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Comment

## ***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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The paper describes an 11-year aerosol reanalysis carried out at the Naval Research Laboratory using the Navy Aerosol Analysis and Prediction (NAAPS) system and assimilating data of Aerosol Optical Depth (AOD) from the Moderate Resolution Imaging Spectroradiometer (MODIS) on Terra and Aqua, and the Multi-angle Imaging SpectroRadiometer (MISR) on Terra. The system is described in great detail, in particular the aerosol model as well as the observational datasets used in the assimilation. The most impressive part of the paper, is without doubt the attention given to the verification aspects. Independent data from AERONET are used to assess the value of the

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reanalysis at the global, regional and local scales. The paper offer a comprehensive set of statistics and results which can easily be considered the benchmark for any other evaluation effort of aerosol reanalysis. Variables examined are the total aerosol optical depth and fine/coarse mode aerosol optical depths which are parameters available in the AERONET dataset. The reanalysis is shown to be very robust, also thanks to the tuning of the aerosol sources with AERONET which allowed the first guess to be already close to the assimilated observations and the analysis only to perform small corrections. The tuning of the precipitation field using observations was also beneficial for the reanalysis. The best product is shown to be the AOD, which is also the assimilated variable. Excellent skills are also demonstrated in fine and coarse AOD, with a slight high bias in fine AOD and low bias in coarse AOD, which is a common feature of many aerosol assimilation models. The reanalysis is also shown to perform better downstream from sources than close to local sources, for example over deserts, consistently with findings from other centres and associated to the variational (incremental) formulation and the definition of the background error covariance matrices as well as the paucity of observations over source regions. The trend analysis also extremely interesting, and deserves a separate publication.

Overall this paper is exceptionally well conceived and enjoyable to read. It can be considered a benchmark paper for aerosol applications. The authors did a very good job in striking a balance between technical details and scientific facts. I list minor questions/comments below, and recommend publication of this manuscript.

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

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.

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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?

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.

Other comments/typos:

Line 108: explain what modal means

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

Line 235: perhaps another symbol can be used

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

Line 316: “diel”?

Line 432: “assimilatable”?

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

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.

Figure 10-12 are a masterpiece of synthesis.

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

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