

Interactive comment on “Coupling sky images with three-dimensional radiative transfer models: a new method to estimate cloud optical depth” by F. A. Mejia et al.

Anonymous Referee #1

Received and published: 27 November 2015

In my view this is a good manuscript that presents significant new advances worth publishing. It describes a new method for estimating cloud optical thickness throughout the sky observed by a ground-based imager. Estimating optical thickness throughout the sky is an important goal, because current methods provide optical thickness only for the vertical column directly above an instrument or give only a single optical thickness value that characterizes the entire (overcast) sky as a whole. Optical thickness images could help in several areas, for example in short term forecasting of solar irradiances for photovoltaic cells that generate electricity.

The methodology appears sound and the presentation is clear and concise. Even so,

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I believe important changes are needed to make the paper ready for final publication. I therefore recommend major revisions to the manuscript. My detailed comments are listed below.

Major:

Page 11298, line 25: I am not convinced that 3-D effects are minimal except for cloud edges. It would seem important to show this by including into the paper some test retrievals based on radiances from 3-D radiative transfer simulations. Alternatively, the wording should clarify that 3-D effects being minimal away from cloud edges is only the authors' guess, and that the issue still needs to be explored.

Page 11298, lines 26-29: I recommend expanding the discussion on the impact of uncertainties in aerosol properties. For example, sample calculations could alleviate the concern that variations in aerosol optical depth, absorptivity, and particle size (all of which affect the spectral dependence of radiances) could impact cloud optical thickness retrievals by modifying the used red-blue ratios.

Page 11301, lines 22-26: It would be interesting to see how retrieval accuracy improves when clouds brighter than the radiance peak are not assigned the maximum value (e.g., $\tau_c=7.25$), but instead are excluded as “unreliable” retrievals.

Page 11321: The figure should be clarified, for example by expanding the caption. What do the red and black diamonds represent, and what is the difference between them? What is a “small DNI” mentioned in the caption? Results from USI are compared to results from which other method(s)? The caption says that the figure shows results from the DNI method, but the horizontal axis label says that it shows results from the MWR method. I guess the red diamonds represent DNI results and black diamond represent MWR results, but this is only a guess.

My impression is that the described approach works only for single-layer liquid phase clouds. I recommend discussing the issue of applicability somewhere in the

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manuscript, perhaps by also mentioning some possibilities for identifying the situations where the approach can or cannot be applied.

Minor:

Page 11288, line 2: Part of the text seems to be missing right after “Pincu”.

Page 11288, line 20: I suggest changing the word “between” to something like “for all”. I think this could help because my initial (incorrect) guess in reading the text was that the sentence was about the clear-sky gaps that lie between nearby contrails.

Page 11294, line 2: I suggest deleting the word “are”.

Page 11295, line 8: There are two equal signs at the solar zenith angle.

Page 11295, line 19: The phrase “consistent to” should be replaced by “consistent with”.

Page 11298, line 1: For consistency, I suggest including the index `theta_0` for `I_620_meas`, or excluding it for `I_620`. The same applies lower in the page.

Page 11299, line 24: I suggest adding the word “sites” between “ARM” and “Min”.

Page 11300, Equation (9); I suggest replacing the symbols “[“ and “]” by “<” and “>” or perhaps using overbars, as these are more often used to indicate averaging.

Page 11301, line 18: I suggest spelling out the acronym “MBE”, which is not as widely used as the RMSE mentioned a few lines earlier.

Page 11301, line 24: I suggest replacing the word “thicker” by “brighter”, because the discussion suggests that clouds get outside the look-up table range due to 3-D effects rather than large thicknesses.

Page 11311: I suggest specifying in the table caption what RMSE[-], RMSE[%], MAE[%], and MBE[%] mean, and perhaps mentioning that the MWR and DNI data is for both overcast and partly cloudy skies.

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Page 11316: The caption or axis label of Figure 5 should say what PZA stands for.

Page 11316: I recommend making the curves for various optical thicknesses easier to distinguish. The $\tau=0$ and $\tau=10$ curves are especially difficult to distinguish.

Page 11319: The caption should describe what each of the four panels show.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 11285, 2015.

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