Modelling mixed-phase clouds with large-eddy model UCLALES-SALSA

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We have extended the large-eddy model UCLALES-SALSA (Tonttila et al., 2017) to include formation of ice and mixed-phase clouds. The model has exceptionally detailed aerosol description for both aerosol number and chemical composition. We confirmed the accuracy of newly implemented ice microphysics with a comparison to a previous mixed-phase cloud model intercomparison study.

In a further simulation the model captured the typical layered structure of Arctic mixed-phase clouds: a liquid layer near cloud top and ice within and below the liquid layer. The simulation also demonstrated how larger droplets froze first. Moreover, the simulation showed realistic freezing rates of droplets within the vertical cloud structure. These characteristics were possible to capture with a heterogeneous ice nucleation scheme, where also ice nucleating particles (INP) are prognosed. Here, dust containing particles acted as INPs.

The prognostic simulation showed the importance of the self-adjustment of ice nucleation active particles. This is in good agreement with an observational study where resilient mixed-phase clouds are seen together with relatively high ice nuclei concentrations.

The implemented detailed sectional ice microphysics with prognostic aerosols is essentially important in reproducing the characteristics of mixed-phase clouds. The manuscript of this study is submitted for publication.