Geophysical Research Abstracts
Vol. 17, EGU2015-11207, 2015
EGU General Assembly 2015

Cloud Susceptibilities to Ice Nuclei: Microphysical Effects and Dynamical Feedbacks

Marco Paukert (1) and Corinna Hoose (2)

(1) Karlsruhe Institute of Technology, IMK-AAF, Germany (marco.paukert@kit.edu), (2) Karlsruhe Institute of Technology, IMK-TRO, Germany (corinna.hoose@kit.edu)

The impact of aerosols on cloud properties is currently not well established. This is largely attributed to the interdependencies of aerosols and cloud microphysical processes, among which primary ice formation contributes to considerable uncertainties. Although it is known that in a large range of thermodynamic conditions aerosol particles are required to initiate ice formation, identifying and characterizing the effect of specific ice nuclei is among current scientific efforts.

Here we attempt to quantify the change of cloud properties with varying aerosol background concentrations. We adapt the concept of susceptibilities for mixed-phase and ice clouds, defining the susceptibility as the derivation of a macrophysical quantity with respect to ice nucleating aerosol concentrations.

A focus of our study is the use of different model approaches in order to identify the distinct contributions of both cloud microphysics and cloud-dynamical feedbacks to the overall susceptibility. The classical method is the direct comparison of two independent model runs, where the whole range of microphysical and cloud-dynamical feedbacks contributes to different cloud properties in a perturbed simulation. Our alternative method relies on a single simulation which incorporates multiple executions of the microphysical scheme within the same time step, each "perturbed microphysics" scheme with varying aerosol concentrations and an additional set of cloud particle tracers. Since in the latter case the model dynamics are held constant and only microphysical feedbacks contribute to the properties of perturbed clouds, we can distinguish between the pure microphysical effect and the dynamical enhancement or suppression.

For a persistent Arctic mixed-phase stratocumulus cloud layer which is expected to be particularly sensitive to feedback cycles, we show an enhancement of the cloud susceptibility to ice nucleating particles by dynamics of around 50%, but a decay of the enhancement with time due to the adjustment of turbulent transport. Furthermore, simulations of Weisman and Klemp (1982) convective clouds are going to be presented.

Results are based on three-dimensional, idealized LES-like simulations with the COSMO-ART model (Vogel et al., 2009) and an extended version of the two-moment bulk microphysics scheme of Seifert and Beheng (2006).

Seifert, A., and K. D. Beheng (2006), A two-moment cloud microphysics parameterization for mixed-phase clouds. Part 1: Model description, Meteorol. Atmos. Phys., 92, 45–66.

Vogel, B., H. Vogel, D. Bäumer, M. Bangert, K. Lundgren, R. Rinke, and T. Stanelle (2009), The comprehensive model system COSMO-ART - Radiative impact of aerosol on the state of the atmosphere on the regional scale, Atmos. Chem. Phys., 9, 8661–8680.

Weisman, M. L., and J. B. Klemp (1982), The dependency of numerically simulated convective storms on vertical wind shear and buoyancy, Mon. Wea. Rev., 110, 504-520.