



Reconstruction of Aerosol Concentration and Composition from Glacier Ice Cores

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Reconstruction of the concentration and composition of natural aerosol in an undisturbed atmosphere enables the evaluation of the understanding of aerosol-climate effects, which is currently based on highly uncertain emission inventories of the biosphere under pre-industrial conditions. Understanding of the natural state of the pre-industrial atmosphere and evaluating the atmospheric perturbations by anthropogenic emissions, and their potential feedbacks, is essential for accurate model predictions of the future climate (Boucher et al., 2013).

Here, we present a new approach for the chemical characterization of the organic fraction preserved in cold-glacier ice cores. From this analysis historic trends of atmospheric organic aerosols are reconstructed, allowing new insights on organic aerosol composition and mass in the pre-industrial atmosphere, which can help to improve climate models through evaluation of our current understanding of aerosol radiative effects.

We present results from a proof-of-principal study, analyzing an 800 year ice core record from the Lomonosovfonna glacier ice core, drilled in 2009 in Svalbard, Norway, using a setup that has until then only been applied on offline measurements of aerosol filter extracts (Dällenbach et al., 2016): The melted ice was nebulized and dried, such that aerosols are formed from the soluble and insoluble organic and inorganic compounds that are preserved in the ice. To improve the sensitivity, the aerosol stream was then enriched by the application of an online aerosol concentrator, before the aerosol was analyzed by electron ionization within a high resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS). We were able to demonstrate that this setup is a quantitative method toward nitrate and sulfate when internal inorganic standards of $\text{NH}_4^{15}\text{NO}_3$ and $(\text{NH}_4)_2^{34}\text{SO}_4$ are added to the sample. Comparison between AMS and IC measurements of nitrate and sulfate resulted in an excellent agreement. The analysis of the organic fraction, however, was biased by a source of organic contamination, likely introduced during sample storage. However, freshly prepared ice blanks showed no significant source of organics, and the calibration with an organic surrogate standard demonstrated that this technique is applicable for the analysis of newly prepared ice samples.

Furthermore, we present first results of the method development towards organic molecular tracer analysis using solid phase extraction and liquid-chromatography coupled to ultra-high resolution mass spectrometry.

References:

Boucher, O., et al., *Clouds and Aerosols: 7*, in: *Climate Change 2013: The Physical Science Basis.*, Cambridge University Press, 571–658, 2013.

Dällenbach, K. R., et al., *Atmos. Meas. Tech.* **9**, 23–39, 2016.