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Laboratory and Cloud Chamber Studies of Formation Processes and Properties of Atmospheric Ice Particles

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The formation of ice in tropospheric clouds controls the evolution of precipitation and thereby influences climate and weather via a complex network of dynamical and microphysical processes. At higher altitudes, ice particles in cirrus clouds or contrails modify the radiative energy budget by direct interaction with the shortwave and longwave radiation.

In order to improve the parameterisation of the complex microphysical and dynamical processes leading to and controlling the evolution of tropospheric ice, laboratory experiments are performed at the IMK Karlsruhe both on a single particle level and in the aerosol and cloud chamber AIDA.

Single particle experiments in electrodynamic levitation lend themselves to the study of the interaction between cloud droplets and aerosol particles under extremely well characterized and static conditions in order to obtain microphysical parameters as freezing nucleation rates for homogeneous and heterogeneous ice formation. They also allow the observation of the freezing dynamics and of secondary ice formation and multiplication processes under controlled conditions and with very high spatial and temporal resolution. The inherent droplet charge in these experiments can be varied over a wide range in order to assess the influence of the electrical state of the cloud on its microphysics.

In the AIDA chamber on the other hand, these processes are observable under the realistic dynamic conditions of an expanding and cooling cloud- parcel with interacting particles and are probed simultaneously by a comprehensive set of analytical instruments. By this means, microphysical processes can be studied in their complex interplay with dynamical processes as for example coagulation or particle evaporation and growth via the Bergeron – Findeisen process. Shortwave scattering and longwave absorption properties of the nucleating and growing ice crystals are probed by in situ polarised laser light scattering measurements and infrared extinction spectroscopy. In conjunction with ex situ single particle imaging and light scattering measurements the relation between the overall extinction and depolarization properties of the ice clouds and the morphological details of the constituent ice crystals are investigated.

In our contribution we will concentrate on the parameterization of homogeneous and heterogeneous ice formation processes under various atmospheric conditions and on the optical properties of the ice crystals produced under these conditions. First attempts to parameterize the observations will be presented.