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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.

Anonymous Referee #1

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Our current skill in modeling atmospheric evolution of aerosols is still very low. A major reason for this is the model uncertainty due to various approximations in formulating aerosol processes and also crude estimation of source and sink strengths. This paper reports an effort to quantify selected uncertain parameters of a global aerosol model. For this purpose, the authors first derived a Gaussian emulator for the global aerosol model. They then used this emulator combining a Latin Hypercube sampling method to analyze the uncertainty in modeling cloud condensation nuclei concentration over two selected areas attributed to a group of 8 uncertain parameters. The analysis is only on a selected month (June). This significantly reduced the required computations but somehow limited the scope of the analysis. Certain conclusions have been drawn from this effort, including the dependence of investigated uncertainty on location (polluted vs. clean) and altitude.

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.

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.

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

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?

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