

## ***Interactive comment on “Development of an OMI AI data assimilation scheme for aerosol modeling over bright surfaces – a step toward direct radiance assimilation in the UV spectrum” by Jianglong Zhang et al.***

**Anonymous Referee #1**

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This paper sets out a methodology and presents summary results for assimilating aerosol index measurements in to an aerosol forecasting model. This is relevant and interesting for the modelling community as it is effectively aerosol radiance assimilation. Radiance assimilation is common place in the NWP data assimilation community but has still to be explored for aerosol assimilation. For NWP it provides improved results compared to a level 2 retrieval and it has not yet been established whether the same may be true for aerosol assimilation.

The article is very nicely written and provides a clear and precise overview of the

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work carried out. The detail of the forward model and assimilation procedure used is thoroughly covered but the clear structure of the article means the overall message of the paper is not lost in all the detail. The results of the assimilation experiment are succinctly presented in easy to understand figures without inflating the results or claiming more than is shown.

This well written paper presents an advance to modelling science and deserves publication. I do, however, have a few minor comments that I list below

Minor comments

1. It was not quite clear to me from the article whether the three models whose results are compared were the same version of the NAAPS model? I understand that the NAAPS reanalysis v1 was used to show the results with AOD assimilation (pg 8, paragraph 1) and that a free running version was used to provide the results without any aerosol assimilation at all (line 176). You also state that the assimilation system is based on variations of aerosol particles from NAAPS (line 106). Are all three the same version at the same resolution or are there differences between them? It would be beneficial to clarify this in the article as any differences will also impact on the results of the three experiments compared to Aeronet.

2. Related to this, I'm slightly confused by your description of the post-processing system in lines 209-211. I would consider the construction of a new NAAPS analysis based on the background NAAPS aerosol concentrations and increments as derived from the assimilation system to be part of the assimilation process itself. In fact I would assume that this updated analysis state would be forecast forward in time to create the background state for the next cycle of the data assimilation process. Is this not the case?

3. Your Figure 7 is a comparison of the vertical profiles of the NAAPS natural and AI DA runs. Assuming that the AI DA runs are as described above, so an analysis model state that is used as the initial condition for a short forecast to create the background state

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for the next assimilation cycle, then I don't believe you can draw the conclusions that you do in lines 493-498. There is no guarantee that the profile before assimilation is the same as the nature run profile and so you can not disentangle what profile differences come from previous assimilation versus what is due to the assimilation of the AI data in the current cycle. To look at the impact of assimilating AI data in one specific cycle you would need to plot the background model state versus the analysis state, rather than the nature run.

4. What do you think is the impact of using gridded OMI data (line 130-133) versus the higher resolution (I assume) AOD data of the reanalysis. Do you think that the results would change if you were able to use the AI data at its native resolution and that it would closer match the results of the reanalysis?

5. It is interesting and useful to have an idea of the computational burden of the call to the radiative transfer model in Section 4.4, but it would add perspective if this could be compared to the equivalent computational burden for AOD assimilation.

Typos

Pg. 7, line 147: AERONET

Pg. 8, line 169: precipitation data are used to constrain the wet removal process

Pg. 18, line 405-407: It is unclear to me which figures you are talking about in this sentence. I assume it is Figure 3c, but coming directly after discussion of a comparison of 3b to 3d it needs further clarification.

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