Abstract ID : **205**

Molecular reconstruction of organic aerosol composition from a firn core collected at Grand Combin, Swiss Alps

Content

Atmospheric aerosols are fine solid or liquid particles suspended in air, which originate from various natural and anthropogenic sources. Aerosols influence the Earth's radiative balance by scattering and absorbing solar radiation as well as influencing cloud p roperties. The overall extent of radiative forcing caused by aerosols is the largest source of uncertainty in global climate models. Part of this uncertainty is related to organic aerosols, which make up a large portion of today's fine particulate matter in the lower tr oposphere. While the mechanisms by which the inorganic aerosol fraction is formed from gas phase precursors are well established, current state-of-the-art models consistently underestimate the organic aerosol burden, highlighting major gaps in our understanding of the pathways by which organic aerosols accumulate and evolve in the atmosphere, and finally effect climate.

One way to mitigate this knowledge gap is to utilise natural archives such as high-alpine glaciers, which are located close to the anthropogenic emission sources. Here, we show data from a firn core collected on Grand Combin, Swiss Alps, in 2020. The firn core was dated using annual layer counting using the well pronounced seasonality of the stable oxygen isotope ratio (18O) and major ion concentrations (e.g. ammonium (NH4+)).

In comparison with a firn core drilled in 2018, we observe melt effects from 2016 to 2008 removing seasonal trends for major ions.

In addition, we analysed the organic tracers in the firn c ore. Up to now organic aerosols in ice core research have been mainly reported as bulk parameters, e.g. water insoluble organic carbon or dissolved organic carbon. Other studies focused on specific parameters, e.g. biomass burning tracers. Here, we present a non-target screening approach optimized for determining oxidation products of volatile organic compounds. Since, such organic tracers are present in low concentrations, we performed solid phase extraction to pre-concentrate the samples prior to analysis. Non-target screening was conducted using ultra-high-performance liquid chromatography coupled to high-resolution mass spectrometry as a sensitive detection method, using ESI ionisation and Orbitrap technology. We will present a high-resolution seasonal record of the molecular composition of organic aerosols from this firn core and evaluate the atmospheric sources of the detected c ompounds. In addition, we will discuss the effects of melting on organic tracers.

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Track Classification: High-alpine ice cores