Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-621-RC3, 2019

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Interannual Variability and Trends of Combustion Aerosol and Dust in Major Continental Outflows Revealed by MODIS Retrievals and CAM5 Simulations During 2003–2017" *by* Hongbin Yu et al.

Anonymous Referee #1

Received and published: 2 October 2019

In this study, the authors examined the 15-year trends and interannual variabilities of dust and combustion aerosols using MODIS retrievals from 2003 to 2017, with the aid of CAM5 simulation. The goal of this paper is clearly stated in the text, and scientifically important. The tables and figures are well prepared. The approaches used is well-established. I recommend publication of this paper with several minor modifications.

General comments:

1. The term of "combustion aerosol" may not be suitable for SOA (shown as green

bars in Figures 8∼11), since some SOA, like biogenic SOA, is not formed through combustion processes. The authors can either use term "pollution" as in Yu et al., (2009), or explicitly state what aerosol species in CAM5 are considered as "combustion aerosols".

2. Why dust emissions from different regions are not tagged? From Figure 4, it seems that some regions are very likely affected by dust emitted from different regions. It may also help to diagnose the discrepancies between MODIS and CAM5 simulations as shown in Figure 12.

3. In Figure 8∼Figure 11, what types of simulated sulfate are considered? I am assuming sulfate formed from DMS and sulfate formed in coarse mode are excluded in the plots. Is this correct?

4. Strictly speaking, the presence of clouds affects MODIS retrievals of aerosols, but not the CAM5 simulations. Is cloud screening performed for CAM 5 analysis also?

Specific comments:

Line 135: please mention the exact version of CAM5 used in the study.

Line 142: I think it is called CEDS emission dataset in Hoesly et al. (2018), and the dataset is only available till 2014? Is this correct?

Line 149: By tagging SO2, the source regions of sulfate aerosols can also be tracked. Is this correct? If so, please mention it in the text.

Line 196 and Table 1: Are fc and fd derived from Figure 3 used for all 13 outflow regions? If I remember correctly, in Yu et al. (2009), different sets of fc and fd for different regions and seasons are derived. This is important since different aerosol characteristics in different regions and seasons.

Line 336 "simulated relative contributions by sulfate, POM, BC, and SOA to the total AOD". Should it be total AOD or ïĄţc only, because the authors are trying to compare

combustion AOD here. We know that, in MAM3/CAM5, SO2 can condense on accumulation mode and coarse mode and form sulfate at the same time. Are sulfate aerosols in coarse mode considered as one contributor of Tau c or Tau d?

Line 416: The spherical dust assumption may explain the large difference in spring since it is dust storm season in China. However, it can not explain the large difference in June and July, since the occurrence frequency of dust storm in these two months are not high.

Figure 10: It is well known that anthropogenic aerosol concentrations peaks in winter season in EAS region (or China), like in Zhang et al. (2012, https://doi.org/10.5194/acp-12-779-2012). And it is well known that CAM5 fails to reproduce observed seasonality of sulfate aerosols in China. Therefore, it surprises me to see that combustion AOD in NWP does not peak in winter. What are the reasons?

Figure 12. and Line 483: As shown in the figure, it appears to me that the interannual variability in CAM5 simulation is much smaller compared to observations. What is the reason? How comes the nudged simulation can not reproduce observed interannual variability?

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