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Metastable Nitric Acid Trihydrate in Ice Clouds

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The composition of high altitude ice clouds is still a matter of intense discussion. The constituents in question are ice and nitric acid hydrates. The identification and formation mechanisms, however, are still unknown but are essential to understand atmospheric processing such as the seasonal ozone depletion in the lower polar stratosphere or the radiation balance of planet Earth. We found conclusive evidence for a long-predicted phase, which has been named alpha nitric acid trihydrate (alpha-NAT). This phase has been proven by combination of X-ray and neutron diffraction experiments allowing a convincing structure solution. Additionally, vibrational spectra (infrared and inelastic neutron scattering) were recorded and compared with theoretical calculations. A strong affinity between water ice and alpha-NAT has been found, which explains the experimental spectra and the phase transition kinetics essential for identification in the atmosphere. On the basis of our results, we propose a new three-step mechanism for NAT-formation in high altitude ice clouds.

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