

Interactive comment on “Supersaturation, dehydration, and denitrification in Arctic cirrus” by B. Kärcher

Anonymous Referee #1

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Review of Supersaturation, dehydration, and denitrification in Arctic cirrus.

This paper presents model calculations of the sedimentation of cloud particles from a water vapor and temperature profile derived from a case of Arctic cirrus. The paper is generally well written. The topic area is suitable for ACP. The cloud model is a good hybrid of a bin aerosol scheme along with, for lack of a better name, a quasi-Lagrangian-particle ice scheme. The most novel part of the cloud model is the explicit calculation of the amount of nitric acid adsorbed and absorbed in the particles and the sedimentation of that nitric acid.

The nitric acid is based on a new uptake calculation from Kärcher and Basko (2004).

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This new method is not unreasonable but neither is it proven. Given that the nitric acid uptake is the most novel part of the paper, it would make the paper much stronger if there were a scenario in the cloud model comparing the sedimentation of nitric acid using a more conventional equilibrium calculation of nitric acid uptake to the new method. This could be added to, for example, figure 7.

A key assumption in the model is the updraft velocity. First, the model is running a very extreme case of uplift. Note that 5 cm s⁻¹ for 7 hours is almost 1.3 km total uplift. For comparison, I'm looking at the ECMWF 100 hPa height chart for yesterday (28 Mar 2005) and there is less than 800 m variation across all of Europe. There would be less on a single synoptic trajectory. Ideally, the authors would relax the assumption of having a constant updraft of 5 cm s⁻¹ for 7 hours, but perhaps some of that will be future work. For this paper, the authors should at least only present data from a realistic amount of uplift, even if they run the model on out a couple of hours past that. The assumption of a rapid, constant updraft velocity is important enough to be mentioned in the abstract.

In section 1.2, a reference to an earlier measurement of the vertical redistribution of nitric acid is Huebler et al., GRL, 17, 453, 1990.

Besides the nitric acid uptake, the other significant part of the paper is the way the model shows significant in cloud super-saturations of order 1.2. This happens when enough particles sediment out that the continued cooling occurs in a region without a lot of surface area. For this discussion, it would be helpful to have a figure showing the relaxation time of water vapor onto the cloud surface area. This might be an additional panel on Figure 5.

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