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Towards a Two-Moment Two-Mode Cloud Ice Scheme for High-Resolution Global Models

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Cirrus cloud properties are still a big uncertainty when it comes to atmospheric modeling. Approximately 20-25% of the globe is covered by cirrus clouds which merits future studies. Their formation is distinguished by the ambient air and dynamics which leads do different microphysical and radiative properties.

The main mechanisms for cirrus formation are homogeneous and heterogeneous freezing. Homogeneous freezing of liquid aerosols takes place at very low temperatures and high vertical updrafts resulting in small ice particles and a high number density while heterogeneous freezing occurs at warmer temperatures and causes the ice crystals to be larger but fewer. The latter process is triggered in warmer air with lower vertical velocities causing a competition in depleting ice supersaturation. This complicates the parameterisation and numerical implementation of these processes in atmospheric models.

For a better representation and understanding of these processes the ice crystals are divided into two different modes originating from either homogeneous or heterogeneous nucleation. Additionally implemented is an extension of the microphysics schemes operational at DWD NWP models with a state-of-the-art parameterisation for homogeneous and heterogeneous freezing.

The enhanced ice nucleation scheme is compatible with nonhydrostatic regional as well as high-resolution global models.
Results are presented by use of idealized simulations and experimental model runs. The sensitivities are then investigated in detail with an emphasis on the separate nucleation mechanisms taking into account the influence of aerosol-cloud interaction on size and number density of the ice crystals.