Atmos. Chem. Phys. Discuss., 4, S3881–S3884, 2004
www.atmos-chem-phys.org/acpd/4/S3881/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Nitric acid trihydrate (NAT) formation at low NAT supersaturations" *by* C. Voigt et al.

C. Voigt et al.

Received and published: 24 March 2005

We thank the referee the positive comments and for the comprehensive work with the manuscript.

According to the suggestions we made the following adjustments:

Important points:

Abstract: We tried to clarify the sentences on denitrification by changing it to: Provided the temperatures remain below the NAT equilibrium temperature TNAT, these NAT particles have the potential to grow further and to remove HNO3 from the stratosphere, thereby enhancing polar ozone loss.

P8583 L7-9: We tried to clarify the sentences on denitrification by changing it to: Pro-

vided the temperatures remain below TNAT, these particles can grow to larger sizes, sediment down and remove HNO3 from the stratosphere. Thus, these particles could provoke denitrification and enhanced polar ozone depletion.

P8583 L7 We now give the volume sampling rate in the text: The flow through each inlet is controlled at 1Nlpm (Normal liter per minute). In the stratosphere (assuming 70mbar, 200K and E(d)=21 for large particles) this corresponds to an effective particle sampling rate of 8 l/sec.

P8583 L7 We clarified this point in the text.

P8583 Comment on water vapor instrument has been added.

P8585 L4 Volume sampling rate and distance are now given.

P8585 L6-7 Enhanced fluctuations are fluctuations, that exceed the background instrument noise. We now added a panel (A) in Fig.3 comparing the background instrument noise to measurements in the PSCs.

P8585 L21-29 We labelled NAT and STS in Fig.3. In addition we extended the STS particle size distribution to larger diameters in Fig. 3. We now give the nitric acid content of the NAT and the STS particles. The STS particles basically shift the delta NOy instrument background distribution from 0 to 0.3 ppbv, see Fig.3a and b. The NAT particles account for the difference between the background distrubution and the measurements at higher delta NOy. There could be smaller NAT particles (d$<2\mu$m), which cannot be resolved by the simulations. We state that in the text. There are no measurements of sulfate or background aerosol on the Geophysica.

P8586 L14 Agreement has been changed to basic consistency

P8587 L2-10 The measurements have been performed at temperatures above the ice frostpoint, therefore nitric acid uptake on ice has been neglected. The ice frostpoint is 7.5K below TNAT

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P8588 L16 The units are correct. We derive the number of gas molecules and the number of nitric acid molecules, that are measured in a second in the sampling volume. Therefore the units sec cancel.

P8589 L5-7 We now emphasize the importance of our measurements: Measurements of low number densities n˜10ˆ-4 cmˆ-3 of small NAT particles (d$<$6μm) as observed in the present case have not been reported so far. Such NAT particles containing very little nitric acid with small number densities are in fact not detectable with most existing instruments. This does not only underline the unique capability of the NOy instrumentation, it is also the reason for the paucity of such measurements. These NAT particles are not necessarily rare, but hard to detect.

P8592 L17 We change this sentence as follows: Neither homogeneous NAT nucleation nor NAT nucleation on ice can explain the present observations. Therefore other nuclei must be available in the stratosphere, on which NAT can nucleate either by heterogeneous immersion nucleation (the nuclei are immersed in the preexisting STS droplets) or by heterogeneous deposition nucleation (nucleation of NAT directly from the gas phase). One potentially important, ubiquitous kind of nuclei are meteoritic smoke particles.

P8594 L1-2 Biermann et al. measured the immersion freezing of STS solutions, thereby the composition of the frozen state is not known. However, NAT is the stable phase under the experimental conditions. Therefore we can compare our measurements to those laboratory data. The meteoritic inclusions are only 2.4 %vol of the sulfate aerosol, therefore the sulfate dominates the particle composition.

Smaller points All smaller points have been corrected according to the referees comments.

P8583 L6 Normal liter is at 0°C, standard liter is at 23°C.

P8583 L26 PT100 is a resistance thermometer, that measures the voltage drop over a

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resistance at a given constant current. The voltage drop changes with temperature.

P8595 L17 Up to now, NAT formation has been measured only at higher NAT supersaturations or lower temperatures. We show that NAT does already nucleate in the temperature range TNAT $<$ T $<$ TNAT-3.1K. Because these temperatures are more frequent in the polar stratosphere, the time scales at which NAT particle can form are increased.

Caption of Fig.4 We dont wont to emphasise the low temperatures, therefore we leave the old caption.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 8579, 2004.