Atmos. Chem. Phys. Discuss., 15, C11287–C11290, 2016
www.atmos-chem-phys-discuss.net/15/C11287/2016/


Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Developing and bounding ice particle mass- and area-dimension expressions for use in atmospheric models and remote sensing" *by* E. Erfani and D. L. Mitchell

**Anonymous Referee #2**

Received and published: 8 January 2016

Review on "Developing and bounding ice particle mass- and area-dimension expressions for use in atmospheric models and remote sensing" submitted to Atmospheric Chemistry and Physics by E. Erfani and D. L. Mitchell

The paper describes a level more complex and better fit to m-D and A-D relationships than the traditional power law relationships, and then the paper presents an accommodation on how the more complex relations can be used in climate and cloud models without requiring all too expensive computation.

The reviewer is especially impressed on the quality of the writing, and the thoroughness and completeness of the arguments. While we may have differences in writing style and



different preferences for expressing error or representing measurements, the paper comes across as well edited and prepared. Also clearly the topic is relevant and makes an important line-item to list of potential improvements in climate modeling.

Recommendation is publication after revision addressing the following suggestions:

The reviewer's main concern in the paper in its current form is how the natural variability is represented, and how approximations are justified. The stated purpose of the paper is to "develop m-D and A-D expressions that are representative of all ice particles for a given cloud type and temperature interval, suitable for use in climate models." (28523/3-5) The goal is to get past the natural variation in ice crystal ensemble properties to an average parameterization suitable for representing ice crystal properties in ∼25x25km^2 grid boxes in just ∼2 coefficients. Natural variation could be seen as a nuisance or unimportant noise. The reviewer would prefer to see it portrayed and dealt with more, while others might argue it's outside the scope of the paper. The reviewer argues that seeing the natural variation in figures and laid out more clearly in text strengthens the paper in that it helps the reader understand and trust the results more than if it goes un-portrayed and unsaid.

28527/18, Suggested is a two-panel figure showing something similar to Figure 5, but with data points from each temperature range in Tables 1 and 2 on m-D and A-D axes. The idea being to show the scatter.

28528/19, Says greater accuracy can be made by fitting to temperature intervals. But the fits appear so similar in Figure 4. Could the authors please comment on a fit without the temperature dependence, and quantify the improvement in splitting up into temperature regimes? How could a climate model smoothly vary between the fits once a temperature boundary is crossed?

28524/26-30, The "all-in" criteria limits the sample volume for the larger ice crystals measured by the 2D-S. That is, a 1mm ice crystal has a smaller chance of appearing all-in vs. a 0.2 mm crystal. If this limitation in volume sample rate is accounted for, it should be stated.

28543/10-13, The reviewer invites the authors to speculate on how broadly this fit might be applied to other similar clouds such as tropical or subtropical anvil cirrus, or perhaps arctic cirrus. The fact is many parameterization studies such as Brown and Francis 1996 are applied (extrapolated) outside their valid regime in models and other studies (Heymsfield et al. 2010). The synoptic and anvil cloud fits in this paper aren't so different. How different could the fits to ice particle data from other clouds be? Or where might the ice appear so different these parameterizations would be clearly inappropriate to use? Any insight would be appreciated.

28544/21-22, The reviewer invites the authors to quantify in some way how much their columnar representation of small ice crystals is more accurate than the traditional spherical ice assumption.

Tables 1 and 2, How were the temperature ranges -40 to -20, -55 to -40, and -65 to -55 chosen, with their uneven intervals? Was there a similarity criteria that led to putting the 5C temperature intervals together sometimes, and not other times?

Figure A1 lacks orientation for the reader. Suggested is adding axes to show flow direction, diode array direction and diode array width. Why are there two ice particle shadowgraphs shown? What's the difference between them? Why is L4 in the right figure so much smaller than its crystal?

Figure B1 and the discussion in Appendix B1 on planes P1, P2 and P3. The reviewer is at a complete loss how these planes and the columnar crystal in the CPI sample volume are oriented. By far the best help would be a helpful drawing or figure. Suggested is adding orientation information to Figure B1. Show the axes, the planes, and the instrument sample volume.

28528/21 resulted -> resulting

28545/16 Formula should be 3ˆ(3/2) aˆ2 / 8, if the reviewer understands the variable



meaning correctly

The paper has just enough symbols, it may be appropriate to add a variable index.

---

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 28517, 2015.