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Interactive Comment

Interactive comment on "Understanding effective diameter and its application to terrestrial radiation in ice clouds" *by* D. L. Mitchell et al.

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1) Agreed. It will be pointed out that there are exceptions where historical PSD measurements involving the VIPS are not subject to shattering and that the McFarquhar and Heymsfield CEPEX PSD scheme (reference included) is based on VIPS and 2DC measurements.

2) Agreed.

3) Agreed.

4) The measured PSD is contrasted with (1) a PSD having a different shape (produced

from a PSD scheme) but having the same ice particle shape composition as the measured PSD and (2) a PSD having a different shape from the measured PSD and also containing different ice crystal habits. All 3 PSD have the same De and IWC. The purpose for (2) is to show that changing the ice particle shape requires a subsequent PSD change (within the constraint of a PSD scheme) in order to conserve De and IWC. The fact that optical properties for (1) and (2) are different illustrates that a different particle shape assumption imposes a change in PSD shape in order to conserve De and IWC, and these changes combined result in different optical properties. In this way it is demonstrated that the common assertion that De accounts for differences in ice particle shape is not really correct. Assuming a different particle shape will still change the optical properties even though De is conserved.

5) Since this point was not clear, more text will be added to explain this point. Regarding the question "Is this because the observed mixture of habits is not being assumed in the development of the optical property database?", the answer is YES. For a given PSD bin, the mean effective photon path or de observed [i.e. (bin mass/bulk ice density)/bin projected area)] does not equal the de in the ice optics database when matching observed PSD bin dimension with database bin dimension (dimension refers to bin mid-point size). This is because these database de correspond to a particular model ice crystal shape whereas the observed de generally corresponds to a mixture of shapes, making the two de different even though the observed bin particle size matches the database bin particle size. Since ice optical properties are a strong function of de, matching the observed physical particle size with the closest database bin particle size results in erroneous optical properties for the observed PSD. To solve this problem, one should work with de and not the physical particle size. Matching observed bin de with the closest de interval in the Yang database yields the correct optical properties. If the reviewer would like, we can add an appendix on this topic with figures illustrating this point. In fact, this methodology can be extended so that any ice particle shape recipe can be assumed using the Yang database, with correct optical properties calculated. This extended approach is much more involved and would require a separate article,

provided we are not “reinventing the wheel”.

6) Indeed quasi-spherical particles generally correspond to D < 100 microns. From Fig. 4, the observed PSD is comprised mostly of ice particles < 100 microns (certainly true for particles that contribute significantly to extinction and absorption). In addition, Fig. 5 is showing that almost all the observed ice particles (from PSD used to produce the mean observed PSD in Fig. 4) correspond to masses approaching spherical masses. The same is true for projected area (not shown). Thus the ice particles in the observed PSD are having masses and areas approaching that of spheres, indicating they are quasi-spherical. Droxtals are a good surrogate for quasi-spheres. More text can be added to make this clear.

7) These particle shapes were observed and modeled for TC4 on 5 August 2007, and have no relation to CEPEX. See reply above for #6. The observed shapes were modeled using m-D and A-D power laws in PSD produced from a CEPEX PSD scheme (Ivanova 2004). This was to attribute differences in optical properties (between the observed and CEPEX PSD) to PSD shape differences ONLY.

8) OK, we can streamline and shorten Section 3.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 29405, 2010.