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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cloud-resolving simulations of mercury scavenging and deposition in thunderstorms" *by* U. S. Nair et al.

Anonymous Referee #3

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This paper uses thunderstorm simulations, varying properties of thunderstorms consistent with the Southeast and Northeast U.S., in an attempt to explain the differences in Hg deposition between the regions. The model analyses are useful, explained thoroughly, and well-planned. However, the paper is essentially a model parameter space exploration for soluble tracer scavenging, and the conclusions are phrased such that they apply to the real world. Thus the authors seem to be overreaching in the conclusions and general applicability of this study.

In general, without comparison to data (and with no published paper on data to compare to numerically) it is unclear why this study should be about mercury at all. It is essentially asking how a soluble tracer is scavenged due to thunderstorm properties in simulations. This sort of model parameter exploration is useful, but it is a bit dangerous

to apply this to a specific tracer and deposition scenario without thorough data analysis. I would suggest that the authors reframe the paper to make clear exactly what they can do, paying attention to previous work on tracer scavenging (e.g. nitric acid) which might help to validate revised conclusions that are circumscribed to apply only to model behavior and not specifically to mercury in the environment.

Specific comments follow:

Holmes et al. 2010b: this citation is to a conference presentation. It suggests that there is data to support this contention, which has not yet been published as a peer-reviewed paper. Given the authors this paper overlap, why have some of this data not been included?

Issue of concentrations versus deposition.

p 3578: the actions of thunderstorms on other trace species scavenging could be better summarized. How does solubility play a role? Which species might be similar to mercury, and why? How well do these models reproduce data? Given this, why is the application to mercury novel (i.e. in a model, mercury is going to act just like any other species of similar solubility. . .right?)

p 3579: "meteorological controls on cloud dynamics and microphysics likely explain part of the regional enhancement of mercury deposition in the Southeast". This is an ambitious conclusion and I don't think it is supported in this paper.

Section 2.1: A figure might be helpful to explain the different processes of mixing in thunderstorms. I suspect many of the readers of this paper would be mercury and not thunderstorm experts, and this discussion is a bit dense and hard to follow.

p 3580: Have any previous studies looked at scavenging using these parameter spaces? Again, mercury in model-world is not particularly unique. Does or should this apply to other deposited species?

p 3581: If nitric acid was previously simulated, and mercury is exactly the same, what

else do we know about nitric acid? One could argue then that if nitric acid were previously evaluated, we know exactly what the Hg behaviour will be.

p 3582: If RAMS only reproduces half the observed variability, and only where RAMS simulates precipitation amounts, then what impact does this have on results? Does this mean that RAMS is getting the GOM concentrations wrong, or the fraction of GOM scavenged? The latter seems to be a bigger potential problem in interpreting these results.

p 3582 line 20-25: It would be useful here to cite the uncertainties in GOM measurements (Gustin et al., ES&T 2012) and discuss what influence an underestimate of GOM surface concentrations might have on results.

p 3583: GOM/HgP – some more discussion about how the processes of GOM and HgP scavenging would be expected to differ would be helpful, here or in the methods section above. Also, what are the timescales are for GOM/HgP conversion and how would they compare to the timescales in the thunderstorm simulations?

p 3584: the nomenclature tutorial is potentially useful, but I would suggest that the authors find a way to simplify the discussion so that the reader doesn't necessarily have to remember this throughout.

p 3586 line 6: is "PW" meant here?

p 3587 line 12-15: the idea that thunderstorms can mix the high-altitude reservoir of mercury downwards and make it more susceptible to scavenging later is an interesting hypothesis that is easily testable by measurements. What evidence might exist to support it? There are studies of event-based precipitation for mercury, and it might be useful to look into the record of published studies to see if there is any suggestion of this effect in data that has previously been overlooked.

Figure 9: this doesn't really look statistically significant. What tests were done to ensure this? What is the quantitative comparison?

p 3590 line 14-15: "This study shows that meteorological conditions in the Southeast US favor more frequent thunderstorms than in the Northeast" – this surely has been discussed before in the literature, and can't be new.

Line 18-24: again, this is not a published paper. Here, we have no quantitative information to support this finding. The key to this is "large part" – I don't see evidence for this in Fig 9.

Conclusions: the language in the three main conclusions make it seem like the conclusions apply to the real world rather than model-world, which they don't. I'd suggest rephrasing.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 3575, 2013.