Review of acpd-022-226 manuscript *'Modeling radiative and climatic effects of brown carbon aerosols with the ARPEGE-Climat global climate model'* by Drugé et al.

General Overview

This manuscript describes model-calculated aerosol extinction and absorption optical depth (AOD and AAOD) as well as single scattering albedo (SSA) by the ARPEGE-Climat global climate model. The authors give a detailed description of the modelled processes and parameterizations and evaluate their results by comparison to ground-based and satellite observations.

General Comments:

The weakest part of the presented work in the evaluation of their results using satellite observations. For this task they have used the POLDER-GRASP aerosol product as well as an OMI aerosol product.

The accuracy of POLDER-GRASP retrievals has been evaluated by comparisons to AERONET observations as documented in the provided references. As for the OMI aerosol product, the authors seem unaware of the availability of two quite different OMI aerosol products: OMAERO and OMAERUV.

For the OMI-OMAERO satellite product they have used, the authors do not provide any references on the evaluation of AOD and SSA with ground-based observations. Because of the large differences in retrieved aerosol parameters between the two satellite datasets (POLDER-GRASP and OMI-OMAERO), and between the model and OMI-OMAERO as reported in the different tables and figures, especially over the oceans, it is important to properly document the expected accuracy of the reference satellite data sets.

Without a literature-supported accuracy analysis of the OMI-OMAERO aerosol data, this satellite-product should not be used as a reference data set. This issue as well as the minor comments below should be addressed for the paper to be published.

Specific Comments:

Pg. 6

Line 29. Although OA's can be considered largely non-absorbing in the visible, they do absorb in the UV.

Pg. 7

Line 9. Add Andreae et al (2019) reference.

Pg. 9

Line 19. The availability of recently produced global representation of spectral aerosol absorption from the combined use of AERONET AOD and satellite radiances from OMI and MODIS observations (Kayetha et al., 2022) should be mentioned.

Line 24. What does 'most satisfactory results' mean?

Line 27. The source of the data shown in Table A1 should be clearly identified. An additional column indicating the source (i.e., reference) should be added.

Line 30. Provide references (or supporting reasoning) for the choice of rain and snow washout efficiencies as well as for BrC fractions content in cloud-mixtures. Please comment on the overall importance of these assumptions (i.e., sensitivity) on the study results.

Pg. 8

Line 2. Provide a literature reported quantitative estimate on *predominance of absorption by primary BrC from BB and BF emissions over that of the absorbing SOA*.

Line 20. The description of the OMI aerosol product is ambiguous. As described in the Torres et al (2007) reference, there are two different aerosol algorithms: OMAERO and OMAERUV. In this work, it looks like the authors refer to the OMAERO product.

Line 22. Remove the Ahmad et al (2003) and Jethva et al (2014) references. The Ahmad et al (2003) reference is a pre-launch publication irrelevant in the context of the work presented here. The Jethva et al (2014) reference addresses the evaluation of the OMAERUV aerosol product.

Line 24. Provide references for the quoted AAOD and SSA uncertainties (0.01 and 0.03) of the OMI-OMAERO aerosol product.

References

Remove Ahmad et al (2003) reference

Remove Jethva et al (2014) reference

References to add:

Andreae, M. O.: Emission of trace gases and aerosols from biomass burning – an updated assessment, Atmos. Chem. Phys., 19, 8523–8546, https://doi.org/10.5194/acp-19-8523-2019, 2019.

Kayetha, V., Torres, O., and Jethva, H.: Retrieval of UV–visible aerosol absorption using AERONET and OMI–MODIS synergy: spatial and temporal variability across major aerosol environments, Atmos. Meas. Tech., 15, 845–877, https://doi.org/10.5194/amt-15-845-2022, 2022.

Technical Corrections

Pg. 9

Line 3. Replace OMI with OMI-OMAERO

Line 21. Replace 'including or not' with 'with or without'

Line 23. Replace 'include two members' with 'two modelling configurations'

Pg. 12

Lines 27 and 32. Replace OMI with OMI-OMAERO

Pg.13

Lines 4, 8, 15, 17. Replace OMI with OMI-OMAERO

Pg. 16

Line 27. Replace OMI with OMI-OMAERO

Pg. 17

Line 32. Replace OMI with OMI-OMAERO

Pg. 29

Replace OMI with OMI-OMAERO in row 1 and caption of Table 2

Pg. 31

Replace OMI with OMI-OMAERO in column 1 row 7 and caption of Table 4

Pg 32

Replace OMI with OMI-OMAERO in column 7 row 1 and caption of Table 5

Pg. 37 to Pg. 44

Replace OMI with OMI-OMAERO in legends and captions of Figures 3 to 10

Appendix

Replace OMI with OMI-OMAERO in legends and captions of Figures A1 to A3