T-dependent rate measurements of homogeneous ice nucleation in cloud droplets using a large atmospheric simulation chamber

The rates of photochemical reactions in the atmosphere depend on the optical properties and lifetimes of clouds. These are critically affected by the process of droplet freezing, because ice crystals can grow to large sizes at the expense of the metastable supercooled droplets, thereby initiating graupel formation and precipitation. The large evacuable and coolable aerosol chamber AIDA at Forschungszentrum Karlsruhe has been used to generate supercooled clouds under controlled conditions. Homogeneous freezing was detected below −35.5 ◦C, and nucleation rates $J(T)$ were measured to about −37 ◦C. They vary between ~10^6 cm^{-3} s^{-1} at the highest and ~10^8 cm^{-3} s^{-1} at the lowest temperature, although the temperature dependence of the nucleation rate is not very well constrained by the measurements. The results agree within the combined error limits with recent literature data. Homogeneous ice nucleation, which sets a lower limit to cloud freezing temperatures when other nucleation mechanisms are inefficient in the atmosphere, is important in deep convective systems and in cirrus. For these investigations adiabatic expansion experiments were performed in the ADIA aerosol and cloud simulation chamber of Forschungszentrum Karlsruhe. A detailed description is given in the paper by Benz et al., 2005.

Stefan Benz, Khaled Megahed, Ottmar Möhler, Harald Saathoff, Robert Wagner, Ulrich Schurath , *T*-dependent rate measurements of homogeneous ice nucleation in cloud droplets using a large atmospheric simulation chamber, Journal of Photochemistry and Photobiology A: Chemistry 176 (2005) 208–217

The data given here correspond to the AIDA ice nucleation experiment IN05_18 or experiment number 2 in the Benz et al. paper (blue circles in figure 8).

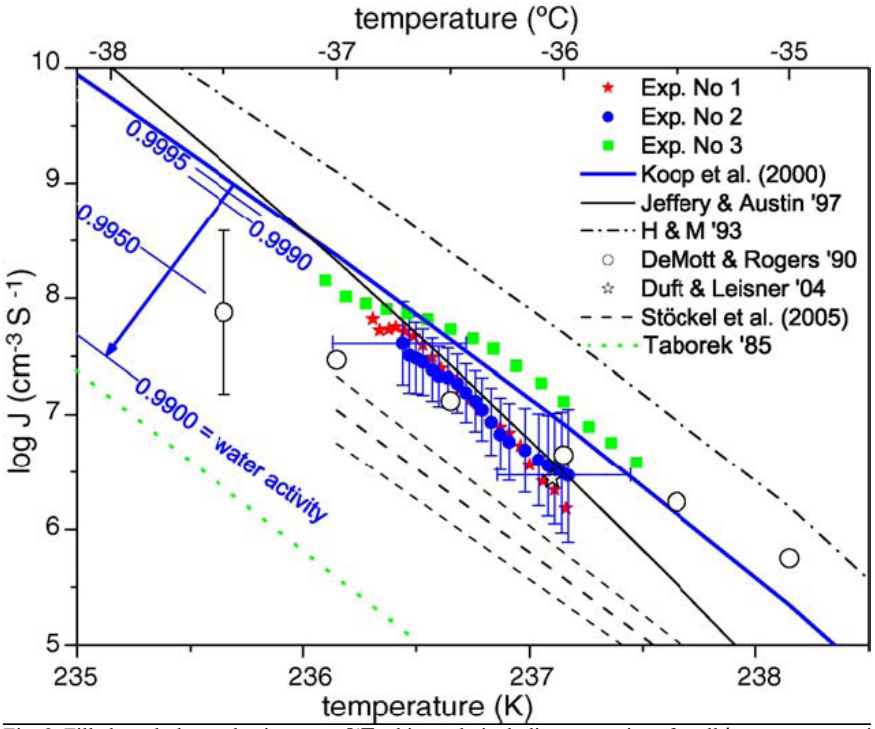

Fig. 8. Filled symbols: nucleation rates $J(T)$, this work, including corrections for all *known* systematic uncertainties, error bars shown for one experiment only. Thick solid line: parameterisation of the nucleation rate by Pruppacher [10] and adopted by Koop et al. [35] in their parameterisation of $J(T,a)$, as explained in text; thin solid line: parameterisation proposed by Jeffery and Austin [13]; dash-dotted line: parameterisation based on measurements in clouds by Heymsfield and Miloshevich (H & M) [26]; large open circles: cloud chamber study by DeMott and Rogers [19]; dashed line with error range (thin dashed lines): levitated droplet measurements by St¨ockel et al. [36]; open star: levitated droplet measurement by Duft and Leisner [18]. Short dashed line in lower left corner: emulsified droplet measurements of Taborek [37].