

## Referee report regarding the manuscript: Aerosol absorption in global models from AeroCom Phase III

Authors: M. Sand et al.

### General comments

In my opinion this manuscript is not suitable for publication in Atmospheric Chemistry and Physics. I do not think it contains enough new and interesting material within the Aims & Scope of ACP. The area of aerosol absorption is certainly of interest for ACP, but the manuscript is mainly a model intercomparison of technical character, with no clear scientific conclusions or substantial new concepts, ideas, methods etc. regarding the subject of the paper.

It would be more suitable as a Technical report (or it would have been useful as Supplementary material to the large AeroCom III Model intercomparison already published in ACP; Gliß et al., 2021, <https://acp.copernicus.org/articles/21/87/2021/acp-21-87-2021.html>).

Since some of the material presented in the manuscript could be of some interest to other modellers it could perhaps have been acceptable in a more technical journal (possibly Geoscientific Model Development), if a much more substantial discussion of the results was added, but since it has already been published as a preprint in ACPD — and will thus remain permanently archived, citable, and publicly accessible — I do not think a submission to GMD would be worthwhile. The Preprint in ACPD can, in a sense, be considered an “extra Supplement” to the article by Gliß et al. (2021).

My suggestion is thus that the manuscript is not accepted for publication in ACP.

*Response: We thank the reviewer for reading the manuscript. We disagree with the reviewer that this should be a supplement to Gliß et al. (2021). The Gliß et al. (2021) paper concerns a general description of optical properties of the AeroCom models, while in this study we document the absorption in detail, and we look at different wavelengths and for different species. It is important to document this in a separate paper, and not as a supplement to an already large, published paper. We have rewritten the manuscript based on recommendations from the other reviewer, focusing on causes of the spread in absorption among the models. The manuscript in its current form is the result of a lot of work, analysis, and discussion among the modelers. We get the impression that the reviewer simply does not seem to see the point of model intercomparisons and feel that the feedback is less than constructive. We hope that the substantial changes we have done to the paper based on the other reviewer's comments, will make this manuscript within the scope of ACP.*

Since I do not think the manuscript is suitable for ACP I have not made a full in-depth review of all the details, but I noted a few minor things when reading it, and I list these below.

### Some specific comments

Page 2, line 60: Stier et al. 2017 — I guess this should be Stier et al. 2007

*Response: Yes, thanks, this has been changed.*

Page 3, line 69: Textor et al., 2006 — should be Textor et al., 2007?

*Response: Yes, thanks, this has been changed.*

Page 4, line 97: Randells et al. 2013 — missing in reference list?

*Response: we have removed the citation.*

Page 5, line 119: What do you mean by “dust (OA)”?

*Response: there should also have been a number 10 in bracelets, explaining that 10 models reported OA, while 11 models reported dust and BC. This has been changed.*

Page 6, Table 1 is essentially a copy of Table 2 in Gliß et al. (2021) — not necessary to duplicate here (a reference to Gliß et al. would be enough)

*Response: we think it is convenient to have the table in both papers, and because there are minor differences from Gliß et al. (2021). For instance GISS-MATRIX is not in Gliß et al. (2021). .*

Page 6, Table 1: References Bauer et al., 2008 and Bauer et al., 2020 are missing in the reference list

*Response: the two references has been added to the reference list.*

Page 10, Figure 3: The resolution of the subfigures is quite poor (at least on my screen)

*Response: we have made new figures.*

Page 10–11, Table 3: Half of the data in this table (BC MAC, BC Burden, BC lifetime, OA lifetime, Dust lifetime) were included already in Gliß et al. (2021) [Table 3]. Perhaps it is not necessary to include the same information here. However, some of the data clearly disagree with Gliß et al. (2021) and this needs an explanation:

*Response: We have removed Table 3 and made new figures focusing on burden, load, and refractive indices. We can refer to lifetime, if the same, in Gliß et al. (2021). The small differences are because there are slightly different model versions and some modelers have made additional runs, + for AAOD; we use all-sky only, while Jonas also use clear-sky for comparisons with observations. Jonas Gliß is a co-author of the study and we have closely compared numbers to avoid any errors.*

*We think it is better for the analysis to see the numbers for mass load (now included as bars in Fig 4,6 and 8), to better follow the discussion.*

Large difference for BC MAC for NorESM2; here 5.2 m<sup>2</sup> g<sup>-1</sup>, but 3.2 m<sup>2</sup> g<sup>-1</sup> in Gliß et al.

*Response: this was because we added the coating effect from BC, as we explained in the paper (we did report both numbers in the manuscript).*

BC MAC for OsloCTM3 is 12.4 m<sup>2</sup> g<sup>-1</sup> here, but 13.0 m<sup>2</sup> g<sup>-1</sup> in Gliß et al.

*Response: this was because OsloCTM3 did an additional run after a minor update.*

BC lifetime in EMEP is substantially different here (2.2 days) compared to in Table 3 of Gliß et al. (2.9 days)

*Response: An additional run with EMEP as well.*

BC lifetime in TM5 8.6 days, compared to 8.4 days in Gliß et al.

*Response: see comment above*

OA lifetime in GFDL 4.1 days, compared to 4.5 days in Gliß et al.

*Response: see comment above - GFDL has also made new runs.*

Page 20, line 264 — the Section header is “BC MAC values” but this section also includes MAC for OA and dust.

*Response: this is no longer its own chapter as we have rewritten the manuscript.*

Page 20, line 275: Reference (Yttri et al 2014) is missing in the reference list (and I suspect it should rather be Yttri et al?)

*Response: yes, this reference was only in the supplement, and has been added to the reference list with the correct name (Yttri).*

Page 20, line 275: Fig 8 — should be Fig 9

*Response: Yes, and the sentence has been removed (new figure).*

Pages 21–22 I found the discussion of “partial sensitivities” of AAOD to “variations in emission, lifetime, and MAC” confusing, and I do not see how it actually give any clear explanations of the AAOD differences between the models. A much more detailed discussion would be needed to understand this (I think). Also, I do not understand why Figure 10 is made as line plots? I think it just messes up the diagrams and make them less clear — perhaps bar diagrams would have been better?

*Response: We have made 3 new figures with bar diagrams illustrating MAC, load, density, and refractive index to better explain the model differences. We have also changed to text describing the figure to better describe the figure.*

Page 25, line 335: Fig. 10 — should be Fig. 13?

*Response: yes, and this have been changed.*

Page 25, lines 337–338: “Many of the AeroCom models have not updated their OA refractive indices to include BrC.” — Be more specific! Which models have, and which have not, included the BrC?

*Response: we have added more discussion on this related to the new Fig 6. We have also rewritten the sentence: ‘Most AeroCom models (except OsloCTM3 and GISS-OMA) have not updated their OA refractive indices to include BrC. BrC is mostly responsible for the spectral dependence.’*

Page 27, line 356: “and for the first time 11 (10) these models have reported” — What do you mean by (10)? Also, I guess there should be an “of” in the sentence (i.e. 11 of these models).

*Response: we have added this. We have removed ‘10’.*

Page 27, line 374: 8.6 m2 g-1 a [3.1-15.0] — remove a

*Response: this has been removed.*

Page 27, line 385: “BC lifetime (ranging from 4 to 9 days)” — I guess the range should be 2 to 9 days? According to Table 3 the BC lifetime in the EMEP model is only 2.2 days (but 2.9 days according to Table 3 in Gliß et al. 2021)

*Response: this has been changed.*

References (pages 29–36): In addition to the missing references mentioned above, a couple of references are not in the correct alphabetical order.

Supplement:

Figures S1, S3, S5 and S6 need to be larger or at least to be of better resolution.

*Response: we have removed the figures from the Supplement as they were redundant.*

Figure S2: The figure caption and legends lack information about the “fat” line and dots (measurements I assume).

*Response: we have removed the figure from the manuscript, but we kept the references in the supplement.*