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Ice nucleation sensitivity studies using the detailed microphysical model MAID

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The influence of heterogeneous freezing on the ice crystal number of cirrus clouds have been evaluated by extensive model simulations using the detailed microphysical model MAID (Bunz et al., 2008). MAID includes heterogeneous as well as homogeneous freezing and, as a new feature, freezing thresholds for different types of ice nuclei (IN), derived from ice nucleation experiments at the cloud chamber AIDA.

Cirrus formation scenarios are simulated in the temperature range 180 - 240 K in 10 K steps. For each temperature, six different vertical velocities were assumed, ranging from 1 - 1000 cm/s. Thus, one scenario contains 42 model runs. A variety of scenarios are simulated by variing the IN number between 0.001 and 0.2 cm^{-3} and using the freezing thresholds of coated soot and mineral dust. Further, the simulations are performed for constant vertical velocities u_z as well as for u_z superimposed with temperature pertubations of 1 and 3 K, respectively.

Earlier studies (Gierens, 2003; Kärcher and Lohmann, 2003) concluded that homogeneous nucleation dominates in regions with updrafts stronger than 20-30 cms^{-1}. Our simulations show that heterogeneous ice formation progressively influences the ice crystal concentrations up to u_z = 100 cm/s, increasing with the IN number and with the temperature. Lowering the freezing threshold decreases the ice crystal number, while temperature pertubations increases the ice concentration, but both only for $u_z \leq 10$ cm/s.

In addition to the ice nucleation sensitivity studies, we performed an intercomparison of MAID with a detailed microphysical model (DLR Oberpfaffenhofen, B. Kärcher) and a double moment bulk microphysics scheme (ETH Zürich, P. Spichtinger), resulting in a good agreement between the models.

References:

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