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Metastable Nitric Acid Hydrates – PSC Constituents

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Nitric acid hydrates are important constituents of solid PSC and Cirrus cloud particles. Due to the phase diagram only hexagonal ice and nitric acid trihydrate have a reasonable thermodynamic stability and are commonly observed in the stratosphere. Besides, also a number of metastable modifications might exist: α-NAD, β-NAD, α-NAT, NAP and cubic ice. The existence of these metastable compounds remains uncertain and has not been proofed yet.

In the laboratory we have developed a model procedure in order to prepare and investigate all hydrates as pure phases. The investigation methods are X-ray diffraction [1], [2], FTIR spectroscopy [3], Raman spectroscopy [4] and Environmental SEM [5]. The aim is to verify the phase composition by diffraction and collect the spectroscopic data of the respective phases, which are needed for interpretation of field measurements and aerosol chamber experiments. Here, the morphology of the particles has to be considered since it has an important impact on the respective extinction spectra.

Particular interest has been directed towards the modifications of NAD, which have been discriminated for the first time by spectroscopic methods. The morphologies of NAD particles have been recorded by ESEM and the respective extinction spectra have been determined by T-matrix calculations. Beside the mid-IR region, where normal vibrations have been assigned, we have also focused on the low-frequency region below 200 cm^{-1} where phonon bands are observed by Raman spectroscopy. These intermolecular vibrations are closely connected to the symmetry and structure of the unit cell of a hydrate crystal [6]. Thus, a distinction between the phases becomes easily accessible.

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