Response to RC2

Manuscript amt-2018-316: "Cloud Products from the Earth Polychromatic Imaging Camera (EPIC): Algorithms and Initial Evaluation"

By:
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RC2 comments:

This paper provides a brief and succinct description of the algorithms leading to the cloud products from the EPIC instrument on the DISCOVR spacecraft. The results are compared with similar retrievals from geostationary and polar-orbiting satellite in- struments. I have only minor comments regarding the conclusions drawn from the comparison with other retrievals. The paper should be suitable for publication after some minor revision.

In the abstract (line 21) and again in section 3.2 (line 9, p. 8) the authors claim that the comparison of the EPIC retrievals with retrievals from other instruments demonstrate that the EPIC retrievals are "consistent with theoretical expectations" or "theoretical predictions". But these claims are not clearly justified. Can the authors elaborate on what they mean by "theoretical expectations" and clarify quantitatively how the EPIC results demonstrate consistency?

Response:

We thank the reviewer for the comments. We have added the following text to the manuscript to clarify the issue: "The EPIC cloud pressure is essentially the centroid of the reflected photons registered at the satellite sensor. Photons penetrating into and through clouds have longer path lengths compared to photons reflected at the cloud top. Since the MLER model does not take these factors into account, it is expected that the EPIC CEP is lower in altitude than the physical cloud top (higher in pressure); hence the results shown here are consistent with previous studies and theoretical predictions."

We also added Figure 3a to better illustrate the MLER model:

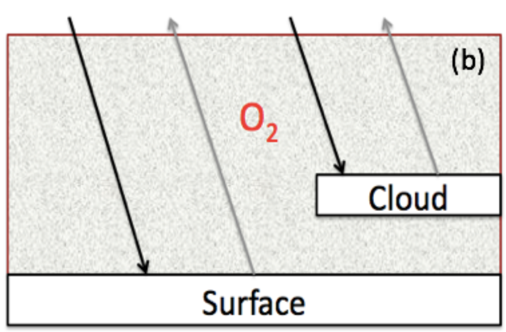

Figure 3b: the two types of photon paths considered in the MLER method. The picture shows one partially cloudy EPIC pixel.

Furthermore, the comparisons are not discussed in any sort of quantitative manner in the narrative. While the quantitative comparison is present in the figures, the text provides merely qualitative conclusions such as "in general, the two products match each other well" (line 32, p.8). This, of course is a close to meaningless statement when comparing two quantities that each have some uncertainty. Much more meaningful would be if they agree within the range of expected uncertainty. And if that is the case, then naturally one would need to know the reasonable range of uncertainty for the retrievals. If the authors expect other members of the community to use these products and cite this paper as evidence that they are suitable for atmospheric research purposes, then they should make a credible effort to offer realistic uncertainty bounds.

Response:

We agree with the reviewer. We redid analysis attempting to provide uncertainty estimates. The following text and results are given in Section 3 of the revised manuscript:

"With the performance assessment, we also attempt to provide uncertainty estimates for the EPIC cloud products. Retrieval uncertainty can come from many sources, including the assumptions and simplifications in the retrieval algorithm, instrument calibration, geolocation inaccuracy, cloud evolution within the latency between imaging different wavelengths, etc. Note that pixel-level uncertainties of the COT retrievals, accounting for known and quantifiable error sources including radiometry, ancillary atmospheric profile, surface spectral reflectance, cloud forward model, and cloud effective radius assumptions, are provided in the current version of the operational products (Meyer et al., 2016, Platnick et al., 2017); uncertainty for other products will be included in the next version."

For the cloud mask uncertainty, the following is added:

"To further quantify the uncertainty in the cloud mask, we use the GEO/LEO composites as the reference and calculate the accuracy, the percentage of correct detection (POCD) and the percentage of false detection (POFD):

$$Accuracy = (\alpha+\beta)/(\alpha+\beta+\chi+\gamma) \quad (6)$$

$$POCD = (\alpha)/(\alpha+\chi) \quad (7)$$

$$POFD = (\gamma)/(\beta+\gamma) \quad (8)$$

where α, β, χ, and γ are the number of pixels corresponding to the following scenarios: 1) both the EPIC cloud mask and the GEO/LEO composite identify as cloudy, 2) both identify as clear, 3) EPIC identifies as clear, but the composite identifies as cloudy, and 4) EPIC identifies as cloudy, but the composite identifies as clear, respectively. Note that we count both the low and high confidence cloudy pixels in the EPIC cloud mask as cloudy. For the GEO/LEO composites, we consider pixels with a cloud fraction greater than 50% as cloudy. Since the EPIC cloud mask has known issues over ice sheets, which are being worked on, we excluded ice sheets in the calculations. Results show that using the GEO/LEO composites as a reference, *Accuracy* is 82.4%, *POCD* 88.7%, and *POFD* 13.1%."

For the EPIC CEP, the following is added:

"In general, the GEO/LEO cloud pressure are lower (higher in altitude) than the CEPs, as their sensitivity lies closer to the physical cloud top. The mean differences between the EPIC A-band and B-band CEPs and the GEO/LEO cloud pressure are 92.7 hPa and 147.5 hPa, respectively"

For the COT retrieval, we have conducted a separate study on the uncertainty of using a one channel retrieval algorithm (Meyer et al. 2016) and the results are reiterated here:

"for ice clouds, uncertainties are mostly less than 2%, because even though a fixed particle size is assumed (30µm), the ice crystal model used in the retrieval (i.e., severely roughened aggregate of hexagonal columns) (Yang et al., 2013a; Holz et al., 2016) is not sensitive to the particle size; for liquid clouds the uncertainty is larger, roughly 10%, although for thin clouds (COT $<$ 2) the error can be higher."

References:

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