

Interactive comment on “Aerosol water parameterization: long-term evaluation and importance” by Swen Metzger et al.

Anonymous Referee #2

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Metzger et al. present global model simulations of AOD that account for the uptake of particulate water due to inorganic aerosol using EQSAM4clim as well as other methods such as ISORROPIA II and a previous study. The conclusions outlined in the abstract (consistency with ISORROPIA, Pozzer et al. (2015) and this work as well as sensitivity of aerosol water to RH near 100%) seem supported by the figures. However, the manuscript would benefit from clarifying what is meant by “aging” and providing more information on EQSAM4clim.

Major comments:

1. The aging vs no aging cases were not completely clear and largely read as a sensitivity of hysteresis. Is it correct that “aging” is really a hysteresis assumption with increasing deliquescence as a function of age? With age, couldn't particles have

deliquesced or effloresced in their history? How is table 2 to be read in terms of bulk compound and reagent? Is OC assumed to coat ammonium sulfate and bisulfate or vice versa?

2. More documentation on EQSAM4clim (briefly presented) would help the reader. For example, Page 7, line 6 references equation A3 of Metzger et al. 2016b. Can that equation be reproduced here since there is no equation in main text for water uptake coefficient? How does the approach here compare to using kappa hygroscopicity parameters instead (Petters and Kreidinweis 2007 ACP <https://www.atmos-chem-phys.net/7/1961/2007/acp-7-1961-2007.html>)?

3. Clarification in terms of inorganic aerosol components is needed. How is the elemental speciation of dust and seasalt and other bulk species determined? The speciation is discussed in section 2.4 and Table 2 is referenced, but table 2 isn't a direct mapping of bulk to species. Is Table 2 implying dust is $\text{Ca}(\text{Cl})_2$ and $\text{Ca}(\text{NO}_3)_2$ while sea salt is NaCl ? Is the composition of bulk dust and seasalt tracked in the model or prescribed? Can nitrate replace chloride in sea salt in the model?

Minor comments:

1. Abstract line 10: Why is it important to reproduce Pozzer et al. 2015? Indicate the domain, evaluation data, or some other characteristic that is being reproduced. Perhaps state something along the lines of "...our EMAC results of aerosol optical depth (AOD) are comparable to independent results obtained for [insert description of domain, time period, or identifier that characterizes usefulness of Pozzer et al. 2015] (Pozzer et al., 2015)..."

2. A few references did not display properly in text (for example: page 4 line 13 should have (Ganzeveld et al., 2006) instead of Ganzeveld et al. (2006); Page 4 line 20 uses "poz")

3. Page 3, line 27 "We conclude with section 5" is not necessary.

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4. Page 5, near line 28: What are the default cutoffs for minimum and maximum RH for simulations other than the sensitivities exploring cutoff?
5. Can you assess the potential limitations associated with the lack of water uptake on organic aerosol, the effects of organic aerosol on inorganic partitioning and resulting water uptake, and water uptake and resulting AOD? For example, if organics could increase aerosol water by 40%, what would that mean for AOD?
6. Page 8, line 30-31: An evaluation of aerosol composition and neutralization first could have informed some of the comparisons here. I suspect that the AOD will be less sensitive to model assumptions (e.g. ISORROPIA vs EQSAM4clim) than inorganic aerosol composition will be.
7. Page 8, line 29: Were any observations (AERONET?) hourly? Were those observations averaged to the same 5-hour timescale as the model for comparison or were hourly observations only matched with the model when the observation fell exactly in the middle of the 5-hour model prediction?
8. Page 10, section 3.2 introduces 6 figures in less than 1 page without much guidance for the reader in terms of what to take away. Consider summarizing the message from each figure in section 3.2 as the figure is introduced or moving figures that repeat the same message to the SI.
9. Appendix C: I encourage the authors to consider a version controlled (repository) method of code distribution.
10. Figure 1: could be moved to the SI. Is a reference for the figure needed?
11. Figure 9: Consider a scatter density plot or just a table for this information.
12. Can any lessons be learned where all methods fail to capture AOD (e.g. Figure 12 eastern US, Figure 13 Beijing)?

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