Thank you for your comments. Our responses are in blue.

My first concern about this paper is that it does not discuss seasonal impacts on temperature and precipitation as a function of latitude at all. This must be done. For example, we know that the annual average temperature impacts of climate change on annual average temperature occur most in the high northern latitudes, in places like Alaska. Furthermore, in theory, having more CO2 in the atmosphere over such regions clearly has a huge impact in reducing radiative cooling in winter, thus increasing surface temperatures substantially. Yet, having sulfate particles over Alaska in winter won't have much impact in reducing temperatures since the periods of sunlight are so short. Furthermore, having most of the sulfate particulates much farther south, as shown in Figure 2, would seem to imply that incoming summer radiation will not be reflected very much in the far north were it is needed to be reflected during the long daytimes of summer to cool the air. Similar seasonal assymetries are probably important for precipitation impacts of climate change even though these would be much harder to model accurately. The seasonal assymetries with regard to surface temperature seem to derive much more simply from the physics of CO2 concentrations and the density of sulfate particles in the air. Thus, concluding that "on average" over the year or over many years solar geoengineering can mitigate climate change is not very helpful when trying to analyze the impact of climate change on human society and the ecology. Seasonal and time of day (day vs. night) differences in impact on temperature and precipitation are very important to consider.

We completely agree with you that the seasonal impacts on temperature and precipitation must be explored, and they have been in previous simulations (for instance, see Simpson et al., 2019, Visioni et al., 2020). The reason they are not included in this manuscript is that the purpose of this paper is to provide an overview of the simulations and experimental protocol, and we expect subsequent publications will address detailed changes, including seasonal changes. In particular, detailed calculations of extreme temperature and precipitation changes are also in progress (and will be coming in forthcoming manuscripts). Since this topic is clearly important to you, we include the plots of seasonal precipitation and temperature changes in this response for the time period (2050 - 2069) - (2020-2039) in Figures 1 and 2 below. We will wait for the editor's comments on whether they should be included in the revised manuscript.

My second concern is that I do not quickly see any discussion of how the impact of sulfate particles on the reflectivity of solar radiation is modelled at different wavelengths, and at different times of the day.

We will add some discussion of this specific topic. In particular, Earth System models treat solar radiation in discrete spectral bands, and especially in terms of model output only offer information for the overall shortwave and longwave radiation incoming (both direct and diffuse) and outgoing. Previous discussions over changes in ratio of diffuse/direct radiation can be found for instance in Visioni et al. (2021). In the visible part of the spectrum, the impact of the added sulfate burden has been discussed in Kravitz et al. (2012).

Also, I do not see any discussion of the impact of continually falling particles have on air quality, human beings breathing the air, and on ecology and agriculture.

Similarly to the first comment, we fully agree that all of these impacts need to be evaluated, however evaluating all of the above suggested impacts simply can not fit into one manuscript. The idea with this overview paper is to get the data out to the community, fully explain the rationale behind our modeling choices and offer detailed information in order for more models to be able to reproduce our results, and have subsequent manuscripts evaluating impacts on all aspects of the Earth system. To this point, our simulations include extensive output for all model components that can be used to investigate more in depth some of the points raised by the reviewer. Some of the points raised by the reviewer have been discussed in Zarnetske et al. (2021), which we will add in the revised manuscript.

References:

Kravitz, B., MacMartin, D. G., and Caldeira, K. (2012), Geoengineering: Whiter skies?, Geophys. Res. Lett., 39, L11801, doi:10.1029/2012GL051652.

Simpson, I. R., Tilmes, S., Richter, J. H., Kravitz, B., MacMartin, D. G., Mills, M. J., et al. (2019). The regional hydroclimate response to stratospheric sulfate geoengineering and the role of stratospheric heating. Journal of Geophysical Research: Atmospheres, 124, 12587– 12616. https://doi.org/10.1029/2019JD031093

Visioni, D., MacMartin, D. G., Kravitz, B., Richter, J. H., Tilmes, S., & Mills, M. J. (2020). Seasonally modulated stratospheric aerosol geoengineering alters the climate outcomes. *Geophysical Research Letters*, 47, e2020GL088337. https://doi.org/10.1029/2020GL088337

Visioni, D., MacMartin, D. G., & Kravitz, B. (2021a). Is turning down the sun a good proxy for stratospheric sulfate geoengineering? Journal of Geophysical Research: Atmospheres, 126, e2020JD033952. https://doi.org/10.1029/2020JD033952

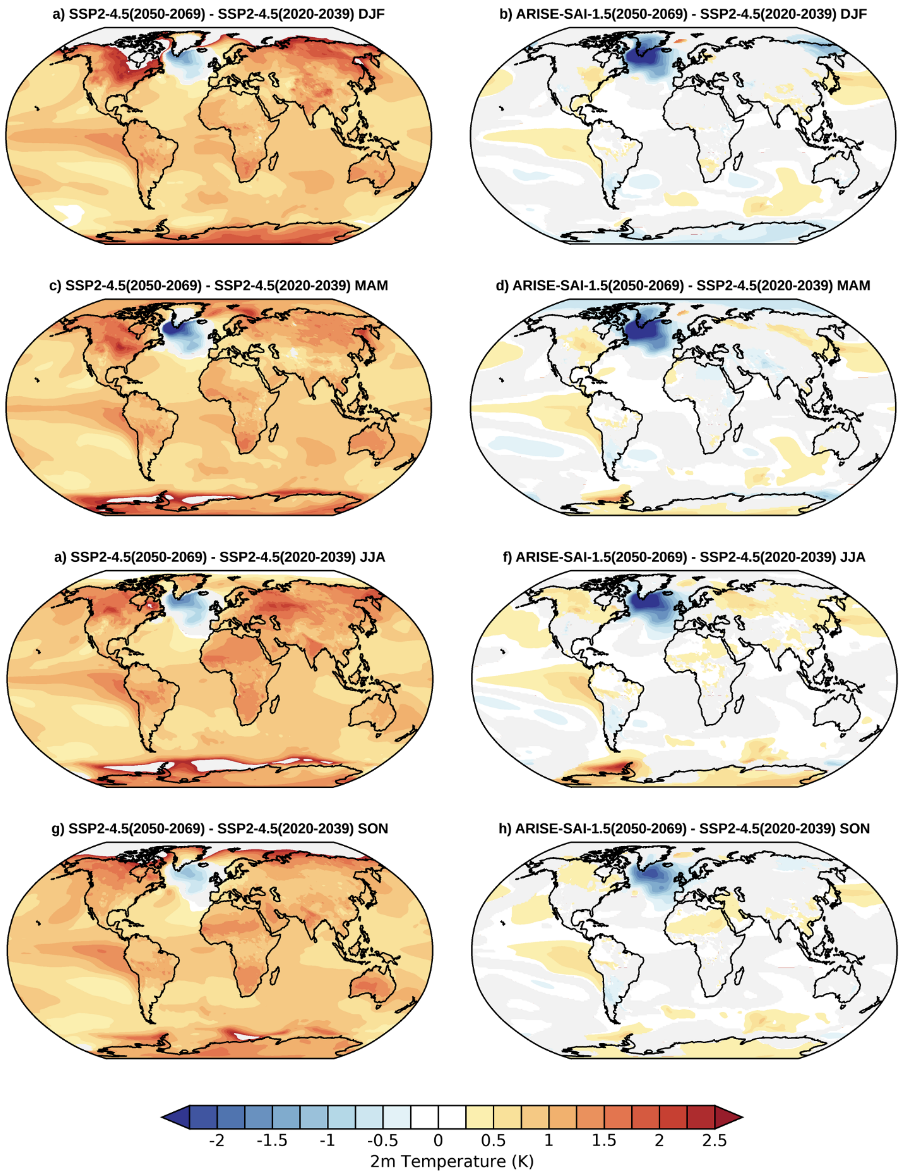

Figure 1: Ensemble and seasonal mean surface (2m) temperature differences between SSP2-4.5 (2050-2069) and SSP2-4.5 (2020-2039) (left columns) and ARISE-SAI-1.5 (2050-2069) and SSP2-4.5 (2020-2039) (Right columns) for four seasons: December, January and February (DJF), March, April, May (MAM), June, July, August (JJA), and September, October, November (SON). Season shown is depicted in the figure titles. Gray shading indicates regions where the differences are not statistically significant at the 95% level using a two-sided Student's t test.

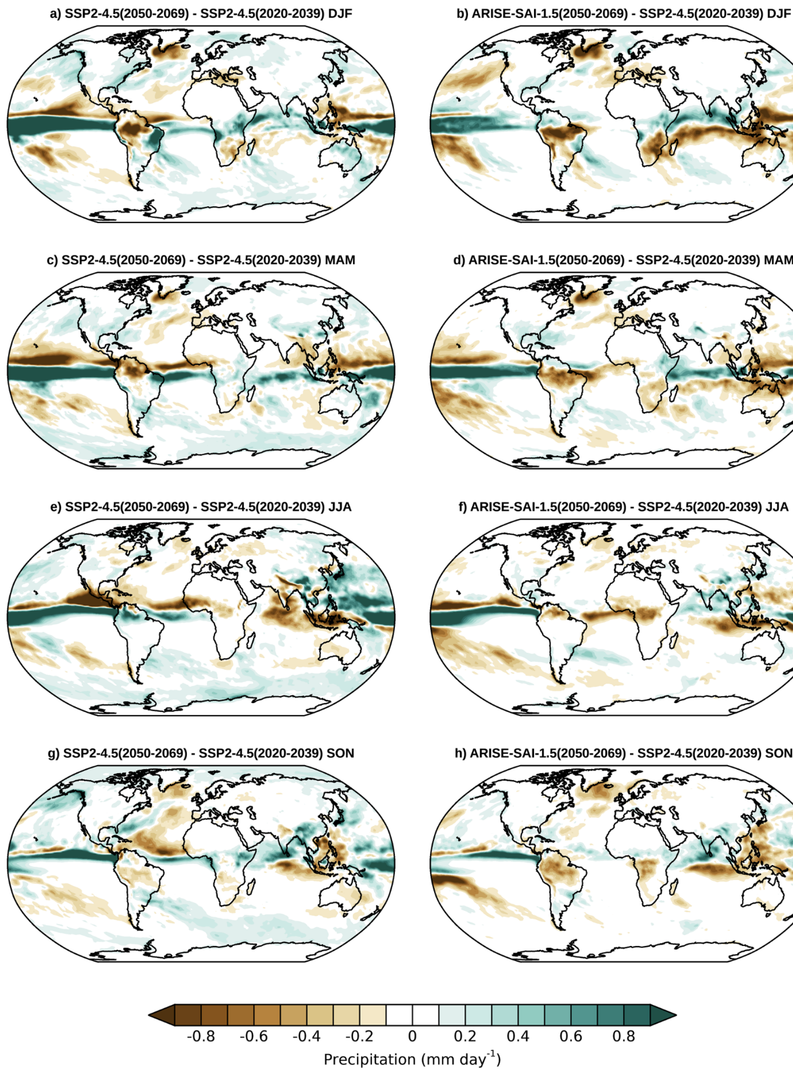

Figure 2: Same as Figure 1 but for precipitation.