Impacts of Aerosol Concentration Variability on Turbulence in Convective Low Level Mixed-phase Clouds in the Arctic

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Arctic mixed-phase clouds are still not properly represented in weather forecast and climate models. Recent field campaigns in the Arctic have successfully probed low level mixed-phase clouds, however it remains difficult to gain understanding of this complex system from observational datasets alone. Complementary high-resolution simulations, properly constrained by relevant measurements, can serve as a virtual laboratory that provides a deeper insight into a developing boundary layer in the Arctic.

Our study focus on the impact of variability in cloud condensation nuclei (CCN) concentrations on the turbulence in Arctic mixed-phase clouds. Large-Eddy Simulations of convective mixed-phase clouds over open water were performed as observed during the ACLOUD campaign, which took place in Fram Strait west of Svalbard in May and June 2017. The Dutch Atmospheric Large Eddy Simulation (DALES) is used including a well-established double-moment mixed-phase microphysics scheme of Seifert & Beheng.

The results highlight various impact mechanisms of CCN on the boundary layer thermodynamic state, turbulence, and clouds. Lower CCN concentrations generally lead to decreased turbulence near the cloud top. However, they can also enhance the turbulence in the lower part of the boundary layer due to increased amount of sublimation of ice hydrometeors. Further implications for the role of mixed-phase clouds in the Arctic Amplification will be discussed.