Exploring Aerosol-Cloud Interactions in Arctic Mixed-Phase Clouds Using ICON-LEM

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Arctic mixed-phase clouds (MPCs) are impacting hydrological and radiative processes and could therefore play an important role in Arctic Amplification. However, this role remains unclear, and the complex interplay of microphysical processes and environmental forcing still lacks in understanding. Thus, the accurate representation of MPCs in climate models remains a significant challenge. Investigating the sensitivity of MPC properties to aerosol load using 600m ICON-LEM simulations could improve the overall understanding. Since June 2020, daily semi-operational simulations at 600m resolution around Ny-Ålesund have been conducted using the large-eddy model of the ICON system (ICON-LEM). These simulations provide a robust dataset for analyzing MPCs. Comparisons with ground-based observations have shown promising agreement in key variables such as wind flow and precipitation, making them a valuable tool for process studies. Additionally, a microphysical wrapper (Kiszler et al., 2024, Atmos. Chem. Phys.) developed for the ICON model enables detailed evaluation of ice and liquid water processes, enhancing the ability to assess microphysical interactions. With this basis, the study investigates how important the modelled representations of CCN and INP are for the persistence and dissolution of low-level MPCs. To address this, the dataset is filtered for clean and polluted cases which are compared to investigate the sensitivity of different cloud structures to the aerosol load. Utilizing the microphysical wrapper allows for a more detailed investigation of the influence of aerosols, particularly cloud condensation nuclei (CCN) and ice-nucleating particles (INPs), on MPC formation, persistence, and phase transitions.