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Interactive Comment

Interactive comment on "Parameterizing the competition between homogeneous and heterogeneous freezing in cirrus cloud formation – monodisperse ice nuclei" *by* D. Barahona and A. Nenes

D. Barahona and A. Nenes

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We thank the reviewer for his/her comments and feedback. Our responses to the comments raised are given below.

My major comment is similar to that from referee 1 such that the comparison with existing parameterizations seems a bit arbitrary. Given that the authors state that Kärcher et al. (2006) present the first comprehensive physically-based parameterization for cirrus formation, it seems odd that this parameterization is not used for comparison. I am happy to see that you agree to add this comparison. This is very much needed.

Comparison against K06 is now provided in section 3.3 and Figure 5 of the revised paper.

p. 15666, l. 13: Lohmann and Diehl (2006) did not investigate cirrus clouds, but mixed phase clouds. The proper reference might be Lohmann et al., JGR, 2004

Thank you for pointing this out. The reference has been corrected.

p. 15669, l. 9-15: It is not true that Kärcher et al. (2006) consider either homogeneous or heterogeneous nucleation. They do parameterize the competition between homogeneous and heterogeneous nucleation. Also, I do not understand why the authors say that the dependence of the ice crystal number on the heterogeneous freezing threshold and the number of IN cannot be unraveled. That is not true. The dependence on IN is presented in the Kärcher et al. (2006) paper (see also comment by Bernd Kärcher)

Our statement refers to the numerical integration approach, which by nature does not analytically unravel the dependencies. We've further clarified this in the text.

p. 15671, l.1-3: Explain the physical reasoning behind going from eq.1 to eq.2.

The relevant statement in the manuscript now reads "The $\alpha V S_{\max}$ term in Eq. 1 represents the rate of change of S_i at S_{max}. The presence of IN perturbs S_{max}, but Eq. (1) can still be applied if $\alpha V S_{\max}$ is replaced with the (perturbed) rate of change of S_i, $\dot{S}_{\max,IN}$ (calculated in section 2),"

p. 15671, l.10: What is the timescale of Smax? Please add

The time scale of for the change in S is roughly $10^{-3}V$. The statement now reads,

"...which can be considered constant over the timescale of S_{max}, which is around $10^{-3}V$ s, with V in m s^{-1}),"

p. 15671, l. 17: How long does the freezing pulse last? Please add

From the simulations presented in Barahona and Nenes (2008), the freezing pulse

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length (in seconds) can be approximated with $\frac{25}{V}$ (V in m s^{-1}). The relevant statement in the manuscript now reads "frozen crystals due to a longer freezing pulse, which for the pure homogeneous case (in s) is approximately $\frac{25}{V}$ (with V in m s^{-1}) (Barahona and Nenes, 2008)"

References

Barahona, D., and Nenes, A.: Parameterization of cirrus formation in large scale models: Homogenous nucleation, J. Geophys. Res., 113, D11211, doi:11210.11029/12007JD009355, 2008.

Kärcher, B., Hendricks, J., and Lohmann, U.: Physically based parameterization of cirrus cloud formation for use in global atmospheric models, J. Geophys. Res., 111, D01205, doi:01210.01029/02005JD006219, 2006.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 15665, 2008.

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