Dear reviewer,

Thank you for your thoughtful and valuable comments, which are of great help for improving our paper. We have carefully considered all the comments by you and other reviewers, and prepared to revise the manuscript accordingly. A point-by-point response to your comments is provided below.

Thank you again for your valuable time and work, and we look forward to your positive decision on our paper.

With warm regards,

Ou Wang, on behave of all co-authors

General comments:

This study uses the UK Earth System Model (UKESM1) simulation results to examine the effect of solar radiation modification (SRM) geoengineering on precipitation extremes in China. As part of the GeoMIP project, UKESM1 was used to conduct two sets of SRM simulations: stratospheric aerosol injection (G6sulfur) and solar constant reduction (G6solar). Both G6sulfur and G6solar simulations are designed in such a way that global mean surface temperature under the scenario of SSP5-8.5 was brought down to the level under SSP2-4.5. Using a set of precipitation extreme indices, the authors investigated the effect of G6sulfur and G6solar on precipitation extremes for different regions of China. The authors found that compared to SSP5-8.5, both G6sulfur and G6solar ameliorate precipitation extremes over different parts of China, but increase drought risks in some northern part of China. The authors also compared the similarities and differences between precipitation extreme response to G6sulfur and G6solar for different regions of China. The analysis of this paper itself is largely sound, but I do not recommend its publication in ACP in the present form for the following reasons:

I see little science in this study. I have to say that I have not carefully examined the Results part, which is just the description of figures with little scientific insight. What the authors did is just to compare simulated precipitation extremes over different regions of China under SS5-8.5, SSP2-4.5, G6solar, and G6sulfur. Regional climate extremes are strongly dependent on the SRM scenarios (location, timing, and intensity of SAI and solar reduction). Also, regional climate extremes are strongly dependent on climate models. If one uses another climate model and/or another SAI strategy, most results presented in this paper might be different. At least, the authors should use multiple model results from GeoMIP instead of just one model. Also, the authors should try to investigate some science underlying the presented precipitation extreme comparisons. For example, why the difference between G6sulfur and G6solar? In the present form, this paper just presents simulation results from a specific model with little interpretations. At least for me, I see little science here.

Response:

We greatly appreciate your time and effort in reviewing our work and providing detailed and insightful comments on the manuscript, which are very helpful for improving the quality and clarity of our paper.

Indeed, in our present study, we mainly dedicated to compare the simulated precipitation extremes over different regions of China under different scenarios (SS5-8.5, SSP2-4.5, G6solar, and G6sulfur), with special focus on potential impacts of the SAI on precipitation extremes. We admit that there lack of sufficient interpretations on the results, particularly in terms of mechanism linking the response to the impacts. This is partially because of our limited knowledge in relevant fields. However, considering relatively scarce research and limited knowledge on the impact of SAI over East Asia, we think our findings are useful for deepening some understanding of the potential mitigation strategies of climate change. Thanks to the valuable suggestions provided by you as well as other referees, more interpretations will be added in our revised manuscript so as to make up the deficiency, at least to some extent.

We understand your concern regarding the use of only one climate model. We agree that the one model may not capture the diversity among different models, and employing multiple models for analysis could enhance the robustness of the findings and provide a more comprehensive perspective. Given this limitation in our study, we have realized that the title rather over-reached in terms of what is presented in the paper and changed the title to "Projected future changes in extreme precipitation over China under stratospheric aerosol intervention in the UKESM1 climate model".

We chose the UKESM1 model due to its extensive validation in prior studies and its reputation as a reliable tool for simulating climate dynamics. UKESM1, as described by Sellar et al. (2019), represents a significant advancement over its predecessor, HadGEM2-ES, with enhanced complexity in its components and internal coupling. The model performs admirably, maintaining a stable pre-industrial state and demonstrating strong agreement with observations across various contexts (Sellar et al., 2019). Furthermore, we conducted a validation of precipitation against APHRODITE data, which demonstrated that the model has a very credible performance. Previous studies also utilized the standalone UKESM1 model to evaluate the physical and biogeochemical state of the global ocean component (Yool et al., 2020), to assess the impact of both SAI and MCB on standard meteorological variables (Haywood et al., 2023), and to research other meteorological related (Haywood et al., 2022; Wells et al., 2023; Jones et al., 2020; Jones et al., 2022; Visioni et al., 2021).

In our study, while some biases were observed, UKESM1 reasonably captures precipitation patterns, particularly in eastern China, when compared with APHRODITE data from 1981-2010. Additionally, as noted in previous research (Liang and Haywood, 2023), UKESM1 is currently the sole model capable of providing outputs of pressure-level winds and specific humidity data every 6 hours, satisfying the requirements of the ARDT (Atmospheric Radiation Detection and Tracking) method. Furthermore, Tian et al.(2021) validated the UKESM1-0-LL simulation, demonstrating robust agreement between simulated and observed precipitation in China from 1961 to 2014, surpassing that of the CMIP6 multi-model ensemble (MME). Although acknowledging that a single model may not fully encompass the complexity of all climate variations, we

believe that UKESM1 offers a valuable initial assessment of the potential impacts of SRM strategies in different regions of China.

Certainly, future research could benefit from incorporating a broader range of models to validate our findings and further explore inter-model differences. This would contribute to a more comprehensive understanding of the effects of SRM on precipitation extremes and yield more robust conclusions.

About the difference between G6sulfur and G6solar, G6solar serves as a parallel experiment to G6sulfur, aiming to compare the effects of solar reduction with those of stratospheric aerosols. G6solar adopts the same setup as G6sulfur, but geoengineering is achieved through solar irradiance reduction. Specifically, the inter-model differences in the spatial distribution of forcing are expected to be smaller in G6solar than in G6sulfur, offering valuable insights into the effects of uncertainties in stratospheric sulfate aerosol transport (Kravitz et al., 2015). These have already been explained in L134-7 of the article.

Additionally, we would like to note that, when assessing impacts, it is common to focus on the most relevant metrics that are influenced. For example, the recent paper by Mari Tye (https://esd.copernicus.org/articles/13/1233/2022/):

Tye, M. R., Dagon, K., Molina, M. J., Richter, J. H., Visioni, D., Kravitz, B., and Tilmes, S.: Indices of extremes: geographic patterns of change in extremes and associated vegetation impacts under climate intervention, Earth Syst. Dynam., 13, 1233–1257, https://doi.org/10.5194/esd-13-1233-2022, 2022.

In Tye et al. (2022), a single model is used: Community Earth System Model (CESM1), for assessing extremes in temperature, precipitation and vegetation. Actually, Tye et al. (2022) provide no more than a discussion of impacts in the conclusion section and some general links to large scale dynamics that have been noted in other papers. While it should be more meaningful to delve into the causal mechanisms linking the response to the impacts, simply documenting impacts in extremes (as in Tye et al. (2022)) also appears worthy, at least to some. Other examples of published work that use a single model and focus on the impacts include, but are not limited to:

Muthyala, R., Bala, G., & Nalam, A. (2018). Regional scale analysis of climate

extremes in an SRM geoengineering simulation, Part 2: temperature extremes. Current Science, 1036-1045.

Tilmes, S., Sanderson, B. M., & O'Neill, B. C. (2016). Climate impacts of geoengineering in a delayed mitigation scenario. Geophysical Research Letters, 43(15), 8222-8229.

Jones, A.C., Hawcroft, M.K., Haywood, J.M., Jones, A., Guo, X. and Moore, J.C., 2018. Regional climate impacts of stabilizing global warming at 1.5 K using solar geoengineering. Earth's Future, 6(2), pp.230-251.

Specific comments:

Lines 36-59: This first paragraph of the Introduction part is very lengthy and most part is not directly relevant to the study here. For example, the detailed description of extreme precipitation in Zhengzhou and Beijing is not needed at all.

Response：

Thank you very much for pointing out the redundancy of the introduction part. In the revised manuscript, we will make (actually we have made) the first paragraph (lines 36-59) more concise and pertinent to the study, including shortening the description of extreme precipitation in Zhengzhou and Beijing.

Lines 61-72: This paragraph can also be substantially shortened and combined with the first paragraph.

Response：

According to your suggestion, we have substantially shortened the second paragraph (line 61-72), and combined it with the first paragraph.

Line 85: check the grammar here. ‘,the climate’

Response：

The error has been corrected. It should be “on the climate”.

Lines 90-101: The use of ‘prediction’ in this paragraph is not appropriate.

Response:

We have replaced "prediction" with "projection" in the paragraph.

Lines 98-99: Whether SAI would decrease precipitation depends on the scenario of SAI deployment. Also, instead of Pinto et al. 2020 and Liu and et al. 2021, more influential papers on the climate effect of SAI should be cited.

Response:

Yes, we agree that different scenario of SAI deployment would have different effects on the climate, in particular, the spatial and temporal distribution of precipitation. The statement (in lines 98-99) “SAI will exert a negative radiative forcing and reduce near-surface air temperature (including temperature means and extremes) (Pinto et al., 2020), and precipitation (Liu et al., 2021)” has be revised as: "Previous studies indicated SAI would exert a negative radiative forcing and reduce near-surface air temperature (including temperature means and extremes) (Pinto et al., 2020), and precipitation (Liu et al., 2021). However, the climate effects in terms of magnitude as well as spatial and temporal distribution depend largely on the scenario of SAI deployment. Furthermore, as suggested by some studies, although SAI can effectively counteract anthropogenic global warming at the global scale, it cannot fully offset the effects at regional scale (Tilmes et al., 2013; Niemeier et al., 2013; Simpson et al., 2019)”.

Line 120: Why only use results from a single model? Why not use multi-model results from GeoMIP?

Response:

Thank you for pointing out this issue. In the response to your comment at the beginning, we have answered this point. Please refer to our explanation there.

Lines 186-187: I don’t quite understand this sentence.

Response:

We'd like to clarify that since we have already employed the Wilcoxon test for the significance testing, the field significance analysis mentioned here are not necessary, and in fact, it was not used in this study. Therefore, the description (line185-194) should

be deleted. We are sorry for the confusion due to our carelessness.

Line 199: The word of ‘accurate’ is not appropriate here.

Response:

The "accurate" was replaced with "similar to the observed precipitation" in line 199.

Line 133: ‘reducing the solar constant or increasing SAI’. Check grammar and spelling here.

Response:

The sentence should be changed to “increasing SAI”.

Lines 225-226: I don’t understand what ‘SAI is sensitive to global warming’ means.

Response:

The sentence has been revised as “This suggests that the effect of SAI on future precipitation is more widespread and remarkable compared to that of SSP5-8.5.”

Line 245: Where are ‘the other three G6 models’?

Response:

Sorry for our carelessness. The “models” should be “simulations”, and it has been corrected in the revised manuscript. The other three simulations refer to that of SSP2-4.5, G6sulfur, and G6solar.

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