Three years monitoring of sugars in Arctic aerosol

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Introduction

The processes occurring in the Arctic aerosol during atmospheric transport were described using selected sugars as source tracers. Monosaccharides (arabinose, fructose, galactose, glucose, mannose, ribose, xylose), disaccharides (sucrose, lactose, maltose, lactulose), alcohol-sugars (erythritol, mannitol, ribitol, sorbitol, xylitol, maltitol, galactitol) and anhydrosugars (levoglucosan, mannosan and galactosan) were measured in the Arctic aerosol collected during 2013, 2014 and 2015 sampling campaigns.

The main aim of this study was to determine how these compounds are distributed in size-segregated aerosols after short-range and long-range atmospheric transport and understand the possible sources of sugars.

Arabitol and mannitol can be used as tracers for airborne fungal spores (Bauer et al., 2008), primary saccharides, as glucose and sucrose, can originate from microorganisms, plants, animals and soil biota (Simoneit et al., 2004). Carbohydrates were found in airborne marine organic particles generated by sea spray (Hawkins and Russell, 2010).

Methods

The aerosol samples were collected using a high-volume cascade impactor (TE-6070, PM10 high volume air sampler) at Gruvebadet, Ny Ålesund, (Svalbard Islands, 78°54'59''99 N 11°55'59.99'' E) from April 29th to September 15th for 2013, from April 2nd to June 29th for 2014 and from April 4th to June 13th for 2015. Blank samples were collected by loading, carrying and installing the filter on the instrument with the air pump closed.

Determination and quantification of all compounds were performed using an ion chromatograph (Thermo Scientific™ Dionex™ ICS-5000, Waltham, US) coupled to a single quadrupole mass spectrometer (MSQ Plus™, Thermo Scientific™, Bremen, Germany). Two analytical methods, developed by Barbaro et al. (2015), were applied to Arctic aerosol samples.

Conclusions

This study presents the first results of sugar composition and concentration in the Arctic aerosol. The total mean concentration of sugars in the aerosol was 1.8 ± 2.2 ng m^{-3}, 2. 3 ± 3.9 ng m^{-3} and 0.5 ± 0.6 ng m^{-3} for 2013, 2014 and 2015, respectively. The study of particle-size distribution allowed us to identify the natural emission from spores, sea-spray and biomass burning as main sources. The enrichment of sugars in the fine fraction of the aerosol collected in Arctic is due to the degradation of particles during long-range atmospheric transport (Barbaro et al., 2015).

Arabitol and mannitol show a clear increase in concentration for 2013 summer season, probably due to the production of fungal spores in ice-free areas. Primary saccharides and carbohydrates follow the same temporal trend in 2013 and 2014.

The increase in concentration of anhydrosugars in April 2013, 2014 and 2015 (Feltracco et al., 2019) proves the presence of biomass burning events that may also affected the concentration of sugars in these periods.

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