

Interactive comment on “Aerosol effect on the distribution of solar radiation over the clear-sky global oceans derived from four years of MODIS retrievals” by L. A. Remer and Y. J. Kaufman

Anonymous Referee #1

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1. As the authors articulate in their Introduction, developing an observation-based assessment of aerosol radiative effect on regional and global scales is an important next step, which they have taken.
2. Several key issues seem to be glossed over in the present text. This is not to detract from the work they have actually done, but their presentation of results appears to overstate the strengths of their conclusions, and does not straightforwardly admit the limitations.
3. Section 2, second paragraph. “Ėavoids any unnatural bias to cloud-free conditions”

seems overstated, as does a related statement near the beginning of Section 3. The higher spatial resolution certainly helps in many situations, but sub-pixel clouds will sometimes occur even for MODIS resolution, and other issues related to scene heterogeneity, such as side-scattered light and cloud shadow, especially in the presence of broken or scattered cloud, can still contribute uncertainty to the results (see, for example, Coakley et al., JAOtech 22, p3, 2005). Estimating the size of these effects may be difficult, but that in itself does not mean they are negligible.

4. Sections 2-4. I agree that using the MODIS radiances, as modeled by aerosol parameters, to derive fluxes, eliminates the dependence on some of the assumptions involved in retrieving aerosol models. But other assumptions are required, and the wording here confuses this point. For example, the statement “MODIS aerosol retrieval provides a complete set of aerosol optical properties” is neither true nor relevant. What matters is the degree of confidence with which the radiative transfer code extrapolates narrow-band MODIS spectral radiances in wavelength and angle, regardless of what intermediate values of τ_a , w_0 and g are derived.

The issues involved range from requiring a bi-modal mixture in the column, to the impact of particle shape and small chemical inclusions on aerosol UV optical properties, to assumptions about ocean surface reflectivity and white cap contributions. Saying, for example, that TOA fluxes are “mostly insensitive to the extrapolation to the UV” etc. (Section 4.2), does not represent a quantitative assessment of accuracy, and the paper cited [Ichoku et al.] does not provide the comprehensive assessment suggested by the current text. There may not be an established way to assess the errors in derived TOA fluxes for the approach used here, but that does not justify claiming a retrieval accuracy that seems to assume most of these errors are negligible.

5. Section 4.1. The data aggregation process described here also introduces uncertainties that are not assessed quantitatively and do not seem to be accounted for in the final error budget. The authors provide plausible qualitative explanations for observed trends, which is certainly a fair approach for initial data analysis. But they then report

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quantitative accuracy for their results beyond what seems to be supported by the work they have actually done.

For example, since MODIS is a wide-swath, nadir-viewing instrument, the multi-angle data used comes from images taken on different days. Given the importance to global and especially to regional aerosol budgets of single, short-lived events such as major dust storms and forest fires, aerosol observations taken over a month will not in general form a consistent data set, and treating them as such contributes error to the flux calculation. Further, this contribution is likely to be greatest in many of the regions where aerosol forcing matters most, such as downwind of the Sahara desert.

6. Differences between MODIS-Terra and MODIS-Aqua are raised in Section 4.3, where it is stated that they apply only to the particle properties, but that the TOA fluxes “should remain relatively insensitive” to calibration and other factors that affect retrieved properties.

If so, what do these differences imply about systematic changes in aerosol properties during the day? This bears on the internal consistency of the paper as a whole. In Section 4.4, the authors assume diurnally constant aerosol properties to estimate diurnal average fluxes, even though the sun-locked AM and PM equator-crossing MODIS instruments give systematically different results, quite large in some regions. It is not made clear how the sizes of these effects are figured into the reported $\pm 0.3 \text{ W/m}^2$ TOA flux accuracy, and the significance is not discussed of the conclusion in Section 5 that the estimated global mean F24s for Terra and Aqua come out exactly 0.3 W/m^2 apart.

7. The aggregation approach could use some clarification. Section 4.4 seems to suggest that if a one-degree grid square has only one sample in that month, it will be weighted proportionately less than the same grid square on a month with 3000 samples. If this is a region influenced by forest fire aerosols, for example, and one of these months happens to be at the peak of the burning season, the annual average result could be highly skewed.

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8. This paper presents an important first attempt at a measurement-based estimate of global aerosol effect, but the uncertainties in the results have yet to be discussed transparently.

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