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Large-eddy simulation of a stratocumulus-topped arctic boundary layer

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Arctic low-level stratocumulus is the main contributor to the intra-seasonal variability of surface radiation balance, while surface latent and sensible heat fluxes influence the existence and evolution of the clouds. Although stratocumuli may extend over hundreds of meters vertically, phenomena on scales below few tens of meters, like cloud-top entrainment or mixing within the atmospheric boundary layer, drive their development. The interaction of radiation, microphysics, and turbulence represents not only a major challenge for climate and weather modeling but also for large-eddy simulation. Using highly-resolved large-eddy and direct numerical simulation, recent studies (e. g. Matheou and Chung, 2014; Kopec et al., 2016; de Lozar and Mellado, 2017) for the first time yield a detailed view of the cloud-driving processes. While these studies focus on steady and homogeneous cases, transitional cases and heterogeneous surfaces remain elusive. Studies with comparable resolutions are non-existent for the Arctic where observational data is lacking, most clouds are mixed-phase, and the characteristic eddies are even smaller than for other regions.

To analyze non- or under-resolved microphysical, radiative, and turbulent processes and their interaction, we performed a resolution-convergence study of a well-investigated low-level stratocumulus case (DYCOMS-II RF01) using a modified version of WRF-LES. We find that the first-moments of e. g. liquid potential temperature, total water mixing ratio, and boundary layer height are independent of the horizontal resolution only below 10 m – less than what many other studies of low-level stratocumulus employ. Based on observational data from ACLOUD and PASCAL (Wendisch et al., 2017), two recent measurement campaigns focusing on the Arctic boundary layer, we investigate a case with low-level mixed-phase stratocumulus during summer over ice surface. Benchmarking the simulations against observational data allows process-level insight to the cloud-driving processes beyond what can be learned from observational data or large-eddy simulation alone.

De Lozar and Mellado (2017), J. Atmos. Sci., vol74(3), 751-765.
Kopec et al. (2016), Q.J.R. Meteorol. Soc., vol142(701), 3222-3233.
Matheou and Chung (2014), J. Atmos. Sci., vol71(12), 4439-4460.
Wendisch et al. (2017), EOS, vol98(8), 22-26.