Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ice condensation on sulfuric acid tetrahydrate: implications for polar stratospheric ice clouds" *by* T. J. Fortin et al.

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We would like to address the comments of Anonymous Referee #2 one by one.

1) How would the presence of HNO_3 affect the ice particle formation if NAT nucleated on top of SAT?

The presence of NAT could have two consequences. First, NAT would actually preclude the SAT dissolution that is expected in the presence of gaseous HNO_3 (e.g., Koop et al., 1997a), thus preserving solid SAT particles for ice deposition. Second, as long as even a small number of SAT particles remain uncoated by NAT, those remaining will still provide effective surfaces for ice nucleation, thus enabling ice formation at temperatures warmer than those required for homogeneous freezing. Furthermore, if NAT is also an efficient nucleus for ice deposition, this will introduce an additional ice formation mechanism, thus strengthening the argument that homogeneous freezing

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may not be important for ice formation. Unfortunately, we were unable to find data for the vapor deposition of ice on NAT in the literature. The only reference we found indicates that ice nucleates out of an aqueous HNO_3 layer on top of NAT at ~ 2 K below the frost point. Therefore, we've added a sentence in the conclusions section indicating that, particularly in light of the efficiency of SAT as an ice nucleus, NAT should also be investigated. Please refer to section 3 of the final manuscript for additional discussion of the HNO_3 issue.

2) How would the SAT particles have formed in the stratosphere? Would it not require temperatures several degrees below the ice frost point, thereby masking their effect on ice particle formation just slightly below the ice frost point?

The literature points out that the formation mechanism for SAT in the stratosphere is unclear, but is most likely a heterogeneous rather than a homogeneous process with one possibility being nucleation on ice (e.g., Peter, 1997). However, once SAT has formed, its relatively high melting temperature implies that it could continue to exist for a significant period of time. Thus, SAT would be available for ice deposition in subsequent cooling cycles. In other words, SAT formation and ice deposition needn't occur in the same cooling cycle.

3) It seems there are negative saturation ratios before 500 seconds in Figure 4.

This is indeed what Figure 4 shows. It is due to the fact that before additional water vapor is added to the chamber, the pressure is below the detection limit of the Baratron gauge (10^{-6} torr), occasionally leading to "negative" pressure readings. Because the false negative saturation ratios occur before the start of an experimental run, we made no effort to correct this artifact.

4) What are the units of Vortex-averaged dehydration?

The vortex-averaged dehydration is in units of %. The figure has been altered to indicate this.

5) Will SAT particles survive in the solid state in those trajectories where the temperature goes above the SAT melting temperature?

In the model simulations, all SAT particles are assumed to melt when the temperature exceeds the SAT melting point as calculated from Zhang et al. (1993). However, these same particles will freeze again upon cooling with SAT formation occurring before reaching the ice frost point.

6) Is ice allowed to nucleate on type 1 PSC particles in these simulations?

Ice nucleation on NAT is assumed to be inefficient (i.e., $m = 0.75$) in both the main set of simulations (with an unrealistically low frequency of Type 1 PSCs) and the more realistic simulations mentioned at the end of section 4.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 867, 2003.

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