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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Regional and monthly and clear-sky aerosol direct radiative effect (and forcing) derived from the GlobAEROSOL-AATSR satellite aerosol product" *by* G. E. Thomas et al.

Anonymous Referee #1

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Review of "Regional and monthly and clear-sky aerosol direct radiative effect (and forcing) derived from the GlobAEROSOL-AATSR satellite aerosol product" by Thomas et al., submitted to Atmos. Chem. Phys.

The manuscript describes an estimate of clear-sky aerosol direct effect, forcing, and their uncertainties based on GlobAEROSOL aerosol optical depths (AODs) and observationally-based constraints on aerosol optical properties, vertical profiles, and other relevant environmental factors. Estimates are within ranges previously published, but uncertainty ranges are larger. The paper is well written and the treatment of uncertainties makes it worth publishing, although the total uncertainty is likely overestimated

by the method used. The estimation of sampling error is especially interesting. The use of regional, monthly-averaged AODs, and unnecessary limits on the number of radiative transfer calculations, are unfortunate, however.

I recommend publication after the following comments, aimed at documenting better the limitations of the study, are addressed.

1 Main comments

- I do not understand why the authors use regional and monthly AOD values to compute direct effect and forcing, instead of the 1x1-degree daily distributions from GlobAEROSOL. It seems to me that losing the finer details is unnecessary, even considering AATSR's limited sampling and the need for more radiative transfer calculations.
- The author's bottom-up approach to compute total uncertainty is bound to produce large ranges, since it cannot account for compensating errors. Aerosol direct effect is subject to compensating errors, for example at the TOA when AOD is overestimated and single-scattering albedo is underestimated. For the forcing, some errors (such as surface albedo or spectral variability, for example) should compensate since they impact more the absolute values of the radiative fluxes than their change since pre-industrial condition. Model ensembles or Monte-Carlo/Bayesian emulation approaches are able to account for compensating errors, but require more efforts.
- Showing a figure similar to Figure 2, but for the direct effect, would be a nice way to summarise the results and uncertainty analysis.
- Page 18461, lines 20–25: The description of results by Myhre [2009] is wrong. That paper does indeed read that the "*change in the aerosol optical proper-*

ties due to anthropogenic activity is a main reason for the difference between observation-based and model estimates of the radiative forcing", but models are able to reproduce that change, whereas observation-based methods are not, since they lack observations of pre-industrial aerosols.

- Page 18468, line 19: It would be helpful to compare GlobAEROSOL's performance against AERONET with similar studies for other sensors, such as MODIS, MISR, or POLDER. A 0.1 error in AOD seems large when compared to publications for other sensors and when considering that getting the direct effect within 1 Wm^{-2} requires knowing the AOD within 0.02 (McComiskey *et al*., 2008).
- Page 18470, line 20, and 18472, line 5: The radiative transfer calculations are not really state-of-the-art. Nowadays, one can do better than assuming spectral invariance of aerosol optical properties, and using only three values of the solar zenith angle to represent the strong dependence of direct effect with that parameter (see Figure 5 of Boucher *et al*, 1998). I find those choices difficult to justify, even in terms of computational costs.

2 Other comments

- Why is *and forcing* in brackets in the title?
- Page 18465, line 18: The surface albedo retrieval is presumably strongly constrained by the MODIS BRDF product used to prescribe surface properties in the first place. Is that correct?
- Page 18467, lines 22-25: The difficulty here is that this assumption may turn out to be a unreasonable, unless one first identifies the regions which experienced large aerosol trends (independently of the satellite retrievals to be assessed).

- Page 18470, line 7: It would be useful to point out that this statement only applies to cloud-free conditions.
- Page 18469, section 2.2, and page 18471, equations 1 and 2: The risk with prescribing regional optical properties is that those may be different from the optical properties used when retrieving the AOD, thus making the AOD and direct effect inconsistent with each other. However, the method described in section 3 may correct for this inconsistency. Can the authors confirm that this is the case?
- Page 18472, line 14: An additional source of error is the radiative transfer code itself. This could be quantified using the results of the intercomparison by Randles et al. (2012), soon to appear in Atmos. Chem. Phys. Discuss., which includes the radiative transfer code used by the authors.
- Page 18479, lines 23–24: Different aerosol sources, rather than air quality measures, are the cause of the larger importance of photochemically-driven secondary aerosols in the North Hemisphere compared to the South. (In other word, industrialised countries tend to emit aerosol precursors, while biomass-burning areas are dominated by primary aerosol emissions.)
- Page 18479, line 25 to page 18480, line 4: To avoid those artificial positive forcings, the authors could have derived the relative change in AOD using AeroCom present-day and pre-industrial experiments, and applied that change to present-day GlobAEROSOL AODs.
- Page 18481, lines 21–28: Kahn (2011) is a good reference here, as he makes similar points.

3 Technical comments

- Page 18464, line 18: Typo: Cerrado.
- Page 18465, line 27: Typo: AEROCOM.
- Page 18470, line 6: Typos: absence, composition.
- Page 18482, line 8: Typo: almucantar.
- Caption of Table 3: Typo: literature.

4 References

Boucher, O., et al. (1998), Intercomparison of models representing direct shortwave radiative forcing by sulfate aerosols, J. Geophys. Res., 103(D14), 16,979–16,998, doi:10.1029/98JD00997.

Kahn, R.A. (2011), Reducing the uncertainties in direct aerosol radiative rorcing, Surv. Geophys., 33, 3–4, 701–721, doi:10.1007/s10712-011-9153-z.

McComiskey, A., S. E. Schwartz, B. Schmid, H. Guan, E. R. Lewis, P. Ricchiazzi, and J. A. Ogren (2008), Direct aerosol forcing: Calculation from observables and sensitivities to inputs, J. Geophys. Res., 113, D09202, doi:10.1029/2007JD009170.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 18459, 2012.