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Homogeneous Freezing of Water Droplets and its Dependence on Droplet Size

Thea Schmitt, Ottmar Möhler, Kristina Höhler, and Thomas Leisner
Institute for Meteorology and Climate Research, Karlsruhe Institute of Technology, Germany (thea.schmitt@student.kit.edu)

The formulation and parameterisation of microphysical processes in tropospheric clouds, such as phase transitions, is still a challenge for weather and climate models. This includes the homogeneous freezing of supercooled water droplets, since this is an important process in deep convective systems, where almost pure water droplets may stay liquid until homogeneous freezing occurs at temperatures around 238 K. Though the homogeneous ice nucleation in supercooled water is considered to be well understood, recent laboratory experiments with typical cloud droplet sizes showed one to two orders of magnitude smaller nucleation rate coefficients than previous literature results, including earlier results from experiments with single levitated water droplets and from cloud simulation experiments at the AIDA (Aerosol Interaction and Dynamics in the Atmosphere) facility. This motivated us to re-analyse homogeneous droplet freezing experiments conducted during the previous years at the AIDA cloud chamber. This cloud chamber has a volume of $84\,\mathrm{m}^3$ and operates under atmospherically relevant conditions within wide ranges of temperature, pressure and humidity, whereby investigations of both tropospheric mixed-phase clouds and cirrus clouds can be realised. By controlled adiabatic expansions, the ascent of an air parcel in the troposphere can be simulated. According to our new results and their comparison to the results from single levitated droplet experiments, the homogeneous freezing of water droplets seems to be a volume-dependent process, at least for droplets as small as a few micrometers in diameter. A contribution of surface induced freezing can be ruled out, in agreement to previous conclusions from the single droplet experiments. The obtained volume nucleation rate coefficients are in good agreement, within error bars, with some previous literature data, including our own results from earlier AIDA experiments, but they do not agree with recently published lower volume nucleation rate coefficients. This contribution will show the results from the re-analysis of AIDA homogeneous freezing experiments with pure water droplets and will discuss the comparison to the literature data.