

Interactive comment on “The Impact of Neglecting Ice Phase on Cloud Optical Depth Retrievals from AERONET Cloud Mode Observations” by Jonathan K. P. Shonk et al.

Anonymous Referee #3

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Summary: This paper reports the results of an algorithm that builds naturally on earlier ones developed by Marshak, Chiu, and others for retrieving cloud optical depth from two-channel (visible and near infrared) downwelling radiance measurements. Here, the goal of the algorithm enhancements is to reduce retrieval error when ice particles, as well as liquid particles, contribute to the downwelling radiances. The paper is easy to understand and all of the analyses make sense. I recommend its publication in AMT. My comments are minor in nature.

Comments:

1) The algorithm makes use of one-dimensional radiative transfer theory and differen-

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tial surface reflectivity at the two wavelengths to compensate for it. After reading the Introduction it was not clear how accurate this approach is when applied to different cloud types. In particular, how good is it when applied to fields of horizontally small but vertically developed convective clouds in the tropics as a function of overall cloud fraction? Does significant side illumination and/or cloud side leakage of the convective elements cause problems? If Aeronet is located near a coastal site, do differences in the surface reflectivity of the land and the ocean cause problems? These types of questions are relevant to the paper because the algorithm is applied to tropical convective clouds at sites with mixtures of surface types in their environs. Strengthen the Introduction by making clear, with supporting references, how accurate the retrieval is expected to be for different cloud types and mixtures of different surface types. If this is not known, then say so and caveat your optical depth retrieval accuracies towards the end of the paper. A study that uses three-dimensional radiative transfer theory to pound on these types of uncertainties would be valuable if such a study has yet to be performed. If it has, do reference and discuss it within the Introduction.

2) Lines 23-25 on Page 5 and Lines 1-2 on Page 6 indicate that the radiative transfer is always performed with the ice in a top layer and the liquid in a bottom layer. So these calculations are done with ice on top and liquid underneath and not for what are traditionally called mixed-phase clouds. Does it make any difference if the layers are mixed up together to form what is generally called a mixed-phase cloud? On Page 10, Line 4, the paper refers to mixed-phase cloud in the traditional sense. But on Page 12, Line 12, it is not clear what mixed phase means here. Just be sure to be clear everywhere exactly how the liquid and ice are being dealt with. It may not make any difference for the calculations, but it sure does make a difference for the retrievals: retrieving the properties of liquid only and ice only clouds is not easy but it sure is easier than retrieving the properties of ice and liquid particles all mixed together. Error estimates for the retrieved liquid and ice particle properties would be more convincing if they were provided in the context of the types of clouds above. These context-based error estimates would be of value if percolated into uncertainties for the retrieved optical

depths. For example, in convective clouds with mixtures of in-cloud rain, in-cloud ice precipitation, liquid cloud, and ice cloud, not clear at all as to what the actual errors in the retrievals might be.

Minor Details:

0) A marked-up manuscript is being returned to the authors; perhaps some of the mark up may be of value to them.

1) First sentence of the abstract: "Cloud optical depth remains a difficult variable to represent in climate models" might be true for a bunch of different reasons not related to "a need for high-quality observations of cloud optical depth from locations around the world". So, the first sentence of the abstract is not compelling.

2) The words "could", "could be", "can be",..., are used a lot in the paper. These are weak words in a scientific context and replacing them all with well thought out stronger words would improve the paper.

3) Page 4, Figure 1: The dashed line is really hard to see close to 0.

4) Page 5, Line 13: Wrong units for radiance.

5) Page 6, Figure 3: Why not squares for the top row of figures with the same x- and y-axis range? A line along the diagonal would help too.

6) Page 8, Lines 23-24: "hence far less of an issue ..." is a subjective statement and would depend upon the application. As such, it is not a correct statement for all situations.

7) Page 10, Lines 14-19: Past tense would probably be better for describing what you did to execute the study.

8) Page 13, Figure 7: Make sure all of the minor tick marks show up in the figure.

Please also note the supplement to this comment:

<https://www.atmos-meas-tech-discuss.net/amt-2019-169/amt-2019-169-RC2-supplement.pdf>

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-169, 2019.

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