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Experimental Investigation of Ice Nucleation by different Types of Aerosols in the Aerosol Chamber AIDA: Implications to Microphysics of Cirrus Clouds

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Microphysical properties of cirrus clouds like the ice crystal number density and size distribution do not only affect the radiative impact of these clouds, but also cloud lifetime, possible heterogeneous reactions on the ice surface, or potential removal of substances by sedimentation of larger ice crystals. Experimental studies which examine the conditions of homogeneous or heterogeneous ice cloud formation and the resulting microphysical properties are of major importance for the development and validation of respective parameterisations and process models.

The aerosol chamber AIDA of Forschungszentrum Karlsruhe was used as an expansion cloud chamber with cooling rates at the onset of ice nucleation between -1.3 and -3.0 K/min to investigate the nucleation and growth of ice crystals at temperatures between 185 and 238 K. Sulphuric acid (SA) and ammonium sulphate (AS) aerosol was used for homogeneous ice nucleation, whereas pure soot, soot coated with sulphuric acid or Ammonium sulphate, and mineral dust aerosols were used for heterogeneous ice formation. The SA aerosol nucleated ice at relative humidities with respect to ice (RH_ice) increasing from 144 to 166 % with temperatures from 220 and 196 K. This is in good agreement with literature data. In contrast, the AS aerosol nucleated ice at the significantly lower RH_ice of 120 to 127 % in the same temperature range, though Fourier-Transform infrared (FTIR) extinction spectra revealed that the AS aerosol mainly consisted of the liquid phase. The number concentration of ice

crystals formed during the homogeneous freezing experiments agree well with model results from the literature.

During heterogeneous ice formation experiments, distinctly lower freezing thresholds were observed. Deposition ice nucleation on mineral dust particles turned out to be the most efficient ice nucleation mechanism, both with respect to RH_ice at the onset of ice nucleation (100 to 120 % in the temperature range 195 to 238 K) and the ice crystal number concentration. Between 30 and 90 % of the mineral dust particles nucleated ice.