10 years of cloud droplet activation data from Pallas GAW station in sub-Arctic Finland

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Activation of atmospheric aerosol particles into cloud droplets has been studied in situ at Pallas GAW station (See Hatakka *et al*., 2003) in sub-Arctic Finland from year 2005 to present day. The site is located on a hill top, about 300 m above the surrounding lowlands, and it is inside cloud (visibility < 1000 m) for 23 % of time. The in-cloud periods were most frequent in fall (Figure 1).

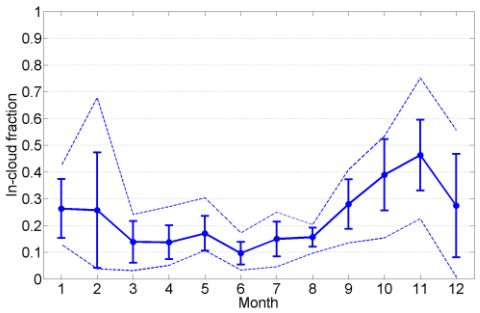

Figure 1. Monthly mean in-cloud fraction of time. The error bars are ± 1 standard deviation and the dashed lines are the minimum and maximum monthly mean values.

There are two parallel Differential Mobility Particle Sizers (DMPS) at the site, measuring the number concentration and dry size distribution of atmospheric aerosol particles. One DMPS is connected to an inlet which prevents particles larger than abiout 5 µm from entering the sample line. The other DMPS is connected to a total air inlet with no nominal cut-off diameter. After each inlet the particles are dried to evaporate any water in them. This way it is possible to measure simultaneously the dry number-size-distribution of all particles, and that of particles with wet diameter smaller than 5 µm. As the latter does not include cloud droplets, the difference between the two measurements represents the number concentration and size distribution of those particles that have activated into cloud droplets (Komppula *et al*., 2005).
The number concentration of particles at Pallas has a clear seasonal cycle, being highest during summer and lowest during winter. The monthly mean number concentration of particles with diameter (D_p) larger than 100 nm (N_{100}) varied from 38 cm^{-3} in November to 270 cm^{-3} in July. During in-cloud periods the monthly mean number concentration of activated particles of this same size class showed a similar pattern, varying from 23 cm^{-3} (November) to 110 cm^{-3} in April. The monthly mean D50 activation diameter (diameter at which 50 % of particles activate) varied from 85 nm (February) to 189 nm (July), showing an average 0.1 nm increase for each added particle in N_{100}. The activated fraction of particles in all sizes decreased sharply when visibility exceeded 1000 m (Figure 2). The highest activated fractions of particles were not observed during the periods of the thickest clouds (lowest visibility), but during clouds with in-cloud visibility between 100 m and 400 m. The lowest D50 values were also observed in these clouds.

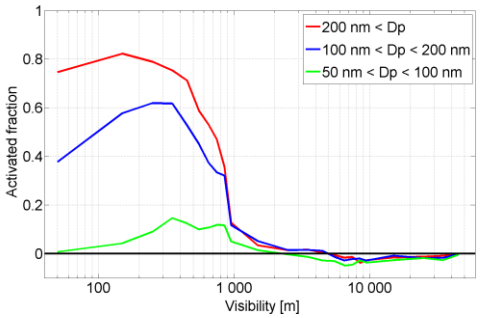

Figure 2. Mean activated fraction of three particle diameter ranges as function of visibility.

Visibility during in-cloud periods was higher in winter (December to March) than during the rest of the year. The optically thickest clouds were observed in summer, when the particle number concentration was highest. The high particle number concentration at summer can be the reason why the thickest clouds were connected to lower activated fractions and higher D50 values.

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Hatakka, J. *et al*. (2003), , *Boreal Environ. Res*., **8**, 365– 384.
Komppula M., Lihavainen H. and Kerminen V.-M. 2005., *J. Geophys. Res.* 110(D0): 6204, doi:10.1029/2004JD005200.