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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Mapping the uncertainty in global CCN using emulation" *by* L. A. Lee et al.

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The authors would like to thank the referee for reviewing our manuscript. Please find responses to the review below where the original comment is in bold and the response in normal font.

One key thing to note is that the knowledge gained from such an uncertainty analysis is of course entirely dependent on the model to which it is applied. In that regards it seems to me that multi-model intercomparisons are still valuable. We think it is a strong overstatement to say that the knowledge gained through this technique is entirely model dependent. Single models are often used to gain general knowledge about the processes they are trying to represent, so with 168 model runs this method can be used to gain knowledge about the processes being represented in GLOMAP. We agree that multi-model ensembles are still valuable but the uncertainty

represented by the two methods is different. The method here aims to identify the effects of parameter uncertainties whilst multi-model ensembles aim to identify the effect of structural uncertainties (but often with some undefined parametric uncertainty included). The sensitivity analysis here together with multi-model ensembles will provide valuable information on which processes in different models are driving global CCN and its uncertainty.

A discussion on emulator uncertainty would be helpful.
A new section has been added to the text regarding emulator validation which now includes some discussion of emulator uncertainty and its effect on the sensitivity analysis along with a new figure 1.

Do the authors have an idea as to how many parameters this technique would handle to assess sensitivity to?
The number of parameters the technique can handle is dependent on the ability to invert the covariance matrix in a reasonable time and the time taken to carry out the sensitivity analysis. It is therefore limited mainly by computational time constraints. We demonstrate the technique in our next study with 28 parameters. We assume the standard model approach here refers to running GLOMAP. GLOMAP is a well-established model so the parameters are well defined in the model. In the next study we identified 37 parameters to study from an initial set of about 50 and chose 28 to study in more detail (this process will be explained more when we write up our next study). From this further study we can see whether the parameters in GLOMAP represent enough processes to explain observations or whether further complexity needs to be added to the model – a key use for this technique. If more parameters are added to the study then more training runs will be required (in fact a new experimental design and new runs will be needed) but only if the output responds to this parameter. It is important at the outset to choose the relevant parameters for study to make sure the model runs are appropriate.

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typo 'Lee11' Lee11 refers to Lee et, al. (2011) introduced on Page 14092, Line 7. Lee et, al. (2011) was our first paper in which the maths of this method was introduced with the illustration of two grid boxes.

Further technical changes have been made in response to minor comments.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 14089, 2012.