Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2021-409

Anonymous Referee #3

Referee comment on "Quantifying the structural uncertainty of the aerosol mixing state representation in a modal model" by Zhonghua Zheng et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-409-RC1, 2021

General comments:

The current work evaluated the several mixing state indices (χs) derived from a global modal model (CESM2/MAM4) by a global distribution of χs derived from the machine learning (ML) model based on the results of the mixing state resolving model PartMC/MOSAIC. The authors also compared their χs against those obtained from the field observation data. This is the first study to evaluate the spatial distribution of χs in models, which are currently used for the climate predictions. Let me congratulate the authors to achieve this. The manuscript will be acceptable after the authors address the following couple of minor comments, general and specific ones.

- The differences of χs between CESM2/MAM4 and PartMC/MOSAIC-ML should originate from different aerosol representations and different rates in aerosol dynamical processes such as rates of secondary aerosol formations, condensation/evaporation, and coagulation. However, the authors only addressed the former, the difference in aerosol representations. Is it because the latter (difference in aerosol dynamics processes) is negligibly small with compared to the former (difference in aerosol representations)? If so, please describe how the authors quantified or estimated them. Are the condensation/coagulation rates or size distributions of aerosols of the two models similar with each other?
- How the existence of coarse mode particles in CESM2/MAM4 can make the global χs distributions different from those of PartMC/MOSAIC-ML which does not consider the existence of coarse mode particles? A part of secondary gases condenses to coarse mode particles such as mineral/anthropogenic dust and sea salt, and thus neglection of coarse mode particles can cause overestimation of condensational growth of fine mode particles. Is this effect negligibly small in the current assessment?

Specific comments:

- Uppercase letters are used for the abbreviations of aerosol species in Sects. 2 and 3, such as SOA, POM, and BC, while lowercase letters (pom, dst, ncl, soa, and so4) are used in the panels. Any reasons? “soa” in panels and tables are different in definitions from SOA in the main text?
- Figure 1 is not referred in the main text.