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Comment on acp-2021-569

Anonymous Referee #3

Referee comment on "An interactive stratospheric aerosol model intercomparison of solar geoengineering by stratospheric injection of SO_2 or accumulation-mode sulfuric acid aerosols" by Debra K. Weisenstein et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-569-RC3, 2021

This study investigates the implications of using SO_3 or H_2SO_4 instead of SO_2 in deliberate emissions in the stratosphere in order to modify Earth's climate. Using SO_3 or H_2SO_4 would produce smaller particles (accumulation mode – AM-H_2SO_4) which are more radiative effective than those formed from emissions of SO_2. The effects of geoengineering with AM-H_2SO_4 is investigated using three global climate models. The effects on the stratospheric size distribution, aerosol load, temperature, water vapour and ozone as well as the radiative effects are investigated. All models show that there is increased radiative efficiency using AM-H_2SO_4 but there are large intermodel differces.

The study is well performed and many different aspects of using AM-H_2SO_4 instead of SO_2 is investigated. This type of investigation using three models in one study has not been performed before. The three models used in the study have different strength and weaknesses in their representation of the stratosphere which gives relevant information of the uncertainties in the modelling geoengineering in the stratosphere with AM-H_2SO_4 and SO_2. The paper is well written in general and has a clear structure. The paper is well within the scope of ACP and I recommend publication after the following comments has been addressed.

General comments:

It would be interesting to include a short discussion on the feasibility of using SO_3 or H_2SO_4 instead of $SO_2$and whether one of the options is more technically challenging than the other one.

Specific comments:

Page 6, line 27: Why were the emissions released at different heights in the different models?

Page 6, line 30: I miss an explanation or motivation of the choice of the different injections and injections points. What was the scientific motive for choosing those emissions and emissions points? Which scientific questions could be answered with these?

Page 12, line 26: "main particle size distribution from an R_g". What is the main size distribution R_g? R_g was defined as the mode radii value, but the main size distribution cannot have one mode radii value.

Page 24, line 11-16. There is quite a lot of discussion here that has not been included previously in the manuscript. The section head should perhaps be changed from "summary and conclusion" to "summary and discussion."

Technical corrections:

Page 9, line 7: It is a bit vauge to start the sentence with "This figure" no figure has been mentioned for several sentences.

Page 10, line 10-14. This sentence is very long. Please divide it.

Page 13, line 7: This sentence is awkward, please revise.

Figure 11: The legend in this figure uses SO_2 and H_2SO_4 to denote the simulations rather than AM- H_2SO_4as in the rest of the manuscript. Please revise for consistency.