

Sources of Arctic Aerosols at Villum Research Station during Spring 2016

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Introduction

In addition to long-lived greenhouse gases such as CO₂, atmospheric aerosols impact the radiation balance of the Earth. Aerosols affect the radiative balance in various ways, and it is crucial to understand natural sources in addition to anthropogenic sources of Arctic aerosols. In the CLIF project we studied composition and sources of Arctic aerosols at Villum Research Station (VRS) in North Greenland.

Methods

Equipment installed in the measurement house at VRS included a Scanning Mobility Particle Sizer (SMPS) and a Time-of-Flight Aerosol Chemical Speciation Monitor (ToF-ACSM). Ambient air was sampled through a slightly heated (5°C) custom-build particle inlet and a Nafion dryer prior to entering the instruments. ToF-ACSM was calibrated using ammonium nitrate and operated at an alternating sample mode/filter mode protocol for background correction from May 1st - June 23rd 2016. ToF-ACSM provided online mass concentrations of SO₄²⁻, NO₃⁻, Chlorine, NH₄⁺ and organic compounds in PM₁.

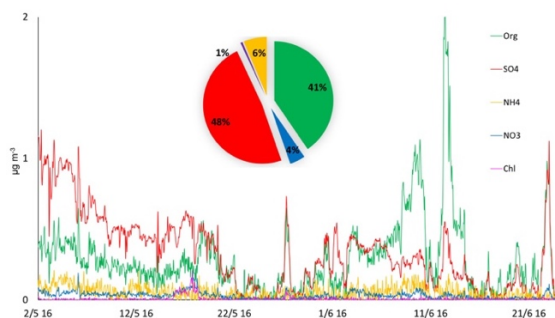


Figure 1. ToF-ACSM time series (µg/m³)

SMPS and ACSM measurements were in excellent agreement ($R^2 = 0.84$). The organic fraction was source apportioned using the SoFi (Canonaco et al., 2013) version of Positive Matrix Factorization (PMF). A 3-factor solution returned a Hydrocarbon-like Organic Aerosol (HOA), Oxygenated Organic Aerosol (OOA) and a Marine Organic Aerosol factor (MOA), which was in accordance with previous results (Nielsen et al., 2019).

Conclusions

PM₁ averaged 0.57 µg/m³ with organics 0.23 µg/m³, SO₄²⁻ 0.27 µg/m³, NO₃⁻ 0.02 µg/m³ and NH₄⁺ 0.04 µg/m³. SO₄²⁻ and NO₃⁻ declined steadily to approach limit of detection in June evidencing little influence of anthropogenic activity during summer. However, preliminary results indicate moderate concentrations of organics prevailing during late spring - summer. Furthermore, the ratio of sulfate-to-organics averaged 1.2 in the CLIF campaign as compared to a ratio of 2.8 obtained in a previous winter-spring campaign at VRS in 2015, where PM₁ averaged 2.3 µg/m³ (Nielsen et al., 2019). Methanesulfonic acid appeared to be abundant up to end of June and not linked to the concentrations of organics.

PMF factors were assigned to anthropogenic emissions related to fossil fuel (HOA, 5%) and mainly secondary organic aerosols (OOA, 77%). The natural marine source (MOA) contained methanesulfonic acid (MSA), an oxidation product of dimethylsulfide, averaged 18% of OA over the campaign period.

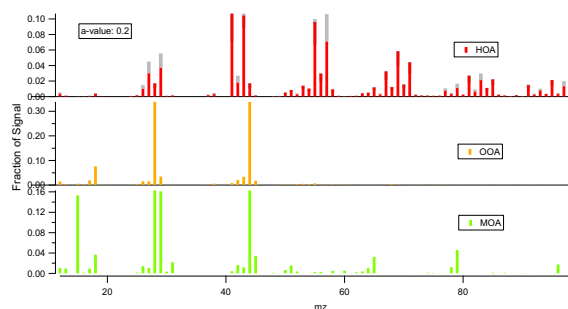


Figure 2. PMF factor profiles HOA, OOA and MOA

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Canonaco et al., 2013. *Atmos. Meas. Tech.*, 6, 3649-3661.

Nielsen et al., 2019. *Atmos. Chem. Phys.*, submitted