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A Long-Term Study of the Aerosol Effects on Convective Clouds over Southern Sweden and Finland

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MODIS (Moderate Resolution Imaging Spectrometer) cloud data have been combined with ground based measurements of aerosol number size distributions from Vavihill (9 years) and Hyytiälä (10 years) to investigate how convective clouds over Scandinavia are influenced by the amount of aerosol particles present in the air.

Aerosol size distributions data from DMPS (Differential Mobility Particle Sizer) instruments at Vavihill in Southern Sweden (56.01° N 13.9° E) and Hyytiälä in central Finland (61.51° N 24.17° E) have been used to calculate the daily average particle number concentrations over 80 nm (N_{80}) and several other aerosol parameters. N_{80} has been utilized as the main measure of the amount of CCN (Cloud Condensation Nuclei). Satellite images, from the two MODIS instruments onboard the Terra and Aqua satellites, were investigated for the days with available aerosol data from Vavihill and Hyytiälä. A smaller area surrounding each station was examined and satellite scenes containing convective clouds were selected. Level 1B data were used to calculate the cloud top temperature at a 1 by 1 km pixel resolution and the cloud effective radius (r_e) data were obtained from the Level 2 cloud product data. The approach developed by Rosenfeld & Lensky (1998) and Freud et al. (2006) has been applied to find vertical r_e profiles of the clouds by plotting the r_e against the cloud top temperature. Furthermore, Convective Available Potential Energy (CAPE) data from ECMWF (European Centre for Medium-Range Forecasts) has been used to examine how the instability of the atmosphere affects the clouds. Finally, precipitation data from Hyytiälä and SMHI (Swedish Meteorological and Hydrological Institute) for Vavihill have been investigated to find how the aerosols affect precipitation.

The number of profiles included in the study is 569 for Vavihill and 474 for Hyytiälä. The results show that the profiles of r_e are clearly affected by the aerosols since profiles with higher aerosol number concentrations measured at the ground, have lower values of r_e. The cloud base temperature (T_b) also has a strong effect on the r_e profiles, r_e decreases with an increasing T_b. This is thought to occur since a higher T_b causes the ice formation to occur higher up in the clouds resulting in smaller droplet sizes. The T_b and N_{80} are positively correlated, (r equal to 0.37 and 0.68 for Vavihill and Hyytiälä, respectively) so which one of the two that affect the profiles the most is hard to determine.

The instability parameter CAPE does not affect the r_e profiles and we find no correlation between any aerosol parameters and the amount of precipitation. There is however a weak, but significant at a 99% confidence level, correlation between CAPE and the amount of precipitation and also between the latter parameter and the r_e profiles vertical extent.

A large study, including several hundred cases, of how aerosols affect convective clouds at mid-latitudes has been performed using ground based aerosol measurements combined with satellite data. The results show that aerosol number concentrations and cloud base temperature are important for the cloud droplet sizes but that the atmospheric instability and the vertical extent of the clouds control the amount of precipitation produced by the clouds.

Freud, E., Strom, J., Rosenfeld, D., Tunved, P., & Swietlicki, E. (2006). *Tellus B*, Vol. 60, No. 2, 286-297.

Rosenfeld, D. & Lensky, M. I. (1998). *Bull. Amer. Meteo. Soc.* 79(11), 2457-2476