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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The magnitude and causes of uncertainty in global model simulations of cloud condensation nuclei" *by* L. A. Lee et al.

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Many thanks for reviewing our paper and providing constructive comments. As a result changes have been made to the paper as detailed below. Please find your comments in bold with a response in normal text. The additions to the paper are in italics.

As GLOMAP is run within a chemical transport model, does the prescribed model meteorology make it less sensitive to certain processes that would cause larger uncertainties in models that calculate their own meteorology?
We cannot answer this question for sure because we would need to repeat the runs using a coupled GCM, which is beyond the scope of this study. In a model in which the aerosols are coupled to meteorology, some parameters could have a different sensitiv-

ity if the changes in aerosol caused significant changes in meteorology which then fed back on the aerosol. To first order, the aerosols are driven by meteorology rather than the converse (i.e., weather models mostly get away with neglecting aerosols). One potentially important coupling is with clouds and precipitation. If changes in aerosol caused changes in precipitation, then this would affect the CCN we have calculated here, and hence the sensitivities. This will be an important issue for future research.

Is it relevant if the dynamical responses are complex or not when studying how the variance in an aerosol process translates to variance in CCN?
The complicating effects here refer to the complications dynamics would introduce to the statistical methods. To isolate how the aerosol parameters are affecting the CCN variance we have to ensure that all other dynamical processes remain fixed in all 168 runs. In our current study we can say that the CCN variance we have calculated is purely due to the uncertainty in the parameters we have studied and then we can decompose this variance into the precise sources. If we allowed other things to develop dynamically independently in the model in the 168 runs, we would no longer be able to decompose this variance into the original sources since we will have an extra source of variability. We could trace the dynamically evolving features and add these into the statistical analyses but that is beyond the scope of this study - it will be a topic of a future study.
Added to P6310, Line 6: If meteorology developed dynamically independently in the model, we would not be able to decompose the variance into the original sources due to the extra source of variability. The dynamically evolving features could be added to the statistical analyses but that is beyond the scope of this study.

Does emitting primary aerosol into the lowest model layer cause dry deposition to be the highest uncertainty? Models with vertical profiles for emissions would be less sensitive.

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We have now clarified in the text the model levels at which primary aerosol are emitted. We have not perturbed the levels at which the primary aerosol are emitted and the emission of primary aerosol at specified levels rather than using a vertical profile is a structural uncertainty. This study is carried out at cloud base (915hPa) rather than the surface layer and aerosol are emitted at various model levels thus the importance of dry deposition is not an artefact of emitting primary aerosol into the lowest model level. It would certainly be interesting to test the sensitivity to dry deposition in a model using a different vertical profile for primary emissions but this is beyond the scope of this study. This structural uncertainty in models might be the cause of some of the model diversity shown in intercomparison studies. We think this is one way in which a study of this nature complements the intercomparison studies.
Added to Page 6310, Line 16: Aerosols and precursor gases in GLOMAP are emitted over a few model levels: SO2 emissions from industry/power plants are emitted between 100-300m, volcanic SO2 and biomass burning SO2, BC and OC are emitted over a range of altitudes depending on the location.

Page 6301 – first mention of GLOMAP, it would be good to first introduce what kind of model it is.
We have swapped Sections 2 and 3 so that GLOMAP is discussed first.

Page 6319 – Notation 'x0.5/2.0' difficult to understand.
We have changed the text on Page 6319 to remove the notation.
We conflate uncertainties in these two factors by varying the calculated sea-air transfer flux by a given factor.

The description of anthropogenic SOA is difficult to understand.
The SOA production here is detailed further in Spracklen et al. (2011b).

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Goldstein and Galbally (2007) estimate upper limit of SOA of 910TgCa-1 – why did this study use 520Tga-1?
We used an upper limit of 360 Tg based on Spracklen et al. (2011b). This upper estimate is based on an attempt to constrain global Aerosol Mass Spectrometer organic aerosol measurements. Spracklen used the same model. If we used a higher upper limit, we would definitely be assuming that global organic aerosol mass could exceed the AMS measurements.

Which AEROCOM intercomparisons are referred to?
We have added a reference to the AEROCOM intercomparison study mentioned here: Mann et al. (in prep). *The effect of structural changes in the host global transport model have not been assessed here, but AEROCOM intercomparisons suggest the variance could be large, Mann et al. (in prep).*

Text in Figured 3,8,9, and 11 is difficult to read. We will aim to improve this in the final manuscript.

What is the added value of Figure 11? Part of this study has been to find ways in which to present the results and the two different representations in Figure 8 and Figure 11 show two of the ways we have explored. Both Figure 8 and Figure 11 highlight the different ways to visualise these types of results and so we believe they both have a place in the paper.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 6295, 2013.