

Comment on acp-2021-1003

Anonymous Referee #2

Referee comment on "Stratospheric ozone response to sulfate aerosol and solar dimming climate interventions based on the G6 Geoengineering Model Intercomparison Project (GeoMIP) simulations" by Simone Tilmes et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-1003-RC2>, 2022

The paper by Tilmes et al. considers the stratospheric ozone response to sulphate and solar geoengineering across a set of models participating in GeoMIP. As such, the paper investigates an important potential environmental side effect of solar radiation management geoengineering. The study is well-written and quite comprehensive already in terms of the various impacts and points discussed. I would thus recommend publication subject to a few minor comments listed below.

Minor comments:

- l. 12 on p.1 to l. 26 on p.2: in the abstract are quite complex and contain a lot of highly specific details. Maybe this could be summarised more briefly/in a simpler fashion, especially for the general reader. I think the complexity arises from discussing different regions, simulations, baselines, solar, sulphate and GHG effects, plus multiple variables. I recommend just summarising the overarching messages.
- p. 2 l. 43: maybe the effect of changing TTL temperatures on stratospheric water vapour / composition is also worth mentioning?
- p. 6 l. 168: the effect on the BDC requires a reference
- Figure 1: is the temperature (T) response (stratospheric warming) due to the aerosols mainly determined by how much warming has to be offset in each model (e.g. how much aerosol has to be injected), or is it a real mixture of factors, or other aspects are more relevant (e.g. radiative heating intensity for a given aerosol increase)? I see you comment on this in the main text, i.e. there are substantial differences. Interesting to see that the interactive chemistry models appear to show smaller T-responses. Coincidence or possibly effects of ozone loss (cooling) and increasing in stratospheric water vapour (cooling, too)? Could you comment on this?
- l. 204: "largely driven by tropospheric temperatures". Maybe dangerous to express this way as it ignores the actual mechanism? (lifting of the tropopause under tropospheric warming and changes in the jet stream affecting wave propagation) I know there are uncertainties in the mechanism but best to rephrase. We certainly wouldn't want new

students for example to misunderstand this.

- l.212-216: could this simply be internal variability? 20 years are fairly short for polar vortex coupled atmosphere-ocean simulations. Statistical significance can give strange results in such cases, especially if p-values are not adjusted for multiple hypothesis testing.
- Caption Figure 6: maybe clarify: "for the three INTERACTIVE stratospheric chemistry models" and that this is "Aerosol surface area density".
- l. 268: do you mean STRATOSPHERIC humidity changes (across all models considered)? Better to clarify.
- Figure 8: could you increase the resolution slightly? It looks quite coarse.
- Figure 9: maybe worth highlighting how significant those changes are relative to historical observed variability (e.g. by a grey shading for one observed sigma around zero)? For example, in the top right subfigure models show vastly different variability characteristics, which leaves the reader to wonder which model is too variable or shows too little variability.
- l. 404 don't -> do not
- l. 413: can you say though which model(s) probably performed best / are best suited for the task? The CNRM model seemed strangely unresponsive? Is this a feature also found in Keeble et al. (2021), ACP? There, results were extremely dependent on the model and showed quite clearly that certain chemistry responses could be discounted.
- l. 425 -430: this is a central result it seems, and probably worth highlighting even more in the abstract instead of the detailed discussion of certain results? Your final sentence in the abstract already covers this point, but it be clearer/more explicit about the implications and why this questions state-of-the-art thinking in our discipline.