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Sensitivity of Arctic mixed-phase clouds simulated with the global climate model ECHAM6-HAM2 to the heterogeneous freezing parameterization

Luisa Ickes (1), André Welti (1), Corinna Hoose (2), and Ulrike Lohmann (1)

(1) Institute for Atmospheric and Climate Science, ETH Zurich, Zurich, Switzerland (luisa.ickes@env.ethz.ch), (2) Institute for Meteorology and Climate Research, Karlsruhe Institute of Technology, Karlsruhe, Germany

Different methods can be used to parameterize heterogeneous freezing in mixed-phase clouds either based on field mesurements, laboratory experiments or using theoretical approaches. In this study a parameterization for immersion freezing based on Classical Nucleation Theory (CNT) and laboratory data from Welti et al. [1] is developed for the GCM ECHAM6-HAM2. The scheme is able to incorporate laboratory data to describe microphysical properties of ice nuclei [2].
As CNT is very sensitive to the description of unconstrained kinetic and thermodynamic parameters in case of homogeneous freezing [3] the sensitivity of immersion freezing to these parameters is investigated. Additionally, several approaches to represent ice nuclei properties are tested in terms of their capability to reproduce temperature, time and size dependence of the experimentally observed freezing process.
The developed CNT parameterization scheme for kaolinite, illite, montmorillonite, microcline (K-feldspar) and ATD (Arizona test dust) is then introduced into the global climate model ECHAM6-HAM2 with a two-moment cloud microphysics scheme [4] coupled to the aerosol module HAM [5]. The sensitivity of the parameterization is tested in the framework of an Arctic case study. The parameterization will be evaluated against an empirical freezing parameterization to study if the choice of a parameterization scheme can influence the representation of Arctic mixed-phase clouds in ECHAM6-HAM2.

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