncertainties in boundary conditions, in particular through the use of three different realisations of the expanded ice sheets and two realisations of the change in dust forcing. Additional sensitivity experiments have been designed to quantify feedbacks associated with land-surface changes and aerosol loadings, and to isolate the role of individual forcings. Model analysis and evaluation will capitalise on the relative abundance of palaeoenvironmental observations and quantitative climate reconstructions already available for the LGM. This poster will present the PMIP4 LGM experimental design and will give us the opportunity to discuss this design with the PAGES community.

ID: 02256, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Atmospheric and Oceanic reorganisations during glacial abrupt events: an IPSL model study

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Available reconstructions of glacial abrupt events as well as model studies have shown that when the Atlantic Meridional Overturning Circulation quickly changes, in an abrupt slow down or resumption, there are large reorganisations of the atmosphere circulation, which ultimately translates into climate changes. In previous work, we have analysed changes in the ITCZ (Intertropical Convergence Zone), over the Indian Monsoon area (Kageyama et al., Climate of the Past, 2009, Marzin et al., Climate of the Past, 2013) and South American sector (Montade et al., Geology, 2015). In this study, we analyse these reorganisations in the mean atmospheric circulation at mid-latitudes, in particular in the North Atlantic/Europe zone. We will also examine its variability at the daily and interannual time-scales, in order to better understand the climatic response, in particular in terms of precipitation, over this area to changes in AMOC. We perform these analyses on experiments of the LGM and MIS3 states realized with the IPSL coupled model, versions 4 and 5.

ID: 02134, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Paleoenvironmental changes during the Holocene in the Winter-Rainfall-Zone of South Africa – A continuous, high-resolution, multi-proxy record from coastal lake Verlorenvlei

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Coastal lake Verlorenvlei, located in southern Africa's Winter Rainfall Zone, provides a scarce Quaternary, terrestrial climate archive, from which a 15 m paired parallel sediment core was recovered within the project RAiN (Regional Archives for Integrated iNvestigations). Twentyfour ^{14}C AMS ages in stratigraphic order, covering 9400 cal BP, indicate continuous sedimentation throughout the covered period. Optical luminescence ages suggest the base of the core date back to the Last Glacial Maximum. This lowermost part of the record, almost entirely composed of sand with high proportions of Si and Zr, indicate sediment reworking (dune sand?), pointing to drier conditions with very low sea and lake levels. During the early Holocene, distinctly elevated Ca and Sr values, the occurrence of marine gastropods and brackish water ostracods and foraminifers point to marine conditions at Verlorenvlei. Contemporaneously, rather high levels of terrestrial input proxies (K, Si), highly variable granulometric parameters (mean, sorting) and larger amounts of terrestrial organic material suggest a dynamic estuarine system within a moister environment. During the mid to late Holocene very fine (4 µm), well sorted particles of terrestrial origin co-occurr with reduced organic matter contents and distinctly reduced marine influence. This suggest a disconnection of Verlorenvlei from the ocean and a tendency to a drier climate. Terrestrial input proxies decline during the late Holocene, probably indicative of further aridification. However, low levels of marine indicators, enrichment in organic matter and coarser minerogenic particles suggest a lacustrine phase of Verlorenvlei, being mainly influenced by fluvial input. Here climatic and environmental reconstructions derived from Verlorenvlei will be compared to records from the other rainfall zones of South Africa which finally will lead to a better understanding of large-scale variability in the atmospheric circulation systems and seal level variations during the Holocene.

ID: 01959, 18.- Human Impact on Global Aquatic Systems, (Poster)

Does river regulation trigger emergent macrophytes growth? An integrated assessment of palaeo- and-modern food web approaches in Australia's River Murray system

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Ecosystems of the world's large rivers are supported by the dynamics of carbon and nutrient exchange between the river and adjacent wetlands. The natural hydrological regimes of these river systems have been profoundly modified by humans over the past century. The vast floodplain wetlands of the River Murray system in southeast Australia is no exception, as the eco-hydrological regimes of this river system have shifted following the arrival of Europeans in the early 1900s. After the 1930s, many clear water wetlands have transformed into turbid water regimes with widespread growth of shoreline emergent macrophytes. The cumulative perturbations of multiple stressors including climate change over the past century have led to a non-liner response of these wetlands to the ecosystem changes. An integrated palaeo-and modern food web approaches have been used to test the wetland ecosystem shifts in different hydrological regimes: pre-regulation (1900-1930); immediate post-regulation (1930-1970); and current regulation (1970s-present) of Kings Billabong, one of wetlands of the River Murray system. Subfossil cladocerans, d^{13}C values of *Daphnia*, chironomid, and bulk sediments as well as modern d^{13}C and d^{15}N values of emergent and sub-merged macrophytes and *Daphnia* and fish were analysed. The result suggests a possible disruption of carbon energy flow affecting the food web dynamics and subsequent increase in the growth of emergent macrophytes in the wetland following river regulation.

ID: 01561, 26.- Data Stewardship for Paleoscience, (Poster)

Data stewardship in the PAGES 2k project

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Data Stewardship is one of the current PAGES Integrative Activities. It seeks to advance best practices for archiving paleodata such that they are easily and accurately reused for future and potentially unforeseen purposes. Many PAGES Working Groups are engaged in major data syntheses. Their goal is to develop community endorsed products to investigate global-scale issues and to benchmark model simulations. Difficulties arise because paleodata tend to be heterogeneous and multifaceted, their interpretation is nuanced, reporting standards are limited, and much of the data are not archived in public repositories. Moreover, creating a community wide product is challenging because it should involve broad international participation by regional and topical experts, assure that the data are accurate, maintain a high degree of uniformity and completeness, promote transparency, accountability and reproducibility in the procedures used to assemble the product, and assign proper credit to both data producers and database developers. Objective criteria must be crafted to select a particular subset of the vast assortment of paleodata in a way that maximizes the potential scientific benefit and minimizes potential selection biases, including which of the older data recourses should be rescued and which new data are missing from public archives. The essential metadata must be identified and extended metadata fields must be developed to encapsulate information needed to correctly reuse the data, including the evidence that underpins the interpretation and cautionary notes about alternative or evolving interpretations or shortcomings of individual records. A flexible database structure is essential to contain additional fields of unlimited variety, and a systematic and universal versioning scheme is required to track revisions and cross-reference individual records. We will present examples of strategies used to address these challenges in context of the paleoclimate proxy datasets that have been assembled for the PAGES 2k project.

ID: 01444, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Quantitative reconstruction of atmospheric temperature in Japan for the last 2000 years

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Coastal sedimentary cores in Bays, Japan, provided an opportunity to quantitatively estimate terrestrial (atmospheric) temperatures (AT) using the alkenone sea surface temperature (SST) proxy for the last 2K years. The results are mainly obtained in Hiroshima Bay (ref.1) as well as Funka and Osaka Bays. The monthly AT is positively correlated with the monthly SST (r2=0.84, P=0.001), especially in modern summer in Hiroshima (AT= SST+1.6°C).

The SSTs/ATs) showed a variation of 1.9°C, with a maximum in 820AD (24.3°C/25.9°C) and two minima in 760BC (22.2 °C/23.8°C) and 990AD (22.4 °C; 24.0°C). Sustained high SSTs were observed in 30BC–510AD, 670–940AD, and 1170–1420AD with small fluctuations. Low SSTs were observed in 560–620AD, 990–1150AD, and 1440–1570AD. The period from 950 to 1190AD showed rapid temperature fluctuations.

The Medieval Warm Period (MWP) in 950–1250AD (sometimes 1000–1400AD) is a period of warming by a few degrees that was primarily confined to Europe and North America. However, MWP was not identified in Hiroshima Bay because a cold climate prevailed in 990–1150AD in Japan. This low SST/AT was also identified in northern Japan. Although it is difficult to exactly specify the causes, low temperature could be therefore be a result of the combination of El Niño episodes and reduced solar activity.

Because several factors, including external forcing (solar activity) and internal forcing (volcanic activity, ENSO, and the Asian monsoon), can affect the climate, we compared SST fluctuations with each of those factors. A combination of several factors, not single factor, is most likely the cause of major climate change at the century scale.

Ref.1 Kawahata, Matsuoka, Togami, Harada, Murayama, Yokoyama, Miyairi, Matsuzaki, and Tanaka, Y. (2016) Climatic change and its influence on human society in western Japan during the Holocene. Quaternary International, DOI:10.1016/j.quaint.2016.04.013

ID: 01702, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Comparing records to understand past rapid climate change: An INTIMATE database update

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Integrating multi-proxy records from ice, terrestrial and marine records enhances the understanding of the temporal and spatial variation of past rapid climatic changes globally. By handling these records on their own individual timescales and linking them through known chronological relationships (e.g. tephra, ^{10}Be and ^{14}C), regional comparisons can be made for these past climatic events. Furthermore, the use of time-transfer functions enables the chronological uncertainties between different archives to be quantified.

The chronological database devised by the working group 1 (WG1) of INTIMATE, exclusively uses this methodology to provide a means to visualise and compare palaeoclimate records. Development of this database is ongoing, with numerous additional records being added to the database with a particular focus on European archives spanning the Late Glacial period.

Here we present a new phase of data collection. Through selected cases study sites across Europe, we aim to illustrate the database as a novel tool in understanding spatial and temporal variations in rapid climatic change. Preliminary results allow questions such as time transgression and regional expressions of rapid climate change to be investigated. The development of this database will continue through additional input of raw climate proxy data, linking to other relevant databases (e.g. Fossil Pollen Database) and providing output data that can be analysed in the statistical programming language of *R*. A major goal of this work to is not only provide a detailed database, but allow researchers to integrate their own climate proxy data with that on the database

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ID: 02165, 06.- Before and after - climate contrasts across the MPT, (Poster)

Terrestrial palaeoecological evidence of the Mid-Pleistocene Transition in southeastern Australia

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Pollen records constructed from volcanic crater sediments within southeastern Australia provide a discontinuous record of vegetation and climate prior to, during and post the Mid-Pleistocene transition (MPT). We focus here on the continuous 100m lacustrine sequence from Garvoc that, from fission track dating and record comparison, covers the period ~1.2 –~0.7 Ma. The pollen record indicates that a major transition occurred here between about 1.0 and 0.87 Ma, characterized by a shift from an open woodland displaying low amplitude but high frequency variability, to a vegetation displaying high amplitude but low frequency variability alternating between open woodland, sclerophyll forest and cool temperate rainforest. The timing of this transition corresponds to that in recent marine benthic data from the Southern Ocean. The transition to a vegetation regime including rainforest is consistent with evidence for an increase in interglacial temperatures from the marine data. Although the latter part of the record clearly shows 100 ka cyclicity, the length of vegetation cycles in the earlier, woodland-dominated part of the record is uncertain, despite the dominance of the 40 ka obliquity cycle in marine proxies. A second pollen record deposited between about 1.8 to 1.5 Ma clearly demonstrates the dominance of precession on the predominantly warm temperate rainforest vegetation, implying that vegetation at Garvoc may similarly have been influenced by precession up until the MPT. Perhaps the most parsimonious explanation for the contrast between (obliquity-dominated) marine and our (precession-dominated) terrestrial records prior to the MPT in this area is that marine environments were responding predominantly to global/northern hemisphere signals while the climate of southern Australia remained under the influence of the tropical monsoon. With the MPT, the intensification of global climatic circulation resulted in the development of a westerly wind system over southeastern Australia and ‘evolution’ of a distinctive cool temperate vegetation.

ID: 02368, 06.- Before and after - climate contrasts across the MPT, (Poster)

Reconstruction of the North Atlantic end-member of the AMOC across the Mid-Pleistocene Transition

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The glacial-interglacial periodicity shifted from 41- to 100-kyr between ~1.3-0.8 Ma, marking the Mid-Pleistocene Transition (MPT). Pena and Goldstein (2014) concluded from two South Atlantic cores that the MPT was marked by major disruptions of the Atlantic Meridional Ocean Circulation (AMOC) between MIS25-21 (~950-850 ka). However, knowledge of the coeval North Atlantic is key for interpreting the South Atlantic data. We report εNd of Fe-Mn oxide encrusted foraminifera and fish debris from North Atlantic Sites

607 (41.00N 32.96W, 3427m) and 1063 (33.68N 57.62W, 4585M) over the past ~1.5 Ma.

In Site 607 interglacial εNd-values are similar to present-day NADW and literature Mn-crust data, with median εNd-values of -14.3 pre-MPT and -13.8 post-MPT. Glacial εNd-values are higher by ~1 εNd-unit pre-MPT, and ~1.5-2 εNd-units post-MPT. Site 1063 shows much greater variability, with εNd as low as -26.

We interpret the North Atlantic AMOC source as best represented by the Site 607 interglacial εNd-values, which remained nearly stable. The higher glacial εNd-values reflect incursions of some southern-sourced waters (SSW) to Site 607, which is supported by coeval shifts to lower benthic $d^{13}C$. The Site 1063 εNd-values appear to reflect local effects.

In Site 607, approaching the MPT AMOC-crisis during MIS 26, a singular negative-εNd excursion indicates a special input event of Nd from the surrounding cratons into the North Atlantic, possibly signaling a triggering event. This was followed by SSW incursions, evidenced by high εNd-values until MIS19. The Site 607 data thus confirm that the "MPT AMOC-crisis" observed in the deep South Atlantic by Pena and Goldstein (2014) involved the entire Atlantic basin.

ID: 02321, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Poster)

Origin of the first Scots pine (Pinus sylvestris) trees in north central Sweden: insights from aDNA analyses

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The faster than expected post-glacial migration rates of plants in Europe following deglaciation of the Weichselian ice-sheet have puzzled paleoecologists for long (i.e. the Reid\'s paradox). Even though pollen analysis from natural archives (lake and peat bogs) have been able to describe early arriving plant communities, there are still limited physical and genetic information available about the composition and origin of the first forests that established after deglaciation. Here, we present analyses conducted at a newly excavated site in northern Sweden where we found a Scots pine *(Pinus sylvestris)* forest buried under a more than 2.5 m thick layer of glacifluvial deposits. The area was de-glaciated around 9.5 kyr BP according to glacial theories and ^{14}C dates of five buried trees suggest an age of these trees going back to 9.5-9.7 kyr BP; hence, the forest established directly after deglaciation. That the pine trees grew on the burial site, and were not derived from long-distant transport, was evident by both their still standing stems and preserved soil inclusions surrounding the roots. Ancient DNA analyses of the wood from a one of the pine trees (14 m long and excavated intact) made it possible to reveal the likely geographical origin of the trees. We use this information in combination with insights from findings of macrofossils, preserved in soil inclusions from the roots, to describe the likely formation of this early forest.

ID: 01261, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Evaluation of 20CR reanalysis data based on model results and observations from Franz Josef Land during the ETCW

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The HIRHAM5 regional climate model, developed at the Alfred Wegener Institute (AWI), with its pan-Arctic domain (including most areas north of 60°N) was initialized and run over the time period from January 1, 1915 to December 31, 1940 with 6-hourly "NOAA-CIRES Twentieth Century Global Reanalysis Version 2" (20CRv2) forcing at the lateral boundaries. Sea-ice concentration and sea-surface temperature were prescribed based on daily 20CRv2 fields. Historical surface-based observations for the Arctic were collected and transcribed by Nicolaus Copernicus University (NCU) within various data-retrieval projects (e.g. AWAKE, AWAKE-2, ArcRu).

With the aid of the 6-hourly HIRHAM5 model output, 20CRv2 reanalysis data, and surface-based observations carried out at Franz Josef Land (Calm Bay, 52.8°E, 80.32°N), the reproducibility of the early Arctic warming has been checked. Both the model and reanalysis have been evaluated by comparison with the measured sea level pressure, 2m air temperature, 2m specific humidity, and 10m wind speed. More importantly, the vertical baroclinic structure of the atmosphere has been analyzed by use of radiosonde data that have been acquired in the framework of ERA-CLIM.

Finally, the upgraded Twentieth Century Global Reanalysis dataset (20CRv2c) has been also taken into account. The latter was improved not only by assimilating additional surface pressure data (e.g. from Teplitz Bay 1899-1900, provided by NCU) but also by using the Centennial Observation-Based Estimates of SST version 2 (COBE-SST2) instead of the Hadley Centre Sea Ice and Sea Surface Temperature data set

(HadISST1.1) to prescribe sea-surface temperature and sea-ice concentration.

It can be expected that HIRHAM5 performs equally well as the 20CRv2 data, but it is unclear whether the model is even able to reproduce the station observations with the same quality as the improved 20CRv2c (corrected 20CRv2) reanalysis data. If the model has the skill to perform comparably or even better than 20CRv2c this might give evidence of a more realistic simulation of Arctic clouds, which will be checked as well.

ID: 01393, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Anthropogenic land use change during the Holocene; HYDE 3.2

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Land use plays an important role in the climate system. To assess the effects of land cover changes on the climate system, models are required which are capable of simulating interactions between the involved components of the Earth system. Since driving forces for global environmental change differ among regions, a geographically (spatially) explicit modeling approach is called for. Integrated records of the co-evolving human-environment system over millennia are needed to provide a basis for a deeper understanding of the present and for forecasting the future.

This requires the major task of assembling and integrating regional and global historical, archaeological, and paleo-environmental records. The PAGES LandCover6k working group provides a crucial network for bringing together scientists and data to help with this task. It offers a platform to improve historical land use reconstructions such as the History Database of the Global Environment (HYDE) (Klein Goldewijk *et al.*, 2011; Klein Goldewijk *et al.*, 2016). The latest update consists of improved historical population estimates and upgraded land use allocation algorithms which change over time for 10 000 BCE to 2015 CE. Population maps are provided for total, urban, rural numbers, population density and built-up area. The cropland category can now be sub-divided into irrigated and rain fed crops (other than rice) and irrigated and rain fed rice. Grazing lands can be sub-divided into remote rangelands or more intensively used pasture. An overview will be given of the latest results, and an example will be presented of the influence of incorporating archaeological case studies for North and Central America on the HYDE land use allocation scheme in 1500 CE.

ID: 02243, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Stable isotope records (δ13C, δ18O) as paleoclimate proxies in vascular plant dominated high-Andean cushion peatlands: The Cerro Tuzgle Peatland (24° S, NW Argentina)

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High-Andean cushion peatlands, situated in the extreme habitat of the high Andean highlands between ~4000 and 4800m a.s.l, are promising archives for palaeoenvironmental studies. However, knowledge about these sensitive ecosystems still need to be extended. Here, we present results of the Cerro Tuzgle cushion peatland (CTP, 24°03′ S, 66°28′ W), located in NW Argentina.

We investigated the stable isotope composition of bulk material and cellulose ($\delta^{18}O$, $\delta^{13}C$, $\delta^{15}N$) of the dominant cushion-forming species Oxychloe andina (Juncaceae) and Zameioscirpus muticus (Cyperaceae) as well as water samples ($\delta^{18}O$, $\delta^{2}H$) of several pools interspersed within the peatland to improve the knowledge base on the modern ecology of these peatlands. To gain insight into the palaeoenvironmental development of CTP during the last 4000 years, we further analysed element contents, ash content and the stable isotope composition of bulk material and cellulose ($\delta^{18}O$, $\delta^{13}C$, $\delta^{15}N$) of three fractions (<200 µm, 200-1000 µm and >1000 µm) of a peat core.

Modern samples of O. andina and Z. muticus expose significant differences in cellulose $\delta^{18}O$ e.g. between leaves and rhizomes of O. andina ($\Delta\delta^{18}O_{l\text{-}r}$ = 4.11‰) and between leaves of O. andina and Z. muticus ($\Delta\delta^{18}O_{l\text{-}l}$ = 2.8‰). Modern water samples exhibit strong isotopic differences between single water pools (max. $\Delta\delta^{18}O$ = 13.09‰) due to local variable evaporative enrichment. The results of the modern plant data underline the importance of consideration of different plant species for the interpretation of the core data.

Based on the regional relation between decreasing $\delta^{18}O_{prec}$ values with increasing precipitation amount

(GNIP-Data) and 18O enrichment in the peatland waters due to evaporation, we suggest an interpretation of our $\delta^{18}O$ cellulose record as moisture proxy for CTP. Based on this interpretation, a pronounced drier phase could be identified from 1500 to 1159 cal. yr BP.

ID: 02350, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Modern environmental implications and Late Holocene development derived from a vascular plant dominated high-elevation cushion peatland in the Chilean Andes (27° S)

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High-altitude cushion peatlands are a typical element of the Andean vegetation belt that represents important water reservoirs as well as highly sensitive (geo-)archives (Schittek 2014). Considering their potential for paleoenvironmental investigations, cushion peatlands received insufficient attention so far, although archives for paleoecological investigations are scarce in the harsh environment of the high Andes. Here, we present first results of the Lagunillas cushion peatland (LCP, 27°12' S, 69°16' W), located in the Chilean Andes, close to the Parque Nacional Nevado Tres Cruzes.

To deepen the knowledge of the modern ecology of these peatlands, we analysed the stable isotope composition of bulk plant tissue and cellulose ($\delta^{18}O$, $\delta^{13}C$) of several modern plant samples (leaves and rhizomes) along a 18m long cross-section (transect) though the peatland dominanted by *Oxychloe andina* (Juncaceae) cushions. To supplement this dataset, the stable water isotopic composition ($\delta^{18}O$, $\delta^{2}H$) of several pools surrounding and crossing the transect was measured, showing $\delta^{18}O$ values between -10.84 and -8.89 ‰.

Additionally, a first core from the same archive, spanning the last 1750 cal. yr BP, was analysed in a multi-proxy approach: XRF, LOI and stable isotope composition of bulk material and cellulose ($\delta^{18}O$, $\delta^{13}C$, $\delta^{15}N$). Stable carbon isotopes of bulk material fluctuating between -27.47 and -24.44 ‰, while stable nitrogen isotopes vary between 1.89 and 8.32 ‰ within the record. The cellulose extraction is based on an improved method starting with sample bleaching with sodium chlorite and followed by cellulose dissolution with cuprammonium ($[Cu(NH_3)_4](OH)_2$) solution (CUAM) and re-precipitation by using sulphuric acid (Wissel et al., 2008).

Both informations are brought together in this contribution to derive first insights in the isotopic signatures and core compositions of the LCP.

ID: 01851, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

Continuous records of the atmospheric greenhouse gases CO2, CH4, and N2O and their radiative forcing since the penultimate glacial maximum

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Continuous records of the atmospheric greenhouse gases (GHG) CO_2, CH_4, and N_2O are necessary input data for transient climate simulations and their related radiative forcing important components in analyses of climate sensitivity and feedbacks. Since the available data from ice cores are discontinuous and partly ambiguious a well-documented decision process during data compilation followed by some interpolating post-processing are necessary to obtain those desired time series. Here we document our best-guess data compilation of published ice core records and recent measurements on firn air and atmospheric samples covering the period from the penultimate glacial maximum (~156 kyr BP) to 2016 CE. A smoothing spline method is applied to translate the discrete and irregularly spaced data points in continuous time series. These splines are assumed to represent the evolution of the atmospheric mixing ratios for the three GHGs. Global-mean radiative forcing for each GHG is computed using well-established, simple formulations. Newest published age scales are used for the ice core data. While CO_2 is representing an integrated global signal, we compile only a southern hemisphere record of CH_4 and identify how much larger a northern hemisphere or global CH_4 record might have been due to its interhemispheric gradient. Data resolution and uncertainties are considered in the spline procedure and typical cutoff periods, defining the degree of smoothing, range from 5000 years for the less resolved older parts of the records to 4 years for the densely-sampled recent years. The data sets describe seamlessly the GHG evolution on orbital and millennial time scales for glacial and glacial-interglacial variations and on centennial and decadal time scales for the anthropogenic period.

ID: 01850, 01.- Open Session on past global changes, (Poster)

Using the Suess effect on the stable carbon isotope to distinguish the future from the past in radiocarbon

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Since the beginning of fossil fuel emissions by mankind the carbon isotopes (13C, 14C) are altered due to the so-called Suess effects. Furthermore, the depletion of ^{14}C due to the emission of radiocarbon-free fossil fuels (^{14}C Suess effect) might lead to similar values in future and past radiocarbon signatures potentially introducing ambiguity in dating. I here test if a similar impact on the stable carbon isotope via the ^{13}C Suess effect might help to distinguish between ancient and future carbon sources. To analyze a wide range of possibilities, I add to future emission scenarios carbon dioxide reduction (CDR) mechanisms, which partly enhance the depletion of atmospheric Δ^{14}C already caused by the ^{14}C Suess effect. The ^{13}C Suess effect leads to unprecedented depletion in δ^{13}C shifting the carbon cycle to a phase space in $\Delta^{14}\mathrm{C}$–$\delta^{13}\mathrm{C}$, in which the system has not been during the last 50 000 years and therefore the similarity in past and future Δ^{14}C (the ambiguity in ^{14}C dating) induced by fossil fuels can in most cases be overcome by analyzing ^{13}C. Only for slow changing reservoirs (e.g. deep Indo-Pacific Ocean) or when CDR scenarios are dominated by bioenergy with capture and storage the effect of anthropogenic activities on ^{13}C does not unequivocally identify between past and future carbon cycle changes.

ID: 01313, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Methodology for studying continental-scale Holocene human-vegetation interactions using archaeological and paleoenvironmental data

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The ongoing development of comprehensive online open-access repositories of archaeological, environmental and paleoclimate data suggests new methods of comparing and synthesizing these types of data are now possible and necessary if the understanding of past human-environment-climate interactions is to be improved. In North America, extensive archaeological and fossil pollen records can currently be obtained from the Comprehensive Archaeological Radiocarbon Database (CARD) and the Neotoma Paleoecology Database permitting the detailed analysis of the relationship between humans and the environment over the course of the Holocene. This poster presents a new methodology to correlate vegetation abundance (based on spatiotemporal fossil pollen data) with radiocarbon-based estimates of population density obtained from a previously-published study. Nonparametric spatial and temporal smoothing methods are applied to the pollen data to reduce data gaps, eliminate sampling errors (or noise) and to produce spatially continuous maps of vegetation abundance within each taxon range. Cross-correlations of vegetation abundance and population intensity are estimated and analyzed for a series of time intervals between 13,500 and 500 BP. Cross-correlation results are synthesized using 2D heat maps to show the dynamic relationship between changes in human population density and vegetation abundance across time and space in North America. This methodology demonstrates new opportunities to use point data for more sophisticated spatiotemporal analyses of multivariate data that are relevant to both statisticians and paleoecologists.

ID: 02205, 26.- Data Stewardship for Paleoscience, (Poster)

Paleoecological database for South Asia: overview and challenges

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Knowledge about the past vegetation – as a “natural” component of the environment and in terms of its “use” by humans and their prehistoric ancestors provides concrete inputs to understanding and modelling future environments/ ecosystems. An application of this in climate models is important due to feedback effects of “land cover” and “land use”.

A pollen and paleoecological database for South Asia has been in the making since nearly 16 years, with the initiatives on the Indian sub-continent Biomization (INDSUBIO). This has now been revived in the framework of the Landcover6K initiative, with a slightly different focus – on case studies and their regional level integration.

This by itself is a challenge to data stewardship: linking this with phytoliths as a complementary proxy is the second one. A third challenge comes in the form of additional knowledge about humans and their environment during the past nearly 3000 years (Late Holocene) comes from archaeology, epigraphical records, Classical Literature of southern India (Hart, 2015) and oral history traditions in other regions with strong cultural links to southern India, such as Cambodia.

The last three of these sources are descriptive in nature. Epigraphical records contain "incidental" information. Classical literature especially the "Sangam Tamil Poetry" provides a visualization of "landscape" (mindscapes) by Early Historic Peoples. Such literature does provide information that almost reads like a naturalist's checklist.

The present context, where the need for involving the humanities better in defining the Anthropocene and the fact that one of the regions of the world where its definition is the most complex is South Asia make it important to include this dimension in the building of such a database. The task is a daunting one, given the very nature of this kind of "information" does not allow quantification and poses a radical methodological challenge.

ID: 01420, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Bivalve shells as archives of past environmental changes

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Bivalve shells are one of the most important archives of past environmental changes because some species can live more than several decades and distribute broadly (e.g., from high to low latitude, fresh/brackish/sea water). We have investigated potential of long-lived cold water bivalve, *Mercenaria stimpsoni* (Stimpson\'s hard clam) living in the water off NE Japan. We will show sclerochlonological and geochemical records (e.g., oxygen isotopes and radiocarbon) of both live-caught and dead specimens by which we attempt to establish master-chronology and to reconstruct past environmental changes for the last 150 years in the western North Pacific (e.g., water temperature, nuclear bomb-^{14}C peak) (Kubota et al., 2017; Shirai et al., in revision). **Kubota, K., Shirai, K., Murakami-Sugihara, N., Seike, K., Hori, M., Tanabe, K.** Annual shell growth pattern of the Stimpson\'s hard clam *Mercenaria stimpsoni* as revealed by sclerochronological and oxygen stable isotope measurements. Palaeogeography, Palaeoclimatology, Palaeoecology (2017) **Shirai, K., Kubota, K., Murakami-Sugihara, N., Seike, K., Tanabe, K.** Stimpson's hard clam *Mercenaria stimpsoni*, a century-long climate recorder for the northwest Pacific coast. Marine Environmental Research (in revision)

ID: 01284, 01.- Open Session on past global changes, (Poster)

Monitoring of Ice Sheet Dynamics Change and their Assessment using LANDSAT and Sentinel-2 Sensors Time Series Data

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Presently, 10 percent of land area on Earth is covered with glacial ice, including glaciers, ice caps, and the ice sheets. Mapping glaciers and their changes will help us to understand the regional climate changes and water cycles in those regions. Remote sensing images acquired from different platforms (satellite, aircraft) using sensors that operate in different spectral regions (visible, infrared, microwave) have been widely used to study glaciers over time. Remote sensing techniques have been used for spectral characterization of different snow and ice faces, preliminary inventory of glaciers including aerial extent and position of large crevasses, and for mapping and monitoring glacial variations especially at the glacier margins and terminus location. Using remote sensing data, we can estimatet the change in glacier propoties over large area with low finacial cost using semi-automated process.

The study conducted in the Uttarakhand state in the Central Himalaya located in the foothill zones of the Kumauni Lesser Himalaya. From the study we have detected that Landsat data are very useful to detect the Himalayan glacier changes quickly and accurately. Glacier area of the Uttarakhand is rapidly changing due to different atmospheric phenomenon. The Landsat data provide an ideal tool to understand the status of dynamic changes on glaciers for last 21 years. Normalized difference snow index (NDSI) and Normalized difference Vegetation index (NDVI) map were generated from optical data, which is easier to extract information about the Snow, Vegetation, soil and other land. NDSI value remain consist with the variations in slope and aspect and thus it can take care of topography effects. Snow cover mapping methods using snow indices are compared to find the suitable mapping technique for the glacier region.

ID: 02004, 01.- Open Session on past global changes, (Poster)

On the relation between local and global variability—a key issue for proxy record interpretation

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The relation between small scale and large scale climate variability, of the local versus global scale, is a fundamental issue and is relevant, in particular, to the field of paleo-climate reconstruction. Individual proxy records always represent the climate history of one specific local site, and also contain a considerable amount of noise, which has itself an unknown structure in both space and time. For these reasons, it is not clear a priori how to infer the variability at larger, up to global scales from such local reconstructions, even if scattered around the globe. Simple conceptual models (like stochastic-diffusive systems) as well as complex climate models suggest that the relation between the spatial scales is inextricably linked to the temporal scales at which the variability occurs, with slower variations having a tendency towards increased spatial coherence. Large discrepancies between observational and model data indicate, however, that this issue is not yet fully understood. Hence, a systematic advancement of our understanding of the joint space-time structure of climate variability is needed for an adequate interpretation of proxy records in a larger scale context. Here, we approach this issue by a joint space-time spectral analysis and by utilizing simple but timescale-dependent measures of the spatial degrees of freedom, with a focus on surface temperature. We investigate (i) reanalysis datasets, spanning the past few decades, (ii) the output of climate model simulations with and without external forcing and up to millenial scale variability, and (iii) selected high-resolution proxy datasets from the PAGES-2K synthesis. Finally, the possibility to distinguish externally forced climate signals from internal variability by their respective and potentially different space-time structure is also discussed.

ID: 01668, 01.- Open Session on past global changes, (Poster)

Distortion of radiocarbon-based age records by Zoophycos burrows

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In contrast to homogenous bioturbational mixing common in the topmost sediment layer deep dwelling fossils like Zoophycos may reach far deeper and potentially rework sediment and microfossil tests down to >1 m depth. Though the burrowing animal has not been discovered yet, it has been shown that sediment material in the tube-shaped Zoophycos burrows possibly serves as a nutrient reserve and resemble the depositional conditions at the sediment surface during the time of burrowing. By displacement of planktonic foraminifera into deeper sediment levels this process may seriously bias the faunal and isotopic composition and, in particular, the radiocarbon age (^{14}C) of the ambient host sediment by up to several thousand years. Here, we present two high-resolution radiocarbon records from sediment cores retrieved at intermediate water depths off Brazil and New Zealand, where ^{14}C ages are largely biased by Zoophycos activity by 1000-5000 years. On the basis of closely spaced ^{14}C ages and ^{14}C plateau tuning, we distinguish various periods with strong burrowing activity of Zoophycos. These time intervals always coincide with time spans of decreasing sedimentation rates and thus probably with the onset of reduced nutrient supply. In the sediment record off New Zealand, we constrain the age of burrowing activity close to the Bølling/Allerød – Younger Dryas boundary and track displaced sediment as far back as to the onset of the Heinrich 1 stadial and the terminal Last Glacial Maximum. Our data suggest that ^{14}C-based age models obtained in sediment cores from intermediate water depths along the upper continental margin may be substantially distorted by burrowing activity and age models need to be revised accordingly.

ID: 01370, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Testing the potential of Pinus roxburghii and P. wallichiana in the dry interior of eastern Nepal as hydroclimatic proxies

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The climate of Nepal has changed more rapidly than nearly any other part of the planet over the last few decades, with more than 2.5 degrees of warming observed in Kathmandu since the early 1970s. Tree-ring width data have previously been used to reconstruct annual or seasonal temperatures over the last few centuries, but to date, there are no equivalent paleoclimate product targeting precipitation or streamflow. Here we report a new effort to establish a network of moisture-sensitive tree-ring records within the Koshi River basin of eastern Nepal. The Koshi is the country's largest watershed (by area), and the river regularly poses a major flood hazard to communities in Nepal and downstream in India. Because a prior synthesis of Nepalese tree-ring record indicated that pine trees (specifically, *Pinus roxburghii* and *P. wallichiana*) were sensitive to variations in monthly precipitation, we have targeted these two species for further collections in the Koshi watershed. In the summer of 2016, we collected cores for tree-ring width and isotopic measurements at six locations within the watershed (in total, more than 500 cores from 250 trees). These trees were growing a relatively low elevations (between 800 and 2000 masl) in dry interior forests, we hypothesize that variations in their annual growth and the isotopic composition of the wood will be linked to precipitation and (indirectly) streamflow. By comparing this new multi-proxy tree-ring network against instrumental meteorological and hydrological observations from eastern Nepal, we intend to summarize the paleoenvironmental signal recorded by these pines and potentially develop new multi-century reconstructions of hydroclimate in this part of the country.

ID: 01965, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Identification of the volcano from the poem "Vila Slovinka" (Fairy Slav)

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The Croatian poet Juraj Baraković, the author of the poem "Vila Slovinka" ("Fairy Slav", 1614), dedicated almost an entire canto of the poem to the description of volcanic phenomena and activities. The canto reflects the knowledge inherited from ancient authors as well as the beliefs related to Christianity; however, upon removing those layers there remains an excellent description of all the phases of an eruption, a phenomenon the author once witnessed himself. In spite of the fact that the Baraković intentionally set the plot of his work on the island of Vulcano, a comparative analysis of all data leads to the conclusion that the events in fact took place on the island of Stromboli. Arguments in favour of the thesis are the physical descriptions of particular parts of the island and the recognizable features of a Strombolian eruption – from fumarolic activities, earth tremor and underground rumbling sounds to the details of the paroxysmal ejection of bombs and expulsion of lava from the main crater and flank craters. We can specify the year of Baraković's stay on Stromboli as 1573, when he, following the end of the Fourth Ottoman-Venetian War, deserted the papal army and sailed to the island. There he boarded a ship from Dubrovnik which came to the island to load pumice and sailed to Šibenik (Croatia).

ID: 01925, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Challenges in climatic reconstructions using tree-ring data in Volga region: streamflow and PDSI

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The aim of the study was to define possibilities and restrictions for the tree-ring reconstruction of climatic parameters and streamflow. We examine sensitivity of nine pine chronologies (*Pinus Sylvestris*) to the main hydrometeorological factors that determine tree growth patterns, and analyze the climatic response of these chronologies.

The climatic data for Volga region (53-56N, 46-52E) is limited by length of instrumental hydroclimatic observations. The length of meteorological datasets for precipitation and temperatures is shorter then 120 years, and for the streamflow, is even shorter and goes up to a maximum of 70 years only.

Tree ring growth in Volga region is mainly controlled by temperatures and precipitation during the vegetation period. Most tree-ring chronologies have stable and significant negative correlation with summer temperatures and positive response to precipitation in current year period from July to September as well as previous year period from July to August.

All pine chronologies have stable and significant response to Palmer Drought Severity Index (PDSI) during the year. The strongest signal was found for the dry season in the current year period from July to September.

As for relations between streamflow and tree growth, the strong dependence was identified between the tree's response to streamflow and the distance to hydrology stations. Our reconstruction of Ilet river streamflow from 1827 to 2013 was based on this relation.

We also reconstructed PDSI from 1828 to 2013, using the master-chronology based on PCA analysis.

The models explain 27 to 34 % of the PDSI and streamflow variability. The reconstructed datasets reflect the main extremes in the actual data.

The study was supported by RFFI project № 16-35-00408.

ID: 01842, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

HUMAN ENVIRONMENTAL INTERACTIONS DURING THE LATER STONE AGE AND IRON AGE INTERFACE AT KANSYORE ISLAND Western Uganda

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Human environmental interactions in Kansyore Island of Western Uganda

Abstract

Archaeological investigations at Kansyore Island have provided new information on human-environmental interactions during the Holocene. It addressed the transition from the Later Stone Age to the Iron Age or specifically the timing of the transition to farming in Africa in general and East Africa in particular. The aim of this paper is to show how faunal remains from Kansyore Island in South Western Uganda reflect the interaction between ceramic-using forager fishers and their environment, and how the subsistence and settlement patterns of the Holocene Kansyore people were influenced by environmental change. The paper also accounts for the lack of domesticated fauna despite the existence of other herding/farming signatures like Urewe ceramics. The objectives were to examine the impact of environmental change on hominin dispersal from Kansyore Island to other Kansyore sites and how human adaptations evolved in response to environmental instability. An examination of the skeletal composition, bone modifications and physical characteristics led to identification of wild animal taxa and fish bones, while both land and aquatic shells were shown to be abound. The results reveal that human choice was a key determinant of site formation processes. The human is not considered as a master but as part of the environment and ecosystem, both of them dependent on each other for survival. The human adapted her/his needs to the dictates of nature that fashioned his subsistence strategies and settlement patterns. The present study on human environmental interaction in the Kansyore landscape therefore elucidates existing environmental resources of the Holocene period using the Kansyore area of Uganda as a case study and also determines how the landscape was then utilized. This investigation addresses key questions of cultural change and adaptability during the Holocene in Uganda in relation to environmental change.

Key words: Kansyore. Human. Interaction. Later Stone Age. Early Iron Age.

ID: 01843, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

KANSYORE ISLAND CRESCENTS, FOOD PROCUREMENT STRATEGIES, AND ENVIRONMENTAL CHANGE

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This presentation is on the lithics from Kansyore Island and specifically on one of the backed pieces called the crescents. The aim is to examine the variation in tool sizes and the way in which crescents were utilised by using the metric attributes, edge modifications and edge damage. This will be significant in understanding the evolution of projectile points and giving insights into food procurement processes and subsistence economy and the way the Later Stone Age people adapted and controlled the over changing environment that characterized most of Africa at that age. The examination of Kansyore Island material is based on the fact that limited attention has been given to Kansyore Island the type site and so far the limited work laid emphasis on ceramics. The Kansyore are a unique LSA group who combined use of lithics with ceramics.

ID: 01457, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Holocene coastal and palaeoenvironmental evolution in the surroundings of the Rioni Delta (Kolkheti lowlands, W Georgia)

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The Kolkheti lowlands (Colchis) form the central part of the extensive coastal lowlands along the Black Sea coast of Georgia. Due to continuous deltaic sedimentation and progradation of the Rioni River, and to sea-level fluctuations of the Black Sea, considerable changes of the coastal configuration and the palaeoenvironmental conditions in its hinterland are considered. Because there is a paucity of data regarding the Holocene coastal evolution of Western Georgia, this study aims to (i) determine the stratigraphy of the Kolkheti lowlands; (ii) elucidate the

palaeogeographical and palaeoenvironmental changes along the Georgian Black Sea coastline; and (iii) reconstruct the (relative) sea-level (RSL) evolution in the study area, and compare these results with other regional studies.

This research is based on ten sediment cores which were analysed for geochemical and geophysical parameters (XRF, granulometry, LOI, CN analysis). The chronostratigraphy is based on 4 IRSL and 13 ^{14}C ages. Our results show that significant palaeoenvironmental changes have taken place in the surroundings of the Rioni delta during the last eight millennia: Shallow marine conditions dominated most of the research area during the 6th millennium BC. These deposits were covered by brackish/lagoonal sediments and, since the 4th millennium BC, by floodplain-related fine-grained alluvial deposits. Both, the lagoonal and alluvial deposits are intercalated by peat layers. ^{14}C age estimates of the different peats enable the reconstruction of the RSL evolution in the study area. The formation of the sand spit system started during the 2nd millennium BC. Luminescence dating of the oldest foredune ridges indicate a last mobilisation of the dunes between the 10th and 12th century AD. Based on these results, we provide a valuable framework for further interpretations of the region\'s archaeological record, such as the identification of appropriate locations for the as yet “lost” city of Phasis.

ID: 01707, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Poster)

Spatial distribution and Timing of Dust-Induced CO2 Drawdown during the Last Termination

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Mineral dust aerosols in the atmosphere are thought to impact on Earth’s climate system directly by absorbing and scattering electromagnetic radiation, and indirectly by acting as cloud nuclei and by influencing biogeochemical cycles through micronutrient fertilization of the biosphere. Iron fertilization of the world’s High Nutrient Low Chlorophyl (HNLC) oceanic regions through increased dust deposition during glacial times has been linked to the lower atmospheric pCO_2 levels during the Last Glacial Maximum (LGM), 21 ka ago. According to the latest estimates, of the 80-100 ppm difference in atmospheric CO_2 concentration between average Holocene and LGM climates, about 40 are due to ocean stratification, 20 to iron fertilization, and 30 to other effects like ocean salinity and temperature, terrestrial biomass, etc. Here we investigate the contribution of each dust source (South America, Oceania, China, Sahara etc.) to the total iron fertilization effect. We also determine the timing of each region’s dust contribution during the last glacial termination.

ID: 02313, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Poster)

Indian summer monsoon dynamics and marine productivity in the Arabian Sea, a model-data comparison perspective

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In this study we analyze the relationship between monsoon intensity and marine productivity in the Arabian Sea. We show that the general paradigm used to reconstruct past monsoon changes and based on the fact that to a stronger summer monsoon corresponds higher productivity levels, is not verified in all climates. The simulations highlight the importance of the monsoon pattern, especially the position of the low-level jet above the Arabian Sea, in driving productivity changes. Both the insolation and ice-sheet cover changes have an effect on the monsoon pattern. Our results show that boreal summer productivity can contribute to the reconstructed higher glacial than interglacial productivity, in agreement with a new paleo-productivity reconstruction from northwestern Arabian Sea. Productivity reconstruction was obtained thanks to a transfer function based on the calibration of core-tops in the Indian Ocean with satellite chlorophyll concentrations. We investigate the reliability of such a transfer function in the different mean climate states of our simulations. It appears that the function reproduces past productivity changes quite well in the different simulations. However we point out some discrepancies linked to the calibration area and seasonality.

ID: 01871, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Antarctic ice sheet evolution over the last glacial cycle: Exploring the parameter phase-space of the Glacial Systems Model

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To better understand the role Antarctica played in the global climate, the observed contemporaneous change, and to make predictions of its future behaviour, reconstructions of past ice sheet evolution are required with uncertainty estimates. Glaciological modelling is an effective tool to generate continental-scale reconstructions over glacial cycles, but the models depend on parameterisations to account for the deficiencies (*e.g.*, missing physics, unresolved sub-grid processes, uncertain boundary conditions) inherent in any numerical model. These parameters, considered together, form a parameter phase space from which sets of parameters can be sampled; each set corresponds to an ice sheet reconstruction. We explore an updated Glacial Systems Model (GSM) of the Antarctic ice sheet over the last glacial cycle by performing a Latin hypercube sampling of the parameter phase space. This yields a large ensemble of Antarctic reconstructions which can be compared against observational constraints. This provides the opportunity to assess the ability of the GSM to envelope the observational constraints given the parametric uncertainties and discuss the implications for the evolution of the Antarctic Ice Sheet.

ID: 01883, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Holocene hydrological changes in the Eastern Equatorial Pacific

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The Eastern Equatorial Pacific region is marked by extreme latitudinal gradients in sea surface temperature and precipitation regimes, varying from the hyperhumid warm pool region North of Panama Basin to the hyperarid coast of southern Ecuador and northern Peru. In between those two regions lies a fresh pool, with the lowest mean and strongest seasonal cycle of sea surface salinity. The expansion and contraction of the fresh pool at the seasonal and interannual timescales are associated with changes in atmospheric circulation that cannot be easily tracked back in time. Yet, major changes in the central American monsoon intensity and in the El Niño/Southern Oscillation occurred during the Holocene, but it is still unclear if both climate phenomena have varied independantly or if they were intrinsically tied to each other. We will present preliminary results of a multiproxy study performed on a latitudinal transect of marine sediment cores to track changes in riverine runoff and hydrological parameters such as sea surface temperature and salinity during the Holocene. Those results will allow refining how the fresh pool dynamically responds to regional ocean-atmosphere-land interactions under natural climate variability.

ID: 02066, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Environmental Dynamics in the crater lakes region of Western Uganda: Evidence from Phytolith and Charcoal Records

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The Ndali crater landscape of western Uganda is rich in proxies of Palaeo-environmental records. Recent analysis of phytolith and charcoal assemblages from a sedimentary core extracted from Kabata swamp provide evidence of long-term forest dynamics and human interactions in western Uganda. The early Holocene ca. 10,000 yr. BP. is characterized by pronounced grassland habitat with variable forested environment. The charcoal record is evident during the last ca 5000 to 2000 yr. BP with significantly low assemblages of Plamae trees, suggesting evidence of anthropogenic fires and deforestation in the Early Iron Age in EASt Africa (ca. 500 BC) and matches the earliest evidence of iron working and rise of complex agricultural societies and high demands for fuel wood and impacts on forest cover along the western edge of Lake Victoria at ca. 500 BC. The forest cover became pronounced during the last ca. 1500 yr. BP indicating reduced human activity during this phase. However, the last ca. 1000 yr. BP is characterized by increased grassland habitat at the expense of forest habitat correlating with episodes of increased human influence in the region. Keywords: Charcoal, environmental dynamics, phytoliths, western Uganda.

ID: 01954, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Strip-bark morphology and radial growth trends: Considerations for hydroclimatic reconstructions

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Some of the oldest and most important trees used for hydroclimatic reconstructions develop strip-bark morphology, in which only a portion of the stem contains living tissue. The potential effects of strip-bark morphology on radial ring widths, and subsequent hydroclimatic reconstructions, are not well understood. Strip-bark growth patterns could alter our understanding of recent changes in moisture relative to past variations. In this study, we compared radial growth of ancient whole-bark (i.e. active cambium all around the stem) and strip-bark drought-sensitive *Pinus sibirica* trees growing on a lava field in central Mongolia. Ring widths of strip-bark and whole-bark trees show common year-to-year variability, however, the strip-bark trees contain long-term growth trends not evident in the whole-bark trees. In particular, the average growth rate of strip-bark trees significantly exceeds whole-bark trees during the 20th and 21st centuries. Further, trees with extreme cases of strip bark (>40% stem dieback) have a higher mean growth rate, and a higher positive trend in mean ring width from 1800-2014, as compared to trees with a smaller percentage of strip bark. These findings suggest that the morphology of some long-lived trees can influence ring-width patterns, and estimates of hydroclimate, through time. Potential morphological effects on radial growth should be considered when including and standardizing strip-bark trees for interpretation of past hydroclimate. Further study is required to understand how these effects might vary depending on tree species or site conditions.

ID: 01382, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Palaeoceanographic productivity changes in the Eastern Equatorial Atlantic since the penultimate glaciation

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A 150,000 year multiproxy record from the eastern equatorial Atlantic, offshore Gabon, has been investigated in order to examine the effects of changing glacial – interglacial climate on marine productivity.

Higher δ^{13}C values of the benthic foraminifera *Planulina wuellerstorfi* are documented during the penultimate glaciation (150 -130 kyr BP) in comparison to the Last Glacial Maximum [LGM] (24.5 – 19 kyr BP). In conjunction with higher $CaCO_3$ and larger variability in the isotopic difference between surface and bottom waters during the penultimate glaciation, this suggests that the eastern equatorial Atlantic was much more productive at this time than the LGM, most likely driven by increased nutrient input through strong bottom water upwelling.

The benthic δ^{18}O and planktonic δ^{18}O record of *Globigerinoides ruber* (white) infer that both the surface and bottom waters were warmer during the penultimate glaciation than the LGM. The sea surface temperature [SST] record assimilated through Mg/Ca analysis of the *G. ruber* evidences much lower SSTs during the last deglaciation in comparison with other regional records, and with the present day SST, which together with high Fe input, we attribute this to a greatly enhanced discharge of the Ogooué River.

Bulk coccolith carbonate δ^{13}C demonstrates a shift towards lower δ^{13}C values from the penultimate glaciation towards present day which does not dovetail the other proxies. The δ^{18}O coccolith record mirrors that of *G. ruber* during the two glacial periods, but presents much higher isotopic values during the interglacials. We interpret this as a shift in seasonality in the calcification of the coccoliths between glacial and interglacial periods, which in combination with the long term decline in δ^{13}C values reflects a change in the habitat preferences of this phytoplankton over the last glacial – interglacial cycle.

ID: 02104, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Fire regime during the Holocene in the Central Pyrenees (Spain) and its consequences in vegetation

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Landscapes are dynamic entities, exposed to continuous change as a result of long-term climatic, environmental and cultural processes which have been shaping them through time. Particularly, alpine ecosystems have been proved to be extremely sensitive to current Global Change. The long-term relationship between fire and vegetation is one of the critical features shaping mountain ecosystems, as this is a recurrent disturbance that implies large transformation in mountain areas, which are often less fire-prone than other ecosystems. Thus, understanding the long-term landscape dynamics is essential for modern conservation of forests in alpine areas.

Several palaeoecological studies have been carried out in Pyrenean lake and peat bog records covering the Lateglacial and Holocene. However, most of these studies are focusing on vegetation changes, so there is a lack of knowledge in understanding the role of fire as disturbance agent in landscapes. The goal of this research is, thus, to study how did fire act in terms of landscape transformation and how was vegetation responding to this perturbation.

We present here two records from high-mountain sequences; Marboré lake (2612 m a.s.l.) and La Basa de la Mora (1914 m a.s.l.) both located at the Central Pyrenees and comprising the last 14.5 kyr cal BP. Fire activity has been reconstructed based on sedimentary microcharcoal preserved on lake sediments. Identification and quantification of microcharcoal has been performed using automated image analysis in transmitted light. In addition, palynological, sedimentological and geochemical data have also been used for this study. The preliminary results show a synchronous pattern in the charcoal curves in terms of fire occurrence linked both to orbital parameters and human activity that could be proved to be as early as 4 Kyr cal BP.

ID: 02106, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

The last ice caves of western Mediterranean mountains and its potential for palaeoenvironmental reconstructions: an announced disappearance in the Pyrenees

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Mediterranean mountains are excellent sensors for environmental change as they are among the most vulnerable and fragile ecosystems to Global Change. Thus, palaeoenvironmental approaches in these areas are highly helpful to identify the system\'s responses to climate and/or human induced perturbations. Despite lacustrine sequences are one of the most usual palaeoenvironmental records, there are other potential archives which, in spite of its remote location and scarcity, can be key for accurate reconstructions in mountain lands. This is the case of ice deposits located within caves in Mediterranean mountains. The occurrence of ice caves has been known in the Iberian Peninsula since many decades, although their scientific study has started only in very recent years when, however, the ice-deposits are suffering a dramatic reduction as a consequence of the current global change.

Thus, we present here a pioneer study from an archive destined to disappear, as the A294 ice cave (2238 m a.s.l.), located in the Spanish Central Pyrenees, which offers the first pollen, charcoal and macrofossil record from an ice cave in the Iberian Peninsula.

The deposit is composed of both ice and several well delineated detrital layers plenty of plant remains, offering palaeoecological information and accurate chronologies based on ^{14}C dates. The time period comprising the whole deposit ranges from 5680 to 2230 cal yr BP. The good preservation of leaves, needles, seeds and fruits within the ice body (with taxa such as *Pinus uncinata*, *Abies alba*, *Vaccinium myrtillus*, *Dryas octopetala* and *Iris latifolia* among others), have allowed us to understand how environmental changes during the Mid-Holocene impacted the treeline communities in the area. Meanwhile, the obtained pollen data permits to discuss our results in the light of the regional Holocene vegetation history, where past climate and human activities could have shaped the general landscape of the Central Pyrenees.

ID: 01622, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Rapid climate fluctuations over the past millennium: evidence from a lacustrine record of Basomtso Lake, southeastern Tibetan Plateau

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Abrupt climate changes and fluctuations over short time scales are superimposed on long-term climate changes. Understanding rapid climate fluctuations at the decadal time scale over the past millennium will enhance our understanding of patterns of climate variability and aid in forecasting climate changes in the future. In this study, climate changes on the southeastern Tibetan Plateau over the past millennium were determined from a 4.82-m-long sediment core from Basomtso Lake. At the centennial time scale, the Medieval Warm Period (MWP), Little Ice Age (LIA) and Current Warm Period (CWP) were distinct in the Basomtso region. Rapid climate fluctuations inferred from five episodes with higher sediment input and likely warmer conditions, as well as seven episodes with lower sediment input and likely colder conditions, were well preserved in our record. These episodes with higher and lower sediment input were characterized by abrupt climate changes and short time durations. Spectral analysis indicated that the climate variations at the centennial scale on the southeastern Tibetan Plateau were influenced by solar activity during the past millennium.

ID: 01464, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Quantitative reconstruction of past vegetation in the forest-steppe ecotone of northern China:calibration and validation of a pollen-vegetation model

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Modelling efforts to quantitatively reconstruct vegetation from pollen have never been attempted along the forest-steppe border of China, however such studies are important in interpreting fossil pollen assemblages of vegetation change along this ecotone. In this paper, relative pollen productivity (RPP) and relevant source area of pollen (RSAP) as two important parameters in quantitative vegetation reconstruction using LRA（Landscape Reconstruction Algorithm approach） model, are estimated from the forest–steppe ecotone north of Shanxi, China, where pollen sampling and vegetation survey was performed at 18 random sample sites. The pollen analysis results show that *Artemisia*, Asteraceae, Poaceae, *Pinus*, *Picea, Quercus*, *Betula* and *Hippophae* dominate the pollen assemblages with more than 80% proportion. ERV（Extended R-value） analysis found that the RSAP is about 600m and that around 50% of the pollen in each sample comes from beyond this distance. $\text{RPP}_{\text{Poaceae}}$ is estimated as more than 10 for *Pinus* and *Hippophae* and around 5 for *Picea* and *Betula*. Estimates for *Artemisia* (3-4) are substantially lower than those reported from other studies in the steppe biome, and for *Quercus* (0.5) are substantially lower than those from the forest biome in north-east China or Europe. Four additional samples were then used to test the effectiveness of two different methods for reconstruction of vegetation proportion from pollen assemblages, the Landscape Reconstruction Algorithm (LRA) and the Modern Analogue Technique (MAT) method. Ordination showed that that both methods can give generally reasonable results, but there is still some discrepancy between the two methods.

ID: 01618, 01.- Open Session on past global changes, (Poster)

Eutrophication in Poyang Lake (Eastern China) Over the Last 300 Years in Response to Changes in Climate and Lake Biomass

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Poyang Lake in Eastern China is suffering from persistent eutrophication, which is degrading the local ecosystem. A better understanding of the mechanisms that drive eutrophication in lake systems is essential to fight the ongoing deterioration. In this study, hydraulic residence time (HRT) was used to evaluate Poyang Lake's trophic state. A hydrology and ecosystem forced

model was constructed to simulate long-term changes in algae and aquatic plant biomass and total phosphorous (TP). A comparison analysis revealed that between 1812 and 1828 (i.e., a consistent-change stage), climate and hydrology were the main driving forces, while algae and aquatic plant biomass contributed only 20.9% to the trophic changes in Poyang Lake. However, between 1844 and 1860 the biomass predominated contributing 63.6%. This could be attributed to nutrient absorption by algae and aquatic plants. A correlation analysis of the water TP and algae and aquatic plant biomass revealed a strong positive relationship. However, the algae and aquatic plant growth rate tended to decline after the biomass reached half of the maximum. This research reconstructs the long-term trophic evolution of Poyang Lake and provides a better understanding of the relationship between climatic and hydrological changes and lake ecosystems.

ID: 01916, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

The exodus of snails: European roads of malacological expansion during the MIS 11 interglacial

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Quaternary climatic cycles have had a strong effect on species distributions in general and on continental molluscs expansion in particular. During glacial periods most non-marine molluscs vanished from North-West Europe but during interglacial phases they progressively spread from refugia to recolonize these once periglacial territories. Interglacial malacofaunas thus provide a good means of evaluating biogeographical and biodiversity changes during the Pleistocene. The importance of calcareous tufas for Quaternary palaeoenvironmental reconstruction, and particularly for malacological studies, has been recognized for many years and among Pleistocene interglacial calcareous tufa deposits, those allocated to Marine Oxygen Isotope Stage (MIS) 11 are the most numerous in northern Europe. Tufas with rich malacological records dated to MIS 11 are known from Great Britain, northern France and central Germany. MIS 11 malacofaunas containing a distinctive assemblage from forest environments, together with species of Mediterranean plants, have been referred to as the '*Lyrodiscus* biome'. However preservation is unequal, the La Celle thick tufa in northern France has yielded the longest molluscan succession allowing the reconstruction of faunal history for the MIS 11 interglacial. A malacological framework based on the order of appearance of forest snails at La Celle is used reconstructing the progressive malacological recolonization of Europe during the interglacial. Expansion currents from western and eastern origins alternate during the first episodes of forest development. Those of the earliest forest phase at the beginning of the interglacial consist of species with current North and West European ranges. Species with Central European distributions appear just before the warmest phase, whereas Eastern and Southern European species are registered only later during the optimum itself. Finally stage 11 data show the slip northward of the biodiversity hot spot from the Alps in the modern fauna up to Germany, North France and South UK during the MIS 11 optimum.

ID: 02188, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Climate variability during the last millennium from literature data and model

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The last millennium marks a time with rich climate reconstruction using various methods. It is an excellent time period to quantify the relative importance of natural and anthropogenic forcings in explaining recent climate changes and would be of great help in understanding near future climate. For this very reason, we have conducted the East Asian construction using literature documents. This abstract is a paired analysis with another abstract in the same session (Lin et al.) which shows 4-6 year periodicities in precipitation records during 1644-1795 AD in Eastern China monsoon region. The frequency suggests a possible linkage with tropical El Niño–Southern Oscillation (ENSO). To explore this possibility, we use last millennium simulation with transient forcings from 850-2006 AD to access both the regional temperature and precipitation variations over time and space and changes in ENSO behaviors. Analysis was done over the entire simulated period with a focus on the 17-18th century to enable better understanding for our literature reconstruction. We show greater simulated ENSO amplitude during the end of the Little Ice Age that is consistent with model/data comparison for the North American drought (Coats et al., 2015) where the result suggests that internal variability may play important role on multidecadal and centennial time scales climate variability.

ID: 02046, 18.- Human Impact on Global Aquatic Systems, (Poster)

Historical variations and current state of atmospheric trace metal pollution in Southwest China: Reconstruction from lacustrine sediment in the Erhai Lake

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A 35-cm long sediment core and 42 surface sediment (0–2 cm) samples - retrieved from Erhai Lake - was analyzed for the concentrations of trace metals (Cr, Cu, Cd, Ni, Pb, Zn, Hg and As) and major metals (Al, Fe and Ti) and Pb isotope ratios ($^{207}Pb/^{206}Pb$ and $^{208}Pb/^{206}Pb$) to gain an understanding of regional atmospheric pollution and its impact on aquatic ecosystem. The trace metals pollution and sources was studied by combining the multivariate statistical analysis, enrichment factor (EF) and Pb isotope ratios, and the potential eco-risks were comparatively discussed by combining the sediment quality guidelines (SQGs), potential ecological risk index (Er and RI) and EF indices. The results indicated that Hg, Pb, Zn, Cd and As in the sediments were affected by anthropogenic contamination. During the 1860s-1890 CE, decreasing EFs of Hg, Pb and Zn and Pb isotope ratios suggest improving atmospheric quality, which may relate to the shrinking metallurgy activities during the late Qing Dynasty in SW China. Pollution levels of the metals remained stable during 1890-1960 CE, whereas they increased after 1960 CE, especially since the 1980 CE, suggesting degradation of the regional atmospheric environment with the economic development after the reform and opening in the late 1970s. In surface sediments, the contamination levels of the metals were moderate to significant for Pb, As, Cd and Hg on a whole lake basis. Pb isotopes and the PCA reveal that the atmospheric Pb is mainly from regional ore mining and smelting, which is also the dominant source of atmospheric Zn, Hg and Cd pollution in SW China, and anthropogenic As was derived primarily from agricultural sources. According to the consensus-based SQGs, the potential eco-risk index and EF values, the metals As, Cd and Hg are identified as the priority pollutants in surface sediments. These metals may pose high eco-risks to the aquatic ecosystem, and the risks are likely to increase with eutrophication.

ID: 01445, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Copper isotope signatures in the marine environment governed by complexation to strong organic ligands

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The development of metal stable isotopes as tools in paleoceanography requires a thorough understanding of their modern marine cycling. Copper is an interesting element to study because it is bioessential yet toxic, it is complexed by strong organic ligands in the aqueous phase, and it exhibits two redox states. Here we combine dissolved and particulate phase water column Cu isotope data, collected as part of the U.K. GEOTRACES GA10 section in the South Atlantic, with data for marine sediments from a variety of redox regimes. Despite the complexity of Cu aqueous chemistry, and the fact that these samples integrate the behaviour of Cu isotopes over a range of timescales, the data can be interpreted in terms of one key process: the preferential complexation of heavy Cu isotopes in the aqueous phase. Copper in the dissolved pool is universally isotopically heavy ($\delta^{65}Cu$ at +0.5 to +0.9‰ relative to NIST SRM 976). By comparison, authigenic Cu in particles and sediments has a surprisingly homogeneous, lighter, isotopic composition of about +0.3‰. We suggest that this signature reflects an equilibrium isotope fractionation in the aqueous phase between soluble, isotopically heavy Cu complexed to strong organic ligands, and isotopically light, uncomplexed or weakly complexed Cu, which is scavenged within the water column and delivered to the sediment. An isotopic shift in black shale Cu isotope values, from light (about –0.3‰) to heavier (about +0.2‰) values similar to those reported in this study, has recently been linked to the onset of oxidative weathering at 2.4 Ga. We suggest that the appearance of sedimentary $\delta^{65}Cu$ values that are similar to modern may instead hint at the establishment of modern-like organic ligand-dominated biogeochemical Cu cycling in the aftermath of the Great Oxidation Event.

ID: 02367, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

The biogeochemical signature of rapid climate events in the North Atlantic

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The North Atlantic is often thought of as the powerhouse of rapid glacial climate change, with stadial and interstadial events linked to different modes of the Atlantic Meridional Overturning Circulation. However while changes to ocean circulation and atmospheric dynamics continue to be well studied, less is known about the response of North Atlantic biogeochemistry to rapid climate change events. Recently it has been suggested that the North Atlantic may play a direct role in abrupt CO_2 rise, however little data exists to test this hypothesis. Here we present new boron isotope data from planktic foraminifera that allow us to reconstruct changes in surface ocean pH and CO_2 during a Heinrich Event-Dansgaard-Oeschger tandem. These are complemented by trace element and nutrient proxy data that together allow us to test the North Atlantic's role in abrupt CO_2 change, and evaluate potential controlling mechanisms.

ID: 01291, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Poster)

Provenance discrimination of siliciclastic sediments in the central Bay of Bengal and their implication for paleoenvironmental records since 42.8 ka

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Siliciclastic grain-size, rare earth elements (REEs), major elements and clay minerals of core sediments from the central Bay of Bengal were analyzed for the identification of sediment origins and paleoenvironment evolution reconstruction since 42.8 ka BP. Discrimination plots based on geochemical and clay mineral parameters suggest that the cored sediments are predominately derived from the Himalayan source transported by the Ganges-Brahmaputra (G-B) rivers with minor contributions from the Indian peninsula. Based on the clay mineral compositions, contribution percent of the Himalayan source and the Indian source were calculated. Sedimentary signals including contribution percent of two provenances, Chemical Index Alteration (CIA) and Al_2O_3 (%) imply that the sea level changes play important roles in the terrigenous input to the core site areas by controlling the depositional regime between the lowered sea level stands and the high stands of sea level. However, the Indian summer monsoon (ISM) play primary roles in the terrestrial material input and the chemical weathering intensity (CWI) in the millennial scale. The Dansgaard/Oeschger (D/O) pattern was discovered over the last glacial and deglacial periods. Warmer interstadials correlate with higher contribution percent of the Himalayan source, CIA values and Al_2O_3 (%) than colder stadials. According to the variations of these records, paleoenvironment evolution since 42.8 ka BP was reconstructed and divided into six stages (Ⅰ: 42.8-37.4 ka BP; Ⅱ: 37.4-29.3 ka BP; Ⅲ: 29.3-23.5 ka BP; Ⅳ: 23.5-15.8 ka BP; Ⅴ: 15.8 ka BP-10.7 ka BP and Ⅵ: 10.7 ka BP~).

ID: 01586, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Abrupt winter monsoon changes on the western Chinese Loess Plateau since the last deglaciation

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Abrupt cooling events since the last deglaciation had significant influence on ecological change and human civilization. However, imprints of these abrupt events are significantly different on regional to global scale, largely due to chronology uncertainty and proxy sensitivity. Here we present a centennial-resolution grain size record of a 13.5-m core retrieved form the river terrace on the western Chinese Loess Plateau to infer abrupt winter monsoon changes since the last deglaciation. Based on ^{14}C chronology, mean grain size exhibits significant fluctuations during the last deglaciation, corresponding to the Heinrich event 1, Bølling-Allerød warming, and Younger Dryas cooling. Between 10-6 ka BP, centennial-scale strengthening of the winter monsoon intensity with large amplitude and short duration occurred around 10.1, 9.8, 9.2, 8.2, 7.1, and 6.5 ka BP. During 6-1 ka BP, the winter monsoon intensity was relatively strong over three intervals (6-5.4, 4.6-3.8, and 2-1.8 ka BP). Comparison of these abrupt winter monsoon changes with proxies from high- and low-latitude regions indicate that both north Atlantic and tropical processes played important roles in driving abrupt climate changes.

ID: 01316, 01.- Open Session on past global changes, (Poster)

Understanding the temporal slope of the temperature-water isotope relation: The slope equation

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The temporal and spatial slopes of water isotope-temperature relations are studied for the last

21,000 years over the middle and high latitudes using a series of simulations in the isotope-enabled atmospheric model isoCAM3. Our model simulation suggests

that both the temporal slope and spatial slope remain largely stable throughout the last deglaciation.

The temporal slope can vary substantially across regions. Nevertheless, on average, and most likely, the temporal slope is about 0.3‰°C and is about half of the spatial slope. Furthermore, the relation between temporal and spatial slopes is understood using a semi-theoretical equation that is derived based on both the Rayleigh distillation and a fixed spatial slope. The slope equation quantifies the Boyle's mechanism and suggests that the temporal slope is usually smaller than the spatial slope in the extratropics mainly because of the polar amplification feature in global climate change.

ID: 02293, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

The influence of the ITCZ mean positioning in the precipitation variabilities during PDO events in the Sibuyan Basin, Philippines during the Holocene

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At present, in the western Pacific, positive PDO is contemporaneous with severe megadroughts. But is this pattern similar to the last thousand years? Here, we look at how changes in precipitation varies during PDO events in the Holocene using geochemical and grain size proxies. A 9.6m long sediment core from Sibuyan Sea Basin within the internal seas of the Philippines, was raised from a water depth of 1660m. It was analyzed using an XRF core scanner at 1 cm resolution. Grain size was determined using a laser particle analyzer. Nine AMS radiocarbon dates from bulk organics provide age control spanning back to 14 ka. Overall, the Ti/Al, mean grain size, percent sand, and mass accumulation rates follow the 10° N winter insolation curve. Wavelet analysis of Ti/Al reveals occurrence of low frequency solar activity cycles at 11 ka to 6 ka, and higher frequency cycles from 6 ka to present. Lower frequency cycles from 6 ka to present are associated with the PDO cycles. High frequency patterns are consistent with the occurrence of El Nino events from the Palcacocha and El junco records. Most of the observed PDO cycles showed opposite pattern from the present day relationship. PDO cycles during the late Holocene may not be reflective of the present relationship due to the positioning of the ITCZ affecting rainfall variations. At present the relationship of the positive PDO is reflected since the ITCZ location may veered further to the south of the study area thereby relatively reducing rainfall distribution.

ID: 01438, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Pre-Columbian settlement patterns and landscape modification in the Bolivian Amazon since the early Holocene.

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The landscape of the Bolivian Amazon is dotted with thousands of pre-Columbian earthworks. Although most of them were built between 2k and 600 yrs. BP, some are as old as 10k yrs. Hunter gatherers started to modify the landscape in the early Holocene by creating shell middens, which later became elevated patches of forest in the savannah, today known as forest islands. These first Amazonians lived here until 4k yrs. BP, when an abrupt change in river dynamics brought about by an increase in precipitation forced the abandonment of the Bolivian Amazon. After two thousand years of archaeological hiatus, which matches the period of highest river activity in the region as inferred from 30 paleosol radiocarbon ages, agriculturists reoccupied the Bolivian Amazon. This late Holocene occupation is characterized by a high diversity of earthworks and agricultural strategies that were finely adapted to local soils and hydrology. These late Holocene "moundbuilders" deeply transformed the landscape by building raised fields, monumental mounds, causeways, canals, fish weirs and ring ditches. Through the construction of these earthworks, pre-Columbians changed the local and, in some areas, the regional hydrology. The Bolivian Amazon is, therefore, a spectacular example of human-environment interactions, where climate driven changes in the hydrology shaped settlement patterns but, in turn, human engineering of the landscape changed the hydrology.

ID: 01987, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

High-resolution transient simulations of Holocene climate with the MPI Earth system model, forcing and experiments

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The Max Planck Institute Earth System Model MPI-ESM1 consists of the latest version of the atmospheric general circulation model ECHAM6, including the land surface model JSBACH3 with carbon cycle and vegetation dynamics, coupled to the ocean circulation model MPI-OM, which includes the HAMOCC model of ocean biogeochemistry. Several simulations over the Holocene period of the last 8000 years have been performed and feature relatively high resolution for multi-millennial simulations: a horizontal resolution of 1.875 deg (spectral truncation at T63) in the atmosphere and from 12 to 180 km in the ocean. The forcing encompasses recent compilations of reconstructed drivers of the transient Holocene climate: atmospheric greenhouse gas (CO_2, CH_4, N_2O) concentrations and stratospheric volcanic aerosol distribution, spectral solar irradiance variations and stratospheric ozone, as well as orbital insolation forcing and land-use changes.

Besides a \'baseline\' Holocene simulation, we have performed a second experiment, where the atmosphere can freely exchange CO_2 with land and ocean, but its CO_2 concentration is forced towards the ice-core target values via decrease in surface ocean alkalinity, resembling coral reef growth during the Holocene. Furthermore, two \'slow forcing\' experiments exist, driven with orbital and greenhouse gas forcing only, where in one experiment the forcing was accelerated by a factor of 10: 800 instead of 8000 model years simulate the whole Holocene. The suite of model simulations is complemented by ensemble simulations of certain periods of particular interest. Our high-resolution transient Holocene simulations allow for a better understanding of the climate system with its interaction between internal variability and externally forced climate signals. Different periods with a length of several centuries within the Holocene are in the research focus. These are distinct in particular through the radiative forcing due to volcanic eruptions of different amplitude and probability.

ID: 01732, 21.- Sediment Flux: Past Peaks and Troughs, (Poster)

Increased sedimentation following the Neolithic Revolution in the Southern Levant

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The Dead Sea drainage basin offers a rare combination of well-documented substantial climate change, intense tectonics and abundant archaeological evidence for past human activity in the Southern Levant. It serves as a natural laboratory for understanding how sedimentation rates in a deep basin are related to climate change, tectonics, and anthropogenic impacts on the landscape. Here we show how basin-wide erosion rates are recorded by thicknesses of rhythmic detritus laminae and clastic sediment accumulation rates in a long core retrieved by the Dead Sea Deep Drilling Project in the Dead Sea depocenter. During the last ~11.5 kyr the average detrital accumulation rate is ~3-4 times that during the last two glacial cycles (MIS 7c-2), and the average thickness of detritus laminae in the last ~11.6 kyr is ~4.5 times that between ~21.7 and 11.6 ka, implying an increased erosion rate on the surrounding slopes during the Holocene. We estimate that this intensified erosion is incompatible with tectonic and climatic regimes during the corresponding time interval and further propose a close association with the Neolithic Revolution in the Levant (beginning at ~11.5 ka). We thus suggest that human impact on the landscape was the primary driver causing the intensified erosion and that the Dead Sea sedimentary record serves as a reliable recorder of this impact since the Neolithic Revolution.

ID: 01416, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Resilient landscapes in isolated mountain areas. The late Holocene in Montes de Toledo (Spain)

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Mountain areas have traditionally been considered marginal spaces affected by harsh climate conditions and rough topography where is hard to survive. These landscapes embrace some biological diversity, hosting resilient communities despite long-term anthropic interaction. Agriculture, fire and grazing linked to charcoal extraction and felling have manage the environment drawing a complex cultural landscape to fulfil human purposes. Montes de Toledo, a historical shire in the heart of central Iberian could be a good example of isolated landscape with interesting changes along time due to the human actions. The aim of this study is to know the biogeographical history of many species such as birch (*Betula*), yew (*Taxus*), hazel (*Corylus*) or deciduous and evergreen *Quercus*, along this historical area without archaeological evidences using natural peat deposits.

ID: 01894, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

PALEOFLOOD HYDROLOGY AND RELATED ENVIRONMENTAL CHANGES OF A MEDITERRANEAN RAMBLA (CASTELLÓN, NE SPAIN)

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Rambla de la Viuda (drainage area of 1500 km^2) is a Mediterranean ephemeral river with a hydrological regime characterised by large floods. The region has a long history of anthropogenic land-use changes, which contributed to temporal phases of increased rates of sediment yield and changes in flood hydrology. Valley sides revealed important accumulations of slackwater flood deposits. These slackwater flood deposits emplaced by high stage floodwaters show a complete stratigraphy from which we can reconstruct long-term records of floods and environmental changes. Interbeded with these flood units, colluvial units can be observed, and several edaphic horizons developed on colluvial and fluvial deposits were identified.

The alluvial and colluvial chronostratigraphical, sedimentological and palaeobotanical (phytoliths) analysis of these units, together with the hydraulic flood modelling approach, made possible to determine: a) the way in which hydrological extreme events may be changing both in frequency and intensity as a result of climate variability, b) the weight of human influence (land-use) on soil hydrology, c) geomorphic channel changes, and c) human/climatic induced changes on landcover during this temporal scale (last 500 yrs).

ID: 01360, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

Towards a novel continuous sublimation extraction/laser spectroscopy method to unlock the greenhouse gas record in deepest ic

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Ice cores are unique archives of ancient air providing the only direct record of past greenhouse gases – key in reconstructing the roles of greenhouse gases in past climate changes. The European Partnership in Ice Core Sciences (EuroPICS) plans to drill an ice core extending over 1.5 Ma, nearly doubling the time span of the existing greenhouse record and covering the time period of the Mid Pleistocene Transition. The ice covering the time interval from 1-1.5 Ma is close to the bedrock and, due to glacial flow, extremely thinned. A 10,000 yr glacial/interglacial transition can be compressed in 1 m of ice. The targeted 100 yr resolution therefore constrains the sample size to 15-30 g containing only 1-2mlSTP air.

Within the deepSlice project we aim to unlock such atmospheric archives in extremely thinned ice by developing a novel coupled semi-continuous sublimation extraction/laser spectroscopy system. Vacuum sublimation, with an infrared source, is the best method that allows 100% gas extraction of all gas species from ice without changing the isotopic composition of CO_2. In order to reduce ice waste and accelerate sample throughput, we are building an extraction system able to continuously sublimate an ice-core section and subsequently collect discrete full air samples. For the gas analytics we develop a custom-made mid-infrared laser spectrometer allowing simultaneous measurement of the CO_2, CH_4 and N_2O concentrations as well as the isotopic composition of CO_2 on air samples of only 1-2 mlSTP. The two systems will be coupled via cryo-trapping of the sample air in dip tubes, followed by expansion of the sample air into the laser spectrometer. Due to the nondestructive laser technique, the air sample can be recollected and reused for further analytics.

ID: 02169, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Land Use 6k: A First Assessment of South Asia

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This paper will review the current state of archaeological evidence for human land use in South Asia in the middle to late Holocene. The review forms part of a larger effort of the PAGES-funded Landcover6k and LandUse 6k project (http://landuse.uchicago.edu/about/) to reconstruct global land use and land cover datasets for the purpose of improving models of anthropogenic land cover change being used by climate scientists. Here we will present archaeological and paleoecological data from different regions of modern day India, Pakistan, and Bangladesh in an effort to identify significant changes in agricultural, pastoral, hunting and foraging land use and anthropogenic land cover changes between ca. 6000 BP and 3000 BP. As we will detail, during this period there was an intensification and expansion of agricultural and pastoral land use across many regions of South Asia that significantly affected land cover and other environmental conditions.

ID: 02132, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Living at the edges? Human responses to the onset of the post-Holocene Climatic Optimum aridity

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The end of the Holocene Climatic Optimum (the Mid-Holocene transition at ca. 5 kya BP) marked a turning point in several regions of the Old World. A general decrease in water availability determined a transformation of continental ecosystems, with notable effects on natural resources. North African savannas turned into deserts or semi-deserts, not differently than many areas in the Arabian peninsula and the Far East, that changed, with few exceptions, into significantly drier contexts. Yet, in the frame of widespread drying, local geomorphological and physiographic settings mitigated or enhanced the outcome of the aridification process. Human societies reacted in different ways, ranging from the collapse and migration, to adaptation and shifts to new strategies of food security. Clearly, local sequences are key to understand the development of the human-environment interactions, local adaptations, and frequentation pulses. In this paper, we review selected examples of successful adaptation to arid lands, from the Late Holocene to the present, focusing on the variety and originality of human responses to the onset of new environmental conditions. The aim of this presentation is to outline a different perspective on human exploitation of arid lands, highlighting stories of resilience and continuity in occupation of areas generally described as inhospitable. Finally, we suggest reconsidering the hypotheses that view the post-Holocene Climatic Optimum cultural trajectories merely in terms of abandonment and societal collapse.

ID: 01351, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Reassessing Climate and pre-Columbian Drivers of Paleofire Activity in the Bolivian Amazon

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There is considerable debate over the extent of pre-Columbian impact on Amazonia ecosystems, ranging from near pristine to intensely humanized ecosystems. To explore long-term drivers of fire and vegetation change, a 50,000 year old sediment core record from Laguna Chaplin is reanalyzed to develop a paleoecological toolkit to detect pre-Columbian human disturbance in the Bolivian Amazon. A modified pollen sieving method is used to concentrate potential crop pollen as an indicator for past human occupation. High-resolution sampling of macrocharcoal is analyzed using statistical algorithm software including CHAR Analysis and Regime Shift Detection to identify changes in past fire regimes on local and regional scales. Over the past 50,000 years climate, particularly changes in precipitation, is the dominant driver of fire activity and biomass burning at Laguna Chaplin. For most of the record vegetation is dominated by fire adapted seasonally dry forest/savanna swamps. There is a shift towards less flammable, non-fire adapted rainforest vegetation after ca. 2000 cal yr BP. At ca. 1,000 cal yr BP, increased fire frequency became antiphased with local and regional decreases in biomass burning. During this period the presence of corn pollen (*Zea mays*) indicates that agriculture is practiced around Laguna Chaplin. These data suggest pre-Columbian forest and fire management practices are occurring since the last millennium. Frequent low intensity human caused fires are likely used to clear land and ameliorate the nutrient poor tropical soils to benefit agricultural crop yields. Climate ultimately drives late Holocene forest expansion and decreased local and regional biomass burning despite local forest and fire management around Laguna Chaplin. This study demonstrates the benefits of a multi proxy, high-resolution paleoecological toolkit to detect pre-Columbian occupation and distinguish climate and human drivers of past ecological change in the Amazon.

ID: 01929, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Asynchronous patterns of Quaternary disappearance of tree taxa from Southern Europe

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The Pleistocene palaeoenvironmental sequences from Southern Europe record the disappearance of several tree populations. Here, based on a new compilation of pollen and macrofossil data, we show that the timing of extinction appears very diverse among taxa and regions. Three cases are considered in detail, showing unexpected patterns and ruling out simple N-S or W-E trends. *Sciadopitys* is currently represented by a single species in high rainfall montane areas of Japan. The Italian Peninsula is the only region of Southern Europe where it was present during the Gelasian and early Calabrian. *Sciadopitys* persisted there for over one million years after it had disappeared from the rest of Europe. The genus *Eucommia* includes one single extant species living in S China. It persisted in Southern France until the late Calabrian, expanding into Northern Italy without reaching Central Italy. A population at Tenaghi Philippon, lasting until approx. 600 ka, was possibly a separate one, as it is not matched by any other data from Greece and around the Black Sea. The genus *Tsuga* is an important element of subalpine coniferous and temperate broad-leaved deciduous forests, with disjunct distributions in Asia and North America. Its Southern European Quaternary records appear rather homogenous, with sparse presence in the most southern sites (Alboran Sea, Rhodes), and significant abundances in NE Spain-S France and the Italian Peninsula during the Early Pleistocene, especially during the Calabrian. After 700 ka a severe disruption of its range lead to its rapid and definitive disappearance. This is recorded at different times during the Middle Pleistocene: approx. 750 ka in N Italy and Greece, 550 ka in S France and peninsular Italy, and 280 ka in Anatolia. These insights highlight the critical role of palaeobotanical data in elucidating the diverse spatiotemporal trajectories of tree populations in southern Europe during the Quaternary.

ID: 02337, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Tracing the northern edge of Southern Westerlies dynamics as an indicator of precipitation seasonality in Subtropical Chile since the Late Pleistocene

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The high Andes from Subtropical Chile is a key area to study interaction between Subtropical Southeast Pacific High and the northern edge of the Southern Westerlies Wind Belt (SW) in the past since its location, the availability of proper palaeoclimatic archives and the low human disturbance. Here, the interplay between both systems determines the current mediteranean-type climate characterized by rainy winters and dry summers, allows to trace the winter activity of SW at millennial-to-interannual time scales. The present paper aims to show the dynamics of the northern edge of the SW during the last 15ka based on pollen records from high Andean lakes (30°-33°S). These records suggest cooler/wetter than present conditions during the Late Pleistocene followed by warm/humid conditions during early Holocene followed by very dry conditions between 7-6ka which gradually turned to more humid conditions at 2ka. These climatic trends show a high concordance with records of lowlands from Subtropical Chile, suggesting a regional climatic control related to the SW past dynamics. Then, the comparison of these winter precipitation inferences to those of pollen records from southern Chile, sensitive to summer precipitation, allowed to establish the seasonality dynamic of the SW at centennial-to-millennial timescales. Anti-phased (or in-phase) rainfall patterns between both areas since the Late Pleistocene could be therefore explained by strong (or weak) seasonality changes of the SW. Acknowledgements: FONDECYT#1140837

ID: 02037, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Influence of atmospheric circulation on isotopic composition of precipitation in foothill Altai Mountains (Russia)

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During the past three decades, several atmospheric and oceanic general circulation models (GCMs) have been enhanced by the capability to explicitly simulate the hydrological cycle of the two stable water isotopologues (water isotopes) HDO and $H_2{}^{18}O$. The input parameters for GCM models that take into account the changes in isotopic composition of precipitation are the results obtained by the GNIP –

Global Network of Isotopes in Precipitation. In the wide area of Russia, at different times there were not more than 40 stations, which conducted the sampling of atmospheric precipitation at the same time. This study presents the first results of isotopic composition of atmospheric precipitation and snow cover sampled in foothills of Altai during 2014-2016 (using GNIP recommendations). The isotopic composition of precipitation varied within a wide range with maximum 30, 204 and 51 ‰ for $\delta^{18}O$, δD and d_{exc} respectively. The comparison of results of the isotopic analysis of the snow cover integral samples with the corresponding in time interval the average weighted values of precipitation showed high consistency. We found that the isotope composition of precipitation is closely related to atmospheric circulation patterns (NAO) through their effect on the sources and transport of atmospheric vapor. The backward trajectories of the motion of the air-masses responsible for Altai precipitation, calculated using HYSPLIT model (> 1200 trajectories), allowed to find the main regions-sources of precipitation. The found relations can be used as the reliable transfer functions for the regional paleoreconstructions and climate modeling in Altai Mountains and/or to support robust interpretations of isotopic archive data. This work was supported by the Russian Foundation for Basic Research (project no. 16-35-00188mol_a) and project № 01201374142.

ID: 02018, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Mid-Holocene data-model comparison of paleoceanography and paleoclimate in Peru based on CMIP5 simulations

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Several paleoceanographic studies of the Mid-Holocene have been realized along the Peruvian coastal margin and MH paleo-precipitations have been evaluated in the northern region as well as in Ecuador. We use these data for an evaluation of CMIP5 climate model performance in this region. The models used are those available at ESGS site.

Proxies of sea surface temperature (SST) based on alkenones in marine cores and $\partial^{18}O$ on coastal shells indicate differences on the order of -1 °C between MH and present conditions in most of the studied sites. Contrastingly, some foraminifer Mg/Ca studies indicate MH SST comparable or slightly warmer than present. This descrepancy has been interpreted as a lower seasonal amplitude at MH since alkenones are produced in the summer season (JFM). The models indeed indicate lower MH SST from January to June in northern and southern regions, with a maximum difference (MH-PI) of -0.5 to -1.5°C in March. This is in agreement with alkenones results although the simulated change in annual temperature is much lower than 1°C. From July-August to November-December, simulated SST are slightly warmer during MH and this is best marked in the northern region.

The reduced clastic sedimentation on the continental margin in the Northern region during MH has been interpreted as a decrease in precipitations, which is reproduced with different degrees of intensity by the models on the adjacent continental region. Lacustrine studies at Pallcacocha lake in Ecuador point to a reduction of El Nino events frequency leading to less intense precipitation before 5000 BP. An analysis of IPSL transitional simulation between 6 and 3000 BP do not indicate any reduction in ENSO intensity but indeed a reduction of precipitation intensity linked to a migration of ITCZ.

ID: 01413, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Wetland transgressions and recent late Holocene vegetation and fire variability in the semi-arid Amboseli landscape, southern Kenya

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The semi-arid landscape of Amboseli, southern Kenya, is characterised by a number of groundwater-fed wetlands that record past ecosystem changes in the sedimentary geoarchives. Pollen, non-pollen palynomorphs (NPP) and macroscopic charcoal analyses were performed on a 247.5 cm long radiocarbon-dated sediment core collected from Esambu Swamp to provide an environmental history since 5000 cal yr BP. From 5000 until as late as 500 cal yr BP, the pollen record was dominated by the semi-arid taxa (*Acacia*, *Aloe*, Amaranthaceae-Chenopodiaceae, Asteraceae and *Capparis*) and low charcoal concentrations that suggested a xeric ecosystem with low plant biomass and poorly connected fuels. Radiocarbon dates suggest an unconformity with a potential temporal range of 3800-

500 cal yr BP. Subsequent peat accumulation has preserved a 500 cal yr BP record of wetland ecosystem dynamics. Woodland taxa, scrub and savannah, as well as aquatic taxa increased in abundance and charcoal drastically increased notably associated with *Typha*. Increased abundance of wind-blown Afromontane forest taxa (*Celtis, Juniperus* and *Olea*) most likely derived from the adjacent slopes of Mount Kilimanjaro and the Chyulu Hills and local arboreal taxa (*Acacia, Acalypha, Commiphora* and *Salvadora*) suggest a period of increased moisture concomitant with increased local biomass burning. Increased, yet intermittent, abundances of *Nymphaea* after 400 cal yr BP suggest expanded open water at the swamp and semi-arid taxa such as *Balanites* increased and *Acacia* decreased until 100 cal yr BP. Poaceae pollen >60 µm in diameter, potentially derived from introduced cereal crops, occurred consistently from 300-100 cal yr BP. Anthropogenic modifications to the ecosystem have intensified dramatically since the 1980s, most notably with agricultural transformation of neighbouring wetland areas.

ID: 02302, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Proof-of-concept for solution-based Mg/Ca on individual planktonic foraminifera: 250 years of ENSO variability

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Individual foraminiferal analysis (IFA) is a potentially powerful tool for probing vertical and seasonal habitats, the past amplitude of the seasonal cycle, and past interannual variability such as ENSO. We have developed a method to analyze Mg/Ca in individual foraminifera following the established ‘wet chemistry’ protocol of crushing, oxidative cleaning, dissolution, and analysis by magnetic sector ICP-MS. This method is relatively fast and provides a direct comparison to the many multi-specimen Mg/Ca studies that have been undertaken over the past 15 years. Measurements on liquid standards indicate that analytical precision is better than 1% down to sub-microgram post-cleaning sample sizes. Multi-spot laser ablation measurements made on the same individual specimens are in good agreement across several species. Core top analyses at Ontong Java Plateau document little change in the shapes of paleotemperature distributions as dissolution proceeds.

We demonstrate the utility of this method using an unbioturbated box core from Soledad (aka San Lazaro) Basin, located off Baja California Sur in the eastern subtropical Pacific, a site that is strongly teleconnected to ENSO today. We present Mg/Ca measured on individual specimens of *Globigerina bulloides* (upwelling season) over the past 250 years, with ~5-year resolution. For the late 20th century population we use a Monte Carlo approach to simulate what water depths, months, and temperature fidelity these individuals are actually recording. By comparison to hydrographic reanalysis data, we find a best fit at 25 ±20 m, April ±2 months, and ±1.5°C (all 1s). Mg/Ca average values indicate that this site was warmer during the final century of the Little Ice Age, consistent with an ‘El Niño-like’ mean state at that time. Quantile-quantile analyses of populations document significant changes in ENSO variance at multi-decadal to centennial timescales.

ID: 01958, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Holocene glaciation of northwest Greenland

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Given the long response time of ice sheets, characterizing the sensitivity of the Greenland ice sheet (GIS) to both atmospheric and oceanic forcings in the past plays a vital role in forecasting future GIS changes. Our terrestrial-based study is primarily focused along the margins of the marine-terminating Petermann Gletscher of northwestern Greenland, and is part of a larger multidisciplinary research effort with oceanographers, geophysicists, and atmospheric scientists that aims to better understand Petermann’s response to past perturbations in climate and the primary mechanisms that drive those changes. The deglacial and Holocene history of the GIS along the northwestern margin is constrained primarily by minimum limiting ^{14}C ages from Ellesmere Island and the Greenland coast with limited chronologic information from the ice-free interiors (England, 1999; Bennike, 2002; Weidick & Bennike, 2007). In order to more accurately resolve the ice sheet history of the northwestern sector of the GIS, rock samples from approximately 170 erratic boulders on moraines and from across an expansive ice free region (Washington Land) adjacent to Nares Strait were collected for surface exposure dating with ^{10}Be.

Here we present cosmogenically derived exposure ages (n=14) for the youngest moraine complex along the margin of the GIS, south of Petermann Gletscher. This innermost moraine is dated to approximately 250 ± 90 years B.P. and marks the Little Ice Age (LIA) advance of the GIS. The timing of this advance is similar to other advances in southern Greenland (Lowell et al., 2013; Sinclair et al., 2016) and our new ages from NW Greenland demonstrate an extensive LIA advance across the GIS margin. In addition to our preliminary ages from the late Holocene moraines, other ages from lateral moraines along the Petermann Gletscher margin and from erractic boulders in the interior of Washington Land will also be presented as our processing continues into the spring

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ID: 01976, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Paleoclimatic reconstruction from marine records of central and western Mediterranean area over last five millennia using planktonic foraminifera

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Planktonic foraminifera have been used to reconstruct the climate evolution of the last five millennia from marine sediment cores of western and central Mediterranean Sea. We provide the comparison between planktonic foraminiferal paleoclimatic curves obtained from different Mediterranean areas: Sicily Channel; Minorca Basin; north and central Tyrrhenian Sea. These results are compared with paleoclimatic curves from extra Mediterranean areas to evaluate the geographical extent of the recognised climatic variability.

The paleoclimatic curves document an overall warm and stable climatic condition from 3500 BCE to 750 BCE, corresponding to low amplitude oscillation in D14C residual and to a period where NAO index does not show particular trend and/or main oscillation. From 750 BCE to ca. 250 BCE, the Mediterranean and extra-Mediterranean paleoclimatic curves document a transition-cooling phase, which becomes consistent at ca. 250 BCE, in correspondence of the sharp global cooling related to Homeric solar minimum.

The global cooling over the last two millennia, related to the decrease in insolation, is documented by the almost isochronous response of Mediterranean and extra-Mediterranean planktonic foraminifera. This long-term cooling trend results parallel to the shift of NAO index *vs* positive values and reach the maximum cooling during the Little Ice Age at ca. 1800 CE (Maunder Minimum). At ca. 550 CE the planktonic foraminiferal paleoclimate curves show a further cooling phase, which age corresponds to the Late Antique Little Ice Age (LALIA), considered as an additional environmental factor contributing to the establishment important change in human culture. At 1800 CE, the paleoclimatic curves show a turnover *vs* the modern warm climate condition.

This comparison will provide a more complete high-resolution picture about the climate changes in the Mediterranean region and the validity of planktonic foraminifera as tool for global paleoclimate reconstruction over the last five millennia.

We acknowledge NEXTDATA Project (http://www.nextdataproject.it)

ID: 02043, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Marine response to climate changes during the last five millennia in the central Mediterranean Sea

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We present a high-resolution paleoclimatic and paleoenvironmental reconstruction of the last five millennia froma shallowwater marine sedimentary record from the central Tyrrhenian Sea (Gulf of Gaeta) using planktonic foraminifera, pollen, oxygen stable isotope, tephrostratigrapy andmagnetostratigrapy. Thismultiproxy approach allows to evidence and characterize nine time intervals associatedwith archaeological/cultural periods: Eneolithic (base of the core–ca. 2410 BCE), Early Bronze Age (ca. 2410 BCE–ca. 1900 BCE), Middle Bronze Age–Iron Age (ca. 1900 BCE–ca. 500 BCE), Roman Period (ca. 500 BCE–ca. 550 CE), Dark Age (ca. 550 CE–ca. 860 CE),Medieval Climate

Anomaly (ca. 860 CE–ca. 1250 CE), Little Ice Age (ca. 1250 CE–ca. 1850 CE), Industrial Period (ca. 1850 CE–ca. 1950 CE), Modern Warm Period (ca. 1950 CE–present day). The reconstructed climatic evolution in the investigated sedimentary succession is coherent with the short-term climate variability documented at the Mediterranean scale. By integrating the planktonic foraminiferal turnover from carnivorous to herbivorous–opportunistic species, the oxygen isotope record and the pollen distribution, we document importantmodification from the onset of the Roman Period to the present-day. From ca. 500 CE upwards the documentation of the cooling trend punctuated by climate variability at secular scale evidenced by the short-term δ18O is very detailed. We hypothesise that the present day warm conditions started from the end of cold Maunder event. Additionally, we provide that the North Atlantic Oscillation (NAO) directly affected the central Mediterranean region during the investigated time interval.

ID: 01919, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

THE PROBLEMS OF CHANGE CLIMATE CONDITIONS FOR THE PERIOD OF OVER THE LAST CENTURY OVER MOUNTAINOUS TERRITORY OF ARMENIAN REPUBLIC

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As a result of climate global changes are changed weather phenomena in different regions, which, mainly, depend on common circulation of atmosphere. Armenia as a mountainous country, with dry climatic conditions, for his whole territory is vulnerable for global climate change. So, identification and assessment of spatial distribution of the dynamics of climate change, a reliable prediction of climate change and the timely warning, the development of rapid response systems, warning of the population and higher levels of education are the main conditions for human security and sustainable development of the republic. Considering the above, the set a goal to study, identify and analyze the dynamics of air temperature and precipitation over the last century (instrumental observations), analyze the problem of climate forecasts.

For the solution of the offered problems, as the theoretical basis was presented a relevant research, in particular, the works on climate change. As starting material, the actual observations of Armstatehydromet of air temperature and precipitation were used. As a methodological basis was used: in the geographical, physical and mathematical, correlation methods and characterization techniques, statistical analysis and extrapolation. Using the trend equation and the extrapolation method, in the work was estimated dynamics of the change in the average surface air temperature and annual precipitation of the study territory for the period 1935-2015.

As a result of studies have shown that almost the entire territory of the republic there is a tendency of growth of annual the temperatures. Unlike temperature changes in annual precipitation is not allocated its uniqueness. In some areas of the country there is a tendency to increase, and in others - decrease. In our opinion, this is due to the peculiarities of the complex orography and local circulation of atmosphere. Therefore, assessment the dynamics of the changes of air temperature and precipitation, and its socioeconomic impact, of risk and vulnerability of this territory towards the change climate, predicting the expected values, processing management policy strategy should be carried out in the local small scale volumes, particularly in mountainous countries.

ID: 01927, 28.- Climate variability signals in groundwater (and unsaturated zone) archives, (Poster)

THE CHALLENGES OF RATIONAL USE AND PROTECTION OF GROUNDWATER RESOURCES THE ARID REGION OF ARARAT VALLEY IN THE CONTEXT OF CLIMATE CHANGE

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In the country underground waters constitute the main component of predominantly water resources and have a major role in the water balance. Thus, about 40% of the water used is derived from groundwater, and 96% of the water used for drinking is carried by groundwater. They are also used for irrigation, industry, fisheries and other purposes.

As a rule groundwater are formed under the influence of natural and anthropogenic factors, of which are the defining elements of the climate components. So, due to the observed at the present time of global warming, which has not spared our country and observed changes in the climate elements undoubtedly affect the overall balance of underground resources.

Ararat depression, which is characterized by its arid climate, one of the richest areas of underground water resources. More than 65-70 % of fresh underground water is used in different sectors of the economy is taken from this territory.

So, considering the above, the set a goal to find out and analyze the problem of the use and protection of groundwater resources of the arid Ararat valley region in the context of global climate change.

Due to lack of required number of observation points for continuous monitoring, which are needed to display the protection of underground fresh water and good governance, it is impossible to assess the qualitative and quantitative changes in groundwater, as well as to ensure their sustainable management during operation.

So, the following is considered to be a priority:

- Create an optimal balanced network of observations and scientifically based program of observations that will provide an objective assessment of the state and the groundwater regime in conditions of constant exposure to man-made.
- Provide planning, management and protection of water resources of the Republic of Armenia, including groundwater (fresh, mineral, thermal) for various economic purposes.
- Provide further permanent comprehensive study of the groundwater and water-thermal regime of study area.

ID: 01588, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Estimation of volcanic explosivity index (VEI) by light rings in larches from northern Siberian forest tundra

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Powerful explosive eruptions are drivers of climate variability and have a negative impact to ecosystems and human society, ejecting in environment a huge amount of volcanic debris, dusts, gazes, and aerosols. An index of volcanic explosivity estimates the amount of emissions. High explosive eruptions lead to a significant temperature drop by 0.7-1.8 ° C in next one-two years, due to decreasing of incoming solar radiation.

Short-term climate changes generate large- and regional-scale surface cooling in a particular year following the volcanic eruptions. Additionally, the effects of volcanic eruptions occur in the form of extraordinary weather events and climate extremes: summer frosts, extreme short /cold summer and dry mist during the growing season.

Trees archive the climate changes and especially cold/ short growth period by changing of tree ring width and formation of light rings. Light rings are annual rings with light-colored area of latewood, compared with adjusted rings, due to morphological and anatomical changes of latewood tracheids.

Different species of larches collected at the profile from 18 site over northern Siberian forest-tundra in every 250-300 km were used to estimate the relationship between the mass formation of light-rings, spatio-temporal widespread of light rings and VEI values.

Eruptions during the period 1550-1992 were analyzed and selected with VEI ≥4. Nonparametric statistics methods Mann-Whitney U-test and Kruskal-Wallis H-test and the median test were used for comparison.

Mass formation of light rings can be identified over large areas. Intensity of light ring formation (percentage of damaged trees) shows the differences between VEI4 and 6. Differences between amount of sites with light rings over Siberia and different VEI were revealed.

This work is supported by RFBR projects No 14-04-91356 and 15-04-04933.

ID: 02246, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Landscape and land use in south-eastern Bulgaria during the Late Bronze Age and Iron Age (1600 BC – 100/50 BC): a synthesis of bioarchaeological and geoarchaeological data

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During the Late Bronze Age and Iron Age period, modern south-eastern Bulgaria represented a core area between the Carpatho-Danubian a in the north and the Aegean region in the south, constituting a unique area of interaction between prehistoric societies. Major social and economic changes took place, including among others the beginnings of urbanization, production intensification and the development of market economies. All this resulted in a large human impact on the natural environment. The aim of this paper is to present the agricultural economy and animal husbandry practices of ancient societies within this region throughout the considered periods, in parallel to the palaeoenvironmental context and rapid climate change events. The methodological approach is based on a synthesis of archaeozoological, archaeobotanical and stable isotope analyses, combined with the results of catchment analysis and pollen records from the region. This study forms part of an interdisciplinary project, which is still ongoing. The bioarchaeological data are obtained from 24 archaeological sites, and the stable isotope analysis is performed on a selection of both plant and animal samples. The palynological evidence presents the results of two pollen profiles. The catchment analysis is based on GIS-modelling, which is interpolated from several parameters of the modern ecological environment, including vegetation and climate. All together, they will allow to describe the relation between global climate change, natural environment and land use, as well as human impact on the landscape, in the quest of man for survival and economic prosperity.

ID: 01634, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Revisiting the Last Interglacial period in the SW Pacific: new palynological evidence

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The Last Interglacial period (LIG) (~130-115 ka) has been the focus of international research interest over the last few decades as its study (either proxy-based or modelling) underlines temperatures globally warmer by 2 to 3 degrees C and a sea level 4 to 6 m higher than present-day. Because these conditions may represent the likely increase in oceanic temperature (~0.6 to 2ºC) in the next 85 years as forecast by the latest IPCC scenarios in 2013, it is therefore crucial that LIG climatic variability and its regional expression are understood. Whereas the Atlantic Ocean has been well studied, the SW Pacific Ocean yields sparse records of past LIG conditions. Annual sea-surface temperatures have been estimated in this region for the LIG time-slices using foraminiferal assemblages, and there are a handful of core sites in the region where SST has been estimated using other proxies. To support and test this previous work, the aim is to produce maps of LIG time-slices of annual and seasonal sea-surface temperature (SST), salinity (SSS) and marine productivity, from 55º south to 25º south, over a 40º east-west gradient. To this end, dinoflagellate cyst assemblages from a number of cores, collected east and west of New-Zealand, are being studied and the Holocene and the LIG records compared. Preliminary results will be presented, comparing dinocyst assemblages for Holocene and LIG as well as the quantitative reconstructions of sea-surface conditions based on a set of different palaeoceanographical proxies for LIG time-slices.

ID: 01639, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Atlas of modern dinoflagellate cyst distribution in the Black Sea Corridor

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We present here the first compilation of recent distribution of environmental tracers (dinoflagellate cysts) from 185 surface samples collected in the Black Sea Corridor, from the Aegean to the Aral Sea (including Marmara, Black, Azov and Caspian Seas). Recent anthropogenic activities have here deeply influenced marine ecosystems and biodiversity and by studying both modern and past distributions of this important phytoplankton group, we can provide a baseline of land-sea linkages. A large diversity of 71 taxa have been identified, and their taxonomy has been revised in accord with new studies and/or biomolecular data. Several species show distinct morphotypes that are being related to specific sea-surface conditions in low salinity seas. Maps of distribution and statistical analysis show the strong influence of annual and seasonal sea-surface salinity, as well as temperature, to a lesser degree. The most common taxon, *Lingulodinium machaerophorum*, dominates most of the assemblages except in the Caspian Sea, where *Impagidinium caspienense* is the dominant species. Species associated with marine conditions are well distributed in Marmara and the Black Sea, such as *Operculodinium centrocarpum*, *Spiniferites mirabilis* and *S. ramosus.* In contrast, *Spiniferites cruciformis*, which was first described from early Holocene sediments from the Black Sea, today occurs in low abundance in the northern Black Sea, and in the Caspian and Aral Seas. A few taxa in the low salinity Black Sea, e.g. *Achomosphaera andalousiensis*, may be modern relicts of more widespread Mio-Pliocene distributions. In addition, based on late Quaternary records, we can estimate when species have entered these seas, either due to climatic conditions or anthropogenic activities. This modern database also provides a baseline for quantitative reconstructions of past salinity, in particular for the Holocene pre-reconnection period of the BS.

ID: 01589, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Multi-model comparison of the volcanic sulfate deposition from the 1815 Mt. Tambora eruption

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The eruption of Mt. Tambora in 1815 is estimated to be the 6th largest eruption in the last 2500 years. The eruption had significant climatic impacts, leading to the 1816 'year without a summer' and remains a valuable event from which to understand the climatic importance of large stratospheric volcanic SO_2 injections. It is also one of the strongest, and most easily identifiable volcanic signals in polar ice cores, which are widely used to reconstruct the timing and magnitude of past eruptions. As part of the Model Intercomparison Project on the climatic response to Volcanic forcing (VolMIP), 5 state-of-the-art aerosol climate models have simulated this eruption. We analyse both simulated background (non-volcanic) and volcanic sulfate deposition to polar regions and compare to ice core records. Background sulfate deposition is similar across all models and compares well to observations, with models capturing the east-west gradient in sulfate deposition in Antarctica and the north-south gradient in Greenland. Volcanic sulfate deposition, however, varies in timing, spatial pattern and magnitude between the models. Mean deposition to Antarctica in the Tambora simulations ranges from 16 kg SO_4 km^{-2} to 260 kg SO_4 km^{-2}, and in Greenland from 33 kg SO_4 km^{-2} to 194 kg SO_4 km^{-2}. Scaling factors between the average polar deposition and the corresponding hemispheric sulfate burdens also differ between models. Sources of the inter-model variability include the formation and transport of sulfate aerosol, and differences in the treatment of wet and dry deposition in each model. These results have implications for the validity of historic volcanic forcing, derived from the scaling of volcanic sulfate at the poles to atmospheric burdens, based on the 1991 eruption of Mt. Pinatubo and previous modelling efforts.

ID: 02033, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Climatic influence in the distribution of non-biting midges (Diptera: Chironomidae) in the Araucanian region, south-central Chile

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During the last decades, south-central Chile (30°S-40°S) has experienced a decline in precipitation and increase in temperature, and it is expected that towards the end of 21th century these trends will maintain. The detailed study of Chironomidae fauna can provide useful tools for monitoring the effects of climate change, the effect of human induced-activities, and other natural disturbances such as volcanism over freshwater ecosystems. We present a preliminary study of spatial distribution of modern chironomids in the Araucarian region (37-39°S) obtained from 22 surface sediment samples of lakes located from the high-altitude Andes Cordillera to lowland and coastal sites. Additionally, 20 limnological, climatic and geographical variables were assessed using canonical ordination analysis (DCA and then CCA), and stepwise selection to determine the best explanatory environmental variables influencing the chironomid assemblages. We indentified 45 taxa, highlighting Tanytarsinii 1B and 1A, *Parapsectrocladius*, *Ablabesmyia longistyla*-type as the most common. The CCA showed that mean annual temperature was the most significant driver controlling the chironomid distribution in the Araucanian region, followed by mean annual precipitation. The Orthocladiinae subfamily, *Chironomus anthracinus*-type, *Podonomus and Apsectrotanypus* I-type are present at high altitude lakes associated with cold temperatures, whereas *Dicrotendipes* and others Chironominae genera are characteristic of lowland lakes, especially in the northern part of the study area that is influenced by higher annual temperatures. From mid-to-long timescales, an expansion of warm-tolerant taxa, possibly associated to the habitat restriction of cold stenothermic taxa, is expected to occur particularly in the Andes where a faunal turnover may occur as a consequence of severe warming (ca. +3–4 °C) projected for 2100. Likewise, these preliminary results have a good potential to be used for the quantitative

reconstruction of paleotemerature using fossil chironomid assemblages in south-central Chile. Acknowledgement: FONDECYT11140677, CONICYT doctoral fellowship and L. Jarpa

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ID: 01338, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Palynology discovers the plants response to climate changes during the last interglacial complex at Lake Ohrid (FYROM/Albania)

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The importance of Lake Ohrid (Albania / FYROM) as precious archive of climate change, biodiversity, volcanic ashes, and tectonic activity is noteworthy. The lake is considered the oldest continuously existing lake in Europe and is declared UNESCO World Heritage Site. The lake hosts over 210 endemic species that make it one of the largest water-reserves in the world.

Since 2013 the lake has been object of a multidisciplinary study that has involved about 50 scientists from 10 countries. 6 parallel cores, recovered thank to the ICDP (International Continental Scientific Drilling Program) support, have been collected from the depocenter of the lake. They reach the impressive length of 569 m and span at least the last 1.2 million years.

A portion of the sequence has already published (Sadori et al. 2016, Biogeosciences 13: 1423-1437). It covers the top 200 m (about the last 500,000 years) at a time resolution of about 1600 years. The record evidences the cyclic changes of at least five glacial/interglacial cycles and a general long trend from cooler and wetter to warmer and drier conditions.

In this frame, pollen analysis has been improved for sediments ascribed to the last interglacial complex (LIC) corresponding to marine isotope stage 5 (MIS5). Thanks to the detailed chronology (Francke et al., 2016 Biogeosciences 13, 1179-1196; Zanchetta et al., 2016, Biogeosciences 13, 2757-2768) and the increased time resolution analysis (roughly one sample every 400 years) this work is a valuable contribution to the LIC knowledge. Preliminary results show that mesophilous communities prevailed, during the interglacial Eemian and during the two interstadials, on montane ones and that Mediterranean vegetation was less spread than expected.

ID: 01995, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Role of dynamical ice loss during the demise of the early-Holocene Laurentide ice sheet.

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At the start of the Holocene, the Laurentide Ice Sheet (LIS) experienced rapid ice loss associated with the disintegration of the ice saddle over Hudson Bay. Constraining the early Holocene rates of ice loss is important as meltwater flux from the LIS has been identified as a likely major forcing of the abrupt 8.2 ka northern hemisphere cooling event, the most profound climate change event of the Holocene. Holocene LIS retreat is thought to be largely driven by surface mass balance processes. However, the influence of Hudson strait ice stream and interactions with ocean and proglacial lakes likely provided an important feedback mechanism for surface mass balance processes in the disintegration of the ice saddle, leading to higher rates of ice loss. Simulating such processes require computationally expensive 'higher order' ice sheet models scarcely used for past ice sheets. Now, the recent BISICLES 3D ice sheet model, thanks to its unique adaptive mesh refinement is capable of accurately and efficiently resolving ice stream dynamics and grounding line migration, allowing us to accurately simulate the demise of the Laurentide Ice Sheet.

We drive BISICLES (offline) with temperature and precipitation forcings from a climate model (FAMOUS) under climatic conditions 9,000 years ago. We investigate the contribution of dynamical ice loss through ice streaming and marine interactions, and combine this with changes driven by surface energy balance. This experiment provides constraints on rates of ice sheet changes and mechanisms of rapid, sub-century ice sheet changes during the early Holocene.

ID: 01706, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

The 8.2 ka cooling event caused by Laurentide ice saddle collapse

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Recent climate and ice sheet modelling studies suggest that a meltwater pulse from the Laurentide ice sheet could have been the main driver of the 8.2 ka event. This challenges the earlier consensus on a proglacial lake flood having caused the most profound abrupt climate change event of the Holocene. The meltwater pulse would have been produced by an acceleration in ice melt as the Labrador and Baffin ice domes around Hudson Bay separated.

We tested this hypothesis by evaluating the climatic impact of the saddle collapse. We forced a General Circulation Model (HadCM3) with scenarios of freshwater input to the Labrador Sea. Out of our ensemble a scenario with a 100-year meltwater flux reaching a peak forcing of 0.6 Sv best reproduces the cooling anomaly as seen in the Greenland ice core records and terrestrial high-resolution proxies from Europe. Climatic and ocean circulation response to the simulation of the lake release is short-lived compared to that of the saddle collapse. The scenario representing the saddle collapse also reproduces the two-stage signal in geological records that has been thought to result from multiple forcings.

Our experiments give support to the hypothesized ice saddle collapse having been the main forcing of the abrupt climate change 8,200 years ago. This forcing, once further constrained with ice sheet modelling, should be taken into account when setting up simulations of the 8.2 ka event.

ID: 01688, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Antarctic Intermediate Water intrusion at the Florida Strait related to the last glacial millennial-scale variability

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In the North Atlantic, the glacial-interglacial cyclicity affects, among others, the strength of the Atlantic meridional overturning circulation (AMOC) and the general distribution of the water masses. Oceanographic variability is further visible at the millennial-scale, e.g. during Dansgaard-Oeschger cycles and Heinrich Events. Changes in the past water mass distribution can be traced by changes in the neodymium isotopic composition (eNd) of a record. Previous eNd results from the western subtropical North Atlantic are conflicting in relation to the northward penetration of the Antarctic Intermediate Water (AAIW) during stadial periods. Here we present an eNd record of the cold-water coral *Lophelia pertusa* from the East Florida Strait (at 700 mbsl) for the last 65 kyr to better constrain the AAIW variability in the NW Atlantic. The obtained eNd record varies by more than two units, between -11.1 and -8.7. More radiogenic isotopic signatures suggest an increased presence of AAIW in the Florida Straits at 48 ka, 40-36 ka and 23 ka, in comparison to the Holocene. Changes in the isotopic signatures seem to coincide with variations of the AMOC strength and, thus, follow the pattern of the last glacial millennial-scale variability.

ID: 02062, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Extending tree-ring chronologies in the Northern Caucasus for paleoclimatic and historical purposes

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Long tree-ring chronologies are essential for high resolution climatic reconstructions as well as for the dating of past human activity supported by wooden artifacts. It can also reveal new evidence on climate history in the Caucasus, because construction activity is inevitably connected to climate change and human adaptation to it. There are hundreds of medieval buildings in the mountain part of Ingushetia, including early Christian churches, crypts, temples, war towers, and living buildings. No radiocarbon or dendrochronological dates for buildings in the mountain Ingushetia region have been published so far. The longest existing tree-ring records in the Caucasus start in the 15th century. We collected wooden material from medieval buildings of mountain Ingushetia and analyzed it by means of dendrochronological and radiocarbon methods. 135 samples were collected from wooden construction elements of 40 stone buildings. All the samples were prepared and tree-ring widths were measured. Maximum length of tree-ring series reaches 177 years. Most of the wooden elements were made from pine, oak, and lime. We additionally prepared 18 wooden samples from six buildings (two early Christian churches, one early war tower, two temples and a crypt) for accelerated mass spectrometry radiocarbon analysis. These samples were collected from distinct tree rings that allowed us to use wiggle-matching procedure for the enhancement of precision of the dating results. Finally we got *terminus post quem* radiocarbon dates for these six buildings and six floating tree-ring chronologies dated by radiocarbon up to 177 years long. Unfortunately, we failed to cross-date these series with the existing tree-ring chronologies from the Northern Caucasus because of the small overlap. It will be possible in future when additional timber will be collected. The study was supported by the RF President grant no. MK-1351.2017.6.

ID: 01560, 01.- Open Session on past global changes, (Poster)

Climate and environment in the northern Alps during the last glacial - first results from the Nesseltalgraben paleolake in southeastern Germany

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In the northern Alps few lacustrine sequences are known from the Würmian, i.e. the Last Glacial period in the Alpine realm. Even fewer sedimentary archives extend to before the Last Glacial Maximum. The recently discovered sediment outcrops at the Nesseltalgraben site in southeastern Germany comprise more than 30 m of predominantly lacustrine sediments overlain by glacio-fluvial sediments of MIS 2 age. A diamict bed marks an erosional unconformity that divides the sediment sequence into a lower and an upper part. Paleomagnetic, palynostratigraphic and radiocarbon analyses place the upper part into the Middle Würmian (MIS 3), while palynological indicators point to a Lower Würmian (MIS 5c) age for the lower part. These lake sediments consist of carbonate mud beds likely representing cold periods, and organic-rich layers (compressed peat, organic mud) presumably deposited during milder periods. Especially the organic-rich beds contain well-preserved biotic remains like palynomorphs, ostracods, wood, mosses, and molluscs. Bulk organic geochemical analyses suggest that planktonic organic matter was predominantly deposited during the colder periods, while higher fractions of terrestrial vascular plant remains were admixed during warmer phases. Ongoing research aims at elucidating the rapidly changing climatic conditions during MIS 5-3 in the Alps and how they affected regional paleoenvironments.

ID: 02195, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Antarctic Circumpolar Current (ACC) and ocean evolution in the Kerguelen sector during the deglaciation and the last climatic cycles

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"IndienSud-" expeditions aboard the RV Marion-Dufresne in 2011 and 2012 in the Kerguelen sector of the South Indian Ocean provided Casq and Calypso sedimentary cores documenting past ocean changes, in particular that of the Antarctic Circumpolar Current (ACC), during the last climatic cycles, with a focus on the last deglaciation.

For the deglaciation, high-resolution multiproxy records were obtained at two sites along the main branch of the ACC in the Indian sector of the Southern Ocean. Changes in the ACC intensity are investigated using environmental magnetism methods tracing both the amount and size of sedimentary magnetic grains. In addition, oxygen isotopes and foraminifera faunal assemblages and δ13C are documented. A precise age scale is derived from 14C ages determinations, complemented by regional correlations. A marked decrease in the ACC intensity is documented, with millennial scale variations closely associated to changes of the meridional and deep ocean circulation, to the southern Antarctic Cold Reversal (ARC), to climatic events in the northern hemisphere and to atmospheric CO2 changes. For the long-term, results document a stronger ACC during glacial than during interglacial periods for at least the past 600 kyr. This pattern is opposite to that of the NADW branch (WBUC) south of Greenland. These observations highlight an antiphase pattern between ACC and NADW on orbital timescales. This study is funded by the French-Swedish program Soclim

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ID: 01909, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Agulhas leakage to the Atlantic Ocean during the Pliocene

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The Agulhas leakage is an important contributor to the global thermohaline conveyor system, adding warm and saline subtropical waters from the Indian Ocean to the South-east Atlantic Ocean. However, little is known about the strength of Agulhas leakage during the Pliocene (2.7-5.3 Ma), when the continental ice sheets were smaller in size, and the position and strength of key ocean and atmosphere circulation systems in the South Atlantic region were different (e.g. Martinez-Garcia et al., 2010; Petrick et al., 2015). The Pliocene is also characterised by a series of gateway changes which are argued to have affected North Atlantic climate (e.g. de Schepper et al., 2015), but the response of the Agulhas leakage system remains unclear.

Here we present initial results from a new Cape Basin site (Site U1479, 35°03.53'S; 17°24.06'E), which was recovered by IODP Expedition 361 in 2016 from the western slope of the Agulhas Bank (Hall et al., 2016). We combine reconstructions of sea surface temperatures (using the alkenone-derived U^{K}_{37}' index) with analysis of planktonic foraminifera assemblages, to identify and understand variability in Agulhas leakage operating across both orbital and longer timescales.

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ID: 01910, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Late Pliocene variability in Antarctic Intermediate Water properties recorded in the Southeast Atlantic

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The reconstruction of past surface and intermediate water temperatures are critically important for understanding feedbacks within the ocean-climate system. Comparatively little is known of mid- and high-latitude evolution in the southern hemisphere through the Pliocene, yet these regions are important for climate feedbacks including sea ice distribution and low-high latitude heat transport. Using a site in the Southwest Pacific, the first record of Pliocene AAIW properties demonstrated both an overall equatorward displacement of the subtropical and subantarctic fronts relative to modern, and high variability on glacial-interglacial timescales (McClymont et al., 2016). Here, we present preliminary data from a site in the Southeast Atlantic (ODP site 1087, 31°28'S, 15°19'E, 1374 m water depth), which is currently bathed by AAIW. Benthic foraminifera Mg/Ca and stable isotope ratios ($d^{18}O$, $d^{13}C$) detail glacial-interglacial variability in AAIW properties, including temperature, through the late Pliocene (~3.0-3.5 Ma). A pronounced cooling of AAIW marks the MIS M2 glacial at ~3.3 Ma, but is less clearly observed in the $d^{13}C$ record. We compare our results to published alkenone-derived U^{K}_{37}\' sea surface temperature data (Petrick et al., 2015) to consider the interactions between the mid-latitude atmospheric and ocean circulation systems and the high-latitude drivers of changes in AAIW properties.

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ID: 02031, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Abrupt climate change explained by a paradigm shift in the scheme for outgoing longwave radiation (OLR).

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Three major abrupt climate change events happened in the Northern Hemisphere during the last glacial termination: two abrupt warmings on entry to the Bølling-Allerød inter-stadial and the Holocene inter glacial; and an abrupt cooling on entry to the Younger Dryas stadial. The climate models have been unable to replicate these events, because the models are based on the paradigm that the energy balance at the top of the atmosphere (TOA) is maintained by changes to the OLR. Since the CO_2 15µm radiation band is saturated, then changes to the concentration of CO_2 cannot affect OLR at the TOA. The energy balance at the TOA is maintained by changes to the outgoing shortwave radiation (OSR), which are caused by alterations to the planetary albedo, mainly from changes in ice and cloud cover.

The paradigm which should be used was proposed by G.S. Callendar, who argued that since the terrestrial radiation is absorbed at the bottom of the atmosphere, an increase in the concentration of greenhouse gases results in the radiation being absorbed closer to the base of the atmosphere. Since the back radiation is emitted from a lower and warmer altitude, it heats the Earth's surface. This causes the snow line to rise, both in altitude and in latitude. It is this indirect effect of a decrease in planetary albedo which causes the increase in global temperatures from a rise in atmospheric CO_2.

A simple explanation for both abrupt warming and cooling is changes to the extent of the Arctic sea-ice, driven by two positive feedbacks: the ice-albedo effect and the greenhouse effect of water vapour. When the Arctic sea-ice vanishes, an abrupt warming will occur only ending when cloud cover has increased to compensate for the lost sea-ice albedo.

ID: 02100, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

The PAGES 2k Network, Phase 3: Introduction, Goals and Call for Participation

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The past 2000 years (the "2k" interval) provides critical context for recent anthropogenic forcing of the climate, baseline information about Earth's natural climate variability, opportunities to improve the interpretation of proxy observations, and evaluation of climate models. The PAGES 2k Network (2008-2013 Phase 1; 2014-2016 Phase 2) built regional and global surface temperature reconstructions for terrestrial regions and the oceans, and used comparisons with realistically forced simulations to identify mechanisms of climate variation on interannual to bicentennial time scales. The goals of Phase 3 (2017-2019), which launches in May 2017 at the PAGES Open Science Meeting, are to:

1. Further understand the mechanisms driving regional climate variability and change on interannual to centennial time scales (Theme: "Climate Variability, Modes and Mechanisms");
2. Reduce uncertainties in the interpretation of observations imprinted in paleoclimatic archives by environmental sensors (Theme: "Methods and Uncertainties"); and
3. Identify and analyse the extent of agreement between reconstructions and climate model simulations (Theme: "Proxy and Model Understanding")

Research will be organized as a linked network of well-defined projects and targeted manuscripts, identified and led by 2k members. The 2k projects will focus on specific scientific questions aligned with Phase 3 goals, rather than being defined along regional boundaries.

An enduring element from earlier phases of PAGES 2k will be a culture of collegiality, transparency, and reciprocity. Phase 3 seeks to stimulate community based projects and facilitate collaboration of researchers from different regions and career stages, drawing on breadth and depth of the global PAGES 2k community; support end-to-end workflow transparency and open data and knowledge access; and develop collaborations with other research communities and engage with stakeholders. If you would like to participate in PAGES 2k Phase 3 or receive updates, please join our mailing list, or speak to a coordinating committee member.

ID: 01630, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

An integrated Holocene tephrostratigraphy for East Asia: A high-resolution cryptotephra study from Lake Suigetsu (SG14 core), central Japan

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The importance of palaeoenvironmental archives for our understanding of key climatic and hazard events is well recognised, but it is essential that these disparate records can be precisely integrated to assess questions across broader spatio-temporal scales. Volcanic ash (tephra) layers preserved in these sedimentary sequences can provide ideal isochronous markers facilitating high-precision correlations, assuming that these tephrostratigraphic tie points are underpinned by robust geochemical fingerprinting. The absence of a well-characterised tephrochronological framework in East Asia, combined with the pacucity of crypto- (non-visible) tephra studies, currently hinders our capability to (i) link disparate archives, (ii) transfer chronological information, and (iii) map the impact of natural hazards (e.g. past volcanic ash fallout). To build this framework, the newly obtained (SG14) core from Lake Suigetsu, a high-resolution palaeoclimate record in central Japan, was analysed to detect cryptotephra layers preserved during Holocene sedimentation. We detected 17 discrete ash layers, 13 of which are newly characterised and precisely dated here. The major element geochemistry of the volcanic glasses within these layers were compared to new and published proximal glass datasets to verify their correlations. Notably, new ash layers identified in the SG14 core relate to the Ma-b and To-C eruptions of Mashu (Hokkaido) and Towada (northern Honshu) volcanoes respectively, and the U2 and U3 tephras from Ulleungdo volcanic island (South Korea), with these discoveries considerably extending their known ash dispersal. Crucially, the Changbaishan ‘Millennium’ (B-Tm) tephra is also found, which provides a tie-point between this key East Pacific archive and the Greenland ice cores. The detection of these layers provides improved chronologies and tie points to numerous other lacustrine, marine and archaeological Holocene archives in this region. These findings establish this distal archive as the most comprehensive Holocene record of volcanism for East Asia.

ID: 02085, 01.- Open Session on past global changes, (Poster)

Geomorphologycal significance of fluvial deposits in the Granite Cave (Bujaruelo Valley, Central Pyrenees)

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The Granite Cave is located on the left side of Ara River (Bujaruelo Valley, Central Pyrennes, Iberian Peninsula). The cave is formed by a unique slightly pseudo-horizontal conduit, characterized by an important sequence of fluvial deposits up to 40 m-thick. The origin of these deposits is related to the erosion of moraines situated in the upper absorption sector of the karstic system. The fluvial deposits are mainly formed by the alternation of sands and clays, in addition to blocks and gravels (some of which are of granite lithology). The deposits are affected by small-scale faults and liquefaction structures. The sedimentation is related with high/low energy water flows and slackwater areas. Accumulation of fluvial deposits reaches the ceiling of the cave, suggesting that the cave was completely filled up with sediments. Two OSL (optically stimulated luminescence) ages from the bottom and top of the deposit show that the sedimentation process took place between 71.8±5.6 ka and 26.5±2.5 ka. This age range partially overlaps with the major glacial advance in the Pyrenees. In addition, a lateral moraine downstream to the Granite Cave indicates the presence of a glacier around 65-60 ka. As a consequence, the glacier could have obstructed the lower entrance of the cave, avoiding the out flow of fluvial sediment causing the accumulation of fluvial/lake deposits inside the cave. U/Th ages from speleothems (111±1.5 ka and 11.3±2 ka), formed before and after the fluvial sedimentation, are in agreement with the estimated OSL ages. These fluvial

deposits represent an exceptional study case to better understand the glacier evolution in the Pyrenees during the Pleistocene.

ID: 02180, 21.- Sediment Flux: Past Peaks and Troughs, (Poster)

Palaeoenvironmental evolution and sediment fluxes of Conquezuela lacustrine basin during the last glacial cycle based on luminescence dating and multiproxy analyses

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Evolution of the Conquezuela palaeolake, located in the eastern margin of the Iberian Peninsula Northern Plateau, has been investigated using multiproxy analyses (sedimentology, XRF geochemistry, palynology) and with a chronological control based on optically stimulated luminescence (OSL) and AMS techniques. The 10 m-thick sedimentary sequence shows a large variability of depositional environments including shallow carbonate and clastic- alluvial-influenced lakes and peatbogs. This heterogeneity adds more complexity to the luminescence response (variable concentration of radioelements controlled by detrital input) and hydrological and vegetational changes recorded in pollen and geochemical proxies. OSL ages of 17.9 ± 1.5 ka and 126.3 ± 9.5 ka have been estimated at depths of ~2.5 and ~8.6 m, respectively, pointing to a sequence covering the last two interglacials and last glacial periods. OSL measurements show very well defined dose distributions for these two units, providing robust ages in agreement with both sedimentological and preliminary pollen results. In contrast, widely scattered dose distributions have been observed in some intervals suggesting that sediments were incompletely bleached, i.e. insufficient exposure to daylight during transport. Specific statistical approaches have been necessary in these cases in order to estimate accurate ages based on the population of quartz grains most likely to be well bleached. Nevertheless, estimated ages ~1.4 and ~6.9 m deep are not coherent with hydrological and vegetational evolution interpreted from geochemical and palynological data. Radioelement concentrations in these two units are surprisingly much higher than those from the rest of the units, thus, the incoherent ages initially estimated suggest that the present composition is not representative of burial time. A detailed compositional and geochemical knowledge on the sedimentary sequence based on multiproxy analyses is key to establish an accurate chronological record of Conquezuela paleolake, its palaeoenvironmental reconstruction and the factors controlling the large variability in sediment input to the basin.

ID: 01848, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Poster)

Influence of Holocene relative sea level variations in the evolution of the Almenara marsh (Castellón, Spain)

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Integration of geochemical, stratigraphic, sedimentological and micropalaeontological techniques and 14C dating allows us to characterize the processes and evolution of the Almenara marsh (Castellón, Spain) during the Holocene, and to reconstruct the relative sea level fluctuations for the Western Mediterranean. The analysis of 4 cores has allowed recognize six transgressive-regressive (T-R) parasequences. These can be grouped in two systems tracts which are separated by a maximum flooding surface, dated ca. 7 ka cal. BP. The lower one (ca.11-7 ka) is a transgressive system tract (TST) during which there was an open coastal lagoon whose barrier was located eastwards to the present coast line. The upper one (7 ka-present) is a high stand system tract (HST) during which a coastal wetland, without marine connection, developed. Parasequences record a fast rise of sea level but the amplitude of the fluctuations during the lower system tract is greater, usually more than one meter, than the amplitudes during the upper system tract, generally below one meter. These fluctuations of sea level took place with a periodicity of 1,500 to1,800 years.

ID: 01847, 01.- Open Session on past global changes, (Poster)

The Atuel river basin, central-west Argentina: a present-day anthropically modified system

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The Atuel River fluvial system (ARFS; ~34°30´S-70°09'W, ~37°30´S-67°00'W) is located in central-west

Argentina, in the South American Arid Diagonal (~200 mm/year rainfall). Its perennial seasonal-regime flow originates from snowfall ablation in the Andes Cordillera catchment mountain area. At the extra-andean lands, the middle basin is a transporting zone formed by a proximal piedmont with alluvial fans, and to the east, by a main trunk stream (MTS) crossing the *San Rafael* tectonic block. In the AR lower basin, the MTS bifurcates into a distributary drainage network formed by many meandering streams flowing along the *Depresión de la Travesía* plain and disappearing into a terminal wetland area. The AR lower basin alluvial sedimentary record consists of three main morphological units: a Regional Aggradational Plain (late Pleistocene- early Holocene), a fill terrace (middle and late Holocene), and a present floodplain (≤ *ca*. 400 yr BP.).

Today, the ARFS is a 'misfit' fluvial system compared with the previous glacial-stage flows. In addition, on the 40's started the construction of a series of dams at the AR transporting reach affecting the lower basin fluvial regime which uppermost part turned into an agricultural irrigated oasis in detriment of the terminal wetland area. At the lower basin the fluvial network was also modified by channel constructions to derivate water for irrigation, and soils became strongly salinized. As a result, the present active surface runoff zone in the lower basin and particularly at the wetland area has a minimum expression, it is restricted to channel, marshes, and crevasse splays of the *Arroyo de La Barda*, the only present-day active channel. Consequently, this extreme misfit condition in the AR lower basin conducted to a major socio-economic impoverishment of this arid land historically used by local people for agricultural-livestock activities, and now totally diminished and restricted to subsistence livestock farming.

ID: 01972, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Simulation and inversion of borehole temperature profiles in surrogate climates: last millennium LULC influence on SAT-GST coupling

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The knowledge of last millennium climate variability leans on reconstruction methods that use proxy data as predictors as well as on simulations with climate models. Borehole reconstruction is a well established proxy approach to reconstruct past surface air temperature (SAT) based on the assumption that SAT changes are coupled to ground surface temperature (GST) changes and transferred to the subsurface by thermal conduction. However, there are several physical processes that impact the hypothesis of the borehole method by decoupling SAT and GST. Such processes might have an impact on the surface temperature reconstructions based on the borehole technique. Herein, the influence of these processes on SAT-GST coupling at long-time scales is specifically assessed in pseudo proxy experiments.

We have assessed different processes that may impact the coupling between SAT and GST at local and regional scales in a set of simulations with the Community Earth System Model Last Millennium Ensemble (CESM-LME) by identifying their influences on the surface-ground heat transfer. Then, we have used a heat-conduction forward model driven by simulated SAT and GST to produce global underground temperature perturbation profiles. Finally, a pseudo reality experiment has been developed in which an inversion approach has been applied to reconstruct the last millennium (850-2005 CE) ground surface temperature from the simulated profiles and to compare them with climate model SAT.

The results suggest that albeit some processes may corrupt the coupling between SAT and GST, they have only a local or regional impact and do not affect the global long-term coupling, supporting the reliability of the borehole reconstruction technique in retrieving the low frequency past surface temperature variations.

ID: 01704, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Reconstruction of San Lorenzo Ice Cap, central Patagonia (47.9°S), using geomorphological mapping and cosmogenic surface exposure analysis

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Patagonia, in Southern South America, is uniquely positioned to study past climate and environmental change as it intersects key atmospheric and oceanic systems in the southern mid- latitudes. Robust glacial chronologies can demonstrate leads and lag in the climate system, allowing us to test hypothesis about the drivers of climate change at orbital and millennial time scales.

San Lorenzo Ice Cap coalesced with the Patagonian Ice Sheet during Last Glacial Maximum (LGM) and an outlet glacier occupied Lago Belgrano Valley. We targeted a unique glacial geomorphological record preserved in Lago Belgrano Valley, unaffected by constrained melt-water erosion typical of over-deepened basins or glacial dynamics associated with fast-flowing outlet glaciers. We utilised geomorphological mapping and cosmogenic ^{10}Be surface exposure dating to develop a high-resolution glacial chronology, which sensitively reflects past climate change. We aim to resolve an apparent anomaly on the timing of the local LGM and ambiguity on glacial response to millennia-scale cooling events during the Late Glacial in central Patagonia. Here, we present preliminary cosmogenic ^{10}Be surface exposure results, which underpin our reconstruction.

ID: 02253, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Poster)

On the sensitivity of the mineral dust cycle response to Marine Isotope Stage 3 conditions

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Mineral aerosols and their radiative-forcing potential are still a major source of uncertainty in future climate projections. Aerosol-cloud interactions and the role of aerosols in affecting the global biogeochemical and hydrological cycles are only partly understood, with additional challenges by the ranges of spatial and temporal scales involved in mineral dust processes. On glacial-interglacial timescales, marine sediment and ice-core records exhibit pronounced variations with substantially increased dust deposition fluxes and dust concentrations during glacial periods. Furthermore, on millennial timescales, Greenland ice-core records show significant decreases in mineral dust concentrations from stadial to interstadial periods. These variations may be related to changes in aerosol source strength, atmospheric transport patterns and dust deposition which can be directly or indirectly impacted by the various paleoclimatic boundary conditions such as greenhouse gas concentrations, ice-sheet and orbital configurations. So far, the relative role of these contributing factors has not yet been fully explored. For this purpose, we conducted simulations with the fully-coupled comprehensive general circulation model CCSM3 for Marine Isotope Stage 3 (MIS3) to assess the dust cycle during this period of pronounced millennial-scale variability. Our experiments are centered on 35 ka BP and based on a setup including a prognostic dust module. Individual boundary conditions are prescribed as single forcing factors at a time. Our model results reveal that the individual MIS3 boundary conditions induce different responses in dust deposition and that a clear distinction between annual mean and seasonal signatures of dust deposition needs to be made. We will show that in some regions, orbital forcing induces a response of comparable magnitude as the greenhouse gas forcing, but of opposite sign. Changes of dust transports and deposition will be discussed in the light of spatial and temporal characteristics of atmospheric dynamics and teleconnections during MIS3.

ID: 01791, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

PALEOENVIRONMENT AND CLIMATE EVOLUTION DURING THE HOLOCENE IN SIERRA NEVADA (SOUTHEASTERN IBERIA)

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Here we show a detailed palynological, geochemical and magnetic susceptibility (MS) study of a Holocene alpine lake sediment core from Laguna Hondera (LH), Sierra Nevada (southern Iberian Peninsula). Overall humid climate conditions occurred during the Early Holocene in Sierra Nevada, characterized in the LH sediment record by high fluvial-detrital input. Since ca. 7000 cal yr BP a trend towards more arid conditions is recorded and enhanced Saharan eolian dust deposition is observed until Present. This trend is modulated by millennial-scale climate variability and relatively humid conditions occurred during the Iberian Roman Humid Period (2600-1400 cal yr BP). However, a relatively arid event interrupted this generally humid period between 2300-1800 cal yr BP. Predominantly arid conditions occurred during the Dark Ages and the Medieval Climate Anomaly (1400-650 cal yr BP), coinciding with a solar maximum and a persistent positive NAO phase. The Little Ice Age (650-150 cal yr BP) is characterized in the LH record by an increase in runoff and a minimum in eolian input, agreeing with solar minima and a persistent negative NAO phase at that time. Human impact in the area is observed through *Olea* cultivation, *Pinus* reforestation and Pb pollution during the Industrial Period (150 cal yr BP-present).

ID: 02349, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Palaeolimnological records of climate change in the Central American – Intra-America Seas region over the last 2000 years

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Drought is one of the most serious outcomes of climate change for society, particularly in the subtropics, where the Central American – Intra-America Seas region is one of the most important climate change 'hot spots' for the period to the end of the 21st century. This is a region where inter-annual variability in precipitation is marked and spatial patterns of change are complex. Although there are an increasing number of records from this area, these have served to highlight this complexity and key questions remain about whether present day relationships between forcings such as ENSO/PDO and AMO/NAO hold true over longer timescales. Here we present initial results from lake sites in Jamaica, Barbuda, the Dominican Republic, and the Mexican Yucatan, based primarily on stable isotope analyses, which provide further evidence for change over this important time period. The dating and interpretation of lacustrine sequences where limestone geology often predominates is discussed. Periods of widespread drought across the region, such as those occurring during the Terminal Classic period and at times during the 'Little Ice Age' are of particular interest.

ID: 01647, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Drilling a crater at the Equator-insides from ICDP DeepCHALLA

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Long and continuous sediment records from equatorial Africa are rare, resulting in a so far fragmentary understanding of the effects of a warming atmosphere on the tropical hydrological cycle at the regional scale. Serve and recurrent droughts is the principle weather-related hazard throughout sub-Saharan Africa, and the quality of long-term weather prediction a principle bottleneck hampering drought mitigation and adaptation. The impact of 21st-century anthropogenic climate change on the African rainfall is highly uncertain, implying unforeseeable effects on freshwater resources.

During the "CHALLACEA" project (2005-2008) detailed investigations of Lake Challa, a relatively small and deep crater lake on the border between Kenya and Tanzania, revealed the lake is a key site for reconstructing the climate and environmental history of equatorial East Africa. Various biological, bio-geochemical and sedimentological investigations of the ~22 long CHALLACEA-core helped to understand the systematics of Lake Challa under present-day conditions as well as to reconstruct environmental changes over the past 25,000 years. Due to the good quality of the Lake Challa sediment and the high scientific outcome of the record, a new International Continental Scientific Drilling Programme (ICDP) project "DeepCHALLA" was established to drill a longer sediment record, going further back in time. During the drilling campaign in November 2016 a ~ 215 m long sediment sequence was obtained which will provide unique information about environmental changes in low-latitudes over a complete glacial - interglacial cycle. Therefore, the record opens new opportunities to study East African environmental changes and paleo-hydrological conditions much further back in time, encompassing the entire known existence of modern humans (*Homo sapiens*) in East Africa.

Here we present a compilation of the environmental reconstructions based on the CHALLACEA sediment sequence and will give an outline of future work on the DeepCHALLA record.

ID: 02265, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Southern Ocean deep water changes during the last deglaciation: Antarctic divergence upwelling and AAIW formation in the South-East Pacific sector

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The Southern Ocean (SO) plays a central role in ocean-atmosphere exchange of heat and CO_2, and the distribution of nutrients to low latitude through Antarctic Intermediate Water formation. During the last deglaciation wide reorganization of the deep ocean circulation took place and the atmospheric carbon dioxide content increased by more than 30%. Here we compare benthic and planktonic foraminifera records from the Pacific South-East sector of the SO. Knowledge of the surface water 14C reservoir age changes along the last deglaciation allows us to study the evolution of Δ14C of deep waters at 1600 and 2500 meters depth, while $^{\delta 13}C$ of epi- and endo-benthics gives clue on the oxygen evolution of these waters. Decreases in benthic –planktonic difference in carbon isotopes indicate SO upwelling increased periods at the beginning of the deglaciation, linked to older ^{14}C reservoir ages of surface waters. At the same time benthic foraminifera isotopes and assemblages indicates large changes in AAIW formation with changes in both the depth extend and oxygen content. Deeper waters (2500m depth) undergo a increased oxygen content and a reduce ^{14}C age latter in the deglaciation.

ID: 01663, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Paleoenvironmental archives of the submerged karst landscapes of the Eastern Adriatic

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The Croatian coastal region is a part of Maritime Dinaric Alps which coincides with the Adriatic Carbonate Platform (AdCP). Some of the coastal karst depressions/basins developed into larger lakes. Sediment core records show a tight correlation between sea level rise and lake formation during early Holocene. Terrestrial sequences in the Croatian coastal karst regions are often incomplete due to erosion or nondeposition. Therefore, accumulation of lake and marine sediments offer complete and well-dated archives spanning throughout most of the Holocene. Since a part of the karstified AdCP is drowned and its palaeo-dolines, depressions of variable size, as indicated by seismic data, contain up to 400 m of well stratified sediments (Kvarnerić bay, N. Adriatic) allowing insight to earlier periods of the Quaternary. Generally larger karst depressions lie between the islands at present day water depths from -40 m to -90 m. These karst basins contain archives of climate change and have experienced repeated relative sea-level cycles during the Quaternary. Coring and geophysical data of a 40m thick sediment sequence indicate at least two glacial (lake sediments) and three interglacial (marine) cycles are be present in Lošinjski kanal due to submerged sills at -50 m. Most of the present day lakes along eastern Adriatic coast formed during the early Holocene (Bokanjačko blato, Vransko jezero near Biograd, Veliko jezero- Mljet). Vransko jezero on the Island of Cres survived from the Pleistocene as probably did lake Crniševo (Baćina lakes). The LGM lakes of Lošinjski kanal and Valun bay were flooded at onset of the Holocene, while the Pleistocene lake in Pirovac bay was flooded by the sea 8 ky cal BP and Veliko jezero on Mljet Island at 3 ky cal BP.

ID: 01448, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Late Holocene vegetation and ocean variability in the Gulf of Oman in the last 1900 years

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Fossil pollen & dinocyst records in marine successions are increasingly combined to reveal the response of vegetation and ocean conditions to changes in past climate and the impact of natural hazards. We analysed these proxies in 2 sediment cores, spanning the last 1900 years, off the Iranian coast in the Gulf of Oman, a data-poor area. The vegetation record from S. Iran indicates a replacement of savannah by desert at *c*. 910 CE, shortly after the Islamic expansion and the subsequent collapse of the Sassanid Empire. From *c*. 910 to 1145 CE, during the Medieval Climate Anomaly (MCA), the vegetation was dominated by desert. In parallel, in the ocean, increased *Impagidinium paradoxum* indicates a lack of freshwater discharge into the ocean. The desert taxa of the MCA were subsequently replaced by savannah at *c*. 1145 CE, corresponding to the Little Ice Age (LIA), indicating a wetter climate. A sudden increase in *Spiniferites ramosus* at *c*. 1440 CE suggests an increase in the strength of the SW summer monsoon, with increased freshwater discharge. Additionally, palynology was able to distinguish a major flash-flood event at AD 1842. Our data indicate that the NW Arabian Sea region has alternated between contrasting climates, with firstly a humid phase equivalent to the cultural period of the Sassanid Empire, a significantly drier climate during the MCA and then a relatively wetter climate during the LIA. Possible mechanisms resulting in the dry conditions experienced during the MCA in the Middle East include a northward shift of the ITCZ and the associated shift in annual rainfall distribution. These mechanisms may be similar to those which caused the aridity which dominated the Early Holocene in the Zagros. Our data suggest that an anthropogenically-induced warmer world will likely result in increased drought frequency in the Middle East.

ID: 02075, 18.- Human Impact on Global Aquatic Systems, (Poster)

Aquatic Transitions (a PAGES Working Group): Establishing a framework for understanding threshold changes in aquatic ecosystems

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The primary aim of this Working Group is to integrate records of "change" in aquatic ecosystems to provide a global synthesis of the sensitivity of these sites to critical stages of human impact. By detailing the nature of these changes, we will provide insights for management of these aquatic ecosystems. The principal objectives are to: (1) document the history of human impact on aquatic systems through the identification of the first point of human impact, and the inception and peak of the industrialised phase; (2) examine the nature of these transitions to identify the ecosystem dynamics that have resisted human pressures, as well as the changes leading up to the point where the system succumbed, and the degree to which new, stabilising forces have entrenched the system in a new regime.

Global and local policymakers have defined an urgent need for understanding how aquatic systems function under increasing threats from people and climate. Many aquatic systems exhibit a non-linear response to these stressors, with ecosystems responding abruptly, or showing some degree of resilience until a threshold is breached. Established ecological theory is based on contemporary approaches to understanding non-linear changes in aquatic systems, yet a meta-analysis shows there are few examples in the contemporary data that suggest the existence of regime shifts with feedback changes following the removal of the stressor. This is likely an artefact of contemporary studies being short in duration, and which rarely pre-date the point of impact. Palaeoecology can play a critical role in understanding and identifying the cause of non-linear shifts. Long-term records of change provide evidence of the ecosystems dynamics that may have occurred leading up to a threshold change and can provide early warning signals that may be lessons to prioritise intervention measures for future management.

ID: 01469, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Do changes in detrital sources during Heinrich events affect the sedimentary 231Pa/230Th circulation proxy?

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The Atlantic Meridional Overturning Circulation (AMOC) is a major component of the climate system through its impact on meridional heat transport and on the carbon cycle. Despite numerous studies, its role during abrupt climate changes of the last glacial period remains poorly constrained.

Sedimentary $^{231}Pa/^{230}Th$ is currently used as a kinematic circulation proxy, which has, in particular, contributed to evidence a substantial slowdown of the AMOC during Heinrich events. However, the calculation of $^{231}Pa/^{230}Th$ implies several corrections that include the estimation of the lithogenic contribution. The latter correction is based on a prescribed value of the $^{238}U/^{232}Th$ activity ratio for the detrital fraction of sediments.

However, the provenance of the detrital material can vary through time, especially across Heinrich events, which are characterized by high contents of Ice Rafted Debris (IRD) in North Atlantic sediment. These variations may imply changes in the value of the $^{238}U/^{232}Th$, and thus induce substantial changes in the calculated sedimentary $^{231}Pa/^{230}Th$ and associated proxies such as ^{230}Th-normalized fluxes.

In order to better assess circulation changes across abrupt events we have evaluated the changes of the lithogenic $^{238}U/^{232}Th$ through time in sediment core SU90-08 (43°N, 30°W, 3080m), located in the Ruddiman belt.

Preliminary analyses on hand-picked IRD grains (>150µm) from Heinrich layers H1, H2, and H4 show that their $^{238}U/^{232}Th$ activity ratio is significantly higher than 0.5, the value usually taken for $^{231}Pa/^{230}Th$ calculations in the Atlantic. To complete these measurements, we will extract the detrital fraction of the sediment by sequential leaching and measure its $^{238}U/^{232}Th$ for key intervals such as Heinrich events, the Holocene and the Last Glacial Maximum. This set of measurements will yield the first complete characterization of the variations in lithogenic $^{238}U/^{232}Th$ in a central North Atlantic core over the last 40 ky, and hence help reducing uncertainties on sedimentary $^{231}Pa/^{230}Th$.

ID: 02276, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Poster)

Preliminary magnetic evaluation of air quality monitoring in north-east Spain (DONAIRE Project)

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In this work, we investigate the magnetic properties of atmospheric deposition collected in northeastern Spain, at locations ranging from urban areas (Barcelona, Palma de Mallorca, Pamplona and Zaragoza) to pristine natural environments of the Ebro Basin, Pyrenees, the Costero-Catalan Ranges and the Balearic Islands. Bulk atmospheric deposition was regularly collected every 15 days since June 2016 and will be sampled to complete one year. We combine magnetic susceptibility data with artificial remanences (e.g., the anhysteretic remanent magnetization or ARM; and two isothermal remanent magnetizations at fields of 0.3 and 1.2 T or IRM@0.3T and IRM@1.2T) in order to characterize atmospheric deposition and to try to unravel its natural (e.g. dust) or anthropogenic (e.g., pollution) origin. Preliminary data indicate relatively measurable amounts of magnetic minerals in the studied samples, whose type and concentrations appear to be linked with the type of prevalent component of atmospheric deposition (e.g., dust versus pollution). By combining magnetic parameters with geochemical and mineralogical data, in future study stages, we aim to define magnetic-geochemical proxies that can be used to discriminate natural sources (e.g., episodes of Saharan dust) and anthropogenic factors.

ID: 01376, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

High resolution study of benthic foraminiferal community from the northern Bay of Biscay (northeastern Atlantic) over the past 7000 years: a look at climatic and oceanic forcing factors

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Sediment core CBT-CS11 is located in the northern Bay of Biscay (off the Penmarc\'h Pointe, France), and covers the past 7000 yrs with exceptionally high sedimentation rate (55 cm/ka). A multiproxy approach (XRF-major elements, grain size, $\delta^{18}O$ and $\delta^{13}C$ measured on benthic foraminiferal shells, and benthic foraminiferal faunal indentificaction) was applied in order to better understand paleoclimatic, paleohydrological and paleoecological changes occurring in the area. Our results show a major change in faunal, sedimentological and hydrological characteristics around 3000 yrs cal BP. This change is characterized by an eutrophication of the benthic ecosystem, as evidenced from an increase in sedimentary sulfur content and in the proportions of eutrophic species (e.g., *Bulimina* spp. and *Bolivina* spp.). This environmental shift is probably due to the combined effect of: (1) the stabilization of sea-level around its present-day value leading to the infilling of upstream estuarine domains and therefore to a better channelization of riverine flows, especially the Gironde and the Loire rivers that are the main sediment contributors to the study area, and (2) a shift to a predominantly negative NAO state leading to increased precipitation in southern France where the major part of the catchment areas of the Gironde and Loire rivers are located.

ID: 01390, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Evaluation of palm swamps palaeoecology related to past climatic & human practices variability

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The paucity of palaeoecological data is acute in the Neotropics, where the low number of good quality records (i.e.; reliable dating, continuous sedimentation) prevents the development of a regional understanding of the vegetation and climate dynamics. Within the Neotropics, low wetlands are poorly known due to the scarcity of potential archives. We present here an ongoing project designed to improve the understanding of wetland forests' responses to changes in climatic and human variability by studying their long-term dynamics. The project will focus on specific scales: i) the geographic area (northern South American wetlands), and ii) the time period (last 6 kyr). The region has been chosen because of the occurrence of globally important big wetland areas dominated by the palm *Mauritia flexuosa*, and the perceived threats to the fluvial-linked systems. Within this broad area, two specific locations have been chosen that represent the northern limit of *M. flexuosa* current distribution. Time frame has been selected to allow: i) the comparison between intervals with and without human activity, and ii) covering the establishment of *Mauritia*, which will allow a better understanding of the current trends (communities in expansion or reduction). The knowledge of past interactions between wetlands, seasonality changes, human practices and other disturbances will provide new insights into how this poorly understood community could face future projections of climatic and land use changes. In addition, emphasis will be placed on studying what influenced the composition of modern plant communities, to analyse their sensitivity to external drivers and to identify the occurrence of irreversible tipping points or thresholds in the recent past. The research will be addressed by using a combination of indicators (proxies) of past environmental change in sedimentary sequences, including: vegetation (pollen), erosion/run-off/sedimentation (palaeomagnetism, XRD), and human impacts (non-pollen palynomorphs, charcoal particles).

ID: 02000, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Insights into the long-term impacts of changing fire regimes, grazing and human activities on southern European forest ecosystems: implications for forest management and biodiversity conservation

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Disturbance regimes have long affected (sub-)Mediterranean ecosystems, largely shaping their current composition and structure. Fire plays a prominent role in the Mediterranean Basin, where it has usually triggered significant ecosystem changes. We currently know that human activities have altered Mediterranean fire regimes for millennia. However, our knowledge about the magnitude of these changes and their effects on the long-term dynamics of Mediterranean forest communities is far from complete at present. Land-use history, mostly comprising livestock raising and arable farming, has been a significant landscape disturbance not only causing changes in the natural fire regimes but using fire as a major land-use tool. In this communication we present several case studies where changes in fire regimes directly or indirectly induced by land-use largely contribute to understand present landscapes and guide current and future nature management. (1) First, we studied fire regime changes associated to the introduction and establishment of *Castanea sativa* cultivation in the southern Swiss Alps. Then, we assessed the importance of the use of fire as a management tool as well as the consequences of recent and ongoing land-use abandonment on this valuable cultural landscape. (2) Later, we focused on the fire ecology of the once dominant and widespread but currently extinct *Pinus nigra* forests of the Northern Iberian Plateau. We showed how land-use intensification and the changes it induced on the natural fire regime caused the demise of these pine forests in the Middle Ages. (3) Finally, we have investigated the effects of disturbance regimes (fire, grazing) and land-use history on the vegetation dynamics of two National Parks of central Spain, Sierra de Guadarrama and Cabañeros. Here we have found that current densities of wild and/or domestic ungulates are unprecedented in the context of the last millennia and population control is consequently needed to guarantee forest regeneration

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ID: 01878, 18.- Human Impact on Global Aquatic Systems, (Poster)

The impact of mining and hydropower in alpine lakes: The sedimentary record of Lake La Cueva (Asturias, NW Spain)

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La Cueva is a 21 m deep lake of glacial origin located at 1550 m.a.s.l in the western area of the Cantabrian Range (Asturias, NW Spain). Iron ore within the carbonatic bedrock outcropping in the catchment has been mined since the early 19th century until 1978. The area was recently subjected to an environmental restoration (2006) involving the re-deposition of large tailings in the lake watershed. Additionally, the construction of a hydropower plant downstream (1917), motivated the damming and hydraulic connection of La Cueva with this plant and two other

lakes located upstream, leading to seasonal, human-controlled water level oscillations (<5 m). The multidisciplinary analysis of a 66 cm-long sediment core (sedimentology, geochemistry and diatoms), dated by ^{210}Pb and radiocarbon, allows reconstructing the evolution of this lake from its natural, pristine status in the 12th century AD to the present. The oldest, recovered sediments (12th-19th centuries) are banded, siliciclastic silts and detrital carbonates, with predominantly benthic diatoms. The drastic change in sedimentation at the 19th century, marked by the deposition of reddish, massive hematite-rich silts and planktonic diatom species represents the input of mining wastes and the effects of major oscillations on the lake water level. An increase in sedimentation rates (from 0.5 to ca. 1.4 mm/year) was recorded during the mid-20th century, coinciding with the start of underground mining. A higher concentration of hematite and sedimentation rates (ca. 7 mm/yr) characterize the 21st century, after the end of mining activities and restoration. Smaller planktonic diatom species during this period might indicate lower nutrient availability and/or a more stable water column. The sedimentary record of La Cueva illustrates the complex interaction of climate variability and human impact in the recent evolution of alpine lakes and the importance of paleolimnological research on the evaluation of restoration measurements in natural protected areas.

ID: 01975, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Reconstructing Holocene hydrological variability from the western Mediterranean region

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Major climatic oscillations during the Holocene are relatively well-known at a worldwide scale. However, in the Mediterranean region, where changes in precipitation (more than temperature) have controlled most of the observed variability during last millennia, at least three important questions have recently arisen as more records have become available and chronologies improve. First, the onset of the Holocene, defined globally as the warmest period, is one of the driest intervals in most NE Iberian lacustrine sequences. Coherently, very few speleothems grew during that period, pointing to low water availability in caves. Second, in spite that the 5 ka BP change remains undoubtedly the most dramatic switch during the Holocene, the seasonal pattern along and after this mid-Holocene transition rests unresolved. In Iberia, most lacustrine records from NE sites point to an amplified aridity, sometimes considered as the onset of Mediterranean climate. On the contrary, new speleothem data indicate an increase in winter precipitation at that time. And third, the hydrological signal during the Holocene rapid climate changes (RCCs) is not spatially homogenous along the Iberian Mediterranean façade.

To solve these questions, comparison of different proxies (isotopes, pollen, sedimentary facies) and paleoarchives (marine, lacustrine and speleothems) with a good spatial coverage in the western Mediterranean is needed. This approach takes into account the potential differences in the response time of the depositional systems to a particular climate event, and, particularly, the variable sensitivity of the indicators to precipitation events (annual average, seasonality, Atlantic vs Mediterranean origin). Besides, a careful study of the processes transferring the climatic signal to the measured proxies throughout long term and complete monitoring surveys is proposed to advance in the study of Holocene climate in the Mediterranean borderlands. This approach aims including all the complexity of this region with both North Atlantic, Mediterranean and subtropical climatic influences.

ID: 02300, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

VEGETATION, CLIMATE AND FIRE-REGIME SHIFTS IN NORTHWESTERN PATAGONIA SINCE 24,000 yr BP

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We examine hydroclimate changes at centennial/millennial timescales since 24,000 yr BP in northwestern Patagonia based on the pollen and charcoal record from Lago Pichilaguna, a small closed-basin lake located in the Chilean Lake District (41º15'S, 73º03'W). Precipitation in this region is delivered solely from the southern westerly winds (SWW), which show strong positive correlations along the coast and the western Andean sectors. We observe cold/wet conditions during the Last Glacial Maximum, with a conspicuous increase in arboreal pollen between 19,300-24,000 yr BP and a reversal between 17,700-19,300 yr BP which correspond with the Varas interstade and the final advance of piedmont glacier lobes in the region, respectively. A rise in *Nothofagus* started at 17,700 yr BP and led to arboreal diversification, establishment of thermophilous trees/vines and closed-canopy rainforests within 1500 years. This event attests for an abrupt warm pulse that initiated the last glacial termination, concurrent with glacial collapse in the lowlands of northwestern Patagonia. Millennial-scale changes ensued including cooler/wetter conditions during the Antarctic Cold Reversal, a decline in precipitation during Younger Dryas time, warmer/drier conditions at the beginning of the Holocene and an intensification of the latter at 10,000 yr BP. The interval between 7800-10,000 yr BP represents the warmest/driest interval in the record followed by a multi-millennial increase in precipitation at 7800 yr BP and the onset of centennial-scale hydroclimate variability at 6200 yr BP. The most recent 3000 years feature cooler conditions and highly variable precipitation regimes, establishing the backdrop for the onset of large-scale disturbance by Euro-Chilean settlers in the region over the last ~350 years. Our results allow assessment of centennial, millennial, and multi-millennial changes in the SWW at regional and zonal scale, and their putative role as driver of CO2 fluxes from the deep ocean to the atmosphere since 24,000 yr BP.

ID: 01991, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

The impact of recent land use change on the Araucaria forests of North Patagonia

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The Andean forest in northern Patagonia around 39°S is characterized by Araucaria araucana (Molina) K. Koch. The specie is symbolic for the region and of high cultural importance for the indigenous people. Due to its limited distribution area it is declared an endangered species. The mountainous region between Chile and Argentina was settled by Euro-Americans since around 1900 AD and A. araucana along with other trees were cut for timber or burned to clear pastures. In addition, woodlands and adjacent open areas at the forest steppe ecotone are used for grazing. In recent years the area is increasingly used for pine plantations.

Here we aim to assess the influence of these changing land use regimes on the forest composition. Short gravity cores were collected from 6 lakes in Chile and Argentina and the sediment was analyzed for pollen. All short cores document the increase in Pinus pollen in the uppermost samples that corresponds to the initiation of Pinus plantations in the 1980ies and is thus providing a time marker. The pollen diagrams also document the spread of the alien species Rumex acetosella L., which is currently wide spread dominating dry pastures and open areas at the forest steppe ecotone. Forest composition has changed little until the recent plantation of Pinus species that are now spreading into natural forests. Although historical documents show that Araucaria was cut its overall abundance around the investigated sites has not significantly decreased and some sites even show an increase in Araucaria pollen.

ID: 01624, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Postglacial vegetation dynamics and climate in north-western Patagonia, Argentina

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Studies on past climate change help anticipating possible future changes with climate warming over the next century. The transition from the Last Glacial Maximum to the Holocene is a period of particular interest to examine possible biotic responses to rapid and abrupt changes in climate because they can provide good analogues for future changes. The objective of this research is to reveal the spatial and temporal patterns of the most important climatic changes that occurred since the LGM at different sites along the Patagonian Andes, based on past vegetation changes. Changes in vegetation observed in the fossil record may be attributed to a range of environmental factors and ecological processes. The Andean Cordillera of southern South America is a critical region that allows us to evaluate the role of different factors which influence changes in vegetation because it presents a range of vegetation types along climatic gradients, it has been influenced by volcanic eruptions and by frequent fires. Therefore, we first analyse the effect of volcanic eruptions on the composition and structure of the vegetation, before reconstructing the climatic changes. Here, we present a late-Quaternary sedimentary record of changes in vegetation and volcanic activity from Mallín Piedra Pintada (39°6\'16.00"S; 71°4\'39.31"W), a site located at the forest-steppe ecotone in an open *Austrocedrus* *chilensis* woodland. The 8m long sediment core recovered is intercalated with numerous tephra layers of varying thickness. The vegetation around the site is today an open woodland with *Nothofagus* species, *Austrocedrus chilensis*, *Araucaria araucana* and steppe elements. The woodland composition shows stability with gradual change in species abundance, indicating that volcanic eruptions have no significantly affected the vegetation. Human impact on the landscape is significant during the last ca. 100 years, associated to the establishment of European settlements in the area.

ID: 01460, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Winter amplification of the European Little Ice Age cooling by the subpolar gyre

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Europe experienced a particularly severe cold period between the late-16th and 19th centuries, the so-called Little Ice Age (LIA). Anomalous climate conditions in these centuries were, however, much colder in winter than in summer. Although several potential drivers have been suggested to explain the European LIA cooling, including solar minima and/or volcanic eruptions, together with a persistent negative phase of the North Atlantic Oscillation (NAO) and/or a weakening of the Atlantic meridional overturning circulation (AMOC), no coherent mechanism has yet been proposed for such characteristic seasonal contrast. Here we demonstrate that Northern and Central Europe experienced a regional amplification of the LIA winter cooling as a result of persistent atmospheric blocking conditions, arising from sea-ice expansion and reduced ocean heat losses in the Nordic and Barents seas. Changes that were ultimately driven by a multicentennial reduction in the northward heat transport by the subpolar gyre (SPG). These anomalous oceanic conditions were largely decoupled from the European atmospheric variability during LIA summers, when the amplifying mechanism was inactive. We reject previous hypotheses that linked the anomalously cold European conditions during the LIA with a weakened AMOC or with a persistent negative NAO. This novel, dynamical explanation is primarily derived from analysis of an ensemble of last millennium climate simulations performed with Max Planck Institute Earth System Model, and further supported by a broad number of reconstructions of European temperature and atmospheric circulation variability and of paleoceanographic conditions from the North Atlantic/Arctic region. We conclude that internal climate feedbacks related to the SPG were responsible of the European LIA winer cooling amplification. Characterization of SPG dynamics is thus essential for understanding multicentennial seasonal variability in the European/North Atlantic sector.

ID: 02103, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

The impacts of climate change and disturbance regime shifts on the spruce-fir forests of the Colorado Plateau, USA

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In Western North America, increasing wildfire and outbreaks of native bark beetles have been mediated by warming climate conditions. Recent bioclimatic models forecast losses of many key high-elevation species throughout the region, including Engelmann spruce (*Picea engelmannii*). To better understand the sensitivity of Engelmann spruce to climate change and intensifying disturbance regimes, we developed a high-resolution record of vegetation and fire history from six subalpine lakes on the Colorado Plateau, USA. Our analysis uses data from lake sediment cores, stand inventories, and historical records. Pollen data for spruce were calibrated to carbon biomass (C t/ha) using standard allometric equations and a transfer function. Charcoal samples were analyzed with statistical models to facilitate peak detection and determine fire recurrence intervals. Our study area has been dominated by Engelmann spruce forests for the last ~10000 years, with subalpine fir (*Abies lasiocarpa*) becoming more prominent since 6000 years ago. This landscape has experienced a dynamic fire regime, where burning events are more frequent and of higher magnitude during the last 3000 years. Two important disturbances have impacted Engelmann spruce in the historical period: 1) high-grade logging during the late 19th century; and (2) a high-severity spruce beetle (*Dendroctonus rufipennis*) outbreak in the late 20th century that killed >90% of mature spruce (>10 cm dbh). Several lines of evidence suggest that 19th century logging promoted a legacy of simplified stand structure and composition such that, when climate became favorable for accelerated beetle population growth, the result was a landscape-scale spruce beetle outbreak. Our study shows that spruce-dominated forests in this region are resilient to a range of climate conditions and disturbance regimes.

ID: 02105, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Modern pollen from small hollows reflects pencil pine density across a wildfire gradient in subalpine forests of the Central Plateau, Tasmania, Australia

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Pollen assemblages from 50 small hollows were used to resolve fire-caused vegetation patterns in a ~ 2 km2 subalpine landscape on the Central Plateau of Tasmania, Australia. Sites were characterized by varying abundance of the dominant tree species, pencil pine (*Athrotaxis cupressoides*), reflecting mortality from a wildfire that occurred 53 years prior to sampling. Sites were classified a priori based on fire-related pencil pine mortality as burned (100% standing dead), unburned (< 5% standing dead) and mixed (intermediate proportions). Non-parametric analysis of variance and discriminant analysis were used to quantify the variability in key pollen taxa and pollen ratios among burn classifications. The ratio of pencil pine to grass pollen was the clearest metric distinguishing among burn classifications. When discriminant analysis was informed with data from the eight most dominant pollen data, samples were classified with high accuracy (0.96- 0.98). Macroscopic charcoal concentrations varied widely among sites, but median values were consistent with inferred fire patterns, increasing in abundance from unburned to burned sites. The results support the use of small hollows to resolve fine-scale vegetation patterns (e.g., within 100 m of a site). The discriminant analysis function was also applied to five late-Holocene pollen samples from the study area, to test the potential of these methods to classify samples with unknown group assignments. The posterior probability of assigned group membership ranged from 0.85 to 0.99, demonstrating the similarity of the fossil pollen to the calibration dataset. Our calibration dataset provides a means to classify fossil samples from the region in terms of Athrotaxis cover and fire-caused mortality. This approach could be applied to other regions to quantify disturbance-related vegetation patterns or spatial heterogeneity over Holocene timescales.

ID: 02220, 01.- Open Session on past global changes, (Poster)

Importance of site-specific variables other than temperature in shaping chironomid composition and distribution: implications for climate and environmental reconstructions.

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Chironomids are well-established palaeotemperature indicators, but have also been broadly used to track in-lake trophic changes, salinity, pH, etc., showing the relevance of other environmental factors in explaining its distribution and assemblage composition. However, there is still lack of understanding about the relative influence and interaction between these factors and the chironomid communities. In addition, there is scarce ecological approach to investigate direct and indirect causes of the strong nature of the relationship between chironomids and temperature, particularly in the southern hemisphere. The Andean region of Patagonia is ideal for monitoring late Quaternary ecological variability, because of its altitudinal and latitudinal gradients within the belt of the southern westerlies. Using chironomid samples retrieved from 63 lakes located between 40° to 54º S; 67° to 74° W, along an altitudinal gradient of 2000 masl, we investigated the relationship between key environmental factors encompassing biogeographic, trophic, climatic and physicochemical variables and changes in assemblage composition and richness. Ordination techniques (RDA, NMDS) showed that summer water temperature, organic matter, conductivity, mean annual precipitation and vegetation cover were the main factors explaining variation in assemblage composition, revealing differences between sites above and under the timberline, at approximately 1500 masl. Indicator species for lakes above or under the timberline did not share species in common. Richness pattern showed an abrupt decrease between 1400-1500 masl, in concordance with the ordination results. Our results confirm the importance of temperature influencing chironomid distribution and composition at a regional scale, but most importantly, they suggest that these changes are mediated by changes in organic matter, conductivity and vegetation cover, which is ultimately driven by the precipitation gradient in the area. These findings highlight the multiscale nature in chironomids response and the need to account for it in future studies to improve our understanding of past and future environmental change.

ID: 02120, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Climate history at Aurora Basin North, East Antarctica: A 2,000 year isotopic record

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In Antarctica, a reasonable coverage of ice core records exist for the last couple of hundred years, however there is poor spatial coverage of high-resolution climate data over the last 2000 years, particularly from East Antarctica (EA). The aim of the Aurora Basin North (ABN) ice core drilling project is to provide a 2000 year climate record from a data sparse area of EA to add to the IPICS 2k array and PAGES Antarctica2k projects. ABN is a 303m ice core from EA, 550km inland and about half way between the coastal Law Dome and inland Dome C sites. Contiguous measurements of water stable isotopes (d18O and dD) have been performed along the entire length of the ABN ice core and provides a climate record at seasonal-decadal resolution for this region of EA spanning the past ~2000 years. The isotopic variability at ABN shows annual cycles in the upper ~50 m and longer-term variability on decadal to centennial timescales. The ABN record shows no long-term isotopic trend over the past ~2,000 years, similar to the 4 isotopic ice core records used in EA for the PAGES Antarctic 2k temperature reconstruction (PAGES2k, 2013). Mean ABN isotopic values fall along the modern Antarctic spatial isotope/elevation and isotope/distance from the ocean relationships and the second order isotope parameter, deuterium excess displays a relatively stable record with occasional sharp transitions. A comparison of the preliminary dated ABN isotope record with the Law Dome isotopic record shows that they are correlated, despite the differences in site-specific influences. This correlation indicates a common climate signal at both sites and a spatial coherence in regional climate from the coastal Law Dome to the inland plateau of the ABN site.

ID: 02047, 06.- Before and after - climate contrasts across the MPT, (Poster)

Mid Pleistocene productivity events in the Gulf of Alaska (NE Pacific)

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IODP Site U1417 in the Gulf of Alaska provides a continuous sedimentary record of environmental changes (e.g. in sea surface temperature (SST), marine productivity, ice-rafting) in the subpolar NE Pacific through the Plio-Pleistocene time interval. Here, we present a multi-proxy data set, which allows us to discriminate between different fertilization mechanisms that promoted primary productivity events in the study area between 1.5 Ma and 0.5 Ma. Based on biomarker, micropaleontological, XRF, and sedimentological data, we find that diatom growth benefited from iron-fertilization from aeolian dust, iceberg, and volcanic ash input. Glacial-interglacial SST fluctuations were superimposed by a slight cooling trend with a first pronounced temperature drop during MIS 38 and significantly lowered SSTs persisting through MIS 30 and MIS 28. While the diatom productivity pulses were mainly independent from SST changes, they coincide with terrigenous organic matter input and their occurrence during both glacial and interglacial periods suggest that iron supply from glacigenic dust was mainly controlled by local ice-sheet dynamics. This data set highlights the complexity of fertilization mechanisms in areas affected by evolving ice-sheets and their potential control on the biological carbon pump in subpolar ocean environments.

ID: 01882, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Estimating Antarctic climate variability of the last millennium

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Climate variability is determined by the climate system’s internal variability as well as its response to external forcing. A quantitative understanding of past Antarctic climate variability is therefore essential if we are to attribute and to detect anthropogenic influences on the current and future climate in Antarctica, and thus crucial for projecting the evolution of the Antarctic ice sheet. Analysis of stable water isotope data from ice cores in principle provides information on past temperature variability, but its quantitative interpretation is challenged by strong non-climate effects. So far, the magnitude and timescale dependency of both the climate signal and the noise in Antarctic isotope records remains largely unknown. Here, we present a new spectral method to separate climate signal and noise in a large collection of published and new annually-resolved ice core records from East Antarctic Dronning Maud Land and the West Antarctic Ice Sheet, spanning the last 200—1000 years. With this, we derive the first timescale-dependent estimate of Antarctic temperature variability and isotopic signal-to-noise ratio on decadal to centennial time scales. In contrast to the raw isotope data, we find a stronger increase in temperature variability on longer time scales, which is similar between the two study regions and to estimates from reanalysis and marine SST data. Spatial analysis of the estimated noise levels allows the separation of local stratigraphic noise from larger-scale noise due to precipitation intermittency. Signal-to-noise ratios only reach values above one for multi-centennial time scales. Our findings illustrate a consistent way of interpreting isotope records, but also highlight the remaining knowledge gaps in our understanding of Holocene climate and ice-core derived variability. We emphasize that our new method is applicable for distinguishing climate variability from local effects for any spatial, well-dated array of proxy temperature records.

ID: 01737, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

OSL-chronology of Caspian depression paleogeographic evolution in Late Pleistocene

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Caspian depression is unique object for reconstructing Caspian sea Pleistocene history, for correlation its paleogeography with glaciations of East European plain and global and local climate change. Chronology of paleogeographic events is one of the most controversial issues in the study region. There are currently obtained estimates of the age by electron paramagnetic resonance spectroscopy, thermoluminescence, uranium-ionium, radiocarbon, which often gives contradictory results. The main purpose of this research is the reconstruction of paleogeographic events in the Late Pleistocene of the Caspian depression region by summarizing the dating results for the reference Srednaya Akhtuba section (Volgograd region, the left bank of the Akhtuba river). This section was selected because it\'s representativa for local Late Pleistocene events. It was the first time when geochronological scheme of paleogeographic events was created for the Caspian depression region for the Late Pleistocene (based on 11 OSL dates obtained by authors). We identified five stages of development of this territory in the Late Pleistocene: Late Khazarian (MIS 5e; Eemian interglacial), Hirkanian (MIS 5d-a, the transition from the era of Eemian interglacial to Weichselian glacial stage), Atelian (MIS 4-3 and the last glacial maximum, LGM), Early Khvalynian (MIS 2, degradation of glaciation), Late Khvalynian - Holocene (the end of the MIS 2 and MIS 1). Moreover, the age of chocolate clays (Early Khvalynian deposits), which are of broad occurrence at the Caspian depression region, usually rates as arguable and highly rejuvenated. Due to this research the results of chocolate clays dating confirm radiocarbon and uranium-thorium dating. All of stages received dates and was correlated with the glacial and interglacial events of the East European Plain.

ID: 01961, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Impact of volcanism on Fennoscandian Ice Sheet melting during the last deglaciation

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Volcanic eruptions can impact the mass balance of ice sheets through changes in climate and the radiative properties of the ice. Yet, empirical evidence that highlights the sensitivity of ancient ice sheets to volcanism is still scarce. Here we present a new precise 1257-year long chronology from a continuous sequence of annual glacial varves, which record changes in the melting rate of the Fennoscandian Ice Sheet at the end of the last deglaciation (13,200-12,000 years ago). Precise synchronization to the Greenland ice-core chronology allows for the first time comparison to ice-core volcanic records at an unprecedented precision. Our data indicate that abrupt ice melting events coincide with volcanogenic aerosol emissions recorded in Greenland ice cores. We suggest that enhanced ice ablation rates are associated with albedo effects due to deposition of ash sourced from high-latitude volcanic eruptions. Results from snowpack mass balance simulations show evidence for enhanced ice sheet runoff under volcanically forced conditions. The sensitivity of past ice sheets to volcanic aerosols highlights the need for an accurate coupling between atmosphere and ice sheet components in climate models.

ID: 02115, 01.- Open Session on past global changes, (Poster)

New technical and methodological development in past global changes

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Traditional taxonomic methods for pollen identification in Quaternary palaeoecology based on morphology are highly time consuming and can also be limited by taxonomic precision . Two separate approaches have the potential to improve methods of pollen analysis in sediment cores. Automatic classification and identification using the Classifynder system (Holt et al. 2011; Lagerstrom et al. 2015) has the potential to use detailed morphological measurements and machine learning techniques to distinguish pollen types at higher levels of taxonomic resolution. Fourier transform infrared (FTIR) spectroscopy is an alternative approach which can providing information on chemical composition of pollen by characteristic spectral bands and features (Zimmermann and Kohler 2014; Dell'Anna et al 2009). Pollen infrared spectra contain specific signals from lipids, carbohydrates, sporopollenin and other cell wall biopolymers that can be used to fingerprint species. Combined, these two appproaches open new and exciting prospects for the classification of pollen. We have characterized 4 Eucalyptus species from Bega Swamp, Australia using morphological as well as chemical composition data. Fresh pollen samples were gathered from 4 species of Eucalyptus dominant around Bega Swamp which are difficult to classify using standard morphological approaches (E. fraxinoides, E. fastigata, E. radiata and E. dalrympleana). Taxa were analyzed using both FTIR and with the automated Classifynder system was used to gather morphological information on the collected pollen. Using multivariate statistical analyses, the chemical composition of the pollen was determined as well as characteristic spectral bands for the different species. The spectral data is combined with the morphological results to identify differences between the species that can be used as a new technique to automate pollen classification based on morphology and chemistry of species hard to identify with conventional light microscopic methods.

ID: 02238, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Poster)

The South China Sea paleoceanographic conditions and terrigenous sediment supply in the last 400 ka

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The high sedimentation rates of the South China Sea (SCS) makes this marginal basin a potential region for paleoceanographic reconstructions. The climate, hydrography, and the terrigenous input to the SCS respond to the seasonal reversal of winds promoted by the East Asian Monsoon System (EAM), which is composed by two subsystems, the East Asian Winter Monsoon (EAMw) and the East Asian Summer Monsoon (EAMs). As the EAM affects substantially SCS water column conditions we here investigate the Late Quaternary evolution of this coupled air-sea dynamic trough geochemical and planktonic foraminifera proxies. For this the first 20m of core 349-U1431D (15°22.5379'N, 117°00.022'E, 4240m water depth), retrieved on board the Joides Resolution, during Expedition 349 – South China Sea Tectonics of the International Ocean Discovery Program (IODP) was investigate for its elemental ratios (Fe/Ca, Ti/Ca, Fe/K and Ti/Al) and the planktonic foraminiferal content. Our preliminary results suggest that during interglacial (glacial) periods, the SCS received a larger (lower) contribution of terrigenous sediments originating mainly from Taiwan (Luzon), associated with greater (less) precipitation in the adjacent continent resulting from a more Intense (weak). Also, during interglacials, the weaker winds of the winter EAM promoted strong water column stratification and lead to warm and oligotrophic SCS surface waters, as suggested by high abundances of the *Globigerinoides ruber* (white) assemblage. Although preliminary, our data reveals a complex response of the SCS to Late Quaternary changes in the EAM.

ID: 01400, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Poster)

Holocene sea-level changes in Korea

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One of the most well-known consequences of global warming is sea-level rise. Sea-level fluctuation is the primary factor for the evolution of coastal landscapes and sedimentary environments, and can be a major cause of coastal erosion, flooding, and saltwater intrusion. Understanding the local factors is crucial for establishing the countermeasure plans for the future sea-level rise. The Yellow Sea was subaerially drained during the Last Glacial Maximum (about 21,000-18,000 yrBP), and the Korean region was no longer peninsular but was a part of the East Asia mainland. After the Last Glacial Maximum, the Yellow Sea region has been gradually flooded according to the postglacial global sea-level rise. Several researchers reported that the maximum sea-level during the Holocene was approximately 1-2 m higher than the present sea-level at around 6000 yrBP. These changes influenced the lifestyle of prehistoric human beings and affected the formation of present topographic shoreline features. Along the western coast of the Korean Peninsula, alluvial or coastal plains are widely distributed, especially in the low-lying coastal and river mouth areas. The recent Quaternary geology mapping project, conducted by the Korea Institute of Geoscience and Mineral Resources (KIGAM), drilled numerous cores in and around the Honam and Naju Plains and revealed that the largest parts of the plains were originally tide-dominated macrotidal flats. This paper deduces the late Holocene sea-level changes from the distribution of tidal flat sediments along the western coast of the Korean Peninsula. Our data show that the effects of local-scale factors such as changes in paleotidal range and sediment flux are more substantial than ever thought. This implies that the tidal power should be considered first for the future coastal defence and conservation.

ID: 01355, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Quantitative reconstruction of sea ice duration and SST from Southern Ocean: Using diatom transfer function

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A diatom transfer function has been applied to the diatom assemblages from the sediment cores SK 200/22a (7.54 m) and SK 200/27 (4.89 m) to provide down core estimate of February SSTs and sea ice duration. The sediment core SK 200/22a covers the past ~95 kyr and was retrieved from polar frontal zone (PFZ), whereas SK 200/27 represents the past ~75 kyr and was recovered from permanent open ocean zone. The advance phases in sea ice coverage occurred during glacial periods (MIS 2 - 4) with sea ice duration < 1 month/year and coincided with the drop in summer SSTs at both the core sites. The SSTs during the glacial periods were close to 4°C suggesting the presence of APF at the core site SK 200/22a. The northward shift of APF is also indicated by larger *F. kerguelensis* and *T. lentiginosa* valves size and higher diatom productivity to the north of APF (SK 200/22a), during glacials (MIS 4 and 2) as compared to interglacials (MIS 5 and 1). However this scenario doesn't seem to be valid for the region south of APF (SK200/27), where larger diatom and higher diatom productivity occurred during the interglacial period (MIS 1) relative to glacial period. This could be explained by the fact that the summer SST at the site SK 200/27 were significantly lower (<4°C) during MIS 2 and 4 complementing the sea ice presence of about 1 month/year and also indicating the shift of the APF to the north of the site SK 200/27 during glacial periods. Lower SSTs and increased duration of sea ice cover at the site SK 200/27 could have been a probable reason for lowering the diatom productivity and the sizes.

ID: 01498, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

Millennial scale atmospheric CO2 variably during Marine Isotope Stage (MIS) 9-11

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High resolution CO2 records measured on the TALDICE and EDML ice core for the last glacial period (38 - 115 kyrBP) have shown that the phasing between CO2 and the variations of the bipolar seesaw are not always in phase (Bereiter et al., 2012). Millennial scale CO2 variations in MIS5 peak approx. 250 years after the onset of the abrupt Dansgaard-Oeschger (DO) events, whereas the CO2 peak in MIS3 lags the onset of DO events by almost 900 years, unveiling a mode shift in the Atlantic Meridonial Overturing Circulation (AMOC) between MIS5 and MIS3. This raises the question whether this is a specific phenomenon of the last glacial period or a constant feature throughout previous glacials. In order to investigate this phenomenon highest resolution and precision CO2 and CH4 data from ice cores are required that allow to directly determine the phase relationship between Southern Ocean CO2 release and northern hemisphere CH4 response to DO events. In 1999 Petit et al.

published a CO2 record covering the last 400'000 years which stands as a landmark in paleo research. To date, this CO2 record obtained from the Vostok ice core is still the only CO2 data available for the period between 150'000 and 400'000 years. Unfortunately, the data resolution is not yet sufficient to study millennial scale variations in the climate system. With state-of-the-art CO2 measurement techniques and available ice from the EDC ice core, we are now able to fill this "low resolution" gap with a record that will have a three times better measurement precision and a five times higher temporal resolution, allowing to investigate millennial scale processes.

These measurements are currently in progress and we will present the first high resolution CO2 record covering the MIS9-11 period using ice from the EDC ice core.

ID: 01638, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

The influence of proxy noise on hemispheric temperature reconstructions during the last Millennium

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Recent reconstructions of Northern Hemisphere (NH) mean temperature over the last Millennium show a remarkable agreement with independent climate model simulations. At smaller spatial scales and for the Southern Hemisphere (SH) this agreement is considerably weaker.

Potential causes of these differences between reconstructions and model data are imperfect simulation of the influence of external forcing on the climate system, or underestimated multidecadal and large-scale climate variability in the model. But they might also arise from low quality or coverage of proxy data, deficiencies in reconstruction techniques, or a combination of all these factors.

Here, we use Pseudoproxy Experiments to evaluate the potential influence of the noise inherent in the proxy data on hemispheric temperature reconstructions and subsequent model comparisons. A range of noise realizations of varying magnitude and autocorrelation structure was added to grid-cell temperatures of 14 simulations from two different climate models (CESM1 and HadCM3) to generate a large suite of pseudoproxy reconstructions for both hemispheres.

These pseudoproxy reconstructions were compared to the results based on real proxy data for a range of diagnostics, for which data-model discrepancies have been reported: Inter-hemispheric correlations and differences, the response to volcanic eruptions, the timing of extreme periods and the magnitude of scaling factors in formal detection and attribution (D&A).

Lower inter-hemispheric correlations and D&A scaling factors in reconstructions compared to models can be accounted for by the proxy noise. For most other metrics, some discrepancy remains after accounting for the proxy noise. For example, proxy noise can explain about half of the signal loss in reconstructed volcanic cooling compared to the simulated response in both hemispheres.

Despite the considerable challenge of identifying realistic levels of proxy noise, our results shed new light on uncertainties for the interpretation of climate over the past 1000 years.

ID: 01572, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Pollen climate reconstructions for three interglacials from New Zealand and their relevance to climate projections for the 21st century.

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Although the climate forcings were different to today, MIS 5e and 11, along with the early Holocene, can provide important insight into regional biophysical responses in a warmer world. We present temperature reconstructions for these three interglacials from pollen records from New Zealand (NZ) in the southern mid-latitudes, a region under-represented in these records. Quantitative reconstructions for the Holocene and MIS5e are determined using the transfer function approach applied to the NZ pre-deforestation database. Mean annual air temperature (MAAT) at two sites from northern North Island attained modern temperatures early in the Holocene but did not exceed them within errors. An Early Holocene thermal optimum at levels similar to present is also evident in other records from throughout NZ. In contrast, our new MAAT record for MIS 5e from central North Island indicates temperatures at least 1.6 ± 1.5 ^{o}C above present, also consistent with most other available evidence. As with the Holocene, a thermal maximum appears to have been reached early in the Interglacial. Although no terrestrial MIS 11 sites have been reported from NZ, we present a new MIS 11 terrestrial pollen record from a marine core taken on the continental shelf offshore southwestern New Zealand. Quantitative pollen-temperature reconstructions are not viable in this setting, but SST estimates from the same core were

~1.5 – 3.0 ^{0}C warmer than present during MIS11, analogous to a likely range of global warming that is currently projected for the end of the 21st century. The pollen assemblages for this interval are derived from the adjacent Westland region, a UNESCO natural World Heritage property. During MIS 11, these temperate rainforests were substantially altered in response to a significantly warmer and more humid climate. These results suggest that NZ's iconic lowland podocarp forests – may be under threat from climate change in the near future.

ID: 01263, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Exploring the paleoenvironmental potential of laminated maar sediment in central Vietnam: An archive of regional paleo-flooding?

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Global warming increases atmospheric humidity and will likely affect the monsoon system and the impact of typhoons in Vietnam. It is essential to know the long-term regional climatic history to properly judge modern trends along global climate change. In the absence of a long written history and instrumental records in Vietnam, we rely on geological paleoenvironmental archives. Sediments from East-Asian maar lakes have a demonstrated value as long-term recorders of monsoon strength, for example in China and Cambodia. The landfall of a typhoon would exacerbate regional flooding, as Vietnam experienced in October 2016. Central Vietnam's Pleiku volcanic field features numerous maar lakes and dry maars ranging in age from 2.4 to 0.2 Ma. Their natural sedimentary archives extend from the Anthropocene deep into the Pleistocene. Maar lakes with suboxic bottom waters likely harbor well-preserved and high-resolution laminated sedimentary archives with paleoenvironmental information, including episodes of intense runoff from their generally small catchment areas. Agriculturally utilized dry maars near Pleiku can be cored more easily than lakes, but would not be able to provide high-resolution records up to the most recent past.

In March of 2016 we recovered an exploratory 0.5-m sediment core from Biển Hồ maar lake in central Vietnam at a water depth of ~14 m. Go-Pro subaquatic visual coverage of the coring procedure documented an unconsolidated, extremely water-rich sediment surface. The sediment core yielded organic-rich, anoxic, sapropelic sediment below a slightly cohesive microbial mat. After dewatering, the core was split and indicated the presence of sedimentary laminae. Light-gray laminae suggested the presence of distinct flood layers. Renewed coring efforts with improved equipment in a maar lake and a dry maar are planned for December 2016, followed by physical and geochemical characterization.

ID: 01465, 26.- Data Stewardship for Paleoscience, (Poster)

Chinese Pollen Database: Current status and future plans

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The first, national-wide data collection for building up a Chinese Quaternary Pollen Database was conducted in 20 years ago, within the framework of palaeovegetation mapping project BIOME 6000 of the International Geosphere-Biosphere Programme (IGBP). First-series publications of palaeobiome reconstructions in the Mid-Holocene and during the Last Glacial Maximum based on ca. 650 modern pollen records and 120 fossil pollen records have been performed around year 2000 and later on the basis of ca. 800 modern pollen records and 190 fossil pollen records, all using the Biomisation method. More high quality pollen and radiocarbon data has been recently available and further data collections have been made during the first decade of the 21st Century. In total 2434 modern pollen records and 228 fossil sites have been used for further 500-year interval palaeobiome reconstructions based on an updated classification scheme of plant functional types. There have been many other pollen data collections at regional and national scales for modern pollen-vegetation-climate study and many other pollen profiles and cores have been available for past vegetation and climate studies. Potentially, ca. 6000 modern pollen and 1000 fossil pollen records are so far available in China. Such robust resources will be used to build up a Chinese Pollen Database according to common protocols as the European Pollen Database and the Neotoma adopted. Here in this presentation, the current status of approaching to build up the Chinese Pollen Database will be introduced and future plans will be discussed. These data can be used to further explore large-scale

modern pollen-vegetation-climate-disturbance relationships and to numerically investigate past changes of vegetation and climate in China.

ID: 01433, 24.- Regional versus global in past monsoon dynamic: disentangling wind and precipitation proxies., (Poster)

Late Miocene onset of dominant 100,000 year East Asian summer monsoon cycles

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East Asian summer monsoon (EASM) precipitation received by northern China over the past 800 kyr is characterized by dominant 100 kyr periodicity, attributed mainly to CO_2 and Northern Hemisphere insolation-driven ice sheet forcing. Here we established an EASM record in the late Miocene from lacustrine sediments in the Qaidam Basin, Northern China, which exhibits a dominant 100 kyr periodicity similar to the EASM records during the late Quaternary. Because limited ice existed in the Northern Hemisphere during the late Miocene, we attribute the 100 kyr cycles to CO_2 and Southern Hemisphere insolation-driven Antarctic ice sheet forcing. This indicates a >6 million year earlier onset of the dominant 100 kyr Asian monsoon and likely glacial and CO_2 cycles and suggests dominant forcing of Northern Hemisphere climate by CO_2 and Southern Hemisphere ice sheets in a warm world.

ID: 01757, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Poster)

Influence of climate forcing on the Northern Hemisphere Ice Sheets evolution through the last glacial cycle

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Here we use a three-dimensional thermo-mechanically coupled ice sheet model, Parallel Ice Sheet Model (PISM), to simulate ice sheet evolution of the Northern Hemisphere through the last glacial cycle. The simulation is driven by the calibrated index of NGRIP d18O records combined with climate forcing at two time slices, the Last Glacial Maximum (LGM) and present day. The present day climate forcing data includes the NCEP/NCAR reanalysis for temperature and GPCP for precipitation. For LGM, we use the results from different general circulation models of PMIP3 members. Different scaling methods are also investigated. The influence of different climate forcing parameters on ice sheet evolution is studied. The results show that volume and spatial distribution of ice vary based on different climate forcing parameters, which give us insights on how sensitive of ice sheets are to temperature and precipitation, due to surface mass balance change. We conclude that there is a needs for coupling an ice sheet model to a general circulation model to take into account the missing processes in climate system.

ID: 01282, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

An insight into the mid-late Holocene vegetation of southeast Nigeria as deduced from a pollen profile of pond sediment, Nsukka, Nigeria

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A mid-late Holocene vegetation record is presented from southeast, Nigeria. Pollen analysis of 2 m sediment was used to reconstruct the vegetation of Ohe pond swamp, Nsukka, Nigeria. The pollen record reflected aspects of the southern guinea savanna; Lowland rainforest, secondary forest, savanna woodland and freshwater swamp. The high occurrence of trees and shrubs point to the existence of woodland vegetation interspersed with forest elements prior to 6,417 ± 67 BP around the pond. During this period the savanna elements of the mosaic lowland rainforest and secondary grassland vegetation seem to have been established although, it never completely dominated the rainforest species. However, after about 6388 ± 71 BP the pollen profile showed that the savanna components became wide spread, a feature attributed to climatic factors rather than human influence. The presence of charred plant particles and pollen of farmland weeds which were recorded around this period cannot be conclusively attributed to prehistoric agriculture because this period predates all evidence of human activities in the area. From the findings of the study, there appears to be a shift in vegetation structure and flora from a more closed structure, dominated by lowland rainforest and freshwater swamp forest species (*Alchornea cordifolia*, *Elaeis guineensis, Draceana* sp., *Berlinia grandiflora,* Cyperaceae, Moraceae complex) prior to 6388 ± 71 BP, to that of woodland vegetation dominated by savanna components (*Phyllanthus muellerianus, Lophira lanceolata*, Combretaceae / Melastomataceae, *Antidesma* sp, *Syzygium guineensis, Smilax kraussiana*, *Aparagus africana*) from about 6388 ± 71 BP to around 1840 ± 46 BP. This probably represents a notable change in the vegetation history of the area and climatic factors rather than human influence were responsible for the change in vegetation.

ID: 01823, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Characterising the geochemical fingerprint of Adélie Land Bottom Water: A multi-proxy approach

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Changes in ocean circulation on the Antarctic margin has important implications for the evolution of the Antarctic ice sheet. Basal melting of buttressing ice shelves by warm ocean water has been attributed to the rapid ice loss observed in West Antarctica, and new observations suggest a similar mechanism for large drainage basins in East Antarctica [*Rintoul et al.*, 2016]. Assessment of past ocean forcing on Antarctic ice sheet dynamics can contribute to testing ice-ocean feedbacks, with implications for future sea level predictions. To achieve this, reliable proxy-based reconstruction of ocean circulation and water mass properties in Antarctic sediments is required. The nature of polar sediments however, makes it challenging to reconstruct environmental conditions around Antarctica.

A multi-proxy calibration study was carried out on a suite of seawater and shelf sediment samples from the Adélie and George V Land margin. In this region, high salinity shelf waters are exported via the Adélie Sill to form Adélie Land Bottom Water (ALBW). The cold, fresh oxygen-rich properties of this 'flavour' of Antarctic Bottom Water makes it distinguishable from modified Circumpolar Deep Water that upwells onto the shelf. To determine the end member Nd isotopic composition of ALBW a series of different chemical extraction techniques were performed to isolate the authigenic fraction. The most promising method relies on sufficient buffering of the leaching solution to prevent leaching of the detrital fraction. Redox metals (e.g. Mn, U and Re) in the authigenic sedimentary fraction were used to evaluate bottom water ventilation; thorium normalised opal and barium fluxes for export production; and the use of GDGTs were explored in relation to Antarctic-sourced waters.

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ID: 02028, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

A short history of human relationships with nature in the Canary Islands and Cape Verde

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Palaeoecological studies on islands worldwide have shown that human impacts are nothing new and that in most cases the effects of human settlement are noticeable even at early stages and for long periods. We present a review of the palaeoecological results obtained from the Canary Islands and a new charcoal record from Cape Verde. Both archipelagos are part of the Macaronesian biogeographical region that is often considered a model system for research in ecology and biogeography. In this poster, we analysed both micro- and macro- charcoal and pollen to identify regional and local fires for both archipelagos.

While humans colonized Canary Islands approximately 2500 years ago the colonization history of Cape Verde is currently uncertain. Therefore it is not well known when did humans arrive first, or when did their effects began to be noticeable. This uncertainty is a clear limitation when interpreting palaeoecological and archaeological records. Emphasis will be placed on anthropogenic fires in Tenerife (La Laguna), Gran Canaria (Laguna de Valleseco), La Gomera (Laguna Grande) in the Canary Islands, and Santo Antão (Cova de Paúl) in Cape Verde. The four sedimentary records analysed so far are starting to display some similarities in the response of Macaronesian ecosystems, especially in the event of human disturbances. These two archipelagos provide a unique setting to study human impact on a singular island biota on the long-term.

ID: 01334, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Using co-located lake and bog paleohydrologic records to improve proxy climate interpretations

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Terrestrial hydrologic variability over the Holocene can be documented by many different proxies. In particular, in the northeastern United States two key methods are sedimentological lake level reconstructions and testate amoebae inferred water table depth reconstructions from ombrotrophic peat bogs. There is an existing network of both of these types of reconstructions, but they have never been used in the same location. Thus, it is difficult to directly compare the resulting reconstructions because potential proxy differences are confounded with regional climatic differences. Here we present a new lake level record from Giles Pond, Aurora, Maine, US and a new bog record from Caribou Bog, Old Town, Maine, US. These records from the southern Maine highlands are located approximately 40 km apart and overlap in time over the past approximately 7000 years and provide the first directly comparable pair of co-located records. In comparing these two very different types of hydroclimate proxies we are also leveraging their unique strengths, especially in the frequency domain. Lake level records best preserve centennial-to-millennial length events and trends whereas bog records are best at decadal-to-multidecadal frequencies. So by having the two types of records in the same place we can develop a multi-scale reconstruction of past hydroclimate variability that provides texture to the individual reconstructions that is not possible otherwise. Our approach of developing new, co-located records is a critically important and underused approach to better understand the fidelity of these methods that we use to reconstruct past climate.

ID: 02242, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Review of “The Beyşehir Occupation Phase”: possible marker assemblage pollen zone for the biostratigraphic division of the Late Holocene in the Eastern Mediterranean or not?

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In contrast to the regionally abundant archaeological records indicating prominent settlement activity during early Holocene in Anatolia, pollen evidence of the intensive anthropogenic influence on the landscape is not convincing and patchy. Traces of strong human activity are just recorded in the pollen records from the Late Bronze Age onwards. This period, characterized by combination of different primary and secondary anthropogenic indicators for cereal cultivation, arboriculture, grazing, strong deforestation and fire, is termed as the Beyşehir Occupation Phase (BOP). Although it is clearly visible in the records from southwest Turkey (approximately between 3500 and 1300 ^{14}C BP) and partly from Greece, spatial and temporal extent of this period is ambiguous. In addition, lack of agreement on the start and end dates of this period produce inconsistency in the correlation of different sites. Long duration of this phase that covers different settlement systems of archaeological periods (including the Late Bronze Age, Iron Age, Hellenistic, Roman and early Byzantine periods), makes it challenging to draw parallels between pollen data and archaeological/historical data. Moreover, some sites do not cover the whole range of BOP that is consisting of 5 different pollen assemblage subzones in the most representative site (the Beyşehir I core). Apart from differences in dating the BOP, it also shows different types of land use in different sites. That makes it difficult to properly identify this period across Turkey. Clear conclusions cannot be drawn due to the possible role of Late Holocene climate variability on vegetation history and high levels of uncertainties in age models from many older pollen records. Therefore, this paper aims to review this phase by comparing preliminary results of new pollen data from Bafa Lake with the available high resolution pollen data.

ID: 02319, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Mid- and late Holocene environmental variability in Arctic Siberia: evidence from sediment core records from the Laptev Sea inner shelf adjacent to the Lena River Delta

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We obtained lithological and microfossil (terrestrial/aquatic palynomorphs, benthic/planktic foraminifers, ostracods) evidence on past environments constrained by 12 AMS^{14}C datings from marine sediment cores, PM9482-2 and PS51/80-13, aging back to *c.* 2.6 and 6.35 cal. ka, respectively. PM9482-2 is located northward the Lena Delta within the influence of Tumatskaya branch outflow and PS51/80-13 - to the northeast from it close to Trofimovskaya branch.

Two chronozones in PS51/80-13 correspond to the periods of low and high sedimentation rates. The opposite trend was revealed in PM9482-2, thus manifesting redistribution of the river flow from Tumatskaya branch to Trofimovskaya one.

In both cores, abundances of freshwater colonial algae *Pediastrum* sp. and *Botryococcus* sp. are higher than those of marine dinoflagellates cysts indicating persistent river input onto the shelf. Two distinct peaks in both pollen and freshwater algae concentration exceeding $80×10^3$ and $7.5-14.5×10^3$ grains/g, respectively, were dated to 5.2 and 1.6 cal. ka. They might be associated with warm/wet climate pulses causing particularly strong freshwater/suspended organic matter influxes from the Lena River. Dinoflagellate cysts appear in PS51/80-13 core since *c.* 4.5 cal. ka and reach the peak abundance of up to $9×10^2$ grains/g. Increased marine influence in bottom water layer 4.5-1.4 cal. ka is reconstructed by the appearance of relatively deep-water ostracods, benthic foraminifer *Cassidulina reniforme* and single planktic foraminifer *Neogloboquadrina pachyderma* sin. Sediments become more sandy 2.7-1.5 cal. ka. The observed situation manifests enhanced estuarine circulation, i.e. strong freshwater influence in the upper water layer (due to climate amelioration or/and redistribution of river outflow) and opposite inflow of open sea water in the bottom layer along the Lena submarine paleovalley. Significant decrease in the abundance of floodplain and tundra shrubs in favor of long-distant wind-blown *Pinus* pollen since 1.6 cal. ka points to decreasing pollen productivity of tundra plants due to climate deterioration.

ID: 02344, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Evidence for human impact on natural landscapes of Upper Oka Region, Central Russian Plain, during Late Holocene as revealed from a case study of peat section from Orlovsky Polesye National Park

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Orlovsky Polesye NP is located within the border of deciduous forest and forest-steppe zones of the Russian Plain. Scots pine, spruce, oak, birch, linden, aspen, maple, ash and alder in various combinations form modern forest stand. The territory of modern NP was inhabited in the Bronze Age, presumably by nomadic tribes of Fatyanovskaya Ugric culture, which came from the Upper Volga and founded the first permanent settlements. Our study sought to establish the start rooting appropriating economy in the afforested left bank of the Oka River, and get the first palaeobotanical evidence for transformation of forest ecosystems at the initial stage of human impact.

The peat deposit was extracted from oligotrophic marsh in the southwestern part of NP (53º27\' N, 35º34\' E). According to radiocarbon dating, peat growth began 3600 cal. years BP. Prior to major human disturbance (3600 to 1600 cal. years BP), the landscape was dominated by mixed broadleaf-pine forests with birch and spruce covering about 50% of the study area.

A single pollen of cultural cereals, high percentages of pine pollen and relatively low proportion of pollen of broadleaf plants in 0.95-1.0-cm interval of the section most likely indicate the first violation of the forest by ancient farmers. The period after 1500 cal. years BP features with pronounced changes in plant cover of the studied region. The share of pollen of broad-leaved trees is sharply reduced in favor of pollen of birch and pine. Changes in the spectra show a gradual xerophytization of plant communities and species depletion, which likely might be associated with more frequent fires. To the top of the section, the proportion of pollen of cultural cereals and commensal species (*Centaurea cyanus*, Urticaceae, *Potentilla* sp, *Rumex* sp, *Plantago* sp.) increases indicating the rooting of agriculture and the strengthening of human impact on forest stand.

ID: 01611, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

The complexity of millennial-scale cooling events in southwestern Europe during MIS 11

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Climate and vegetation of southern Europe are particularly sensitive to present and future global climate changes. The Marine Isotope Stage (MIS) 11, which is characterized by muted insolation changes, has recently been highlighted as a warm stage with higher than present-day sea-level, most likely related to Greenland and West Antarctic ice-sheet collapse. Consequently, sedimentary archives of MIS 11 may provide valuable information on the abrupt climate variability in southern Europe under non-anthropogenic forcing.

We present a new direct land-sea comparison of MIS 11 from the IODP Site U1385, “Shackleton Site”, on SW Iberian margin. Our study documents with an unprecedented high time-resolution, the SW European vegetation and subtropical North Atlantic sea surface temperature (SST) changes to millennial-scale climate variability during MIS 11. This multiproxy approach reveals that climate instabilities are a pervasive feature of MIS 11 in SW Europe, but most importantly it highlights the diverse expression of the cooling events in terms of magnitude, character and duration. We propose that this diversity relies on atmospheric and oceanic processes whose predominant role likely depends on baseline climate states. Repeated atmospheric shifts recalling the positive North Atlantic Oscillation mode, inducing dryness in SW Iberia without systematical SST changes, would prevail during low ice volume conditions. Mechanisms associated to ice-sheet dynamics, such as magnitude and origin of iceberg discharges, related AMOC perturbation and regional precipitation would be critical to produce enhanced cooling and drying episodes of extended duration in SW Europe.

ID: 01862, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Northeast Siberian ice wedges confirm Arctic winter warming over the past two millennia

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Arctic climate has experienced major changes over the past millennia that are yet not fully understood in terms of external and internal controls, spatio-temporal, and seasonal patterns.

The interpretation of stable water isotope data ($\delta^{18}O$) in permafrost ice wedges provides unique information on past winter climate conditions. Recently, an ice-wedge record from the Lena River Delta suggested for the first time, that Siberian winter temperatures were warming throughout the Holocene, contradicting most other Arctic paleoclimate reconstructions likely because these are mostly biased towards the summer season. As this was based on a single record, the representativity and spatial extent of the reconstructed winter warming signal remained unclear.

Here, we present a new ice-wedge based oxygen isotope record from the Oyogos Yar mainland coast (Northeast Siberian Arctic), based on paired stable-isotope and radiocarbon-age data spanning the last two millennia. The record confirms the long-term winter warming signal as well as the unprecedented temperature rise in the last decades. This demonstrates that winter warming over the last millennia is a coherent feature in the Northeastern Siberian Arctic, supporting the hypothesis of an insolation-driven seasonal Holocene temperature evolution followed by a strong warming most likely related to anthropogenic forcing.

Considering additional Arctic ice-wedge data we furthermore discuss potentials and limitations of ice wedges as high-quality climate archives, methodological approaches as well as possible future directions of ice-wedge studies.

ID: 02332, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Cirque glacier rejuvination and retreat on South Georgia since ~10 ka BP

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The world's glaciers are receding at an unprecedented rate according to observational and historical records, especially so in the Polar Regions. A consistent pattern of retreat from the Antarctic Peninsula to Patagonia suggests that glaciers in this region are responding to large-scale changes in forcing. Since glaciers are recognized as trustworthy proxies of climate change a growing body of works detail not only present and historical glacier change but also past variability beyond the instrumental era. In an effort to provide new, high-resolution evidence of centennial-scale glacier variability from the sub-Antarctic region during the last 10,000 years we targeted a glacier system at the northeastern part of South Georgia (54-55°S, 36-38°W).

Here we present a continuous reconstruction of a cirque glacier in West Cumberland Bay based on two sedimentary archives retrieved from a downstream lake and a bog containing peat and sediments deposited during the last 10 000 years. Variability in influx of minerogenic material, quantified by magnetic susceptibility and titanium, are interpreted to reflect variations in the up-valley glacier's extent and tentatively tied to the deposition of nine individual moraines. Equilibrium-Line-Altitudes (ELAs) were calculated for each moraine revealing a variation of circa 60±20 m, which equals a shift of roughly 0.5 °C.

The combined record of the cirque glacier shows centennial fluctuations with peaks at 4000, 2900, 2200, 1200 and 350 years ago. The timing of three of these glacier events – the ones occurring at 2900, 1000 and 300 years ago – overlap with exposure dates of individual moraines. Overlap is also found at 3800, 3000, 2000 and 1000 years ago with a reconstruction of Block glacier in neighboring Strømnes Bay. This indicates a coherent picture of Holocene glacier fluctuations in this part of the Southern Ocean.

ID: 02339, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

The last thousand years at Talos Dome, Antarctica

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The Antarctic has an unusual climate history compared to other continents for the past 2000 years : unlike other regions, the last 50 years are not unusually warm, and the period around 1850 is not unusually cold. All of Antarctic 2000-year climate records are derived from water isotopes from ice cores. Could it be that water isotopes are not a faithful temperature recorder, or is it that Antarctica has a distinct climate variability over this time period ? Here we compare a temperature reconstruction derived from the analysis of inert gas isotopes (δ^{15}N and δ^{40}Ar) with water isotopes to assess how faithfully water isotopes record temperature trends over the last 1000 years at Talos Dome, Antarctica. Talos Dome (15°11\' E, 72°49\' S, 2315m a.s.l.) is a peripheral dome located in the South Pacific/Ross Sea sector of the East Antarctic Plateau. It receives air masses mainly from the Indian and secondarily from Pacific sectors of the Southern Ocean. As a result, its climate presents similarities both to West Antarctica (Pacific air masses) and to the East Antarctic plateau sites of Dome C and Vostok (Indian air masses). We find that inert gas isotopes indicate a long term cooling trend at the site, which is not recorded in the δD signal. Second order parameters (d-excess and 17O-excess) show that the partitioning between Ross and Indian air masses likely has changed over this period, with a decrease in the Ross sea contribution. These results show that circulation changes likely complicate the interpretation of water isotopes. The combination of two methods at Talos Dome provides new constraints on the changes in the circulation associated with the Little Ice Age cooling in West Antarctica.

ID: 02294, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Extreme ENSO-driven torrential rainfall episodes at the southern edge of the Atacama Desert during the mid-Holocene and its projection for the 21th century

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Anticipate extreme precipitation events associated to El Niño Southern Oscillation (ENSO) and their severe impacts, as the last devastating floods occurred at Atacama in March 2015, are among the most critical issues regarding global climate change.

Coastal marine sediment record (30°S) shows increased runoff driven by intensifying rainfall trends during the mid-Holocene, following a warming trend in coastal sea surface temperatures together with strengthened coastal upwelling. The occurrence of severe alluvial episodes driven by heavy rainfall events, associated to the interplay between interannual and interdecadal ENSO variability, increased since ~1820 CE superimposed on a secular aridification trend, as revealed by historical and geological records.

From Coupled Model Intercomparison Project Phase 5 results, we propose a reduction of 15–30% in total annual precipitation together with more extreme rainfall episodes towards the end of the 21th century at the southern edge of Atacama Desert.

ID: 01923, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

The PMIP4-CMIP6 Simulations for the Mid-Holocene and Last Interglacial with the Community Earth System Model

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Two interglacial epochs are included in the suite of Paleoclimate Modeling Intercomparison Project (PMIP4) simulations in the Coupled Model Intercomparison Project (CMIP6). Experimental protocols have been established for the Tier 1 simulations of the mid-Holocene [*midHolocene,* 6000 years before present] and the Last Interglacial [*lig127k*, 127,000 years before present] (Otto-Bliesner et al., *Geoscientific Model Development Discussions*, 2016). These equilibrium simulations are designed to examine the impact of changes in orbital forcing at times when atmospheric greenhouse gas levels were similar to those of the preindustrial period and the continental configurations were almost identical to modern. The changes in insolation are characterized by enhanced seasonal contrast in the northern hemisphere (NH) (and reduced seasonal contrast in the southern hemisphere, SH), with these changes stronger in the *lig127k* experiment than the *midHolocene* experiment. Here, we report on the *lig127k* and *midHolocene* simulations with the Community Earth System Model, version 2 (CESM2), the same model and same resolution as is being used for the CMIP6 DECK, historical, and future projection simulations. Results will highlight the simulated climate changes at high latitudes in comparison to data and the implications for the Greenland and Antarctic ice sheets.

ID: 02375, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Two Interglacials: Scientific Objectives and Experimental Designs for Holocene and Last Interglacial Simulations in PMIP4 and CMIP6

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Two interglacial epochs are included in the suite of Paleoclimate Modeling Intercomparison Project (PMIP4) simulations in the Coupled Model Intercomparison Project (CMIP6). The comparative abundance of paleoenvironmental data and of quantitative climate reconstructions for the Holocene and Last Interglacial make these two epochs ideal candidates for systematic evaluation of model performance and the ability of state-of-the-art models to simulate climate changes realistically. Experimental protocols for the CMIP6 Tier 1 simulations of the mid-Holocene (midHolocene, 6000 years before present) and the Last Interglacial (lig127k, 127,000 years before present) have been established. These equilibrium simulations are designed to examine the impact of changes in orbital forcing at times when atmospheric greenhouse gas levels were similar to those of the preindustrial period and the continental configurations were almost identical to modern. The changes in insolation are characterized by enhanced seasonal contrast in the northern hemisphere (NH) (and reduced seasonal contrast in the southern hemisphere, SH), with these changes stronger in the lig127k experiment than the midHolocene experiment. These simulations test our understanding of the connections between radiative forcing and large-scale and regional climate changes giving rise to phenomena such as land-sea contrast and high-latitude amplification in temperature changes, and responses of the monsoons, as compared to today. They also provide an opportunity, through carefully designed additional CMIP6 Tier 2 and Tier 3 sensitivity experiments in PMIP4, to quantify the strength of atmosphere, ocean, cryosphere, and land-surface feedbacks. As well, sensitivity experiments are also proposed to investigate the role of freshwater forcing in triggering abrupt climate changes within interglacial epochs and transient experiments to focus on climate evolution during interglacial epochs.

ID: 02333, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Lacustrine clay mineral assemblages as a proxy for land-use and climate changes over the last 4 kyr: The Amik Lake case study, Southern Turkey

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Lake sediments are sensitive to landscape changes and most of these changes seem to be modulated by land-use (anthropogenic factors) coupled to palaeoenvironmental/palaeoclimatic changes. In its detrital fraction, the lacustrine sediments record the history of soil erosion within its catchment via the inputs of clays and others detrital products. Within a Mediterranean context, the study investigates the upper sediments infilling the central part of the Amik basin in southern Turkey. This tectonic basin was occupied and exploited by modern human at least since 6000-7000 BC. We focus on the clay mineralogy (x-ray diffraction on oriented aggregates) and magnetic susceptibility measurements (Bartington) of the sedimentary record in the area over the last 4000 years, to assess environmental changes in relation with the different land uses and/or weathering during the successive Bronze, Iron, Roman, Islamic/Ottoman and Modern civilizations. The clay fraction of Amik Lake sediments comprises smectite, kaolinite, illite, chlorite and chlorite/smectite mixed layers that are the inherited clay phases. A relative change in abundance and crystallinity and chemistry of illite attests that environmental conditions evolved in the Amik Plain from the Bronze to Modern Age in relation with climates and/or land-use changes. The history of the Amik Lake reveals different soil erosion episode. The most intense erosion phase occurred during the Bronze/Iron Ages as indicated by the clay and magnetic susceptibility proxies. The Roman period was an exceptional period with soil erosion products arriving from the watershed, probably due the water channelization. A reduction of soil erosion occurred during the post Roman period until nowadays. Significant pedogenesis transformations are evidenced, especially during the Islamic/Ottoman periods suggesting intense chemical weathering conditions related to climate change.

Keywords: Climate; Weathering conditions; Land erosion; Clay mineralogy; Lake sediments; Last millenia.

ID: 02159, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

A revised chronology of the Dome Fuji ice core (80–165 ka) from O2/N2 of trapped air

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Precise ice core chronology is essential to examine the sequences and durations of climate events as well the phasing with other well-dated paleoclimatic records. A chronology for the first Dome Fuji (DF1) ice core (DFO-2006) was constructed by synchronizing variations in O_2/N_2 of occluded air with local summer solstice insolation, with accuracy generally better than ±2 kyr (Kawamura et al., 2007). However, from detailed age comparison with the EPICA Dome C ice core and Chinese speleothem records, DFO-2006 around 100 kyr BP was suggested to be too old by ~3 kyr (Fujita et al., 2015). The end of Termination II in DFO-2006 is also older than that in the speleothem chronology (although within uncertainty). Poor quality of the O_2/N_2 data due to gas loss during core storage at relatively high temperature (-25 °C) might be responsible.

In order to examine and improve the Dome Fuji chronology, we re-analyzed O_2/N_2 in the core between 80 and 165 kyr BP. We used samples stored at -50 °C to minimize diffusive gas loss, but we expect some gas loss from near-surface ice because of its long storage (~20 yr). We thus tested different thickness of surface removal, and found that ~1 cm from the surface is depleted in O_2/N_2 and must be removed. Because of the improvements in sample handling and other measurement techniques, our new O_2/N_2 data on average do not indicate preferential loss of O_2. The revised O_2/N_2 chronology do not show sharp artefactual steps in annual layer thickness, which were found in DFO-2006 at 94.2 and 150.3 kyr BP, and the deviation from the speleothem chronology is less than

1200 yr. These results suggest that the revised chronology greatly improved from DFO-2006, and that O_2/N_2 in the DF core is a faithful recorder of summer insolation at the site.

ID: 02097, 21.- Sediment Flux: Past Peaks and Troughs, (Poster)

Sediment Contribution in Different Spatial and Temporal Scale off Southwestern Taiwan since 50 kyr BP based on VNIR Reflectance Derivative Spectroscopy

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Marine sediments are essential for evaluating the spatiotemporal variations of sediment provenance and transport at local, regional and larger scales. The distribution pattern of clay mineral assemblages is a critical proxy to reveal the sources and transport pathways of detrital sediment from adjacent mainland. Their role as paleoclimatic and paleoenvironmental proxies has been investigated worldwide using semi-quantitative X-ray diffraction (XRD) techniques. However, quantitation of the absolute abundance of clay minerals remains a big challenge. To fill this gap, this study applied visible near-infrared (VNIR) Reflectance Derivative Spectroscopy (RDS) procedure to acquire high-resolution, relative changes of absolute abundance of clay mineralogical signals for the past 50 kyr off southwestern Taiwan. The mineralogy information can be derived by calculating the changes in the slope of the percent reference spectral curve (first-derivatives).Based on the height of the characteristic first derivative peaks observed in spectra from 420 samples, the downcore variation of the clay mineral assemblages from Taiwan (Illite), South China (Kaolinite) and Luzon (Smectite) can be recognized. Kaolinite and illite yield peaks at 2200-2220 nm and 2250-2270 nm (near-infrared band) respectively, whereas a smectite-related peak is observed between 420-440 nm (visible band). These high sedimentation records allows us to assess the complicated sediment contribution associated with East Asia monsoon intensity, oceanic current and sea level variations.

ID: 01337, 01.- Open Session on past global changes, (Poster)

Holocene evolution of mangrove vegetation in relation to palaeoclimate and sea level changes at the Chilka Lagoon, Odisha, India

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High resolution multiproxy data (pollen, dinoflagellates and charcoal) have been used to reconstruct Holocene evolution of mangrove vegetation in relation to sea-level changes and concurrent climatic fluctuations from the Chilka Lagoon, Odisha, India. It is the largest brackish water lagoon in Asia, situated in the humid tropical climatic zone along the east coast of India. Four radiocarbon dated sediment profiles, two (CHI 1 and CHI 10) from the northeastern region and rest two (CHI 51 and CHI 31) from the eastern and southeastern region have been collected and analyzed. The results indicate three phases of mangrove development from the study area: between 11000 to 8800 yrs B.P.; 8800 to 5500 yrs B.P. and 2500 to 2200 yrs B.P. Development of mangroves at the Chilka Lagoon began since 11000 yrs B.P indicating the initiation of warming phase. Diversification of mangrove forests at the study site took place during 8800 to 5500 yrs B.P. During this period, increase in mangroves and reduction in midland taxa are recorded. Rhizophoraceae became the dominant vegetation followed by *Sonneratia apetala*, *Aegialitis rotundifolia*, *Xylocarpus granatum*, *Aegiceras corniculatum* and *Acanthus ilicifolius.* Marine elements, such as tintinnids, foraminiferal linings and dinoflagellate cysts are also recovered in good values. The overall palynological assemblage suggests the prevalence of deltaic environment with insurgent sea tides periodically inundating the area. This change to mangrove dominated vegetation was due to sea-level rise and warm moist climate, which provided conducive environment for the optimum development of mangrove forests. The rich mangrove vegetation started deteriorating after 5500 yrs B.P. due to changes in sea-level. An intertidal environment reappeared for short span of time around 2500 to 2200 yrs B.P., resulting in the rejuvenation of the mangroves. Around 2200 yrs B.P., loss of the intertidal environment occurred due to relative sea-level fall triggered the disappearance of the mangroves from the area. The deterioration of mangroves during the late Holocene in the Chilka Lagoon was a result of change in climate towards more aridity, relative sea-level fall and accelerated by human activities.

Keywords: Mangrove, Holocene, Sea-level, Chilka lagoon, Odisha

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ID: 01672, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Pliocene vegetation and climate evolution in Arctic Norway controlled by North Atlantic Current variability

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A strengthening of the Atlantic overturning circulation has been invoked to explain the enhanced warming in the Nordic Seas region during the Pliocene Epoch. While marine records are indicative of changes in the northward heat transport via the North Atlantic Current (NAC), the long-term evolution of terrestrial climate and its driving mechanisms are poorly understood. We present the first continuous Pliocene pollen record for the Nordic Seas region from Ocean Drilling Program Site 642, to assess the influence of oceanographic and atmospheric controls on the Pliocene vegetation and climate of Arctic Norway. We show that cool temperate (warmer-than-present) conditions prevail between 5.03–4.30 Ma, 3.90–3.47 Ma and 3.29–3.16 Ma and boreal (similar-to-present) conditions predominate between 4.30–3.90 Ma, 3.47–3.29 and after 3.16 Ma. Over subsequent warm intervals, a gradual cooling trend is suggested to be driven by decreasing atmospheric CO_2 concentrations. Eccentricity forcing (400 ka) shows a strong expression during the concurrence of eccentricity minima with low-amplitude obliquity/precession variations, corresponding to cooler climatic conditions. During the early Pliocene, changes in marine productivity and the main atmospheric circulation pattern, resulting in reduced pollen influx, are inferred to have occurred in response to the shoaling of the Central American Seaway (CAS). Climate model simulations confirm that the closure of the CAS results in changes in the strength and direction of the prevailing winds in the Nordic Seas region.

ID: 01577, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

TEX86-derived temperature variability during the Holocene in the Hupo Basin of the southwestern East Sea (Sea of Japan)

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The East Sea (ES; Sea of Japan) comprises one of continental margins in the northwest Pacific Ocean and has been regarded as the marine environment sensitive to global climate change, particularly, the East Asian monsoon. The numerous paleoceanographic/paleoclimatic records in the ES have been reported, but the sea surface temperature (SST) data based only on microfossils and alkenone are limited. Recently, TEX_{86} (Tetra Ether indeX of tetraethers consisting of 86 carbon atoms), based on the membrane lipids (GDGTs) of marine Archaea, has been broadly used as powerful SST proxy. However, the application of TEX_{86} to the ES paleoceanography has not yet been made. Thus, we carried out testing the applicability of TEX_{86} using a sediment core (ES14-GC02) from the Hupo Basin in the southwestern ES in order to reconstruct the Holocene temperature variability with high resolution (*ca*. 240 yr interval). Holocene concentrations of GDGT are high and their origin is mostly from marine. TEX_{86}-derived temperature (including TEX_{86}^H and TEX_{86}^L) increased greatly at the boundary between Holocene and last glacial period, and showed the centennial- to millennial-scale variability within a range of *ca*. 5°C during Holocene. On the basis of the comparison with observational data and TEX_{86}-derived temperature on sediment core-top, TEX_{86}^H-derived temperature coincides with the SST during autumn (Oct.), whereas TEX_{86}^L-derived temperature corresponds to either the SST during winter (Dec. to Feb.) or the mean annual temperature at subsurface (~30 m) below the mixed layer depth. Our results suggest that TEX_{86} is applicable to reconstruct the past SST in the ES, and indicate that the Hupo Basin has experienced the centennial- to millennial-scale paleoclimate changes during the Holocene.

ID: 01294, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Biogeographic distribution of extant Coccolithophores in the Indian Sector of the Southern Ocean

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Water samples from nine vertical profiles down to 110 m water depth and 19 samples from the sea-surface were studied for obtaining information on coccolithophore abundance and distribution across

oceanic frontal regions of the Indian sector of the Southern Ocean. Sampling was performed along a north-south transect (between 39°S and 65.49°S, ~57.3°E) during the 4th Indian Southern Ocean Expedition (between 31st January and 18th February, 2010). Both coccospheres and coccoliths were counted separately using a Scanning Electron Microscope (SEM). A total of 39 taxa (including morphotypes, types and subspecies) were recorded as intact coccospheres with abundances reaching up to 745x10^3 coccospheres/l. In addition, 85 taxa (including varieties, morphotypes) were counted as coccoliths reaching up to 914×10^5 coccoliths/l. *Emiliania huxleyi* was recognized as the most abundant species, accounting for more than 86% of the total coccolithophore assemblage at each station. Elevated coccolithophore diversity was observed at the subtropical zone whereas high coccolithophore abundance was observed at the Subantarctic zone. A monospecific *Emiliania huxleyi* assemblage was recorded at and south of the Polar frontal zone. Three assemblages were recognized based on coccolithophore abundance and diversity. The assemblage of the Agulhas Retroflection frontal zone and Subtropical zone is highly diverse (39 taxa) and can be linked to relatively warm, high saline and oligotrophic waters. The Subantarctic zone assemblage is characterized by a reduced number (thirteen) of coccolithophore taxa, whereas Polar Frontal zone comprises a monospecific assemblage of *E. huxleyi* (preferentially morphotype C and B/C). Multivariate statistics indicated regions with elevated temperature and low nutrient concentration show high coccolithophore diversity whereas the regions with high nutrient concentrations and low temperature reduces coccolithophore diversity but increases monospecific *E. huxleyi* (morphotype B/C and C) abundance.

ID: 02372, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

The contribution of ‘Citizen Scientists’ to determining the influence of ocean-atmospheric oscillations on lake ice phenology in eastern North America

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Long-term trends in spring ’ice out’ dates (1836–2013) for twelve lakes in Maine, New Brunswick and New Hampshire, in eastern North America reveal a remarkable coherency across the region (rs=0.462–0.933, p<0.01). These data have been compiled since the early 19th century, primarily by amateur citizen scientists, for a variety of purposes, including determining fishing seasons, estimating the spring opening of ferry boat routes, community contests, and general curiosity. Ice out dates correlate closely with late-winter/early-spring, March–April (MA), instrumental temperature records from across the region (rs=0.488–0.816, p<0.01). This correlation permits use of ice out dates as a proxy to extend the shorter MA instrumental record (1876-2013). Mean ice out dates trended progressively earlier during the recovery from the Little Ice Age through to the 1940s, and gradually became later again through to the late 1970s, when ice out dates had returned to values more typical of the late nineteenth century. Post-1970’s ice out dates resumed trending toward earlier dates, with the twenty-first century being characterized by the earliest ice out dates on record. Spectral and wavelet time series analysis indicate that ice out is influenced by several teleconnections including the Quasi-biennial Oscillation, El Niño-Southern Oscillation, North Atlantic Oscillation, Atlantic Multidecadal Oscillation as well as a significant correlation between inland lake records and the Arctic Oscillation. The relative influence of these teleconnections is variable with notable shifts occurring after ca 1870, ca 1925, and ca 1980–2000. The intermittent expression of these cycles in the ice out and MA instrumental record is not only influenced by absolute changes in the intensity of the various teleconnections and other climate drivers, but by phase interference between teleconnections, which periodically damps the various signals.

ID: 01730, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Tropical storm activity enhanced by Sahara greening and reduced dust emissions during the African Humid Period

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Tropical cyclones (TCs) have devastating socioeconomic impacts and understanding the nature and causes of their natural variability is of paramount importance for society. However, historical records of TCs are too short to fully characterize such changes and paleo-sediment archives of Holocene TC activity are still very few both temporally and geographically. Here we investigate global TC activity during a warm climate state (mid-Holocene, 6,000 yr BP) characterized by increased boreal summer insolation, vegetated Sahara, and reduced dust emissions. We analyze a set of sensitivity experiments in which not only solar insolation changes are varied but also prescribed vegetation and dust concentrations. Our results show that the greening of the Sahara and reduced dust lead to more favorable conditions for tropical storm development compared to the orbital forcing alone. In particular, the strengthening of the West African Monsoon induced by the greening of the Sahara triggers a change in atmospheric circulation that embraces the entire tropics. Furthermore, while stronger boreal summer insolation and hence warmer sea surface temperature may actually lower TC activity in the Northern Hemisphere as shown in previous studies, accounting for the Sahara greening and its associated reduction in dust emissions leads instead to an increase of TC activity in both hemispheres, particularly over the Caribbean basin and east coast of North America. Our study highlights the importance of regional changes in land cover and dust concentrations in affecting the potential intensity and genesis of TCs, and suggests the roles they might play in a future warmer climate.

ID: 01729, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Greening of the Sahara suppressed ENSO activity during the Mid-Holocene

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The evolution of ENSO over the Holocene remains highly uncertain. In particular, a host of new paleoclimate records suggest that ENSO internal variability or other external forcings may have dwarfed the fairly modest ENSO response to precessional insolation changes simulated in climate models. Here we use a fully coupled ocean-atmosphere model simulation for 6,000 yr BP (MH) in which we prescribe not only the MH orbital forcing but also more extensive vegetation and reduced airborne dust concentrations from North Africa due to wetter climatic condition in the Sahara. We show that accounting for a vegetated and less dusty Sahara can reduce ENSO variability by 25%, more than twice the decrease obtained using orbital forcing alone (10%). We identify changes in tropical Atlantic mean state and variability as fundamental agents driving ENSO variations. The momentous strengthening of the West Africa Monsoon (WAM) simulated under vegetated Sahara leads to an Atlantic Niño-like mean state and a reduction of its variability (46%). These changes in the equatorial Atlantic, in turn, affect the ENSO behaviour over the Pacific through changes in the Walker circulation. Our results thus highlight that Saharan vegetation and dust emission are critical factors in driving ENSO's response to insolation forcing, suggesting that potential changes in the WAM due to anthropogenic warming may influence ENSO variability in the future, as well.

ID: 01302, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Common Era climate reconstructions from the northeastern United States

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High-resolution paleoclimate records are essential for improving detection and attribution of internal and forced climate system responses. The densely populated northeastern United States is at high risk from increasing temperatures, changes in storm intensity and frequency, droughts and floods, and sea level rise. The region has limited annual or seasonal-scale proxy climate records beyond the instrumental record. Here we present a network of Atlantic white cedar tree-ring chronologies across the northeastern United States. Ring width variability reflects winter through summer temperatures at inland sites in the northernmost section of the species' range. Multivariate climate signals embedded in the full northeastern network are evaluated for their potential to provide reconstructions of both temperature and drought variability. We demonstrate skillful climate reconstructions for the last several centuries and the potential to use sub-fossil samples to extend these records over the entire Common Era. Our tree-ring network provides the long-term context at multidecadal and centennial time scales for the large-scale ocean-atmospheric processes that influence the climate of the region

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ID: 01504, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Experimental paleo-proxy calibration in the cold water coral Desmophyllum dianthus

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Cold-water corals (CWCs) display an almost cosmopolitan distribution over a wide range of depths. Similar to their tropical counterparts, they provide continuous, high-resolution records of up to a century or more. Several CWC elemental and isotopic ratios have been suggested as useful proxies, but robust calibrations under controlled conditions in aquaria are needed. Whereas a few such calibrations have been performed for tropical corals, they are still pending for CWCs. This reflects the technical challenges involved in maintaining these slow-growing animals alive during the long-term experiments required to achieve sufficient skeletal growth for geochemical analyses. We will show details of the set up and initial stages of a long-term experiment being run at the ICM (Barcelona), where live specimens (>150) of *Desmophyllum dianthus* sampled in the Comau Fjord (Chile) are kept under controlled and manipulated chemistry (pH, phosphate, barium) and feeding conditions. With this set up, we aim to experimentally calibrate specific elemental ratios including P/Ca, Ba/Ca, B/Ca, U/Ca and Li/Mg as proxies of nutrient dynamics, pH, carbonate ion concentration and temperature. Regarding geochemistry, we will analyze coral skeletons using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS), which will allow running quantitative analyses on spot sizes of tens of microns. We will also attempt measurements using NanoSIMS, to resolve nano-scale details in relative composition. Preliminary data obtained from these techniques will be presented, together with suitable parameters to monitor coral growth and physiology including skeletal growth, coral calcification and respiration.

ID: 01917, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Influences of the atmospheric variability and external forcing on flood frequencies in the Hasli-Aare (Bernese Alps, Switzerland) during the last 700 years

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External forcings and their influence on atmospheric variability may have a decisive role in the generation of large floods. However, the link between solar forcing, the physical climatic processes and flood frequency is still under discussion.

The variability of large summer floods in the Hasli-Aare catchment (Bernese Alps) during the last 700 years, reconstructed by delta flood plain deposits and written sources, provides evidences that the 1300-1350, 1420-1480, 1550-1620, 1650-1720 and 1811-1851 AD flood clusters occurred largely in phase with the pulses of paleoclimate proxies (reduced solar irradiance, lower $\delta^{18}O$ anomalies, cooler summer temperatures and phases of drier spring climate in the Alps) and North Atlantic dynamics. Most of the large flood events (7 of 10 floods) since 1670 occurred during positive SNAO (Summer North Atlantic Oscillation: cyclones of Mediterranean origin) phase. However, the largest recorded flood (1762) occurred during negative SNAO (North Atlantic front systems).

The objective is to explore the flood variability in the Hasli-Aare catchment during the last 700 years, particularly the changes in external forcing and atmospheric variability. For this purpose, we applied paleoclimate modelling to the periods of flood clusters individually, first, to analyse the contribution of different forcings, and second, to reconstruct a complete image of the flood variability in a densely inhabited mountain area.

The grid database for modelling was provided by the CESM Paleoclimate Working Group at NCAR, which processed the experimental series of the Last Millennium Ensemble Project (LME). The LME project used a ~2-degree atmosphere and land, ~1-degree ocean and sea ice version of CESM-CAM5_CN (1.9x2.5_gx1v6). The Ensemble members range from 850 to 2006 AD for the transient evolution of solar intensity, volcanic emissions, greenhouse gases, aerosols, land use conditions, and orbital parameters. These forcings were processed together and individually to estimate the contribution of each one.

ID: 01806, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

EQUATE – Building a European Quaternary Aminostratigraphic Timescale

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Timing is everything: accurate dating of the archaeological record is essential to an understanding of the history of the human species, but beyond the limit of radiocarbon dating (~60 ka), sites become more difficult to date. Amino acid geochronology, which uses the time-dependent breakdown of proteins in biominerals, has the potential to date the whole of the Quaternary, and recent work on isolating the intra-crystalline fraction of calcitic biominerals (*Bithynia* opercula) has enabled the development of an aminostratigraphic framework for Britain for the Pleistocene. The intra-crystalline protein decomposition (IcPD) within the opercula provides a framework for understanding the regional geological and archaeological record, and has revealed a temporal structure within the British archaeological record for the Palaeolithic.

Correlation of Quaternary sequences, even in adjacent regions, is often problematic, but the development of regional aminostratigraphies promises to provide robust chronologies, enabling more confident correlation. The calcitic opercula of bithyniid (or similar) gastropods occur commonly in many Quaternary sequences, offering potential for development and correlation of regional aminostratigraphies around the world.

Extending the British framework to continental Europe (and beyond) is the next step, and we present the results from analyses of a series of key archaeological and palaeontological sites from across Europe from France to Russia. In order to build the most comprehensive framework possible, we are targeting type localities for interglacial stages, horizons that can be related to glacial sediments, river terrace sequences, biostratigraphy and archaeology. As an important region both for early human occupation, and for definition of the Pleistocene small mammal biostratigraphy used across Europe, a key focus for our research is the Black Sea, and we present our first framework for this region. These dating schemes will shed light on our human story, providing temporal context for episodes of human occupation across Europe, framed within their palaeoenvironments.

ID: 01899, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Late glacial to Holocene western Mediterranean paleoclimate variability and its impact on deep and intermediate water circulation

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In this study, we analyze micropaleontological (benthic foraminifera) and geochemical (Mg/Ca-deep water temperatures, stable isotopes) data to reconstruct the impact of climate variability on western Mediterranean deep and intermediate circulation since the Last Glacial Maximum (LGM). Sediment core UB6 was recovered in the Alboran Sea (westernmost Mediterranean Sea) at 946 m water depth. This location is bathed at present by the Western Mediterranean Deep Water (WMDW) but relatively close to the boundary with the overlaying Levantine Intermediate Water (LIW). Our results show a tight connection between changes in deep water ventilation and temperature. The LGM and Heinrich Stadial 1 were characterized by good deep ventilation and cold temperatures, indicating strong WMDW convection during cold intervals. During the Bølling-Allerød and Younger Dryas (YD) periods, temperatures remained cold but the benthic assemblage shows the poorest ventilation conditions coinciding with the deposition of the early part of the last Organic Rich Layer in the deepest Alboran Sea. A re-ventilation trend started at the end of the YD extending along the early Holocene while deep temperatures increased. Oxygenation and temperature maintained relatively high values during the middle Holocene but presenting short-term variability with the warmest peaks corresponding to relatively low peaks in oxygenation. Finally, a significant change in deep waters conditions was observed around 4 ka when oxygenation enhanced while temperatures stabilized at slightly cooler values. These changes, added to the synchronous disappearance of *Cibicidoides pachyderma*, supports that WMDW became the dominant water mass bathing the studied site. This new finding opens the question if LIW was dominant during the early and middle Holocene and, in this case, why it reached deeper areas in the Alboran Sea. These observations underline the high variability of the Mediterranean thermohaline system and the need to better characterize its variability.

ID: 01903, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Glacial-interglacial and insolation-controlled climate and environmental variability on early Pliocene deposits from the lower Guadalquivir Basin (SW Spain)

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In this study, we present an early Pliocene (4.5-3.7 Ma) marine multiproxy record of paleoclimatic and paleoenvironmental changes from the La Matilla core drilled in the lower Guadalquivir Basin (SW Spain). The reconstruction of paleoenvironmental changes related to glacial-interglacial and insolation-controlled variability is based on micropaleontological (benthic foraminifera, pollen) and geochemical (XRF, TOC, C/N) proxies. Our record was also compared with the global benthic O isotope record and insolation curve. The estimated sedimentation rates show a distinct interval with very low sedimentation rates from 4.187 to 3.890 Ma. Below this interval, benthic foraminifera suggest an outer shelf or deeper setting with high variable fluctuations in organic matter flux to the sea floor and related oxygen depletion. Marine and continental inputs are the main possible sources of organic matter, which are controlled by glacial-interglacial conditions and insolation. Strong influence of upwelling and/or phytoplankton blooms along with cold/arid conditions occur during glacial periods with low insolation as showed by the high abundance of *Uvigerina peregrina*, and low *Quercus* abundance and C/N ratio. On the contrary, high terrestrial organic matter supply derived from river runoff and related oxygen decrease take place during interglacial periods (higher *Quercus* abundances) coinciding with high insolation. Under these humid and warm conditions, *Bulimina aculeata*, *Brizalina spathulata* and *Nonion fabum*, species feeding from degraded organic matter, TOC, C/N and Mo/Al ratios, increase significantly. Finally, above the low sedimentation rate interval, a trend towards more continental organic matter and higher riverine discharge is recorded by benthic foraminifera (higher *Nonion fabum* abundances) and geochemical proxies (higher Mo/Al, Zr/Al, Ti/Al and C/N ratios). This is consistent with a gradual sea-level fall trend and grain size increase.

ID: 01627, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Human-Environment interactions in Northern Iberian Peninsula during the Middle Holocene: the role of farmers in the landscape configuration

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In the Middle Holocene, a new decisive factor appears as determinant in the evolution of the landscape: the first farmers. Those human groups are characterized by a series of novelties of broad spectrum that will result in the alteration of the Mesolithic ways of life (based on hunting and gathering) by others dominated by agriculture and livestock. The main novelties affect aspects as diverse as the replacement of the habitat in caves or natural shelters by open-air settlements (which host a larger group of people and a presumably more complex social organization), the transformation of the basically predatory economy by another model based on the regular production of food and the appearance of new industrial elements that will affect the evident enlargement and diversification of the equipment available by these populations (ceramics, polishing, circle segments, retouching in double bevel, etc.). Fortunately, many of these transformations leave traces in the fossil record of the vegetal landscape. In this sense, paleoenvironmental studies are an extremely effective tool to clarify some of the questions inherent to these events, particularly when defining the selective patterns of human action on ecosystems (anthropization) and the diachrony of the acquisition of the main elements of the productive economy. The objective of this communication is to contribute with a regional synthesis of human-climate-environment interactions, evaluating the anthropogenic impact on the landscape in mountain areas in the North of the Iberian Peninsula since the Neolithic period, through palynological studies. The main results indicate the beginning of anthropization in this area from *ca*. 6500 cal BP, at the same time as other Neolithic settlements in this region.

ID: 01636, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Vegetation dynamics and climate variability during the MIS-5 in the Northern Iberian coast: The palynological study of the Oyambre deposit.

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The palaeoenvironmental study of the last glacial cycle is essential for the understanding of the current Global Change. However, the scarcity of records makes the palaeoecological reconstructions of these chronologies very difficult. At Oyambre (Cantabria, north of Spain) is located a 15 m-thick coastal sequence made of coarse, sandy (and muddy) sediments. This outcrop has a lithostratigraphy that comprises two well defined units. A first transgressive lower unit (2.3 m thick), that includes a basal bed of boulder gravels followed by brown pebbly fine sands with abundant planktonic and benthic foraminifera, indicates an ancient beach environment. The base of the gravels represents a sea-level highstand and this unit has been dated between 116 to 108 ky by quartz optically stimulated luminescence (Qtz-OSL). From the palynological point of view we have studied the second phase, a regressive upper unit (12.8 m thick) made of sandy layers intercalated by thinner mud layers, and interpreted as an aeolian dune environment dated at 102 ky to 89 ky by Qtz-OSL. Pollen contents of different silty levels analysed suggest a generally dry phase, with an oldest phase characterized by the existence of cold conditions, with large forests of *Pinus* and *Abies*, and *Betula*, *Alnus* and Poaceae in a secondary role. Then, conditions seem to be more temperate due to the dominance of deciduous forests with *Quercus* and *Corylus*. Very interesting is the presence of some relict taxa such as *Fagus* and *Carpinus*. Finally, conditions become again cooler due to the development of coniferous forest (*Pinus* and *Abies*) and the decline of deciduous taxa. These results support the existence of some climate variability during this interval and the development of coniferous forest with *Abies* in a coastal area, a species currently limited to high-land areas in the Pyrenees.

ID: 01486, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

High frequency hydrological variability since last glacial inception: the speleothem record of Ejulve Cave, NE Iberia

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The high sensibility of the Iberian Peninsula climate conditions to changes in temperature or ice volume in the North Atlantic region has been demonstrated in previous studies covering last glacial cycle. However, the precise timing of this connection and the response of a terrestrial area under the influence of

Mediterranean climate remain to be investigated. We present here the stalagmite ANDROMEDA from Ejulve Cave in NE Iberia that covers in a continuous way from 119 to 36.8 kyr representing the first terrestrial sequence from this area to explore past climate variability since last glacial inception. Accordingly, our preliminary results suggest wet and stable conditions during MIS 5e, high variability towards a dry interval during MIS 5d and a gradual decrease to lower growth rates from MIS 5c to MIS 5a. At MIS 4 onset, both $d^{13}C$ and Mg/Ca show a marked trend to dry conditions. Afterwards, during MIS 3, significant changes between wet/warm and dry/cold events in synchrony to rapid GS and GIs are recorded. On the other hand, $d^{18}O$ time series is clearly driven by precession during MIS 5, suggesting a temperature-dependence confirmed by the correlation with $d^{18}O$ curves from Atlantic marine records and NGRIP. The lack of coupling of $d^{18}O$ and precession during MIS 4 and following millennia possibly indicate a change in the boundary conditions associated to the increasing aridity as the glacial stage progressed. Thus, the comparison of $d^{18}O$ with $d^{13}C$ and Mg/Ca in MIS 4 and MIS 3, give as a result high $d^{18}O$ values in high Mg/Ca peaks (dry), so the amount-effect of rainfall dependence in this part of the record in the $d^{18}O$ signal cannot be discarded, reinforced by the high correlation with another amount-effect proxies as $d^{18}O$ of Soreq cave in Eastern Mediterranean.

ID: 02191, 26.- Data Stewardship for Paleoscience, (Poster)

The PMIP4-CMIP6 Database: using standards to successfully share and use climate model data

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The Paleoclimate Modelling Intercomparison Project (PMIP) is a long standing initiative that has provided an efficient mechanism for coordinating paleoclimate modelling activities. The resulting model output database is used not only by climate modellers, but also by ecological niche modellers and other multidisciplinary research dealing with environment and society.

The fourth phase (PMIP4) has started in 2015 and the 16 modelling groups involved will run all or part of the following experiments: Last Millennium, Mid-Holocene, Last Glacial Maximum, Last Interglacial, Mid Pliocene, transient simulations and sensitivity experiments. PMIP4 follows the CMIP6 (Coupled Model Intercomparison Project) requirements, which makes it possible to use the CMIP6 database model data distribution tools (Earth System Grid Federation).

Successful data sharing on such a large scale can only be achieved by following strict standards developed and regularly improved by a large community. This poster will give an overview of the PMIP4 participants and which experiments they intend to run. It will also present the CMIP6 data search and access portal, the models and experiments documentation tools (es-doc), and focus on the format of the distributed files. The database not only uses the self-describing NetCDF binary file format, but also standard meta-data in the files (variable names, axes, attributes, ...), as well as standard file names and a directory structure defined in the project DRS (Data Reference Syntax). All of this makes it easier for the data end-user to perform reproducible multi-model and model-data comparison.

We invite the climate data users to meet us and tell us about the kind of data and software tools they (would like to) use. This will help us identify existing and future PMIP database users, so that we can better meet their needs.

References:

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ID: 02272, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Poster)

The DONAIRE project “Atmospheric deposition in natural and anthropized environments over northeastern Spain; integrated geochemical and magnetic characterization”: first results

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DONAIRE project is carring out an integrated study on atmospheric deposition in 12 micro-environments in NE Spain, from pristine areas in the Pyrenees or in Catalan Coastal Ranges towards strongly anthropized urban areas such as Pamplona, Zaragoza, Barcelona or Palma de Mallorca, passing throughout particular areas, including irrigated crops, a eolic park and an high-biodiversity salty lake system in the Ebro Basin. The project foresees the geochemical, magnetic and mineralogical characterization of bulk atmospheric deposition samples. Moreover, a first evaluation of ecological impacts on edaphic bacterial communities is being conducted.

Project performance is taking the advantage of consolidated analytical methodologies (geochemistry + environmental magnetism + mineralogy + ecotoxicology) usually applied individually but not in a combined manner as occurs in this proposal. Therefore, global atmospheric deposition fluxes are being quantified, as well as those transfers of individual geochemical species; local contributions and enrichment factors in anthropized environments are being computed; a detailed characterization of magnetic properties is being completed (see Mochales et al. abstract); a source apportionment study from the geochemical database will be conducted; relationships between geochemical species and/or aerosol sources and magnetic properties are being investigated; an special care will be paid to the study of peculiar events, including Saharan dust inputs, severe pollution episodes or specific pollution sources, and their origins will be studied.

Up to date, an extreme Saharan dust wet-deposition event has been observed in November 2016 as well as other moderate ones in summer 2016; persistent foggy episodes have been recorded from November 2016 to January 2017 along the Ebro Basin; or a number of Mediterranean cyclons have affected half of DONAIRE sites during fall season 2016. These scenarios have resulted in large differences in bulk deposition fluxes as well as in certain geochemical species.

ID: 01415, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Poster)

On the dog that did not bark in the night: the curiously sporadic precession signals in records of recurrent Ice Ages

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Precession, which redistributes sunlight over the course of a year and hence is forcing at the high frequencies of the seasonal cycle, should induce a response that is energetic in the swift atmosphere, modest in the slow ocean, and faint in torpid glaciers. Records of global ice volume nonetheless have sporadic, energetic precession signals that also appear in records of tropical sea surface temperature. This paper proposes that, when perihelion and the northern summer solstice coincide, the eastern equatorial Pacific experiences a prolonged warm, wet season that affects the global atmospheric circulation, and polar glaciers. Variations in the depth of the thermocline, induced by obliquity and the saw-tooth signals, modulate this response to precession. The movements of tropical rainfall bands today -- the Intertropical Convergence Zone (ITCZ) – provide tests for this hypothesis.

ID: 02102, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

The evolution of the Southern Hemisphere climate within transient simulations of the Holocene

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The Southern Hemisphere Assessment of PaleoEnvironments (SHAPE) project aims to reconstruct and understand past changes in the atmospheric and oceanic circulation of the Southern Hemisphere. Within this context, climate modelling plays a critical role in testing the interpretation of the proxy data and exploring the underlying dynamical mechanisms. Here, we analyse a suite of transient simulations of the Holocene climate. These are generated using state-of-the-art climate system models, and include simulations conducted by Phase Three of the Paleoclimate Modelling Intercomparison Project. We examine the changes in the atmospheric circulation and surface temperature. The majority of the models simulate a progressive strengthening and poleward shift in the position of the Southern Hemisphere westerly winds (SHWW) during the Holocene. This trend is accompanied by cooling over Antarctica and the Southern Ocean, combined with a deepening and a poleward contraction of the circumpolar trough. The results are sensitive to the spatial resolution of the models and to the combination of forcings applied, with the lowest-resolution model simulating no changes in the location of the westerly wind belt. There is strong seasonality in the simulated response of the SHWW to external forcings, and also in the relationship between the SHWW and local climate. This needs to be taken into account when using palaeoclimate proxies to reconstruct changes in the SHWW during the Holocene.

ID: 02109, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Assimilation of Southern Hemisphere proxy records into a climate modelling framework

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The assimilation of palaeoclimate proxy records into climate modelling frameworks allows for the reconstruction of past climatic fields. By combining the real-world information recorded by the proxies with the dynamical information encoded within the models, data assimilation (DA) represents an integrated approach whereby climate modelling becomes part of the process of palaeoclimate reconstruction. Here, the potential of DA is demonstrated by presenting an assimilation of Southern Hemisphere proxy records into a climate model. An offline approach is employed, whereby the model is integrated first and the assimilation is performed second. To generate a model ensemble, the CSIRO Mk3L climate model is used to simulate the evolution of the global climate from 801 to 2000CE. A 50-member ensemble is generated by initialising the model from different years of a pre-industrial control simulation. The ensemble is then forced with best estimates of past changes in the Earth\'s orbit, anthropogenic greenhouse gases, solar irradiance and explosive volcanism. The records chosen for assimilation are the temperature-sensitive Southern Hemisphere proxy records synthesised by Phases 1 and 2 of the PAGES 2k Network. A cost function is defined and is used to generate a weighted mean of the climate model ensemble, thereby using the proxy data to constrain the state of the model. The reconstruction generated through this process is shown to have greater skill than any of the individual ensemble members. A distinct advantage of offline approaches towards DA, such as the one presented here, is that they can be applied to existing climate model ensembles. Thus DA can be performed without even running a model. Further work will extend the assimilation further back in time to span the Holocene. Preliminary results are presented using a three-member ensemble of simulations spanning the past 8,000 years, demonstrating the potential to implement DA over longer timescales.

ID: 01326, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Linking explosive 19th century volcanoes with wild storms over southernmost Africa: a case of cause and effect or mere coincidence?

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The importance of historical weather observations and associated data rescue has gained recognition in recent years, particularly in the context of improving the quantification of recent long-term climate trends, fluctuations and extremes. To this end, our study uses one of the longest continuous instrumental weather records available in the southern hemisphere (Royal Astronomical Observatory, Cape of Good Hope, South Africa: 1834-2016) to establish dynamical linkages between climate forcings/anomalies (e.g. volcanic eruptions, solar variance, ENSO events) and ground-based weather (synoptic) responses, with a specific focus on the 19th century. The presentation focuses specifically on the likely extent to which volcanic eruptions and El Niño events (operating in isolation or in combination) may have separately or collectively impacted upon observed weather/climate at the Cape of Good Hope – also known as the Cape of Storms. Work entailed a two-year digitisation (from original archived hard copy Meteorological Registers) and data quality/cleaning processes, followed by statistical analysis of daily data including: barometric pressure; wind direction and speed; air temperatures and rainfall. Tentative results indicate significant positive departures in wind velocity at the Cape of Good Hope immediately (within a few weeks) following major volcanic eruptions (Coseguina (1835), Amargura (1846), Cotopaxi (1855) and Makjan (1861). Such positive wind velocity anomalies are particularly apparent during summer months, while lower mean barometric pressure may suggest enhanced northward displacement of mid-latitude cyclones from the Southern Oceans during months following such eruptions – overall, providing for increased [wind] storminess. It would seem that in most instances, major 19th century volcanic eruptions were followed by El Niño conditions (possibly inducing or strengthening El Niño events), yet the most pronounced ('extreme') climate departures occur soon after major eruptions, rather than when only influenced by El Niño.

ID: 01860, 26.- Data Stewardship for Paleoscience, (Poster)

The French NATIONAL CYBER CORE REPOSITORY: a user-oriented approach to promote the referencing of scientific cores

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In plaeosciences the question of data management is made sensitive by the need of preserving and managing high value fragile geological samples: cores. Large international scientific programs, such as IODP or ICDP led intense effort for such, proposing detailed high standard work- and dataflows. However many paleoscience results derived from small-scale research programs in which data and sample management are too often managed only locally – when they are.

In France a national effort is currently led to develop an integrated system to curate ice and sediment cores. Under the umbrella of the national excellence equipment program CLIMCOR, we launched a reflexion about core curating and the management of associated fieldwork data. Our aim was then to preserve all data from fieldwork in an integrated cyber-environment. To do so, our demarche was conducted through an intimate relationship with field operators and laboratory core curators in order to propose user-oriented solutions.

We built a single web portal that is used as a national hub from any team's data and to international standards (IGSNs, INSPIRE) and databases (IMLGS). For legacy samples, this requires the establishment of a dedicated cores list with associated metadata. However, for forthcoming core data, we developed a mobile application to capture technical and scientific data directly on the field. This application is linked with a unique coring-tools library and is adapted to most coring devices (gravity, drilling, percussion etc.) including multiple sections and holes coring operations.

In this paper, we present the architecture of the integrated system, future perspectives and the approach we adopted to reach our goals. We will also present our mobile application through didactic examples.

ID: 01339, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Mid-late Holocene vegetation responses to climatic and disturbance drivers in Western Indian grasslands

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Tropical semi-arid and arid grassland biomes or Savannas are one of the most important terrestrial biomes in terms of their extent, economic and ecological importance. This ecosystem deserves much attention in the context of current day scenarios of changing climatic, edaphic, grazing and fire regimes, to all of which this system is especially sensitive. In this study, mid –late Holocene dynamics of semi-arid vegetation and drivers of vegetation change are assessed based on the reconstruction of past vegetation, climate, herbivore abundance and fire events. This is done by analysing multiple proxies such as pollen, phytolith, stable isotopes of carbon, geochemical proxy- Al_2O_3, fungal spores and charcoal from sediment cores and by determining age of the sediment layers.

Results show that Banni was composed mostly of C_3 vegetation with higher abundance of pollen types (Syzygium, Acacia and Combretaceae) and phytolith morphotypes(tree/shrub) that indicate woody savanna from ~5000 to ~2500 cal yr BP, after which there was a decline in C_3 vegetation and an increasing trend in grass phytolith. Since ~700 cal yr BP, there was a decline in C_4 vegetation and grass phytolith abundance and an increase in leguminous taxa. These vegetation dynamics were coincident with rainfall changes from more mesic conditions during ~5000 to ~2500 cal yr BP to more arid conditions towards the present as indicated by Al_2O_3 data. The period of increase in C_4 vegetation also coincided with a period of increased biotic disturbances in the ecosystem, either from fire or herbivory or both. In the current scenarios of global warming, recurrent drought events and increased anthropogenic use of grassland ecosystems, such studies can inform us about the future trajectories of these ecosystems.

ID: 01913, 01.- Open Session on past global changes, (Poster)

A long-term progressive accumulation of benthic and planktonic diversity in a mountain lake recurrently peaks during the Holocene cold spells

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Over recent decades, palaeolimnological records from remote lakes have provided convincing evidence on their sensitivity to different aspects of global environmental change (from climate change to diffuse pollution) that have consequences in the biogeochemical cycles and biodiversity of Earth ecosystems.

To better understand current biotic diversity patterns, it is necessary to consider the dynamic processes of species distribution that exceed observational data series. In this context, sediment records of siliceous algae (diatoms and chrysophyte cysts) could be a useful source of long-term diversity records from two different lake environments (plankton and benthos) that have been under the same external forcing variability.

We found a steady increase of diatom and chrysophyte richness trough the Holocene in a deep mountain lake (Lake Redon, 2240 m a.s.l., Pyrenees). Diversity, therefore, appears related to the ecosystem ontogeny rather than to climate. We also found, however, that species richness maxima at sub-millennial time scales were positively related to North Atlantic cold spells periods (e.g. GISP2 dO18 negative excursions and Bond events). The occurrence of less common species was higher during these cold events, although the arrival of new species followed a random distribution trough time. We suggest that climate oscillations might be a mechanism to maintain species diversity by periodically enhancing the population of less common species and thus declining their extinction probabilities.

ID: 01289, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Impact of mid-Holocene drought upon Bolivian seasonally-dry tropical forests

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Dry forests are the most threatened tropical forest type in South America, with higher rates of deforestation and fragmentation than humid rainforests. The Chiquitano dry forest is the largest block of intact seasonally-dry tropical forest in South America and is a priority ecoregion for conservation. Understanding how resilient these forests will be to future climate-change-induced drought in the region is critical to conservation efforts. This study uses a palaeo-ecological approach to improve understanding of the long-term impact of drier climatic conditions on the Chiquitano dry forest. This enables investigation of forest sensitivity/resilience over centennial-millennial timescales. The mid-Holocene drier period, ~6000ya, is used as an imperfect analogue for future climate-change-induced drought in the region. I present some of the findings of my PhD work including pollen data from a lake sediment record from eastern lowland Bolivia. The vegetation record shows significant changes in forest composition during the mid-Holocene drier period, with increases in abundance of several indicators of more open, savannah-like systems such as Alternanthera (Amarnathaceae) and Curatella Americana (Dilleniaceae). However dry forest indicators, Anadenanthera (Fabaceae) and Astronium (Anacardiaceae), are also present at this time. This suggests that dry forest was not resilient, as a biome, to drier-than-present climatic conditions as previous work in the region had suggested. This has serious implications for future conservation of this biome under climate change induced drought scenarios. Phytolith, charcoal and d13Csediment data from this site will also be presented, providing a detailed reconstruction of this biome’s vegetation and fire dynamics under drought.

ID: 01667, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Do sub-annual climate impacts on human populations leave a detectable legacy in palaeoenvironmental archives? A tephra-dated interrogation of settlement in a marginal environment

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Significant advances in the correlation of annually-dated archives of past climate change have recently highlighted the susceptibility of human populations to extreme weather events and long-term climate oscillations. During the last millennium, rising population densities and increasingly complex economic systems rendered societies particularly vulnerable to devastating crop failures, famines and pestilence. We consider whether these documented social catastrophes register in a bidecadally-resolved peat sequence typical of many palaeoenvironmental studies. Using a series of historically-dated tephra layers to pinpoint the timing of major demographic collapses and climate perturbations, we examine continuous, integrated palaeohydrology and palynological records from an upland raised bog in the northeast of Ireland. The site currently lies above the current crop-growing limit in this region, remote from present-day settlement, but abandoned houses and field systems testify to the former occupation of the area. The pollen record reveals that settlement expanded into the area around AD 1200, and entailed mixed crop agriculture. Farming continued through the Little Ice Age up until the start of the 20th century, declining only for a short period in the 15th century. On the basis of the pollen record, it appears that expansion of settlement into this marginal environment post-dated the Medieval Warm period, and that the local population was not notably impacted by extreme weather events, wetter or colder conditions associated with the Little Ice Age, or demographic crashes in the long-term. We evaluate the reasons for this apparent resilience, including the limitations posed by the temporal resolution of the palaeoenvironmental record, and the potential buffering afforded by the relative isolation and perhaps economic independence of the population. We consider the implications of our findings for identifying and understanding population vulnerability to climate change further in the past.

ID: 02326, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Did the AD 854 Mount Churchill eruption trigger societal and climatic impacts in the northern mid-latitudes?

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Mount Churchill, Alaska, produced two of the largest North American eruptions of the last 2,000 years. The younger event dispersed a minimum of 50 km^3 of ash to the east of the volcano, which is preserved as a visible tephra bed (known as the White River Ash east lobe, or WRAe) >1,000 km from source, and is represented by cryptotephra ("AD860B") in European sites >7,000 km away. It has been postulated that the substantial ash deposition had a major regional impact on wildlife and triggered the migration of Athapaskan-speaking people from the Yukon Territory to the American South-West. The recent identification of tephra in Greenland ice cores dates the eruption precisely to AD 854 enabling the event now to be considered in light of historical records for unsettled weather in the summer of 855 and extreme cold in the winter of 855/6, despite what appears to have been a modest atmospheric aerosol loading. Here we examine palaeohydrological and palynological data from peatlands in North America and Europe in which WRAe/AD860B tephra has been found to evaluate the wider environmental and cultural impact of the eruption. We assess the role of high latitude eruptions in terms of their contribution to extra-regional climate forcing and we consider the challenges of discerning the legacy of volcanic impacts in non-annual proxy records.

ID: 01503, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Ecosystem trajectory of Cavallo Island over the last 7000 years driven by human activities and relative sea-level rise (Corsica, France)

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Mediterranean islands represent major biodiversity hotspots but very little is known about the role of past human activities and natural factors such as relative sea-level fluctuations in shaping the current landscape and biodiversity of the smallest of them. Thus, retrospective studies are a key to reconstruct complex interactions between human activities and insular ecosystems, while offering a 'past analogue' to understand coastal environmental responses to relative sea-level rise.

This palaeoenvironmental approach was carried out on Cavallo Island (120 ha, Corsica, France). The palaeoentomological and palynological analysis of a coastal sedimentary archive on this little island, permitted to reconstruct the ecosystems dynamics over the last 7000 years and to unveil the main factors driving these changes.

Combined with archaeological evidences of local human settlement, our results reveal successive phases of agro-pastoral practices: the first dates back to the Middle Neolithic (7000–6200 cal. BP), the others date back to the Chalcolithic (5000–4000 cal. BP) and the Iron Age (2700–2000 cal. BP). A major consequence of this long-term human impact is the demise of *Erica arborea* scrublands which once dominated the island landscape.

At the same time, a decrease of wetland beetle diversity and the local disappearance of some species occurred: freshwater aquatic beetles seem more impacted compared to halotolerant species, suggesting an increase of salinity in the coastal wetland. The comparison with available sea-level data suggest that the turning point in the sequence seems to be located around 3700 cal. BP when the relative sea-level rose above –1.5±0.3 meters.

Our results emphasise that anthropogenic pressures on a small island context, although moderate, could be sufficient to induce an early pronounced opening of the vegetation and could exacerbated the effect of relative sea-level rise on coastal environments.

ID: 01920, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Radiometrically dated speleothem records of MIS 11c and other key Quaternary interglacials from Corchia Cave, central Italy

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Speleothems offer an excellent opportunity to improve our understanding of Quaternary interglacial climate diversity for three main reasons. Firstly, they yield multi-proxy terrestrial records that can be anchored very precisely in absolute time using U-Th and U-Pb dating techniques. This facilitates robust comparisons of recorded climate shifts with astronomical parameters and other absolutely dated records from across the globe. Secondly, in circumstances where speleothems respond predictably to the same climatic parameters as nearby ocean sediment records, it is possible to link the two records by correlating relevant proxy time-series and thereby anchor the rich marine record to the absolute speleothem chronology. Thirdly, recent work has shown that speleothems deposited under very slow degassing conditions are ideal candidates for application of clumped-isotope thermometry, which offers the realistic possibility of attaining the pinnacle of palaeoclimate reconstruction: namely, a time-series of absolute palaeotemperatures. Here, speleothems from Corchia Cave (central Italy) are analysed to compile precisely dated records of key pre-MIS 5e but post-MPT Quaternary interglacials. In particular, we focus on MIS 11c because of its relative warmth, duration, and pattern of insolation forcing, which bears considerable similarity to the Holocene. Corchia Cave is an ideal setting to undertake work of this nature because its speleothems are well-suited to U-Th and U-Pb dating methods and contain multiple proxies that can be linked to nearby North Atlantic and western Mediterranean marine sediment records. Corchia Cave also hosts unique slow-growing subaqueous speleothems that have been deposited continuously over at least the past 1 million years under conditions as close to true isotopic equilibrium as one would expect to find in a natural cave setting. These speleothems are well-suited to clumped isotope thermometry, opening up the possibility of assembling an absolute palaeotemperature record for terrestrial western Europe that covers multiple interglacials.

ID: 01613, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

The interaction of authigenic and detrital Nd in North Atlantic sediments

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Authigenic neodymium (Nd) isotopes of marine sediments are commonly used for the reconstruction of past ocean water mass provenance. In order to provide viable information, it is a necessary prerequisite that the extracted signal is controlled by past bottom water. Recent studies, however, showed that this assumption may not hold in general by suggesting that a benthic Nd flux possibly contributes the pore water as well as the bottom water Nd isotopic composition.

To test the integrity of authigenic Nd as a paleo water mass tracer, we investigated the interaction of authigenic Nd and sediment at a site of the ‘Dreizack’ seamount, located within the North-East Atlantic IRD belt. Two IRD layers associated with the Heinrich events 1 and 2 as well as an Icelandic ash turbidite provide extreme sedimentary conditions that are easily identified in the stratigraphy. The exceptional Nd isotopic signatures associated to these events allow us to identify diffusive processes within the sediment during early diagenesis.

The deposition of ice rafted detrital carbonate and ash turbidites in the North-East Atlantic has indeed led to a certain extent to an exchange of Nd between authigenic and detrital phases. Although pore waters must have been the medium of exchange, we assess that there was no significant flux of Nd in the sediment column or into local bottom waters. Thus, we propose that even though detrital Nd was released into pore waters under such extreme sedimentary conditions, the deep water Nd isotopic composition was still dominated by the quasi-conservative behaviour of radiogenic Nd.

ID: 01642, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Astronomical forcing of an exceptionally long North African wet phase during Marine Isotope Stage 11

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The African Humid Period during the early-to-mid Holocene has been extensively studied by means of proxy records and climate modeling. Increased rainfall and expanded vegetation over North Africa was related to an intensified West African monsoon, triggered by astronomical forcing. Similar North African wet phases are evidenced for earlier interglacials such as the Last Interglaciation and Marine Isotope Stage (MIS) 11c. We performed a series of interglacial time slice simulations using the coupled climate model CCSM3 including a dynamic vegetation module in order to examine the dynamics of the MIS 11c humid period. Proxy records from a marine sediment core site off Northwest Africa suggest an extremely long wet phase between ca. 420 and 405 ka ago, revealing that North African monsoonal rainfall did not simply follow local summer insolation during this interglacial wet phase. Instead, the climate model simulations suggest an important role of the obliquity-driven intra-hemispheric insolation gradient in driving the West African monsoon. The specific phasing between precession and obliquity during the MIS 11c interglacial resulted in a particularly long North African wet phase.

ID: 01383, 21.- Sediment Flux: Past Peaks and Troughs, (Poster)

Tropical climate dynamics through the Holocene using varve analysis from Yaal Chac, Mexico

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Using varved sediment cores from lake Yaal Chac, Mexico, annual climate is reconstructed through the mid-Holocene (~8.8-5.1 ka cal BP) using microfacies analysis and their geochemical composition. High seasonality at the site drives varve formation; the annual wet and dry seasons lead to the deposition of organic matter and autochthonous calcium carbonate respectively. By developing a mechanistic model of varve formation, the environmental conditions required to cause changes in the observed sedimentology can be inferred. The record displays a long-term decline in varve thickness between ~8.8-5.1 ka cal BP, and a switch from aragonite to calcite deposition, generally associated with a decreasing evaporation/precipitation ratio. Continuous varve deposition ends abruptly at ~5.1 ka cal BP when fresher water no longer exceeds the carbonate solubility level on an annual basis; although carbonate precipitation events return periodically through the later parts of the record and are visible in near-surface sediments today. Depletion of oxygen isotopes from the carbonate material at 5.1 ka cal BP supports the inference of a system switch to fresher lake water at this time.

Climate is inferred to drive carbonate precipitation and mineralogy change during the varved sequence in the early-mid Holocene indicating a wetting climate, which has also been observed in other palaeorecords across the Yucatan. Future work aims to further investigate the abrupt switch in sedimentology at ~5.1 ka cal BP. This likely relates to a threshold change to the catchment's hydrology acting to reduce carbonate precipitation, but is potentially driven by complex interactions between groundwater, climate and catchment stability, the latter increasingly impacted by regional human activity. The short-lived re-emergence of calcareous varves and peaks in Ti deposition in the late Holocene are hypothesised to be associated with Mayan activity.

ID: 01578, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Reconstructing climate signals from fluvial, aeolian and marine sequences of southern Saurashtra during the last 100 ka

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The southern Saurashtra coast and its coastal plains in western India host bioclastic carbonate deposits that were formed due to combination of near shore marine, fluvial and aeolian processes. These deposits are archived inform of fluvial terraces, sheet deposits, coastal shore platform/intertidal facies and dunal facies. Using optical chronology we reconstruct Late Quaternary climatic conditions since the past 120 ka, i.e. MIS 5e. The available ^{230}Th/^{234}U and ^{14}C ages on the bulk carbonates were compared with newly estimated OSL ages. The optical dating coupled with detailed sedimentology of these sequences suggested periods of aridity and wetter phases oscillating between 100 to 70 ka and 40 to 20 ka period. The southern Saurashtra region has witnessed wide spread aeolian activity during the arid phases which has led to deposition of miliolite in the inland parts of Saurashtra. These aeolian miliolite has been reworked and deposited in fluvial system in form of sheet and valley fill deposits during the 100 to 70 and 40 to 20 ka period. The coastal tract forms the marine miliolite which hosts uplifted marine notches and palaeo dunes. These coastal miliolite is the youngest marine aggradation event at 40 ka. Similarly the aeolian activity in the fluvial systems dates back to 20 ka period, coinciding with the Last Glacial Maximum. The study reveals the available ^{230}Th/^{234}U and ^{14}C ages on the bulk carbonates were older than the OSL ages. This we attribute most likely to the sampling carried out in diagenetically altered carbonates by earlier works. The study supports the earlier hypothesis of higher sea level along west coast of India during the middle Holocene period.

ID: 01260, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Air temperature in Novaya Zemlya Archipelago and Vaygach Island from 1832 to 1920 in the light of early instrumental data

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In this paper, the results of an investigation into the air temperature conditions in Novaya Zemlya Archipelago and Vaygach Island (NZR) from 1832 to 1920, on the basis of all available early instrumental data gathered during exploratory and scientific expeditions, are presented. Traditional analysis based on mean monthly data was supplemented by an approach less popular in the scientific literature, i.e. the additional use of daily data. Moreover, the daily data used were not limited only to mean daily air temperature, but include also maximum daily temperature, minimum daily temperature, and diurnal temperature range. Such rich sets of data allowed for more comprehensive and precise recognition of air temperature conditions in the NZR. Based on these kinds of daily data it was also possible to calculate the number of so-called 'characteristic days' (i.e. the number of days with temperatures exceeding specified thresholds) and day-to-day temperature variability and, for the first time, to determine different characteristics of thermal seasons (duration, onset and end dates) according to Baranowski's (1968) proposition. The results were compared with contemporary temperature conditions (1981–2010) to estimate the range of their changes between historical and present times.

Analysis reveals that in 1832–1920, the NZR was markedly colder than today in all seasons. Coldest was autumn (on average by ca. 5°C), and least – summer (by 1.6°C). Mean annual air temperature was colder than today by about 3°C. The majority of mean monthly air temperatures in historical times lie within two standard deviations from the modern mean. This means that values of air temperature in historical times lie within the range of contemporary air temperature variability. Different air temperature characteristics calculated on the basis of daily data for the NZR for historical/contemporary periods also confirm the occurrence of climate warming between the studied periods.

ID: 02049, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Comparison of the Eastern Equatorial Pacific UK'37, TEX86 and Globigerinoides ruber derived sea temperatures: insights from Termination II

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Research on the physical and biological processes controlling the transitions from glacial to interglacial periods has mostly focused on the most recent Termination (TI). However, studying previous deglaciations should provide further insights into the mechanisms involved with these transitions. In this study, we focus on the penultimate deglaciation in the Eastern Equatorial Pacific, a strategic location under the influence of upwelled nutrient-rich waters with a tight link to the Southern Ocean through the advection of intermediate waters. We intend to describe a detailed picture of the undergone climatic changes in this area through the compilation of data reconstructed using three different paleothermometers (the $U^{K'}_{37}$, the TEX_H^{86} and the Mg/Ca ratio measured on the planktonic foraminifera *Globigerinoides ruber*) and the comparison with other environmental records from the same core of surface ocean productivity, dust input and thermocline condition across Termination II (TII) (110-150 kyr BP). $U^{K'}_{37}$ sea surface temperature (SST) and Mg/Ca SST oscillate around the same range of temperatures when compared with the TEX_H^{86}, which displays a significant offset towards colder values. The $U^{K'}_{37}$ SST record, which is shows the lowest SST amplitude within the investigated period, and Mg/Ca SST show larger discrepancies during glacial and interglacial peaks, while both evolve in good accordance during TII. On the other hand, TEX_H^{86}-derived temperatures behave differently: the magnitude of the offset is larges during the penultimate glacial maximum (up to 5°C) and TII, while temperatures reach similar values to the $U^{K'}_{37}$ SST during the interglacial maximum (around 26°C). Different responses of the organisms related to each proxy to environmental changes such as nutrient availability, water column mixing/stratification and changes in seasonal or water-depth related-growth patterns probably explain the observed discrepancies and similarities between these paleothermometers, thus shedding light on the environmental conditions during TII.

ID: 02377, 28.- Climate variability signals in groundwater (and unsaturated zone) archives, (Poster)

Noble gases in the Cambrian-Vendian aquifer system in Estonia

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Several studies have shown that glacial origin paleo-groundwaters from the Weichselian time are widespread in the Cambrian-Vendian (Cm-V) aquifer systems in Estonia (Vaikmäe et al., 2001). So far the phenomenon has been explained by glacial basal meltwaters that have been pressed into the aquifer systems. Additionally, Vaikmäe et al. (2001) show that the Cm-V groundwaters in Northern Estonia exhibit enormous amounts of excess air (oversaturation 200–400%), possibly from air bubbles found in glacial basal ice. As far as we know, however, such high gas contents in glacial ice have not been registered anywhere and the maximum gas contents to be expected for basal meltwater are much lower.

The prevailing opinion seems to be that the Baltic ice tongue, whose northern part overlaps the outcrop area of the Cm-V aquifer system, was an active, so-called temperate glacier, where accumulation was accompanied by high-rate melting. The meltwaters follow the topography of the glacier stream towards its margins or accumulate in local depressions forming ponds and lakes. Such water bodies either refreeze or, having reached a critical water amount, percolate rapidly through the glacier (e.g., Das et al., 2008). This allowed for a significant amount of meltwater to reach the bottom of the glacier and developed a drainage system under the glacier.

Our results indicate that the elevated gas contents in the Cm-V aquifer system are not uniform, but there are areas where the gas concentration is considerably higher. These areas match with the local topographical units which could support a development of the subglacial canal system. We explain the high gas content in the Cm-V paleogroundwater with the collapse of the canal system during the more active glacier sliding in summer. During this process some air was trapped under the glacier, being later pressed into the subglacial water.

ID: 01573, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Assessing Holocene Forest Stability with a Bayesian Biomass Reconstruction

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Dramatic vegetation fluctuations in response to changing climate over the Holocene in the Upper Midwest of the United States have been shown in paleoecological records. Vegetation shifts like these have implications for the global terrestrial carbon budget, but empirical reconstructions of the biomass consequences of vegetation shifts are scarce. Here, we describe a new Bayesian statistical model that uses fossil pollen to estimate changes in Midwestern biomass over the Holocene. Our main scientific question was whether biomass was stable during Holocene climate changes. There has been increasing evidence that climate-vegetation feedbacks make open forests unstable, and it has also been suggested that the stability of closed forests might be sensitive to changes in precipitation. Our statistical model estimates aboveground biomass based on fossil pollen data from 41 sites across the Upper Midwest. Biomass estimates in the model are calibrated against a Bayesian estimate of vegetation and biomass at time of settlement (~1850) derived from Public Land Survey data. Leave one out cross validation of our model reproduced the observed biomass with high precision (R

2 = 0.942). Predictions back through the Holocene occurred at sites with good radiocarbon control spanning vegetation types. We define ecosystem stability as the squared sum of the second derivative and found that the largest instability was along the prairie forest ecotone closely followed by sites that were invaded by america beech (Fagus grandifolia) and hemlock (Tsuga canadensis).

ID: 02269, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Marine and terrestrial signals in surface sediments from the Caribbean and the eastern tropical Pacific: a multiproxy approach

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Long-term paleoclimatic and paleoecenographic reconstructions using a multi-proxy approach allow for a broader and more comprehensive understanding of past climate shifts and their consequences in the environment. However, few multiproxy studies have addressed the horizontal spatial dimension, thus leaving a gap in our understanding of geographical distribution of proxies in relation to climatic and environmental variables. Additionally, most studies on continental margins relay on the analysis of surface sediments for either micropaleontological proxies or alternatively for geochemical proxies thus lacking a more holistic approach that would provide a better understanding of past conditions. Here we present the first overview of the spatial distribution of marine (organic-walled dinoflagellates) and terrestrial (pollen and spores) palynomorphs from recent sediments in the southern Caribbean and the eastern tropical Pacific (equator–16°N, and 62°W–85°W). In addition the study integrates organic biomarker distributions, and geochemical elemental composition, to provide a complementary reconstruction of oceanographic and climate regimes in tropical oceans. The assemblage composition and the concentration of palynomorphs allowed for a clear differentiation between the Caribbean and the Pacific that was supported by the concentrations of major and trace elements (e.g. Ba, Ca, K), and biomarkers that all together indicate higher diversity, higher productivity, and higher terrestrial input in the Pacific ocean. Main river discharge areas could be traced by distinct assemblages of marine and terrestrial palynomorphs that are coherent to a clear biomarker signature and elemental ratios (Fe/Ca, Fe/K), highlighting their potential to trace back hydrological changes and weathering over continental tropical South America. Therefore this study demonstrates that a multyproxy approach is essential to fully understand not only the temporal dimension but also the spatial variability associated to local, regional and even global phenomena.

ID: 01674, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Human impact during the Late Holocene based on vegetation reconstruction from alpine and montane peat bog sediment records from Sierra Nevada (southeastern Spain)

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Sediments from alpine peat bogs and lakes from the Sierra Nevada range in southeastern Spain (western Mediterranean area) have been very informative in giving us information about paleoenvironment and past climate change. Recent studies try to find out the relationship between vegetation evolution, climate change and human impact. Some of them point to climate change as the most important factor determining in the Mediterranean vegetation evolution, however other suggest that we are still far from understanding the correlation between vegetation and human influence. Previous research from Sierra Nevada shows human influence in the alpine environments during the late Holocene, however anthropogenic impact is minimal compared with other lower elevation areas. In this study, we compare evidences of human impact in two different elevation peat bog records form Sierra Nevada: Borreguil de la Caldera located above treeline in the crioromediterranean vegetation belt at ca. 2990 m elevation, and Padul peat bog in the mesomediterranean vegetation belt situated at ca. 725 m elevation. A high-resolution pollen and non-pollen palynomorphs analysis have been carried out in both records giving us information about vegetation history during the late Holocene. These analyses show the signal of pasturing and agricultural evidences probably due to the influence of human disturbance, which became more prominent since the last 1500 years. This study is necessary to try to understand the correlation between natural and anthropogenic climate change in the Sierra Nevada environments during the last ca. 4500 years.

ID: 01666, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Late Holocene climate change in Southern Iberia through a high-resolution multi-proxy analysis from Padul peat bog (Sierra Nevada)

María J. Ramos-Román[1], Gonzalo Jiménez-Moreno[1], Jon Camuera[1], Antonio García-Alix[1], R. Scott Anderson[2], Francisco J. Jiménez-Espejo[3], Jaime L. Toney[4], Dirk Sachse[5] 1) Departamento de Paleontología y Estratigrafía, University of Granada, Granada, Spain. mjrr@ugr.es 2) School of Earth Sciences and Environmental Sustainability, Northern Arizona University, USA. 3) Department of Biogeochemistry, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan. 4) School of

Geographical and Earth Sciences, University of Glasgow, UK. 5) Helmholtz Centre Potsdam, German Research Centre for Geosciences GFZ, Section 5.1 Geomorphology, Organic Surface Geochemistry Lab, Germany. * María J. Ramos-román, mjrr@ugr.es The Iberian Peninsula, located in the Mediterranean area, is an interesting location for paleoclimate studies due to its geographic situation between arid and humid climates. Sediments from peat bogs and lakes from Sierra Nevada, in southeastern Iberian Peninsula, have been very informative in terms of how vegetation and wetland environments were impacted by Holocene climate change and human activities. These studies are essential if we want to understand past climate change as the key to predict a possible environmental response of the montane and alpine Sierra Nevada ecosystems to future climate change. Padul basin, located in the southwest of the Sierra Nevada mountain range, contains a ca. 100 m-thick peat bog sedimentary sequence that was deposited during the past 1 Ma making this area interesting for paleoenvironmental and paleoclimatic reconstructions. A new 43 m-long sedimentary record has recently been retrieved from the Padul peat bog. In this study we show a high-resolution multiproxy analysis of the late Holocene part of the Padul-15-05 core including pollen analysis, XRF-core scanner, magnetic susceptibility and organic geochemistry, supported by an age control based on AMS radiocarbon dates, providing with information about vegetation, climate change, and human impact at centennial-scale variability during the past 4800 cal yr BP.

ID: 01292, 28.- Climate variability signals in groundwater (and unsaturated zone) archives, (Poster)

Water resources and changing climate in Indian Himalayan Region

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The Himalayan region is most dynamic and complex mountain systems. Studies established that water resources in this region are extremely vulnerable to changing climate. Effects of this change on the availability of, and access to, water resources are widespread but ever high-resolution climatic model fails to provide a reliable future projection. Based on regional climate models, it is predicted that the temperatures in the Indian sub-continent will rise between 3.5 and 5.5 ˚C by 2100, and on the Tibetan Plateau by 2.5 ˚C by 2050 and 5 ˚C by 2100. According to IPCC 2007a, warming in the Himalayas has been much greater than the global average of 0.74 ˚C over the last 100 years. The effect of this change on groundwater hydrology and flow of numerous seeps and small streams is necessary to sustain water need of 1.5 billion people in the low-lying area. More research on Himalayan precipitation processes and its hydrological system is required for understanding the potential impact of *climate change* on the *hydrological* regime in the *Himalayan* region. Current study tried to establish the impact of climatic variability on the flow of seeps and stream and its relationship with the hydrological system in the Himalayan region on a sub-watershed level.

ID: 01777, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Tree-ring reconstruction of Upper Indus Watershed Streamflow using Hierarchical Bayesian Regression

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We present a tree-ring based reconstruction of Upper Indus River watershed flow using hierarchical Bayesian regression. One distinct advantage of hierarchical Bayesian regression is that we can use partial pooling of information across multiple streamflow gauges. This allows us to reconstruct streamflow across a watershed network (seven gauges), including at stations where streamflow records are too short to reconstruct using traditional methods. We do this by explicitly modelling the covariance structure of streamflow residuals and regression coefficients across different stations. Additionally, using Bayesian methods we can develop reconstructions for gauge records with missing data, which maybe interspersed through the length of the record. We compare the reconstruction uncertainty estimates (or Bayesian credible intervals) using Hierarchical Bayes, to prediction intervals provided by the semi-parametric Maximum Entropy Bootstrap and show that they are comparable. Consistent with a prior study we find that current flows since the 1980s are higher than average for past five centuries, but may be comparable to streamflow during the mid 1500s and late 1600s. We will also examine the climatic forcings of streamflow in the region.

ID: 01833, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Mid to late Holocene climate variability in the Garhwal Himalaya, India

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The Indian summer monsoon (ISM) is one of the most exciting climate systems that accounts for >80% of annual rain over the Indian subcontinent. The small scale spatio-temporal variability in the distribution and intensity of rainfall can have a pronounced impact on the hydrological and socio-economic conditions of the region, resulting in floods and droughts. Thus, understanding the impact of ISM and its spatio-temporal variability in different basins (Geographic domains) holds a key research challenge to understand the past extreme climate events and their impact on human settlements. In the present study, a ~116 cm long organic-rich lake trench from the alpine meadow located at an altitude of ~3,350 m.a.s.l., in Chamoli, Garhwal Himalaya is investigated for multi-proxy analyses (elemental chemistry, grain size, organic carbon (OC) and environmental magnetism) to reconstruct the mid to late Holocene climate. The chronology of lake sediments was established using 6 AMS dates covering a time span of ~6,000 yrs. The decreased magnetic concentrations (χlf, SIRM and Soft-IRM) and elemental concentrations (Fe, Mg, Si, Ti, and K) between ~4000 and 2000 cal yr BP suggests reduced influx of minerals. The increased clay% and decreased sand% during this interval also suggest near stagnant lake level conditions. The increased phosphorous and OC% between ~970 and 730 yr BP suggest high productivity under warm-wet climate corresponding with the Medieval Warm Period (MWP). The reduced OC% and phosphorous concentration between ~730 and 560 yr BP suggest a reduction in productivity due to unfavourable climatic condition for growth of plants during the transition from MWP to Little Ice Age (LIA). The increasing trend of elemental ratios Na/Al, Na/K and Na/Ti and Ca, Na and Mg values suggest high intensity of drought like condition in the region during this interval corresponding to the early part of the LIA.

ID: 01342, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Relative impact of climate change and human activities on the ecosystems in southwest Madagascar

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Madagascar is commonly regarded as a biodiversity hotspot that is primarily impacted by human activities. However, climate variation, especially the reduction of rainfall has been considered as a potential key driver impacting species composition in the Southwest of the island. Some of the legacy of past climate change , but also current climatic factors is the vegetation distribution gradient from dry to spiny forest. Few studies have investigated the impact of rainfall variability on vegetation composition and structure. A long _term study using sedimentary and dendroclimatological records may facilitate the understanding of the patterns of environmental change in the last 2000 years in response to regional rainfall variability. Preliminary results obtained from the Carbone isotope content of baobab demonstrated millennium to decadal variation of the regional rainfall. During the next six months, I will be finalizing my rainfall records and count pollen content of my sediments samples to reconstruct vegetation change. The presentation will discuss the vegetation, climatic gradients, human impact and land_use change in Southwestern Madagascar. This study has implications in the prediction of future scenarios in rainfall variability and vegetation changes to enable stakeholders and conservationists to develop better adaptive strategies reconciling sociological and conservation aspects within this unique biodiversity hotspot.

ID: 02131, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Modelling marine radiocarbon during abrupt climate change

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The Atlantic Meridional Overturning Circulation (AMOC) is a key element of the global climate system because of its role in transporting heat from low to high latitudes. During the last glacial period, rapid changes in the strength of the AMOC have been linked to millennial-scale abrupt climate change events, which had widespread impact on global climate and atmospheric CO_2 levels. Marine radiocarbon can be used both as a tracer of ocean circulation and carbon cycling during these events, as well as an important chronometer for sediment core records. Here, we use cGENIE, an Earth System Model of intermediate complexity, to simulate radiocarbon for the glacial climate and stadial events. We explore spatial and temporal variations in modelled radiocarbon in the North Atlantic and compare these results to new high latitude surface radiocarbon reconstructions. We use this coupled data-model approach to assess broad patterns of change in AMOC strength and associated carbon cycle changes during abrupt climate change events over the last 30,000 years.

ID: 01889, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Is a cold planet Earth's climate more sensitive to volcanic forcing than a warm one?

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It is unclear how regional and global climate variability depends on the mean state of the climate system, and whether the sensitivity to natural forcing from volcanic eruptions and solar variations is different. Investigating recent volcanic eruptions, well covered by the instrumental record, can give detailed insights into the response of the system close to its present-day state. The paleoclimate record, however, is crucial to establish the role of natural forcing in generating climate variability in states that are very different from today. It is clear that small and large volcanic eruptions occurred throughout the last Glacial cycle and the Holocene, although possibly at a lower rate than during the last millennium. Yet, most climate model experiments for these periods are performed with constant solar and no volcanic forcing. This biases model estimates in model-data comparisons for past climate variability. Here we present first results from a suite of long (1000a) and short (25a) paleoclimate model experiments for the Last Glacial Maximum and the mid-to-late Holocene with variable natural forcing. We evaluate, to what extent regional and global climate impacts of volcanic eruptions and solar luminosity changes are dependent on the mean climate state, and to what extent the variability is consistent with the paleoclimate proxy evidence from ice cores.

ID: 01321, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Holocene Activity of the Petermann Glacial System, Northwest Greenland

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Large calving events of the Petermann Ice Tongue, Northwest Greenland, in 2010 and 2012 seem unprecedented in the context of the limited historic record, dating back to the 1875-1876 British Arctic Expedition led by Sir Nares, and more recent satellite observations of the last two decades. Modern studies demonstrate that this marine terminating sector of the Greenland Ice Sheet is especially sensitive to oceanic forcing, but paleo data are required to provide a more holistic context of these changes. We present a suite of analyses on sediment cores collected during the international and interdisciplinary 2015 expedition to Nares Strait and Petermann Fjord onboard the Swedish Icebreaker Oden, documenting new perspectives of the early Holocene deglaciation of Nares Strait and a new high resolution record of mid to late Holocene dynamics of the Petermann glacial system. CT scans allow for clear identification of a number of glaciomarine depositional environments and for high resolution quantification of >2 mm clasts. The distinct local carbonate bedrock surrounding Petermann Fjord and crystalline basement rocks excavated by the inland Greenland Ice Sheet are tracked using Q-mode factor analysis of scanning XRF data, displaying strong gradients in sediment composition between the Ca-rich sediments proximal to tidewater glaciers of the local ice cap and sediments proximal to the grounding-line of Petermann Glacier. Paleomagnetic measurements isolate a strong and stable characteristic magnetization, which show remarkable similarilty to Paleosecular Variation (PSV) recorded in nearby mid to late Holocene varved lakes on Ellesmere Island. Together, this non-destructive dataset provides robust correlations, indicating a coherent and dynamic record of changes in the Petermann glacial system during the Holocene, including evidence for at least two significant grounding-line retreats followed by the late Holocene growth and relative paleo-extent of the modern Petermann Ice Tongue observed by Sir Nares.

ID: 01650, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

A diatom-based transfer function for quantitatively sea ice reconstruction in the western Arctic Ocean

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Sea ice plays a vital role in the global climate change by its high albedo influencing the energy balance and by preventing heat and mass exchange between ocean and atmosphere. To understand the mechanism behind and to forecast the future environment changes, it is essential to know the sea ice history in the Arctic Ocean, where sea ice is undergoing rapid retreat. However, such research in the western Arctic Ocean is sporadic and consequently the sea ice history in this area remains unclear.

This study aims to establish a reliable diatom-based transfer function for sea ice variability reconstruction in the western Arctic Ocean. Here we combine two published diatom data sets with new data from surface sediment samples retrieved during the 7th Chinese National Arctic Research Expedition (CHINARE-7) in 2016, which includes 214 surface sediment samples recovered in the Bering Sea, the East Siberian Sea, the Chukchi Sea, the Beaufort Sea and the Arctic open ocean between 50°N and 85°N, representing a large area of winter sea ice coverage. Sea ice variability estimates are generated with the Imbrie and Kipp Method (IKM), the Modern Analog Technique (MAT), and the Weighted Averaging Partial Least Squares regression (WAPLS). The diatom-based transfer function is applied to four multicore sediment samples in the Bering and Chukchi Seas, covering the last century, which allows for the validation of sea ice estimates by comparing to local and global instrumental records. Comparisons between sea ice reconstructions derived from different proxies are also made to discuss the merits and demerits of these methods.

ID: 01507, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Spatial variability and signal content of Holocene temperature proxy records

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Analyzing the natural climate variability of the Holocene is necessary to improve predictions of future climate due to human-made climate change. Unfortunately, the climate signal which is contained in proxy records is affected by noise, time uncertainty and seasonal recording which hinders detailed climate reconstructions as well as the analysis of natural forcing and dynamical processes leading to climate change.

To improve proxy-based temperature reconstructions and estimations of past climate variability, we analyze a global set of marine and terrestrial Holocene temperature proxy records by estimating its signal content. For this, we compare the spatial correlation of proxy records and model simulations in dependence of data resolution, proxy type and seasonality, as well as the effects of noise and time uncertainty. This allows an improvement of further reconstructions of the Holocene temperature evolution and variability by knowing the properties of proxy records.

ID: 01479, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

Atmospheric methane variability: Multi-centennial scale signals in the Last Glacial Period

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In order to understand atmospheric methane (CH_4) biogeochemistry now and in the future, we must apprehend its natural variability, that without anthropogenic influence. Samples of ancient air trapped within ice cores provide the means to do this. Here we analyze the ultra-high resolution CH_4 record of the West Antarctic Ice Sheet (WAIS) Divide (WD) ice core 67.2–9.8 ka and find novel, atmospheric CH_4 variability at multi-centennial timescales throughout the record. This signal is characterized by recurrence intervals within a broad 80–500 yr range but we find that age scale uncertainties complicate the possible isolation of any periodic frequency. Differences in signal amplitude between the glacial and Holocene may be related to incongruent effects of firn-based signal smoothing processes. The peak-to-peak amplitudes of signals within interstadial and stadial periods vary in proportion to the underlying millennial scale oscillations in CH_4 concentration—the relative amplitude change is constant. We propose that multi-centennial CH_4 signal is related to tropical climate variability that influences predominantly low latitude wetland CH_4 emissions.

ID: 01532, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Climate variability, human use and landscape change of high mountain environments: Coma de Vaca and Ter valleys, Eastern Pyrenees

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Interambar and Teramar research projects (MINECO, 2011-2016) aim at tracing the long-term Holocene history of human uses and landscape changes of upper mountain areas above 2000 m at the Eastern Pyrenees. Human-environmental interactions at high altitudes have been studied in the Coma de Vaca and Ter valleys.

This region reports high rainfall due to the topographic barrier effect to eastern Mediterranean moist winds, resulting in high quality alpine grasslands and pastures. Written sources stress the use of these valleys in the past for grazing, mainly in relation with transhumance. Mining and forestry activities have been also reported.

Aiming at determining environmental changes as well as land-uses and human adaptation to high altitude environments, an integrative approach has been adopted, combining the palaeoenvironmental study of natural records and archaeological diggings. High-resolution multi-proxy analyses including pollen, non-pollen palynomorphs (mainly coprophilous fungal spores), macrocharcoal particles, mineralogy and geochemistry have been carried out in four fen records distributed at different altitudes from 2167 and 2437 m. High-resolution time models obtained on the base of numerous radiocarbon dates allow reliable correlations of palaeoenvironmental with archaeological and historical data.

Archaeological survey of these valleys has reported more than 400 archaeological structures, and 37 of them have been excavated. 20 radiocarbon dates obtained at archaeological structures in the Coma de Vaca valley suggest the presence of pastoral structures since the Middle Neolithic in the valley.

The integration of palaeoenvironmental and archaeological data indicate the existence of human impact at high altitudes since the Middle Neolithic, with large deforestations during the Late Neolithic and the Bronze Age. However, the definitive configuration of alpine grasslands in this area occurred mainly during the Late Antiquity and the Early Medieval periods.

ID: 01912, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

A high resolution multiprocy fire reconstruction of an eastern Iberian lake, Estany de Montcortès, during the last millennium

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Fire is a key environmental and climatic driver. Humans have also played a role in the occurrence of fires, mostly with the development of agricultural practices and the consequent land clearing. Arguably, there are still important gaps in current understanding of the role and significance of human-environment-climate interactions driven by fire during historical times, prior to the Industrial Revolution.

In that sense, in here we show a new multidecadal reconstruction using fire biomarker proxies, derived from a varved karstic lake (Montcortès; Pre-Pyrenean Range), spanning the last 1200years. The high mountain region chosen in our study is a highly sensitive environmental-climatic area, that has a long history of human settlement, well documented since the Middle Ages.

We have applied a combination of some relatively new fire biomarkers proxies, levoglucosan and polyaromatic hydrocarbons, which are complementary to traditional charcoal proxies. In addition, we have also studied plant (n-alkanes) and archeal/bacterial (GDGTs) biomarkers to get new insights in the regional fire history related to human activities, and its relation with vegetation and climate decadal variability. Detangling between human and climatic induced fires also relies in the use of charcoal records from previous studies and historical archives on fire occurrence from the same region.

We expect to improve the development of this new set of fire biomarkers proxies as a valuable tool to reconstruct fire signals, complementary to charcoal. We will also show how this levoglucosan and polyaromatic hydrocarbons fire signal can give an interesting different approach to the charcoal conclusions about how preindustrial societies affected climate and landscape in the study area.

ID: 01881, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Appraisal of biomass combustion biomarkers to track the paleo-occurrence of forest fires

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Fires influence many aspects of the Earth system, including ecosystem distribution, biodiversity, the carbon cycle, atmospheric chemistry and climate. The study of ancient climates can be helpful to understand not only the fires natural drivers and their effects on ecosystem properties, but also the role that humans have played as a disturbance force from an earlier time. However, the reconstruction of fires is not straightforward and is limited by the nature of the proxies available, chiefly charcoal.

In here we evaluate the application of a complementary approach to that of charcoal to track and reconstruct the fire palaeo occurrence. For this purpose we have compiled an extensive collection of soils and lacustrine sediments representative of the wide range of climates and ecosystems within the Iberian Peninsula. We have measured the abundances of a monosaccharide anhydride (MA) biomarker called levoglucosan, and polyaromatic hydrocarbons (PAHs), as well as general plant biomarkers such as n-alkanes. Charcoal has also been measured in the lake samples for comparison with the biomarker data.

The data obtained has been mapped and compared to the documented occurrence of fires in Spain over the last two decades. The aim is to get new insights into how the use of biomass combustion biomarkers (PAHs and MAs) and their ratios can be used to quantitatively track biomass fire occurrence, intensity and sources.

ID: 01514, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Development of a regional glycerol dialkyl glycerol tetraether (GDGT) temperature calibration for Antarctic and sub-Antarctic lakes

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Temperature calibration models based on the relative abundances of sedimentary glycerol dialkyl glycerol tetraethers (GDGTs) have been used to reconstruct past temperatures in both marine and terrestrial environments, but have not been widely applied in high latitude environments. This is mainly because the performance of GDGT–temperature calibrations at lower temperatures and GDGT provenance in many lacustrine settings remains uncertain. To address these issues, we examined surface sediments from 38 Antarctic, sub-Antarctic and Southern Chilean lakes. First, we quantified GDGT compositions present and then investigated modern-day environmental controls on GDGT composition. GDGTs were found in all lakes studied. Branched GDGTs (brGDGTs) were dominant in 36 lakes and statistical analyses showed that their composition was strongly correlated with mean summer air temperature (MSAT) rather than pH, conductivity or water depth. Second, we developed the first regional brGDGT–temperature calibration for Antarctic and sub-Antarctic lakes based on four brGDGT compounds (GDGT-Ib, GDGT-II, GDGT-III and GDGT-IIIb). Of these, GDGT-IIIb proved particularly important in cold lacustrine environments. Our brGDGT–Antarctic temperature calibration dataset has an improved statistical performance at low temperatures compared to previous global calibrations (r^2=0.83, RMSE=1.45◦C, RMSEP-LOO=1.68◦C, n=36 samples), highlighting the importance of basing palaeotemperature reconstructions on regional GDGT–temperature calibrations, especially if specific compounds lead to improved model performance. Finally, we applied the new Antarctic brGDGT–temperature calibration to two key lake records from the Antarctic Peninsula and South Georgia. In both, downcore temperature reconstructions show similarities to known Holocene warm periods, providing proof of concept for the new Antarctic calibration model.

ID: 01408, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Lost in transition. Deciphering forest evolution during the late Holocene in the Gredos range (central Spain).

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Pollen analyses in the Gredos range (central Spain) have been interpreted to reconstruct the late Holocene vegetation history in this mountain region. We present the high-resolution pollen record of Fuente de la Leche (1382 m) and Fuente del Pino Blanco (1343 m) peat sequences, supported by fifteen AMS ^{14}C dates. The results are then compared with other sequences from the Spanish Central System in order to better understand the past dynamics of the main forest constituents and to provide a critical view of the dialectic between conifers and deciduous forests. The vegetation record at Fuente de la Leche starts at 3000 cal yr BP, with the occurrence of rather closed forests composed of *Pinus sylvestris* and *Betula*. *Pinus sylvestris* was the dominant pollen taxa for almost the entire period. However, during the last 850 years, *Pinus sylvestris* forests were progressively replaced by *Quercus pyrenaica* woodlands and grasslands, as a result of a high pastoral pressure, until forming mixed woodlands ~400 years ago. The interpretation of Fuente del Pino Blanco record is that dramatic changes commenced about 265 years ago. Prior to this date, an open canopy woodland included species (*Alnus glutinosa*, *Quercus pyrenaica*) whose distributions no longer exists in the studied area, replaced by *Pinus* forests. These new data reassess the Pyrenean oak canopy was consumed by fires, providing openings for *Pinus pinaster* and broom communities better adapted to fire. That has allowed us to propose a forced change in the role of fire in the supramediterranean belt of the Gredos range, due to the increase of agricultural (rye and other cereals) and livestock activities.

ID: 01887, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Initial Results from Deep Drilling of Lake Junín, Perú

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Lake Junín (11.0°S, 76.2°W) is a shallow (z_{max}~12 m), intermontane, high-elevation (4080 masl) lake in the inner-tropics of the Southern Hemisphere that spans ~300 km^2. It is dammed by glacial alluvial fans that are >250 ka. Lake Junín has not been overrun by glacial ice in >250ka and is ideally located to receive glacigenic sediment. The Junín basin is underlain by carbonate rocks that provide Ca and HCO_3 ions; during the present interglacial period precipitation of $CaCO_3$ in the western margin of the lake has occurred at ~1mm yr^{-1}. An airgun seismic survey reveals a strong reflector at ~105 meters depth, which marks the base of the lacustrine section. Drilling focused on three sites. Site 1, located near the depocenter and most distal to glacial sources, yielded a composite sediment thickness of ~95m; Site 2, proximal to glacial outwash fans, yielded a composite thickness of 28 m; Site 3, located at an intermediate distance yielded a sediment thickness of 55m. The stratigraphy of Site 1 is marked by 8 interstadial units that are characterized by low bulk density and magnetic susceptibility (MS)and high $CaCO_3$. These units are intercalated with glacigenic sediment that has high density and MS, and low $CaCO_3$. The age model for Site 1 is based on numerous AMS radiocarbon dates on terrestrial macrofossils and dozens of U/Th ages on authigenic $CaCO_3$. Comparison of the MS record of glaciation in Junín over the past 700 ka with the global ice volume record reveals many common features and several prominent differences. The signal of the last 50 ka suggests that glacial pulses are correlative with increases in tropical moisture and steep meridional sea surface temperature gradients in the North Atlantic.

ID: 02240, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Late Holocene Mg/Ca based sea surface temperature estimates for the SW Atlantic in the

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Past sea surface temperature (SST) reconstructions are an essential step to assess future climate changes. Even though the South Atlantic plays a major role in interoceanic exchange it still lacks paleoceanographic data, especially for the Holocene. The SE Brazilian margin is under the influence of the Brazil Current (BC), a superficial current that transports warm and saline waters, providing optimum environmental conditions to the planktonic foraminifera *Globigerinoides ruber* (pink). Here we analyze SSTs variations in the SE Brazilian margin spanning the past 5 kyr cal BP using Mg/Ca ratios from *G. ruber* (pink) as a proxy. To achieve our goal, five multiple-cores were retrieved between the latitudes of 23°S and 25°S. The age models were obtained by radiocarbon dating. The geochemical data were obtained in approximately 40 *G. ruber* (pink) tests (fraction 250-300 mm) analyzed with an induced plasma mass spectrometer (ICP-MS). After obtaining the Mg/Ca ratio, we applied the paleotemperature equation for the *G. ruber* species to access the SST estimates. Moreover, a regional SST reconstruction was obtained through a stack record. Our results show a general SST decreasing trend in the last 5 thousand years. Furthermore, we found two trends within the Late Holocene: from 5 to 2 ka cal AP, we observed a cooling trend in the SST; and from 2 ka cal AP to the Present, we observed a warming trend in SST. For the SE Brazilian margin cooling (warming) SST are related to the increase (decrease) in South Atlantic Central Water (SACW) upwelling driven by a strengthening (weakening) of the BC. It was possible to observe an anti-phase relationship between the BC and the Atlantic Meridional Overturning Circulation (AMOC). This study provides data that contributes to the improvement of our understanding of the South Atlantic paleoceanography and paleoclimatology.

ID: 02200, 06.- Before and after - climate contrasts across the MPT, (Poster)

Tracking major climate changes in the southwestern Iberian Margin during Mid Pleistocene Transition

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We investigated long term evolution of Sea Surface Temperature (SST) before, during and after the Mid-Pleistocene Transition (MPT) on the Iberian Margin, a key location to understand major past climatic and oceanographic changes, using sediments from Site U1385 "Shackleton site" (recovered during IODP Expedition 339). The MPT is a critical period in which low-amplitude and high-frequency obliquity-forced glacial-interglacial cyclicity (~41ky) shifted to higher amplitude and lower frequency cycles (~100ky). Our 1.5 Ma record shows a clear and strong linkage between Iberian Margin SST and insolation forcing, ultimately controlled by the Earth\'s orbital parameters. The prominent cooling detected around 900 ka in SW Iberian Margin could be related with the onset of the MPT (900-650 ka) in this region. After the MPT, glaciations and deglaciations are longer and more intense while glacial/ interglacial transitions became fairly abrupt. The comparison of Iberian Margin records with paleoclimate data from multiple North Atlantic locations allows the identification of four sea surface circulation modes, under different glacial boundary conditions, which were mainly controlled by the latitudinal position of the subpolar front across the last 1 Ma. Major changes in surface and deep-water circulation occurred at approximately 650 ka, at the end of the MPT, related to the final establishment of the quasi-periodic 100 ky cycles.

ID: 02218, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

The Warmest Interglacials (MIS 5e and MIS 19) over the last 1Ma in SW Iberian Margin

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Climate has changed significantly along the last decades, affecting ecosystems and population. Natural events and human activities are believed to contribute to this trend. Differentiating natural from anthropogenic forcing on the climate record is one of the major challenges for climate scientists, and it is of key importance to estimate future climate predictions. Comparing the Holocene to a large set of older interglacial periods allows us to improve our understanding of natural climate variability, and therefore, to disentangle the contribution of natural and anthropogenic forcings to the present-day interglacial. In order to better understand the climatic and productivity conditions during past interglacials we are studying Marine Isotope Stage 19 and 11 and 5e, in the recently collected SW Iberian margin sequence of

Site U1385, the Shackleton Site, from IODP Expedition 339. In this study we present records of past sea surface temperature (based on $U^{k'}_{37}$-SST), paleo-productivity (from total alkenone and total organic carbon content), and continental input (terrigenous biomarkers) reconstructions at orbital, millennial and sub-millennial scales. Interglacials occurring at around 780 ka (MIS 19) and 420 ka (MIS 11) are, in terms of orbital configuration, the closest analogues to the present interglacial. However, in terms of temperature, MIS11 shows similar temperatures to the present interglacial while MIS 19 and MIS 5e were the warmest interglacials of the last 1 Ma on the Iberian Margin. This work aims to shed light on interglacial climate evolution patterns to provide crucial information on the dynamics of the ongoing climate. The results also, show warmest conditions during the oldest interglacials, but similar ocean primary productivity pattern during past and present interglacials.

ID: 01508, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Spatangoids ichnofabrics at site U1475; a key to interpret paleoenvironmental conditions

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Site U1475, located on the southwestern flank of Agulhas Plateau, near the sub-tropical front, shows a complete and continuous section, span the interval through the last 7 million years. This extraordinary contourite record provides the opportunity to approach detailed analysis of the ocean-atmosphere dynamics, including high-resolution climate reconstructions of the Agulhas Return Current and connections with the Subtropical Front, productivity, and deep-water circulation. Variably proxies can be applied to interpret changes in associated paleoenvironmental conditions, being ichnological data of special interest in this current related deposits based on the narrow relationship between limiting factors and behavior of tracemakers.

Previous sedimentological analysis conducted onboard revealed that bioturbation is widespread throughout the sequence of Site U1475, mainly characterized by centimeter-scale diffused mottling, as well as common discrete burrows (*Planolites*). Preliminary detailed ichnological analysis shows the presence of well-developed spatangoid-produced ichnofabrics. This ichnofabric is characterized by intense bioturbation dominated, near exclusively, by spatangoid activity, consisting of the ichnogenera *Bichordites* and/or *Scolicia* (large meniscate backfill burrows showing a single central core, drainage tube, or two parallel canals at the base of the structures, double drainage tube, respectively). Both ichnogenera are related with particular paleoenvironmental conditions, including preference of full-marine environments, coarse silty to fine sandy sediments, relatively high energy conditions, high sedimentation rates, quantity and quality of food on the sea floor or in shallow tiers near the surface, as well as oxygenated environments. According to this a detailed study of the distribution of this ichnofabric thought the Site U1475 will be very informative to assessing changes in the ocean-atmosphere dynamics and the involved phenomena.

ID: 01509, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Integrative analysis of ichnological and physical properties data at site U1475: assessing paleoenvironmental changes during the Messinian at the Aguhlas Plateau region

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During the Messinian took place marked major oceanographic events including synchronous Antarctic ice-sheet expansion and Mediterranean Sea partial and/or almost complete evaporation. Despite devoted research it remain unclear how these events affected to the global Thermohaline Circulation. Site U1475 was drilled during recent IODP Exp. 361 “Southern Africa Climates” on the southwestern flank of Agulhas Plateau, and preserved a complete Messinian sequence. This is a unique location in order to study variations in Indian-Atlantic Ocean gateway linked with high-latitude climate dynamics by deep water masses and atmospheric teleconnections at different scales.

Here we present preliminary results of the integrative analysis of ichnological and physical properties data conducted on Messinian sediments from Site U1475, of the IODP Expedition 361, located on the southwestern flank of the Agulhas Plateau. Trace fossil assemblage reveals relatively poor diverse, mainly consisting of *Planolites* and *Thalassinoides*, and occasionally *Palaeophycus* and *Scolicia*/*Bichordites*. However, ichnofabric analysis shows not a uniform distribution, but significant differences from bottom to top of the studied interval, with variations in the mottled appearance as well as in the abundance of discrete traces. Physical Properties onboard obtained data, especially color reflectance parameters a* and L*, as well as NGR shows certain correlation with ichnofabric especially at 6.0 Ma when marked Antarctic ice-sheet expansion took place.

The conducted integrative analysis reveals as a significant tool to interpret fluctuations of a variable range in the paleoenvironmental conditions during the Messinian at the Aguhlas Plateau, affecting physical properties and inducing changes in the macrobenthic tracemaker community.

ID: 02340, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Understanding the links between functional traits and palaeoecological processes in lake Arcellinida (testate lobose amoebae): the 'ECOTRAIT' Project

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There has been an unprecedented growth in recent years in the measurement of functional traits (FT) in many biological groups, particularly plants. These are measured characteristics that define species in terms of their ecological roles, i.e. how they interact with the environment and with other species. Traits-based approaches have, however, been under-utilized in palaeoecological studies, as many biological groups are limited by issues of poor preservation and incomplete records. There is considerable potential to apply traits-based approaches to the subfossil remains of shell-forming micro-organisms like testate amoebae that are abundant and diverse, and whose short generation times make it possible to achieve high temporal resolution. This has been highlighted in recent work with peatland testate amoebae, which has shown that traits can be used to reconstruct hydrological changes independently of species data. In this paper we describe the 'ECOTRAIT' project, an EU-funded project that is employing interdisciplinary methodologies to explore the utility of trait-based approaches in lacustrine testate amoebae (Arcellinida). Specific project objectives include: to examine the character and causes of FT variability in modern and palaeo-limnological settings; to develop new approaches to aid in trait delimitation; to apply genetic sequencing techniques to assess whether variations in shell morphology of select 'morphospecies' are a response to environment (i.e. that the 'variants' are ecophenotypes and not different species); and to evaluate the significance of trait-based approaches for understanding temporal changes in species composition. In this paper we review the methodologies that can applied to delimit FT and present preliminary data from a core from a eutrophic pond in Norfolk, UK. This record is characterised by a number of perturbations which are well constrained by numerous proxies (macrophytes, diatoms, invertebrates, testate amoebae species data), thus providing an important test site to examine the utility of FT for understanding ecological change.

ID: 01648, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Climate Change across the northern boundary of the Sahara: A review of the Quaternary in Tunisia

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Tunisia lies in central North Africa, extending from ~37oN on the Mediterranean coast to ~30oN at its southernmost limit. Climatologically, Tunisia straddles the transition from the Mediterranean zone in the north and the Saharan zone in the south, reflected in a rainfall trend from 1534 mm yr-1 in Ayn ad Darahim in the northwest to ~5 mm yr-1 in the southernmost region. Meridional changes in the boundary between mid- and high latitude cells will alter the location and gradient of the precipitation transition in Tunisia, and therefore be strongly expressed in regional rainfall changes. Moreover, increased (decreased) thermal gradient across the boundary will drive increased (decreased) atmospheric pressure gradient and therefore stronger (weaker) westerlies. As these westerlies transport significant moisture from the Atlantic, this would also alter the spatial distribution of precipitation in Tunisia. In contrast, the physiography of the eastern Atlas mountains limits the freedom of precipitation distribution to vary. Overall, Tunisia provides an exceptional laboratory in which atmospheric moisture transport at the mid-latitude transition can be studied through time. Despite this, the literature describing palaeoclimate changes in

Tunisia is sparse relative to similar-area regions of southern Europe, reflecting the striking under-representation of the larger North African continental region in Quaternary Science. This poster sumamrises out ongoing efforts to review the state of knowledge concerning the Quaternary of Tunisia, focusing on extent to which past changes in the amount and distribution of rainfall can be elucidated. We cordially invite discussion and suggestions for further literature we can exploit from those attending the OSM.

ID: 01564, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Global changes during MCA and LIA: From temperature to hydroclimate

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The Medieval Climate Anomaly (MCA; ca. 950-1250) and the Little Ice Age (LIA; ca. 1450-1850) were periods characterized by a different climate in several regions. External forcing, and particularly volcanic eruptions and solar activity, contributed to these different conditions. The larger amount of volcanic eruptions during LIA and the increased solar activity during MCA led in most regions to higher temperatures during MCA and lower temperatures during LIA. In general, there is a good agreement regarding these results, both in proxy-based reconstructions and model simulations. Hydroclimate responses to external forcing are less clear and internal variability plays a more relevant role in them. Nevertheless, some reconstructions suggest that various regions had an opposite behavior in MCA and LIA with regard to hydrological variables. This behavior could indicate that external forcing was also an important factor in the definition of the last millennium hydroclimate. Two ensembles of simulations from two different models (ECHO-G and CESM-LME) have been considered to assess the influence of external forcing on hydroclimate. The response of temperature, sea level pressure, surface wind, precipitation, and soil moisture to changes in external forcing has been analysed. The results from these simulations show that the external forcing could have an impact on hydroclimate through changes in atmospheric dynamics. In particular, variations in forcing could be related to displacements of Intertropical Convergence Zone (ITCZ) and expansions and contractions of Hadley Cell. A pattern of hydroclimatic response have been obtained, with areas more and less influenced by external forcing. These regions of sensitivity to external forcing vary between models and to a lesser degree between simulations of a given model. Despite these differences, a larger impact of external forcing is in general observed in those latitudes more affected by dynamical changes.

ID: 01576, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Late Holocene landscape development in Southwestern Siberia and Northwestern Mongolia: climate, vegetation and humans.

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The serious socioeconomically problems for arid and semi-arid regions are desertification and land degradation due to both climatic changes and human impact. The most drastic changes have been recorded in the mountain areas with high biodiversity and high concentration of economically important resources. The area located on the border of several climatic zones is the important object for study of late Holocene palaeoenvironment development. Our study has an overarching goal to test the hypothesis whether recent desertification and land degradation processes of the Southwestern Siberia and Northwestern Mongolia are (i) primarily influenced by the anthropogenic pressure on the landscapes (e.g. overgrazing, intensive wood cutting, agricultural activities, construction works etc.), or (ii) reflecting the natural trends of climate dynamics, or (iii) driven by the combination of different factors. The answer on these questions requires detailed local and regional-scale environmental and climatic reconstruction using various environmental archives. The best research objects to fill the gap in the knowledge of the linkage between changes in climate and in human societies are small lakes, which store continuous records of environmental changes mostly for few of millennia, sometimes for the whole Holocene, and rarely for longer time.

ID: 01331, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Climatic and anthropogenic drivers of past ecological dyanmics in Lake Montcortes (Iberian Peninsula)

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Lakes with varved sediments are especially well suited for high resolution paleoecological reconstruction because they assure accurate time control. Multi-proxy studies at high resolution provide opportunities to examine frequency and magnitude of abrupt events in response to either climatic change or human impact. Also, these data could be used to reconstruct the past by comparison with historical records and using instrumental data to carry out quantitative paleoclimatic reconstruction. Here we present a study aimed to assess climatic variability of the last 500 years and carry out a quantitative paleoclimatic reconstruction. To do so, we chose Montcortès Lake (Southern Central Pyrenees, Spain) which has a continuous varved record that allows high resolution time control. The selected time frame covers the transition from the Little Ice Age to the industrial era, where climate variability also responds to anthropic origin and instrumental climatic data are available. We focus on understanding how sedimentation processes work related to climate and environmental conditions, by means of an exhaustive monitoring of the lake and using traps to collect sedimentary and modern analogs for pollen and diatoms. To assess the climatic variability, we carry out highest resolution paleoclimatic reconstruction achieved so far in the record using pollen and diatoms. Biological multi-proxy data covering the last 80 years will be calibrated with instrumental data to extract transfer function and quantitatively reconstruct the climate. This contribution will help to propose possible scenarios and responses of the ecological communities to current climate change as well as to assess possible changes in the lake's behavior affecting water quality under the influence of global warming. The data obtained in this study will be used to feed data bases to validate climatic change modeling.

ID: 01391, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Holocene vegetation dynamics in the Apakará summit of the neotropical Guayana Highlands

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The Guayana Highlands (GH) are natural laboratories to study the influence of natural environmental drivers on the ecology and evolution of the neotropical biota. The GH flat summits have been characterized by fairly constant vegetation patterns during the Holocene, with the exception of a few sites close to altitudinal ecotones. In this paper, we report a new pollen record from the Aparaká summit showing two significant vegetation shifts, one from *Myrica* forests to tepuian meadows (5340 cal y BP) and the other from these open communities to *Chimantaea* shrublands (2720 cal y BP). These changes are analyzed in terms of potential forcing factors such as regional climate changes, fire and autogenic successional processes. The first shift occurred shortly after the Holocene Thermal Maximum (HTM) and the onset of a cooling and drying trend. A significant charcoal peak was coeval with this change suggesting some potential influence of fire of unknown origin. The shift from a shallow lake to a bog suggests that autogenic processes related to lake infilling might have also been involved. The second vegetation shift took place during a phase of increased precipitation variability due to an intensification of El Niño-Southern Oscillation (ENSO). The absence of charcoal peaks and of local environmental changes suggests that climate was the prevalent driver in this case. The establishment of present-day *Chimantaea* shrublands started at the end of this phase and began with a sharp *Chimantaea* peak coinciding with a similar charcoal acme (2300 cal y BP). Another, less significant, charcoal peak was recorded during the Little Ice Age (LIA), coinciding with a significant precipitation decline. These results support the idea of relevant ecological changes in the GH during the Holocene, the apparent vegetation constancy recorded in other GH summits could be due to site insensitivity.

ID: 01395, 01.- Open Session on past global changes, (Poster)

Seasonal patterns of pollen sedimentation in a Pyrenean varved lake (Montcortès): applications to high-resolution paleoecology

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Lakes with varved sediments are especially well suited for paleoecological reconstruction from annual to seasonal resolution. The interpretative power of these reconstructions relies on the availability of modern analogs with the same resolution. In this paper, we study the seasonal pollen sedimentation of a varved lake from the Central Pyrenees (Lake Montcortès) as a modern analog for the high-resolution reconstruction of Late Holocene vegetation and landscape dynamics. Seasonal samples were obtained from sediment traps that were submerged near the maximum water depth for a two-year period (from the Fall of 2013 to the Fall of 2015). Seasonal pollen sedimentation was compared with meteorological variables from a nearby weather station. Bulk pollen sedimentation, dominated by *Pinus* and *Quercus*, followed a clear seasonal pattern that peaked during the spring/summer (SS), coinciding with maximum temperature and precipitation, minimum relative humidity and moderate winds from the SSE. Pollen sedimentation lags (PSL) were observed for most pollen types as significant amounts of pollen were found in the traps out of their respective flowering seasons. Two pollen assemblages were clearly differentiated by their taxonomic composition corresponding to spring/summer and fall-winter (FW). This pattern is consistent with the existing interpretation of the sedimentary varves: specifically, that the varves are formed by two-layer couplets that represent the same seasonality. It is concluded that pollen sedimentation in Lake Montcortès exhibits a strong seasonal signal in the quantity of pollen, the taxonomic composition of the pollen and the relationships of the pollen to meteorological variables. Thus, varved sediments provide a powerful tool for paleoecological reconstruction at seasonal resolutions. This method could be useful not only for unraveling paleoenvironmental trends but also for identifying annual layers and therefore, dating the sediments, even in the absence of evident sedimentary laminations. A satisfactory explanation of PSL will require more studies that examine internal lake dynamics and pollen production/dispersal patterns. Project MONTCORTES-500 (CGL2012-33665).

ID: 01394, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Vegetation changes and human impact in the Azores Islands during the last ~700 years: the Lake Azul pollen record

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The Azores archipelago has provided significant clues to the ecological, biogeographic and evolutionary knowledge of oceanic islands. Palaeoecological records are comparatively scarce, but they can provide relevant information on these subjects. We report the palynological reconstruction of the vegetation and environmental dynamics of the São Miguel Island lowlands before and after human settlement using the sediments of Lake Azul. The landscape was dominated by dense laurisilvas of *Juniperus brevifolia* and *Morella faya* from AD 1280 to the official European establishment (AD 1449). After this date, the original forests were replaced by a complex of *Erica azorica/Myrsine africana* forests/shrublands and grassy meadows, which remained until AD 1800. Extractive forestry, cereal cultivation (rye, maize, wheat) and animal husbandry progressed until another extensive deforestation (AD 1774), followed by the large-scale introduction (AD 1845) of the exotic forest species *Cryptomeria japonica* and *Pinus pinaster*, which shaped the present-day landscape. Fire was a significant driver in these vegetation changes. The lake level experienced a progressive rise during the time interval studied, suggesting a general trend from drier to wetter climate, reaching a maximum by AD 1778-1852, followed by a hydrological decline due to a combination of climatic and anthropogenic drivers. Our pollen record suggests that the São Miguel lowlands were already settled by humans by AD 1287, approximately 160 years prior to the official historically documented occupation of the archipelago. The results of this study are compared with the few palynological records available from other Azores islands (Pico and Flores). Projects PALEONAO (CGL2010-15767) and RapidNAO (CGL2013-40608-R).

ID: 01387, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

The effects of the eruption of the Laki volcano in Transylvania

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This lecture is part of a larger project dealing with the environmental history of South-East Europe in the 18th and 19th century. It will discuss the impact of natural and meteorological phenomena on a multicultural society in a borderland of the Hapsburg Empire.

My project will start from the work hypothesis that Transylvania\'s various ethnic groups perceived natural disasters as divine punishments for their sins, that Transylvania’s ethnic, cultural and religious diversity – which also involves a diversity of mentalities –

generated various interpretations of and solutions for disasters.

The lecture will assess this topic from two perspectives: that of contemporary interpretations and that of contemporary intervention measures. The population\'s perceptions at the time were permeated by religious concepts, such as divine punishment, while the official perception had only started to be influenced by the rational, enlightened interpretation of the transition period to modernity.

The eruption of Laki in 1783 triggered a sudden and serious climate change. The ensuing drop in temperature caused a massive decrease in agricultural production which, in turn, lead to famine in the following years. The effects of this catastrophe in this part of Europe have not yet been thoroughly researched thus far. A great number of chronicles, travel books, memoirs, official documents in Central and Western Europe mention low temperatures, price hikes, poverty and famine.

Based on archival sources and on anthropological research, this research will contribute to the development of historiography on the Habsburg agrarian policy in Transylvania by comparing the population\'s nutrition in civil and military zones, will analyze the behavior patterns of various population categories following the Viennese Court\'s reformative policies on nutrition and food.

ID: 02117, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Climate Trends Changing Threads in the Prehistoric Pannonian Plain

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The Pannonian Plain is a region of central Europe enclosed within the Alps on the West and the Carpathian Mountains on the East, and extending from the southern borders of Serbia in the South to northern Hungary in the North. The current work represents an interdisciplinary case study incorporating archaeological analysis and climate modelling results for the evaluation of the effects of past climate change on the development of the prehistoric textile production in the Pannonian Plain. Period of interest, beginning with the middle Eneolithic and ending with the early Bronze Age falls roughly between the late 7th and the end of the 5th millennium BP. Study of technological trends and changes that occurred in the manufacturing traditions of the area focused on fibre processing and production, through the distinction of fibres and their reliance on cultural and environmental contexts. Functionality analysis of spindle-whorls was used in order to gain information on the exploited raw materials and on the final manufacturing products. Subsequently, the results of the archaeological investigations were used together with the oucomes of a climate simulation, in order to propose plausible interpretation of altering technologies. The analysis was additionally supported by multi-proxy climate reconstructions. Results revealed that climate changes might have influenced the observed dynamics of the textile production traditions on a significant level. In particular the analysis showed that the transitional period between the middle Eneolithic and the Early Bronze age was characterized by a higher diversification of the production, possibly indicating the necessity of the populations inhabiting the area to adapt to more challenging climatic conditions.

ID: 02042, 01.- Open Session on past global changes, (Poster)

Added Value of an RCM for Paleoclimate Studies

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In the recent years the application of high resolution climate models for paleoclimate studies has become more frequent. Since the details added by high-resolution models can help in the interpretation of proxy data that are often influenced by processes taking place on smaller scales than the ones resolved in coarser models, they are supposed to be a particularly suitable tool for paleoclimate research. In this study the possible added value of a Regional Climate Model (RCM) for the simulation of past climate changes that characterized Europe during the Mid-to-late Holocene is estimated. For this purpose the results of an RCM and two GCMs at different spatial resolution are compared against the pollen-based reconstructions of Mauri et al. 2015. The analyses showed that the RCM\'s results are in better agreement with the values of the reconstructions only for specific variables, in particular for those variables that are highly influenced by surface processes, such as near surface temperature. Conversely, for variables such as precipitation, mainly constrained by the large scale circulation, the GCMs produced better results.

ID: 02067, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Interplay between sea ice extent in the Nordic Seas and abrupt climate change in Greenland over Dansgaard-Oeschger cycles

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Changes in sea ice extent in the Nordic Seas likely played a crucial role in controlling ocean circulation and climate changes of the Dansgaard-Oeschger (D-O) cycles during the last glacial. To investigate the role of sea ice for abrupt Greenland climate change, we produced a sea ice record from the Norwegian Sea Core MD99-2284 at decadal resolution, covering four D-O cycles at 32–40 ka. This record is based on the sea ice diatom biomarker IP_{25}, open-water phytoplankton biomarker dinosterol and semi-quantitative phytoplankton-IP_{25} (PIP_{25}) sea ice estimates. Two tephra layers corroborate the tuning-based age model and help constraining the GS9/GI8 transition in our sedimentary proxy records in comparison to that in ice core records. For cold stadials we find extremely low fluxes of total organic carbon, dinosterol and IP_{25}, which points to a general absence of open-water phytoplankton and ice algae production under near-permanent sea ice. For the interstadials, all biomarker fluxes are strongly enhanced, reflecting a productive sea ice edge situation and implying largely open-ocean conditions for the eastern Nordic Seas. Our results suggest that the rapid stadial-interstadial sea-ice decline may have induced the abrupt northward shift in Greenland precipitation moisture source as recorded in ice cores. Moreover, we find that the sea ice retreat systematically preceded deep mixing in the Nordic Seas, acting as precursor of oceanic reorganizations that probably generated much of the atmospheric warming of the Greenland D-O events. We thus conclude that rapid changes in sea ice extent in the Nordic Seas amplified oceanic reorganizations and were a key factor in the timing and amplitude of the abrupt Greenland climate changes over D-O cycles.

ID: 01858, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Environmental, historical and archaeological evidence draw the history of Sicily during the last 2000 years

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Human activity is attested in Sicily since prehistoric times. The history of the island has been determined by the presence and political domination of many foreign populations and powers, such as Greek, Roman, Arabic, or Norman. Moreover, Sicily is the largest island of the Mediterranean and is well known for its fertile soil. Its central position and natural resources were considered a crucial strategic asset in the entire Mediterranean.The interrelationship between natural and human history is here examined over the last 2000 years. The multidisciplinary environmental data available for Lago di Pergusa (the only natural inland lake of the island) has been closely compared with the existing archaeological and textual evidence for the socio-economic developments. Isotope and pollen data available for the lake evidence two humid periods (ca. 450-750 AD and ca. 1400-1800 AD) and a dry one (ca. 1100-1350 AD) similarly to what is found in other palaeoclimate datasets from the Central Mediterranean. Historical and archaeological sources indicate that in the two wet periods (late antique-Byzantine times and the late medieval/early modern periods) an impressive demographic and economic expansion occurred. Our data suggest that this progress was due to intense agricultural exploitation of the Sicilian landscape. Isotope data show a short period of aridity, recorded at around 750 AD: palynological data show a decrease in synanthropic taxa and a recovery of arboreal vegetation highlighting a climatic change and the consequence socio-economic decline. The arid event may help to explain the collapse of Byzantine society and the following Arab conquest of Sicily in AD 827. Thus, our parallel approach helps describing local and regional climate-induced phenomena that took place in the past and their consequences for the history of Sicily.

ID: 01852, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

A high-resolution pollen and macrofossil sequence and climatic reconstruction of the Eemian Interglacial (MIS 5e) from northern Finland

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BACKGROUND. The Eemian Interglacial period (Marine Isotope Stage 5e; ca. 115–130 kyr ago) has been subject to an intense scrutiny, as the most recent case of widespread and significant climatic warming in the geological record. However, despite decades of work on the Eemian, little data has been available from the high northern latitudes, due to glacial erosion during the last ice age.

SITE AND METHODS. We present a unique, high-resolution lake-sediment record of the entire Eemian from northern Finland (67°48′N 29°18′E). The 12-metre Eemian sequence was analysed at a high resolution for pollen (217 samples), supplemented by data on plant macrofossils, conifer stomata, and non-pollen palynomorphs. We reconstruct July and January mean temperatures (T_{jul} and T_{jan}) based on the pollen samples, using a multi-method ensemble approach involving multivariate transfer functions, the modern analogue technique, and regression-tree-based machine-learning techniques. A tentative absolute chronology for the sequence is derived by aligning the T_{jul} reconstruction with a sea-surface temperature (SST) reconstruction from a Norwegian Sea sediment core.

RESULTS AND DISCUSSION. The fossil record and climatic reconstruction indicate the presence of a mixed boreal forest, with reconstructed T_{jul} ca. 2–3 °C above present, for much of the Eemian. The T_{jan} trend is clearly decoupled from T_{jul}, with T_{jan} rising during the mid and late Eemian while T_{jul} falls, suggesting decreased seasonality towards the late Eemian. This result is corroborated by indicators of mild winter conditions in diatom data from the same sequence. The pollen and stomata record confirm the local presence of *Larix*, absent from Holocene Fennoscandia. The general warmth of the Eemian is intersected by two distinct periods of climatic instability. These cooling events have apparent counterparts in North Atlantic SST proxies as well as proxies for North Atlantic Deep Water formation.

ID: 02136, 01.- Open Session on past global changes, (Poster)

Climatic implications of Quaternary fluvial records correlated through NE Iberian Peninsula

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The available chronological information from Pleistocene fluvial morphosedimentary records (terraces and tufa) in NE Spain has increased greatly over last decade. As a consequence, it is possible to set up a regional palaeoenvironmental sequence based on long-term climate fluctuations (i.e., warm versus cold) that can be compared with the global Pleistocene climate variability.

Fluvial terrace archives in the south-central Pyrenees and north-east Ebro basin supply consistent evidence of cold conditions. Several cold periods have been dated approximately at 1276 ka, 817 ka, 401 ka, 263 (MIS8), 170-160 ka (MIS6), 95-100 ka (MIS5b), 65-60 ka (MIS4), 35-40 ka (MIS3) and 11ka (YD). It is remarkable that the occurrence of the LGM is not evident in glaciated headwater valleys but it has been recognized in fluvial terrace systems of non-glaciated valleys in periglacial conditions. As for fluvial tufa archives, these are extraordinarily well developed in the Iberian Ranges and provide strong evidence of warm conditions. Maximum frequency of tufa deposition has been recognized at 120 ka (MIS-5e), 105 ka (MIS-5c) and 85 ka (~ MIS-5a). Other tufa deposition phases are found at 345 ka (MIS-10), 284 ka (MIS-9a), 206 ka (MIS-7) and 154 ka (MIS-6).

The resulting regional Pleistocene palaeoclimatic “cold-warm zipper” works well, but it shows two noticeable issues: i) the tooth corresponding to LGM (MIS2) is basically missing, and ii) the cold and warm teeth during MIS6 seem opposite. These regional palaeoclimatic disagreements could be attributed to the geographic location of the Iberian Peninsula relative to the North Atlantic atmospheric circulation system, which is strongly affected by latitudinal drifts of the polar front (PF).

ID: 01612, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Palaeohydrological fluctuations for the last 25000 years as recorded in fluvial sediments of the Guadiana River (central Spain).

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The sedimentary record of the Guadiana River, in the surroundings of Las Tablas de Daimiel wetland (central Spain), for the last 25000 years can be split in two main sequences. The lower one, ca. 25ka-9ka cal BP, is built up by aggradative sequences, composed by fine-grained siliciclastics and abundant fragments of carbonate, bounded by erosive surfaces pointing to incission episodes. The upper one, 9.5ka-present, shows an increase in chemical supply and lesser development of erosive surfaces (almost absent) together with an increase of long-lived ponded areas where fluctuations of the water table are evident. Reconstruction of water/energy fluctuations in the sedimentary systems allows to reconstruct millennial-scale palaeohydrological changes resulting from changes in the ratios of surface water supplies and evaporation.

ID: 01783, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Westerly wind variability at sub-Antarctic Macquarie Island and its link to Southern Hemisphere wind and temperature

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The position and strength of the Southern Hemisphere westerly winds is important for temperature and rainfall variability from the mid- to high-latitudes of the Southern Hemisphere. While observations since the 1950s show the winds have strengthened and shifted southwards, this period is too short to understand their natural variability, especially as stratospheric ozone depletion and rising greenhouse gases from anthropogenic activities are considered to be driving these changes. Here we present a multi-decadal Southern Hemisphere westerly wind strength reconstruction for the last 1600 years from sub-Antarctic Macquarie Island (54°S, 158°E). The reconstruction is based on the application of a diatom-sea spray transfer function. This transfer function was used to assess changes in sea spray inputs to a small, exposed lake on the western edge of the Macquarie Island plateau, where the amount of sea spray is directly related to the strength of the westerlies. In contrast to previous estimates of past westerly wind variability, our record is situated in the core region of the wind belt. It therefore allows a more direct interpretation of westerly wind behaviour not dependent on potentially unstable teleconnections. The reconstruction shows close agreement with the southern South America temperature reconstruction (Past Global Changes) for much of the last Millennium. Together with spatial correlation maps from instrumental and reanalysis data, this demonstrates that changes recorded at Macquarie Island are representative of wind and temperature across the mid- to high-latitudes of the Southern Hemisphere.

ID: 01784, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Late Glacial to present Southern Hemisphere westerly wind variability over the Southern Ocean and relationships with sea ice, temperature and carbon dioxide

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The Southern Ocean currently sequesters about 40% of the earth's anthropogenic CO_2. The main driver of this sink is the Southern Hemisphere westerly winds (SHW), which regulate ocean circulation and sea ice distribution, and controls the upwelling of dissolved inorganic carbon-rich (CO_2-saturated) water to Antarctic surface waters. These processes modulate the net uptake of CO_2 by the ocean from the atmosphere, which means that any changes to their strength or position influences whether the Southern Ocean acts as a net source or sink for atmospheric CO_2. Despite the importance of the SHW to global climate, current understanding and modelling of the past, current and future behaviour of the winds (and CO_2 sink) is limited by short instrumental records of the atmosphere, surface ocean and sea ice, and the lack of agreement between palaeoclimate records of past wind behaviour. Here we present a SHW strength reconstruction from sub-Antarctic Macquarie Island (54°S, 158°E) for the last 12,300 years based on three independent biological and geochemical proxies. Diatoms are used as an indicator for sea spray, while XRF-based estimates of titanium and a high-resolution lithogenic hyperspectral reflectance index (850-900 nm) are used as indicators for windblown material. All of the proxies are consistent with each other and show large variations in past wind strength, especially in the late Glacial and early Holocene. When compared with Antarctic and Southern Ocean palaeoclimate records, we find that millennial-scale variability of SHW strength is closely linked to Antarctic sea ice extent and temperature, but a disconnect with CO_2 is visible in the mid Holocene. Better constraints on the relationships between the SHW, sea ice and regional temperature over multiple timescales are required to model the current behaviour of the Southern Ocean and its future capacity to absorb anthropogenic CO_2.

ID: 01320, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

Disturbance events from Sumava, Czech Republic correlated with historic bark beetle outbrakes

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Central European montane spruce forests are a niche environment, situated outside of their natural boreal range they are sensitive to climate stressors and disturbance dynamics. Recent outbreaks of Spruce bark beetle (Ips typographus) indicate that these pathogens are a major influence in the disturbance history of the region. Dendroecological records suggest that disturbance frequency and intensity of Spruce bark beetle has increased in recent decades (Svoboda et al., 2011). My study aims firstly to correlate records from bark beetles (Scolytinae) with dendrochronological data to quantify disturbance history, while secondly to generate Holocene environmental and landscape reconstructions from sub-fossil beetle assemblages from the Šumava region in Czech Republic and the High Tatra Mountains in Slovakia. Both the Šumava region and the High Tatras have a long history of dendrology studies and many disturbance events have been dated. By linking paleoecological data (pollen, charcoal, diatoms, botanical macro remains and insect remains) from several regional lakes and forest hollows to the existing dendrochronological data we can extend our current knowledge on disturbance history beyond the temporal capability of dendroecology alone. Cores from lakes and forest hollows have been scanned for bark beetle remains and compared to the pollen and dendrochronological record. New methodology on retrieving bark beetle remains from lake sediments has been tested. Several species of bark beetles have been identified, among which the primary bark beetle Pityogenes chalcographus is observed to respond to the 8.2 ka event. Consecutive results show that remains of Ips typographus are present in the record of one of the sites and that correlation to the dendrochronological record is possible. The results from two sites in the Šumava region will be discussed in this presentation.

ID: 02296, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Drivers and implications of a late-Holocene palaeoflood record from Brotherswater, northwest England

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The scarcity of long-term hydrological data is a barrier to reliably determining trajectories of flood frequency and intensity in a warmer world. Lake sediments are increasingly used to reconstruct highly-resolved datasets of past floods but generating quantitative palaeohydrological data to augment flood frequency analysis remains a challenge. Working at Brotherswater, a small upland lake in northwest England, we integrate hydrological and sedimentological monitoring with long (1500-year) sediment sequences that contain coarse-grained laminations inferred as palaeoflood deposits as a potential pathway towards this goal. The sequence of analytical steps followed are presented:

1. A recent extreme event - Storm Desmond, December 2015 - has been exploited by analysing material deposited in sediment traps during the flood and implementing a post-event monitoring programme to trace the propagation of its sedimentological signature into the lake record. This represents a unique opportunity to address the question: 'how does a flood become a palaeoflood'?
2. Integrating a 16-month sediment trap deployment (CE 2013-2014) with the recent (CE 1962 – 2014) depositional record has enabled basin controls (e.g., autogenic and allogenic sedimentation processes) to be discriminated and hydrological thresholds to be estimated.
3. Multi-proxy analysis of a series of sediment cores has produced a 1500-year palaeoflood series, the longest lacustrine record extracted in the UK to date. It is complicated by notable shifts in sediment supply driven by anthropogenic activity but outlier analysis of non-stationary time series reveals a tendency for events to cluster into multi-decadal flood-rich/flood-poor periods. The challenges when inferring climatic forcings of these phases highlights the need for more research in this area. Finally, a proxy:discharge comparison exploiting multiple archives is used to perform an augmented flood frequency analysis, providing more reliable context to the spate of major 21st century floods

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ID: 02305, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

High-altitude peatland records of environmental changes in the central Andes over the last 3000 years

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High-altitude cushion peatlands are versatile archives for high-resolution palaeoenvironmental studies, due to their high accumulation rates, range of proxies and sensitivity to climatic and/or human-induced changes. Especially within the central Andes, the knowledge about climate conditions during the Holocene is limited. In this study, we present the environmental and climatic history for the last 3000 years of Cerro Tuzgle peatland (CTP), located in the dry Puna of NW Argentina, based on a multi-proxy approach. X-ray fluorescence (XRF), stable isotope and element content analyses (d13C, d15N, TN and TOC) were conducted to analyse the inorganic geochemistry throughout the sequence, revealing changes in the peatlands' past redox conditions. Pollen assemblages give an insight into substantial environmental changes on a regional scale. The palaeoclimate varied significantly during the last 3000 years. The results reflect prominent late Holocene climate anomalies and provide evidence that in situ moisture changes were coupled to the migration of the Intertropical Convergence Zone (ITCZ). A period of sustained dry conditions prevailed from around 150 BC to around AD 150. A more humid phase dominated between AD 200 and AD 550. Afterwards, the climate was characterised by changes between drier and wetter conditions, with droughts at around AD 650-800 and AD 1000-1100. A comparison with the results of further investigated high-altitude peatlands in NW Argentina, as well as in S Peru, shows strong similarities. In the past, Andean peatlands recovered from climatic perturbations. Nowadays, many of these fragile ecosystems are heavily degraded by human interventions.

ID: 02241, 06.- Before and after - climate contrasts across the MPT, (Poster)

The variation of the carbonate production during the MPT: Test of the past seasonality and inter-annual variability of water column temperatures using the new insights into Mg/Ca ratios of single foraminifera shells of planktonic species G. ruber by LA-ICPMS

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Investigations in the reef history over the last 1.3Myrs show variations in the rate shallow shelf carbonate production. Which occur approximately during one of the major unexplained alterations in the climate system, the Mid-Pleistocene Transition.

We test the idea that reef production may have been a response to changes in seasonality rather than mean temperature. Our hypothesis is that the range of Mg/Ca temperatures obtained from a series of single specimens by LA-ICPMS of similar age range potentially records seasonal changes in sea surface temperatures.

Our results enable to reconstruct the range of calcification temperatures derived from Mg/Ca ratios for two morphotypes of *Globigerinoides ruber* (sensus stricto: ss and sensus lacto: sl) who live at different water depths. Specimens were sampled from specific time intervals of sediment core MD06-3018 offshore New Caledonia (2470m). Previous Mg/Ca results measurements (ICP-AES) for this sediment core showed that average glacial SST ranged around 23°C and average interglacial SST ranged around 25°C over the past 1.3Ma. We have analysed 30 specimens (15 ss, 15 sl) per level. Statistical analysis suggests detectable changes in the average Mg/Ca range between glacials and interglacials (1,5°C ±0,5°C). Minimum SST are around 21,5°C ± 1.5°C for the LGM and the maximum is around 29,2°C ± 1.5°C for the Holocene. We provides estimates of summer and winter temperatures for the western New Caledonian margin over the last 1.8Myr from these seasonality estimates and compare results to modern day seasonal temperatures. Furthermore, our approach based the analyses of both morphotypes of *G. ruber*, enable to reconstruct past seasonality and past stratification of water mass. The range of temperature values are higher for G. *ruber* ss than sl, throughout the record about 0,7° ±0,5°C.

ID: 02178, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

The vegetation and fire history in southern Spain during the Holocene based on a high-resolution lacustrine record from the Laguna de Medina, Cádiz

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Laguna de Medina is a small shallow endorheic salt lake sensitive to climate variation in south-eastern Spain. It is situated in an evaporitic and karstic environment, resulting in a saline lake with evaporite precipitation and prone to lake level changes. Geochemical and mineralogical data of the core CO1313 as well as a reliable age model provide a strong basis as paleoclimate record up to the last 9500 years cal BP. This record has been extended within this study by investigation of the regional vegetation and fire regime trough pollen and charcoal. Today, the vegetation is dominated by Phragmites australis, Scirpus maritimus and Typha dominguensis, different vegetation patterns are observed through time, giving insights about temperature and rainfall activity. In addition, anthropogenic influences are detected by high abundances of Olea europaea and Cerealia pollen as well as increased appearance of charcoal fragments at certain times of deposition. Pollen preservation and the occurrence of pollen grains within the lacustrine sediments is very variable, nevertheless it leads to fundamental statements about past climate conditions, which will enable the connection to cultural changes of human history.

ID: 01286, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

A 125-year record of climate and chemistry variability at the Pine Island Glacier ice divide, Antarctica

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The Mount Johns (MJ) ice core (79º55\'S; 94º23\'W) was drilled near the Pine Island Glacier ice divide on the West Antarctic Ice Sheet during the 2008–2009 austral summer, to a depth of 92.26 m. The upper 45 m of the record covers approximately 125 years (1883- 2008) showing marked seasonal variability. Trace element concentrations in 2,137 samples were determined using inductively coupled plasma mass spectrometry. In this study, we reconstruct mineral dust and sea salt aerosol transport and investigate the influence of climate variables on the elemental concentrations to the MJ site. The ice core record reflects changes in emissions as well as atmospheric circulation and transport processes. Our trajectory analysis shows distinct seasonality, with strong westerly transport in the winter months and a secondary northeasterly transport in the summer. During summer months, the trajectories present slow-moving (short) transport and are more locally influenced than in other seasons. Finally, our reanalysis trace element correlations suggest that marine derived trace element concentrations are strongly influenced by sea ice concentration and sea surface temperature anomalies. The results show that seasonal elemental concentration maxima in sea-salt elements correlate well with the sea ice concentration winter maxima in the West Amundsen and Ross Seas. Lastly, we observed an increased concentration of marine aerosols when sea surface temperature decreased.

ID: 01596, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Neolithic and Bronze Age pastoralism affects mountain forest dynamics in the Swiss Alps

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Human impact has been identified as one of the major drivers of ecosystem change in recent decades. Here we link archaeological finds from the mountain pass Schnidejoch (2765 m a.s.l) with paleoecological data (i.e. fossil pollen, spore, charcoal and macrofossil analysis) from nearby Lake Iffigsee (2065 m a.s.l.) to study vertical mobility and the effect of early human impact in the Swiss Alps. At Schnidejoch, several hundred objects of mostly organic origin have appeared in a melting icefield. The oldest finds date back to 4700 BC (6650 cal. BP) and confirm that the pass was used to cross from the Rhône Valley to the Bernese Alps from this time onwards. This coincides with the appearance of cultural indicator taxa and spores of the coprophilous fungi *Sporormiella* sp. in the sediment record of lake Iffigsee. Together with archaeological finds in the Rhône valley, we interpret this as early indication of Alpine pastoralism and transhumance. Numerical analysis shows a significant correlation between microscopic charcoal and abundance of dungspores in the sediment record during this time, indicating that fire was used by Neolithic people to increase pastures at the timberline. This had a significant negative effect on the dominant forest species *Abies alba, Larix decidua* and *Pinus cembra*. Especially the decline in *Abies alba* facilitated the mass expansion of *Picea abies*, todays dominant tree species in the study area, during the Bronze Age at ca. 3500 BC (5450 cal. BP). Our results have important implications regarding baselines for natural conservation as well as future vegetation changes in response to climate warming and abandonment of marginal agricultural areas.

ID: 02343, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Holocene vegetation change in Late Quaternary fecal deposits of the Namib Desert and boundary region

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Holocene fossil faecal deposits representing mostly hyraxes and possibly also birds, provide pollen and isotope evidence of environmental change on the desert edge around Naukluft (Namibia). The study is supported by a modern pollen survey of grass and woody communities. General Holocene trends of alternating dry and wet phases can be deduced. During the interval between ca. 9 and 8 ka relatively high proportions of grass pollen suggest sub-humid conditions. However, from 8 ca Kyr BP, a general decline in grass pollen ratio and changes in isotopic records indicate the onset of dry conditions with alternating Asteraceae and Acanthaceae types. Increased *Commiphora* pollen at ca. 7 ka corresponds with evidence of regional warming. Between 6.5-6 ka, a short sub-humid spell is registered with increasing grassy conditions and lower arboreal pollen. Including *Commiphora*, *Euclea,* Capparaceae, *Salvadora*, Mimosoideae and *Searsia*, the woody pollen increases again from 6 ka onwards suggesting savanna conditions and representing the most significant change in the early to middle Holocene record. This change implies a shift from C_3 to more C_4 species and summer seasonality. A temporary decline in grass pollen ca. 5-4.3 ka indicates a relatively dry phase but woody plant pollen persisted and changed in composition to more Combretaceae that peaked at 4.5 ka. Grass pollen numbers recovered somewhat by c. 4 ka and stayed constant until 2 ka but the woody composition varied gradually. Low microscopic charcoal concentrations were found prior to 6 ka and at 3.5 ka and peak at times when grass/savanna pollen was prominent suggesting interplay between fuel cover, seasonality, moisture availability and burning. After 1 ka a weak decline in grass pollen is probably part of a noticeable drought cycle, as recorded along the Kuiseb River, in Damaraland and in Kaokoland previously.

ID: 02186, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

A fresh cut on future flood impacts: learning from the Last Interglacial

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Global warming impacts the hydrological cycle and thus affects human livelihoods. Precipitation patterns and their extremes around the world are likely to undergo substantial shifts, as illustrated by General Circulation Models. These models are run by increasing greenhouse gas forcing, whereas the other climate components are left to adjust dynamically; they thus refer to a future climate that we cannot validate. The output of General Circulation Models is then used in hydrological and impact models to simulate changes in riverine flood risk. An alternative strategy for this research is to use simulations based on past climate states that could resemble the future. The Last Interglacial period (LIG; ~125,000 years ago) seems the most appropriate analog of possible climate at year 2100 and beyond because, compared to today: it was warmer; sea level was several meters higher; ice sheets were smaller; monsoons were likely stronger. The main advantage of using LIG simulations over scenario-based General Circulation Models simulations is that we can validate LIG simulations with proxies. In this new project we will use the output from existing runs of several LIG models, as input to global hydrological models for river floods and therefore to impact models for the socio-economy. We will employ state-of-the-art large-scale models to calculate the shifts of geographic risk patterns. Notably, we will contrast the LIG climatological datasets as well as the flood hazard results against existing proxies for precipitation, river discharge and floods. The objective is to deliver to the climate community a validated picture of the flood impacts of a climate that might resemble the future.

ID: 01422, 05.- Disturbance dynamics across spatial and temporal scales: fire, wind, pathogens and post-disturbance run off as drivers of environmental change, (Poster)

EcoRe3: Resistance, Recovery and Resilience in Long-term Ecological Systems.

Alistair Seddon[1] , Lydia Cole[2] , Jesse Morris[3] , Michael-Shawn Fletcher[4] , Kathy Willis[5] 1) University of Bergen 2) Rezatec LTD 3) University of Utah 4) University of Melbourne 5) Royal Botanic Gardens, Kew * Alistair Seddon, alistair.seddon@uib.no EcoRe3 is a new PAGES working group aiming to devise a set of standardised approaches for comparing components of resilience from the palaeo-record. Resilience is a key attribute needed to ensure the persistence of Earth\'s ecosystems in the face of increasing anthropogenic stressors and climate change, but definitions of resilience, and the methods used to measure it, can differ markedly between studies due to the variety of components that can be identified. These disagreements make it difficult to compare and identify systems with more or less resilience and to plan future mitigation strategies, and to understand the underlying biotic and abiotic controls of resilience along ecological and climatological gradients. In a recent preliminary workshop, members of EcoRe3 have outlined the theoretical basis of two alternative approaches for deriving components of ecological resilience in sediment data. One approach is based on measuring resistance (the amount of change following a disturbance) and recovery rates (the speed to return to equilibrium following a disturbance) in individual proxy records. A second combines statistical modelling, present day and past information on vegetation distributions to infer probabilities of biome transitions for a given set of climate conditions. Here we present preliminary results of the first attempt at applying these concepts to empirical datasets from the palaeorecord and outline future research strategies for the working group over the next three years.

ID: 01423, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Palaeo-UV-B reconstructions in fossil-pollen chemistry: quantifying uncertainties and measuring short-term responses in Pinus spp.

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Major volcanic eruptions have been linked to increases in UV-B irradiance at the Earth\'s surface in the past, with potentially major consequences for biodiversity and ecosystem functioning. However, reconstructing past UV-B to investigate these effects remains a major challenge. UV-B absorbing compounds found within the sporopollenin of pollen exines are enriched in high UV-B environments, and variations in the concentrations of these compounds in the fossil-pollen could act as a UV-B proxy. Here, we present work aimed at tackling three challenges related to the future the development of this proxy designed for use on *Pinus* spp. pollen: (i) analytical precision; (ii) uncertainty characterisation, and (iii) understanding the temporal window of the pollen grain UV-B response.

First, we refined a methodology for pyrolysis-Gas Chromatography/ Mass Spectrometry to improve analytical precision of the measurements of UV-B absorbing compounds. Second, we designed a hierarchical model using Bayesian inference to characterise uncertainty at all stages of our analytical process to enable robust inferences to be made about both the drivers of chemical variability within modern pollen grains, and on down-core fossil-pollen reconstructions. Third, we applied these methods to a set of field experiments and to a European-scale gradient study to investigate the temporal window of the response of pollen chemistry to exposure to UV-B. Results indicate that the response of UV-B absorbing compounds is highly plastic, responding to UV-B exposure in a short window up to one month before flowering. Our work provides improvements into both methodology and fundamental understanding of the mechanisms underlying pollen chemistry techniques. We are now working to apply these techniques to investigate changes in pollen chemistry in sediments across a range of timescales.

ID: 01861, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Storm-scale variations of water isotopes in the Tropical High Andes: Using observations and modeling to improve ice core paleoclimate reconstruction

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Comprehensive understanding of the climatic controls on stable water isotopes (HD, $\delta^{18}O$) in precipitation over the tropical high Andes is fundamental to developing paleoclimatic reconstructions developed from regional ice cores. We utilize the Andean Isotope Model (AIM), an analytical tool developed from an empirically based hypothesis that $\delta^{18}O$ profiles in high elevation tropical Andean ice cores record mesoscale precipitation processes along moisture trajectories upstream of the site of snow deposition. The AIM is based on isotopic fractionation according to Rayleigh distillation theory, and utilizes climatological data from regional weather stations and satellite-based radar as inputs to simulate depth profiles of $\delta^{18}O$ variations in annual layering. Results demonstrate skill at accurately reproducing high and low frequency $\delta^{18}O$ signals and amplitudes observed in annual accumulation profiles.

As such, the AIM enables determination of the controls on near-surface $\delta^{18}O$ annual layer profiles by meteorological phenomena under modern climatic conditions; this in turn informs interpretation of the climatic conditions associated with older $\delta^{18}O$ registered prior to the instrumental era.

In this presentation, we will demonstrate how the model and complementing data collection efforts can greatly improve the sub-seasonal interpretation of isotopic signals preserved in low-latitude ice cores. Storm event precipitation amount and isotopic content measurements being collected in Peru and Bolivia by citizen scientist observers and field researchers are now being used to further refine the model and inferences on paleoclimate derived thereof. Applying the insights gained, we are utilizing AIM and annual layer data from the Quelccaya Ice Cap and other high Andean glaciers to explore the meteorological character of Little Ice Age and other Holocene climate epochs and contrast them with present-day climate.

ID: 01253, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Assessment of variability and distribution of drought over the Kievan Rus' territories during the 11-17 centuries

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In Medieval times the summer droughts caused the crop lost, wildfires, plague of locust and as result a starvation of population. An information about the extreme droughts originally compiled to the old Slavonic chronicles, e.g. the Tale of Bygone Years. The study focuses on reconstructed drought variability during the 11-17th centuries across territory of modern Ukraine. Assessment of distribution and intensity of summer droughts was done using the Palmer Drought Severity Index (PDSI) from the Old World Drought Atlas (Cook et al., 2015), which is based on tree-ring data. Verification of identified droughts was performed using the catalog of extreme phenomena, based on the Russian chronicles of 11-17th centuries (Borisenkov, Pasetsky, 1983). It has been allocated three regions: the Steppe (Black Sea Steppe province), Center (Kievan Rus\') and the East (Russian Povolzhye lands). The largest number of droughts occurred in the Steppe: from 13 cases in the 11th century to 39 cases in the 17th century. In the Center the droughts varied from 6 cases in 16th century to 24 cases in 15th century. In the East frequency of droughts was lowest: from 3 cases in the 14th century to 20 to 15th century. The most intense droughts were detected in the Steppe. During the entire period were marked 175 cases, including 25 severe and 5 extreme droughts. In the Center detected 116 years with droughts, including 4 severe droughts. In the East detected only weak and moderate droughts. According to the Chronicles, summer drought was observed in 10-11 cases in the 11th and 16th centuries to 22-23 cases in the 15th and 17th centuries. An average of 90% droughts found the confirmation in PDSI values. In the 14-15th centuries marked the worst result of 73-79% cases. In other periods up to 100% cases of drought were confirmed.

ID: 01332, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Droughts of the last centenary period in Ukraine

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Analysis of spatiotemporal distribution of drought in Ukraine during the period of 1900-2012 was performed using the Palmer Drought Severity Index (sc-PDSI). In the 20th century was observed at least four dry periods up to ten years. Last dry period occurred at the beginning of 21st century.

In the Steppe area during the study period were observed from 32 years with the summer-autumn drought to 37 years with a summer drought. In the spring the number of moderate droughts was more than weak droughts. Extreme droughts occurred in each season with a maximum in the summer time. The most important from them were observed in 1904, 1921 and 2007.

In the Forest-and-Steppe area the number of dry seasons ranged from 21 years in the spring-summer time to 29 years in the summer-autumn period. Intensity of drought usually increases during the summer. Weak droughts were dominated, especially in autumn. There were only some years with severe drought (1918, 1921, 1946, 1947 and 2007). Extreme droughts are not fixed.

In the Poles\'e (the Mixed Forest area) weak droughts are dominated, the number of which is a maximum in summer-autumn time. In general, in the spring-autumn season there were 24 years with drought, but in the summer only were 19 years. In the spring severe droughts were observed only two times (in 1925 and 1947). One extreme drought occurred in 1921 and continued through all seasons of warm period.

So, the Steppe area is most aridity in the territory of Ukraine. Here the spring-summer droughts are predominant, but toward the north the number of autumn droughts is increases.

There is not found significant trend in the drought frequency and intensity in any region of Ukraine during study period, which may be connected with climate change.

ID: 01283, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Paleogeography of Kerch Strait during the Late Pleistocene – Holocene

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The Kerch Strait between the Black Sea and the Sea of Azov is about 40 km long and 4-15 km wide. The relief of the strait's bottom is complex, with a large central trench (6-7 m deep), which is separated from adjacent marine areas and Taman Bay by underwater thresholds (2-3 m deep). The bedrock of the strait is formed from Miocene clays, which are capped with different loose Pleistocene and Holocene formations. Was it gradual development of transgression of the Black Sea or Was it transgression which includes increasing/decreasing level changing? Out research is attempt to clarify it's paleogeographic development. We carried out a malacofaunistic analysis of two borehole cores that were drilled on the Tuzla Spit. In addition, we used biostratigraphic analysis results of coastal outcrops, which were studied by us earlier. From the late Pleistocene to Holocene changing in malacofaunistic complex traces the development of different ecological groups. Different fauna were formed in different ages, which respectively characterize large paleogeographic stages in the history of the Black Sea and the Kerch Strait. The malacofaunal development had a migratory nature. Marine Mediterranean-type Karangatian fauna had a connection with the major interglacial (Eemian) transgression of the Ocean, and in the regressive epoch was replaced by freshwater and slightly brackish fauna. To the beginning of the Holocene, the New Euxinian basin transgressed, although its level remained low (about minus 30 m). Slightly brackish fauna of the Caspian type were widespread. Salinization and invasion of marine mollusks began in the New Euxinian basin with the gradual development of the Ocean Holocene transgression and the entry of Mediterranean waters. Widespread Mediterranean-type species of mollusks led to the displacement of the brackish New Euxinian fauna to desalted estuarine areas, where they develop even today.

ID: 01288, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Water masses and circulation in the Denmark Strait during abrupt transitions for Dansgaard-Oeschger events 8-5

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The mechanisms responsible for millennial-scale oscillations associated with Dansgaard-Oeschger (D-O) events during marine isotopic stage 3 are not fully understood. While this climate instability appears connected to perturbations in ocean circulation patterns and sea ice cover, it is unclear what role the overturning circulation played in driving abrupt changes. The Denmark Strait is a key region capturing the exchange of cold surface polar waters and warmer intermediate North Atlantic waters and a major conduit for waters feeding the deep western boundary undercurrents of the North Atlantic. Hence the area is a critical region wherefrom data can be obtained to elucidate key mechanisms related to D-O events.

Here we examine the configuration of D-O events 8-5, recognizable by their cyclic patterns of rapid change from cold stadials to warm interstadials and their gradual retreat back into stadial conditions. To capture these abrupt events, the hydrography in the Northern side of the Greenland-Scotland Ridge is investigated using paired Mg/Ca and d^{18}O analysis from the benthic foraminifera *C. neoteretis*, to reconstruct a unique paleo-temperature and seawater d^{18}O that can be correlated to ice core and other marine proxies.

We have also measured the B/Ca ratios of the same samples for reconstructing past ocean carbonate system at intermediate depth. The sampling increments we use allows for a high 30-year temporal resolution that throw light on the chain of events characterizing these swift warmings. This provides new insight into the characteristics of hydrographic changes and associated variations in the exchange over the Denmark Strait across the transitions from stadials to interstadials between 40-30 ka, and how these relate to atmospheric changes and sea ice changes at coeval times.

ID: 01651, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Antidorcas evolution and dietary adaptations in changing palaeoenvironments in southern Africa

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In southern Africa (away from the dynamic landscapes influencing evolutionary adaptations in East Africa) the pace and severity of evolution is yet to be conclusively established. A multiproxy analysis of fossil springbok

(A*ntidorcas*) dentition allows us to map palaeovegetational signals experienced through time. Using the extant species, *Antidorcas marsupialis*, alongside the ancestral *Antidorcas recki* and extinct *Antidorcas bondi and Antidorcas australis* fossils from sites at the Cradle of Humankind, South Africa, a concept of the palaeovegetation available for this geography and temporal area can be established. *Antidorcas* is a continuous, abundant and herbivorous lineage throughout this temporal period (2.8-0.8Ma) and thus a faithful reflector of palaeovegetation. With only one species surviving today, the question of why and how certain species thrive whilst others become extinct is evaluated. It is proposed that differential dietary ranges and community interactions are pivotal in preferential species survival through palaeovegetational changes within any given area.

The taxonomic assignment to species level for these assemblages presents a challenge, as does the complexity of cave stratigraphy. Determining the evolutionary trajectory and relationship of the respective species within the genera is dicusssed. Through dietary, palaeovegetational and inferred habitat signals gained from this multiproxy approach, we hope to provide greater clarity. Prevailing dietary assignments of *Antidorcas bondi* (grazer in a grazing succession), *Antidorcas recki* (browser) and *Antidorcas marsupialis* (mixed feeder) will be examined. As will the homogeneity and faithfulness of dietary practices and the relationship between dietary changes and adaptation.

Dental measurements, mesowear, microwear, isotopic analysis and phytolith analysis are used as complementary proxies to determine the diet and dietary changes observed within the *Antidorcas* lineage from the Cradle of Humankind, South Africa. These can be used to infer the homogeneity of response through time in how *Antidorcas* reacts to the many aspects of ecological change.

ID: 01251, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Poster)

Paleoenvironmental DNA of bacteria as biological proxies for sea level reconstruction

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Paleoenvironmental DNA of bacteria for tracing paleo-sea levels remains unexplored. The present study attempted to unveil sea-level reconstruction based on bacteria through paleogenomics and to check the reconstruction precision by integrating geomorphological, geochemical, geochronological and micropaleontological studies. Sediment core was excavated from a beach ridge at Vettaikaraniruppu (VKI; N 10° 33’20.8’ E 79° 50’12.7’; 2.6Km-inland), Cauvery delta, Tamil Nadu, India. V3 region targeted 16S rDNA metagenomic analysis of VKI subsamples from top (VKIT: 2.8m), middle (VKIM: 7.2m) and bottom (VKIB: 24.5m) revealed 38 bacterial phyla totally. 15 phyla were exclusive for VKIM; 1 phylum for VKI-B and none for VKI-T. Species diversity exhibited 701 species in VKIM, 588 in VKIT and 472 in VKIB. Habitat annotation exemplified 29 exclusive marine bacterial genera in VKI-M; 16 for VKI-T and VKI-B, depicting 81% increase of marine bacterial genera at VKIM when compared to VKIT and VKI-B. Geochemical estimation demonstrated highest macronutrient concentration at VKI-M. Organic matter content increased by 101% and 89% at VKI-M when compared to VKI-B and VKI-T respectively. Sulfur was detected only at VKI-M with subsequent abundance of sulfur bacteria. Optically Stimulated Luminescence (OSL) chronology illustrated VKIB as late Pleistocene (146.64 ± 36.81 Ka BP); VKIM and VKIB as Holocene epoch (6.04 ± 1.25 and 3.36 ± 0.42 Ka BP respectively). Benthic and planktic foraminifera were detected only at VKI-M. The highest marine bacterial diversity and presence of abundant marine bacteria are evident that VKI-M was marine ecosystem; VKI-B and VKI-T were terrestrial ecosystems indicating recurrent marine transgression and regression. Geomorphological, geochemical, geochronological and micropaleontological studies substantiated bacteria based sea-level reconstruction precision for Vettaikaraniruppu paleorecords. Metagenomics served as a suitable tool for retrieving paleoenvironmental bacterial DNA from late Pleistocene and Holocene sediments which was 2.6Km inland suggesting the prospects of bacteria as a biological proxy for paleo-sea level reconstruction.

ID: 02286, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Trace metal composition and growth habit of cultured cold-water coral aragonite: proxy calibration experiments

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With life-spans of decades to more than 1000 years and skeletons suitable for precise U/Th dating, cold-water corals have the potential to provide climate and environmental information with a temporal resolution that can rarely be achieved in sediment cores. We have embarked on long-term culturing experiments using *Desmophyllum dianthus* (a solitary deep coral, typical lifespan 100 yr) in order to calibrate geochemical proxies for dissolved nutrients and the carbonate system (poster by Pelejero et al., this meeting), controlling seawater composition and pH in a flow-through aquarium. An early goal is to better understand and quantify skeletal extension patterns and growth rates on time scales of months-years, currently poorly known for this species. To locate regions of new skeletal growth for subsequent chemical analysis, we tested the suitability of Alizarin and Calcein dyes as a fluorescent markers of the growing surface of *D. dianthus* septa, both upon initiation and at critical time points during culturing experiments. This approach results in stained skeletal sections that are quickly and easily analyzed in 3D by confocal microscopy. Results showed that growth over several months was localized, and extension rates among and even within individual septa varied greatly. Calcein staining lines were particularly useful in selecting regions for analysis by laser ablation ICP-MS. Spiking aquarium seawater with periodically varied enriched Pb isotopes proved to be a relatively inexpensive way to verify growth intervals and confirm complex growth patterns interpreted from stain distribution. We will discuss initial results of analysis of new aragonite grown under tightly controlled seawater conditions with the aim of refining calibrations of the proxies P/Ca, Ba/Ca, U/Ca, and Li/Mg as proxies of dissolved nutrients, the carbonate system, and calcification temperature.

ID: 01713, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Multi-proxy reconstructions of precipitation field in China over the past 500 years

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The dominant precipitation pattern for the whole of China over the past millennium and its causal mechanism remain unclear, the first reason is probably that it is difficult to reconstruct the precipitation field in western China because the published high-resolution proxy records for western China are scarce. Numerous tree-ring chronologies have been archived in publicly available databases through PAGES2k activities, and these provide an opportunity to refine precipitation field reconstructions for China. Based on 600 proxy records, including 491 tree-ring chronologies, 108 drought/flood indices, and a long-term instrumental precipitation record from South Korea, we revised the precipitation field reconstruction for China for the past half millennium using the optimal information extraction method. A total of 3971 of 4189 grid points in the reconstruction field passed the cross-validation process, accounting for 94.8% of the total number of grid points. The first leading mode shows coherent variations over most of China. The second mode is a north–south dipole in eastern China and same-sign variation in western China with southeastern China. The third mode, a "sandwich" triple mode in eastern China and same-sign variations in western China with central China. The results also confirm that five of the six coupled ocean-atmosphere climate models (BCC-CSM1.1, CCSM4, FGOALS-s2, GISS-E2-R and MPI-ESM-P) of the Paleoclimate Modeling Intercomparison Project Phase III (PMIP3), can reproduce the south-north dipole mode of precipitation in eastern China, and two models (BCC-CSM1.1 and IPSL-CM5A-LR) can generate the sandwich triple mode of precipitation in eastern China, although there is still mismatch in terms of their corresponding time coefficients. This implies that the internal variability may play an important role in the precipitation field change over the past 500 years.

ID: 01259, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Interannual to centennial variability of the South Asian summer monsoon in the past millennium

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Proxy based reconstructions indicated that the South Asian summer monsoon (SASM) has shown interannual to centennial oscillations over the past millennium, but their variability and mechanism on different timescales remain not to be explicitly quantified. This is largely because of the inadequate spatial representation of the previous SASM reconstructions with scarce tree-ring records from the core monsoon region. This study uses eight additional Indian tree-ring width chronologies from the core region of the SASM to update the reconstructed SASM index to cover the past 1105 years. The results show that the most significant interannual variability of SASM is mainly related to the El Niño–Southern Oscillation (ENSO) over the past several hundred years. The decadal/multi-decadal oscillations show high negative/positive correlation with the Pacific Decadal Oscillation (PDO)/Atlantic Multi-decadal Oscillation (AMO) in the late 19th century. The centennial component of SASM, which accounts for 19.4% of the total variance, begins to weaken from the mid-13th century and reaches a minimum in the mid-15th century. The centennial component of the SASM gradually strengthens again to reach its peak in the early 17th century. Therewith, it is once again weakening until now. The centennial variations agree well with the historical changes of the solar activity evolution before the 19th century through the change in land-sea thermal contrast. However, the close linkages between SASM and solar activities weaken since the industrial era, probably due to the enhanced influences by the anthropogenic aerosol emissions.

ID: 02351, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Environmental Impact of Plinian Eruptions in Iceland

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Large-scale Plinian volcanic eruptions have repeatedly covered much of Iceland in thick tephra deposits. The environmental impacts of these eruptions, across a range of spatial and temporal scales and subsequent rates of recovery, are poorly understood. This matters in terms of understanding pre-human trajectories of change in a large island ecosystem lacking endemic species. Also, because no similar eruptions have yet mantled settled areas of Iceland in a similar way, the likely impact of future large Plinian eruptions is unknown. As well as perturbing the environment, Icelandic tephra layers provide an unrivalled opportunity to precisely correlate palaeoenvironmental records. We are utilising tephrochronology alongside palaeoenvironmental reconstruction, to assess the likely impact of such eruptions. Multiple sites are being investigated across Iceland, focusing on the Hekla 4 (c.4200 years B.P) and Hekla 3 (c.3100 years B.P) eruptions, which have both been recently remapped in detail. Areas proximal to Hekla were buried under tephra metres thick, and it may have taken thousands of years for a stable post-disturbance environment to form. Elsewhere in Iceland, these layers are thin enough to have only had a temporary direct impact on the environment, and yet provide a precise correlation between environmental records. Thus the varied extent and length of the disturbance, related to tephra depth amongst other controlling factors, can be assessed. By reconstructing the environment prior to and after the eruption, we can distinguish volcanic impacts from changes driven by climate and thus investigate the varied impacts of Plinian eruptions, and how long different environments took to 'recover' to pre-eruption conditions. In doing so, a high-resolution temporal and spatial record of the impact of Plinian eruptions in Iceland can be created, with significance for both understanding drivers of Quaternary environmental change, and potential future natural hazards.

ID: 01451, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Timing of the last deglaciation in the South Eastern Pacific: sea-surface temperature and glacier dynamic reconstructions

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The Southern Ocean (SO) plays a prominent role in the Earth's climate and carbon cycle. Changes in the SO circulation may have regulated the release of CO_2 to the atmosphere from a deep-ocean reservoir during the last deglaciation.

As the SO is considered the focal point of contact between the atmosphere and the deep ocean, an effort has been produced over the past decade to restore the oceanic evolution of the SO during the last glacial-interglacial transition, ie the last 20-25 ka. Accuracy of timing of climatic events (at millennian-scale) recorded in marine and continental archives are crucial for a better understanding of the mechanisms, temporal frequency and the geographical repercussion that govern ocean-climate interactions. Here, we firstly show how to provide robust age models for marine sedimentary archives from the Eastern Pacific sector (SEP) of the SO using volcanic tephra deposited over the marine and terrestrial regions. Then, we present new SST reconstructions by planktonic foraminiferal census counts, using a recently improved database for the Southern Hemisphere Oceans, on 3 deep-sea cores collected in the SEP (41°- 49° S) and their link with local influence of meltwater fluxes from the Patagonian ice sheet.

ID: 02048, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

The role of sea ice in iceberg discharges during Heinrich event 4

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The mechanisms leading to episodic iceberg discharges during the last glacial period in the North Atlantic, referred to as Heinrich event (HE), are still not fully elucidated. HEs have for long been been attributed to ice sheet instabilities at the culmination of glacial conditions. Recent modeling studies have suggested instead that subsurface ocean warming could have been the trigger of iceberg discharges through basal melting of ice shelves. We investigate this hypothesis based on the multi-proxy analysis of a marine core located on the northeastern margin of the Faroe islands. For this purpose, we generated a high-resolution description of surface oceanic changes (including sea-ice conditions) to document the sequence of events that have led to the production of Icebergs during HE 4. Alkenone thermometry was used to estimate sea surface temperatures while Highly Branched Isoprenoids (HBIs) to quantify sea ice seasonal variations. Ice-rafted debris (IRD) concentrations as well as oxygen isotopes of the polar planktonic foraminifera *Neogloboquadrina pachyderma* were also generated, yet at lower resolution. We discuss the relationship and timing between these parameters in the 35 - 41 kyrs time interval that includes the Dansgaard-Oeschger events 10 and 8, and HE4 focusing on the role of sea ice in the sequence of processes.

ID: 01828, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Climate, land-use change and fire activity in Central Asia during the past 6,000 years and its relation to volcanic and solar activity

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Previous studies employing tree-ring width chronologies from the Russian Altai Mountains have demonstrated an exceptional strong cooling response following a series of large volcanic eruptions in the mid-6th century, with cold conditions recurring until 660 CE potentially enforced by reduced solar activity. The authors coined the term “Late Antique Little Ice Age” to describe this period of unprecedented climate conditions evident in other proxy records in Eurasia and much of the Northern Hemisphere. Records of d^{18}O from ice-cores from nearly the same region in south-central Siberia also indicated a strong coherency between long-term trends of temperatures and changes in solar activity .

Here we present a reconstruction of past temperatures, snow accumulation rates, land use change and fire activity for the past 6000 years based on an ice-core from Tsambagarav (4130 m asl., 49°N, 91°E, Mongolia). Based on co-analyses of black carbon, micro-charcoal and pollen assemblages we delineate the history of biomass burning and land use change. Frequent rapid changes in pollen composition, d^{18}O and dustiness occurred particularly during the mid-Holocene (5.5, 4.7 and 4.2 ka BP), indicating distinct reorganizations of hydroclimatic patterns over central Asia. Fire activity in central Asia was strongly reduced during the Maunder Minimum (1670-1720 CE).

A clear signature of post-volcanic cooling is evident in the new Tsambagarav d^{18}O series following the largest volcanic sulphate injections since 1800 CE. Extending the reconstruction of Northern Hemisphere volcanic forcing to cover the past 6,000 years, we find that the largest d^{18}O-indicated cooling extreme in Tsambagarav coincided (considering some dating error) with two colossal volcanic eruptions: the late Minoan eruption of Santorini (Thera) and the 3.6 ka eruption of Aniakchak

(Alaska). We discuss how our findings may contribute to the long-standing debates surrounding the timing and climate impact of the Santorini eruption, a key age marker in early human history and archeology.

ID: 01487, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

8 degrees C of Greenland warming? Ice cores and sea ice retreat during the Last Interglacial

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The NEEM ice core covers the Last Interglacial period (LIG) and shows a significant warming from 129 to 114 thousand years ago (ka). It has been suggested that $\delta^{18}O$ measurement from the core imply a high peak warmth of 8±4°C above the past millennium. Current climate models are not able to simulate this warming. Additionally, this level of warming appears to be inconsistent with Greenland ice sheet retreat shown by ice sheet models. A contributing factor to the discrepancy between $\delta^{18}O$ temperature reconstructions and the climate and ice sheet model simulations may be the conversion from $\delta^{18}O$ values to temperature. To investigate this we use climate modelling with embedded water isotopic code. This approach enables us to simulate isotope measurements which are then directly compared to ice core $\delta^{18}O$ measurements.

Although little is known about the extent of NH sea ice during the LIG, several proxy records show high latitude SATs and SSTs were warmer during the LIG compared to present day and thus it is likely that less winter ice coverage would last the summer compared to present day. During the LIG, planktonic foraminifers lived in the central part of the Arctic Ocean suggesting the presence of seasonal sea ice instead of perennial sea ice in most of the LIG Arctic Ocean. Here, we test the impact of a retreat of the NH sea ice on the Greenland LIG isotopic peak. We find that HadCM3 climate model simulations of a forced retreat of the NH sea ice do provide a possible explanation for the Greenland LIG isotopic peak. If this demonstrates the sensitivity of the NH sea ice extent to warming, this may have implications for thinking about longer-term NH sea ice impacts of anthropogenic warming.

ID: 01705, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

Pliocene palaeoclimate off southeast Africa

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It has been proposed that ocean gateway changes in the Indonesian Seaway affected the transport of moisture from the Indian Ocean to the African continent, influencing the evolution of early hominins as grasslands expanded in the Pliocene (Cane, M. & Molnar, 2001; deMenocal et al., 1995). However, there are limited Pliocene records that can be used to link the evolution of terrestrial and marine conditions, particularly in SE Africa. In this study we show initial results from two new sites, sensitive to local river discharge (Casta.eda et al., 2016; Simon et al., 2015) recovered by IODP Expedition 361 in 2016 (Hall et al., 2016). Site U1478, (25° 49.26S; 34°. 46.16E) is located in the Delagoa Bight east of the Limpopo River and Site U1474 (31°13.00'S; 31°32.71E) is in the northernmost Natal Valley. Both sites provide additionally valuable insights into the upper ocean temperature changes of the Agulhas Current, where it originates and in its core flow path further south. We employ a multiproxy approach combining radiogenic isotopes (Sr, Nd, Pb), clay mineralogy (XRD), K/Ar ages, XRF-scanning derived elemental ratios and their concentrations (MC-ICP-MS) in the bulk detrital sediment fraction. Moreover, we apply a novel approach of combining Mg/Ca ratio and carbonate clumped-isotope measurements. These reconstructions will determine whether oceanographic changes in the Indian Ocean were coupled to changes in the continental hydrologic regime in SE Africa during the key interval between 4-2 Ma.

ID: 01710, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Ocean ventilation changes in the Nordic Seas during MIS 3- Insights into the mechanisms of Dansgaard-Oeschger cycles

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Understanding the dynamics involved in D/O cycles during Marine Isotope Stage 3 is probably one of the most exciting and currently studied topics in paleoclimatology. The role of the Nordic Seas (NS) and their ice-ocean-atmosphere interactions have been recognised to be an important component.

We aim to present an overview about the sequences of events evolving in the eastern NSs during Greenland Interstadials (GI) 9 -5 (40-32 ka BP) equivalent to DO-9 - DO-5. A set of 40 radiocarbon dates on planktic foraminifera *Neogloboquadrina pachyderma* (sinistral) and 20 mixed benthic measurements have been performed on core MD99-2284 (1500m water depth), (Dokken et al., 2013) located on the northeastern flank of the Faeroe-Shetland Channel, on the path of the North Atlantic Inflow into the NSs.

Our results reveal that during Greenland Stadials (GS) the subsurface and intermediate waters in the eastern NS were relatively more ^{14}C enriched (i.e. younger ages) than the preceding and following GI. Conversely, the transitions into GIs and their onset were characterized by relatively more ^{14}C depleted waters (i.e. older ages), suggesting the presence of poorly ventilated waters. We estimate surface reservoir ages of up to 1500 years at the onset of GI-8 consistent with a nearby study by Olsen et al., (2014).

We thus argue that the North Atlantic Inflows first strengthened across these transitions and that incursion changes were associated with vertical mixing up of old ^{14}C-depleted carbon stored in the to deep NSs. Furthermore, changes in the water column ventilation seem to have occurred before sea ice decline, subsurface heat release to the atmosphere, and Greenland temperature rise (Sadatzkiet al, in prep.).

The data additionally displays challenges associated with radiocarbon dating applied on records from the glacial NSs and casts doubts on the reliability of existing ^{14}C calibration curves spanning MIS3.

ID: 02069, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Poster)

Mountain glacier sensitivity to centennial-scale climate change: a case study from Spitsbergen, Svalbard

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Understanding the sensitivity of the cryosphere to climate change at sub-orbital timescales is of critical importance for predicting how Earth's glaciers and ice sheets will respond to anthropogenic climate change at policy-relevnt timescales. Recent advances in cosmogenic exposure dating techniques have allowed increasingly precise dating of glacial features deposited during the late Holocene. This is an ideal time period to study decadal- to centennial-scale glacier fluctuations, because depositional features are generally well-preserved, and several centennial-scale regional to global climate fluctuations have been studied in detail (for example, the Little Ice Age, Mediaeval Climate Anomaly, and Dark Ages Cold Period). Here, we present a case study from Spitsbergen, western Svalbard. Svalbard has been unique in the late 20th and early 21st centuries, in that its glaciers have not experienced the rapid retreat observe in other high-latitude mountain glaciers and ice caps; however several models indicate a significant retreat of these glaciers is possible in the next century. The only direct cosmogenic exposure ages of neoglacial moraines in Svalbard indicate ice retreat from a neoglacial maximum at 1.6±0.2 ka, with nearby radiocarbon ages suggesting this retreat was regional, possibly in response to a climate event. We will test this hypothesis using 20 new 10-Be cosmogenic exposure ages from large moraines just outboard of, and in some cases overridden by, Little Ice Age moraine complexes at Austre Lovénbreen, Midre Lovénbreen, Kongsvegn, and Conwaybreen glaciers. These glaciers have adjacent termini in Kongsfjorden, Spitsbergen, but represent both local and marine-terminating glaciers, and one glacier with recent surging behavior. This cross-section of glaciological environments therefore provides an opportunity to determine whether the observed moraines represent a regional response to a climate event or are deposited by individual glaciers responding to changes in local glaciology.

ID: 02145, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Insights into late Quaternary tropical hydroclimate dynamics using a water-isotope enabled climate model

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Tropical climates are strongly governed by the dynamics of the tropical rainbelt, which is often associated with the Intertropical Convergence Zone (ITCZ). On millennial time-scales the primary drivers of variation in the rainbelt include orbital configuration changes to insolation seasonality and high-latitude forcing (e.g. Heinrich events). The spatial pattern of precipitation variability in the late Quaternary is complex and has long been debated. Stable water isotopes from inland lakes and off-shore ocean core records have provided longitudinal records, variously interpreted as changes to precipitation intensity or changes to moisture source location due to movement of air boundaries and convergence zone (or a combination of several factors). In this preliminary study we have used a global climate model, HadCM3, in which water isotopes are coupled to produce snapshots at 1000-year intervals covering the last deglaciation (21kyr to pre-industrial). In conjunction with a comparison to available palaeodata, this enables us to better elucidate the connections between precipitation and other climate factors with changes to the water isotope signature, as well as how this varies regionally and through time.

ID: 02149, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Impacts of glacial-interglacial climate change on ecosystem structure in a global mechanistic ecosystem model

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There have been various modelling methodologies (e.g. species niche modelling) applied to understanding the impact of glacial-interglacial climate change on the distribution and populations of megafauna, as well as the question of whether the Pleistocene megafauna extinctions was caused primarily by humans or climate change. In such studies there is generally a focus on larger bodied species. Information on the signatures of how ecosystem structures respond to climate change would be valuable additional information to elucidate greater understanding of the causes of past community dynamics and extinctions. Here we use the first Global Ecosystem Model (GEM) driven by glacial and interglacial climates from a climate model (HadCM3) to simulate global ecosystem dynamics. The model (the Madingley model; Harfoot et al., 2012) models micro- to mega- organisms, and produces emergent properties at individual (e.g., growth rate), community (e.g., biomass turnover rates), ecosystem (e.g., trophic pyramids), and macroecological scales (e.g., global patterns of trophic structure). Additionally, we compare the impacts of long-term changes (glacial-interglacial) with idealised millennial-scale abrupt climate change.

ID: 01604, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Poster)

An 8.3ka paleo-dust deposition record from southern Sweden inferred from geochemical methods coupled with mineralogical identification by X-ray diffraction analysis

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Atmospheric mineral dust plays a dynamic role in the climate system affecting biogeochemical cycles, radiation budgets, and cloud formation. The amount of dust in the atmosphere is related to prevailing climate regimes, where glacial periods are known to be significantly dustier (2.5X) than interglacials. Despite recent increases in Holocene paleo-dust records, additional data from continental locations are required to fill regional gaps. During the last decades ombrotrophic (rain-fed) peat bogs have been increasingly used to reconstruct terrestrial dust deposition by geochemical methods such as XRF and ICP-MS. Derived elemental data are commonly used to infer net deposition rates, source changes, grain size, and mineral composition. Currently, Scandinavia is only represented by one such paleo-dust record, and further studies are required from the region to distinguish local, regional and global dust events. Here we present ongoing work from an ombrothropic peat bog in southern Sweden where we combine elemental data with direct mineralogical observations through X-ray diffraction analysis (XRD), bulk density and C/N analysis, to build a dust record covering the last 8.3 kyr BP. The study aims are to: 1) identify periods of increased dust deposition; 2) detect potential source changes; 3) compare our results with past dust and paleoclimate studies from the region; and lastly, 4) verify and/or refine assumptions related to interpretations of dust deposition from bulk elemental data compared to direct observation of mineralogy (XRD).

ID: 01849, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Icebergs in the Nordic Sea during the Pliocene

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The Arctic cryosphere is changing and making a significant contribution to 21st century sea level (SL) rise. The Greenland Ice Sheet (GRIS) contains ~7.36 m of SL equivalent, thus it is important to understand its behaviour in a warmer-than-present world. Pliocene warming is comparable with model predictions for 2100, and is the last time CO_2 levels were similar to present. We have chosen the glacial Marine Isotope Stage M2 (3.3 Ma) to the interglacial mid-Piacenzian

Warm Period (mPWP; 3.264 to 3.025 Ma) as end members of Pliocene climate.

During M2 CO_2 was at ~220ppmv and SL lower. Climate model results show that a medium/large northern hemisphere ice sheet produces a climate state not inconsistent with available proxy data. During the mPWP, modelling shows retreat of the GRIS with ~400ppmv CO_2. The extent of GRIS remains unclear. However, evidence can be found in marine sediment cores as ice rafted debris (IRD). The distribution of IRD in space and time tells us about the location of marine terminating glaciers (MTGs) and the GRIS. Using M2 and mPWP climate scenarios, iceberg trajectories were modelled for the Nordic Seas and compared to data collected from four Ocean Drilling Program (ODP) sites within the region.

Results show persistent IRD signals in ODP sites 907A, 909C and 911A with modelling results indicating Svalbard as a consistent source of icebergs. At site 642B, IRD shows more variability and a loss of signal at 3.17 Ma with models only showing a possible Norwegian source of icebergs. Using a standard mPWP palaeogeography, icebergs from Greenland did not reach any Nordic Seas site, but NE Greenland icebergs reached 907A using a palaeogeography with a subaerial Barents Sea. Future work should combine geological provenance studies within a modelling framework to further understanding of the GRIS and MTGs in the late Pliocene.

ID: 01761, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

MODERN POLLEN-BASED PREDICTIONS OF SOUTHERN AFRICAN VEGETATION AND PALEOVEGETATION USING RANDOM FORESTS

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Here we contribute an updated and revised dataset of approximately 200 modern pollen data from southern Africa. The coarse taxonomic resolution of pollen taxa in the dataset leads to large uncertainties and precludes quantitative reconstructions. However, the dataset is well suited for vegetation assignment and classification. We develop an alternative approach for reconstructing past vegetation at different spatial resolutions (large-scale biomes and small-scale bioregions) via a supervised machine learning approach.

We use a trees-based method known as random forests to grow an ensemble of decision trees, wherein individual bootstrapped trees recursively partition modern pollen data and split sites into vegetation categories. The prediction of each vegetation unit is chosen from the aggregated results using the majority vote rule. The models\' performance is estimated using out-of-bag (OOB) error rate.

When vegetation units are well represent by pollen assemblages, the models are able to correctly predict a given vegetation unit based on modern pollen data to a high degree of confidence. For the biome model we achieve highest OOB performance for grassland (79% accuracy and 69% precision) and savanna (95% accuracy and 82% precision). For the bioregion model we achieve highest OOB performance for Central Bushveld (94% accuracy and 76% precision), Eastern Kalahari Bushveld (94% accuracy and 78% precision), and Drakensberg Grassland (80% accuracy and 67% precision). The models are applied to a classic southern African fossil pollen sequence (Wonderkrater) and show savanna-grassland shifts over the last ~ 60 cal yr BP. The models indicate that the start of the most abrupt vegetation changes occurs at the Glacial-Interglacial transition and continue until 7000 cal yr BP.

ID: 02045, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Climatic signal in the new ring width chronology network in the East-European Plain

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We developed a network of 62 original local tree-ring chronologies of Scots pine (*Pinus sylvestris L.*), Norway spruce *(Picea abies (L.) Karst.*) and the English oak (*Quercus robur L.)* in the European Russia (ER) (http://ruda.igras.ru/). Unlike temperature sensitive trees growing at the northern treeline the ring width (RW) of trees to the south of 50-55N depends on the combination of heat and moisture (drought indices). The climatic signal in RW chronologies gets stronger while moving from the North-East of the Russian Plain to the South and South-East with increasing aridity and continentality of climate.

Using the non-linear methods of statistical analysis we grouped local chronologies into three regional clusters and studied their relationships with meteorological data (years 1901-2012). Usually the narrow rings in the Non-Chernozem zone were formed after the droughts in May and June, those in the Central Chernozem and the Volga regions are associated with the long warm season droughts, including May.

We analyzed climatic conditions for the pointer year of pine in 1921, 1939, 1942, 1964 and 2011 using instrumental data, generalized for the territory between 52,75°-57,25° N and 32,75°-40.25° E. Usually these years of narrow rings were preceded by extremely hot July and August of a previous year and low precipitation in summer and in the second half of winter of the current year. However extremely cold winter in combination with cold and rainy summer in 1941/42 also resulted in the formation of narrow ring in pine.

Our experiments showed that despite of some uncertainties the network is suitable for spatio-temporal reconstructions of drought severity indices in the ER for the past 250 years (Matskovsky, 2016, OSM PAGES Abstracts). Supported by RSF Grant №14-17-00645.

ID: 01256, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Poster)

On the nature of the Mtd-Pleistocene transition

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It is widely accepted to believe that the climate dynamics is unstable to small disturbances (chaotic). The assumed climatic chaos limits our possibilities to predict climate variations for decades and more times ahead. Here we demonstrate that it is not so fatal, as believed because different kinds of mutual ordering co-exist with the climatic chaos within some ranges of timescales where two or more external forces with incommensurate periods collectively affect the climate system. One of such ranges is situated within the ENSO-timescales where the annual Sun-induced periodic heating affects the climate system together with other, very subtle, external periodicities: the Luni-Solar nutation, the Chandler wobble in the Earth's pole motion, and the ~11-year long Sun-spot cycle as well. Another ordered range is determined by the manyperiodic Milankovitch orbital forcing. Just this timescale range is of our interest in this report. Basing on ideas and methods of the dynamical system theory, especially on the notion of the so-called STRANGE NONCHAOTIC ATTRACTOR in the quasiperiodically forced nonlinear dynamical systems, and using wavelets as a tool for analysing paleoclimatic records, we show that the evolution of the global climate during the Pliocene – Pleistocene epoch was nonstationary in general. In particular, the Mid-Pleistocene transition took place during the 34-38 MISs when a sequence of the ~40kyr Pliocene cycles was suddenly changed to a ~80kyr cycle. We show that it was a result of the so-called period-doubling bifurcation well-known in the dynamical system theory. Later, under continuing stresses of a general cooling of the climate system, and increase of its variability (because of the 1000kyr long obliquity beats combined with ~400kyr long eccentricity oscillation) several secondary bifurcations took place when the glacial cycle periods trebled, and doubled again.

ID: 01265, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Middle to late Holocene centennial–multidecadal climate change on the east coast of South Korea and possible influential factors

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A sedimentary core from the stable sedimentary environment of Songjiho Lagoon on the east coast of South Korea, providing high-resolution accelerator mass spectrometry ^{14}C ages, was obtained for centennial–multidecadal-resolution palynological analysis. The data show a general trend from warm to cold from the mid-Holocene to the present, which can be divided into two different stages: a relatively warm stage between 7500 and 1900 cal yr BP and a relatively cold stage from 1900 cal yr BP to the present. However, there are differences within these stages. The climate was warm and wet in 7500–6900 cal yr BP and 5300–1900 cal yr BP, but warm and dry in 6900–5300 cal yr BP. The climate changed to cold and dry in 1900-680 cal yr BP. Human activity impacting the study area began around 1900 cal yr BP and became pronounced from 680 cal yr BP. The East Asian summer monsoon (EASM) climate record in this study suggests a possible close link between solar activity and sea surface temperature (SST). The Dongge Cave area was perhaps mainly impacted by the EASM in 7500–680 cal yr BP, and there is a close connection between the North Atlantic and the EASM system. The impact of solar activity perhaps gradually increases inland from the coast, while the impact of SST shows the opposite trend.

ID: 01566, 10.- Ice-sheet and sea-level variability during late-Cenozoic warm periods: PALSEA2, (Poster)

Holocene relative sea level changes and environmental implications on the west coast of South Korea

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Understanding past relative sea level (RSL) changes is crucial for predicting future coastal evolution, particularly within the context of accelerated melting of polar ice sheets due to global warming. RSL records are scarce in many regions along the Pacific coast. Here, we present a Holocene RSL curve for the west coast of South Korea based on detailed analyses of four sediment cores and the synthesis of existing sea level index points. Our record shows that local sea level rose rapidly during the early Holocene and then fell gradually toward the present position during the late Holocene. An apparent sea level high stand of ca. 1 – 2 m existed during 7 – 4 cal ka BP. The rapid sea level rise at a rate of ~1.4 cm yr^{-1} during the early Holocene is clearly a manifestation of polar ice sheet decay, while the apparent mid-Holocene sea level high stand appears to be a signal of hydro-isostasy of the continental shelf. The responses of the sedimentary environment to sea level changes in the estuary of the Geum and Mangyeong Rivers of the Gunsan area are similar, with both characterized by a transgression process prior to ~8.0 cal ka BP and a progradation process after ~8.0 cal ka BP.

ID: 01482, 27.- The climate record of the past 5 million years: from the seasonal cycle to Ice Ages, (Poster)

Greenland Ice Sheet Enhances Sensitivity of Pliocene Climate to Obliquity Variations in the Kiel Climate Model

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Obliquity modulates the north-south insolation gradient and its seasonality. Proxy data suggest that the Pliocene-Pleistocene transition from 3.2 ~ 3.0 to 2.5 million years before present was characterized by the onset of Northern Hemisphere glaciation (NHG) and progressively enhanced 41-kyr climate cycle. Here we investigate the influence of NHG, specifically the buildup of the Greenland ice sheet (GrIS), on the Atlantic Meridional Overturning Circulation (AMOC) and its role in enhancing the climate response to obliquity variations. We conducted a series of climate model simulations to study the influence of the GrIS on the AMOC and find that the buildup of the GrIS weakens the mean AMOC by about 1 Sv, which is mainly due to stronger zonal atmospheric flow and reduced heat loss over the Greenland-Iceland-Norwegian Sea. The presence of the GrIS enhances the obliquity-forced variation of the AMOC by about a factor of two due to enhanced freshwater export from the tropical Atlantic, which could have contributed to strengthening the obliquity response of Northern Hemisphere surface temperature.

ID: 02155, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

High resolution records of the Northeast Atlantic from the Late Holocene: Exceptional 20th century changes?

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The North Atlantic Ocean plays a key role in modulating global climate via its role in the Atlantic meridional overturning circulation (AMOC). However, instrumental records of the region are sparse prior to 1950 CE. To assess whether recent oceanographic change in the region is due to natural multidecadal cycles or to anthropogenic impacts requires the use of high resolution paleo-proxy archives spanning the last several hundreds/thousands of years. Of particular interest is the strength of the subpolar gyre, which affects the distribution of water masses in the north Atlantic. The transport and mixing of water in the region south of Iceland is very dependent on subpolar gyre strength. Here we present planktonic foraminifera faunal assemblage data and associated Mg/Ca-δ^{18}O records from two cores in the Iceland basin: EN539-MC16A and EN539-MC14A. The cores enable ~4 and ~9 year resolution respectively. In addition to long-term trends over the last millennia in faunal assemblages, we also observe changes during the 20th century that we relate to recent climate events such as the early twentieth century warming of the Arctic, and recent large amplitude variability in inferred subpolar gyre circulation. We also report a dramatic increase in the percent abundance of the subtropical species *O. universa* during the 20th century which appears to be related to both 20th century warming and regional hydrographic variability.

ID: 02323, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Environmental variability of the Sangoan toolmaker at Sango Bay southern Uganda.

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The Sangoan lithic tools were first discovered from Sango Bay in southern Uganda way back in the 1920s. These to date have caused a lot of debate on the suitable landcover adaptation as well as stone nomenclature for the toolmaker. Sangoan cultural materials in Sango bay are found in open grassland yet many scholars attributed the Sangoan to a woodland adaption. The study aimed at examining environmental variability for the Sangoan toolmaker using lithic artefacts from Simba Hill in Sango Bay basing on the evolutionary theory basing on its notion that all life is related and descended from a common ancestor that linked the hominids to the natural habitat where habitation is influenced with availability and distribution of ecological resources with the surroundings. Therefore, technological innovations including the Sangoan industry in East Africa was favored by physical environment and aimed at exploiting the local resources. The study was guided by the three specific objectives: a) To examine the mobility system of the toolmaker based on the lithic raw material procurements and use strategies. b) To examine the typological characteristics of the Sangoan artefacts and c) To examine the environmental variability of the Sangoan tool makers. Archaeological field survey and excavation was done, supplemented by ethnographic inquiries. Preliminary results so far reveal that local material was more preferred as a number of rock outcrops were found within a radius of twenty kilometers and the presence of more tools compared to debitage on hill tops suggested that hominids could have used hill tops for other purposes other than manufacturing. The excavation at Simba Hill proved that Sangoan is not only surface material the way it has been greatly understood but is also in the subsurface at the type site and therefore can be dated. This implies that the Sangoan inhabited a woodland environment from the evidence so far in Sango Bay.

ID: 02074, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

Reconstructing the global atmosphere-ocean dynamics of hydroclimate extremes with data assimilation

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Data assimilation (DA)-based reconstruction methods are statistical tools that optimally combine proxy data with climate models. DA-based paleoclimate reconstructions have the benefit of being physically-consistent across the reconstructed climate variables and are capable of providing dynamical explanations for past climate phenomena. For the first time, DA is used to reconstruct global hydroclimate on seasonal and annual timescales. Through a series of pseudo and real proxy experiments based on the PAGES 2k proxy network, it is found that hydroclimate variables like the Palmer-drought severity index can be skillfully reconstructed using DA. These reconstructions show skill during the boreal and austral growing seasons as well as at annual averages. Some dynamically-relevant drivers of hydroclimate included in the DA-based reconstructions, such as ENSO and ITCZ variability, are also skillfully reconstructed. These driving variables are then used to elucidate the causes of multi-year droughts over the last millennium in the American Southwest and in equatorial Africa.

ID: 01279, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Late Pliocene East African climate variability reconstructed from the Baringo Basin (Kenya) HSPDP drill core

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The Hominin Sites and Paleolakes Drilling Project (HSPDP), and the related Olorgesailie Drilling Project, has recovered ~2 km of drill core from the East African Rift Valley since 2012. A major project goal is characterization of East African paleoclimate in order to evaluate its impact on hominin evolution. XRF core scanning data provide a means of evaluating records of past environmental conditions continuously and at high resolution. The HSPDP records contain complex lithologies reflecting repeated episodes of inundation and desiccation of the lake basins. Careful data evaluation based on detailed lithostratigraphy, which includes smear-slide microscopic analyses and X-radiographic images, allows disentanglement of complex signals and robust identification of continuous sequences for any cyclostratigraphic and statistical analysis.

At the HSPDP Baringo Basin (BTB) site, a 230m core in the central Kenyan Rift, spans the Late Pliocene and samples a portion of the Chemeron Formation in the Tugen Hills Succession. The Chemeron Formation documents repeated cycling of major freshwater lake systems at 23 ka precessional pacing, occurring at the maximum of an Earth orbital eccentricity cycle. Over 30 vertebrate fossil localities, including hominins, can be linked to the sequence. Ongoing research of the new drill core show repeated appreance of diatomites reflected as cyclic repetitions of increasing and decreasing Si/Ti XRF ratios. With the the XRF data, we present a methodological approach to address the highly variable lithostratigraphy of the East African records to establish comprehensive and environmentally meaningful paleoclimate timeseries. Furthermore, the reconstructed hydroclimate variability of the Baringo Basin from 2.6 to 3.3 myrs is explored in relation to regional reconstructions and marine stratigraphies. These data will provide a chance to link evolutionary innovations in the human lineage with environmental changes in the rift valley.

ID: 02063, 28.- Climate variability signals in groundwater (and unsaturated zone) archives, (Poster)

Records of precipitation variation in the southern Kalahari and assessment of the origin and fate of nitrate in the unsaturated zone of the Stampriet Basin.

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Past rainfall reconstructions in dryland regions underpin our understanding of the relationship between climatic forcing and palaeohydrological response. The unsaturated zone (USZ) offers a novel and straightforward archive for palaeorainfall in dryland environments, where proxies for palaeorainfall are notoriously scarce. This presentation presents results of chloride mass balance- (CMB-) based hydrostratigraphies spanning up to six decades from USZ profiles from dunes within the southern Kalahari. CMB data also allows us to establish recent rates of diffuse recharge to the groundwater table to assess the sustainability of the trans-boundary Strampriet Basin groundwater resource in southern Africa.

In addition, we investigate the origin and fate of nitrate in this region using nitrate anion and $\delta^{15}N$ and $\delta^{18}O$ isotopic data. High nitrate concentrations provides a limit on groundwater quality in dryland regions, are a serious environmental issue owing to deleterious implications for both human and animal health. This research will provide vitally needed understanding of the connection between the production of nitrate in the USZ via nitrogen cycling processes in dryland soils and the presence of high NO_3^- in deep groundwater.

ID: 02285, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Poster)

Abundance-based and phylogenetic diatom diversity obtained from recent and ancient sedimentary DNA of Arctic treeline lakes

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The Arctic treeline ecotone, a vegetation gradient from arctic tundra to northern taiga, influences the water chemistry of thermokarst lakes and environmentally-sensitive diatoms respond to such ecological changes in terms of variation in diatom composition, by now mainly documented by morphological studies.

In this study, we applied next-generation sequencing (NGS) to analyse the diatom composition of recent and past lake sedimentary DNA extracted from 80 lake surfaces and two lake cores across the treeline in the Yakutia, Siberia, using a short fragment of the phylogenetically informative rbcL chloroplast gene as a genetic barcode.

Our study aims to investigate, firstly, diatom richness, turnover and its explained variation by environmental parameters and on the basis of inter-generic variation obtained from the genetic approach compared with diatom counts from traditional morphological studies. Our results indicate that both methods give similar results for diatom richness and composition at the genus-level (e.g. modern DNA 12 genera; morphology 19 genera) and dissolved organic carbon explained the highest percentage of variance in both.

Secondly, we compare their intra-generic phylogenetic relationships of 12 genera with their turnover using both of the spatial and the temporal data set. Our results show a significant positive correlation between the phylogenetic diversity within a genus and its abundance based turnover, in space and time.

Summarily, our study shows that genetic analyses on environmental diatom DNA at the genus level can provide a sufficient measure for compositional turnover and its related environmental parameters. Furthermore, the genetic data supplies phylogenetic information, which seems to be a better estimator of turnover and thus ecological breadth of diatom genera shaping the composition of communities in natural habitats. The genetic approach with sedimentary DNA will, in future, allow reliable investigations of diatom composition with potential applications in palaeo- and phylogenetic community ecology.

ID: 02140, 06.- Before and after - climate contrasts across the MPT, (Poster)

Climate reorganisation during the Mid-Pleistocene Transition: the role of moisture delivery to high latitude sites such as the Bering Sea

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The Mid-Pleistocene Transition (MPT) marked a fundamental change in glacial-interglacial periodicity, when cyclicity increased from ~41 to 100 kyr cycles without significant changes in orbital forcing. Here we document through the fossil diatom record, a major sea ice build up at 1.2 Ma in the eastern Bering Sea (IODP U1344A). The long-term trend coincides with East Asian monsoon records after 1.6-1.8 Ma. We propose that the intensification of the Hadley and Walker cells were the mechanism responsible for enhanced atmospheric moisture and its delivery to the high latitudes, which culminated in the unprecedented growth of ice sheets at the onset of the MPT at ca. 1.2 Ma ago. Both monsoon records and this study indicate that La Nina-type climate conditions persisted during the MPT.

The data also provides further insight into the observed freshening of the North Atlantic at 1.15 Ma. Evidence of endemic North Pacific diatom species, *Neodenticula seminae*, in North Atlantic sediments, corresponds with enhanced concentrations in the Bering Sea. The implications are that the freshening may have originated from the Bering Sea, sourced from the collapse of the first substantially larger Bering sea ice sheet, which under enhanced circulation entered the North Atlantic via the Arctic.

ID: 01904, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Holocene river floods in Glomma, southern Norway

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River floods caused by extreme precipitation and/or snowmelt are among the most destructive natural hazards worldwide. Glomma is the longest (601 km) and largest river in Norway and has, both historically and over the last years, caused floods with considerable societal damage. The largest known flood occurred in AD 1789 killing more than 70 people and ruined hundreds of farms. Beyond the instrumental (c. 150 years) and historical records, however, little is known about past flood frequency of this river. Given the shortness of instrumental records they are generally considered insufficient to properly address the connection between climate change and flood frequency on regional and local scales. This is especially unfortunate considering that climate models suggest that winter precipitation in the region – a key climatic factor when it comes to explaining flood variability – is predicted to increase in the century to come.

A first-order approach to meet this challenge is to obtain a better knowledge-based perspective on how floods have changed in relation to shifting climates over the last 10000 years. Lake sediment records capturing the sedimentary imprint of large floods have proven a valuable archive forming the basis of high-resolution records. Here we present new results from lake sediment records capturing flood-transported sediments from the river Glomma over the last c. 10 000 years. By detailed analysis of geochemical elements (ITRAX XRF), CT-radiography and magnetic properties we aim for a reconstruction of Holocene river floods calibrated against instrumental and historically documented events.

ID: 01406, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

East Asian summer monsoon dynamics in past and future warmer climates: mid-Pliocene versus RCP4.5 scenario

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East Asian summer monsoon (EASM) can impact the daily lives of more than one fifth of world population. EASM features the multi-timescale variability with no significant long-term trends detectable over the whole 20 th warming century, which to some extent makes difficult to predict how will the EASM change in the future? The mid-Pliocene warm climate provide an opportunity to constrain the future EASM behavior due to many aspects similar as the present configuration by the end of 21 th century. EASM precipitation exhibits increased response to the higher CO 2 forcing in both past (mid-Pliocene: 405ppm) and future (RCP4.5: 543ppm) scenario above the pre- industrial (PI: 280ppm). Here, moisture budget and moist static energy (MSE) are used to understand the thermal cause and dynamical mechanisms of enhanced EASM 1precipitation from traditional and energy perspectives, respectively. The water holding capacity of atmospheric increases in the warmer conditions as dictated by the Clausius- Clapeyron (C-C) relation, thereby leading to EASM precipitation increase in both warmer climates (thermal cause). Meanwhile, the enhancement of zonal thermal contrast can strengthen the EASM circulation in both warmer conditions and associated with increased moisture transport reaching to the EASM domain, via local convergence in mid-Pliocene but for local divergence in RCP4.5 (dynamical cause). This would explain well why the EASM precipitation in mid-Pliocene (405ppm) increase more than that of higher CO 2 concentration in RCP4.5. Nevertheless, the EASM dynamics in mid-Pliocene is a an interesting analogue for future climate.

ID: 01727, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Bipolar synchronicity of abrupt climate change and the role of volcanism in the last glacial period (MIS4)

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Greenland and Antarctic ice cores have revealed the existence of a series of major, abrupt climate change events occurring throughout the last glacial period. Despite the clear evidence of these changes in ice cores and other paleoclimate records, the underlying mechanisms of the events are a matter of ongoing debate. Here we investigate the bipolar timing of events across the period 71-75 thousand years before present, covering the onset of Greenland Interstadial 19.2 (GI-19.2), Greenland Stadial 20 (GS-20), and the termination of GI-20.

We apply annual layer counting and volcanic synchronization of the Greenland NGRIP and the Antarctic EDML and EDC ice cores to obtain a precise bipolar sequence of events. We demonstrate that abrupt change related to the onset of GI-19.2 occurs synchronously at the two poles within few decades. At the EDC site, an abrupt increase in water isotopes (d18O) and a corresponding 20% increase in snow accumulation occurs right at the onset of GI-19.2. At the EDML site, however, no significant change is observed in relation to the GI-19.2 onset. In the investigated period, climate change in different sectors of East Antarctica thus display very different patterns at the times of abrupt change in Greenland.

Both the onset of GI-19.2 and the termination of GI-20 are associated with periods of high volcanic activity. The very onset of GI-19.2 occurs right after a bipolar volcanic eruption. We, therefore, suggest that volcanism may act as a trigger of abrupt change in a \'preconditioned\' climate system. The precise mapping of the bipolar sequence of events related to abrupt climate change aids to disentangle the involvement of atmospheric and ocean circulation, volcanism and sea ice extent.

ID: 02209, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Diatom oxygen isotope insights into hydrological changes in Lake Baikal during the last glacial

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As the world's oldest lake, Lake Baikal situated in central Siberia contains an unrivalled sediment record that provides key information on the surrounding continental region that is remote from direct oceanic influence. Existing geochemical and taxonomic records from the lake have provided important information on the wider palaeoclimatic history of the region and the response of the lake to both direct and indirect climate forcings. In addition, the development of diatom oxygen isotope ($\delta^{18}O_{diatom}$) records have permitted insights into the hydrological processes operating in the wider catchment. To date, records of $\delta^{18}O_{diatom}$ have been primarily restricted to interglacials due to the absence of sufficient diatom frustules within glacial aged sediments. Here we presents a $\delta^{18}O_{diatom}$ record from the north basin of Lake Baikal that is unique in extending through the last-glacial interglacial transition and into the last glacial. During the last glacial $\delta^{18}O_{diatom}$ varies rapidly by up to 3‰ on centennial to millennial timescales, indicating significant changes in the balance of riverine inflows to Lake Baikal and the wider hydrological/atmospheric processes that regulate such changes. With modern day hydrological conditions in the region connected to those in the North Atlantic region, the results provide a key insight into the resilience of these teleconnections through the last glacial and the abrupt climate changes that are observed in Greenland ice-core records.

ID: 02213, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Late Pliocene diatom carbon isotope reconstructions of pCO2 in the Subarctic Pacific Ocean

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The development of large ice-sheets across the Northern Hemisphere during the late Pliocene and the emergence of the glacial-interglacial cycles which punctuate the Quaternary mark a significant threshold in the Earth\'s history. Although a number of mechanisms have been proposed to initiate the global cooling and glacial advances associated with these transitions, uncertainty remains over the extent to which oceanic processes may have lowered atmospheric CO_2 and so contributed towards these changes. Taking advantage of recent improvements in our understanding of the carbon isotope composition of diatoms ($\delta^{13}\text{C}_{\text{diatom}}$) we reconstruct changes in photic zone $p\text{CO}_2$ at ODP Site 882 in the subarctic North West Pacific Ocean through the late Pliocene and over the onset of major Northern Hemisphere Glaciation (oNHG). Existing records from the region have shown a dramatic drop in opal mass accumulation rates (MAR) from c. 3 g cm^{-2} ka^{-1} to <1 g cm^{-2} ka^{-1}, associated with a transition from a mixed to stratified water column [Haug et al., 1999; Haug et al., 2005]. This event may have resulted in corresponding changes in marine/atmospheric exchanges of $p\text{CO}_2$ with a mixed water column associated with the ventilation of marine CO2 [Haug et al., 1999]. Our $\delta^{13}\text{C}_{\text{diatom}}$ record demonstrates that photic zone $p\text{CO}_2$ in the subarctic North West Pacific Ocean remained relative unchanged through the late Pliocene and the oNHG. Comparison of these results to modelled and proxy records of atmospheric pCO2 suggests the region consistently acted as a net sink of atmospheric CO_2 through this interval.

ID: 02139, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

A new long record of the Pleistocene glacial/interglacial environmental variability in the Amerasian Arctic Ocean (Mendeleev Ridge)

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Arctic Ocean sediments record variations in ice sheets extent on surrounding continents and related sea-level fluctuations, changes in sea ice and bioproductivity, interactions with waters from surrounding oceans. Not so many cores in the Arctic Ocean have well preserved calcareous microfossils in sediments older than Marine Oxygen Isotope Stages (MIS) 7-9. We present here the results of a multiproxy investigation of core KD12-03-10C (79°27,75\' N, 171°55,08\' W, water depth 2200 m) from the Mendeleev Ridge that contains calcareous microfossils throughout its 575 cm long sediment sequence. We obtained lithological (grain size, ice- and iceberg-rafted debris (IRD) counts), geochemical (planktic $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$), micro- and macrofossils (planktic, benthic foraminifers, ostracods, molluscs, cirripeds, polychaets, palynomorphs) evidence on past environments constrained by four AMS^{14}C datings from the uppermost 24 cm aging back to MIS 1-3. Variability of $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ curves suggests MIS 21 as an approximate basal core age. Downcore alternation of eight IRD peaks (corresponding to glacials and glacial terminations of MIS 16, 12, 10, 8, 5/6, 5d, 3/4, 1/2) and several peaks in the abundance of planktic and benthic fossils together with changes in species composition and stratigraphic index-species give evidence for temporally consistent sediment accumulation. The lower IRD-free sediment unit (MIS 17-21) characterizes mild climatic conditions with seasonal sea-ice cover and high bioproductivity. Similar environments are assumed for the interglacial of MIS 11 distinguished by the dominance of subpolar symbiont-bearing planktic foraminifer *Turborotalita egelida*. Since MIS 11, cooling trend is reflected by enhanced amplitude of $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ variations; changes in benthic and planktic assemblages pointing to more permanent sea-ice cover together with the stronger influence of the North Atlantic deep waters; increase in the share of carbonates among IRD fragments. The latter evidences growing iceberg supply by the Laurentide ice sheet and strengthening of the Beaufort Gyre.

ID: 01359, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Simulated sensitivity of the tropical climate to extratropical thermal forcing

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This study investigates the Intertropical Convergence Zone (ITCZ) response to an extratropical thermal forcing using an atmospheric general circulation model coupled to low (slab) and medium complexity ocean models. We focus on the relative roles of the atmosphere, the tropical sea and land surface temperatures (SST and LST) and the tropical ocean dynamics. The imposed forcing consists of cooling in one hemisphere and warming in the other, poleward of 40° and with zero global average, and is intended to represent the asymmetric temperature changes associated with glacial-interglacial and millennial-scale climate variability. We find that the ITCZ response to the extratropical forcing is not possible just trough purely atmospheric processes, but needs the involvement of either the tropical SST or the LST. In particular, the LST plays a mayor role in determining the ITCZ response over Africa and the Atlantic Ocean. The clear-sky longwave radiation effect is highlighted as the main physical mechanism behind this land-based extratropical to tropical teleconnection. Furthermore, our experiments indicate that the tropical ocean dynamics tends to oppose the incoming remote signal, generating weaker annual-mean signals than when only a slab ocean model is coupled in the tropics.

ID: 01361, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Control of the South Atlantic Convergence Zone by extratropical thermal forcing

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The response of the South Atlantic Convergence Zone (SACZ) to an extratropical thermal forcing is investigated in a series of simulations performed with an atmospheric general circulation model coupled to a slab ocean model. Three sets of experiments are performed, varying the extratropical forcing. In the first the forcing consists of warming of the Northern Hemisphere (NH) and cooling of the Southern Hemisphere, with zero global average. In the second and third experiments, the former forcing is divided into its northern and southern components to asses their relative roles in affecting the SACZ. In all the cases realistic surface boundary conditions are implemented.

We find that during its peak in austral summer the SACZ weakens in response to the extratropical forcing and that such weakening is mostly due to the NH component of the forcing. We find that 75% of the SACZ signal in response to the forcing is linked to the generation of a secondary tropical convergence zone in the Atlantic Ocean around 20°N-30ºN, which generates an anomalous Hadley circulation with subsidence over the SACZ. This mechanism appears to be dependent on the tropical ocean response, as it weakens significantly when the simulation is repeated not allowing the tropical sea surface temperatures to change in response to the forcing. The remaining 25% of the signal can be explained through the development of a Walker-type of circulation between western tropical Africa and the SACZ, being this mechanism dependent on the African land surface temperature reaction to the remote forcing.

ID: 02245, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Towards Greenland Glaciation: cumulative or abrupt transition?

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During the mid-Pliocene warming period (3-3.3 Ma BP), the global annual mean temperatures inferred by data and model studies were 2-3° warmer than pre-industrial values. Accordingly, Greenland ice sheet volume is supposed to reach at the most, only half of that of present-day. Around 2.7-2.6 Ma BP, just ~500 kyr after the warming peak of mid-Pliocene, the Greenland ice sheet has reached its full size. A crucial question concerns the evolution of the Greenland ice sheet from half to full size during the 3 – 2.5 Ma period. Data show a decreasing trend of atmospheric pCO2 from 3 Ma to 2.5 Ma. However, a recent study by Contoux et al (2015) suggests that a lowering of CO2 is not sufficient to initiate a perennial glaciation on Greenland and must be combined with low summer insolation to preserve the ice sheet during insolation maxima. This suggests rather a cumulative process than an abrupt event. In order to diagnose the evolution of the ice sheet build-up, we carry on a transient simulation of ice sheet evolutions from 3 Ma to 2.5 Ma. Here, we apply a tri-dimensional interpolation method designed by Ladant et al. (2014), which allows us to accounting for the evolution of pCO2, orbital parameters and ice sheet volume. By interpolating climatic snapshot simulations ran with various possible combinations of CO2, orbits and ice sheet sizes, we can build a continuous climatic forcing that is then used to provide a 500 kyrs-long ice sheet simulations. With such a tool, we may offer a physically based answer to different CO2 reconstructions scenarios and analyze which one is the most consistent with Greenland ice sheet built-up.

ID: 02054, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

The Deglacial Evolution of CO2 in the North Pacific

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The North Pacific is one of the largest carbon reservoirs in the global ocean, but has not typically been thought to play an active role in deglacial CO_2 change based on the assumption that its modern stratified state persisted on glacial-interglacial timescales. New research suggests a more dynamic circulation regime operated in the glacial and deglacial North Pacific and, as such, the role of the North Pacific in deglacial CO_2 rise may have been underestimated. Here we present new planktic foraminiferal boron isotope data from the North East Pacific that provide high resolution surface water CO_2 estimates through the last deglaciation. The general trend from LGM to Holocene is one of increasing surface water CO_2, punctuated by two abrupt CO_2 increases during Heinrich Stadial 1 (HS1) and at the onset of the Bølling-Allerød (B/A). HS1 was characterised in the North Pacific by intermediate to deep mixing, leading to a scenario where previously isolated deep carbon is mixed throughout the water column. This causes a transient increase in surface water CO_2, followed by a return to lower values, as high CO_2 waters are mixed through and then flushed out of the upper reaches of the North Pacific. Circulation during the B/A is markedly different to HS1, with an abrupt switch to stratified conditions. This regime allows for the unimpeded upwelling of CO_2 and nutrient-rich deep waters to the upper reaches of the North Pacific. Although productivity increases markedly in the B/A, our boron isotope data show that this does not overcome enhanced CO_2 supply. These data thus suggest that the North Pacific may have played a role in abrupt CO_2 rise during both HS1 and the B/A.

ID: 01574, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Advances in the understanding of the climate evolution of the Iberian Peninsula since AD 1700 inferred from tree-ring records and documentary evidence

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The IPCC report (IPCC, 2013) highlighted a likely increase of average global temperatures in upcoming decades, and pointed particularly to the Mediterranean basin, and therefore to the Iberian Peninsula (IP), as a region of substantial modelled temperature changes. Consequently, it is particularly important to study past climate evolution to improve future climate scenarios. However, our knowledge of past climate variability and trends is limited by the shortage of instrumental data prior to the 21st century, which triggers the need to discover new sources with which to understand past climate before the instrumental period. In this communication, we present a new paleoclimatic database for the northeast of the Iberian Peninsula based on tree-ring records, documentary evidence and instrumental data. On the one hand, 774 tree-ring, earlywood and latewood width series from old to young trees in the study area (*Pinus uncinata, Pinus sylvestris and Pinus nigra*) were analysed extended back to AD 1510. Three reconstructions were developed with these samples; an annual drought reconstruction since AD 1694, a summer drought reconstruction since AD 1734, and a maximum temperature reconstruction since AD 1604. On the other hand, the documentary records of 16 locations within the Ebro Valley have been carefully examined to identify the so called 'rogations'. In continue periods of severe droughts or wet event rogations were made to ask God for rain or to stop it. We identified 3 levels depending on the importance of religious acts which, in turn, identified the severity of the drought or wet event. A drought index was developed within these documentary sources. In addition, an attempt to explore the links between documentary and tree-ring records was performed.

ID: 02266, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Separating drivers of lake level fluctuations in humid climates

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The study of lake level changes is a key tool for reconstructing the hydroclimate of the past. It is, however, not a trivial task to reconstruct and interpret lake level changes.

Reconstruction is challenging because lake level changes can affect sediment formation in various, even contrasting ways. Carbonate deposition, for example, may rise or decline with increasing lake levels.

Furthermore, cores from lake margins usually provide most detailed information about lake levels of the past, but sedimentation at lake margins is often disturbed or interrupted due to lake level changes. Sediment records from deep basins tend to be continuous, but can hardly be interpreted in terms of absolute lake levels.

Interpretation is challenging because variations in hydroclimate are just one of numerous factors that cause lake level fluctuations. Further factors relate to manipulations of the catchment area, either natural (e.g. beaver activity), or man-made (drainage). Also changes in land cover may affect lake levels because the land cover largely determines evapotranspiration and ground water formation. Interpretation of past lake level fluctuations still focuses on hydroclimate as the main driver.

We here attempt to distinguish between hydroclimate and alternative drivers for Holocene lake level fluctuations. To that end we compare lake level reconstructions from three sites in NE-Germany. The lakes are arranged along a transect from poorly drained morainic to well drained sandy soils. Land use started earlier and has been more intense on the morainic soils. Lake levels have been reconstructed with multiple cores and various proxies, including geochemistry and biological indicators. Human impact through time is reconstructed in high resolution with the Extended Downscaling Approach. The results indicate that changes in land cover, both natural as well as man-made, had long-term effects on the lake level at all three sites.

ID: 02260, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

The extended downscaling approach - using forward modelling to reconstruct vegetation patterns within landscapes

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Studying human-climate-environment interactions is a matter of scale. Estimating the human impact, for example, requires an understanding of where exactly humans have been active within a landscape. Pollen data are probably the most valuable proxy of past human activity, yet pollen data alone are poorly suited to reconstruct the pattern of human activity. Pollen records from large lakes represent vegetation composition on scale that is too coarse to detect patterns inside landscapes. Pollen records from very small lakes or peatlands enable reconstructions on a very small, local scale. Studies using such records potentially increase spatial resolution of the reconstruction but application is usually limited by the high workload and the absence of suitable sites at required positions.

The extended downscaling approach aims to provide spatially explicit vegetation reconstruction within landscapes by combining pollen data with robust landscape patterns. To that end the EDA applies forward modelling: the approach searches for the vegetation composition within the known landscape pattern that produces pollen deposition most similar to the empiric data. Tests on simulated data have shown that the approach is well applicable in species rich settings with a number of landscape units (EDA). The approach requires pollen records from at least 5, ideally more than 20 large lakes or peatlands across a landscape.

The approach will be illustrated using example data from 50 lakes in NE-Germany. Here, the EDA is applied to well defined periods with low and high land use intensity, i.e. mid Holocene, Bronze Age, Iron Age and the medieval settlement period. Using the results, first the shifting pattern of land use is discussed. Secondly, potential effects of land use on the hydroclimate of the area, expressed in lake level fluctuations, are presented.

ID: 01484, 18.- Human Impact on Global Aquatic Systems, (Poster)

Traces of early prehistorical human's residence in UNESCO Trang An Landscape Complex of Vietnam and some initial findings about the impact on aquatic ecosystems

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The Trang An low-lying delta, located in between limestone massif in southwest of the Red River delta, was recognized as UNESCO Trang An Landscape Complex in 2015 and well known for vestiges of prehistoric human’s activities. Recent archeological findings demonstrated the existence of humans since Paleolithic period and emergence of agriculture and animal husbandry, and possibly water rice cultivation in Neolithic period. Initial research on archaeology and ancient environment in Trang An plain showed traces of the early residence of historical human during the period from 20,000 years to 5,500 years ago, with presence of Poaceae phytoliths of about 9,000-6,500 years before, stone tools found in the Oc cave, Thien Ha cave, Da Vang rocky roof, Ong Hay rocky roof and Moi cave.

Wetland environment of the Trang An delta also underwent fluctuations between flooding and drying. Due to Flandrian transgression in Holocene, the environment of bays and marshes began to invade the delta as a result of coastal flooding, leaving water corrosion lines carved into rocks. Since the water table is at same altitude with the current delta, karst valleys become flooded and connected together by regularly flooded cross-mountain horizontal caves of different lengths. The transverse caves run in a zigzac inside the karst towers according to the crisscross lattice fault system, connected with closed lakes, creating an unique continuous wetland system. Remains of some snail species, freshwater crabs, turtles, fishes of ancient time have been found in the caves together with traces of the ancient residence, showing that these underwater species has been caught and used as an essential food source for ancient people. The earliest evidences for that prehistoric human caught snails and freshwater mollusks for food were found in the caves of age from 30,000 to 4,000 years BP. More in-depth study and database is needed to find clear, convincing evidence on regime shift in aquatic ecosystem under impacts of human activities in this region.

ID: 01381, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Reconstructing dust input and its influence on the efficiency of the biological pump in the Southern Indian Ocean over glacial-interglacial changes

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For the earth's climate evolution during glacial-interglacial cycles, the partitioning of CO_2 between the ocean and atmosphere plays a crucial role. It is mainly modulated by Southern Ocean variations in a) vertical mixing intensities close to the Antarctic continent bringing CO_2-and nutrient-rich waters to the surface ocean and b) the strength of export fluxes transporting CO_2 to the abyss. Combined, variations in the efficiency of the so-called biological pump can reasonably explain pCO_2 trends recorded in Antarctic ice cores. Focusing on the strength of export production, two opponent behaviours during glacials/interglacials have been observed in different parts of the Atlantic sector of the Southern Ocean, arguing for the idea of an iron fertilization effect in the subantarctic zone due to enhanced dust input fueling photosynthesis. However, temporal and spatial limitations do not allow drawing firm conclusions from these observations for the entire Southern ocean, yet. Here, we present new sediment records from the Southern Indian Ocean, adding up to existing records for a more complete picture of past Southern ocean dynamics. The sediment cores were collected as part of the IndienSud expeditions aboard the RV Marion-Dufresne conducted with the French polar institute IPEV in 2011 and 2012 in the Kerguelen sector of the South Indian Ocean. We report ^{230}Th-corrected biogenic opal, carbonate and alkenone fluxes as well as n-alkane concentrations as a dust input proxy on two highly resolved sediment cosres in the polar and subantarctic zone, respectively, in order to first reconstruct changes in export production and its possible relation to dust fertilization since the last LGM and second to see whether the patterns observed in the Atlantic sector still hold true for the Southern Indian Ocean.

ID: 01846, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Reconstructing winds in the Amundsen-Bellingshausen Sea over the past 300 years

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Extensive thinning of fast flowing glaciers, has made the Amundsen Sea coast region one of the largest Antarctic contributors to sea-level rise. The dominant patterns of both basal and surface melting and the collapse of Antarctic ice shelves in the Amundsen and Bellingshausen Seas could be explained by wind forcing. However, long records of past wind strength and atmospheric circulation are needed to assess the significance of these recent changes and their impact on Antarctic mass balance. Here we present a novel proxy for past wind strength in the Amundsen-Bellingshausen Sea, based on diatoms entrained in ice cores. The diatom abundance, species assemblages and total particulate content vary from year to year in response to the local and regional wind strength and circulation patterns that influence the onshore northerly winds. We present data from ice cores drilled in the southern Antarctic Peninsula and Ellsworth Land to investigate past wind strength and circulation over the past 300 years and its relationship with snow accumulation and surface temperature on the Amundsen Sea coast.

ID: 02190, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

Millennial scale variability of the AMOC and its link to climate during the Holocene

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Despite its importance for regional and global climate, the Holocene history of the Atlantic Meridional Overturning Circulation (AMOC) is poorly constrained. Improving our knowledge of past AMOC variability will contribute to our understanding of the cause of Holocene climate events.

We present Holocene grain-size records in depth transects from Blake Outer Ridge and Cape Hatteras, sampling the full-depth range of the Deep Western Boundary Current (DWBC), the lower limb of the AMOC. These records complement a depth-transect of grain-size records sampling the Iceland-Scotland (I-S) overflow, showing Holocene variations that reflect deglacial meltwater forcing in the early Holocene and insolation-forced trends from the middle-to-late Holocene. Our extensive datasets enable us to provide a coherent synthesis of changes in the flow strength of key components of the AMOC on centennial-millennial and orbital timescales, which we can use to develop our understanding of past millennial-scale climate variability.

Our results allow us to reveal long-term anti-phasing between the two Nordic overflows. We combine our grain size data with benthic d^{13}C data to show coupling of the strength and depth of the lower limb of the AMOC. We demonstrate that the changes in the deep limb of the AMOC are likely associated with hydrographic variability within the Nordic Seas, with a vigorous and deep lower limb of the AMOC occurring during intervals of enhanced northerly winds, driving strong export of the East Greenland Current, and thus a strengthened Denmark Straits Overflow. We will also report on pronounced centennial-millennial scale reductions in the inferred flow strength at sites bathed by Labrador Sea Water (LSW), which coincide with well-known climate events such as the Little Ice Age, suggesting an important role for LSW in Holocene centennial-millennial climate variability.

ID: 01769, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

An environmental record through Marine Isotope Stage 3 from North Stradbroke Island, sub-tropical Australia

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Marine Isotope Stage 3 (MIS3) is a critical period in earth history but is particularly important to Australia. During MIS3, humans arrived on the Australian continent and the last megafaunal extinctions occurred. Evidence from many parts of the world indicates that there was marked millennial-scale climate variability during MIS3. However, the extent and magnitude of such MIS3 variability is poorly known in Australia. Furthermore, the extent to which (any) climate variability played a part in Australian megafaunal extinctions is a matter of ongoing debate. Further consideration of this issue is hampered by an absence of well-dated records of sufficient resolution from the Australian mainland.

We present a new high resolution record of environmental change derived from elemental analysis by X-ray fluorescence (µXRF) scanning of a sediment core covering the past ca.100,000 years from Welsby Lagoon, North Stradbroke Island, a large sand island off the coast of Brisbane. This record is complemented by compound specific H isotope analyses from leaf waxes and aquatic cellulose oxygen isotope analyses. The chronology has been developed from 21 OSL ages and 20 ^{14}C dates. As there is little or no overland flow into the lagoon, geochemistry of the sediments reflects changes in windblown dust from the Australian continent. Contrary to another recent study, we find no evidence to indicate that there was a substantial hydrological shift that occurred at the time of megafaunal extinction on the Australian continent (ca. 45-50 ka), but do find evidence of marked hydrological variability in MIS3.

ID: 01817, 15.- The Holocene - its climate variability and rapid transitions, (Poster)

A rudimentary Holocene volcanic forcing reconstruction and its climatic impacts in Earth system model simulations

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Volcanic eruptions constitute a strong natural forcing on climate variability on a range of time scales. In support of an activity aiming to perform ensemble simulations of the Holocene (8 ka BP - present) using a full-complexity Earth system model (ESM), we have developed a rudimentary volcanic forcing time series for this time period. Due to the present lack of available synchronized bipolar ice core volcanic records covering more than 2500 years, stratospheric sulfur injections were reconstructed based on a single ice core, namely the GISP2 volcanic sulfate record. The optical properties and spatial distribution of volcanic stratospheric aerosols were produced with a prototype version of the Easy Volcanic Aerosol (EVA) volcanic forcing generator. The GISP2 volcanic sulfate record, and therefore the reconstructed Holocene forcing, contain a number of interesting features, including a handful of major events significantly larger than any of the past 2500 years, a long-term decrease in the frequency of volcanic activity, and isolated instances of apparent long-duration volcanic events. Such features, whether exactly realistic or not, allow an exploration of the simulated climate response to aspects of volcanic forcing not experienced during the Common Era. First results showcasing the simulated global climate response to volcanic forcing over the Holocene will be presented, including changes in temperature, precipitation, and the carbon cycle.

ID: 02071, 31.- Global Dust Deposition in Past, Present, and Future Climates, (Poster)

A multi-annual time series of north Red Sea dust loads and their chemical composition: provenance, impact on marine biogeochemical cycles and implications for paleo-dust reconstructions

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This study reports a multi-annual time series of atmospheric dust loads (2006 – 2016) and their chemical compositions (2006 – 2010) collected in the north Gulf of Aqaba (north Red Sea) at a weekly to bi-weekly resolution. Major and trace element abundances in each sample are reported for three fractions: water-soluble salts (L0), carbonates and oxides (weak acid leach, L1), and Al-silicates (L2).

Dust loads vary seasonally from low values in the late summer (~20-30 ug/m^3) to higher values in the fall, and highest values in late winter and early spring (~150-250 ug/m^3). During late winter and spring months, high dust loads originate predominantly from central and west Sahara, and are characterized by low Mg/Ca (L1, L2), low K/Al and Na/Al (L1), high Ca/Al (L1), and high Mg/Al (L2). By contrast, the ambient winter dust (low dust load intervals) is associated with proximal source regions from the East Sahara and Arabian Peninsula. Low dust loads characterize summer months with limited compositional variability relative to winter-spring months, displaying relatively high K/Al (L1) ratios. The latter is also relatively enriched in anthropogenic trace elements in the L0 and L1 fractions (e.g., Zn/Al, Pb/Al, Cr/Al, Ni/Al and V/Al), and back trajectories indicate that the source of these components is primarily from south and east Europe.

The temporal flux patterns of important nutrients such as Fe and Cd in the bio-available phases (L0, L1) are not correlated with major nutrients (N, P, Si) or Chlorophyll-a sea surface concentrations measured at a monthly and daily resolution, respectively, suggesting that the dust is not a driver of primary productivity in the Gulf of Aqaba. We further explore the compositional relation between the dust and proximal deep-sea sediments, in order to refine the possibility of reconstructing past dust patterns from marine records.

ID: 01971, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Climate variability during MIS 5 in NE Iberia and its surrounding seas

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Marine and terrestrial records are used to characterize climate variability across the last Interglacial period including the glacial inception. Several speleothems records from NE Iberia region are analyzed by means of different geochemical proxies (d^{18}O, d^{13}C, and Mg/Ca) in order to study regional hydrologic variability on land. Accurate U/Th-ages of those speleothems provides independents chronologies from the marine age models, which allow us an accurately constrains of climate changes during this period. Marine reconstructions are based on Cantabric and western Mediterranean sediments to allow to establishing atmosphere-ocean linkages. Sea surface temperatures and changes in evaporation-precipitation rates are estimated measuring $d^{18}O$ and Mg/Ca ratios on planktonic foraminifera *Globigerina bulloides.* On another hand, changes in deep-water currents intensities, associated with the Western Mediterranean Deep Water (WMDW), are identified by means of grain size analyses.

Our results suggest that enhanced aridity on land occurred during cold marine sub-stages. Moreover, our record of WMDW intensity suggests that these climatic conditions favored deep overturning. In contrast, unstable periods of relative high rainfall match with marine warm sub-stages when lower deep currents occurred. One of the most remarkable features in this study is the warm conditions at the end of the last interglacial that succeeds while an intense arid atmospheric shift occurred.

ID: 01802, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

From Antarctic ice cores to Australia's climate: Hydroclimate reconstructions using an alternative proxy

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Research worldwide shows that rainfall and streamflow (hydroclimate) reconstructions developed from paleoclimate proxy records provide more information on the range of climate variability possible than the short instrumental records water resource management plans are currently based on. Hence there is a clear need for the development of hydroclimate reconstructions to allow us to better manage our water resources into the future. In Australia, however, there is a lack of local high resolution proxies, particularly in catchments of interest, and as such the utility of remote proxies for developing hydroclimate reconstructions is being investigated. Here we exploit a teleconnection between summer sea salt deposition recorded in ice cores from East Antarctica and climate variability in eastern Australia to produce millennial-length, annual rainfall and streamflow reconstructions for a case-study catchment on Australia's eastern seaboard. The reconstructions show periods of higher hydroclimatic variability relative to the instrumental era, longer wet and dry epochs and importantly, that wet (dry) epochs in the rainfall record are shorter (longer) in the streamflow record. This has implications for interpreting rainfall proxies as water availability and also for our understanding of the rainfall-runoff relationship in protracted wet and dry periods. Furthermore, the variation in the distribution of the duration of wet and dry epochs between centuries suggests that water resources management and planning based on the statistics of the last 100 years of data (or less) is problematic. This information provides a better understanding of present infrastructure vulnerability in the context of past climate variability. In addition this work emphasises a novel combination of ice core science, paleoclimatology and catchment-scale hydrology that is now being used to develop more robust water resources planning and management.

ID: 01798, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Quantitative land-cover change in space and time over the Holocene in Europe for climate modelling: pollen-based reconstructions using the REVEALS model and statistical modelling for continuous gridded descriptions of past vegetation

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Quantification of the effect of human-induced land-cover change (land-use) on climate in the past is still a subject of debate. Progress in our understanding of the effects of land-use change on climate greatly depends on the availability of reliable, empirical data on past land-use changes in quantitative terms. We present here the achievements so far for Europe as a contribution to the PAGES working group LandCover6k which goal is to produce as reliable descriptions as possible of past vegetation for the evaluation of anthropogenic land-cover change (ALCC) scenarios and climate modelling applications at the global scale. Pollen-based reconstructions of past land cover were performed using the REVEALS model (Sugita, 2007) for i) selected time windows of the Holocene using all available pollen records (gridded reconstructions) and ii) for the entire Holocene using either a selection of pollen records or all records grouped according to biogeographical criteria and numerical classification. The two major increases in landscape openness occurred from i) c. 1.5k calendar yrs BP (in most of the study region) and ii) c. 0.5k (in the entire study region). The time of highest landscape openness in the entire study region was between 0.5k and 0.2k. Before 1.5k, landscape openness was largest in the temperate and hemiboreal zones of the study region and was already very significant around 3k. Statistical models were developed to reconstruct gridded, continuous past land-cover composition over Europe. The REVEALS pollen-based land-cover reconstructions were interpolated using a spatial model for Dirichlet observations with a latent Gaussian Markov Random Field (GMRF). Finally the spatial model was extended in an attempt to disentangle anthropogenic openness from natural, climate-induced vegetation cover by combining the pollen-based reconstructions of vegetation cover with population-based estimates of past human land use.

Sugita S (2007) *The Holocene*, 17(2): 229–241.

ID: 01956, 21.- Sediment Flux: Past Peaks and Troughs, (Poster)

Modern sediment fluxes in Lake Żabińskie (northeastern Poland): A perspective from sediment trapping and limnological measurements

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Process studies including limnological measurements and monitoring of modern sediment fluxes provide insights into seasonal dynamics of sedimentation in lakes. Here, we present results from Lake Żabińskie located in northeastern Poland with the aim to understand the mechanisms behind seasonal variability of sediment fluxes. This lake is particularly interesting because it holds an undisturbed record of annually laminated sediments that covers the entire Holocene.

We conducted a five-year long observation of limnological conditions within the water column (water temperature, oxygen concentrations and chlorophyll-a concentrations) as well as sediment fluxes. Sediment samples collected in different seasons were also analyzed for elemental composition including contents of organic matter, calcite, biogenic silica and minerogenic matter.

Our results show that different mixing patterns (dimictic to meromictic) may occur in Lake Żabińskie, depending on the meteorological conditions. Comparison with meteorological data indicates that the length of winter (ice cover duration) may have major implications for spring and fall mixing of the water column. Sediment fluxes varied substantially during the observation period and were largely dependent on the water column mixing. Most characteristic spring (April-June) maxima appear every year. Spring deposition is related to intense calcite precipitation and can constitute >50% of the total annual flux. Depending on meteorological conditions during late fall, a second maxima in sediment flux may also occur when fall overturn is completed. Considerable variability was also observed for elemental fluxes.

ID: 01741, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

The Kuban River Delta Holocene stratigraphy (grain size analysis)

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The Kuban River Delta is very young landform. It appeared in Early Holocene. Humans started to use “new lands” immediately. The Kuban River Delta has been changing very quickly for last hundreds and thousands years. These changes have as natural as human origin.

Two cores were drilled in the Kuban River Delta during summer 2016. One core is situated in the delta littoral zone. Other core is situated near the branching point. The samples were taken at 10-20 cm intervals. We preformed detailed grain size analysis of these samples was made. The data of field lithologic and geomorphic descriptions was used to create a stratigraphic scheme too.

The history of the youngest (littoral zone) and the oldest (branching point) delta landscape was reconstructed according to the results of paleogeographic reconstruction with the short review of the Kuban River Delta Holocene history. Our field work and analysis results and different scientific literature sources (geology, paleogeomorphology, paleogeography, hydrology, history, archaeology, etc.) were used as part of this research. The main stages and factors of the Delta development in Holocene were identified.

ID: 01565, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Deglacial variability in Eastern Equatorial Pacific deep-water circulation and bottom water chemistry

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The last deglaciation is marked by two periods of gradual atmospheric CO_2 rise during the Younger Dryas and Heinrich Stadial 1. These millennial-scale events are overprinted by periods of rapid (100-200 yrs) increase at 11.7 ka, 14.8 ka, and 16.3 ka. The deep and intermediate ocean is thought to be a major contributor of excess atmospheric CO_2 during the last deglaciation. However, the mechanisms associated with oceanic respired carbon storage are not as well constrained. Changes in the efficiency of the biological pump and in meridional overturning circulation have both been cited as possible mechanisms of respired carbon storage. We investigate the role of these mechanisms in the Eastern Equatorial Pacific (EEP) over the last 25,000 years using a combination of trace element and isotopic studies. Our studies focus on sediment core TR163-23 located at 2,730 m water-depth off the Galapagos margin. This core site is currently bathed in Pacific Deep Water with thermocline depth waters influenced by upwelling Equatorial Undercurrent waters.

ID: 01534, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Environmental change during the LBA-EIA-transition in S-Greece: climate forcing and human contribution

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We here present a newly started project which aims to reconstruct environmental changes and their influence on the cultural development in the region around the Gulf of Corinth during the Bronze Age/Iron Age transition (12th to 8th century BC) based on a complementary study of sedimentary and archaeological archives. The former will be investigated by applying geochemical, sedimentological and pedological proxies to sequences from selected valleys on the northern Peloponnese, Aetolia, and Boetia. The latter will compile and utilize a survey of archaeological data from relevant regions around the Gulf of Corinth. The aims of our project are (a) to reconstruct the changes in air temperature and hydrological dynamics; (b) to describe reactions of regional climate to short-term climate variations reported for the higher latitudes and potentially find coupling mechanisms; (c) to differentiate natural environmental conditions in the region from effects of human influence on the local climate, vegetation, erosion, and sedimentation; (d) to reconstruct social development from the archaeological record. The individual aims cumulate into a better understanding of socio-environmental interactions and possible scenarios of transformation, crisis, and collapse on local and regional scales. Combining organic and inorganic geochemical analyses with sedimentological and pedological analyses from the same archives, promises detailed palaeo-environmental information at a resolution that goes beyond the capabilities of each individual method. The connection with knowledge of social developments derived from archaeological data and the reconstruction of scenarios of transformation and crisis will enable us to disentangle and evaluate the role of natural and human-induced environmental changes within societies of changing complexity.

ID: 02189, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Simulation of the last Sapropel event using a high-resolution regional model

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Since decades, the simulation of sapropel events remains a challenge. These events, occurring periodically in the Mediterranean Sea produce a strong stratification of the water column and break intermediate and deep convection, thereby leading to a decrease in deep water oxygen, of which evidence are recorded in marine sediment cores. Data from Mediterranean sediments have thus helped to better understand the anoxia process, in particular for the last sapropel event, S1, lasting 3000 years about 10 kyrs ago. However the causal link between insolation changes and the African monsoon variations – thought to be the trigger of sapropel events –, and anoxia has still to be quantified. From a modelling point of view, a requisite for studying sapropel events is to capture seasonal winds that are instrumental in producing convection in the Med Sea. Recently, the development of high-resolution several models studies intend to fill this gap, building different scenarios (Grimm et al, 2015). Combining an atmospheric GCM (LMDZ4) and a high-resolution oceanic model (NEMOMED8, resolution of 1/8 degree) dedicated to the Mediterranean Sea, our first objective is to test whether monsoon precipitation triggered by insolation changes can increase the Nile run-off enough to stratify the East Mediterranean Sea. We notably show that a 15 mSv Nile runoff increase triggers a large decrease of convection in the whole Eastern Mediterranean Sea associated with strong anoxia in bottom waters. Comparisons of our first experiments with δ^{18}O and ε-Nd data will also be presented. Future work includes extending our simulations to investigate whether sapropel events can be maintained on longer time scales.

ID: 01550, 18.- Human Impact on Global Aquatic Systems, (Poster)

TOWARDS THE ESTABLISHMENT OF A PYRENEAN NETWORK OF GLOBAL CHANGE IN LAKES AND PEATBOGS: THE REPLIM PROJECT

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High mountain lakes and peat bogs are iconic elements of the Pyrenean landscape, highly vulnerable to recent climate change (CC) and human activities. REPLIM is a network of scientists, managers and citizens aimed to monitor the dynamics of high mountain lakes and peat bogs and their responses to global change and increased human pressure. REPLIM has selected a number of sensitive ecosystems to seasonally monitor main physical (temperature gradients, pH, conductivity) chemical (N and C stable isotopes, GHG emissions, trace elements) and biological (productivity, role of microorganisms in biogeochemical cycles) variables and to characterize the watersheds and the lake/peat bog basins. Because of the complexity of climate fluctuations during the Holocene and the long history of human interactions with the Pyrenean environments – at least since Neolithic -, the evolution of each site will be also assessed using paleolimnological techniques on short sediment cores. The network will help to identify the ecosystem dynamics (watershed erosion, carbon fluxes, heavy metal loads, bioproductivity changes) during the periods of intense human disturbance of watersheds – from the Middle Ages to modern times - and characterize with more detail other periods as the onset of the Industrial Revolution and the Great Acceleration during the 20th century. Some of these periods correspond also to known climate phases as the Medieval Climate Anomaly, the Little Ice Age and recent global warming but the timing, nature and synergies with cultural changes associated to these climate fluctuations are not well constrained at a Pyrenean scale. REPLIM will harmonize the variety of Climate Change indicators used by different administrations and researchers and will characterize the CC at both local (territories) and regional (Pyrenees) scales. Moreover, the network will try to reconstruct the past changes, document the present trends and model the future ecosystem responses. REPLIM will also increase awareness among the stakeholders and the citizenship about climate change in the high mountains environments and, in definitive, will help to define a strategy of management integrated with the socio-economic development of the Pyrenees.

ID: 01551, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

HYDROLOGICAL VARIABILITY IN ATACAMA ALTIPLANO LAKES DURING THE LAST MILLENNIA

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Paleohydrological reconstructions from the Chilean Altiplano document abrupt moisture fluctuations during the last millennia. Although the end of the mid Holocene aridity and the onset of more humid conditions between 6 – 4 ka has been identified in numerous regional marine and terrestrial sites, the timing of late Holocene dry and humid phases shows large regional variability. Laguna Miscanti (23° 43\' S - 67° 46\' W, 4140 m asl, 10 m deep) and Laguna Miñiques (23° 46'S - 67° 47'W, 4100 m asl, 4 m deep) are topographically closed, but connected by surface outflow from Miscanti. Sedimentological and geochemical indicators from two new cores show large facies changes, *i.e.* higher carbonate and evaporite deposition during more arid periods and increased organic productivity (both algal and macrophyte) during more humid phases. As in most Andean lakes located in volcanic settings, large ^{14}C reservoir effects occur complicating ^{14}C dating, so the age models include ^{210}Pb and U/Th dating.

In spite of dating uncertainties, both lakes show similar patterns during the last millennium. A humid phase in Laguna Miscanti prior to *ca* 1200 CE is coherent with rodent middens and geomorphological features indicative of a major pluvial/recharge event at lower altitudes (Atacama Desert) during the Medieval Climate Anomaly (*ca* 800 - 1300 CE). The LIA (1300 – 1850 CE) is characterized by several arid/humid cycles and the last century by a productivity increase. The hydrological changes observed during the last millennium illustrate the complex dynamics of recent climate evolution over the high altitude Andean plateau. Discrepancies between the northern and southern Altiplano records

and with intermediate latitudes (Central Chile) records may reflect contrasting responses to external forcing (Westerlies versus South American Monsoon dynamics) along different climatic zones.

ID: 01813, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Weichselian/Wisconsin interstadial climate and vegetation composition based on palaeobotanical data from northern Finland and Canada

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Uncertain chronological control and a single-proxy approach have hampered the establishment of a comprehensive picture of high latitude Weichselian/Wisconsin interstadial environments. More advanced dating methods, such as OSL method, and multi-proxy studies have recently changed the concept of climate and vegetation conditions during MIS 5c, MIS 5a and MIS 3. New palaeobotanical data derived from organic layers dated to MIS 3 in northern Fennoscandia and the Hudson Bay Lowland, Canada, respectively suggest boreal interstadial climate conditions and vegetation composition. Moreover, in Finnish Lapland a unique and intact sediment series reaching back to MIS 5e has enabled us to reconstruct MIS 5 environmental developments. Palaeobotanical data derived from lake sediment layers suggest that southern to mid-boreal climate conditions and vegetation prevailed in northern Finland during MIS 5c and 5a interstadials, respectively.

These new climate and vegetation interpretations are mainly based on plant macrofossil analysis results, although these data were always accompanied by palynological data. Insolation reconstructions covering the last glacial cycles support our climate interpretations.

ID: 01800, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Variability of the surface stratification in the southern domain of the California Current System during the last 2 millennia

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The stratification of the surface mixed layer is controlled on seasonal time scales by solar radiation and the turbulent mixing processes of the upper ocean. On longer interannual to interdecadal timescales, large atmosphere-ocean coupled systems, such as *El Niño*-Southern Oscillation and the Pacific Decadal Oscillation, control the low frequency variability of the California Current System. The objective of this work is to reconstruct the stratification of the surface ocean in the southernmost region of the California Current that will allow a better understanding of the natural variability beyond the instrumental record. The San Lazaro Basin (SLB) is a semi-enclosed basin located in the Gulf of Ulloa, off Baja California peninsula (25°10\'N, 112°24\'W). Its location, on the dynamic border between the California Current and the subtropical region, is highly sensitive to changes in the oceanography of both regions from interannual to centennial timescales. The restricted circulation in the basin and the high biological export production maintain suboxic conditions in the basin, which in conjunction with the high sedimentation rate (1 mm/yr), allows an excellent preservation of the laminated sediments on the sea-floor of this basin. To characterize the variability of the mixed layer, five cores were sampled continuously at 2-5 mm intervals. The $\delta^{18}O$ isotopic composition of 2 species of planktonic foraminifera with different niches in the water column (*Globigerinoides ruber and Neogloboquadrina dutertrei*) were used to generate a model of density stratification of the surface water column. The time series resulting from the stratification model was validated using instrumental records of the Pacific Decadal Oscillation (PDO) finding a significant correlation (r=0.6559, p=0.0000). The reconstruction of density stratification presents statistically significant periods from decadal to centennial timescales, which are further shared with other reconstructions of the eastern Pacific Ocean.

ID: 01670, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Global climate field reconstruction from 1600 to 2000 based on multi-proxy data and the Ensemble Kalman Fitting approach

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We use the PAGES global multi-proxy dataset to reconstruct past annual mean climate fields as well as past monthly mean fields at global scale over the last 400 hundred years by applying the Ensemble Kalman Fitting (EKF) approach. EKF is a covariance based data assimilation method which we implement to incorporate different types of temperature sensitive proxy records, i.e. tree-rings, ice cores, corals, into an atmospheric general circulation model ensemble with 30 members. We assimilate over 500 proxy records into the model simulations to obtain global, physically consistent climate fields. We use yearly assimilation step and treat the proxies either as annual means or take their seasonality into account. In the latter case, we model the proxy sensitivity to monthly temperature variations with a multiple regression approach to produce monthly climate fields. We compare the yearly and monthly resolved climate fields to reveal whether more information can be obtained by taking the seasonality of proxies into account. The monthly resolution may provide better insight to past climate states and may capture the evolution of the climate in more details which would allow us to further enhance understanding of the underlying mechanisms of past climate changes and their impacts. We expect that by assimilating the retrieved seasonal information from the proxy records will lead to an improved climate reconstruction and will help to better assess the characteristics of the global climate system.

ID: 02179, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Holocene Southern Hemisphere Westerly belt variability: investigating the linkage to solar forcing based on a terrestrial record from the Crozet archipelago, Indian Ocean

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The Southern Hemisphere Westerly wind belt (SHW) dominates the Southern Hemisphere mid to high latitude climate system, acting on large-scale precipitation and temperature patterns. Evidence for the influence of changes in solar activity on the Earth's climate in general and on atmospheric circulation patterns in particular, exists for the Northern Hemisphere but is lacking for the Southern Hemisphere, hampering a global perspective on the Sun-climate link.

Here we present a unique record for past changes in humidity and windiness from the Crozet archipelago at 46° S in the Indian sector of the Southern Ocean, a site strongly influenced by the Southern Hemisphere Westerly wind belt. A shift to wetter and windier climate conditions occurred c. 2800 years BP (before present AD 1950), caused by a strengthening of the SHW and coinciding with a major decline in solar activity during the Homeric minimum. Well-dated records are a prerequisite to investigate the connection of climatic change to external forcing factors such as solar activity changes. We successfully applied a high resolution ^{14}C wiggle-match dating strategy in order to (i) reduce the age uncertainties and (ii) investigate potential Sun-climate interactions. Investigations of climatic parameters from reanalysis data (based on the 11 year solar cycle) as well as from a climate model run encompassing grand solar minima suggest that periods of low solar activity are connected to (i) an equator-ward shift of the wind belt in the south Indian Ocean in agreement with our proxy-record and (ii) a synchronous change in atmospheric circulation of similar sign in both hemispheres. We conclude that a bipolar climate response occurred about 2800 years ago through a change in atmospheric circulation coincident with one of the most prominent grand solar minima during the Holocene.

ID: 01485, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Tracing late Pliocene Eastern Equatorial Atlantic ocean temperatures and water-column structure

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The mid-Piacenzian Warm Period (MPWP, 3.3-3.0 Ma) is the most recent period in Earth's history with a significantly warmer than present-day global climate. For this reason, it is often considered an (imperfect) analogue for end-21st century climate and forms an important target interval of proxy-model intercomparison studies. Because better understanding of late Pliocene climate requires quantification of temporal and spatial trends in sea surface temperature (SST), there is great demand for well-dated high-resolution proxy records. Different SST proxies can be used, each with specific limitations related to e.g. calcite preservation or calibration limits.

The late Pliocene at ODP Site 959 in the eastern equatorial Atlantic (2100 m depth, 2 °N Pliocene paleolatitude) contains benthic and planktic foraminifera of excellent preservation, abundant dinoflagellate cysts and high concentrations of lipids used for U^{K}_{37} and TEX_{86} paleothermometry. The late

Pliocene interval was dated in high resolution with stable oxygen isotope stratigraphy. In our target interval, U^{K}_{37} values are at proxy saturation (mean annual SST > ~27-28 °C), whereas TEX_{86} SSTs are unrealistically low (20-24 °C, using the TEX^{H}_{86} calibration), even if reflecting cold-month (upwelling season) temperatures. We evaluate a potential bias of TEX_{86} towards subsurface temperatures. For this, we build a framework of surface and subsurface signals from planktic foraminifera stable isotope chemistry and dinoflagellate cyst assemblages to trace changes in the water-column structure. Additionally, we compare high-resolution TEX_{86} and $Mg/Ca_{G.ruber}$ trends with a few Δ^{47} (clumped isotope) data and explore the potential of this novel proxy to recalibrate Mg/Ca and/or TEX_{86} if traditional calibrations are insufficient.

ID: 02282, 22.- Understanding past variations in atmospheric greenhouse gases to constrain future feedbacks in the Earth System, (Poster)

High methane output from northern lakes during warm early Holocene

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Small lakes comprise one of the largest natural sources of the potent greenhouse gas methane per unit area. Lakes at high northern latitudes, where current global warming is most pronounced, are expected to increase their methane emissions before the end of the century, but the magnitude and timing remain uncertain. Here we present estimates of Holocene methane emissions for two lakes in Alaska using a novel approach based on the observed relationship between methane flux and stable carbon isotope values ($\delta^{13}C$) of aquatic invertebrate remains. Our records indicate that emissions were 2-5 times higher during the warmer early Holocene (8,000-11,000 cal BP) than at present, which is similar to modelling studies that predict high-latitude lake CH_4 emissions under future warming scenarios.

ID: 01815, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

A high-resolution Holocene palaeoclimate record from the Laguna de Medina, Cádiz, southern Spain.

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Laguna de Medina today is a shallow endorheic lake with a surface area of 1.2 km^2, which is located 25 km to the northeast of Cádiz, southern Spain. The lake was formed by diapiric uplift of Triassic evaporites and Tertiary marls, followed by subrosion and partial collapse, which resulted in a complex basement relief and sedimentary infill. A 25.7 m long sediment core likely recovered from a sinkhole depression in the central part of the modern lake comprises the past 9.500 year continuously and with an exceptionally high temporal resolution. Geochemical and mineralogical data from the Laguna de Medina sediment record provide detailed information concerning the depositional history from a steep and deep doline towards the shallow, elongated lake of today, the chemical evolution of the lake, and the influence of climatic changes on sediment composition. The record can be divided into three periods: From 9.500 to 8.000 cal BP water levels and salinities were moderate, and the climatic conditions were relatively stable. Between 3.700 and 8.000 cal BP maximum lake levels occurred, being associated with the deposition of finely laminated facies. The climate during this period was rather unstable, leading to eleven short-term desiccation events, which are reflected by high Sr/Ca ratios and precipitation of gypsum, dolomite, and aragonite. The ostracod assemblages occurring in the respective sediments confirm high salinities during the stages of evaporite precipitation, with several periods of extreme salty conditions, in which even foraminifera occur. Since about 3.700 cal BP, the former doline is filled up with sediments, leading to the shallow and elongated lake of today, which dries out in very arid years, although the climate is relatively stable.

ID: 01756, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

A New Coral Proxy for Temperature in the Southern Gulf of Mexico

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Isotopic and elemental ratios in coral skeletons are useful proxies for understanding past climates. Coral Sr/Ca is a robust proxy of sea surface temperature (SST) that has been widely used in multi-centennial reconstructions. However, local inputs of Sr and or Ca to coastal oceans from terrestrial carbonate weathering can contaminate the coral Sr/Ca-SST signal.

In 1991, the U.S. Geological Survey recovered cores from five *Orbicella faveolata* colonies from three reefs offshore of Veracruz, Mexico (19.06°N, 96.93°W) with water depths varying from 3 to 12 m. Veracruz is an area where seasonal runoff from rivers enters Gulf of Mexico and seasonal upwelling occurs off the coast. Preliminary geochemical analysis suggests runoff and upwelling could have disrupted the coral Sr/Ca signal. Furthermore, this coral is difficult to sample along the growth-time line with a micromill due to complex skeletal structures and fragility. Coral Li/Ca and Li/Mg ratios are new proxies for reconstructing SST that may not be susceptible to contamination by carbonate weathering and runoff; however, reproducibility and calibration-verification has yet to be robustly assessed within and among coral colonies. Furthermore, we are using laser ablation inductively coupled plasma mass spectrometer (LA-ICP-MS) to precisely sample this coral structure and to conduct preliminary Li/Ca analyses with this suite of corals. Our preliminary analysis of 4 years with LA-ICP-MS reveals coral Li/Ca means and seasonal variations are similar among colonies suggesting good reproducibility this proxy. There will be an extension of coral Li/Ca- and Li/Mg-SST calibration interval to 10 years and we will use AHVRR satellite-derived SST for calibration and for determining reproducible and SST reconstruction error. Additionally, we will analyze other elements (Sr, U, and Ba) with LA-ICP-MS to evaluate their suitability as SST and upwelling proxies.

ID: 01473, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Glacial δ13C decreases in the western Tropical Atlantic during Heinrich stadials of the last 45 kyr

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During Heinrich Stadial (HS) 1, d^{13}C decreased throughout most of the upper Atlantic between ~ 1000 – 2500 m, and in some deeper Atlantic sites. Atlantic Meridional Overturning Circulation (AMOC) during this time is believed to have been weaker. Most explanations of the d^{13}C decrease suggest that it was a response to the AMOC reduction, but different mechanisms have been proposed. Some studies point to a reduction of the fraction of the glacial equivalent to North Atlantic Deep Water in the upper North Atlantic during the events, which promoted the extension of “southern sourced waters” to shallower depths. Other studies suggest that northern sourced waters flowed still, but with a lower d^{13}C due to changes in source water composition. The behavior of mid- and deep waters during previous HS is even less well constrained, in part due to the lack of available records.

In this study, we present carefully dated high-resolution records from marine sediment cores off the Northeast Brazilian margin, covering the last 45 ky. Stable isotopes (d^{18}O and d^{13}C) were measured on the benthic foraminifer *Cibicides wuellerstorfi*. Marked minima in d^{13}C at mid-depths off the Brazilian margin are visible during the last four HS. During all these periods, d^{18}O and d^{13}C values converge with those of the deeper core at ~3600 m, indicating that the same water mass bathed depths between ~ 2300 – 3600 m in the western Tropical Atlantic during HS. We explore different scenarios of the origin of this water mass by comparing our records with previously published ones, and with simulations of the isotope-enabled Earth System Model of intermediate complexity *i*LOVECLIM, but preliminary results do not support a southern origin of the low-d^{13}C water mass.

ID: 01474, 11.- Climate of Quaternary Interglacials from observations and model simulations, (Poster)

Interglacial climate of MIS 7 and MIS 11 influenced by ocean circulation during preceding Terminations

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Marine Isotope Stage (MIS) 7, the interglacial period dated *ca.* 195 – 245 kyr ago, exemplifies the non-linearity subjacent in the astronomical theory of the ice ages. Despite the fact that it coincides with some of the strongest insolation increases over the last 500,000 years, MIS7 is a relatively mild interglacial. In comparison, MIS11, the interglacial period that took place ~400 kyr ago, presents a major response of the climate system in most paleoclimatic records at a time of feeble orbital forcing. This mismatch between insolation forcing and climate response implies that if insolation is driving glacial-interglacial climate change, it can only be as a ‘pace-maker’ that triggers strong, positive feedbacks. Foremost among the mechanisms that may have amplified insolation-paced global change are millennial-scale ocean circulation perturbations, that have been linked to Antarctic temperature and atmospheric CO$_2$ increases.

This study investigates the influence of millennial-scale ocean perturbations in determining global climate during MIS7, by comparing marine sediment cores on a common time scale. New high-resolution data from core MD07-3077 in the Atlantic sector of the Southern

Ocean, together with data from North Atlantic cores, indicate that the terminal seesaw events that took place during Terminations III and IIIa are of a different nature than those acting during Termination I or V. Their impact on global climate is not related in a simple way to their magnitude and duration, and they were probably influenced by the background state of the ocean during MIS8 and by the relative extent of European and North American ice sheets. The comparison of the records with simulations of the isotope-enabled Earth System Model of intermediate complexity *i*LOVECLIM sheds light on the respective roles of insolation and millennial scale events on the development of each interglacial.

ID: 01428, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Historical shifts in oxygenation regime as recorded in the laminated sediments of lake Montcortès (Central Pyrenees)

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Recent spread of anoxia in aquatic ecosystems has become an issue worldwide and is expected to increase with current global warming. Concern exists and different projects on this complex phenomenon are currently ongoing. At the same time, proper long-term instrumental oxygen records are scarce, thus reducing the possibility of recording long-term changes in present and past oxygen shifts that can be related with climate or human influence and making predictions difficult.

In this work we assess the evolution of oxic/anoxic shifts of Lake Montcortès during the last 500 years, taking advantage of its varved sediment record. We combine independent biological (subfossil pigments) and inorganic sedimentary proxies (Fe, Mn, Ti, Ca, Si, S, Br) working at subdecadal resolution. We investigate when oxic/anoxic shifts were driven by anthropogenic impact and when by climatic influence.

Four main scenarios emerge: A) years with abrupt sediment inputs; B) years with outstanding spring mixing and oxygenation of the water column associated with diatom blooms; C) years with strong stratification, intense phototrophic sulfur bacterial activity and increased productivity; D) years with the aforementioned conditions but without a clear prevalence of any of them. Most years of C belong to the 20th century. More than 90% of the years with climatic instrumental records belong to B and C. Most years of A belong to the climatic unstable period of 1850 -1899AD. Most years of D belong to the period 1500-1750 AD, when human activities were most intense. Interestingly, an abrupt depopulation started by 1900 that lasts to our days and implied significant depression of the use of the lake basin. Importantly, current climate warming seems to be taking control over the oxygenation capacity of the lake, especially since the second half of the 20th century. In this aspect, our results coincide with recent findings at the global scale.

ID: 01335, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Pollen sources in studies of camelid coprolites from Patagonia (Argentina)

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Palynological studies on Holocene coprolites provide information about palaeodiets, seasonality and palaeoenvironment. The elucidation of the source of the coprolites pollen is a main issue to interpret what and how past facts happened. The aim of this study is to analyze the source of the pollen of present day Lama guanicoe feces and camelid coprolites. For this, feces and coprolites post-depositing pollen contamination and the plant surface contamination, which are part of the L. guanicoe's diet, were evaluated. The feces and plant were collected in the area near the sites CCP5 and CCP7 (47°57'S 72°05'W, 900 mamsl), Perito Moreno National Park. Moreover, coprolites collected in CCP5 and CCP7 dated by 14C between ca. 9640 and 2740 yr BP, were studied. Feces and coprolites were divided into outer and inner subsamples and extracted pollen from both fractions for analyses. Pollen extraction of the plant surface of Mulinum spinossum, Empetrum rubrum, Senecio filaginoides and Nardophyllum obtusifolium, were done. The results showed differences in the pollen concentration between subsamples of feces that could be linked with the pollination season. Coprolites evidenced a greater Nothofagus (anemophilous) pollen concentration in the outer surface than in the inner ones and certain taxa were only registered in a single part. Plant surface showed a high concentration of pollen of the mother plant, and a low concentration of other anemophilous and zoophilous taxa. A separate pollen analysis of the outer and inner parts of modern feces and coprolites yields information referred to pollen contamination; thus, the diet items of the vegetation not consumed by the organisms can be discriminated. These results are a new contribution to palaeoecological studies of Patagonia during the Holocene and highlight the importance of considering the taphonomic processes, which would be acting in the building of the pollen record of modern feces and coprolites.

ID: 01964, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

On the application of freshwater diatoms from marine sediments as a proxy for monsoons

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Asia has the largest river network due to abundant monsoon precipitation and large annual runoff (Tamura *et al.* 2016). The input of freshwater from the monsoon precipitation brings specific markers, such as freshwater diatoms and specific diatom ecological assemblages that are preserved in marine sediments. Being thus we will use freshwater diatoms as a proxy to try identify the monsoon signal in the Japan Sea, which records the monsoons patterns. Freshwater diatoms are easily identifiable and have been used in the Pacific Ocean to reconstruct environmental conditions (Lopes *et al*. 2006) and flooding episodes (Lopes and Mix, 2009).

Here we show results of the IODP Exp. 346, Core U1427, U1425 and U1423 of freshwater diatoms records from the Japan Sea marine sediments to study the East Asian Monsoon (EAM) patterns to understand how these were affected by Dansgaard-Oeschger (D-O) events and the Mid Pleistocene Transition (MPT).

Understanding how these patterns worked in the past regarding a global climate change transmission, will help to understand if and how EAM will behave facing climate changes that are originating in distant places such as the North Atlantic.

ID: 02111, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Lower Danube loess and millennial-scale paleoclimate changes: new approach, new outcome and new perspectives

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Loess-paleosol sequences are the most widespread terrestrial archives of Quaternary paleoclimate in the Middle-Lower Danube area.

Here we present a synopsis of the latest research carried out using detailed high-resolution sedimentological, geochemical and chronological approaches, including multi-method luminescence dating and tephrochronology of several loess profiles from the Lower Danube area. We provide detailed records of grain-size and loess geochemical composition, with the aim of reconstructing the paleoenvironment as well as complementing the luminescence based age models of these records through comparisons with other records, aided by the presence of volcanic ash beds (particularly the Campanian Ignimbrite), that allow for the building of reliable correlative age models. A series of environmental magnetic proxies provide information on the magnetic mineralogy, grain-size variations and trace the amplitude of past pedological influences that modulate the paleoclimatic significance of proxy data. Most parameters show distinct down-core oscillations that correlate well with regional shifts in paleoclimate. These features, visible also in the grain-size data are complemented by information from geochemical proxies that provide important insights into the nature of the depositional environment and origin of sediments.

Our new records are compared with regionally representative speleothem and marine stacks from

Black Sea, Mediterranean and the high-latitudes of Northern Hemisphere. The comparison reveals consistent millennial-scale variability (e.g., fluctuations that resemble stadial-interstadial events) archived within the proxy data and identification of common features that may allow for the synchronization of records for most of the last glacial cycle, but also intriguing differences. The results also illustrate the value of multiproxy approach in understanding sediment dynamics and variations in processes influencing/controlling loess-paleosol formation during rapid climate changes such as stadials and interstadials.

ID: 02114, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

Millennial-scale geochemical records of anthropogenic impact and natural climate change in the Romanian Carpathians during the Holocene

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Worldwide, reconstructions of natural dust flux and anthropogenic emissions have been used to produce records of past variability in atmospheric circulation, aridity, and human activities. Focusing on peat paleoclimate archives we present the first records of dust deposition over the Holocene for the Carpathian-Balkan region, and of past activities concerning the smelting of metals. Using qualitative (XRF) and quantitative (ICP-OES) data, we identify 10 periods of major dust deposition over the past 10000 years: 9500-9100, 8400-8100, 7720-7250, 6350-6000, 5450-5050, 4130-3770, 3450-2850, 2100-1450, 800-620 and 60 yr BP to present. Our data highlight several discrepancies between eastern and western European dust depositional records, and the impact of highly complex hydrological regimes in the Carpathian region. For example, after 6100 yr BP, we identify a disconnection between local hydrology and geochemical indicators of dust flux. This coincides with the appearance of millennial-scale cycles in the dust input, and geochemical composition indicative of a shift in dust provenance from regional to distal (Saharan) sources at the time of the Saharan desertification. Further, we use the high-resolution geochemical records alongside lead (Pb) isotopic data, from periods with enhanced human impact on the environment, such as the Early Metal Ages, the Antiquity, Medieval and the recent past. From this, we distinguish signatures related to the natural cycling of elements from the anthropogenic contributions due to natural resource exploitation, mining, and smelting activities. Together with existing geological, archaeological, and archaeometric evidences, our results provide a comprehensive record on the long-term history of metal-use development in central-eastern Europe. Through a comparison with records from Europe we document the existence of strong regional differences in the magnitude of past pollution, as well as temporal and spatial shifts in past emission sources.

ID: 01558, 25.- Palaeoenvironments of Africa: Pliocene to Present, (Poster)

ICDP project DeepCHALLA: reconstructing East African climate change and environmental history over the past 250,000 years

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Sediments on the bottom of Lake Challa, a 92-meter deep crater lake on the border of Kenya and Tanzania near Mt. Kilimanjaro, contain a uniquely long and continuous record of past climate and environmental change. The near-equatorial location and exceptional quality of this natural archive provide great opportunities to study tropical climate variability at both short (inter-annual to decadal) and long (glacial-interglacial) time scales; and the influence of this climate variability on the region’s freshwater resources, the functioning of terrestrial ecosystems, and the history of the East African landscape in which modern humans (our species, *Homo sapiens*) evolved and have lived ever since.

Supported in part by the International Continental Scientific Drilling Programme (ICDP), the DeepCHALLA project has now recovered the sediment record of Lake Challa down to 214.8 meter below the lake floor, with almost certain 100% cover of the uppermost 121.3 meter (ca.150,000 year BP to present) and estimated

85% cover over the lower part of the sequence, down to the lowermost distinct reflector in the available seismic stratigraphy. This reflector represents a 2 meter thick layer of volcanic sand and silt deposited ca.250,000 years ago, and overlies still older silty lacustrine clays deposited during early lake development. Down-hole logging produced continuous profiles of in-situ sediment composition that confer an absolute depth scale to both the recovered cores and their three-dimensional representation in seismic stratigraphy. As readily observed through the transparent core liners, Lake Challa sediments are finely laminated throughout most of the recovered sequence. Combined with the great time span, the exquisite temporal resolution of these sediments promises to greatly increase our understanding of tropical climate and ecosystem dynamics, and create a long-awaited equatorial counterpart to the high-latitude climate records extracted from the ice sheets of Greenland and Antarctica.

ID: 01437, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

Multidisciplinary palaeoflood reconstruction using dendrogeomorphology and hydraulic modelling in Portainé (Eastern Pyrenees, Iberian Peninsula)

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The Portainé basin is characterized by a high torrential activity, where flash floods and debris flows produce significant economic losses, especially in the access road to the Port-Ainé ski station, located in the headwaters. Recently, at least one event per year occurs. As there are no flow gauging stations and only one rain gauge (since 2011) within the basin, a multidisciplinary palaeohydrological approach was carried out in the most downstream reach (500 m). It combined dendrogeomorphology (dendrochronological dating), fluvial geomorphology (detailed topography and geomorphological mapping), hydrodynamics (1D hydraulic modelling) and palaeoflood discharge estimations. Such an analysis has never been carried out before in a selected study area and bridges the gap between previous applications of specific methods. Detailed topographic data was acquired in several field surveys with a Total Station and a differential GNSS system. From this data, detailed geomorphological maps of the valley bottom were obtained. Using dendrogeomorphology, 67 trees were sampled (144 samples), and 12 past events were dated from 1957 to 2011. We reconstructed the 2008 and 2010 events by hydraulic modelling, as they were the ones with enough scars on trees. The obtained palaeodischarges were $316m^3s^{-1}$ and $314m^3s^{-1}$ respectively. Hydraulic parameters (water depth, velocity and unit stream power) were determined for each analyzed tree. This allowed estimating the mobilized particle size, using different empirical relations. In order to integrate all the information, flow hydraulics was related to the geomorphic position of trees and the detailed landforms (facets). The obtained results, including the limitations, provide a good knowledge of the behavior of the torrential system and show the high potential of the combination of techniques for flood hazard assessment in ungauged areas with few trees. This study has been supported by MINECO (CHARMA, CGL2013-40828-R) and the University of Barcelona (APIF, 2014-2015).

ID: 01983, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

ENSO activity during the last climate cycle using IFA

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The El Niño / Southern Oscillation (ENSO) is the principal mode of interannual climate variability and affects key climate parameters such as low-latitude rainfall variability. Anticipating future ENSO variability under anthropogenic forcing is vital due to its profound socio-economic impact. Fossil corals suggest that 20th century ENSO variance is particularly high as compared to other time periods of the Holocene (Cobb et al., 2013, Science), the Last Glacial Maximum (Ford et al., 2015, Science) and the last glacial period (Tudhope et al., 2001, Science). Yet, recent climate modeling experiments suggest an increase in the frequency of both El Niño (Cai et al., 2014, Nature Climate Change) and La Niña (Cai et al., 2015, Nature Climate Change) events. We have expanded an Individual Foraminifera Analysis (IFA) dataset using the thermocline-dwelling *N. dutertrei* on a marine core collected in the Panama Basin (Leduc et al., 2009, Paleoceanography), that has proven to be a skillful way to reconstruct the ENSO (Thirumalai et al., 2013, Paleoceanography). Our new IFA dataset comprehensively covers the Holocene, the last deglaciation and Termination II (MIS5/6) time windows. We will also use previously published data from the Marine Isotope Stage 3 (MIS3). Our dataset confirms variable ENSO intensity during the Holocene and weaker activity during LGM than during the Holocene. As a next step, ENSO activity will be discussed with respect to the contrasting climatic background of the analyzed time windows (millennial-scale variability, Terminations).

ID: 02336, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Vegetation and environmental changes related to hydroclimate regimes in Western Pampas, Argentina, over the last 1.5 kyr.

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The Western Pampas of Argentina is a climate-sensitive region located near the eastern fringe of the Arid Diagonal of South America where spatial and temporal fluctuations of the Southern Hemisphere west-wind drift and the South American tropical circulation can be recorded. Shallow lakes formed in blowout dunes in this semiarid/subhumid region (33-34°S; 65°21'W) are a key source for reconstructing Late Quaternary environmental and paleoclimatic evolution because they provide geomorphologic evidences, sedimentary archives, and proxy-indicators (pollen and other palynomorphs, charcoal, C and N stable isotopes, among others) for deciphering the present landscape dynamics and the environmental changes over time. Basal radiocarbon dates of lake cores from different shallow lakes (e.g. Nassau, Los Pocitos and Primera Laguna) suggest that the commencement of organic sediment deposition occurred at dissimilar times. In addition, palynological analyses of these cores reveal local vegetation changes at multi-centennial and decadal scales for the last ~1.5 kyr, concomitant with variable dry and humid phases and anthropogenic activity. Regarding regional vegetation, pollen records indicate that the main components of the Pampean Grassland, Espinal (savannah-like with grasses), and Monte (shrub steppe with scattered woodlands) vegetation units (e.g. *Celtis*, *Larrea*, *Prosopis*) were present in the region since ~1.5 kyr BP. During the last ~300 cal yr BP some variations in the pollen assemblages, representing psammophytic and halophytic communities, seem to coincide with sand-dunes stabilization, rise in lake levels, and lately anthropogenic disturbance. This data highlights the complexity of the hydrological balance of the region and the need to further study this dune-lake landscape.

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ID: 02310, 32.- Large-scale hydroclimate variability and change of the Common Era: Patterns, Impacts, and Processes, (Poster)

A high resolution record of diatom variability (Lake Vichuquén, central Chile) during the last millennium

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A high-resolution sedimentary record in the Vichuquen basin is key for studying recent atmosphere-ocean dynamics as well as recent anthropogenic activity (e.g. sea-level variability and biogeochemical changes). We have reconstructed the recent variability of the lake using diatom functional groups (e.g. planktonic, benthonic, epiphytic) as environmental indicators. Located along coastal central Chile, Lake Vichuquen (~35ºS, 72ºW; 4 m asl, 30 m deep, surface area15 km^2) has a local climate heavily influenced by the coupled atmosphere-ocean-land system (SWW, SPA, ACC, the Oceanic Currents and the Coastal Cordillera). In 2011, we obtained a 1.8 m short core at 20 m water that was then sampled every 4 cm for diatom analyses. The core spans the last 700 years with a sampling resolution of ~12 yr intervals. The main results show a period of epiphytic diatom dominance from 575-720 yr BP, with presence of *Tabularia fasciculata* (28%, associated with chlorophytes) and *Cocconeis placentula* (17%); and a low P/B ratio (0.16) all indicative of the development of littoral environments and likely warmer conditions. The presence of *Diploneis didyma* (epissamic, strictly marine; 595-525 yrs BP) could indicate a shallower lake, with increased conductivity and marine influence in the lagoon. Deeper environments are implied by diatom assemblages during the last 200 years (P/Bmax: 9.3; *Lindavia ocellata*: 88%). Higher percentages of *Aulacoseira*, a highly silicified diatom that requires turbulent waters to stay afloat in the euphotic zone suggest periods of increased currents in the lagoon. Changes in diatom functional groups reflect century and decadal scale variations in depth and salinity during the last 700 years related to climate variability, watershed disturbances and variable ocean influence.

ID: 01664, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

North Atlantic surface and deep-water records reveal millennial-scale variations during the Pliocene Warm Period

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The early Pliocene, with atmospheric CO_2 concentrations at levels similar to today, is seen as a case study for Earth's future climate evolution. During this period the progressive closing of the Central American Seaway led to increased poleward heat and salt transport within the Atlantic with North Atlantic Deep Water (NADW) becoming warmer and saltier and resulting in an enhanced Atlantic Meridional Overturning Circulation (AMOC). In order to understand how stable the Pliocene AMOC really was, we are producing centennial-scale (average 0.9 ky) surface and deep-water records for IODP Site U1313 (41°N, 33°W, 3412m) for the interval from 3.4 to 4.2 Ma. This site is ideally located to monitor past AMOC changes with North Atlantic Drift waters at the surface and NADW in the deep. Besides the interglacial/glacial cycles, higher frequency oscillations are recorded in both the planktonic *G. ruber* (white) and benthic *Cibicidoides* sp. stable isotope records. The benthic $\delta^{13}C$ values indicate nearly continuous NADW presence and confirm a strong AMOC, also during most of the glacial periods. Varying surface water conditions, especially during the younger interglacial periods, are reflected in the *G. ruber* isotope data and appear to be linked to salinity changes since they are not recorded in the alkenone sea-surface temperature data. Although glacial stages Gi 2 and Gi 4 show the expected higher benthic $\delta^{18}O$ values, Gi 6 was the glacial period with the strongest impact on the AMOC as revealed by cooler, less ventilated surface waters and a less ventilated NADW. Overall, the AMOC was strong throughout, but experienced high frequency oscillations at a level similar to the middle Pleistocene interglacial periods.

ID: 01669, 06.- Before and after - climate contrasts across the MPT, (Poster)

Impressions of the Mid-Pleistocene Transition in Surface and Mediterranean Outflow Water Records from the Gulf of Cadiz, Portugal

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The Mediterranean Outflow Water (MOW) forms contourite drift deposits along the Iberian margin and injects heat and salt into the North Atlantic affecting the overturning circulation. Centennial-scale proxy records of IODP Site U1387 in the NE Atlantic reveal surface water (mostly of subtropical origin) and MOW changes during the interval from Marine Isotope Stage (MIS) 16 to MIS 50 (650-1500 ka), encompassing the Mid-Pleistocene Transition (MPT). Interglacial surface water conditions were relatively stable with sea-surface temperatures (SST) near 21°C during MIS 17 to 29 and increasing to 22-24°C during and prior to MIS 31. Starting with MIS 27, transitions into the interglacial stage were abrupt and can include deglacial meltwater events. Transitions into MIS 29 to 45, on the other hand, were more gradual. Interglacial to glacial transitions and most of the glacial periods experienced millennial-scale stadial/interstadial oscillations, similar to those known from the late Pleistocene. Some stadials encompassed extreme cold events with SST dropping below 13°C. The timing of these events varied, occurring either at the end (MIS 18 to 26) or during the first half of the glacial period (MIS 30, 36, 38). Surface water as well as MOW ventilation and velocity records show no indication of a MPT related shift, but the benthic $\delta^{18}O$ data reveals an early response with a step to higher values already during MIS 26. Changes in MOW properties are linked to insolation with maxima leading to poorer ventilation (influence of sapropel formation/African monsoon) and minima sometimes to the formation of contourite layers. Millennial-scale MOW velocity increases, on the other hand, correlated with periods of colder SST, confirming the link between MOW and ice/North Atlantic Ocean interactions.

ID: 02174, 23.- Regional syntheses of human-climate-environment interactions, (Poster)

Environment, Climate and Human impact in the Central Alps since the last deglaciation: Small-scale mires as sedimentological and geochemical archives

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With the end of the last glaciation, humans began to repopulate and use landscapes in Europe, which were previously covered with ice and snow. Mountainous areas like the Central Alps were and still are harsh environments for life. When and how humans began using of the high alpine passes, slopes and valleys for travelling and trade, hunting, pastoralism, agriculture or even mining and metallurgy is not wholly understood. Three locations in different parts and altitudes of the Central Alps are studied: Fimba Valley (Switzerland), Kleinwalser Valley and Piller Moor (both Austria). Each one is in close vicinity to important archaeological sites, but their linkage with the local development of environmental and climatic conditions needs further investigation. Peatlands are able to record sedimentological, geochemical, but also vegetation indicators that can help untangling the interaction in a sufficient temporal resolution. Local paleobotanical studies have proven that peat cores are among the few archives in the mountains that could provide a continuous record, back to the permanent retreat of glaciers. However, mountainous environments can often sustain only small-scale mires, which are usually heterogeneous. They are less well studied and single common proxies must be applied carefully. Therefore, this study follows a multi-proxy approach with a focus on the geochemical methods XRF, ICP-OES/MS and CN-ratios. Radiocarbon dating provides the chronological framework to compare the geochemical data to local archaeological sites and relevant climatic, botanical and historical records. First results can confirm that the Fimba Valley (2400m asl) was ice free at 10.390 cal. years BP although the onset of peat accumulation was delayed from the western to the eastern side of the valley. In the Kleinwalser Valley (1150m asl), peat growth started around 6.100 cal. years BP – simultaneously with a massive deforestation.

ID: 01245, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Late Quaternary paleoenvironmental reconstruction using sedimentological parameters and quartz grains from lacustrine sediments of Schirmacher Oasis, East Antarctica

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In this study we report the sediment grain size parameters and surface textural observations (using scanning electron microscopy (SEM)) of quartz grains of a sediment core from Schirmacher Oasis, East Antarctica, spanning the last 43 cal ka B.P. The sediments are poorly sorted and finely skewed and show different modes of grain size distribution throughout the last 43 cal ka B.P. The statistical parameters of grain size data (sorting, skewness, kurtosis, mean grain size, D_{10}, D_{50}, D_{90} and SPAN index) indicate that the sediments are primarily transported by melt-water channels and glaciers. However, during the last glacial period, sediments were mainly transported due to wind activity as evident by the good correlation between rounded quartz data and dust flux data from EPICA ice-core data. The mean grain size values are low during the last glacial period indicating colder climatic conditions and the values increase after the last glacial maximum suggesting an increase in the energy of the transporting medium, i.e., melt-water streams. SEM studies of selected quartz grains and analyses of various surface textures indicate that glacigenic conditions must have prevailed at the time of their transport. Semi-quantitative analyses of mineral (quartz, feldspar, mica, garnet and rock fragments & other minerals) counts suggest a mixed population of minerals with quartz being the dominant mineral. Higher concentration of quartz grains over other minerals explain the compositional maturity of the sediments. The study reveals the different types of physical weathering, erosive signatures, and chemical precipitation most of them characteristic of glacial environment which affected these quartz grains before final deposition as lake sediments. The palaeoclimatic signals obtained from this study show similarities with ice-core and lake sediment records from Schirmacher Oasis and other ice-free regions in East Antarctica.

ID: 01888, 17.- Abrupt climate change: Challenges for Earth system understanding, (Poster)

Explicit simulation of δ18O and δD changes in atmosphere and ocean induced by a freshwater hosing

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Atmospheric and oceanic general circulation models (GCMs) enhanced by the capability to explicitly simulate the hydrological cycle of the two stable water isotopes $H_2^{18}O$ and HDO can provide an improved understanding regarding changes of the water isotope signals in various paleoclimate archives. However, so far the number of fully coupled atmosphere-ocean GCMs with explicit water isotope diagnostics is very limited. Such coupled models are required for a more comprehensive simulation of both past climates as well as related isotope changes in the Earth's hydrological cycle.

Here, we report results of a set of idealized freshwater hosing experiments performed with the ECHAM5/MPI-OM model, enhanced by explicit water isotope diagnostics. For the different simulations, the underlying background climate, as well as the duration of the freshwater hosing, is varied. First analyses of simulation results for a 150yrs-long hosing event in the North Atlantic reveal a maximum isotopic enrichment of down to -6‰ in ocean surface waters at the end of the hosing and a full recovering to the surface background state after a few centuries, as well as much longer response times in the deeper ocean. Over terrestrial surfaces, such kind of fresh water hosing results in spatially varying isotope depletion in precipitation between -5‰ and +3‰ in agreement with data from various isotope records and previous modelling studies. In further model analyses we investigate how the relation between water isotopes and key climate variables, e.g. land and ocean surface temperatures, precipitation amounts, and oceanic salinity, might has changed due to assumed intermittent fresh water input.

ID: 02325, 19.- Do species move, adapt or die? Exploring past biodiversity, ecological change and community dynamics in the fossil record, (Poster)

Do refugial species have smaller climatic niches than migrating ones ?

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During the advancement and retreat of the Northern European ice sheets, some species resided in glacial refugia whilst others migrated to track their preferred environment. Consequently, different members of a genus experienced different evolutionary histories. Using a novel method of ancestral niche reconstruction, we investigate how different climate regimes affect the climatic niche of a beetle genus through time. We specifically ask if niches have remained stable through time, how niche traits (e.g. thermal tolerance or niche breadth) differ between the species in (i) refugia and (ii) migrating species, and whether these traits are linked to how species have responded to the fluctuations of Quaternary climate.

We address these questions by investigating the impact of past climate change on the evolutionary history of the genus *Hydroporus,* a clade of water beetles widely distributed throughout the Palearctic. A phylogenetic tree for over seventy modern *Hydroporus* species is linked to niche trait data from Maxent. Key niche traits are mapped onto the phylogenetic tree and projected back in time using Bayesian modelling tools. Where applicable, predictions on the ancestral niche are ground-truthed using the fossil record of these beetles and available climate data. We also assess the impact of different climate regimes on both migrating and refugial species.

We predict that the climatic niche of the migrating species is more stable than the refugial species, and that climate stasis, as opposed to climate change, is the major evolutionary driving force for those beetles that live at higher latitude. We test whether refugial species have smaller climatic niches than migrating species, based on the evidence that allopatric speciation and competitive exclusion is more relevant to these species which evolved more recently in the Pleistocene. This work has major implications for our understanding of the likely genetic variation of populations that expanded from glacial refugia at the end of the Pleistocene.

ID: 01476, 16.- Multidisciplinary reconstruction of paleofloods, (Poster)

A multi-centennial record of past floods and earthquakes in Valle d'Aosta, Mediterranean Italian Alps

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Mediterranean Alpine populations are particularly exposed to natural hazards like floods and earthquakes because of both the close Mediterranean humidity source and the seismically active Alpine region. Knowledge of long-term variability in flood and earthquake occurrences is of high value since it can be useful to improve risk assessment and mitigation. In this context, we explore the potential of a lake-sediment sequence from Lago Inferiore de Laures in Valle d'Aosta (Northern Italy) as a long-term record of past floods and earthquakes. The high-resolution sedimentological study revealed 77 event layers over the last ca. 270 years; 8 are interpreted as most probably induced by earthquakes and 68 by flood events. Comparison to historical seismic data suggests that the recorded earthquakes are strong (epicentral MSK intensity of VI-IX) and/or close to the lake (distance of 25-120 km). Compared to other lake-sediment sequences, Lago Inferiore de Laures sediments appear to be regionally the most sensitive to earthquake shaking, offering a great potential to reconstruct the past regional seismicity further back in time. Comparison to historical and palaeoflood records suggests that the flood signal reconstructed from Lago Inferiore de Laures sediments well represents the regional and (multi-)decennial variability of summer-autumn floods, in connection to Mediterranean mesoscale precipitation events. Overall, our results reveal the high potential of Lago Inferiore de Laures sediments to extend the regional earthquake and flood catalogues far back in time.

ID: 02173, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Exploring the potential of Blue Intensity using conifer trees from Tasmania and New Zealand

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In the Northern hemisphere (NH), maximum latewood density (MXD) of tree rings has been the basis of several important multi-century tree-ring summer temperature reconstructions. Several recent studies have shown that latewood minimum blue reflectance (i.e., Blue Intensity - BI) has considerable potential as a cheaper surrogate of MXD. In the Southern Hemisphere (SH), where relatively few long temperature-sensitive tree-ring chronologies have been developed, MXD has rarely been used. To explore the potential of the BI variable in SH tree species, we measured BI from four conifer species (Huon pine, Celery-top pine, Pencil pine and King Billy pine)) at seven sites in Tasmania and two conifer species (Cedar and Pink pine) from two locations in New Zealand. We did not extract resins from the samples prior to light reflectance measurement, so the data represent a worst-case scenario where sapwood/heartwood and resin discolouration would likely bias the measurements. All BI data were detrended using flexible splines and pre-whitened to minimise secular time-scale biases. A significant relationship between BI and summer temperatures was found for all species except Celery-top pine. Principal component regression based calibration r^2 values explain > 50% of the summer temperature variance for both Tasmania and New Zealand. This is consistent with results using MXD and/or BI in the NH. Although these results are highly encouraging, at least for high-frequency calibration, the relationship of BI (and MXD) to summer temperatures for some species is opposite to that observed for NH conifers (i.e. low MXD/high BI values reflects warm summer conditions), which raises fundamental questions about the interactions between climate, tree physiology, and xylogenesis in SH conifers.

ID: 02171, 01.- Open Session on past global changes, (Poster)

Blue Intensity based experiments for reconstructing North Pacific temperatures along the Gulf of Alaska

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The Gulf of Alaska (GOA) is highly sensitive to the variability of the North Pacific climate system. Ring-width (RW) records from the GOA have yielded a valuable long-term perspective for North Pacific changes on decadal to longer time scales in previous studies, but can be less robust on interannual time scales due to autocorrelation and other factors. Similar to maximum latewood density (MXD), the novel Blue Intensity (BI) parameter has recently been shown to correlate strongly with year-to-year warm-season temperatures for a number of sites at northern latitudes. Since BI is much less expensive and labor intensive to generate than MXD, it has much value for future tree-ring studies in the GOA where few MXD records have been developed. Here we highlight the potential for improvement of reconstruction models using various combinations of RW and BI-related parameters (latewood BI and delta BI) measured from eight hemlock (*Tsuga mertensiana*) sites along the GOA. This is the first such study for the hemlock genus using BI data. We find that a combined experimental model using RW, delta BI and latewood BI best reflects inter-annual to multi-decadal temperature variability for the North Pacific sector, particularly during the warm-season months. A resulting test reconstruction (1792-1989 CE) of GOA CRUT 3.24 land JJAS temperatures (57-60°N/154-134°W) is significantly improved over that based on RW alone (58% vs 36% variance explained). Significant validation is also found with 19th century temperature data from Sitka, Alaska and using the BEST gridded data product. We therefore find that BI has considerable potential to become a sensitive, readily accessible alternative proxy for understanding past ocean-atmosphere variability in the GOA and elsewhere around the globe. A key need in furthering the utility of BI as a proxy is experimentation in the extraction of lower frequency variability.

ID: 01426, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Molecular proxy records of the effect of shelf exposure on Indo-Pacific warm pool climate from the past 450,000 years

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The Indo-Pacific warm pool (IPWP) is a major contributor of heat and moisture to the atmosphere and has a strong influence on climate throughout the tropics. During the Late Quaternary period, several different forcing mechanisms are thought to be responsible for changes in IPWP climate: precessional forcing, which alters seasonal temperatures and rainfall, and sea level changes, caused by glaciations, that exposed the Sunda and Sahul shelves, which trigger changes in both atmospheric and oceanic circulation via increased albedo. If the “shelf exposure” mechanism is correct, then the western IPWP should have experienced severe drying during glacial periods, and the eastern Indian Ocean thermocline should have cooled and shoaled. To test this hypothesis, we are analyzing marine core MD98-2152, located in an upwelling zone off of the southern coast of Sumatra (6.328S, 103.879E). MD98-2152 extends 450ka, spanning several glacial/interglacial periods. Specifically, we use the $U^{K'}_{37}$ (alkenones) index, the TEX_{86} (GDGTs) index, and the hydrogen isotopic composition of terrestrial leaf wax lipids (δD_{wax}) as proxies for SST, sub-surface temperature (Sub-T), and aridity, respectively. Preliminary results suggest drying and cooling at both the surface and the thermocline during glacial periods, tentatively supporting the shelf exposure mechanism, but precessional forcing also appears to play a role.

ID: 02137, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Cold spells in interior Iberia across the last glacial cycle, and implications for cultural turnover periods - A study on aeolian archives

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A large variety of terrestrial and marine records enable the reconstruction of climate variations during the late Pleistocene. Besides the importance of large-scale climate fluctuations for an understanding of atmospheric processes, a key question concerns the manner in which these fluctuations are manifested in landscape dynamics in continental areas. In particular the interior of the Iberian Peninsula as a core area of the Western Mediterranean realm still lacks palaeoenvironmental records that are crucial to close the gap in our knowledge of interactions between climate and landscape evolution over the last glacial cycle. In this respect, it is an open question whether and how far cooling events as recorded in marine corings from the Iberian margin affected environmental conditions in the central Iberian Peninsula. A detailed study of a loess record from the central Tajo Basin in Spain demonstrates that during marine isotope stage (MIS) 4 and 2 there is a strong temporal link between Heinrich Events (HE) and phases of loess deposition that are reflective of climate deterioration. However, during MIS 3, land-sea interrelations appear to be more complex with a kind of asynchrony between HEs and loess deposition. The temporal overlap between the beginning of the main period of loess sedimentation and the onset of MIS 2 is consistent with other loess areas in central and western Europe. But since this period obviously ended prior to the global LGM, this may be seen as an indication of more humid conditions between HE-1 and HE-2 in Iberia. According to a review on findings on human occupation in central Iberia, it follows further that cultural turnover periods that were often tentatively correlated with Heinrich Events in fact appear to be related to extreme environmental conditions.

ID: 01475, 06.- Before and after - climate contrasts across the MPT, (Poster)

Synthetic ice core records of the past 1.5 million years

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The search is on for a site in Antarctica where an ice core older than 800 ka can be retrieved. A key part of that search will be accessing the old ice rapidly with new drilling tools in order to assess the age of the ice and its temporal integrity. These tools would allow profiles of water isotopes, dust and methane to be retrieved. However, if we are to use these profiles to assign ages to the ice column we need to have target records: idealised datasets that closely mimic what the ice should record with time.

To do this, we need to look at existing marine and terrestrial datasets that have shown similarities with the ice core record over the 800 ka that already exists, considering both analogue and modelling approaches. While the primary purpose is to assess what a well-preserved record should look like, we can also consider how diffusion and ice deformation might affect the records we retrieve.

For the water isotopes, a starting point is the marine sediment record. It has been argued that the deep-sea temperature (Mg/Ca) record at a southern Pacific site has the same pattern as Antarctic δD. We will consider the evidence for this in the light of the datasets now available. Similarly, we will consider the extent to which dust proxies in southern hemisphere marine records show similar patterns to dust in Antarctic ice. The case of methane is trickier: aspects of the methane record are shared with Chinese speleothem oxygen isotopes, while it has also been argued that there is a coherence between southern European tree pollen records and methane concentrations. We will use these ideas and others to construct a prediction of methane over 1.5 Ma.

ID: 01685, 06.- Before and after - climate contrasts across the MPT, (Poster)

Investigating sea ice, productivity and nutrient utilisation in the Bering Sea over the Mid-Pleistocene Transition (0–1.2 Ma)

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The Mid-Pleistocene Transition (MPT), a global cooling trend between 1.2–0.8 Ma characterised by a shift from 40 to 100 kyr glacial-interglacial cyclicity, occurred in the absence of a long term change in external orbital forcing. This suggests a change in internal forcing as the cause. There are several proposed mechanisms focusing on sea ice, large land ice sheets, changes to deep ocean circulation and high latitude stratification. Sediment cores from the Bering Sea provide an opportunity to investigate how the subarctic North Pacific responded to MPT oceanographic changes. Here we present proxy data from the IODP Sites U1343 (water depth 1953m, 57°33’N, 175°49’E) and U1344 (water depth 3171m, 59°03’N, 179°12’W), located on the Bering slope in a region of high productivity known as the “Green Belt”. Results from $\delta^{15}N_{bulk}$, as a proxy of nutrient utilisation, provide constraint on the processes controlling subarctic primary productivity through the MPT. Fossil diatom assemblage results also allow an investigation into the role of sea ice evolution following MPT increase in glacial severity. Comparisons to records from elsewhere in the Bering Sea at Bowers Ridge and Umnak Plateau provide additional insights into both intermediate water layer conditions and photic zone productivity at shallower sites.

ID: 01687, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

320 years of sea surface pH and SST variability in the South Pacific inferred from Diploastrea heliopora coral proxy records

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Marine calcifying organisms are under threat from global climate change. Ocean acidification (OA) and warming sea surface temperature (SST) are the results from increasing anthropogenic CO_2 emissions. It is thus important to better understand how marine ecosystems and reef-building corals have responded to climate change pressures relative to historical pH and SST variability. To constrain the natural variability of pH and provide baseline reconstruction and quantification for OA, we measured $\delta^{11}B$ composition in an annually banded modern *Diploastrea heliopora* massive coral colony from New Caledonia in the southwestern

Pacific. This coral displays uninterrupted growth between 1690-2010 CE covering historical periods from the termination of the Maunder Minimum (ca. 1690-1715 CE) through the beginning of the Industrial Revolution (ca. 1760-1830 CE) and into the modern era (1900 CE to present). The most striking feature from our pH reconstruction is the evidence of OA (decrease in sea surface pH) based on the depleting $\delta^{11}B$ ratio in the most recent portion of the record. The distinct trend of decreasing $\delta^{13}C$ ratio in this coral documents and confirms the Suess Effect due to increase in anthropogenic atmospheric CO_2 concentration. This modern decrease in reconstructed pH is concurrent to the significant warming trend of at least 1 ºC as revealed by our coral-based SST proxies (i.e., Sr/Ca, Li/Mg, and $\delta^{18}O$). The interannual and longer-term decadal to interdecadal variability of our proxy records indicate a coupled anti-phase relationship between pH and SST reflecting similar climatic drivers related to the El Niño/Southern Oscillation (ENSO) and Pacific Decadal Oscillation. Our results support the potential of this coral genus as an archive to study global climate change where the lower frequency variability of South Pacific pH and SST are strongly modulated by ENSO and are coherent with records across the greater Pacific basin.

ID: 01494, 02.- Quaternary climate and environmental change in the Southern Hemisphere, (Poster)

Variations of the Antarctic Circumpolar Current and environmental conditions in the Kerguelen Islands region, Southern Ocean, during the last 20 kyrs

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As the major hub of oceanic circulation and nutrient redistribution, the Southern Ocean (SO) played an important role in modulating global climate variability throughout the Cenozoic. The SO is a key component of the feedback loop that modulates atmospheric CO_2 concentration variability over glacial–interglacial cycles. However, the mechanisms responsible for the release of the deeply sequestered carbon to the atmosphere during glacial termination remain yet unclear. The feedback loops affecting the air-sea flux of CO_2 include the extent of sea-ice, the position and strength of the westerly wind regime, the dynamics of the Antarctic Circumpolar Current (ACC) and associated physical structure of the water-column, the efficiency/strength of the biological pump and their interactions. Indeed, changes in the westerly wind field modulate ACC intensity and location, which subsequently affects vertical and horizontal oceanic heat transport and, therefore, sea-ice extent and seasonality along with primary productivity. In turn, changes in sea-ice extent impact on the Southern Hemisphere latitudinal thermal gradient which feedbacks on the Westerly winds. Therefore, a robust understanding of these physical and biogeochemical interactions would improve our ability to predict how SO will respond to global warming.

We here present a multi-proxy study on core MD12-3396CQ, located eastward of Kerguelen Islands, to reconstruct changes in sea-surface temperature (diatoms, foraminifera, dinocysts, radiolarians, alkenones), ACC intensity and location (diatoms, mineralogy, magnetic susceptibility, minor elements) and productivity (microfossils, major elements) to gain understanding on physical and biogeochemical interactions over the last 20,000 years and their possible impact on atmospheric CO_2.

ID: 01600, 14.- Hydroclimate variability through the ages: Data, models, mechanisms, (Poster)

Dryland fluvial landforms: Reliable archives for reconstructing palaeoclimatic signals?

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Reconstruction of past climatic and tectonic perturbations has been a topic of debate, especially in dryland environments where sediment availability and transport capacity is nonlinear. Studies from the tectonically active and monsoon dominated regions have revealed that fluvial systems oscillate between aggradation and incision, atleast at millennial scale, due to linear correlation between the sediment flux and monsoonal strength. We employed geomorphology, sedimentology, geochemistry supported by optical chronology and attempted to reconstruct climate of Eastern Northern Hill Range, Kachchh, Western India. We identified aggradational events from Last Glacial Maximum upto present and correlated the results with regional climate history reconstructed form various other more robust archives like marine and lacustrine. We conclude that the fluvial landforms in dryland enviornments are formed by various processes which are dominantly erosive in nature, compared to sediment archives of lacustrine and marine records where dominant processes are depositional in nature. This has been evidenced by discreet packages of climate signals archived in fluvial landforms. The preservation of these climate signals is most likely due to the \'window of opportunity\' they got while being deposited. The climate histories reconstructed form fluvial landforms are pre-dominantly dependant on this window of opportunity as due to unfeasible chronological control and other factors, it may not be clear if part of sediment record has been washed away by earlier processes.

ID: 02039, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Evolution of the Volga river delta during Holocene

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During the maximum Late Khvalynian sea-level highstand the river discharge was restricted to the two main branches – the modern Volga River valley and Sarpinsko-Davanskaya depression. Distinct fan-shaped groups of hollows oriented towards the sea evidence former location of the Caspian shoreline. They do not reach the modern shoreline and either end in the dry limans or flatten out. These are “incised” deltas formed under abrupt sea-level fall. During the Mangyshlak regression the sea level decreased down to –70 m, and the delta was located in the latitude of the Agrakhan spit. Two wide channels were formed in the central and eastern parts of the Volga-Akhtuba valley which served as pathways for river discharge. Delta sediment sequence gives evidence for several stages in its formation during the New Caspian epoch. The Caspian sea-level fall interrupted by episodic rises up to -23 - -24 m reached -29 m by 1977. The above- and underwater parts of the delta were filled with riverine sediments, thus causing considerable seaward advance of the delta. The northern part of submarine delta became exposed and turned into a low insular floodplain, while its frontal part, the avandelta, occupied the shallow Northern Caspian shelf. During the period between 1918 and 1980 the delta front penetrated seaward by 10-50 km, and the number of big branches decreased from 320 to 260. During certain periods (1927-1939) the rate of delta advance reached 1 km per year. On the exposed patches grasslands replaced hydrophite vegetation, and accumulation of specific organogenic deposits of avandelta terminated. Since the onset of the new Caspian sea-level rise in 1978 (up to -27.5 m by the end of 1992) no evident changes in the natural processes within the delta have been observed. These processes are undoubtedly latent, and their manifestation is simply the matter of time.

ID: 01932, 21.- Sediment Flux: Past Peaks and Troughs, (Poster)

Glacial-interglacial sedimentation in the Bohai Sea, China during the last 1 Ma: evidence from magnetostratigraphic and astronomical tuning dating core

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We present a high-resolution magnetostratigraphic and rock magnetic study of a 212.4 m core (BH08, with a basal age of 1.06 Ma) recovered from the shallow (<30 m below sea level) Bohai Sea, China. Astronomical tuning based on the sediment redness (a*) of core BH08 allows the construction of a high-resolution chronology that is assisted by magnetostratigraphic data. Sedimentology and associated proxies (grainsize, redness, paleontology and geochemistry) indicate that the cyclic alternation of neritic/littoral and fluvial at glacial-interglacial timescales. Correspondence between marine-terrestrial sedimentary cycles and global sea-level fluctuations suggests that stacking of marine and terrestrial sediments was driven mainly by glacio-eustatic sea-level fluctuations in a context in which tectonic subsidence was largely balanced by sediment supply over the last ~1 Ma. The a* record of the core can be correlated with marine $\delta^{18}O$ records at 40 and 100-kyr cycles, indicating that the sediments in the study area are continuous at least at orbital timescales regardless of significant base-level variations. This is likely due to continued subsidence in the basin and creation of accommodation space.

ID: 02357, 06.- Before and after - climate contrasts across the MPT, (Poster)

The Equatorial Atlantic Ocean Thermohaline Circulation Across the Mid-Pleistocene Transition

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The Mid-Pleistocene Transition (MPT) marks the change from ~41- to ~100-kyr glacial cycles between ~1.3-0.7 Ma. Pena and Goldstein (2014) reported major disruptions in the Atlantic meridional overturning circulation (AMOC) between MIS25-21 (~950-850 ka) based on Nd-isotopes in two South Atlantic cores (Sites 1088, 1090), and suggested this was the first 100-kyr cycle. We focus on AMOC changes in the equatorial Atlantic through comparison with North and South Atlantic sites. eNd-values of Fe-Mn oxide encrusted foraminifera and fish debris from Site 926 (3.719N, 42.908W, 3598m), over ~1.5 Ma, fall between coeval North and South Atlantic samples (thus far Sites 607, 1267, 1088, 1090), consistent with mixing between northern- and southern-sourced endmembers (NSW, SSW) at each point in time. Pre-MPT data show smaller glacial-interglacial differences than post-MPT data. The equatorial Site 926 eNd-values closely follow North Atlantic Site 607. eNd-values often converge, indicating a coherent deep-water mass from the North Atlantic to the equator. Convergence at negative, NADW-like ε_{Nd}-values indicates dominance of NSW and a strong AMOC, while convergence at more positive, southern-like ε_{Nd}-values indicates incursion of SSW into the North Atlantic and a weak AMOC. The MPT interval marks an unprecedented SSW incursion into the North Atlantic during MIS24, followed by a weak AMOC recovery during MIS23, comparable to weak pre-MPT glacials, followed by an even stronger SSW incursion during MIS22. This time interval coincides with the AMOC crisis of Pena and Goldstein (2014). Incursion of SSW is supported by covariations of ε_{Nd} and benthic-$d^{13}C$. The 926 data confirm that the “MPT AMOC crisis” observed in the deep South Atlantic was a basin-wide phenomenon.

ID: 01419, 03.- Regional and transregional climate variability over the last 2000 years, (Poster)

Long-term aquatic ecosystem responding to climate change during the last 1000 years

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Aiming at understanding long-term lake ecosystem evolution, we used lake sediment records and climate-hydrology-forced ecosystem model to do modelling study to understand climate-aquatic biomass interaction during the last 1000 years. Based on principles and structures of Lotka-Volterra dynamic model, this study firstly built a competition system between phytoplankton algae and higher aquatic plant of the lake primary producers. Then a predator-prey system was constructed between top-level predator of fish and the primary producers in the lake ecosystem. Finally, based on relations between climate-lake water and the biomes, competitive and/or predatory systems were established with delay functions and feedback controls. Poyang Lake is the largest fresh-water lake in China with an area of 4300km^2 and an catchment area of 160000km^2, existing in a mesotrophic-state and a trend toward eutrophication-state ecosystem since the 19th century. Four experiments of different periods, from the modern time to the past 1000 years respectively, were designed to perform the numerical simulations for the lake. The result showed an asymmetrical process of biomass changes. The water increases lead to a slow rate of biomass changes while the water decreases make a fast rate of biomass changes, quantizing the water-controlled negative-feedback. When the precipitation decreased 19%, the lake areas correspondingly decreased 33% and water heights decreased 7%, leading to the lake biomass oscillating and declining during 50~60 years. When the extreme drought climate lasted more than 50 years, the biome growth stopped and the lake ecosystem froze. The result can be evidenced by sedimentary pollen data during Little Ice Age when psammophytes and xerophytes were dominant instead of aquatic and palustral plants. It is suggested that the lake ecosystem would be long-term oscillated and finally collapsed under a last-drought climate, because the changes in the boundary conditions significantly exceeded the capacity of the ecosystem.

ID: 01533, 12.- Trace elements and their isotopes as geochemical proxies of past ocean conditions, (Poster)

Seasonal variations in distribution of dissolved neodymium concentrations and εNd in the Bay of Bengal

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Constrain dissolved neodymium (Nd) sources to the ocean and its cycles are paramount to use Nd isotopic composition (εNd) as a tracer to trace modern water masses and reconstruct past hydrology. Dissolved REE concentrations and εNd values have been conducted on 90 seawater samples collected at 6 stations along the 89°E meridian in the Bay of Bengal on June, 2012 in order to assess the impacts of Ganges-Brahmaputra river systems sediments input on seawater Nd isotopic compositions. The concentration of Nd in surface waters of the BoB decreases from north to south, while the subsurface value exhibits a minimum at a water depth of around 100 m. εNd in the Bay of Bengal displays large variability, from -14.4 to -9.5. Surface and intermediate waters of the northern and central BoB have lower εNd compared to waters from similar depths of the southern BoB. These new results have been compared with those obtained in BoB on nearby water stations but collected in November, 2008 (Singh et al., 2012). This comparison reveals for the first time an important seasonal variability of up to 2 εNd units for surface and intermediate water masses of the BoB. The seasonal fluvial discharge variability of the Ganges-Brahmaputra system induced by Indian monsoon contributes and dominates the seasonal changes of dissolved Nd budget of the BoB. Based on REE dissolved concentrations and εNd distributions, we suggest that release of riverine suspended particles is the main factor controlling the Nd to the BoB.

ID: 01731, 08.- Volcanic eruptions: the thread connecting climate records, societal change and future climate projections?, (Poster)

Modeling Climate Impacts of the 1783-1784 Laki Eruption in Iceland

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The Laki eruption in Iceland, which began in June 1783, was followed by many of the typical climate responses to volcanic eruptions: suppressed precipitation and droughts, crop failure, and surface cooling lasting two to three years. In contrast to the observed cooling in 1784-1786, the summer of 1783 was anomalously warm in western Europe, with July temperatures reaching more than 3°C above the mean in some areas. While climate models can generally reproduce the surface cooling and decreased rainfall associated with volcanic eruptions, model studies have failed to reproduce the extreme warming in western Europe that followed the Laki eruption. As a result of the inability to reproduce the anomalous warming, the question remains as to whether this phenomenon was a response to the eruption, or merely an example of internal climate variability. Using the Community Earth System Model from the National Center for Atmospheric Research, we investigate the role of the aerosol indirect effect of the "Laki haze," and the effect of the eruption on Europe's climate. Results indicate that the extreme summer temperatures may be attributed to natural variability. On the other hand, the unusually cold winter in Europe appears to have been due to the eruption, which forced a negative phase of the North Atlantic Oscillation in conjunction with a positive phase of the El Niño Southern Oscillation. Understanding the cause of this anomaly is important not only for historical purposes, but also for understanding and predicting possible climate responses to future high-latitude volcanic eruptions.

ID: 01542, 20.- From early human impacts to the Great Acceleration: A paleoscience perspective on the climate-landscape-human multiple connections, (Poster)

The termination of the Africa Humid Period: review of Saharan and sub-Saharan climatic and archaeological data and implications for the Anthropocene

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The African Humid Period (AHP) is a climatic phase occurred between 15-5 kya BP, triggered by the northward expansion of the African monsoon domains. The onset of the AHP, its climatic and environmental dynamics, and its impact on humans are well known, thanks to many studies carried out at several archaeological sites and on a variety of archives for proxy data. On the contrary, contrasting hypotheses on the dynamic of the termination of the AHP (from 5 ky BP onward) exist. On one hand, a marked increase in the terrigenous input to the Atlantic Ocean from Sub-Saharan rivers suggests an abrupt termination of the AHP. On the other hand, the investigation on several inland palaeohydrological and geomorphological archives shows a chronologically differentiated reduction of water availability occurred over a millennial-scale period. The response to the reduction of monsoon precipitation therefore occurred in each region on the basis of the physiographic settings and threshold-like behaviour of hydrological reservoirs. In both cases, the major trend in recent archaeological literature links the transition to aridity to the collapse of civilizations and abandonment of regions. In spite of data from selected contexts, this deterministic view has often been assumed in the archaeological reconstructions of past cultural trajectories in the Sahara, overshadowing local cultural adjustments and signs of continuity in human occupations. We offer a fresh review of the archaeological and palaeoenvironmental literature on the termination of the AHP and propose a different perspective on the effects of the Mid-Holocene climatic transition on Saharan and Sub-Saharan populations. Moreover, the analyses of the Mid-Late Holocene demographic shifts occurred in the region hints an alternative explanation to the abrupt increase of terrigenous to the Atlantic, suggesting an early anthropogenic footprint on the North African landscape that could be interpreted as the local begin of the Anthropocene.

ID: 02020, 01.- Open Session on past global changes, (Poster)

Why Resilience and Transformation Centre in China?

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As a harbinger of global environment change, China is undergoing unprecedented social and ecological shifts. Over the past four decades, China has transformed its agrarian based economy to an industrial based economy, which has considerable implications for ecosystem dynamics and services. The freshwater ecosystems in particular which have a long history in shaping China's civilization are becoming critical to sustain as a result of unprecedented human impacts. Cumulative effects of multiple stressors have caused widespread degradation and rapid loss of aquatic ecosystem services beyond the safe operating space. Understanding evolutional dynamics of social-ecological system through time in China can generate new knowledge for future sustainability. However, research focus on resilience and dynamics of social-ecological system in the past are still few and scattered. A new centre of this kind are timely and needed.

The Resilience and Transformation Centre in China (RTCC) at Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences (NIGLAS) is a 'social-ecological resilience think-tank', and its foundation is the outcome of the increasingly growing challenges of freshwater ecosystems management and adaptation to change in China and the South and Southeast Asia region during the 21st century. Our vision is become a global hub for integrated social-ecological system research to generate new scientific knowledge necessary for sustaining the ecosystem goods and services, via world-leading innovative research.

ID: 01953, 21.- Sediment Flux: Past Peaks and Troughs, (Poster)

Sediment fluxes in Lake Żabińskie (northeastern Poland): A 2000 year long perspective from annually laminated sediment core

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Sediment fluxes are variable in space and time.They provide base for quantitative reconstructions of past environments and show fluctuations caused by either natural or man-induced drivers. Here we present the record of varying sediment fluxes in Lake Żabińskie based on annually laminated sediment core covering last 2000 years. We investigated 6.2 m long, entirely varved sediment sequence using varve chronology, µXRF scanning and CNS elemental analysis of sediment composition. Varve counting was performed on thin sections after detailed microfacies analysis supported by XRF scanning results. Calendar-year timescale is supported by AMS radiocarbon dates along the profile as well as ^{137}Cs peaks and Askja 1875 AD cryptotephra horizon in the topmost part. Geochemical analyses were conducted with 3-year resolution which provided an accurate assessment of elemental fluxes variability over time. We recorded substantial differences in mass accumulation rates with highest variability during the last 400 years. Elemental fluxes (TOC, TIC, TN, TS) are clearly controlled by the variability in mass accumulation rates and they show evident discrepancies with standalone percentage values. Periods of intense land clearance in the catchment by developing settlement show sediment fluxes over four times higher compared to the period before deforestations. Moreover, variations in the C/N ratio show substantial changes related to different sources of organic matter accumulated in the sediments.

ID: 02146, 07.- Historical Climate Reconstruction and Impacts of the Common Era, (Poster)

Decadal Variability of Summer Precipitation over Eastern China in Observation, Historical Reconstruction and CESM Simulation

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Based on observations for recent decades, reconstructed precipitation for the period A.D. 1736–2000, dry–wet index data for A.D. 500–2000, and a 1000-year control simulation using the Community Earth System Model with fixed pre-industrial external forcing, the decadal variability of summer precipitation over eastern China is studied. Power spectrum analysis shows that the dominant cycles for the decadal variation of summer precipitation are: 22–24 years and quasi-70-years over the North China Plain; 32–36 years, 44–48 years and quasi-70-years in the Jiang-Huai area;

and 32–36 years and 44–48 years in the Jiang-Nan area. Bandpass decomposition from observation, reconstruction and simulation reveals that the variability of summer precipitation over the North China Plain, Jiang-Huai area and Jiang-Nan area, at scales of 20–35 years, 35–50 years and 50–80 years, is not consistent across the entire millennium. We also find that the warm (cold) phase of the Pacific Decadal Oscillation generally corresponds to dry (wet) conditions over the North China Plain, but wet (dry) conditions in the Jiang-Nan area, from A.D. 1800, when the PDO turned to strengthen. However, such a correspondence does not exist throughout the entire last millennium. Data–model comparison suggests that these decadal oscillations and their temporal evolution over eastern China, including the decadal shifts in the spatial pattern of the precipitation anomaly observed in the late 1970s, early 1990s and early 2000s, might result from internal variability of the climate system.

ID: 01825, 04.- From the Mediterranean to the Caspian: palaeoclimate variability, environmental responses and human adaptive strategies, (Poster)

Atlantic forcing of Western Mediterranean winter rain minima during the last 12,000 years

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In this study we present a newly recovered 19.63 m long core from Lake Sidi Ali in the North African Middle Atlas, a transition zone of Atlantic, Western Mediterranean and Saharan air mass trajectories. With a multi-proxy approach based on magnetic susceptibility, carbonate and total organic C content, core-scanning and quantitative XRF, stable isotopes of ostracod shells, charcoal counts, *Cedrus* pollen abundance, and a first set of diatom data, we reconstruct Western Mediterranean hydro-climatic variability, seasonality and forcing mechanisms during the last 12,000 yr. A robust chronological model based on AMS ^{14}C dated pollen concentrates supports our high-resolution multi-proxy study. Long-term trends reveal low lake levels at the end of the Younger Dryas, during the mid-Holocene interval 6.6 to 5.4 cal ka BP, and during the last 3000 years. In contrast, lake levels are mostly high during the Early and Mid-Holocene. The record also shows sub-millennial- to centennial-scale decreases in Western Mediterranean winter rain at 11.4, 10.3, 9.2, 8.2, 7.2, 6.6, 6.0, 5.4, 5.0, 4.4, 3.5, 2.9, 2.2, 1.9, 1.7, 1.5, 1.0, 0.7, and 0.2 cal ka BP. Early Holocene winter rain minima are in phase with cooling events and millennial-scale meltwater discharges in the sub-polar North Atlantic. A significant hydro-climatic shift at the end of the African Humid Period (~5 ka) indicates a change in climate forcing mechanisms. The Late Holocene climate variability in the Middle Atlas features multi-centennial-scale NAO-type pattern, with Atlantic cooling and Western Mediterranean winter rain maxima probably associated with solar minima.

ID: 01418, 01.- Open Session on past global changes, (Poster)

The analog method as a proxy-data assimilation technique: comparison with off-line Bayesian methods

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Paleo-climate simulations provide only one possible realization of the past climate trajectory from the infinite number of trajectories that are compatible with the imposed external forcing. However, due to the presence of internal climate variations in both simulations and reality, the simulated climate evolution cannot be directly compared with climate reconstructions, since the timing of non-forced variations are uncorrelated (non-synchronized). Data assimilation methods, widely used in weather prediction and to produce the meteorological reanalysis, may provide a way of producing paleo-climate model data that are synchronized with proxy-based climate reconstructions. In this contribution, we compare two methods for off-line (a posteriori) paleo-data assimilation that have been put forward in the literature so far: the analogue method and the off-line Kalman filter, which share some theoretical similarities.

The analog method reconstructs climate anomalies in one particular year by searching through a large pool of simulated fields and select those that are more similar to the proxy-derived climate at the proxy locations. The reconstructed climate is then the full climate field(s) simulated by the climate model in the analogue year. The off-line Kalman filter approach constructs a prior probability distribution of the climate variable of interest in one particular year Y using a large-ensemble of simulated years Y. The prior distribution is updated with the proxy-based reconstructed local climate, obtaining a posterior distribution of that variable.

The assessment of the methods is performed, for the past millennium, with the help of pseudo-proxies experiments, in which virtual proxy records are constructed by contaminating the grid-cell temperature (or precipitation) simulated in a climate simulations with stochastic noise to mimic the imperfect correlation between real proxies and co-located instrumental records. Both reconstruction methods can be then applied to those pseudo-proxies, obtaining a climate pseudo-reconstruction that can be compared to the output of the climate simulation

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ID: 02024, 13.- Pliocene climate variability over glacial-interglacial timescales (PlioVAR), (Poster)

Paleoceanographical conditions of North Pacific Ocean during the Pliocene based on organic-walled

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The analysis of organic-walled dinoflagellate cyst (dinocyst) assemblages at ODP Site 887 in the Gulf of Alaska, northeastern North Pacific, was undertaken in order to document ocean changes over the last 5million years. Our results show a dramatic change in the composition of dinocyst assemblage at~ 2.5Ma, coinciding with the Pliocene-Pleistocene climatic transition. Prior to 2.5Ma, the assemblages are characterized by *Bitectatodinium tepikiense, Nematosphaeropsis labyrinthus*, *Impagidinium pallidum* and *Impagidinium paradoxum,* which occur in the modern cool-temperate North Atlantic Ocean. After 2.5 Ma, the assemblages are often dominated by *Operculodinium centrocarpum* and *Brigantedinium* sp., which indicates a change towards colder conditions. The occurrence of heterotrophic taxa such as *Brigantedinium* is in line with biogenic opal variations, which suggests changes in productivity, possibly related to upwelling conditions more intense during the Late Pleistocene. Beyond these general features, large amplitude variations in concentrations and taxa percentages reflect large changes in sea-surface conditions, possibly related to glacial-interglacial cycles. Furthermore, comparisons with published records from the northern North Atlantic indicate very distinct dinocyst and acritarch assemblages and biostratigraphical marks during the Pliocene, which suggests limited connections between the subpolar North Atlantic and North Pacific.

ID: 02078, 33.- Ancient DNA for understanding past biodiversity, human history, and drivers of ecosystem changes: achievements, limits and perspectives, (Poster)

Ancient DNA from subfossil wood in the Tropical Andes of Colombia

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Paleoenvironmental reconstructions of tropical areas of middle altitudes are limited due to lack of good paleoclimatic evidence. Thanks to the exceptional preservation of a Quaternary fluvio-volcanic deposit found in the Central Cordillera of Colombia (2014 m.a.s.l), we used molecular techniques in order to extract and characterize DNA from two subfossil woods from the Tropical Andes, which will then be compared to microanatomical techniques. Even though the inherent characteristics of the deposit have allowed a good level of preservation of the wood, high temperature and precipitation and acidic environments have promoted DNA's degradation. In addition to these conditions, DNA is not easily extracted from wood due to lack of living cells in most parts of the trunk. Despite methodological issues and preservation difficulties, we present promising preliminary results for ancient DNA (aDNA) extraction and amplification from two different wood trunks that date back to the last glacial period, representing the oldest material from which DNA extraction has been reported in the Neotropics. Aiming to obtain high quality DNA, we assessed two extraction protocols which are used for recent wood material, finding that CTAB protocol works well with our samples. Furthermore, in the amplification process, we evaluated different PCR parameters in order get the best results using the KAPA3G kit, which contains a *Taq* polymerase suited for materials with low values of DNA concentration and high levels of PCR inhibitors. According to our results, DNA extraction and amplification protocols can be used successfully in tropical ancient material, despite the high level of degradation caused by harsh environmental conditions, and the age of the material. These results open a new line of research for paleoclimatic reconstructions, in which traditional methods can be used alongside molecular ones for a better assessment of ancient environments.

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