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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol-cirrus interactions: A number based phenomenon at all?" *by* M. Seifert et al.

Anonymous Referee #1

Received and published: 8 September 2003

This paper relates the number concentration of ice crystals Ncvi to the number concentration of interstitial aerosol Nint. By addressing the similarities/ discrepancies to the relationship of aerosol number concentration and cloud droplet number concentration, the authors are able to speculate on the physical mechanisms causing the positive and negative correlations. While the positive correlation between Nint and Ncvi is similar to what is found in warm clouds, there is no analogous situation for a negative correlation in warm clouds. Here the authors speculate on 2 different hypotheses for a sublimating cloud, suggesting that either pollution retards the sublimation of cirrus clouds or that the sublimation of cirrus clouds leads to new aerosol particle formation. Since this unexpected anticorrelation is a central part of this paper, it would be nice if the authors could try to substantiate each hypothesis.

In particular, if the sublimation of cirrus clouds is a source of aerosol particles, how are

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you suggesting that this happens? Are you suggesting that aerosols form by nucleation in the vicinity of the cloud as discussed by Perry and Hobbs (1994) for warm clouds? If so, I would argue that you do not have the right instrument to prove that because these aerosols should be smaller. Also since aerosol nucleation depends on temperature, aerosol precursors and aerosol surface area, you should evaluate the temperature, aerosol chemical composition and aerosol surface area as a function of Nint and Ncvi.

Or are you thinking along the lines of ice crystals leaving behind an aerosol residue? I suspect that this mechanism would not increase the number of aerosols sufficiently with what you have indicated with arrow 2 in figure 10. Here Nint increases from 50 to 300/cc while Ncvi decreases from 1/cc to below 0.01/cc. So, how can the sublimation of Ncvi explain the increase in Nint?

I understand that it is beyond the scope of this study to evaluate the chemical aerosol composition in the entire data set but could you try to analyze smaller flight segments in more detail, like the one shown in figure 2 to prove or negate one pathway? As mentioned above, I would strongly encourage the authors to try to substantiate their different hypotheses better before publication of this manuscript.

More serious and even harder to understand are the results displayed in figure 7 for RHi $>$ 100%. Why should Ncvi decrease with increasing Nint? I could understand a leveling off or a saturation effect of Ncvi with increasing Nint but not a decrease in Ncvi. From my point of view, the most likely explanation is that the ice crystals are too small to be detected. However, if that is the case, then the ice crystal data shown here are due to a sampling artifact for a large range of Nint, which questions the usefulness of this large part of the data set and the discussion in the paper. Are there no other ice crystal measurements that could be used, such as the FSSP to address this problem?

In summary, I encourage the publication of this manuscript after the major comments mentioned above and minor comments mentioned below have been addressed.

Minor comments:

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p.3626, l.6: From (not form)

p.3626, l.12: Related with (not to)

p.3626, l.24/25: Which mechanism is more likely?

p.3627, l.2: Change "the climate from influence on" to "on climate by influencing"

p.3629, title: Add "Data" after Experimental Please add the measurement uncertainty or error for each instrument.

p.3631, l.6: remains (add s)

p.3633, l.13: Delete: "above as well as colder colors below ice saturation"

p.3634, l.19: Change: "let" to "allowed"

p.3634, l.25: Delete: "a of" before about 100 s.

p.3635, l.7: Add: "-" before 0.2

p.3636, l.8: Change "and we would exclude" to "and therefore we exclude"

p.3638, l.3: I am not sure that I understand the second simulation. Are you weighting the random ice crystal number concentration by the total observed ice crystal number concentration? If so, please add "total". If not, please clarify.

p.3638, l.16: distributions (add s)

p.3638, l.23: I would argue that the w variations are not completely random, but that w has a minimum around Nint=100-300/cc. Please interpret the implications of this minimum for Ncvi as a function of Nint in figure 7. Or maybe add a plot of Ncvi as a function of w.

p.3641, l. 14: I don't understand this argument. Why should a further increase in Nint quench ice nucleation and thus lead to a negative trend between Nint and Ncvi?

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Interactive Comment

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 3625, 2003.

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