

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-630

Anonymous Referee #1

Referee comment on "How aerosol size matters in aerosol optical depth (AOD) assimilation and the optimization using the Ångström exponent" by Jianbing Jin et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-630-RC1>, 2022

This manuscript explores the sensitivity of Ångström exponent to aerosol radius in a CTM, and uses the information together with satellite data to design a hybrid AOD assimilation. The topic is interesting to the aerosol and satellite committee. The paper is well written and the method is clearly described.

My major concern is the authors attribute the discrepancy of Ångström exponent between satellite and model only to aerosol geometric mean radius. However, distribution of aerosol chemical compositions, aerosol mass density, refractive indices, relative humidity, hygroscopic growth, internal/external mixing in model assumptions all have uncertainties, some of them could be even more uncertain than aerosol size. Even we assume Ångström exponent is mostly sensitive to aerosol size distribution, the standard deviation of size distribution is also an important factor in addition to the radius. Are all these factors confirmed to have neglectable bias in the model, or their uncertainties hard to affect Ångström exponent? I would suggest add more analysis or at least discussion for this point.

Other comments:

- The posterior radius could be evaluated with more measurements to make them more convincing. For instance, a brief comparison with size distribution from surface or aircraft observations in the literature.

- Any reason for the choices of wavelength pairs in Ångström exponent calculations (470-650nm for MODIS and 440-870nm for AERONET)? Would be the results different if choosing other wavelengths?

- Section 4.2, paragraph 3. Modeled aerosol mass concentrations are underestimated. Depending on which chemical species are missing, this could largely affect Ångström exponent. Why do you think the bias of Ångström exponent is due to aerosol radius?

- Page 19, line 21. Please provide more evidence for assuming dust and sea salt are not important. What are the concentrations of dust and sea salt in your model simulation? Maybe this is also helpful to support your assumptions of their certain bins.

- Fig 7-9: maybe narrow the range of colorbars to make the distribution clearer.