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Interactive comment on "Development studies towards an 11-year global gridded aerosol optical thickness reanalysis for climate and applied applications" *by* P. Lynch et al.

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Response to the review by A. Benedetti on "Development studies towards an 11-year global gridded aerosol optical thickness reanalysis for climate and applied applications"

Thank you very much for the thorough review of this paper and the appreciation of this work. Here are our replies to your specific comments.

Main comments: 1. Title could be shortened: "An 11-year Global Gridded Aerosols Optical Thickness Reanalysis for Climate and Related Applications"

Answer: Thank you for the suggestion! The title is shortened now as suggested.

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2. Random and systematic in observations and background are not discussed at all. I know this is a sticky subject which has been dealt with in previous papers, but I would like to see a few sentences on the matter to remind the reader of the importance of a correct definition of the error matrices.

Answer: To address this concern, a short paragraph is added in section 2.3.2 right below the section title. "Both observational and model errors could contain systematic bias, either of which could be removed or minimized through pre-processing. For example, our quality assurance (QA) and quality control (QC) methodology (Section 2.3.3) attempts to remove systematic bias as much as possible from the AOD observations. Likewise, the tuning process described in Section 2.4 attempts to remove systematic bias from the model background. Thus, both model background and observations are assumed to be unbiased in NAVDAS-AOT."

3. The importance of the source and precipitation tuning is well emphasized, but the reader is left with no feeling of what the reanalysis would do without the tuning. Is it possible to add something to address that?

Answer: Yes. We have included in the appendix a discussion about the tuning impact on the natural model and its impact compared with the AOT data assimilation process. Four model runs with different configurations were conducted for a year, including NAAPS without tuning, NAAPS with tuning, NAAPS without tuning but with AOT data assimilation, and the reanalysis version, which is with both tuning and AOT assimilation. A table is added, showing the 550nm modal AOT bias, RMSE, r2 and linear regression slope against AERONET from the four model runs. The seasonal mean global distributions of the total, fine and coarse AOTs are also shown in two figures in the appendix. Basically, with the sources and sinks tuning, RMSE decreases about half, bias and r2 also significantly improved for the natural model. The numbers are comparable with those of the DA run without tunings. AOT partitioning between the fine and coarse mode AOTs are also better in the runs with the tuning.

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4. The trend analysis is a terrific addition to the paper in terms of science, but I feel it possibly belongs to another publication altogether as this is already a very long paper. I leave this to the discretion of the authors and the editor.

Answer: Thank you for your interest and the suggestion. The trend analysis here is meant to provide an evaluation of the AOT reanalysis product from another viewing point besides the validation with AERONET observations. So we would like to keep the trend analysis as a part of the paper. This point is also mentioned in the introductory part of section 3.3. "This helps to evaluate the reanalysis from another perspective." But you are correct, that this does open up the field in trying to understand the nature of aerosol trends through the use of reanalysis datasets.

Other comments/typos: Line 108: explain what modal means

Answer: "modal" in this paper means the fine mode, coarse mode AOTs and the total AOT. In the draft, "550nm modal AOT reanalysis" is replaced with "550nm modal (fine mode, coarse mode and total) AOT reanalysis". Also the bracket and the content in the bracket "(fine mode, coarse mode and total)" in line 110-111 are deleted (as it is repeating the above information).

Line 177: is the cloud structure retained from the model?

Answer: Yes. In the draft "in which cloud structure is retained....." is replaced with "in which cloud structure from the model is retained...."

Line 235: perhaps another symbol can be used

Answer: assuming you refer to "RH", which is the relative humidity. Now it is replaced with "r" throughout the text.

Line 260: what is the definition of the Monin-Obukhov length? Please add.

Answer: right after "....and L is the Monin-Obukhov length" add ", which is a measure of the stability of the surface layer (Obukhov, 1971, Eq. 26). ". Also added the following

new reference in the reference section. Obukhov, A.M : Turbulence in an atmosphere with a non-uniform temperature (English Translation). Boundary-Layer Meteorology 2: 7–29, 1971.

Line 316: "diel"?

Answer: "Diel"means denoting or involving a period of 24 hours. To avoid confusion, "diel" is now replaced with "daily".

Line 432: "assimilatable"?

Answer: "assimilatable" means the data is with good quality and can be assimilated in the data assimilation system. Change from "but it is expected that improvements in Collection 6 will be assimilatable (Shi et al., 2013)." to "but it is expected that improvement in Collection 6 will be made and the data could be assimilated (Shi et al. 2013)."

Line 595: often the analysis correction are called "increments" in the literature

Answer: thanks! The 2.4.2 section title is changed from "Tuning with AOT assimilation correction field" to "Tuning with AOT assimilation correction/increment field".

Line 947: Over Indonesia ENSO events tend to produce large positive anomalies due to prolonged drought and associated intense fires. The recent 2015 season was exceptional in that regard. This will surely mask the small negative trend reported over the 2003-2013 period and shown in figure 13 (which is fact does not reach the significance level). Again, the trend analysis is super-interesting, but I believe deserves full attention in a separate paper.

Answer: thank you for your interest and the suggestion. The trend analysis here is meant to provide another perspective as for validation of the AOT reanalysis product. This point is also mentioned in the introductory part of section 3.3. "This helps to evaluate the reanalysis from another perspective." Figure 10-12 are a masterpiece of synthesis. Answer: Thank you!

Interactive comment on Geosci. Model Dev. Discuss., 8, 10455, 2015.

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