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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Formation of large NAT particles and denitrification in polar stratosphere: possible role of cosmic rays and effect of solar activity" *by* F. Yu

Anonymous Referee #1

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MS-NR: 2003-158 Formation of large NAT particles and denitrification in polar stratosphere: possible role of cosmic rays and effect of solar activity (F. Yu)

General Points

This paper argues for the formation of large Nitric acid trihydrate (NAT) particles from a cosmic ray induced freezing (CRIF) mechanism, based on a comparison of observed and predicted nucleation rates. Available empirical evidence is interpreted as consistent with the suggested mechanism.

(1) What does the paper set out to show? It presents material consistent with the proposition that CRIF may explain the formation of NAT particles.

(2) Is this an original suggestion? No. The author points out that the suggestion that cosmic rays could influence stratospheric nucleation was first made by K. Carslaw at a workshop on Ion-Aerosol-Cloud interactions held at CERN in April 2001.

(3) Is the physical freezing mechanism proposed original? An electrical alignment of molecules is suggested, provoking freezing. This is a fairly elementary view and cannot be considered original. Such an electrofreezing mechanism was, across a range of other possibilities, discussed in the recent review paper cited. This paper adds nothing new to the mechanisms qualitatively outlined there.

(4) What is the paper's contribution? I think the purpose of the paper is to formally quantify the previous suggestions made in (2) and (3), and show them to be consistent with observations. To be fair, the words "may" and "possible" are always applied to assertions about the role of CRIF. And making the previous ideas more formal is a useful contribution for a Discussion paper. Beyond that, however, the related theory outlined offers little detail and no new insights. It has not solved the problem. In particular, the theory depends on two parameters P1 and P2. P1 can be constrained theoretically, but P2 is not well-known. The parameter P2 is actually where the physical detail is needed. The paper shows that, by a suitable choice of P2, the theory and the observations can agree. (This is made clear in the middle of page 9.) Consequently whether NAT formation by CRIF is selective (p11), or indeed perhaps just ineffective, is not resolved. And of course it does not settle whether CRIF exists. CRIF will certainly not be the only "...direct and convincing explanation..." (p12) until we know its quantitative details.

If I am correct about the paper's intended basis in formalising the existing ideas on the stratospheric problem, the author should be more careful in defining what the CRIF mechanism actually is, and, most importantly, suggest what could be done to investigate it. This is how the science will progress. Are laboratory experiments needed, or molecular simulations? Would bulk parameters determined in laboratory experiments be of any use anyway? Some idea of how to make progress is needed, or a testable hypothesis formulated. How have other disciplines dealt with comparable problems?

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Interactive Comment

Atmospheric science is surely not alone in dealing quantitatively with freezing.

In summary, the author has distilled the rudiments of an interesting problem drawn from the suggestions of others, and presented general material related to it. The empirical evidence which supports it has been assembled in a constructive and organised way and basic estimates of rates expected made. This is a good basis for a Discussion paper, as the scope for further work is effectively identified. Beyond that however, it represents only a small elaboration on the previous work, and not a substantial original contribution introducing new knowledge in an uncertain topic.

Technical points Section 2 second sentence insert "The" Page 4: last line "...a certain..." Page 8: L13 "unit" (not unity) Page 9: L11 insert "The"...same mixing ratio Page 1 Figure 1 caption. More detail needed: q1 and q2 not defined.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 1037, 2004.