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A study of how aerosols affect low-level clouds over the Nordic Countries using MODIS, ground-based, ECMWF and weather radar data.

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Several types of data have been combined to investigate how aerosol particles and meteorological parameters affect microphysical, radiative and precipitation properties of low-level clouds over Sweden and Finland.

The cloud data was obtained from the MODIS (Moderate Resolution Imaging Spectrometer) instrument on board the Terra and Aqua satellites. The satellite scenes were screened manually for low-level clouds in limited areas around two background aerosol measurement stations. One of the stations, Vavihill, is located in Southern Sweden (56.01° N 13.9° E) and 9 years of number size distribution data from a DMPS (Differential Mobility Particle Sizer) instrument placed there was used in this study. Hyytiälä, the other station, is situated in central Finland (61.51° N 24.17° E) and 10 years of DMPS from this station data were analysed. Furthermore, modelled meteorological parameters from the European Centre for Medium-Range Forecasts (ECMWF) as well as ground-based precipitation measurements from the SMHI (Swedish Meteorological and Hydrological Institute) and from FMI (Finish Meteorological Institute) have been used in the study. Also, to be able to estimate precipitation rates in the clouds, weather radar data obtained in the BALTEX (Baltic Sea Experiment) project were utilized.

The study includes 229 cases from the Vavihill region and 313 cases from the Hyytiälä area. The results from both regions show that aerosol concentrations measured at the ground-based stations have significant negative correlations with the effective radius (r_e) of the low-level clouds. The correlation is stronger when the r_e at 3.7μm is used rather than that at 2.1μm and the highest correlations are obtained when aerosol number concentrations of particles with sizes above 180 nm are used. The correlations between cloud optical thickness (COT) and aerosol number concentrations are on the other hand are positive but lower than for the r_e. Also, the COT correlate better with particles at larger size than the r_e and the strongest correlation occur at aerosol number concentrations of particles above 500 nm. However, the relative humidity at 1000 hPa is the variable that has the strongest correlation with COT. Neither the ground-based precipitation data nor the weather radar data show any significant correlations with the aerosol number concentrations at both stations. Nevertheless, there is a significant but low positive correlation between the r_e and the strength of the radar reflectivity factor. Hence, the first indirect aerosol effect can be detected in this dataset but not the second indirect aerosol effect.