

## ***Interactive comment on “Using the OMI Aerosol Index and Absorption Aerosol Optical Depth to evaluate the NASA MERRA Aerosol Reanalysis” by V. Buchard et al.***

**Anonymous Referee #2**

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Review of “Using the OMI aerosol index and absorption aerosol optical depth to evaluate the NASA MERRA aerosol reanalysis” by Buchard *et al.*, submitted to *Atmos. Chem. Phys.*

This study compares extinction and absorption aerosol optical depth and aerosol index in the MERRA aerosol reanalysis against remote-sensing retrievals from satellite sensors and AERONET. The authors build on the results of the comparison to improve the optical properties of selected aerosols in their model, namely mineral dust and biomass-burning.

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The paper is well written, and relies on a large number of figures which give a thorough view of the skill of the MERRA aerosol reanalysis at simulating aerosol optical properties. The results are interesting, and I particularly like the fact that the authors act upon the results of the comparison. There is room for improvements, however, as detailed below. For those reasons, I recommend revisions before the paper is published.

### **1 Main comments**

- In Section 5.1.4, the authors update the refractive index of mineral dust from the OPAC dataset (which is indeed outdated) to an observation-based dataset. But why do they carefully ensure that the values at 354 and 388 nm are not changed? This means that the AI remains virtually unchanged (Page 32192, line 12 and Figure 7 and 8), but I cannot see the point. Later on, the authors show that AAODs now agree better against AERONET (Page 32192, line 22). But that is hardly surprising, since the “observation-based” dataset is mainly based on AERONET retrievals of mineral dust absorption in the first place.
- On a more general note, the authors seem to use AAOD and AI interchangeably, using the variable that best suit their analysis. This is especially apparent when comparing section 5.2.3, which discusses both AI and AAOD, and section 5.2.4, which drops AI in the sensitivity analysis. I would argue that a more powerful approach is to improve both together: AAOD and AI constrain different aspects of the model (AI being also sensitive to altitude). Could the paper adopt such an approach?
- Section 5.3.1 ends with a discussion of the possibility that emissions are underestimated, thus explaining why AODs are biased low in Asia. But it would seem that the comparison to CALIOP vertical profile is not consistent with that hypothesis: if emissions were underestimated, how can backscatter be too large near

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the surface (section 5.3.2)?

## 2 Other comments

- Page 32181, line 13: Please list the years covered by the aerosol reanalysis here.
- Page 32183, line 1: I'm confused: the abstract and introduction say that MODIS AODs are assimilated. But the text says here that reflectances are assimilated. Which is it?
- Page 32183, lines 26–27: Please summarise what modifications were made to the sulphur dioxide injection heights. Also, there is no mention of dust emissions. Why?
- Page 32184, lines 16–17: In addition to the requirement on AOD, the AERONET inversion of SSA requires that the solar zenith angle be large enough. That requirement means that absorption is sampled in mornings and afternoons, which introduces another bias in the AERONET absorption dataset, especially in regions where the aerosol diurnal cycle is large (e.g. biomass-burning regions).
- Page 32186, lines 18–20: The paper does not seem to rely on polarisation, so that sentence is not relevant to the paper.
- Page 32187, line 10: In the calculation of AI in VLIDORT, do the concentrations and vertical profiles of ozone and water vapour matter? If so, how were they prescribed?
- Page 32188, line 2: What are the white and grey areas in Figure 1?
- Page 32188, lines 23–26: It would be useful to show the regions on one of the maps on Figure 2 or 3.

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- Page 32190, lines 20–22: Do the authors have an explanation for the large surface backscatter in MERRAero?
- Page 32191, lines 14–16 and page 32192, lines 14–16: What point are the authors trying to make here by giving all those numbers? That there are hints that aerosol composition is not right and explains the bimodality of the differences between MERRAero and OMI?
- Page 32192, lines 1–2: Please be more quantitative: what is the new SSA, for example?
- Page 32192, line 19, and similar sections for other aerosol species: Are modelled AODs sampled as in AERONET absorption retrievals (at least  $AOD > 0.4$ )?
- Page 32193, line 2: More specifically, iron oxides.

## 3 Technical comments

- Page 32192, line 20: rephrase to “for which AERONET retrieves SSA...”

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