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Homogeneous nucleation rates of nitric acid dihydrate (NAD) at simulated stratospheric conditions – Part I: Experimental results

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Abstract. The low temperature aerosol chamber AIDA was used to study the nucleation of nitric acid dihydrate (NAD) in super-cooled nitric acid aerosols under simulated stratospheric conditions in the temperature range 192 K–197 K. The nucleating solution droplets had median diameters between 225 and 290 nm and molar fractions of nitric acid between 0.26 and 0.28. Nucleation of solid particles was unambiguously observed in two out of three experiments during time periods of up to five hours. The newly formed crystals could be clearly distinguished from the remaining liquid droplets by their increasing size with an optical particle spectrometer. The solid particles could be unequivocally identified as strongly aspherical nitric acid dihydrate crystals (α-NAD) by in-situ FTIR-spectroscopy. From our experimental data set there is no indication of direct nucleation of NAT or a conversion of NAD into NAT while having saturation ratios with respect to NAT of about 20–26. The temporal evolutions of the NAD particle concentrations were used to derive individual nucleation rates for NAD. The measured volume nucleation rates ranged from 3.9×10^{5} cm^{-3} s^{-1} at 195.8 K and X_{NA}=0.27 to 1.9×10^{7} cm^{-3} s^{-1} at 192.1 K and X_{NA}=0.28. The corresponding hypothetical surface nucleation rates of 2×10^{0} to 1×10^{2} cm^{-2} s^{-1} are smaller than the parameterization of Tabazadeh et al. (2002) by factors between 25 and $>10^{3}$.

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