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Cloud chamber experiments on Arctic Cirrus Cloud Thinning with a focus on the competition of homogeneous and heterogeneous freezing

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The Arctic is one of the areas affected most severely by the global climate change, with a rise of the mean temperature and a continuous melting of the ice being observed since years. An important component in the Arctic climate are frequently occurring cirrus clouds, which have a net warming contribution to the radiation budget, being most substantial in the Arctic winter. Hence, decreasing the cirrus cloud cover in the Arctic winter could potentially lead to an effective cooling at the surface.

The residence time and optical properties of cirrus clouds strongly depend on the size and number of the ice crystals. Aerosol seeding can suppress the homogeneous freezing of sulfuric acid solution droplets and lead to a smaller number of ice crystals with bigger size (Mitchell and Finnegan, 2009). Climate model studies estimating the cooling effect from cirrus cloud thinning deliver diverging assessments (Muri et al., 2014, Storelvmo and Herger, 2014, Gasparini and Lohmann, 2016). One of the reasons for these different results lies in the uncertainties regarding the representation of ice formation processes in climate models.

In this experimental study, focusing on AIDA cloud chamber experiments, we investigate the competition between heterogeneous deposition nucleation initiated by aerosol particles and homogeneous freezing of sulfuric acid solution droplets. Realistic conditions of the Arctic upper troposphere are simulated at temperatures between 210 and 230 K. The experimental starting conditions are varied systematically to obtain information about the sensitivity of homogeneous solution droplet freezing to the presence of ice-nucleating particles. Three different aerosols are tested, namely quartz, fumed silica and calcium carbonate. A main finding is that the total ice number concentration can be minimized by the right seeding of ice-nucleating particles.