Response to Referee #2 on acp-2022-96

Dear Authors,

Thank you for this exhaustive and well-described analysis of the factors governing uncertainty in simulation of atmospheric aerosols in regions affected by biomass burning. This is a problem of long-standing concern in the atmospheric composition community, and your study provides valuable information on the commonalities and differences of the atmospheric simulation models currently in use.

I have only minor recommendations for revisions. I encourage you to also attend closely to the revisions requested by the other reviewers.

Response

We sincerely thank the reviewer for the overall support on our work. All the recommendations have been carefully addressed during revision. Please find our point-to-point response below and highlighted changes in the revised manuscript.

Line 226 The Schutgens (2020) paper makes a number of interesting assertions about the potential effects of cloud contamination, but I do not see the suggestion there that southern hemisphere Africa during the burning season is subject to high cloud contamination. That is not consistent with other literature either. I would examine other explanations such as the extent of arid areas in southern Africa where satellite retrieval is more difficult.

Response

Thank you for the suggestion. The difference is now interpreted as the higher surface reflectance in these less forested regions.

Lines 224-225: "probably due to the higher surface reflectance (less forested) which made the retrievals more difficult and less accurate (Fraser and Kaufman, 1985)."

Ref

Fraser, R. S., and Kaufman, Y. J.: The relative importance of aerosol scattering and absorption in remote sensing. IEEE Trans. Geosci. Remote Sens., 5, 625-633, https://doi.org/10.1109/TGRS.1985.289380, 1985.

Line 377: "For the aerosol lifetime and MEC which were mainly affected by other model aspects than emissions, there was no significant difference found among the three fire regions for the same model." Are you saying that the models used each had uniform MEC among the three regions? Are you saying that the models did not have varying lifetimes for the three regions? Either of these findings is quite significant, as they represent model assumptions and outcomes that can be compared to observations.

Response

Thank you for the note. Here we would like to state that the ensemble median values for lifetime and MEC do not differ much among the three fire regions. In particular, the ensemble median MECs over the three regions were lower than observations, indicating that models need to be improved. The similarity seems to suggest that we could modify some basic assumptions to improve model performance, which is carried out in our following work (in preparation).

For individual models, we did see differences in MEC and lifetime per region which was small for most models. The following sentences were re-written to clarify our finding.

Lines 357-359: "For the aerosol lifetime and MEC which were mainly affected by other model aspects than emissions, we found the ensemble median values for these two factors were similar among the three fire regions."

Lines 518-520: "In spite of the large inter-model diversities, the model ensembles show very similar lifetime and MEC over different BB regions, suggesting that basic model assumptions underlie lifetime and MEC for the current model ensemble."

Line 118: "regarding to knowing issues for BBA models for more than ten years" I would update this sentence and expand to clarify that BBA has been acknowledged as a large source of uncertainty in atmospheric aerosol for a very long time (e.g. AeroCom phase II paper from 2013: https://acp.copernicus.org/articles/13/1853/2013/,

Response

Thank you for the suggestion. We have revised the sentence as follows.

Lines 116-118: "The aim of this work is to provide a satellite-based assessment of the state-of-the-art global models in representing BBA that has long been recognized as an important contributor to the overall aerosol uncertainties (Kanakidou et al., 2005; Myhre et al., 2013)."

Refs

Kanakidou, M., et al., Organic aerosol and global climate modelling: a review, Atmos. Chem. Phys., 5, 1053-1123, https://doi.org/10.5194/acp-5-1053-2005, 2005.

Myhre, G., et al., Radiative forcing of the direct aerosol effect from AeroCom Phase II simulations, Atmos. Chem. Phys., 13, 1853–1877, https://doi.org/10.5194/acp-13-1853-2013, 2013.

Line 135 "in multi" => "in multiple"

Response

Thank you. Revised accordingly. Please see line 133.

Line 191 "To avoid sampling issues" => "To mitigate sampling issues associated with varying coverage of the observational data sources"

Response

Thank you. Revised accordingly. Please see line 190.

Line 256: "impacts of different were" "impacts of verifying against different satellite data products were"

Response

Thank you. Revised accordingly. Please see lines 256-257.

Line 270: "for the whole research" => "for the whole analysis."

Response

Thank you. Revised accordingly. Please see line 271.

Line 421: "positive correlation" is this actually a positive correlation? Your figure shows a positive correlation between precip and deposition load.

Response

Thank you for the note. The correlation is between precipitation and the deposition timescale (i.e., deposition/load). We have added such an item to the text. Please see line 410.

Line 520: "thoroughly" choose a different word—perhaps you mean "uniformly?"

Response

Thank you. We revised the sentence as follows to make it clear:

Lines 513-515: "However, we showed that scaling up emissions was not a perfect solution to address model bias as the correlations did not improve significantly, suggesting that the spatial and/or temporal bias still existed."