

RC1

This study investigates the future changes in spatiotemporal precipitation patterns of the East Asian Summer Monsoon (EASM) using CMIP6 models. It evaluates model performance, assesses future projections, and analyzes uncertainty factors. This study is meaningful but lacks more in-depth discussions on certain aspects. It is recommended that these areas be revised and clarified prior to publication.

Major comments:

1, The object of this study is the spatiotemporal precipitation patterns in East Asian. The two metrics (the time of northward movement of the monsoon band and peak of the monsoon band) might partly describe the spatiotemporal precipitation patterns. Did authors compare to other metrics or choose other methods?

Thank you for the insightful point. We will provide more detailed explanations on the precipitation indices in comparison with other East Asian monsoon circulation and timing indices as appropriate (e.g., Wang et al. 2008; Ha et al. 2020). We will also highlight the advantage of our indices in terms of representing the intraseasonal evolution of monsoon rain bands for East Asia and its three subregions by conducting further observational analyses using pentad precipitation data.

Wang, B., Wu, Z, Li, J., Liu, J., Chang, C.-P., Ding, Y., & Wu, G. (2008) How to measure the strength of the East Asia summer monsoon. *Journal of Climate*, 21, 4449- 4463.

Ha, K.-J., Moon, S., Timmermann, A. & Kim, D. (2020) Future changes of summer monsoon characteristics and evaporative demand over Asia in CMIP6 simulations. *Geophys. Res. Lett.* 47, e2020GL087492.

2, I would like to know, in the context of Moisture Budget Analysis, which processes influence the thermodynamic and dynamic terms—are they driven by global warming or regional sea surface temperature changes?

Thank you for the useful comment. Agreeing that identifying processes associated with the thermodynamic (TH) and dynamic (DY) terms is important, we will improve our interpretations of the physical mechanisms associated with the future precipitation change patterns. We will add more discussions on TH and DY effects by analyzing their relation with global warming and regional SST changes. Specifically, we will perform an inter-model regression analysis, following Zhou et al. (2020) and Huang et al. (2022). By regressing the model TH and DY terms against the low-level circulation and SST changes in the future, we will try to identify modeling factors associated with the inter-model spread in TH and DY in East Asia and provide associated discussions in the manuscript.

Zhou, S., Huang, G., & Huang, P. (2020). Inter-model spread of the changes in the East Asian summer monsoon system in CMIP5/6 models. *Journal of Geophysical Research: Atmospheres*, 125, 2020JD033016.

Huang, D., Liu, A., Zheng, Y., & Zhu, J. (2022). Inter-Model Spread of the Simulated East Asian Summer Monsoon Rainfall and the Associated Atmospheric Circulations From the CMIP6 Models. *Journal of Geophysical Research: Atmospheres*, 127, e2022JD037371.

3, Additionally, I suggest the authors provide a more detailed analysis of regional differences and their causes. For instance, it seems to me that compared to the other two regions, the models perform less effectively in simulating precipitation over China (Huang et al., 2022; Wang et al., 2020).

Reference:

Huang, D., Liu, A., Zheng, Y., & Zhu, J. (2022). Inter-Model Spread of the Simulated East Asian Summer Monsoon Rainfall and the Associated Atmospheric Circulations From the CMIP6 Models. *Journal of Geophysical Research: Atmospheres*, 127, e2022JD037371. <https://doi.org/10.1029/2022JD037371>

Wang, B., Jin, C., & Liu, J. (2020). Understanding Future Change of Global Monsoons Projected by CMIP6 Models. *Journal of Climate*, 33(15), 6471–6489. <https://doi.org/10.1175/JCLI-D-19-0993.1>

Thank you for the valuable suggestion. Agreeing that regional differences require more detailed analysis, we will compare inter-model spread across the three subregions and examine the potential causes of discrepancies across regions focusing on moisture budget analysis. For example, during the northward migration period, the inter-model differences in future precipitation changes are similar across all three subregions, but dynamic (DY) term exhibits a regional difference; i.e. smaller inter-model differences in China than the other two regions. We will try to identify factors (like atmospheric circulations and SST patterns) associated with the regional difference using composite and/or inter-model regression analyses.

4, Based on Fig.4, it indicates that the contribution of M to total uncertainty is dominant. What are the physical mechanisms for the model uncertainty is an important question. That means quantifying the model uncertainties and trace the sources are also important to understand the precipitation regime changes in the warming future. As I understand this is not the key focus of the paper, I think you could provide some hypotheses in the discussion section.

Thank you for the good point. We agree that providing discussions regarding the sources and mechanisms of model uncertainty would enhance the discussion and offer valuable context for future research. Building on our further analysis described above, we will outline key factors for model uncertainty and discuss their roles in shaping future changes in East Asia monsoon precipitation.

Minor comments

1, Line 61: predictàprojection?

We will correct it as 'projection'.

2, Line 120, it is suggested to clarify the meaning of the subscript "REF" for better understanding.

"REF" refers to the climatology period, so we will change it to CLIM.

3, Authors have compared the results based on CMIP5 and CMIP6. However, it seems less differences between them.

They look similar in terms of future projections but we will further check detailed features for which CMIP6 models exhibit differences from CMIP5 models and discuss them in the revised manuscript.

4, Fig.1 ,Fig.2 , It should clarify how does red and blue boxes define.

We will revise the figure captions to better define those boxes.

5, Fig.3, What does the dashed lines mean?

We will explain the meaning of dashed lines (zero lines) in the figure caption.