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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Quantification of sulfur deposition changes under sulfate geoengineering conditions" *by* Daniele Visioni et al.

Anonymous Referee #2

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This is an interesting new investigation into the response of global sulfur deposition to a sulfate geoengineering scenario. Three central questions are addressed: the net global and regional response of sulfur deposition rates to a specific sulfate geoengineering scenario; the quantitative and mechanistic differences between two models (with and without dynamic feedbacks) in their calculated responses; and the role of the quasi-biennial oscillation (QBO) in understanding the response. Feedbacks via modification of the QBO are not investigated. The authors conclude that, although the models are in agreement regarding background sulfur deposition, significant inter-model differences exist between the deposition patterns predicted for a 4 TgS/yr geoengineering scenario. However, the effect of the QBO is broadly consistent between the two models. During the QBO W phase (E shear), longer lifetimes are observed for the injected

aerosols, but the overall AOD achieved is maximized during the E phase (W shear).

The central questions of this paper are mixed in terms of the level of interest, but the methods used are appropriate. The data produced by the paper fully support the conclusions, which have been appropriately caveated to take into account the limited scope. I particularly appreciate the fact that the paper is trying to isolate the effect of the QBO on sulfate geoengineering in the absence of feedbacks, which provides insight which might be lost or obscured in a model with a fully interactive QBO. However, the paper is misrepresented by its title. It promises only a re-run of the work by Kravitz et al (2009), which already quantified sulfur deposition under a geoengineering scenario almost identical to that presented here. This is a shame, because the authors present a detailed and interesting investigation of the mechanisms by which sulfate geoengineering might increase sulfur deposition rates, with a deep dive into the role that might be played by the QBO which I find to be deep and insightful. I would strongly advise that the authors consider a new title which highlights their work on mechanisms, model intercomparison, and the role of the QBO. Such an intercomparison should include a thorough analysis of the differences and similarities between the results from this study and those from Kravitz et al's original analysis. The paper should also be restructured to bring their thorough work on mechanisms to the fore, rather than the already-explored net impact of geoengineering on deposition. If such changes are made, and if the other comments below are addressed, I believe that the results shown would be appropriate for publication in ACP.

Other major comments

As for many studies of geoengineering, the authors make comparisons to results from studies of volcanic eruptions. However, the comparisons often seem superficial, such as the paragraph beginning on line 16 of page 24, where a study of Tambora by Marshall et al (2017) is invoked without any serious quantitative comparison. The Marshall et al paper in particular is heavily referenced in spite of not having passed peer review at time of submission. I recommend that the authors make their comparison

to volcanic eruptions more quantitative. The differences between a volcanic and SG scenario should also be made clearer and more quantitative prior to any comparison, including differences in aerosol size evolution, lifetime, and distribution.

The authors may want to consider reporting their results normalized by the injection rate. This would allow a more direct comparison to other work, including that of Kravitz et al, and is already implied by (eg) the discussion regarding linearity on page 30.

Minor comments and suggestions

Table 1: The GEOS-Chem vertical grid should read “hybrid pressure-sigma”, not “hybrid pressur-sigma” Page 6, line 20: “with a 11.5% due to” should be “with 11.5% due to” Page 10, line 17: “aerosol firsts by looking” should be “aerosol first by looking” Page 10, line 22: The opening of this sentence appears to be missing. Page 21, line 11: I assume this should be “1-2” days. The use of a division sign instead of a dash happens elsewhere too (also page 24, line 13) Page 24, line 4: “pointing out to a” should be “pointing to a” Figures 13, 14, 15, and 16: it is not clear to me why the points are joined by a line. This implies continuity between data points along an axis where none exists, as each point represents a distinct region.

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