Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2015-940-RC1, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Derivation of physical and optical properties of midlatitude cirrus ice crystals for a size-resolved cloud microphysics model" *by* A. Fridlind et al.

Anonymous Referee #1

Received and published: 20 February 2016

General Comments:

This study presents a novel approach in estimating ice particle properties from CPI data, and is worthy of publication in ACP after suitable revisions. It is well organized and written, with figures of good quality.

A good effort is made to compare the new ice properties with selected properties published 20 or 14 years ago, but no analytical expressions are given for the new ice properties. A table should be added to the paper, similar to Table 1, but showing the mass- and area-dimensional coefficients for the new m-D and A-D relationships (based on CPI data); like results for the new bullet rosettes, bucky-balls, and the polycrystal model. That will allow the community to compare these new results in future studies of

Printer-friendly version

Discussion paper

ice properties, and promote progress in this field.

It would also be a service to the community if the recent work of Erfani and Mitchell (ACPD, 2015) were compared against the m-D and A-D results from this study. The Erfani-Mitchell expressions are not for a specific ice crystal habit, but were derived from a mixture of habits (similar to the Cotton et al. m-D results featured in this paper).

In Lawson et al. (2006, JAS), Sec. 3d, A-D power laws are given for irregulars, bullet rosettes, budding rosettes, and rimed rosettes with slide plane wafers between the branches (similar to the polycrystal model developed in this study). It would be instructive to compare these new results against those A-D expressions since they were also based on CPI data.

This study apparently applies a single ice crystal model over the entire ice particle size distribution (PSD). However, this assumption is questionable based on CPI observations; see Lawson et al., 2006, JAS, Fig. 5. There you can see that, with increasing size and mass-weighted percent, the smallest crystals tend to be quasi-spherical, then small irregulars, then small irregulars and budding rosettes, then larger rosettes for a single cirrus flight. While this trend may change somewhat from flight-to-flight, it is illustrative of what is typically encountered for cirrus cloud measurements. Similar results are shown in Fig. 13 of Baker and Lawson (2006, JAS). The paper should include some discussion of this, and how such size-dependent habit variation may impact the model results.

Lastly, due to the large number of symbols used in this paper, an appendix for symbol definition is recommended.

Major Comments:

1. Page 8, lines 20-21: Why is arm width W twice the hexagon side length?

2. Page 9, lines 5-6: Is there vapor competition between homo- and heterogeneous ice nucleation?

3. Page 9, lines 21-22: Are all ice nuclei composed of (NH4) HSO4?

4. Page 13, lines 14-15: How much difference is there between your Dmax and the Dmax that Mitchell uses? For random orientation, it seems that on average the branches would be oriented at ∼45 degrees relative to their maximum extension. Taking that maximum length as L = 1.0 (arbitrary units) and true Dmax = 2 L, then the percent error made by Mitchell by underestimating Dmax as ∼ 2L cos(45) (randomly oriented) would be ∼ 29%. This seems like too small an error to account for most of the 4-fold difference in mass.

5. Page 17, line 3: Please add temperature information to Fig. 10 so that this sentence makes sense.

6. Page 19, lines 22-24: No need to wait for future studies; this information already exists (as noted under General Comments) in Lawson et al. (2006, JAS) and Baker and Lawson (2006, JAS).

7. Fig. 4. Why not use log-log plots when plotting m-D and A-D since this should be quasi-linear and make the results easier to interpret?

8. Fig. 15. Is there a super-position of the Mitchell and Heymsfield curves?

Minor Comments:

1. Page 11, line 11: What are “cap vertices”? Please define.

2. Page 20, line 18: Should < 100 be > 200?

3. Page 24, line 11: Does i need defining?

4. Page 26, line 13: greater => less? This is a Christiansen band where nr < 1.0 but ni is not > 1.0.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2015-940, 2016.