Reply to Reviewers' comments (Reviewer#2)

Legend
Reviewers' comments
Authors' responses
Direct quotes from the revised manuscript

Reviewer #2: This study employs a high-resolution (1d, 1km) precipitation dataset to estimate spatially distributed PMP across China, and compares these estimates with two benchmark datasets. It focuses on analysing the trend of PMP over time, rather than providing a static estimate, and extends its investigation into future changes in PMP based on climate model outputs. The discussion section is thorough, touching upon several interesting topics. Overall, the manuscript is well-written, offering insightful findings and valuable data pertinent to China. I have no significant concerns but would like to offer a few suggestions for consideration in the manuscript revision:

Response: We thank Dr. Tang Guoqiang for his time in reviewing our manuscript and providing useful suggestions for improvement. Revisions for the manuscripts have been made in the new version, as suggested. Please find our specific response to your comments below.

Specific comments:

(1) Line 15: The manuscript mentions that the dataset integrates observations with machine learning algorithms (Section 2.1). Including a brief explanation (e.g., a few words) here could offer valuable context to readers.

Response: As suggested, we have added descriptions for the precipitation dataset in the Abstract to make it more informative to readers as:
Here, we use the finest spatiotemporal resolution (1d & 1km) precipitation dataset from an ensemble of machine learning algorithms to present the spatial distribution of 1d PMP based on the improved Hershfield method.

(2) Paragraph Structure: The manuscript frequently utilizes long paragraphs. I suggest breaking these into shorter, more digestible sections to enhance readability.

Response: Thanks for the suggestion. We have modified the paragraph structures throughout the revised manuscript for better readability.

(3) Figure 3: To aid in comparison, I recommend employing a consistent colour scale across all sub-figures.

Response: We have revised the figure into a consistent colour scheme for better inter-comparison in the new version (Figure 3):

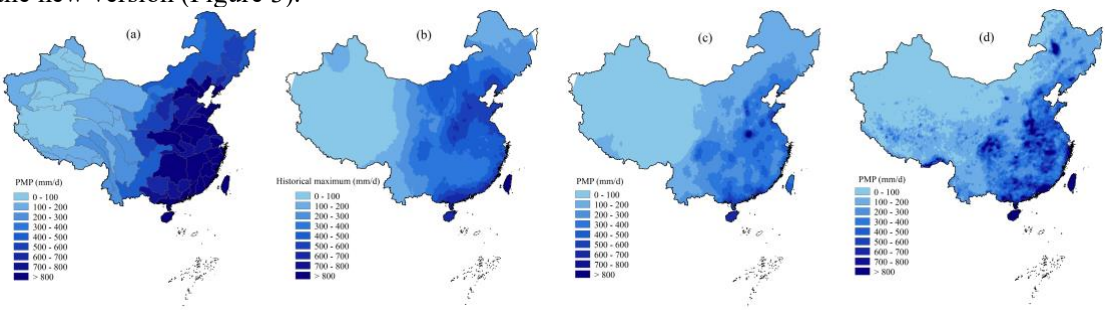

Figure 3: (a) Spatial distribution of field-based PMP over 80 secondary river basins (Wang, 2002). (b) Spatial distribution of recorded historical maximum daily precipitation (Wang, 2002, Table S4). (c) Spatial distribution of PMP based on in-situ daily precipitation during 1961-2014. (d) Spatial distribution of PMP results from the GPMM database.

(4) Figure 6: The patchy patterns observed, particularly in panels (d) and (e), warrant further explanation. Clarifying these patterns could enhance the reader's understanding of the underlying

data and analysis.

Response: The patchy patterns are caused by the opposite direction of trends in X_n' and K, leading to completely different distributions. This is more obvious where the PMP trend is dominated by K, which generally offsets the influences of X_n' and therefore presents extremely high and locally variable contributions. We have added more explanations for this spatial distribution in the revised manuscript as:

We observe the opposite trends in X_n' and K nationwide, resulting in the patterns of extremely high (low) relative contribution of K (X_n') over regions where PMP changes are controlled by the former (Figures 6d and 6e).

(5) Figure 8: The substantial discrepancy between UserSMIP and LFMIP-pdLC raises questions about the reliability of the findings. Incorporating the other reviewer's (Simon) comment for CMIP6 validation and bias correction might address these concerns and strengthen the manuscript.

Response: Thank you very much for the comment. The large differences between the two experiments are considered influences of land-atmosphere coupling, i.e., from the prescription of the climatology of soil moisture and snow. While we acknowledge considerable bias may exist in GCM outputs, the bias correction could not be performed because our study emphasizes the pair comparisons between ideal experiments, while the real-world observations are not available under such scenarios (i.e., LFMIP-pdLC). Given also the fact the chosen CMIP6 models (i.e., CMCC-ESM2, CNRM-CM6-1, EC-Earth3, IPSL-CM6A-LR, MIROC6, and MPI-ESM1-2-LR) reproduce fairly well observed daily extreme precipitation in China (Yang et al., 2021; Abdelmoaty et al., 2021). We attempt to constrain such uncertainties using the ensemble method with more available models (e.g., Qiao et al., 2023; Wei et al., 2023). We apply a total of six models that are the only ones providing daily precipitation variables in both experiments. We demonstrate the ensemble mean and individual projection of each model in the supplementary files to show the potential uncertainty range. Such procedures, to an extent, provide a reliable large-scale PMP projection over the country, which is the focus of this study.

We have added more explanations and justifications in Section 2.5 of the revised manuscript:

Despite the fact that the raw CMIP6 models can contain large bias for precipitation extremes, we could not perform the bias correction or the post-processing adjustments due to unavailable in-situ observations under the LFMIP scenarios. While the multi-model mean method is applied to constrain the individual model uncertainties in simulating precipitation extremes (e.g., Zhou et al., 2022; Qiao et al., 2023). The deviations across models are additionally illustrated in the supplementary files to reflect the model variance. Our findings provide a large-scale assessment of the future PMP changes over the country for policymaking and the local-scale investigations may further be supplemented by future field observations and climate models for informed decision-making.

Reference:

Qiao, L., Zuo, Z., Zhang, R., Piao, S. L., Xiao, D., & Zhang, K. W. (2023). Soil moisture–atmosphere coupling accelerates global warming. Nat. Commun., 14, 4908. https://doi.org/10.1038/s41467-023-40641-y

Wei, L., Xin, X., Li, Q., Wu, Y., Tang, H., Li, Y. & Yang, B. (2022). Simulation and projection of climate extremes in China by multiple coupled model Intercomparison project Phase 6 models. Int. J. Climatol. 43, 219–239. https://doi.org/10.1002/joc.7751

Abdelmoaty, H. M., Papalexiou, S. M., Rajulapati, C. R., & AghaKouchak, A. (2021). Biases beyond the mean in CMIP6 extreme precipitation: A global investigation. Earth's Future, 9(10), e2021EF002196. https://doi.org/10.1029/2021EF002196

Yang, X., Zhou, B., Xu, Y. et al. CMIP6 Evaluation and Projection of Temperature and Precipitation over China. Adv. Atmos. Sci. 38, 817–830 (2021). https://doi.org/10.1007/s00376-021-0351-4