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Comment on amt-2021-8 Kayetha et al., Retrieval of UV-Visible aerosol absorption using AERONET and OMI-MODIS synergy: Spatial and temporal variability across major aerosol environments

Anonymous Referee #3

Referee comment on "Retrieval of UV-visible aerosol absorption using AERONET and OMI-MODIS synergy: spatial and temporal variability across major aerosol environments" by Vinay Kayetha et al., Atmos. Meas. Tech. Discuss.,
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Review of "Retrieval of UV-Visible aerosol absorption using AERONET and OMI-MODIS synergy: Spatial and temporal variability across major aerosol environments."

General Comments

This work attempts to use the OMI-MODIS synergetic data and the measured and retrieved products from the AERONET measurements from different Earth regions. This work used UV-Vis spectral band measurements and retrieved the SSA separately for each bands using a LUT approach. Seasonal variability of the SSA in different regions worldwide is studied using the AERONET products and retrieved SSA and AAE from this work.

In general, the attempt to quantify the aerosol absorption using the retrieved SSA in UV-Vis multi-year multi-dataset is interesting and useful for the scientific community. However, the methodology and the manuscript need to be improved before considering for publication.

Specific comments

- AERONET measurement-based climatology is used for representing the particle size distribution in the retrievals. However, no discussion based on it was found in the manuscript. It would be ideal to provide the details of the PSD used in the retrievals.

You could create similar plots like the figure 6,7,8, and 9; instead of SSA, you could plot the mean PSD distribution with the error bar as the SD (This can go to the supplemental material).

- Authors should discuss the criterion for classifying AERONET stations into biomass burning, dust, Urban/Industrial, and mixed aerosol in detail. E.g., the Sao Paulo station classified as biomass burning is wrong since it is a megalopolis.
- Section 5 is not very clear. Please consider rewriting it to avoid ambiguity.
- Consider moving Table 3 to supplemental material.
- A discussion on the correction of atmospheric gas absorption before the aerosols retrievals is needed

L37: What models are authors discussing here? GCM? Global Earth System models? Please specify it.

L55: Did you mean by SSA retrievals?. Because it is clear that there is a long term measurement of AOD at UV bands from AERONET stations.

L71-73: Specifically mention these retrieval algorithms with citation. Are you specifically talking about MODIS operational algorithms?

L164: Provide geometry information. Like SZA, VZA, RAA used for simulating TOA observation for the GSFC site.

L165-167: This is calculated for a particular satellite-sun geometry, and it can vary considerably in the analysis used in this study. How can you generalize this sensitivity of SSA and AOD to other satellite-sun geometries?

L177-180: Can you calculate the uncertainty in SSA due to the assumption made here?. It will be important, especially since retrieved SSA differs for regions with different spectral signatures and magnitude.

L184-186: Did you use the closest observation as collocated data?

L203: Why the inversion is done independently? You could use the multiple wavelength information in minimization. What is the advantage of doing inversion independently over different spectral bands?. In the discussion section, you are using only the data points with retrievals for all bands. It makes sense to use all the information together to do a retrieval. Please specify the rationale behind not using this method.

L212-214: This is not correct for the blue band. The Rayleigh signal will mainly dominate the signal in this band when the aerosol loading is low.

L270-271: How did you come up with these numbers? Provide references for this. It would be best to use the uncertainty specified by the surface albedo product you are using in the retrieval.

L282: This achievable accuracy depends on the accuracy of surface reflectance products used in this study. It should be calculated based on the accuracy mentioned for the surface product used and should differ based on surface type, and it will become dominant in the longer wavelengths.

L325-327: I can't see a plot for the DJF season. Is this a typo?

L366-367: This can be verified using the plots of PSD from AERONET retrievals.

L369-370: Is this just the author's opinion? What are the pieces of evidence for this?

L395-396: For the case of JJA, the SSA is increasing with the wavelength for the region 340-388 nm. It is contradicting to the sentence in these lines.

L405: Typical urban spectrum based on what work? Cite the literature!

L422-423: This has to be verified using PSD.

L518-521: The SSA difference for those two regions can be due to the error from surface reflectance estimation.

L521-522: This is just another hypothesis; there is no proof here.

L555: What kind of interpolation?

L560: In figure 13, why there is no STD for the UV wavelengths?

L561-563: Show the SSA as a box plot with error bars. It will give us an idea of the spread of the SSA values for the averaging AERONET station.

L576: Move the annotations to the lower right corner of the plots in Figure 14.

L601: You could cite Dubovik et al., 2006 to describe the smoothness parameter imposed in the retrieval.

L601-603: Another difference is the use of multi-angular- multispectral information in the AERONET retrieval, Whereas the work presented here used the PSD and real refractive index from those retrieval and basically, the imaginary part of the refractive index is varied to retrieve the SSA.

L616-618: Define the range of parameters used for this sensitivity study.

L661-662: These two AERONET stations is in the biomass burning aerosols category. Then why you have it here in Urban?

L687: Specify that no SSA and IRI retrievals available at the moment.

Technical corrections

L40-41: Is it a 50% decrease?

L59: Citation required for this statement.

L72: 'observations in the visible assume'. It should be 'visible spectrum' instead of just 'visible'.

L124: In Table 1 it is mentioned that version 2 is used. Which one is correct?

L198-199: Did you mean an exponential distribution?. Because the peak is on the surface.

L290: Is it $\tau_{440} \geq 0.2$?

L305: The values given for SSA are mean; specify it explicitly with the SD as uncertainty.

L441: In figure 9b, instead of 'northeastern china', it is mentioned as 'eastern china.'