



EGUsphere, author comment AC3  
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## Reply on CC2

Jadwiga H. Richter et al.

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Author comment on "Assessing Responses and Impacts of Solar climate intervention on the Earth system with stratospheric aerosol injection (ARISE-SAI): protocol and initial results from the first simulations" by Jadwiga H. Richter et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-125-AC3>, 2022

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*Thank you for your comments. Our responses are in italics.*

It is unfortunate that the authors of this paper have not yet responded to my earlier comments. It is hard to have a community discussion, as the EGU intends for papers submitted to it without such a response. But I will supplement my earlier comments here.

- It is clear from simple physics that if enough sulfate particles are introduced into the atmosphere that the average temperature at the surface of the globe will cool sufficiently to offset the amount of average global heating due to the increase in greenhouse gases the world is emitting. Again, this could clearly be achieved on average across the entire surface area of the globe. But even the IPCC acknowledges that the distributional effects of such cooling on temperature and its impacts on precipitation would not offset the impacts of climate change at the regional/local scale. One does not need to sophisticated computer model of the climate system to understand why this would be true, and I gave some examples in my earlier comments on this paper of the physics behind this issue.

*Please see our response to your earlier comment. We are in full agreement: all impacts on seasonal and regional levels need to be evaluated, however this does not fit in one manuscript.*

- Different climate models give fairly different results, thus the authors need to justify why their paper should focus on only one such model. Why should we believe that the model focused on will yield more accurate regional impacts for sulfate geoengineering and baseline cases than other models in the future?

*You're absolutely correct. Here we describe the experimental protocol so other models can repeat this set-up. Already, the UKESM model is running these simulations and those will be made available to the community as well. The comparison between various models will elucidate uncertainties in impacts of climate intervention, and help highlight inter-model differences both in light of climate change and of climate intervention strategies. For a discussion on inter-model uncertainties in previous GeoMIP simulations, see for instance Vioni et al. (2021b). Here we are describing new simulations that we consider to be more policy-relevant in terms of underlying emission scenarios used and target temperature achieved, but we are not claiming that only one*

*model has the correct answer. Rather, as we already explained above, we are providing a blueprint for other models to repeat the same simulations.*

- Since large amounts of sulfate particles injected into the atmosphere are likely to diminish the strength of sunlight hitting the surface of the earth, the authors should discuss the impact of this likely effect on agricultural productivity for different food crops, since different crops may have different degrees of sensitivity to the dimming of sunlight during their growing seasons. The same should be discussed for forest growth and health.

*There are several people at Rutgers University already looking at changes in crops and agricultural productivity in these simulations. These will be discussed in subsequent manuscripts. Other previous papers already discussed these issues in a generic way (i.e. Zarnetske et al., 2021; Vioni et al., 2021a) or for other, in our view less policy-relevant, simulations (i.e. Fan et al., 2021)*

- Again, to the extent that sulfate geoengineering will likely yield different precipitation patterns across the globe relative to normal rainfall patterns, and relative to the rainfall patterns that will be produced by climate change over the next decades, this issue should be explored. However, it is well known that it is likely to be the case that computer-based climate models have a harder time accurately computing the impact of climate change on precipitation than on temperature, and this is likely to even more true for their ability to compute the changes in rainfall patterns due to sulfate geoengineering. This issue needs to be more fully explored in a revised paper.

*The issue the commenter raised has been discussed before, for instance in Vioni et al. (2021b) for GeoMIP CMIP6 simulations (see Figure 6 and Figure 9 there), but also in other places (Irvine et al., 2020). It is true that climate models present larger uncertainties in their hydrological response to increased CO<sub>2</sub> than they do for temperature; similarly, the drivers of hydrological changes in climate intervention simulations (Simpson et al., 2019) need to be better investigated.*

## **References:**

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