Atmos. Chem. Phys. Discuss., 11, C9583–C9586, 2011
www.atmos-chem-phys-discuss.net/11/C9583/2011/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Emulation of a complex global aerosol model to quantify sensitivity to uncertain parameters" *by* L. A. Lee et al.

L. A. Lee et al.

l.a.collins@leeds.ac.uk

Received and published: 30 September 2011

The authors would like to thank the referee for reading our manuscript and providing comments. The authors' replies are below where the comment is in italics.

The paper reports a most recent approach among the efforts to quantify the uncertainty of global aerosol models started since Pan et al. (1995). Science wise, the paper does not provide much useful information, mostly due to the limited scale of the analysis, especially when comparing with previous works. Methodology wise, it proposes a method of potential to address uncertainty issues of global aerosol models and other types of model inexpensively. It should be informative to particularly global aerosol modeling community, because such approach is still an unfamiliar topic to many. It would be a good report in a statistical journal. To publish in ACP, the current paper reads much as

a report for a proof-of-concept attempt, the authors would have to address further in science aspects.

The analysis in this paper has been purposely kept simple in order to provide motivating examples to highlight the application of the statistical method and its benefit over more commonly applied sensitivity methods to both global aerosol modellers and other modelling groups. The decision to publish in ACP is a deliberate attempt to share the latest technology emerging from the statistical community with the modelling community. We will be using the method applied in this paper to carry out a more comprehensive sensitivity study of our global aerosol model now that we are confident in its applicability.

1. It is difficult to understand why the authors did not include the impaction scavenging of aerosols in their uncertain parameter list. Such scavenging is the single most important factor to determine the lifetime of aerosols in the atmosphere. Global aerosol models usually adopt arbitrary "coefficient" to describe this aerosol sink as a function of precipitation rate. The effect of this uncertainty on modeling aerosol would be amplified by the uncertainty in precipitation predicted by global climate models or derived from reanalysis data.

For this paper the parameters to be varied were not formally elicited but were taken from the Spracklen et al (2005) sensitivity study so that we could test the applicability of the statistical methods before embarking on a much larger sensitivity study; this was deemed necessary due to the novel aspect of our work. We believe that the study here shows that the statistical methods are well suited to carrying out a more detailed sensitivity study of a global aerosol model that is currently underway. The parameters for the more detailed study have been formally elicited and the documentation describing why parameters are included whilst others may not will be available with supporting evidence.

2. From the viewpoint of physical chemistry or aerosol-cloud microphysics, the oxida-

ACPD

11, C9583–C9586, 2011

tion activation diameter (X1) and the cloud nucleation-scavenging diameter (X6) are actually the same parameter based on their descriptions in the paper. The authors mentioned that they have noticed this but rather to still treat them separately because they are different parameters in the model. This appears at least a bad choice in selecting uncertain parameters. It is getting worse when the authors actually provided different scale ranges for them. Note that the method used in the effort sets a Gaussian distribution to each of the uncertain parameters. The practice is therefore equivalent to assigning two different distributions for the same parameter, not mentioning that the lower bound of X1 is much too small (4 nm) based on observations. The range of X6 seems just a simple doubling of that of X1 (or vise versa).

These two parameters are related, but not identical. The oxidation activation diameter corresponds to the CCN activation diameter. Once aerosol particles are activated it is not necessarily the case that all droplets are removed with equal efficiency. In warm clouds the removal is skewed towards larger drops (and hence larger activated aerosol) because of the size dependence of collision-coalescence. Thus, the nucleation-scavenging diameter may be larger than the activation diameter. The parameters are shown in the analysis to affect the CCN concentration in different ways; for example, when we look at CCN concentration through the vertical profile. The uncertain distribution attached to each of the parameters is the uniform distribution (not Gaussian) with the ranges given in Section 3.2.2. We note that the lower limit of dry-equivalent activation diameter is 40 nm, not 4 nm.

3. A two-month spin up to derive the initial field for the global aerosol model seems too short. Initial state of this spin up was not provided so it is difficult to judge whether some of the odd model behaviors were attributed to the inadequate spin up. Also, a single month analysis does not tell too much into the science issues that should be addressed in order to provide useful information to the rest of the community. In addition, would a backward comparison with the previous OAT approach be useful to show the difference between the two methods?

ACPD

11, C9583–C9586, 2011

The spin-up to derive the initial field (starting from zero aerosol) is 5 months long which we have previously shown to be adequate for a steady state global aerosol distribution. This 5 months comprises a 3 month spin-up using the baseline values of the parameters and a further 2 months with the parameter perturbation.

The backward comparison has not been carried out since there are known differences between the two versions of the global aerosol model used in the two studies as discussed in Section 3.1. We have highlighted the technical improvements our method has over the previous OAT approach in terms of quantifying the interaction effects and the ability to test the robustness of the underlying assumptions regarding the input distributions and statistical model without the need to run the global aerosol model again. Also, Figures 7 and 10 show the fraction of the total uncertainty that can be attributed to a non-interacting parameter, which is what one would compute for a one-at-a-time perturbation.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 20433, 2011.