Response to Editor #:

We are very grateful to the editor in providing helpful comments and guidance that have improved the manuscript. In this document, we describe how we have addressed the editor's comments. Comments are shown in black and author responses are shown in blue text.

1) Are these +/- 2 std dev?

Response: Thanks for your suggestion, the spreads in the text are +/- 1 std dev and we added some description and modified the description in Figs 6, 9, 13 and 14 in the revised manuscript.

"By 2050, the hottest day and warm days increase by 2.2 ± 0.7 K (mean ± standard deviation) and 27.7 ± 13.1 % under…" Lines 235-236

"The red and blue shading represents the ± 1 standard deviations across models." Line 823 and 838

"The error bars denote the ± 1 standard deviations across models." Line 859 and 865

2) The what in China? Average temperature?

Response: Yes, we modified this sentence as follows:

"In eastern Asia, under global warming of 1.5 °C and 2 °C, the average temperature in China is expected to grow at a faster rate than the global mean…" Lines 68-69

3) I believe this is just referring to the "Earth system" as the atmosphere is part of the system.

Response: Thanks for your suggestion, we deleted "-atmosphere" in this sentence. Line 107

4) Is this incomplete data to the to AerChemMip?

Response: Yes, and we mentioned it in the revised manuscript.

"Due to incomplete data provided by CESM2-WACCM and GISS-E2-1-G in the AerChemMIP…" Lines 172-173

5) Why were these time periods selected? Also, why just 19 years? I assume it is because of the quicker changes and response of climate to SLCP, but it could help to state it.

Response: Thanks for your suggestion, we mentioned it in the revised manuscript as follows:

"We focused on the changes in extreme climate indices in the future (2031–2050) relative to the reference

period (1995–2014), as this is when reductions in aerosol and ozone precursor emissions and the resulting changes in climate are expected to be significant." Lines 175-177

6) Figures S2 and S3 are not referred to in the text, but are key figures added to address the reviewer's comments. These need to be included in the discussion here.

Response: Thanks for your suggestion, we added some description in the revised manuscript as follows:

"It is worth noting that the global spatial distribution of ERFs shows poor inter-model agreement, with large areas where there is disagreement of the sign with at least one of the models and signal-to-noise ratios ($S_{NR}$) less than 1 (Supplementary methods and Fig. S2), especially over the ocean." Lines 199-201

"The largest increases of more than 1.5 W m$^{-2}$ are found over India, southeastern Asia, and surrounding oceans with relatively good inter-model agreement (Fig. 4c and S2c)" Lines 204-205

"The models agree on the sign of the change across regions and have high level of confidence (Fig. 5a, b and Fig. S3a, b)." Lines 216-217

"Moreover, such warming is exacerbated by future non-methane SLCF emissions reductions in most regions of the world, particularly in the Northern Hemisphere with great inter-model consistency (Fig. 5c and 3c)." Lines 219-220

7) I would recommend expanding this to say that there are large areas where there is disagreement of the sign with at least one of the models (identified by the hatched lines or lines etc.).

Response: As suggested, we expand this sentence as follows:

"It is worth noting that the global spatial distribution of ERFs shows poor inter-model agreement, with large areas where there is disagreement of the sign with at least one of the models and $S_{NR}$ less than 1 (Supplementary methods and Fig. S2), especially over the ocean." Lines 199-201

8) As this is part of methods, I recommend also referring to it first in the methods section.

Response: As suggested, we refer it in the methods section as follows:

"We also quantify the confidence of the MME relative to each individual model using sign agreement and Signal-to-noise ratio ($S_{NR}$). The details of the calculation of $S_{NR}$ can be found in Supplementary method." Lines 152-154

9)The SN<1 in TXx is lines over Mongolia, which is part of higher latitudes, so this statement confuses me some. For the models agreeing on sign, I think that is in Figure 7, correct? It should be referred to here.

Response: Thanks for your suggestion, what we referred to was that under SSP3-7.0 and SSP3-7.0-lowNTCF scenarios, all models agree on the sign and $S_{NR}$ larger than 1. We also refer to the figures in the revised manuscript as follows:

"…and the warming is greater at higher latitudes under both scenarios with all models agree on the sign and $S_{NR}$ larger than 1 (Fig 7a, b and Fig. S4a, b)." Line 246

10) In this sentence it can be indicated that there are still areas in the domain where there is difference in the signs of the models and S/N. The description of the uncertainties and differences in the models was a key corrections suggested by both reviewers.

Response: Thanks for your suggestion, we deleted this sentence in the revised manuscript. Line 246

11) But the 90th percentile is relative to each area, correct? So the 90th percentile would be higher for these regions already. So I am not yet following how just "higher temperatures" here than at higher latitudes would lead to more warm days. I think what this is saying is the distribution was tighter (e.g. lower daily variation as noted here), so smaller increases in temperature still put more days into warm days. Is that correct? Please clarify here.

Response: Yes, the 90th percentile calculation in this paper is obtained by calculating each grid points, lower daily temperature variation at low latitudes could result in more days above the 90th percentile of the reference period. We deleted "higher temperatures" in this sentence in the revised manuscript. Line 252

12) These are only shown in Figure 6 correct, and not over the domain? I can't see them at least. I recommend then including "...and warm nigh (Fig 6), tropical night is also projected to increase over much of the study area (red areas in Fig. 7g and h) in the future". Also check on wording as "the" and "entire" were not deleted in the track changes.

Response: As suggested, we modified these sentence as follows:

"Concomitant with the increases in the coldest day and warm night (Fig 6), tropical night is also projected

to increase over most study area (red areas in Fig. 7g and h) in the future…" Lines 260-261

13) However, much of the domain has S/N<1 and they don't agree on sign. This should be included close to this first statement.

Response: Thanks for your suggestion, we added some description in the revised manuscript.

"Concomitant with the increases in the coldest day and warm night (Fig 6), tropical night is also projected to increase over most study area (red areas in Fig. 7g and h) in the future with some difference among models, but the agreement among models is relatively good in regions where tropical night increases, such as eastern China, western northern China, southern Asia and southern eastern Asia." Lines 260-263

14) Not for all as there are blue areas in Fig 7i. Perhaps you can highlight where the magnitude is larger.

Response: Thanks for your suggestion, we highlight some regions with obvious changes in the revised manuscript.

"The spatial pattern of tropical night changes under SSP3-7.0-lowNTCF is similar to that under SSP3-7.0, but the magnitude of the changes is larger, especially in eastern China, western northern China, and Indo-China Peninsula where models show good agreement (Fig. 7g, h and Fig. S4g, h)." Lines 265-267

15) Figure S4l does seem to show that these areas have SN>1, but Fig 7l also shows that models don't agree about the sign is some of these areas. This uncertainty needs to be included in this discussion.

Response: Thanks for your suggestion, we added some uncertainty description in the revised manuscript as follows:

"Notably, the confidence level of the MME in these regions is relatively high, except for some small areas (Fig. S4l), but the variation in sign among models is large (Fig. 7l)." Lines 279-280

16) It will help to refer to the figures that make these points

Response: As suggested, we refer to the figures here. Line 285

17) This is labeled "Asia" correct?

Response: Yes, "the entire study area" in the text refer to "Asia".

18) In NTCF mitigation, correct?

Response: Yes. We modified this sentence as "The hottest day, warm days, and warm spell duration all show their largest regional increases in NIN and NC due to non-methane SLCFs reduction…" Lines 295-296

19) As noted by the reviewers, precipitation predictions have larger uncertainties and disagreement across models. I strongly recommend addressing this up at the front of this section so that results are put into context right away. Right now, this is only really noted in line 309. Providing this general context then puts in place the caveats and uncertainties of the results from the start. I am not recommending to delete the text lower down, just to add some here.

Response: Thanks for your suggestion, we added some description at the front of this section in the revised manuscript.

"However, precipitation projections have larger uncertainties and disagreement across models." Lines 306-307

20) see a larger inc in the mean, correct - as they overlap within 2 std dev.

Response: We modified this sentence as follows:

"Non-methane SLCFs mitigation causes an increase in extreme precipitation indices after 2035 except consecutive dry day, which shows a complex signal in the future." Lines 310-311

21) S5 should also be referenced here

Response: As suggested, we referred to S5 here as follows:

"However, it is worth noting that the consistency among models is poor (Fig. 10b and Fig. S5b)." Line 320

22) As you are referring to Fig 10 and 11 together, it can help readers to follow if the figs are referred to. So this statement is from Fig 11 b, but the next is Figure 10 c, right?

Response: Thanks for your suggestion, we referred to related figs to make it clearer.

"The reductions in non-methane SLCFs cause an increase of $1.0 \pm 0.5$ days in average heavy precipitation days across the entire study area (Fig. 11b). For the selected regions, robust increases in heavy precipitation days occur in SWC, SC, reaching $2.5 \pm 1.9$ days and $1.5 \pm 0.8$ days, respectively (Fig. 10c and Fig. 11b)." Lines 320-323

23) Fig. 11c

Response: done. Line 329

24) Fig 11e

Response: done. Line 355

25) Refer to the figure here.

Response: done.

"Overall, consecutive dry days decreases by $0.02 \pm 0.8$ days and $0.4 \pm 0.5$ days under the SSP3-7.0 and SSP3-7.0-lowNTCF scenarios, respectively (Fig. 11e), with $S_{NR}$ less than 1, which means model projections have a low level of confidence (Fig. S5j and k)." Lines 354-356

26) Neither of these regions have models agreeing with the sign, or with SN>1, so I can't see how they are referred to as "robust".

Response: Thanks for your suggestion, we modified this sentence as follows:

"Also, for most regions, the models do not all agree on the sign of the responses and have low level of confidence. The increases in consecutive dry days in India and eastern China are accompanied by increases…" Lines 361-363

27) I would recommend considering adding just a few sentences on how your results do highlight again the large uncertainties and model disagreements with simulating future precip. I think that using such indices shows really well how hard it is to try to plan for future impacts of changes in precipitation due to the differences in the model. I think that is shown well here and I would recommend highlighting it here and/or in discussion

Response: Thanks for your suggestion, we highlighted in discussion as follows:

"Notably, our results show a large uncertainty and model disagreement in simulating future extreme precipitation. Previous studies also indicate that there are still large uncertainties in the model's simulations of extreme precipitation, which may attribute to model resolution and natural variation (Li et al., 2014; Deser et al., 2012)." Lines 437-439

28) I recommend adding in here something about the acknowledging the model spread and uncertainty, but motivating for the analysis. It may even help to state clearly how these results should be interpreted/used in light of the uncertainties.

Response: As suggested, we added some description here in the revised manuscript.

"It is important to emphasize that there are still uncertainties among models, especially in future projections of extreme precipitation, the difference in model simulations could also lead to uncertainties in population exposure." Lines 375-377

29) Was the ensemble mean used as "c" in equation 1 to get this?

Response: Yes, the ensemble mean used as "c" in equation 1.

30) Fig 13

Response: We have not mentioned Figure 13 here, as we describe it as "more than". We clarified this sentence in the revised manuscript as follows. Also, as suggested, we referred to the relevant figure here in the revised manuscript.

"Compared to the SSP3-7.0 scenario, future non-methane SLCF reduction will increase the population exposed to extreme temperature by more than $3.5 \times 10^8$ person-days in NIN, followed by more than $1.5 \times 10^8$ person-days in NC and the SCB (Fig. 12c)." Lines 385-387

31) Is this the blue or pink bar in NTCF column in four panels in Fig 13?

Response: It is the blue bar in NTCF column. We modified this sentence as "Future non-methane SLCF reductions increase total population exposure to warm days by…" Lines 398-399

32) recommend this statement is re-written as the point is not yet clear. To me, I am not following the first half of the sentence "It is no difficult to find?" - does this mean it is not surprising that the

variation is large?

Response: Thanks for your suggestion, we modified this sentence as "Also, the inter-model variation is large, which arises from differences in model simulations of extreme precipitation." Lines 408-409

33) this is repetitive

Response: Thanks for your suggestion, we delete "but non-linear" in the revised manuscript. Line 465

34) There was a question on this by the reviewer and it is explained in the response but not yet added here.

Response: Thanks for your suggestion, we added some description in the revised manuscript.

"The rate of response increases with warming is not linear (Pendergrass et al., 2019), as shown in Allen et al. (2020) that some of the extreme indices were not well fitted such as the wettest day and CDD, with lower value of $R^2$ or even lack significance." Lines 464-466

35) these are the reductions already obtained, correct. So this statement is that the impact of emission reductions that have already happened may be underestimated, right? I recommend updating this statement to clarify that these are already realized reductions (as I believe they are).

Response: Thanks for your suggestion, we modified this sentence as follows:

"Consequently, CMIP6 database underestimate emission reductions obtained from China's Action Plan (Wang et al., 2021; Tong et al., 2020), which means that the impact of emission reductions that have already happened may be underestimated, thus may lead to underestimation of the impact of SLCF emissions reductions in China." Lines 513-516

36) This almost makes it sound like the blue line isn't there. Perhaps clearer to say "Only the red line is visibile in (g,h) as ssp......overlap"

Response: As suggested, we modified this sentence to make it clearer. Line 802

37) It may help to state that red indicates that model is over-predicting (is that correct? I think from the wording this is model minus obs). I assume the same convention was used for all the anomalies, and thus I think stating it once would be ok.

Response: As suggested, we added some description in the revise manuscript.

"The right column represents difference between CMIP6 and observations, so the red area in this column indicates that model is over-projecting." 806-807

38) Does this mean the areas with the lines? I am not used to seeing them called "slipped". Perhaps consider "areas with hatching" or "areas with lines". This comment is for all figures with this in this manuscript and in supplementary materials

Response: Thanks for your suggestion, we replaced "slipped" with "areas with hatching" in the revised manuscript.

39) g and h are the only ones that have lines in the individual scenarios (i.e. a and b don't have them).

Response: Thanks for your suggestion, we checked these figs, it is because in Figures 7a, b, d, e and k all models agree on sign across the entire study area. Also, the change of WSDI under SSP-3.70 had lines in small part of northern Asia and northern India (Fig. 7j).
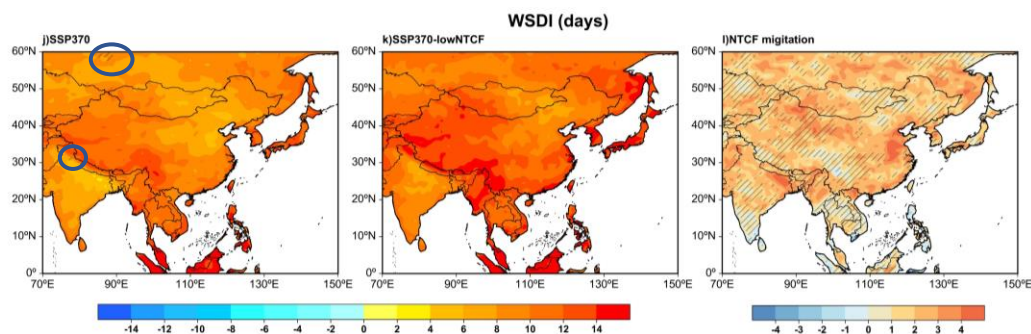


40) the numbers on person days for colour bar R95d is missing.

Response: Thanks for your suggestion, we corrected it in the revised manuscript

41) Comment on S/N method in supplementary material: I think stating that you did both 95th percentile confidence level with t-test and SN test here and they are the same so you are just showing one (as you explained well in author's response) would also strengthen this section. I recommend adding it in.

Response: Thanks for your suggestion, we added some description in the revised supplementary as follows.

"In addition, we also performed the test of confidence level on the MME result. The regions with

significance at ≥ 95 % confidence level from the t-test were broadly in line with those with signal-to-noise ratio larger than 1. So we only show the results of the signal-to-noise ratio here." Lines 20-22

42) Change word "slipped" in figure captions as I believe that is a typo.

Response: As suggested, we replaced "slipped" with "areas with hatching" in the revised manuscript.

43) Figure S4 g and h: This is the only one that shows the lines about S/N for the individual scenarios. Why is it not consistent with others (e.g. a, b)?

Response: Thanks for your suggestion, we checked these figs, it is because in Figures S4a, b, e ,j and k $S_{NR}$ > 1 across the entire study area. Also, the change of TX90p under SSP-3.70 had lines in small part of southern Asia (Fig. S4d).