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Atmospheric Chemistry and Physics Discussions

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

Anonymous Referee #2

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This manuscript discusses the problem of using effective diameter of ice clouds in atmospheric radiation studies. The major point of this work is to demonstrate that the effective particle size is not accurate or sufficient for radiation calculation, if uncertainty in cloud particle size distribution (PSD) exists. This reviewer totally agrees with the authors of this manuscript on this aspect. Since ice cloud particle size distribution varies case by case. The mean or effective particle size cannot be uniquely related to PSD. That means different clouds with different PSD could have very similar mean or effective particle size. On the other hand, the optical properties of the clouds are determined by the volume average of light scattering properties of individual particles in the clouds. The characteristic of different clouds' PSDs results in different optical

properties of clouds. Therefore, similar mean or effective particle size may correspond to significantly different optical properties of clouds. This has always been a trouble for scientists in the radiation transfer modeling and remote sensing studies. In other words, this is a very commonly known problem. For water clouds, since the PSD shapes are relatively similar and particle shape is simply spherical, with considering the particle size variance the mean or effective particle diameter could be roughly uniquely related to clouds' optical properties. However, for ice clouds, the mean or effective particle size or IWC does not uniquely relate to clouds' optical properties. A newly published paper in JQSRT documents a similar discussion, which the authors of this manuscript may need to cite:

W Sun, Y Hu, B Lin, Z Liu, and G Videen, "The impact of ice cloud particle microphysics on the uncertainty of ice water content retrievals" J. Quant. Spectrosc. Radiat. Transfer, 112, 189-196 (2011).

PSD is the major problem for accurate modeling of the radiation of ice clouds. If PSD is uncertain, even a wonderful effective particle size, shape, or IWC could not produce reliable results for modeling or retrieval. Although a lot of work has been done on effective particle size, shape, or IWC for ice clouds, and significant effort has been made on calculation of single scattering properties of nonspherical ice cloud particles (including the labor-intensive particle light scattering database), modeling of radiation in ice clouds cannot be done any better if ice clouds' PSD cannot be measured reliably. On this aspect, this manuscript is worthy of being published in ACP to display the progress in PSD measurement results.

This reviewer recommends this manuscript to be published in ACP after the authors make the following revisions:

1. Significantly reducing the length of the text. Many useless discussions such as the MADA, tunneling effect, light scattering database, etc, must be removed. 2. The problem should be discussed for both ice and water clouds, therefore the title of the

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paper should be changed. 3. The authors should carefully re-organize the text and figures and make the paper readable in a streamlined style.

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

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