EGU22-9347
https://doi.org/10.5194/egusphere-egu22-9347
EGU General Assembly 2022

Application of the spectral cloud microphysics model COSMO-SPECS for sensitivity studies in real mixed-phase cloud scenarios

Roland Schrödner, Johannes Bühl, Fabian Senf, Oswald Knoth, Jens Stoll, Martin Simmel, and Patric Seifert
Institute for Tropospheric Research, Modeling of Atmospheric Processes, Leipzig, Germany (roland.schroedner@tropos.de)

Within mixed phase clouds several microphysical processes exchange water between the three compartments vapor, liquid phase (cloud and rain droplets) and ice phase (ice and snow crystals). In the recent years, mixed-phase clouds were observed at different places on Earth with contrasting aerosol conditions using the remote sensing platform LACROS. The microphysical properties of these mixed phase clouds depend strongly on the availability of particles that serve as cloud condensation nuclei and ice nucleating particles.

The SPECtral bin cloud microphysicS model SPECS was developed to simulate cloud processes using fixed-bin size distributions of aerosol particles and of liquid and frozen hydrometeors. It was implemented in the numerical weather prediction model COSMO, thereby substituting the original bulk one- or two-moment microphysics. Recently, the COSMO-SPECS has been enhanced by considering lateral boundary conditions for the hydrometeor spectra allowing for high-resolution real case studies on nested domains. Furthermore, an additional INP spectrum is introduced, which better enables the future coupling to INP diagnosed from aerosol chemistry transport model simulations.

The simulations are carried out by first applying the meteorological driver COSMO using its standard two-moment microphysics scheme on multiple nests with increasing horizontal resolution. Finally, COSMO-SPECS is applied on the innermost domain with a horizontal resolution of a few hundred meters using boundary data derived from the finest driving COSMO domain. For this purpose, the bulk hydrometeor fields of the driving model need to be translated into the corresponding hydrometeor mass and number distributions of SPECS' hydrometeor spectra.

Detailed sensitivity studies on properties of the aerosol (CCN, INP, ice crystal shape) and on the treatment of the hydrometeor fields at the lateral boundaries for selected observed mixed-phase cloud cases are presented. The model simulations are compared against available remote sensing observations. Overall, the spectral cloud microphysics show improvements in the formation of precipitation for the investigated cases. However, the simulations depend strongly on the given meteorological conditions provided by the outer driving model domains.