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Physical, chemical and hygroscopic properties of activating particles in Northern Finland

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Particle and cloud droplet properties were studied in at the Pallas GAW station in northern Finland from September 16th to October 6th 2005. The station is located on the top of a hill, and was inside cloud for 25% of the measurement period. This allowed us to measure the cloud activation in situ. (Kivekäs *et al.*, 2009)

The dry particle size distribution was measured with two DMPS:s, one measuring the total particle population including the cloud droplets, the other measuring only the non-activated particles. The chemical composition and mass concentration of the particles was measured with an AMS, the measured components being SO_4, NO_3, NH_4 and organics. Particle hygroscopicity was measured with HTDMA from particles having dry diameter of 30, 50, 80, 100 and 150 nm. Cloud droplet number concentration and size distribution were measured with FSSP. Besides these, the meteorological parameters were measured at the site, and air mass back trajectories were calculated for the measurement period. The air masses were classified into three groups according to their arriving path, the groups being clean marine, polluted European and mixed air mass.

The FSSP was running only for a two days during the measurement period. Therefore the main source of information for the number concentration of activated particles was the calculated activated fraction from the difference between the two DMPSs (Komppula et al., 2005). A thorough activation analysis was made only for particles with dry diameter > 100 nm. This was done because the method is vulnerable to differences in the counting efficiency of the DMPS:s, and the activation of smaller particles was found to be within the error. The calculated number concentration of activated particles was compared to the measured one for the time period when the FSSP was running, and a good agreement was found.

The aerosol mass concentration (m_{tot}), as well as number concentration of particles with diameter 100 nm or larger (N_{acc}) depended on the air mass type. European air masses contained the highest amount particulate matter and marine air masses the lowest. The inorganic fraction of m_{tot} (IO) depended on the air mass type as well, being highest in the European and lowest in the marine air masses. The hygroscopic growth factor (GF) depended on solubility, as expected, and had therefore correlation with the air mass as well. Because of the N_{acc}, IO and GF all correlated positively with each other, it was difficult to separate the effects of these three in the cloud droplet activation.

For activation analysis the data was divided in three categories according to visibility at the measurement site. These categories were cloud (visibility < 200 m), unclear (visibility 200 – 3000 m) and no cloud (visibility > 3000 m). In category cloud the activated fraction of N_{acc} (Act_{100}) was on average 65%. The value of Act_{100} in category cloud decreased slightly with increasing Nacc, and did not show any systematic dependency on IO. However, there was a clear difference in the N_{acc} vs IO dependency between the categories cloud and no cloud, as can be seen in figure 1.

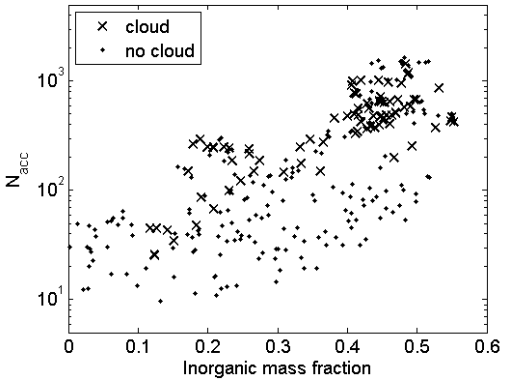

Figure 1. Number concentration of accumulatiun mode particles for cloud and no cloud cases as function of inorganic mass fraction of the particles.

In conclusion we say that the effects of particle number or mass concentration and chemical composition at Pallas are difficult to separate, as the parameters are highly correlated. The air masses arriving to the site are highly different, but cloud activation was observed in all air mass types, meaning that activation happens in very different aerosol conditions.

References:

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