Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-1016-RC1, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Seasonal characteristics of emission, distribution and radiative effect of marine organic aerosols over the western Pacific Ocean: an analysis combining observations with regional modeling" *by* Jiawei Li et al.

Anonymous Referee #1

Received and published: 6 December 2020

In "Seasonal characteristics of emission, distribution and radiative effect of marine organic aerosols over the western Pacific Ocean: an analysis combining observations with regional modeling," Li et al. examined both primary (MPOA) and secondary (MSOA) marine organic aerosol in the western North Pacific Ocean using a regional chemistry/aerosol-climate model. Model simulated aerosol concentrations were validated against observations. Key MOA source regions and their seasonality in the western North Pacific were identified. MPOA was found to be much more important than MSOA, and significant indirect radiative effect was found.

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Discussion paper

The study is thorough and covers interesting findings. However, the presentation is overtly lengthy and should be condensed. Clarification on a few key details of the analysis should also be addressed, particularly as the lack of these pieces of information prevents interpretation of the results. I have trouble understanding how the direct and indirect radiative effects were calculated in this study. Detailed comments are provided below.

Major comments:

1. The paper would benefit from significant summarising and focusing. It may be better to summarise the model description (Sec. 2.1) in more concise terms (e.g. a summary list of all the processes included, and for the key processes, a sentence or so explaining how they are considered) and move the more detailed descriptions to the supplement. The same can also be said for the model validation (Sec. 3). While these are thoroughly done and should be documented, the shear length of the material in their entirety distracts from the storyline of the paper. Replacing with a concise summary in the main text and moving the details of the validation (with the many figures and tables) to the supplement would be helpful.

2. Section 2.3.1: please add how the emitted number is determined alongside emitted mass. The discussion on size distribution between lines 263-272 may fit better here, but additional information should also be given with regards to how these fit in the size bins.

3. L773-775: one cannot make an estimation of the East Asian contribution based on a mixture of regional and global model results, especially since just above, it's noted that the regional model produced higher emission rates than global models for the same region. Note also in the abstract (L30) and conclusion (L1080).

4. L801-803: as noted above, the potential difference due to different model and study time frame may be too large to draw any such conclusion about the ratio to global emission, even approximated. Was Arnold et al.'s West Pacific average similar to re-

sults from the current study?

5. L933-934: how much do the noMOE and FULL simulations differ aside from the added MOA? In terms of properties relevant to DRE: are there differences in the wet and dry deposition that impacted other aerosol species? If yes, how much do these account for the diagnosed DRE? Given that DRE is stated to be calculated under all-sky conditions, does this mean potential differences in cloud cover due to rain suppression by MOA could also play a role? Please specify exactly which variables are used for calculating the DRE_MOA (L933-934), beyond stating that it's a subtraction of the two simulations. Related to this, how was all-aerosol DRE calculated (Table 10)?

6. L977: how is IRE_MOA calculated? Also, the MSOA (L1044), sea salt and all aerosol (L1033-1043 and Table 10) IRE? I have trouble seeing how these can be properly determined from the same two simulations. Please specify the exact variables/equation/diagnostic procedure. Which processes and indirect radiative effects are captured by this definition?

7. Does cloud fraction differ between the two simulations due to rain suppression? Assuming that this is included in the calculated IRE_MOA, what proportion of IRE_MOA is related to changes in cloud microphysical properties (e.g. CDNC/Nc) and how much to changes in macroscopic properties (e.g. cloud cover, precipitation)? Could any of the changes in macroscopic properties be resulting from dynamical feedback? More information would be needed to properly interpret the high IRE_MOA despite relatively low MOA concentration (for instance, compared to sea salt) and to compare to other studies.

8. Given our limited understanding of many of MOA's properties, what's the (potential) sensitivity of the results to assumptions made in the model setup?

More minor comments:

9. A suggestion for consideration, since from my understanding, ACP does not limit

the abstract length: the abstract as it stands right now reads more like a conclusion/summary. Could it be pared down more? (for instance, what are the three key findings of this study?)

10. The title states "...an analysis combining observations with regional modeling," but as I understand it, the observations were not used to bias correct or calibrate the model in any way. In this sense the observations were used purely for model validation, and as such this wording is perhaps misleading (there's no "combining" involved). Instead, perhaps something more along the lines of "model validation and regional modeling" would be more accurate, if the authors decide to retain a focus on the model validation part.

11. L145-147: "supposed to" is not a good word choice here. If one wants to express uncertainty, "may" could be a good replacement. Reference(s) for this claim should also be added.

12. L166-168: the internally mixed anthropogenic aerosol is assumed to have a fixed distribution that does not change shape following activation and sedimentation? If yes, has there been studies justifying this choice? I wonder if the anthropogenic aerosol may be represented by size bins, as is done for the natural aerosols. If yes, please clarify.

13. L168: "Natural aerosols (mineral dust and sea salt)" and MPOA? Also, in general, how do MPOA and MSOA fit in these model descriptions? E.g. on L175: what's the hygroscopicity of MPOA and MSOA? The same as POA and SOA?

14. L210: OMss is the organic mass fraction of sea spray aerosol, not sea salt.

15. L220-221: please add reference for the OM/OC ratio

16. L262: please add reference/justification of choice for the MSOA soluble mass fraction

17. L282-283: perhaps I'm missing something, but if aerosol activation/Nc is al-

ready calculated based on the Abdul-Razzak and Ghan scheme, why is “the number of aerosols activated assumed to be equal to the number of aerosols scavenged in cloud”?

18. L359: Pearson correlation coefficient? Please be specific.

19. L718-719 and Figure 7: how does the sea salt emission look like? Perhaps add a column in figure 7 for sea salt emission (since EM_POA= $\alpha \times$Ess$\times$OMss)?

20. L756-759: please clarify if this is a speculation or confirmed by analysis. It’s difficult to tell by the wording.

21. L777: “annual mean” as in "ng m-2 s-1" averaged over the area and over the whole year? Or “annual emission” in "Tg y-1"?

22. L788-790: what is the relevance of this sentence in the context of the current study? Does this then imply that it is reasonable to compare simulation to observation from a different year for order of magnitude check?

23. Figures 4 and 5: do the standard deviations represent variability of the monthly/seasonal mean across multiple years or also the variability within each month/season?

24. Figure 9: “mean monthly” (cm month-1; total monthly precipitation averaged over multiple months) instead of “monthly mean” (mm h-1; average precipitation rate over each month). Note both in figure title and caption.

25. Table 9: “cm grid-1 month-1”: do the authors mean cm month-1?

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