

Interactive comment on “Improvement and further development in CESM/CAM5: gas-phase chemistry and inorganic aerosol treatments” by J. He and Y. Zhang

Anonymous Referee #2

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This paper discusses a collection of improvements relevant to the representation of aerosols in CESM/CAM5. The present paper represents a large collection of efforts and as such is an important contribution to the model development. However, the use of CESM in a fully coupled climate mode, while allowing for full climate feedbacks, also makes the comparison of very short simulations meaningless. The main reason is that two simulations that are slightly different (whether from initial conditions or slightly different forcings/emissions/chemistry) will generate meteorologies that are significantly different, but this only represents the inherent noise of the climate system. In the configuration used in this study, simulations of at least 20 years (and probably quite longer

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since some of those changes are relatively minor) would be necessary to start seeing differences that are above the natural variability of the system. As written, the paper cannot be considered for publication. I therefore suggest that the authors focus on the chemistry aspect of the study, and perform short simulations in which the meteorology is not affected by the changes in chemistry, or simulations with fixed SSTs (which would probably need to be on the order of 5-10 years). The length of the simulation should be defined such that the response in the system is above the natural variability of the reference case. Since I find that the paper will have to go over major revisions, I have only included a few additional comments.

Other comments

1. The paper would benefit from the addition of simple diagnostics such as global budgets and lifetimes
2. Section 2.2.2: it seems that a major limitation in the evaluation of various methods is the unavailability of observations. Please comment.
3. Section 2.2.4, line 23: where does the HCl come from?
4. Page 27728, line 24: Please add table with emissions
5. Section 4: tables 3 and 4 contain too much information. It would really help to provide this information in an easier format, maybe through bar graphs.
6. Page 27731, line 5: what is the role of optical properties and water uptake on AOD biases?
7. Page 27735, lines 29-30: what are the % with respect to?

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