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Aerosol-Cloud Interactions During Puijo Cloud Experiments – The effects of weather and local sources

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The Puijo measurement station has provided continuous data on aerosol-cloud interactions since 2006. The station is located on top of the Puijo observation tower (306 m a.s.l, 224 m above the surrounding lake level) in Kuopio, Finland. The top of the tower is covered by cloud about 15 % of the time, offering perfect conditions for studying aerosol-cloud interactions. With a twin-inlet setup (total and interstitial inlets) we are able to separate the activated particles from the interstitial (non-activated) particles. The continuous twin-inlet measurements include aerosol size distribution, scattering and absorption. In addition cloud droplet number and size distribution are measured continuously with weather parameters.

During the campaigns the twin-inlet system was additionally equipped with aerosol mass spectrometer (AMS) and Single Particle Soot Photometer (SP-2). This way we were able to define the differences in chemical composition of the activated and non-activated particles. Potential cloud condensation nuclei (CCN) in different supersaturations were measured with two CCN counters (CCNC). The other CCNC was operated with a Differential Mobility Analyzer (DMA) to obtain size selected CCN spectra. Other additional measurements included Hygroscopic Tandem Differential Mobility Analyzer (HTDMA) for particle hygroscopicity. Additionally the valuable vertical wind profiles (updraft velocities) are available from Halo Doppler lidar during the 2011 campaign. Cloud properties (droplet number and effective radius) from MODIS instrument onboard Terra and Aqua satellites were retrieved and compared with the measured values.

This work summarizes the two latest intensive campaigns, Puijo Cloud Experiments (PuCE) 2010 & 2011. We study especially the effect of the local sources on the cloud activation behaviour of the aerosol particles. The main local sources include a paper mill, a heating plant, traffic and residential areas. The sources can be categorized and identified by wind direction. Clear changes can be seen in the aerosol and cloud properties when being under the influence of a local pollutant source. Also differences in the chemical composition of aerosol activated to cloud droplet and those staying interstitial has been observed. For example, the light absorption by cloud interstitial particles is higher when the wind blows from the local pollutant sources compared to a cleaner sector. This may be due to the fact that the absorptive material, e.g. fresh soot, is generally hydrophobic and therefore inhibits activation. Another point of interest is the occasional freezing conditions during the campaign (temperature below zero), which also affects the activation behaviour. The full usage of this special data set will provide new information on the properties and differences of activating and non-activating aerosol particles, as well as on the variables affecting the activation.