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Numerical simulations of homogeneous freezing processes in the aerosol chamber AIDA

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Abstract. The homogeneous freezing of supercooled H_2SO_4/H_2O aerosols in an aerosol chamber is investigated with a microphysical box model using the activity parameterization of the nucleation rate by Koop et al. (2000). The simulations are constrained by measurements of pressure, temperature, total water mixing ratio, and the initial aerosol size distribution, described in a companion paper Möhler et al. (2003). Model results are compared to measurements conducted in the temperature range between 194 and 235 K, with cooling rates in the range between 0.5 and 2.6 K min^{-1}, and at air pressures between 170 and 1000 hPa. The simulations focus on the time history of relative humidity with respect to ice, aerosol size distribution, partitioning of water between gas and particle phase, onset times of freezing, freezing threshold relative humidities, aerosol chemical composition at the onset of freezing, and the number of nucleated ice crystals. The latter four parameters can be inferred from the experiments, the former three aid in interpreting the measurements. Sensitivity studies are carried out to address the relative importance of uncertainties of basic quantities such as temperature, total H_2O mixing ratio, aerosol size spectrum, and deposition coefficient of H_2O molecules on ice. The ability of the numerical simulations to provide detailed explanations of the observations greatly increases confidence in attempts to model this process under real atmospheric conditions, for instance with regard to the formation of cirrus clouds or polar stratospheric ice clouds, provided that accurate temperature and humidity measurements are available.

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