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Cloud droplet number susceptibility to CCN concentrations in low level boundary layer clouds: comparison of in-situ observations and large-scale models

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The susceptibility of cloud droplet number concentration (CDNC) to cloud condensation nuclei (CCN) number concentration is one of the major factors controlling the aerosol indirect forcing. In this study we investigate the sensitivity of CDNC to CCN concentrations using long term in-situ observations from three stations (Puijo, Pallas, Zeppelin) locating in Finland and Arctic. These stations represent semiurban, remote and Arctic remote environments with differences in typical updraft velocity conditions as well as in aerosol number concentrations. We compare the in-situ observations with three large scale models (ECHAM-M7, ECHAM-SALSA and NorESM) having differences in aerosol presentation while the activation parametrization is the same in all three model setups. In the comparison we use CDNC and CCN model outputs of the gridbox corresponding to the location and the height for each station. In addition, we compare the updraft velocities from the models and stations when they are available. Our current observational results show very high susceptibility of CDNC and CCN in all investigated stations. The agreement between the large scale models and observations was very good for Puijo and Pallas stations, but for the Arctic station (Zeppelin) the modelled CDNC susceptibility to CCN was much lower than the observed. This might be related to the recent results demonstrating that Aitken mode particles can active to cloud droplets at Zeppelin station (Bulatovic et al., 2021; Karlsson et al., 2021). In addition, at Zeppelin CDNC exhibits very low values which are below the lower bound imposed by ECHAM.

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