Development and evaluation of cloud glaciation processes in ECHAM-HAMMOZ
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Abstract

Currently, a high spreading exist in the cloud phase partition among global climate models. This is mainly due to poorly constrained cloud glaciation processes, especially in the mixed-phase regime. Particularly, processes involving aerosol-cloud interactions like heterogeneous freezing are not well constrained. This results in differences in the radiative balance and a higher uncertainity in the determination of the indirect radiative effect of aerosols. Furthermore, the relative importance of aerosol-related and dynamics-related glaciation processes is not well understood. Additionally, the correlation between aerosols and dynamical forcings makes it difficult to attribute the variability of cloud phase to aerosol-cloud interactions.

Aerosol-related glaciation processes include mainly immersion, contact and deposition freezing of cloud droplets. The ability of this processes to trigger other freezing mechanisms like ice multiplication, the Wegener–Bergeron–Findeisen (WBF) process or cloud seeding has been poorly studied as well. These mechanisms may have a deep inpact in the aerosol radiative effects, for example trough the cloud glaciation ("Twomey") effect and the cloud lifetime ("Albrecht") effect.

Global satellite observations used together with composition reanalysis are a powerful tool to evaluate such aerosol-cloud interactions. These datasets can be used to evaluate both the spatial and temporal variability of cloud glaciation in the model and can be used to test alternative parameterizations.

The well-established global aerosol-chemistry-climate model ECHAM6-HAMMOZ is jointly developed by partners from several European universities and research institutes. The current release version of the model includes the global atmospheric climate model ECHAM (current version 6.3), the aerosol-microphysics model HAM (current version 2.3), and the atmospheric chemistry model MOZART (current version 1.0). (Schultz et al, 2017). It simulates the lifecycles of the climate-relevant aerosol species including microphysical transformation processes, and their climate impact. Additionally, the stratiform microphysics in the model are used to compute the freezing rates from the interaction (contact and immersion freezing) between cloud droplets and ice nucleating aerosols, particularly mineral dust and black carbon. Several processes relevant to the formation, transport and removal of ice particles are also represented in HAM2.3 (Hoose et al., 2008).

The goal of the project is to improve the freezing parameterizations in ECHAM6-HAMMOZ in order to achieve a better estimation of the aerosol indirect radiative effect. For this purpose, different cloud phase products from the A-Train satellites (DARDAR,CALIPSO-GOCCP and MODIS), together with atmospheric and composition reanalysis (ERA, MACC and CAMS) will be used to evaluate the cloud glaciation in the model, as well as alternative parameterizations.