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Exploring the advantages of automated stations to retrieve continuous weather and snow-related data in high-elevation sites (Monte Rosa massif - Western Italian Alps)

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Anthropogenic climate change is strongly impacting mountain regions. The warming rate observed for the Alpine Region is well above the global average. Moreover, crucial water reservoirs such as glacier ice and seasonal snowpack are extremely susceptible to changes due to their inherent dependence both on the persistence of below 0 °C temperatures and the amount of solid precipitation. In recent years, the European Alps have experienced multiple seasons of intense deficit of snow precipitation compared to historical records. Given that the hydrological assets of the Western Italian Alps have a crucial role in the economic activities of Northern Italy, it is necessary to enhance the monitoring and the studies performed on the region. One of the most pressing criticalities that arise dealing with the study of the Alps is the growing need of direct measurements of meteorological and snow-related variables at high-elevation sites. To address this gap, a network of automated stations (ASs) has been established on the Monte Rosa massif in Western Alps, on the border between the Italian regions of Piedmont and Aosta Valley. The network's responsibility falls under the Laboratory of Alpine Climatology, LabClima, of the University of Turin. Firstly, we present the data collected by the AS installed in the LTER site - Mosso Institute (45°52'30" N; 7°52'18" E; 2900 m a.s.l.), which is also equipped with sensors for Snow Water Equivalent (SWE) measurement based respectively on Cosmic Rays Sensors (CRS) and Global Navigation Satellite System (GNSS) technologies. The daily SWE datasets are compared with field data collected during measurement campaigns to investigate their potential to increase the temporal density and availability of data for remote and harsh mountain environments. We also present the data acquired by another AS (45°53'46.53"N; 7°50'56.96"E; 3500 m a.s.l.) established in September 2024 near the Garstelet Glacier. The sensors installed retrieve continuous data regarding the main meteorological variables (e.g., air temperature, atmospheric pressure, wind speed and direction, relative humidity, solar radiation, precipitation, and snow height) as well as

the temperature of the snowpack layers (measured at 50 cm intervals from the ground level up to 2 m height) and the type of precipitation thanks to the presence of a disdrometer. The variety of data collected by this AS is unprecedented at such elevation in the Italian Alps and could help to address the present gaps of information for end users and future scientific research.

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