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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Sensitivity of the radiative forcing by stratospheric sulfur geoengineering to the amount and strategy of the SO_2 injection studied with the LMDZ-S3A model" *by* Christoph Kleinschmitt et al.

Anonymous Referee #1

Received and published: 5 September 2017

This manuscript reports on studies of geoengineering via stratospheric SO2 injection performed with the GCM LMDZ coupled to a sectional aerosol model S3A (the coupled model is called LMDZ-S3A). The model has some limitations (fixed SST, no ozone feedbacks, fixed chemical time scale for SO2 conversion, fixed aerosol composition for radiative calculations) but nevertheless does include important feedbacks (aerosol feedback on radiation, interactive tropopause height, self-generated QBO) for stratospheric aerosol injection (SAI). The paper is generally well-written and the subject matter appropriate to ACP. This paper repeats some experiments of a study per-

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formed by Niemeier and Timmreck (2015) but with a different model, and interestingly it reaches somewhat different conclusions. Given the uncertainties in global modeling of something like stratospheric aerosol injection, having model results from multiple independently-formulated models is very desirable. And when models diverge in their conclusions, it may lead us to widen the uncertainty bounds, but also to investigate mechanism, feedbacks, and model reliability.

I support publication of this paper after the following scientific issues are addressed.

Specific Comments:

I would like the paper to emphasize somewhat more that the results presented apply only to injection of SO2 – injection of H2SO4 (see Pierce et al., 2010) or even injection of SO2 outside the tropics, may display different RF responses and scalings. In several places the paper uses “stratospheric sulfate aerosol” or “sulfate SAI” to refer to SO2 injection with statements that may not be as appropriate for injection of H2SO4 or preformed sulfate aerosol particles. The language just needs to be more precise (such as “tropical injection of SO2”) to avoid overgeneralizing the conclusions.

The reference Boucher et al., 2017, referred to as a “companion paper” in the introduction, is incomplete. Perhaps this article is currently under review, as searches of GRL do not reveal such a paper. Given that this reference contains analysis of the importance of rapid adjustment of T, H2O and cloud fields to RF, it should have been included with the review materials. It would be useful to show a comparison of radiative forcing generated, not only as the difference in a single simulation calculated with and without aerosols, but also as the SAI scenario minus the CONTROL scenario. This would allow the reader to know the magnitude of the impact of changes in the temperature and H2O on RF. The other part of the RF calculation which should be quantified is the portion of the calculated RF due to background sulfate, which is apparently not subtracted in the current methodology. Calculating RF of the CONTROL case with and without aerosols would provide that.

Text describing Figure 12 is missing. Perhaps an accidental deletion of text on page 10 between “The particle size. . .appears to approach saturation levels below 0.5 um with increasing injection height.” And “Only the aerosol mass on the lower end of the size range decreases further. . .”. The latter part of this paragraph seems to refer to Figure 12.

The “Conclusion” section should mention the lack of chemical feedbacks through ozone.

Technical Corrections:

Page 8, line 23: “monotonously” should be “monotonically”.

In Figures 7 and 10, the colors for LW and SW forcing are different shades of blue which are difficult to distinguish. Why not different colors rather than shades of the same color? Also, a legend on the plots describing the different colors and symbols would aid comprehension.

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