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Aerosol-Cloud-Turbulence Interaction in Multilayer Clouds Modeled on a Closed Trajectory between MOSAiC and MOSAiC-ACA

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The transformation of cloudy air masses plays a key role in the ongoing Arctic Amplification. The complex system of the interactions between aerosols, cloud layers and turbulence is not yet fully understood, mostly due to broad range of scales involved and the lack of reliable in-situ measurements.
We try to fill this gap by using a high resolution numerical simulation constrained with observations as a virtual laboratory. The focus of this study is the transformation of boundary layer mixed-phase clouds in the presence of higher cloud decks advected above them. The recent MOSAiC field campaign provided us with unique observations of developing cloudy air mass on a closed trajectory. The same air mass was sampled twice in September 2020, first by the research vessel Polarstern during the MOSAiC drift, and later by airborne instruments during the MOSAiC-ACA, its sister-campaign northwest of Svalbard. We configured a high-resolution Lagrangian large-eddy simulation based on ERA5 reanalysis data and constrained it by in-situ measurements of the surface boundary condition, vertical thermodynamic structure and aerosol concentrations. The results of the simulations are then validated against independent cloud measurements. Our virtual laboratory also provides us opportunities to investigate the sensitivity of the transformation of the boundary layer clouds to the composition of the advected mid-tropospheric cloud decks. The importance of the seeder-feeder mechanism and radiative fluxes will be discussed, as well as further implications for the Arctic Amplification and future studies.