

Interactive comment on “Sensitivity of the radiative forcing by stratospheric sulfur geoengineering to the amount and strategy of the SO₂ injection studied with the LMDZ-S3A model” by Christoph Kleinschmitt et al.

Anonymous Referee #4

Received and published: 12 September 2017

The paper by Kleinschmitt et al., discusses the sensitivity of radiative forcing by stratospheric aerosol geoengineering to the injection amount and region using the LMDZ-S3A model and a section stratospheric aerosol model. The paper contributes to the question how efficient sulfur geoengineering can counteract radiative forcing. It is therefore an important contribution that should be published. The paper considers injection amounts as large as 50TgS to identify limits of this approach and also explores changes with regard injection locations. All experiments consider injections at the equator or within a region around the equator between 30N to 30S. In contrast to

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earlier studies, the amount of radiative forcing with injection amount is limited, which may be a result of the specific setup and the model. The paper is well written and I would recommend the publication to ACP after my comments and suggestions as listed below have been addressed.

General comment: One general comment is about the setup of the model. The use of fixed SSTs and non-interactive chemistry has limitations in correctly simulating the response of sulfur injections to dynamics. This has been mentioned in the manuscript, but a caveat along these lines needs to be also added in the discussion and conclusions of the paper. In addition, various figures in this paper do not show x and y axis annotations correctly.

Specific comments:

Introduction: Line 18: SOA is a misleading abbreviation, aerosols are not injected. Please change to “sulfur injection” or “stratosphere aerosol geoengineering”

Line 22: “using different aerosol types” is not correct. All the listed studies injected SO₂ and some used H₂SO₄.

Page 3, Line 4: Can you give a reference that discusses the changes in the strength of the tropical pipe with regard to the phase of the QBO?

Line 23: What is pressure at the top of the model?

Line 7: Is there a references that supports that commercial aircraft can hardly fly higher than 15km?

Line 10: Is there a reference that shows that injections at several locations may be more expensive and limited economies of scale? Why would injections at multiple locations be more effective? If there are studies discussing this, please mention those.

Page 5, Line 15: The aerosol distribution is expected to adjust after 2 years, which needs to be shown. Even though 5 year simulations are rather short, I would recom-

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mend to average the last 3 years of the simulation to include the variability between the years. How will the budget in Figure 1 change if the last 3 years of the simulation are considered?

Page 7, Line 5: Total column ozone has decreased after volcanic eruptions in the past, but ozone mixing ratios do not decrease everywhere in the stratosphere but also increase in the tropics due to the hydrolysis of N₂O₅ (Fahey et al, 1993).

Page 9: 3.3 Sensitivity to injection height: what is the injection amount used in these sensitivity studies?

Page 13, Line 23: Niemeier and Schmidt, 2017: is this study published in ACP?

Page 14, last sentence: “and may be implicate stronger side-effects than initially thought”. What do you mean by this? What are the side effects you referring to?

Figure 2, 3, 4, 6, 13: Latitudes not shown. What years of the simulation are shown?

Figure 7, 8, 9: problems with y-axis

Figure 10, 11, 12: problems with y and x axis, and not clear what injection amount is shown.

Figure 15: how much is the amount compared to the tropospheric burden?

Figure 16: color scale needs to be improved, very difficult to make out any structure.

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2017-722>, 2017.