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Subsaturated and supersaturated hygroscopic properties of Arctic aerosols

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Introduction

In the high Arctic a phenomenon called "Arctic amplification" is observed as the temperature increase is about twice as high compared to the rest of the world. The rising CO_2 concentration is identified as the main parameter responsible for this temperature increase. Also, there is great scientific consensus that so-called short-lived climate forcers as e.g. ozone, methane, and atmospheric particles including black carbon play important roles for Arctic amplification (IPCC 2013). Atmospheric particles have direct effects on climate through scattering and absorption of solar radiation and indirect effects through their cloud forming potential (Quinn et al., 2008).

Methods

The role of aerosols and their corresponding climate impacts were investigated in two consecutive filed studies in spring and summer 2016. The subsaturated hygroscopic growth and the CCN activating potential at supersaturation was investigated at the high Arctic site, Villum Research Station (VRS) at Station Nord (SN) in North Greenland. From a Cloud Condensation Nucleus (CCN) counter and a Scanning Mobility Particle Sizer (SMPS) the total CCN numbers at a cloud-relevant range of supersaturations (SS) and the ambient particle number size distributions were retrieved. Hygroscopic growth of Arctic aerosols was investigated at subsaturated conditions using a Humidified Tandem Differential Mobility Analyzer (HTDMA) system.

Conclusions

Based on total CCN count and particle number size distribution measurements the critical diameters for cloud activation were calculated for a set of supsersaturations (SS). From these data, the kappa hygroscopicity parameter was derived and compared to the one obtained from the measurements at subsaturations using the HTDMA. Variations in kappa were observed to be larger in late winter and early spring when Arctic haze was observed which is consistent with larger variations in aerosol chemistry during the Arctic haze season compared to the summer months.

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