

Response to Reviewer #2 comments:

We thank reviewer #2 for the valuable comments and suggestions. According to the comments, we have revised the manuscript. Below we provide a point-to-point response to address the reviewer's comments.

Review of "The NOAA Aerosol Reanalysis version 1.0 (NARA v1.0): Description of the Modeling System and its Evaluation

By Wei et al.

Overview: This manuscript describes an aerosol product generated for the year 2016, referred to as NARA v1.0, using the GEFS aerosol model and NNR AOD product assimilation using a 3Den-Var data assimilation. The results were compared to NASA's MERRA-2 and ECMWF's CAMSRA reanalysis products as well as against the AERONET AOD and surface PM_{2.5} data. The 2016 NARA v1.0 output was found to be more consistent with AERONET than the free model run. The results are also more consistent with MERRA2 than CAMSRA reanalysis. This isn't really surprising as the NARA v1.0 setup has more similarities to MERRA-2, using GOCART aerosol and NNR AOD product that is also assimilated for MERRA-2.

General Remarks: The main issue I have with this manuscript is referring to the output as a reanalysis when the results are only shown for 1 year. A reanalysis is typically over a long period of time (10years+) as is the case for the other aerosol reanalysis products that are available. I would call this an evaluation paper of the performance of the 3Den-Var with the GEFS model. I think it's fair to say that you will apply this setup in the future for generation of a reanalysis product, but don't think you can call it that here. Given that, I think more needs to be done to define what is different here than in the Huang et al. 2023 paper that defined the data assimilation setup and evaluates the analysis results, although for only a month time period versus a year. I also think there are more details needed in the manuscript, including the data assimilation setup. More description of observations and reanalysis data used in this paper would also be helpful. For the observations, was there any QC done prior to using the data? Was there any temporal averaging done in order to make point data comparable to model output? I do want to highlight that reanalysis products are very important and once you are able to generate that, I think that will be a valuable contribution.

Response: We agree the length of dataset is not sufficient for a reanalysis dataset, so we have renamed this 2016 reanalysis product as the prototype NOAA Aerosol ReAnalysis version 1 (pNARA v1.0). For the DA system, we have revised the description, especially the detail of use of MODIS NNR AOD. Specifically,

when the AOD is retrieved via neural network, the cloud-affected data points were screened out and we also thinned the resolution from 10 km to 50 km. We added the pre-process procedure of reanalyses dataset in the beginning of Section 5.2. Please see below for point-to-point response for specific comments.

Specific Comments:

- First sentence in the abstract. I see what you are saying here, but I think this could be a bit misleading. It could come off as you have the first aerosol reanalysis product ever, which is not the case. Please reword this as “the first version of the aerosol reanalysis for NOAA”, or something like that in order to clarify.

Response: The first sentence has been revised according to reviewer’s comment. Now it is ‘the first prototype version of the aerosol reanalysis...’ (L1).

- Page 4, first line: “In this study, we used and designed a specific JEDI-based 3D-EnVar DA configuration to produce the NOAA Aerosol ReAnalysis version 1.0 (NARA v1.0).” Please elaborate on how this differs from the setup described in Huang et al. 2023. The difference is not clear and why is the chosen configuration better for a reanalysis?

Response: It is the same DA system as Huang et al. (2023), but the MODIS NNR AOD at 550 nm is assimilated in pNARA v1.0 and the configurations of scale factor and perturbation of emission are adjusted accordingly.

- Have you also looked at performance of fine mode fraction or fine/coarse AOD?

Response: No, the fine mode fraction or fine/coarse AOD were not assessed in this study, because these information is not available in MODIS NNR AOD retrievals. This task will be pursued in the future when we introduce the assimilation of multiwavelength retrievals/measurements into the system.

- I think looking at timeseries that are not monthly-averaged would also be helpful, at AERONET sites for example, to see if your product is able to generate daily variability. Perhaps you can select reference sites that have a good amount of data and at locations that are representative of big dust/smoke/pollution/sea salt dominated regimes.

Response: Given the horizontal resolution of pNARA v1.0 is in 1 degree, we mainly focused on the performance at large spatial and temporal scale. We have added discussion and figures of temporal statistics against AERONET in Appendix A.