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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluation of climate model aerosol trends with ground-based observations over the last two decades – an AeroCom and CMIP6 analysis" *by* Augustin Mortier et al.

Anonymous Referee #2

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The authors derived trends of total aerosol optical depth, small particle optical depth, large particle optical depth etc. from ground based observations and models. The authors analyzed these trends separated by regions and from 2000 through 2014. The authors show that a limited spatial coverage of ground based observations leads to the AOD trend derived from them not representing the trend over most of the regions except for Europe where ground based observations are most densely populated. The authors also compared observed trends with trends derived from models. In addition, using one of CMIP6 models, the authors show regional trends as well as global trends.

I have two major issues on the current version and one suggestion. Once the paper emphasizes sampling issues in ground based observations in an application of validating global models, the topic discussed in the paper is relevant within the scope of ACP.

The authors did a sensitivity study to test how well the trend derived from ground-based observations represents the trend for the entire region. The result shows that only the AOD trend derived over Europe and Australia represents the entire region (i.e. f factor discussed in Section 3.3 is less than 0.5 so that the true trend falls within a 60% confidence interval). The result of this sensitivity study is only presented as thick black borderlines in Figure 5. In addition, the result of the sensitivity study is not treated the uncertainty in Figure 6. Because the sampling uncertainty is a part of the uncertainty in observed trends, the error bar attached to the observation need to include this sampling error. When the sampling error is included as the uncertainty, the error bars of the observed trends are much larger. I suggest including the sampling uncertainty in the error bar. Then significant modeled trends consistent with observations are those within the error bar.

The second point is related my comment above. The connection between the first paragraph of the Section 4.3.1 and second paragraph is weak. The first paragraph seem to conclude that regional trends derived from limited number of ground based observations can lead a misleading trend. Then why do the authors need to discuss global trends where ground based observations even represent less? Could you elaborate more the reason for discussing the global trend without showing any observations to compare (given the point the authors made in the first paragraph)? One cannot even estimate the uncertainty in the global trend other than perhaps discussing spreads among the models. But the spread is not the uncertainty in the modeled trends. Moreover, Section 4.3 focuses on mostly one model (NorESM2). Furthermore, the authors mention briefly that the ADO trend agrees with the trend derived from MODIS but the trends derived in this study are from 2000 to 2014 while the study by Zhang and Reid

was published in 2010, i.e. their period is shorter than the period used in this study. Therefore, I do not think that their result cannot compare with the trend derived from 2000 to 2014 data.

Given my two comments above, my suggestion is to significantly shorten Section 4.3 and focus on analysis of the representativeness of ground based observations. The results of Section 3.3 are only briefly presented in Figure 5 and are not discussed in detail. The number of ground sites was dramatically changed during the period analyzed in this study (2000 to 2014) as shown in Figure 1. The authors seem to have done the analysis of the impact so why not discus in detail?

Some minor comments Section 3.3. The description of the method needs to be given more. For example, Line 230 to 236, the authors say “collocation”. But I did not understand what was collocated with what till I read the caption of Figure 4.

Figure 4 only shows two regions. Perhaps include a table showing “f “factors for all regions? Also it is not clear how the number of points shown in the top plots of Figure 4 is related to the number of observations.

Line 274 to 278. Move to Section 2.

Line 362. “sign” instead of “direction”?

Line 400 to 402. The statement might be true, but it is also possible that AE is less sensitive to the change in a relative sense.

Conclusions stated in the conclusion section need to be more specific. For example, please state the regions instead of saying “some observations”.

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