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Interactive comment on "AOD trends during 2001–2010 from observations and model simulations" *by* A. Pozzer et al.

Anonymous Referee #1

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Summary: This paper characterizes global and regional AOD trends for the period 2001-2010. These trends are estimated from both satellite retrieved products as well as model simulations, and in general, the modeled trends tend to agree with the observations. What is interesting about this work, is that the simulations are run twice, once with constant emissions (e.g 2000), and one with changing emissions. The conclusions are that decreasing trends over US and Europe are caused by decreased emissions, but that over the Sahara and middle East, observed trends are driven by changes in meteorology. Additional, decomposing AOD trends into individual components suggests that water-soluble components dominate AOD due to enhanced water content.

Overall: I like this paper. It is logical and well written, and I appreciate the simplicity

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in its story. I like the attempt to compare models run with and without changes and emissions. Some reviewers may complain about the lack of mathematical rigor in the statistics, but I think that the story might be lost if it became too mathematical. I appreciate comments by Andy Sayer that suggest that newer MODIS (Collection 6) and SeaWIFS (Version 4) data would be better for this study, but I don't believe the conclusions would be changed significantly. However, I believe that if the study was done with these newer datasets, the trending discrepencies (MODIS vs SeaWIFS vs MISR) might be reduced. There is a new study by Lyapustin et al., (accepted to AMT) that highlights how calibration had created artificial trends in Terra-MODIS data. The new Collection 6 data will have less of a decreasing trend over land. Even though it is not necessary, if making extensive use of satellite datasets in the future, it might be good idea to consult with the product developers.

I have a few comments and suggestions that I would like to see implemented in a paper revision. Most importantly, I think the figures are of poor quality, at least in the printed version (yes, I take a printout home to review).

Fig 1: The axis labels are way too small. I don't really see why you need two panels (Visually I do not see the difference). You could have one plot, and just list the two sets of statistics. Also, why not a linear plot (rather than log-log), the y-offset looks bad. Fig 2: I think that not enough retrievals and zero trend should be different colors. Also, I do not see the "+" symbols to characterize significance. Note that if you used the MODIS Collection 6 data, there will have much less of a negative trend over land. Fig 3: Generally same comments as Fig 2. Is there any difference between top and bottom plots? Okay, I know there is a difference, but why should there be different trends as measured from Terra orbit (10:30) vs SeaWiFS orbit (12:00)? Again, the interesting differences are between left (RCP00) and right (RCP85) plots. Fig 5: I have trouble understanding this plot. The legend and captions are insufficient, and the text does not go into enough detail. This is scatterplot between modeled trends and observed trends? where dots are different regions? What are the diamonds?

Table 1: These trends are in what units. Per year? Per decade?

Other comments: 1. Why RCP8.5 only for changing emissions? I am curious about the other scenarios. While RCP8.5 may be best globally, I wonder about regionally. 2. What about seasons? Yes, multi-year trends are interesting, but sometimes it is the trends over a particular season that really matter. Like for example, over the U.S., is the trend due to lower maximum AOD during the high-loading (summer) season, or due to less AOD over the entire year? I would ask similar questions for biomass-burning versus wet seasons, etc. 3. In section 3, you need more description of the observation datasets. Note that every "validation" expected errors are based on Level 2 (along-orbit) products. No one claims validation for Level 3 (aggregated/gridded data). 4. I really am interested in the section 6 discussion of the WASO component and how the embedded liquid water is dominating the AOD. I think this needs more detail and discussion, and some modeling scenario explaining how much water actually contributes to AOD. Also, are there trends in water vapor and/or humidity from meteorological datasets that must be studied? 5. Since one of the conclusions is that "emissions matter" at least in some regions, are there any other differences in the model outputs, other than AOD? What happens to clouds and precip? 6. It is noted that (page 26629, line 1-) "the model AOD product was extensively evaluated......, the model is generally able to correctly reproduce AOD observed by AERONET, mostly within a factor of two". The trends you are trying to characterize are signficantly less than a factor of two. Personally, I believe that model outputs, even if not necessarily accurate or precise, should still be able to decipher trends. However, I am not convinced by the arguments in this section. 7. Page 26630, lines 20-. There are some statements related to saying that RCP85 better fits the estimated trends from remote sensing observations. I don't necessarily see this when I compare Figs 2 and 3. For example, there is a huge discrepancy over the Amazon with RCP85. Also, realize that most of the satellite trends are insignificant, either for having no or too few retreivals. It does not seem to be a problem in the models.

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