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Atmospheric Measurement Techniques Discussions

Interactive comment on "Fast simulators for satellite cloud optical centroid pressure retrievals, 1. evaluation of OMI cloud retrievals" *by* J. Joiner et al.

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We thank the reviewer for constructive comments that helped to improve the manuscript. We address the detailed comments below in boldface and repeat the comments in regular font.

The paper describes a fast simulator for estimating cloud optical centroid pressure given a vertical profile of optical extinction. The fast simulator is used to compare CloudSat/MODIS based cloud OCPs with two different OMI cloud OCP data sets.

The paper is well-written. A few minor points need to be clarified. They are listed below.

The paper is acceptable for publication after consideration of these points.

Specific comments:

1. Title: "Fast simulators" is in plural, but "a fast simulator" is described in the abstract and the manuscript.

   Thank you. As we produced more than one simulator, we have revised the abstract and paper as appropriate to indicate this.

2. Pages 6190-6191: May something be said about the uncertainties of the various OCP products?

   Yes, we have added the following:

   "Theoretical simulations by Acarreta et al. (2004) and Vasilkov et al. (2008) suggest that cloud OCP errors should be approximately 50 hPa or less for a wide range of typical viewing conditions and for moderate to high values of either f_{eff} or cloud optical thickness. The main method of evaluating cloud OCPs post launch has been comparison of the two retrievals with one another. Sneep et al. (2008) showed that for $f_{\text{eff}} > 0.5$, the mean difference between the two OMI cloud OCP retrievals was 44 hPa and the standard deviation was 65 hPa, generally consistent with the predicted errors."

3. Page 6192, lines 4-9, Section 2.3 Modis cloud top pressure: all other retrieval algorithms used in the paper are described to some extent. Please also include a sentence or two describing the MODIS cloud-top pressure retrieval.

   We have expanded the subsection on MODIS cloud top pressure by describing the algorithm and validation in the revised version as follows:

   "Cloud-top pressures are retrieved with MODIS thermal IR channels by the CO_2 slicing approach for high clouds or with the window channel brightness temperature for lower clouds at 5 km^2 resolution. Menzel et al. (2008)

state that a reliable MODIS cloud-top pressure retrieval is possible for integrated optical depths greater than unity, noting that MODIS detects the radiative mean of cirrus clouds in the CO_2 bands that is frequently more than 1 km inside the cloud as determined by lidar measurements."

4. Page 6193, lines 22-23. What is the effect of this averaging? Has it been quantified?

   We added text to Sect. 5 in which the effect of averaging is quantified; after referring to the method of computing OCP for every CloudSat profile, then reflectance-weighting over the OMI field-of-view, we added:

   "We believe this method to be more accurate than averaging optical thicknesses of CloudSat profiles over the length of the OMI pixel as was done in Sect. 3. Nevertheless, differences between the two averaging methods are small; for a single day of CloudSat profiles with $\tau > 5$, the mean difference in cloud OCP was 3.6 hPa with a standard deviation of 8.3 hPa."

5. Page 6195, lines 9-10. "such a simple model : : :.. appears to be appropriate for providing relative values". Have you done any calculations to justify this statement or are there any relevant references to be mentioned? What are the criteria to justify the use of a simple model? As the model is used in the fast simulator a quantitative justification for its use should be included. Please expand and justify the use of the delta-Eddington approximation of Jospeh et al (1976).

   We have removed the sentence with "such a simple model." After the sentences stating that we use the delta-Eddington approximation, we added "The delta-Eddington approximation provides accurate reflectances and transmittances over a wide range of conditions (errors < 2% for SZA $<$ about 66° increasing to a maximum of 15% as SZA approaches 84°). Errors will be smaller for geometrically thick clouds where the dependence upon SZA is mitigated as light becomes more diffuse inside the cloud. The delta-

   Eddington approximation therefore appears to be appropriate for providing relative values of layer reflectances and transmittances (with respect to one another) that are most important for estimating the cloud OCP."

6. Page 6196, line 8. It is stated that "We tested several other methods...". Please describe these "other methods". As it stands this sentence and the following do not provide any useful information for the reader.

   We have modified this paragraph as follows to provide more quantitative and useful information and provided the additional references:

   "We tested several other methods for computing layer reflectances and transmittances such as those from Coakley and Chylek (1975) and Meador and Weaver (1980) with different input parameters. All methods provided very similar OCP values; although absolute reflectances and transmittances may be somewhat different for the different methods, the relative values as a function of layer, did not differ substantially. For example, correlation coefficients computed with respect to exact simulator calculations for the CloudSat profiles used in Sect. 3 varied within $\pm$0.05 and biases within $\pm$20 hPa for the suite of radiative transfer models and input parameters tested."

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 6185, 2011.