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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Can Semi-Volatile Organic Aerosols Lead to Less Cloud Particles?" *by* Chloe Y. Gao et al.

Anonymous Referee #2

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In this paper the authors discuss results from a box-model sensitivity study comparing changes in parameterized cloud droplet numbers to a representation of semi-volatile organic partitioning.

Before consideration for publication, there are a number of issues that need addressing that are raised below.

Having read the original paper on the MATRIX-VBS model, I couldn't tell whether, since you are prescribing aqueous solubility, water is explicitly included in the organic partitioning simulations? If not, there is an inconsistency between prescribing a 'kappa' value [which will not stay constant unless 100% solubility is assumed] and assuming completely 'dry' partitioning unless all organics are thus actually assumed to have zero aqueous solubility. If so, please describe how you have accounted for varying solubility,

and presumably molecular weight, in the new partitioning simulations.

With varying solubility per bin, how would you then account for the influence of one VBS bin on the other in-line with mixing thermodynamics?

If you do include water in the partitioning simulations, how might you account for this in equilibrium partitioning at 100%RH?

How does the fixed linear change with solubility map to the VBS source VOCs used in a host model? For example, the use of experimentally determined RH variation in Kappa from isoprene and monoterpene SOA experiments has been shown to have significant impacts on two state-of-the-art climate model forcing estimates [Microphysical explanation of the RH dependent water affinity of biogenic organic aerosol and its importance for climate N. Rastak et al. https://doi.org/10.1002/2017GL073056]

It would seem the crux of the conclusions rests on the above process description and how the ARG parameterization takes that information to predict cloud droplet number. ARG would not capture partitioning through the humidity life-cycle, so please elaborate on the link between partitioning within the VBS model at any given RH to feeding parameters into ARG.

The title is certainly a question worth asking. However I wonder whether results from a model sensitivity study that, whilst interesting, rests on a framework that does not apparently capture process level phenomena which would influence results can be used to deliver an answer. Starting with responses to the questions above, I would suggest the following statement requires re-phrasing: 'We expect that implementing the improved box model in the global scale that includes a two moment cloud microphysical scheme (Morrison and Gettelman, 2008; Gettelman and Morrison, 2015) would more accurately represent aerosol-cloud interactions, which will be our focus on a follow up study. Thus it would offer us valuable insights on how the addition of organic partitioning would change cloud activation in the global atmosphere and its implications for climate.' There is no indication that process representation within this study

has improved on any previous. Conflicting implications on process combinations restrict this evaluation. To more accurately represent aerosol- cloud interactions through an attempt to account for organic solubility and volatility, more detail is needed before publication. The alternative, of course, is to not present this as an improved representation but deliver it as an existing model sensitivity study which might be better suited to publication in Geoscientific Model Development.

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