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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Some implications of sampling choices on comparisons between satellite and model aerosol optical depth fields" *by* A. M. Sayer et al.

A. M. Sayer et al.

sayer@atm.ox.ac.uk

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Response to reviewers

The authors wish to thank the reviewers for their efforts and comments on the manuscript.

1 Anonymous reviewer 1

This is an interesting paper related to studies of implications of sampling choices on comparisons of satellite and modelling results. I suggest to accept this paper in its current form.

We thank the reviewer for their kind words, and are glad that they found the study interesting.

2 Review 2

2. P17793, line 9. ": : : aggregated to provide 366 daily fields: : :" Are these global fields for 366 spatial cells over the globe, or something else?

The 366 fields arise as one field for each of the 366 days during the year 2004. The manuscript has been amended to clarify this.

3. P17793, line12. ": : : by averaging all the GEOS-Chen daily fields: : :" You do a nice job pointing out that different spatial and temporal aggregation schemes lead to different results. Please explain what weighting you used here.

For this figure, the annual mean was calculated as a simple mean of all 366 days of model data. The manuscript has been amended to clarify this.

Line 21. ": : : sampled in the same way : : :" Meaning that the model is sampled only for times and locations having AATSR aerosol retrievals?

This is correct.

4. P17793, line 27. ": : : if these events are not coincident: : :"A lot is buried in these words, and you list in the rest of the paragraph some of the key factors involved, but it might be worth making some additional comprehensive observations here. For example, one common view is that the longer the sampling period, the more representative the sparse satellite data will be of the actual aerosol field. However, this is not always true, as systematic sampling effects are not reduced by averaging. Other examples: AATSR mid-morning coverage will never capture the afternoon peak of biomass burning, and there is the whole suite of issues associated with instantaneous as well as seasonal cloud effects on aerosol retrievals, as you discuss later in the section.

We agree with this statement. In this case, as the model fields were output at the local AATSR overpass time, diurnal variations in aerosol will not contribute to differences between the two datasets (page 17792, lines 8-10). We have amended the text to include the observation that averaging reduces random but not systematic differences.

5. P17794, line 24. ": : : the finest common grid : : :" However, you also need adequate sampling, or be willing to allow for gaps.

This is true; sampling adequacy is a main focus of the manuscript, and we have added the observation that due to incomplete satellite sampling the averaged fields will likely contain gaps.

6. P17794, line 27. ": : : any retrievals suspected of this contamination should be discarded : : :" This might be too conservative for some applications, and depending on the cloud masking process and the complexity of the scene, this can create biases too.

We acknowledge that cloud-contamination and cloud masking are complicated processes and agree that the choice of which retrievals to include is dependent on the desired application of the dataset. The manuscript has been amended to include this

point. The issue of low-AOD clear-sky bias is touched on later in the section (page 17795).

7. P17795, line 2. You might add some references here about 3-D cloud effects (e.g., Marshak, Wen, Di Girolamo, etc.).

In line with this and the previous comment, some additional references have been added.

8. P17795, line 6. You might see what Zhang and Reid (JGR 2006) did for MODIS in regard to enhanced cloud screening. It helped for assimilation, though it might not in itself leave you with a representative aerosol field in some places.

Current development for the next version of the ORAC algorithm includes improvements to cloud detection and identification of potentially-contaminated scenes. Spatial homogeneity of scenes and retrieved products is one of the areas of current research.

9. P17795, lines 18-21. ff. Alternatively, there might just not be enough information in the remote sensing data to sort this out. On the next page, you essentially make an arbitrary decision about how to handle cloud masking. It might be worth presenting the main points of the cloud contamination more directly. Also, there are papers by Twohy, Tahnk, and Coakley that are relevant here.

As discussed, cloud contamination is a difficult issue facing satellite aerosol retrievals, and it is true that the TOA reflectance resulting from an optically-thin cloud can often be indistinguishable from an elevated AOD loading, due to a lack of information in the satellite signal. The strengths of such effects are, however, likely to be sensor-dependent (as a function of sensor spectral range, spatial resolution, and signal to noise ratio). We chose not to focus so heavily on the choice of cloud mask because the

other points made in this paper (e.g. daily coincidence of sampling, spatial adequacy of sampling) are applicable in a more general sense to satellite-model comparisons of this type. The conclusions of this paper were found not to change significantly when different cloud masking thresholds were applied (page 17796, lines 18-20). We have added additional references as suggested through this section dealing with cloud clearing, because of the importance of the issue.

10. P17796, lines 25-28. (1) How do you arrive at the AOD uncertainty trends for land and ocean? I can guess, but you might mention it here.

The statement (uncertainties generally independent of AOD over ocean, and proportional to AOD over land) were made based on the personal experience of the authors with the ORAC retrieval. The uncertainty esimates are obtained through the Optimal Estimation methodology used, through propagation of uncertainties in the measurements, forward model, and a priori data into the retrieved state. The manuscript has been amended to clarify this. The difference in general behaviour between land and ocean is a result of the relative contributions from surface reflectance and aerosol scattering to the TOA reflectance measured by the sensor in each case.

(2) The relative spatial coverage of retrievals within the model grid cell might also be an important consideration for weighting individual points. For example, if many points are clustered in one corner of the cell, they might receive lower individual weights than points spread more uniformly over the region, which would be important if there are AOD gradients. Weighting points only by a function of retrieval quality does not take this into account.

This is a good point which we previously considered but decided not explore in detail in the manuscript. For homogeneous areas, such as the open ocean, clustering is likely to be of low importance. However, as the reviewer suggests, it will be important

in a highly heterogenous region. This will, again, depend to an extent on the particular model dataset used (with a finer grid size likely leading to a diminishing of such a heterogeneity error). The manuscript has been amended to explicitly mention this point; however, we feel that a detailed analysis is out of the scope of this paper, and that the absolute spatial coverage (denoted p in the paper) is a good first proxy for the adequacy of sampling.

12. References: An updated version of Martonchik et al. (1998): Martonchik, J.V., R.A. Kahn, and D.J. Diner, 2009. Retrieval of Aerosol Properties over Land Using MISR Observations. In: Kokhanovsky, A.A. and G. de Leeuw, ed., Satellite Aerosol Remote Sensing Over Land. Springer, Berlin.

We have added the above reference to the manuscript.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 17789, 2010.