Geophysical Research Abstracts
Vol. 15, EGU2013-4831, 2013
EGU General Assembly 2013

Simulation of Arctic mixed-phase clouds with the ECHAM GCM

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Mixed-phase clouds are the dominant cloud type in the Arctic and crucial for the Arctic climate and its seasonality by having a profound impact on the radiation balance and thus on the sea ice coverage [1, 2]. The formation and evolution of these clouds is highly dependent on their microphysical processes.

Aerosols acting as ice nuclei (IN) cause heterogeneous freezing of water droplets and deposition ice nucleation from the water vapour phase (formation of a mixed-phase cloud). A modest change in IN concentrations can influence the lifetime of mixed-phase clouds. However, the interaction of IN with Arctic clouds is not very well represented in many (global) models, which could be related to inadequate parameterizations of ice nuclei, heterogeneous freezing processes and the cloud processing of aerosols.

In this study the freezing processes in mixed-phase clouds and their role for Arctic climate are analyzed using the global climate model ECHAM with a two-moment cloud microphysics scheme [3] coupled to the aerosol module HAM [4]. Therefore a new freezing parameterization scheme based on Classical Nucleation Theory (CNT) [5] is introduced into ECHAM. This scheme is able to incorporate laboratory data to describe microphysical properties of the IN. It will be evaluated against two different Arctic case studies in comparison to an empirical freezing parameterization. For evaluation the data of the ARM Mixed-Phase Arctic Cloud Experiment and observations (MPACE) and the Indirect and Semi-Direct Aerosol Campaign (ISDAC) is used. In this study we will investigate if the new freezing parameterization leads to a better representation of Arctic mixed-phase clouds in ECHAM.

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