Atmos. Chem. Phys. Discuss., 6, S4241–S4243, 2006
www.atmos-chem-phys-discuss.net/6/S4241/2006/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Technical note: A numerical test-bed for detailed ice nucleation studies in the AIDA cloud simulation chamber" *by* R. J. Cotton et al.

Anonymous Referee #2

Received and published: 31 October 2006

This technical note describes a parcel model for ice nucleation and growth. This model originates from a version that has been evaluated in the framework of GEWEX. The present paper describes modifications introduced to directly simulate ice-related processes as observed in the aerosol-cloud chamber AIDA. This model tool can be expected to provide valuable interpretations of such measurements, with close-to-atmospheric conditions. With a few remarks/modifications I recommend to accept this work for publication as a Technical Note in ACP.

p.9485, l.2+3 – There is a claim for evidence that heterogeneous nucleation is sometimes *the dominant* process in cloud formation. I don't go for this strong statement. I would rather argue on the contrary, that it has never been shown explicitly that a cirrus cloud formed exclusively on heterogeneous IN (to justify their dominance). Rather, the quoted data merely suggest that cirrus formation started early due to the presence of some efficient IN, but both in the SUCCESS and INCA campaigns, homogeneous freezing did still occur (Haag et al., 2003a; Hoyle et al., 2005).

This combination of heterogeneous nucleation of few IN and subsequent homogeneous freezing is in line with earlier expectations (DeMott et al., 1997) and what Kärcher et al. (2006) called the negative Twomey effect in their corresponding cirrus parametrization.

p.9485/-86 – The review of ice nucleation seems very detailed and might be shortened for conciseness. It does not address the main purpose of this paper.

p.9486, l.20-24 – The model in the quoted Haag et al. (2003b) study can in fact be regarded as a precursor of the present parcel model. These authors pointed out the relevance of AIDA for cirrus studies, and applied a detailed microphysical model–evaluated within the same GEWEX effort–to study ice nucleation constrained by AIDA parameters. While it is correct that this study focussed on homogeneous freezing, it is not true that the partitioning of water has been prescribed by Haag et al. (2003b) This misinterpretation must be corrected.

Haag et al. prescribed measured temperature T, pressure p, and total water histories, and initial aerosol size distributions. This eliminated the need to introduce heat and vapour flux equations for T and p as in Cotton et al. (although I regard this as a step forward in building a self-consistent model for the AIDA). Importantly, homogeneous freezing plus the partitioning of water between gas and ice phase was explicitly simulated by Haag et al. (2003b) (no ice particle injection, but simplified sedimentation).

p.9487, l. 10+11 – A note of caution may be appropriate that the chamber pressure is substantially higher than in cold cirrus conditions.

ACPD
6, S4241–S4243, 2006
Interactive Comment

p.9500ff Section 6.6 – I wonder whether the dependence of ice growth and supersaturation relaxation on the H_2O deposition coefficient α could be added. Haag et al. (2003b) performed such a sensitivity study supporting $\alpha > 0.2$ for the higher supersaturation growth after homogeneous freezing. It would be interesting to see which range of α is consistent in conjunction with the simple growth model for low supersaturation growth after nucleation of efficient (early freezing) IN.

Minor:

p.9488, l.19/20 – shift sentence in () to start before "Figures 1a and 1b shows ...''

p.9491, l.16 – asphericity

References

DeMott, P.J., D.C. Rogers, and S.M. Kreidenweis, The susceptibility of ice formation in upper tropospheric clouds to insoluble aerosol components. J. Geophys. Res., 102, 19575–19584, 1997.

Haag, W., B. Kärcher, J. Ström, A. Minikin, U. Lohmann, J. Ovarlez, and A. Stohl, Freezing thresholds and cirrus cloud formation mechanisms inferred from in situ measurements of relative humidity. Atmos. Chem. Phys. 3, 1791-1806, 2003a.

Haag, W., B. Kärcher, S. Schaefers, O. Stetzer, O. Möhler, U. Schurath, M. Krämer, and C. Schiller, Numerical simulations of homogeneous freezing processes in the aerosol chamber AIDA. Atmos. Chem. Phys. 3, 195-210, 2003b.

Hoyle, C.R., B.P. Luo, and Th. Peter, The origin of high ice crystal number densities in cirrus clouds J. Atmos. Sci., 62, 2568-2579, 2005.

Kärcher, B., J. Hendricks, and U. Lohmann, Physically-based parameterization of cirrus cloud formation for use in global atmospheric models. J. Geophys. Res. 111, D01205, doi:10.1029/2005JD006219, 2006.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 9483, 2006.