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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Influence of ice particle model on retrieving cloud optical thickness from satellite measurements: model comparison and implication for climate study" *by* Z. Zhang et al.

Anonymous Referee #2

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Following is a review of "In64258;uence of ice particle model on retrieving cloud optical thickness from satellite measurements: model comparison and implication for climate study", by Z. Zhang et al., submitted to Atmospheric Chemistry and Physics Discussions.

This paper summarizes a very interesting study that quantifies the contributions of ice cloud scattering model differences between operational POLDER and MODIS retrieval algorithms, and their subsequent impacts on optical depth retrievals. The POLDER ice scattering models have a fixed effective radius and habit (hexagonal columns with air bubbles), while the MODIS retrievals use the Baum et al. models that have size and

habit mixture dependences based on in situ observations (but use idealized crystal habits with no air bubbles or roughened surfaces). The authors show that POLDER systematically reports lower optical depth than MODIS and the reasons for it (primarily differences in the asymmetry parameter). Further, they replace retrievals of optical depth from MODIS and POLDER using each other8217;s scattering models, and show that the primary cause of a bias in optical depth is due to the use of fixed scattering models. Whether one or the other scattering model is more often right is still up for debate, the point is that a large sensitivity to the choice of scattering model is quantified. This is also extended to some radiative forcing calculations and to optical depth retrievals sorted by scattering angle and season. The authors show that there are biases in optical depth retrievals that depend on season, driven by the earth-sun geometry. Ultimately, this has implications for climate process studies over long enough time periods where these effects will become important, including global-scale, multi-year cloud climatologies, trend analyses, and inter-seasonal variability.

This paper is mostly acceptable as is except for some relatively minor corrections for clarity and use of grammar, and for some further discussion on aspects of the conclusions. These more specific comments are listed below.

The title is not entirely satisfying. The “model comparison and implication for climate study” seems to be a bit misleading, as in showing climate model results and/or intercomparisons, rather than presenting differences between two data sets. Should mention that this is about MODIS and POLDER. Here8217;s a suggestion: “Sensitivity of ice scattering model on retrieving cloud optical thickness from MODIS and POLDER”. I8217;m sure the authors can come up with something better.

Some editing is necessary in the first part of the abstract: “The influence of the assumed8230; shortwave radiance is investigated.”

Abstract, line 17: how about ”cancel each other out”

p. 1768, line 13: “in good correlation” is a bit awkward

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p. 1769, lines 9-13: This sentence is really long and unclear. Can probably clarify better and/or split up into two sentences.

P, 1771, title of sub-section 4.1: how about “Implications for the calculation of ice cloud radiative forcing from satellite observations”

p. 1771, line 7: retrievals

p. 1774, lines 1-6: This also comes up in the Conclusions section. The reviewer would argue that there is, in fact, no correct scattering model, ever. Perhaps the Baum et al. model is more realistic than the POLDER model some of the time. This begs the question about using the true power of the A-train to do a simultaneous retrieval of size and/or habit distribution characteristics. There is even some sensitivity within measured vis, near IR, and mid IR spectra to constrain the size/habit distributions a bit better. The reviewer is not suggesting to develop a retrieval for this paper, but rather consider it for future work. But, this paper should be revised to include some discussion of this, and especially de-emphasize that there is in fact a correct answer, yet to be shown what it is, for appropriate scattering models. Some papers that address the sensitivity to size and habit distributions (various combinations of vis to IR channels) are below:

Baran and Francis (2004), On the radiative properties of cirrus cloud at solar and thermal wavelengths: A test of model consistency using high-resolution airborne radiance measurements, QJRMS, 130, 763-778.

Cooper, S. J., et al. (2006), Objective assessment of the information content of visible and infrared radiance measurements for cloud microphysical property retrievals over the global oceans. Part II: Ice clouds, J. Appl. Meteor. Climatol., 45, 428211;62.

L8217;Ecuyer, T. S., et al. (2006), Objective assessment of the information content of visible and infrared radiance measurements for cloud microphysical property retrievals over the global oceans. Part I: Liquid clouds, J. Appl. Meteor. Climatol., 45, 208211;41.

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Posselt D., T. S. L'Ecuyer, G. L. Stephens (2008), Exploring the error characteristics of thin ice cloud property retrievals using a Markov chain Monte Carlo algorithm, J. Geophys. Res., 113, D24206, doi:10.1029/2008JD010832.

Wendisch, M., et al (2007), Effects of ice crystal habit on thermal infrared radiative properties and forcing of cirrus, J. Geophys. Res., 112, D08201, doi:10.1029/2006JD007899.

Yue, Q., et al. (2007), Interpretation of AIRS data in thin cirrus atmospheres based on a fast radiative transfer model, J. Atmos. Sci., 64, 38278211;3842.

Hopefully these papers, or their references contained therein, are useful for elucidating the above points on scattering models and thinking about retrievals in the future.

p. 1775, lines 15-16: "there is still a considerable"

p. 1777, line 3: "in the literature"

p. 1777, line 7: "uncertainty in real retrievals"

p. 1778, line 7: Is this true? I think the authors showed that this is definitely a big issue in the VIS/near IR, but what about the thermal IR?

p. 1778, lines 20-26: The reviewer suggests that the authors reconsider the substance of the conclusions here. Really, what the community should be striving for is using everything available in a simultaneous retrieval to maximize the information in the retrieval. Of course, this comes with it8217;s own infinitely large set of caveats. Also, what about some mention of the power of other measurement platforms like CALIOP, and its ability to say something about the microphysical nature of ice crystals? A careful reconsideration of the conclusions is worth the effort and time.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 1757, 2009.