Geophysical Research Abstracts
Vol. 14, EGU2012-8743, 2012
EGU General Assembly 2012

Heterogeneous ice nucleation parameterizations based on laboratory experiments

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Aerosol influences on mixed-phase and cold clouds have received increasing attention in recent years. Possible effects of anthropogenic aerosols include enhanced glaciation of mixed-phase clouds, deactivation of natural ice nuclei, or they could be negligible compared to the natural background. The numerical simulation and quantification of these effects requires aerosol-specific ice nucleation parameterizations, which can be based either on field measurements or on laboratory experiments. The advantage of laboratory studies is that the aerosol samples can be well characterized with respect to their composition and size distribution. A simple empirical parameterization of ice nucleation ability is the so-called active site density. Experiments in the AIDA (Aerosol Interaction and Dynamics in the Atmosphere) chamber have been used as a basis for fitted active site densities for various particles, such as desert dusts, volcanic ash, agricultural soils and pollen grains. The parameterizations will be compared to results from other experiments, and the differences and limitations will be discussed. The derived values of the active site density are sensitive to assumptions on the particle shape. In addition, the temperature range which can be covered is limited by the detection threshold of the employed instrument. For deposition nucleation, it is more difficult to obtain temperature- and supersaturation-dependent fits of the active site density.

Furthermore, other recently developed ice nucleation parameterizations (Phillips et al, 2008; DeMott et al, 2010; Hoose et al, 2010), which are based on continuous flow diffusion chamber measurements and classical nucleation theory, respectively, are presented as "equivalent active site densities" to make them directly comparable to the AIDA measurements and active site density fits. These approaches differ both with respect to their absolute values, temperature- and time-dependence. The resultant differences in predicted atmospheric ice nuclei concentrations will be shown for a simulation with the COSMO-ART model.