Ground-based observations of aerosol and cloud properties at sub-arctic Pallas GAW-station

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Clouds constitute perhaps the largest source of uncertainty in predicting the behaviour of the Earth's climate system. Vulnerable Arctic region is slowly heading towards a new climatic state with substantially decreased permanent ice cover. However, due to poorly understood feedback mechanisms, the rate of Arctic climate response to changes is very hard to predict with current global models. Arctic clouds are supposed to play a central role in these feedback processes (Vavrus, 2004).

The 4th cloud campaign was carried out six weeks, between September 17th and October 30th 2012, at Finnish Meteorological Institute's Pallas Global Atmosphere Watch (GAW) station in northern Finland (Hatakka et al., 2003). The measuring site - Sammaltunturi station (67°58′N, 24°07′E) - resides on a top of the second southernmost fjeld at an elevation of 565 m a.s.l. Sammaltunturi station is, due to topography of the surrounding terrain, a great place for ground-based observations of orographic clouds (Lihavainen et al., 2008; Anttila et al., 2012).

In autumn, probability the station to be inside cloud is high, during the campaign it was 50 % of time. The maximum and minimum temperatures were between 8 and -13 °C. The temperature was below 0 °C during half of time. The winds were mostly western and north-eastern with average wind speed of 6.5 m/s (1 m/s to 15.4 m/s). Time series of selected aerosol particle and CCN properties measured during the campaign are presented in Fig. 1.

The measurements at Pallas (GAW) station included instrumentation for: aerosol number size distribution with differential mobility particle sizers (DMPS), total number particle counters (CPC, TSI 3010), particle absorption with Aethalometer (model AE 31, Magee Scientific), Multi-Angle Absorption Photometer (MAAP, Thermo Scientific) and the Single Particle Soot Photometer (SP2, DMT), and particle scattering with the integrating Nephelometer (model 3563, TSI). The ambient RH was measured with Vaisala HUMICAP sensor, and visibility and temperature were measured with Vaisala FD12P weather sensor.

In addition to above mentioned equipment, the aerosol CCN and hygroscopic properties were measured with the HTDMA (Hygroscopicity Tandem Differential Mobilitity Analyzer) and the Cloud Condensation Nuclei Counter (CCNC, DMT model CCN-100). In situ cloud properties were measured with a Forward Scattering Spectrometer Probe (FSSP, 3-47µm, model SPP-100, DMT) and the Cloud, Aerosol and Precipitation Spectrometer (CAPS, DMT), which includes three instruments: the Cloud Imaging Probe (CIP, 12.5 µm-1.55 mm), the Cloud and Aerosol Spectrometer (CAS-DPOL, 0.51-50 µm) with depolarization feature, and the Hotwire Liquid Water Content Sensor (Hotwire LWC, 0 - 3 g/m^3).

Mass and chemical composition of non-refractory submicron particulate matter was characterized with Aerosol Chemical Speciation Monitor (ACSM, Aerodyne) and the chemical composition of gas and aerosol phase was measured with an online ion chromatograph for Measuring AeRosols and GAses (MARGA 2S ADI 2080, Metrohm Applikon Analytical BV).

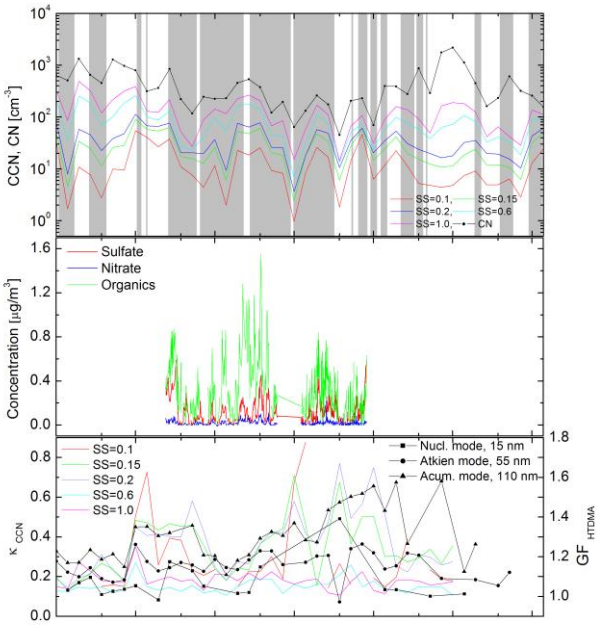

Figure 1. Example of measured properties: from the top total particle count CN together with CCN (gray areas represent cloud events), observed mass concentrations of sulfate, nitrate and organic aerosol, and derived kappa values from size-resolved CCN measurements together with growth factor from HTDMA measurements.

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