

Interactive comment on “Reaching 1.5 °C and 2.0 °C global surface temperature targets using stratospheric aerosol geoengineering” by Simone Tilmes et al.

Anonymous Referee #2

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In the present paper the authors propose new testbed experiments for the Geoengineering Model Intercomparison Project. Based on the emission scenarios SSP5-85 and SSP5-34-OS (overshoot scenario) three geoengineering simulation are performed. Stratospheric sulfur injections at different locations are used to limit global warming to 1.5C (for both scenarios) and 2.0C (for SSP5-34-OS). A feedback controller computes the needed amount of sulfur to be injected at different locations to reach temperature targets, and to reduce side effects. The simulations are run utilizing the CESM2(WACCM6) model. Large-scale climate variables are analysed, and some changes are discussed relevant for societal and ecosystem impacts. The results show that some changes depend on the defined temperature targets while others appear to

be sensitive to the amount of the sulfur injections or the CO₂ concentration.

Overall I find the paper well-written and well-structured. The designs of the individual scenarios and the analysis of the results are sound. In general, I also appreciate the, according to the authors, main goal of this study: establishing a new model testbed with a clear protocol. In this respect, the proposed scenarios and analyses may serve as a guideline. However, in my view the present version does not provide enough material to warrant publication, and major modifications are needed. Beside a more concrete definition of the proposed testbed (major 1 & 2, minor 2), my main concern is the high level of uncertainty, which may prevent significant interpretation and comparison of the results (major 3).

Major

1) It is not completely clear to me, what the actual proposed testbed (and the related protocol) is. From the abstract it appears (to me) that two simulations limiting global warming to 1.5C or 2.0C (with reducing side effects) based on an overshoot baseline scenario are the central experiments. However, it seems (e.g. discussions and conclusions) that also the comparison with the high greenhouse emission baseline is part of the protocol. This needs clarification. Furthermore, if the latter is true both the 1.5C and the 2.0C case need to be included in this study.

2) The feedback controller appears to me a major factor defining the results, as it determines the sulfur dioxide forcing. It is not clear to me whether the forcing computed by the controller is unique in terms of reaching the given targets and limiting the side effects. A clear defined forcing is, in my view, a major point in defining testbed experiments. In the present case, it seems even more important as some results strongly depend on the particular sulfur injection. Thus, some more words on the forcing (and controller, see minor 3) are needed, in particular: how unique is the forcing obtained from the controller given the set of target temperatures?

3) So far, only one simulation for every scenario has been performed. This strongly

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hampers the assessment of uncertainties. For example, it is not clear how much of the pronounced North Atlantic warming hole is related to internal variability or the models sensitivity to the particular forcing. This makes the interpretation of the presented results difficult, and complicates the comparison with simulations performed by other models following the proposed protocol. Thus, without having an (at least very small) ensemble, or any other convincing assessment of the uncertainties, the presented results may not include enough robust information.

Minor & technical

- 1) It would be valuable to have a more comprehensive motivation for such a testbed. What information may we get from it, except the sensitivity of particular models to a specific forcing scenario which may 'not be policy relevant' (L422)?
- 2) Independent of my major points above, I think that a protocol as precise as possible would help to establish such a testbed.
- 3) As the feedback controller appears central for the scenarios and results (see Major 2). Thus, a thorough description would be helpful.
- 4) Table 1: It may be noted that the RCP-85 simulations are run with a different model version (as far as I understand).
- 5) L300: citep[[]Kravitz2013 -> (Kravitz et al., 2013)
- 6) L415: SSP5-34_OS 1.5 -> SSP5-34_OS 2.0
- 7) Figure 3, caption: See text more more -> See text for more

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