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Chemical composition of summertime High Arctic aerosols using chemical ionization mass spectrometry

Karolina Siegel[1,2], Paul Zieger[1], Matthew Salter[1], Ilona Riipinen[1], Annica M.L. Ekman[2], and Claudia Mohr[1]

[1]Stockholm University, Department of Environmental Science, Atmospheric Science, Stockholm, Sweden (karolina.siegel@aces.su.se)

[2]Stockholm University, Department of Meteorology, Stockholm, Sweden

Low-level clouds and fogs play a key role in the radiative balance over the Arctic pack ice by regulating surface energy fluxes. The radiative features of clouds are dependent on the amount of airborne aerosol particles and their properties, since the particles can act as CCN (cloud condensation nuclei) and INP (ice nucleating particles). As the Arctic climate is currently warming, the local emissions and formation mechanisms of aerosols are expected to change, possibly leading to altered cloud properties.

We measured aerosol chemical composition using FIGAERO-CIMS (Chemical Ionization Mass Spectrometer coupled to a Filter Inlet for Gases and AEROsols) analysis of samples collected during the MOCCHA campaign (Microbiology-Ocean-Cloud-Coupling in the High Arctic) close to the North Pole in 2018. The goal of the campaign was to investigate natural aerosol emissions from the ocean to the atmosphere during summertime in terms of local sources and potential contribution to cloud formation. The sampling period was therefore around the seasonal sea ice minimum in September. With our CIMS setup, the sample molecules are ionised by iodide ions (I^-). The negatively charged adducts are then separated by mass, allowing for characterisation on a molecular level. This is the first time aerosol chemical composition of High Arctic aerosols has been measured using this technique. As the current knowledge about the atmospheric composition in this region is low, our results suggest a potential for using this method for further aerosol chemical characterisation in the pristine Arctic environment.

Our analysis shows that sulphur-containing compounds were most abundant in the aerosol samples, including sulphuric acid, sulphur trioxide, methanesulphonic acid (MSA) and dimethyl sulphoxide (DMSO). MSA and DMSO are oxidation products of dimethyl sulphide (DMS), which is released by marine phytoplankton to the atmosphere under ice-free conditions. Non-sea-salt sulphate (nss-SO_4^{2-}) aerosols are known to be efficient CCN. The results will be compared to aerosol samples from the NASCENT campaign (Ny-Ålesund Aerosol and Cloud Experiment), analysed using the same CIMS technique. The campaign runs for a year during 2019-2020 at the Zeppelin station in Svalbard. Our findings are expected to contribute to better understanding of the connection between aerosols and cloud formation in the polar regions and the effects on the ocean and pack ice.