Atmos. Chem. Phys. Discuss., 2, S831–S832, 2002
www.atmos-chem-phys.org/acpd/2/S831/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the transition between heterogeneous and homogeneous freezing" *by* K. Gierens

Anonymous Referee #1

Received and published: 9 January 2003

The radiative properties of cirrus clouds, and hence their climate effects, depend crucially on the number of ice particles, which in turn depends on the formation mechanism, either homogeneous or heterogeneous. Heterogeneous nucleation requires lower supersaturation, generally increases the coverage of optically thinner cirri. It is significant to know the critical concentrations of heterogeneous ice nuclei at which homogeneous freezing begins to be quenched. The paper is suitable to be published at ACP after the author has addressed the following comments properly.

1. The mathematical expression of (5) is accurate, but the context is a little bit questionable. $c(t) = -\frac{de}{dt}$ includes both the time dependent deposition rate and the expansion effect of an uplifting air parcel. The combination of (6), (7), and (8) is only the first (and how dominating?) part of $c(t)$ which the author should indicate in the paper, since it is the same expansion that causes cooling. Moreover, the combination should

be $c(t) = 4\pi NDr(t)(e - e^*)$ where $r(t)$ is the ice crystal radius when equal-size and spherical ice crystals are assumed. The final ice crystal radius is $r_{max} = r(\infty)$. From this consideration, $\tilde{\tau}_g(\infty) = [4\pi NDr_{max}]^{-1}$. So either (7) or (8) needs a change to ensure the relationship. The time scale is a kind of scale, just like the length scale. You can use either foot or yard to measure the same distance, but the result will be different by a factor of 3.

2. Express (17) is conceptually inconsistent. It is correct only if no further cooling after supersaturation s_0 were assumed as Karcher and Lohmann (2002) did, in which case, $s_{max} = s_0$ and homogeneous nucleation will never take place. While further cooling is necessary for this paper to go ahead, more than $s_0 e^*(T)$ water vapour is available to deposit. It is simple and safe to use $(1 + s_0)e^*(T)$ instead of $s_0 e^*(T)$, and even $s_{hom}(T)e^*(T)$ is a better candidate than $s_0 e^*(T)$ if no further cooling after supersaturation s_{max} were assumed.

3. The accurate expression of (12) should be $s(t) = e^{\int_0^t a(t')dt'} \int_0^t \tau_u^{-1} e^{-\int_0^{t'} a(t'')dt''} dt' + s_0 e^{\int_0^t a(t')dt'}$ in a definite integral form, and (13) can be omitted or left there in a definite integral form as well to be informative.

4. Check spelling again to eliminate misspellings like homogenous, heterogenous, hydrophobous, ansatz.

Interactive comment on Atmos. Chem. Phys. Discuss., 2, 2343, 2002.