EGU24-15251, updated on 14 Oct 2024
https://doi.org/10.5194/egusphere-egu24-15251
EGU General Assembly 2024


# The global distribution of ice-nucleating particles and their impacts on cirrus clouds and radiation derived from global model simulations

**Christof Beer**, Johannes Hendricks, and Mattia Righi
Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany

Atmospheric aerosols can act as ice-nucleating particles (INPs) thereby influencing the formation and the microphysical properties of cirrus clouds. However, the knowledge on the atmospheric distribution of INPs is still limited and consequently the understanding of their climate impacts is highly uncertain. We perform model simulations with a global aerosol-climate model coupled to a two-moment cloud microphysical scheme and a parametrization for aerosol-induced ice formation in cirrus clouds and present a global climatology of INPs in the cirrus regime. In addition to the broadly considered mineral dust and soot INPs, this climatology also comprises crystalline ammonium sulfate and glassy organic particles. The simulated INP number concentrations range from about 1 to 100 $L^{-1}$ and agree well with in-situ observations and other global model studies. Our model results show large ammonium sulfate INP concentrations, while the concentrations of glassy organic INPs are mostly low in the cirrus regime. By coupling the different INP-types to the microphysical cirrus cloud scheme, we analyze their ice nucleation potential under cirrus conditions, considering possible competition mechanisms between different INPs. The resulting radiative forcing of the total INP-cirrus effect, considering the difference between a simulation with all different INP-species and a simulation with purely homogeneous freezing, is simulated as −28 and −55 mW $m^{-2}$, assuming a smaller and a larger ice-nucleating potential of INPs, respectively. While the simulated impact of glassy organic INPs is mostly small and not significant, ammonium sulfate INPs introduce a considerable radiative forcing, which is nearly as large as the combined effect of mineral dust and soot INPs. Assuming a larger ice-nucleating potential of INPs, the INP-cirrus effect due to anthropogenic INPs, considering the difference between present-day (2014) and pre-industrial (1750) conditions, is simulated as −29 mW $m^{-2}$.