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Aerosol-Cloud Interactions Measured at Puijo Measurement Station: The effect of surrounding terrain

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Puijo measurement station has provided continuous data on aerosol-cloud interactions since 2006. The station is located on top of the Puijo observation tower (tower height 75m, measurement altitude 224 m above the surrounding lake level) in Kuopio, Finland. The top of the tower is covered by low altitude cloud about 15 % of days, offering perfect conditions for studying aerosol-cloud interactions. In the measurements, a twin-inlet setup (total and interstitial inlets) is used 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 weather parameters and cloud droplet size distribution are measured continuously. During the campaigns the twin-inlet system is additionally equipped with aerosol mass spectrometer (AMS) and cloud condensation nuclei counter (CCNC). This way we were able to define the differences in chemical composition of the activated and non-activated particles, and the number of potential cloud condensation nuclei (CCN) in different supersaturations.

As the tower is located on the top of a hill, it is possible that updrafts created by the hill are affecting the cloud droplet formation. In this study the terrain effect on wind fields around the measurement station was modelled using PALM Large Eddy Simulation model. The LES domain covered 15 km x 8 km area around the Puijo tower and extended up to 1 km height while the boundary-layer depth was about 370 m. The LES grid spacing was 5 m in the mean wind direction and 4 m in both cross-wind and vertical directions. The terrain topography needed was obtained from the National Land Survey of Finland with spatial resolution of 2 meters.

Results from this work show that in some conditions the updrafts caused by the hill are affecting cloud droplet number concentration measured at the station. This is dependent on the wind speed and direction, and cloud base height. In some cases the updraft is high enough to produce water supersaturation higher than at the cloud base where droplets are normally activated, and this will cause second activation of cloud droplets inside the cloud. This can be observed as a bimodal cloud droplet size distribution in the measurements. However, analysis of the size dependent aerosol activation into cloud droplets shows that most of the time aerosol particles activated to cloud droplets at supersaturations between 0.1 and 0.2, and thus the updraft at cloud base was on average lower than 0.2 m/s. In the cases when second activation was observed, the hill produced updrafts of 1m/s. Overall, the data from measurement station can be used as a representative for large area low altitude clouds when some limits are set for wind direction and speed.