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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.

R. J. Cotton et al.

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1 Response to second reviewer

I thank the reviewer for the helpfull comments. The following are the replies and changes to the text.

1.1 a) Page 9485:

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.

The text has been changed to be clearer and agree with this statement:

There is evidence that even for temperatures colder than -38C, not all ice is produced by homogeneous freezing, a small amount of ice is sometimes formed by heterogeneous nucleation. Aircraft observations suggest that initial ice formation in mid-latitude cirrus can occur at relative humidities lower than the homogeneous freezing threshold (see Heymsfield98). Seifert03 showed that the size distribution of the residual aerosols after cirrus ice crystals have been evaporated was not that expected for homogeneous freezing alone. Aircraft observations of orographic wave clouds have also implied that ice crystals can be initiated by heterogeneous nucleation Jensen98,Field01, although homogeneous freezing is the dominant process.

1.2 b) Page 9485/6:

The review of ice nucleation seems very detailed and might be shortened.

The introduction has been shorted by removing the paragraphs on ice nucleation by modes other than deposition nucleation.

1.3 c) Page 9486 line 20-24:

The model in the quoted Hagg et al (2003) study can in fact be regarded as a precurser 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

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GEWEX effect - 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 presecribed by Haag et al (2003). This misinterpretation must be corrected.

Added to the text the following:

Haag03 showed the relevance of AIDA for cirrus studies by using numerical simulations of homogeneous freezing processes in the AIDA chamber. The measured temperature, pressure and total water time-series was used to constrain the model, and the measured initial aerosol size distribution was an input. The homogeneous freezing process and partitioning of water between gas and ice phase was explicitly simulated and tested by the model. Prescribing the temperature, pressure and total water histories, eliminates the need for the heat and vapour fluxes from the chamber walls to the bulk gas. A different way to describe the evolving chamber conditions during an expansion is to run an parcel model with diabatic terms representing heat and water vapour flux terms which are derived from observations. This method leads to a more self-consistent model and is used in this paper.

1.4 d) Page 9487:

A note of caution may be appropriate that the chamber pressure is substantially higher than in cold cirrus.

Added: The chamber pressure is however, substantially higher than in cold cirrus.

1.5 e) Page 9500, section 6.6:

I wonder wether the dependence of ice growth and supersaturation relaxation on the

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water deposition coefficient could be added. Haag et al (2003) 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 alpha is consistent in conjunction with the simple growth model for low supersaturation growth after nucleation of efficient (early freezing) IN.

The dependence of ice growth and supersaturation relaxation on the deposition coefficient and the ice crystal capacitance is shown in a new figure. This is for expansion 28 which has two ice nucleation modes. The deposition coefficient was varied from 1.0 to 0.05 and the capacitance from 1.0 to 0.5.

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