We thank the reviewers for the valuable comments that contributed to a substantially improved version of the manuscript. The major changes resulting from the two reviewer reports obtained are:

- adding further model evaluation criteria (interannual variability, spatial distribution, 850hPa wind) resulting in some changes in the selected model set

- focusing the results on the best performing models only, called TOP6 throughout the manuscript and adapting previous results accordingly

- focusing on area that additionally fulfills monsoon definition (JJA minus DJF rainfall exceeds 2 mm/day) and providing results only based on this area

- using observational data (GPCC) instead of reanalysis data (W5E5) for reference

- discussing underlying physical mechanisms for changes in mean circulation (wind 850 hPa)

- adding a significance measure to give insight into the robustness of the projections following IPCC standards

- adding new subchapter regarding the wet bulb temperature projections

We are looking forward to further feedback from the reviewers.

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Reviewer #2

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General comment:

This study examined future changes of East Asian Summer Monsoon (EASM) including seasonal mean precipitation, interannual variability and extreme wet seasons using CMIP6 models. According to the simulated magnitude of regional, seasonal mean precipitation, the CMIP6 models are divided into two groups. The projections are then based on the group of models with reasonable magnitude of EASM precipitation. It is shown that mean precipitation, interannual variability and extreme wet seasons of EASM will increase in the future under different SSP scenarios.

However, the current analyses lack significance and robustness in a few aspects.

Firstly, many methods are inappropriate.

(1) The model evaluation is based on regional mean and seasonal mean precipitation over East Asia. But the EASM is a complex system, in which the monsoon circulation and spatial pattern of precipitation is very important. Hence this evaluation metric is insufficient to represent the EASM, which means that the model selection is not robust.

We added a broader set of model selection criteria including:

- The mean JJA rainfall is within two standard deviations of the observed mean in the GPCC dataset (1995-2014).

- The model's standard deviation is within plus/minus 50% of the observed GPCC standard deviation (1965-2014).

- The centered root mean square error (CRMSE) is smaller than 2 mm/day (1995-2014).

- The main features of the EASM circulation (southwest winds originated from the Bay of Bengal and western flank of the tropical Western Pacific High) are captured according to the JRA-55 dynamics (1995-2014)

In the revised manuscript, we performed the model selection on basis of these criteria resulting in 6 models with better performance regarding the EASM that we call TOP6. We provide new figures and a new table to present the results. Besides, we adapt all results throughout the paper accordingly.

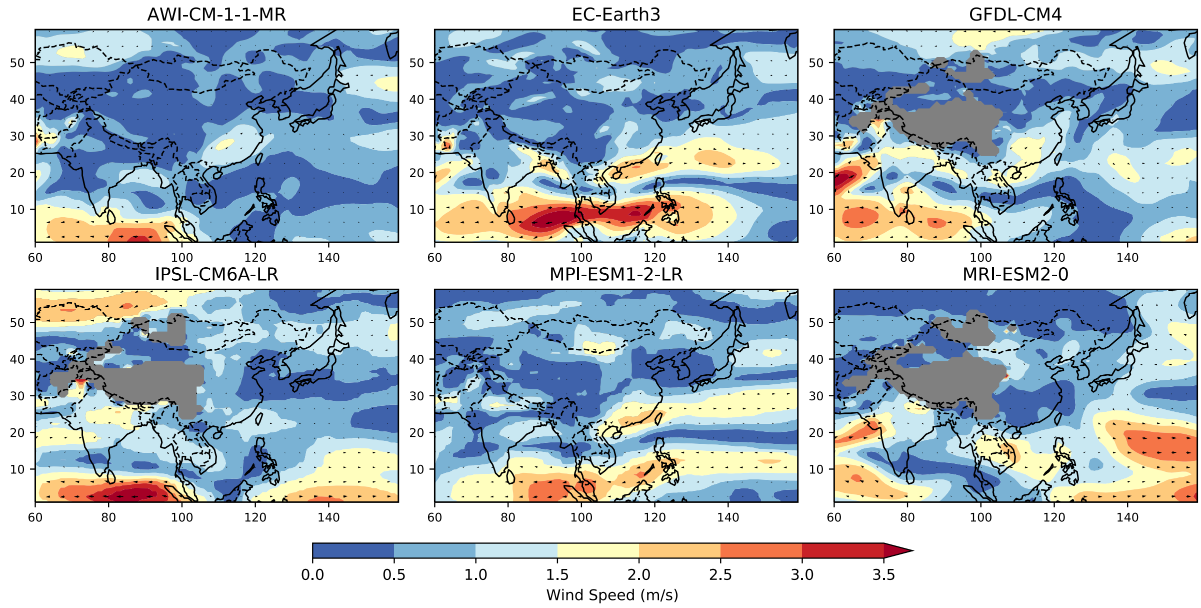

Figure 1. Wind vectors at 850hPa and wind speed (m/s) for 1995-2014 for the CMIP6 models with best performance regarding EASM (TOP6).

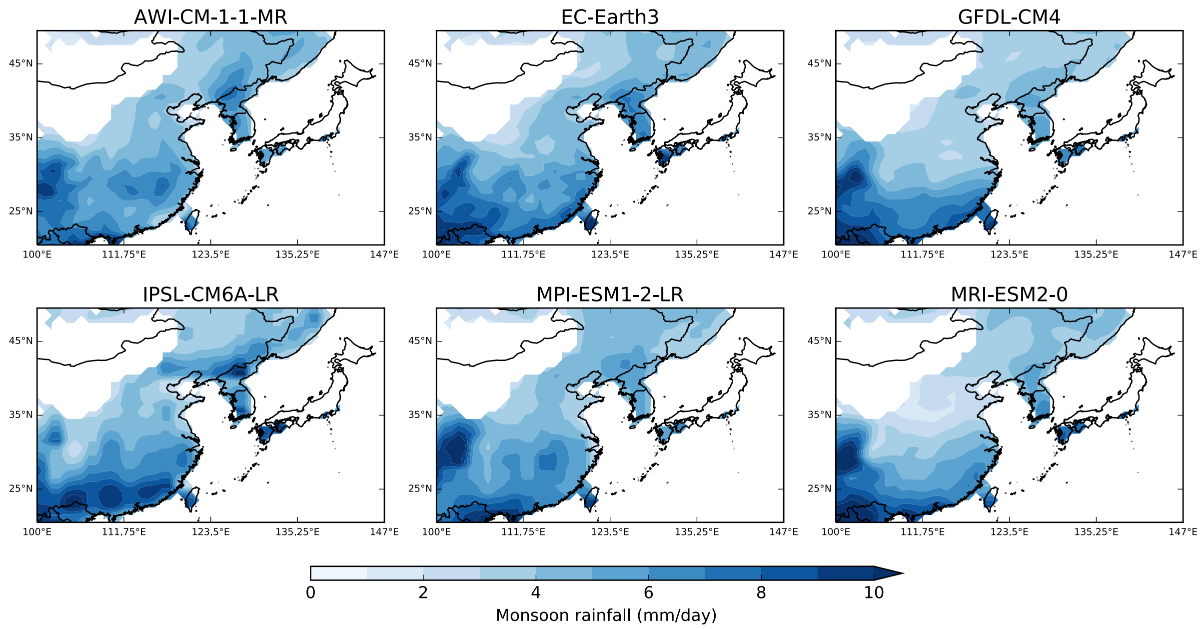

Figure 2. Spatial distribution of EASM averaged over the period 1995-2014 from the TOP6 CMIP6 models

(2) Reanalysis, rather than observational data, is used to evaluate the model simulated precipitation. As there are many observational datasets (e.g., APHRODITE, GPCC, GPCP) in East Asia, they should be used for model evaluation.

In the revised manuscript, we use GPCC as observational reference data.

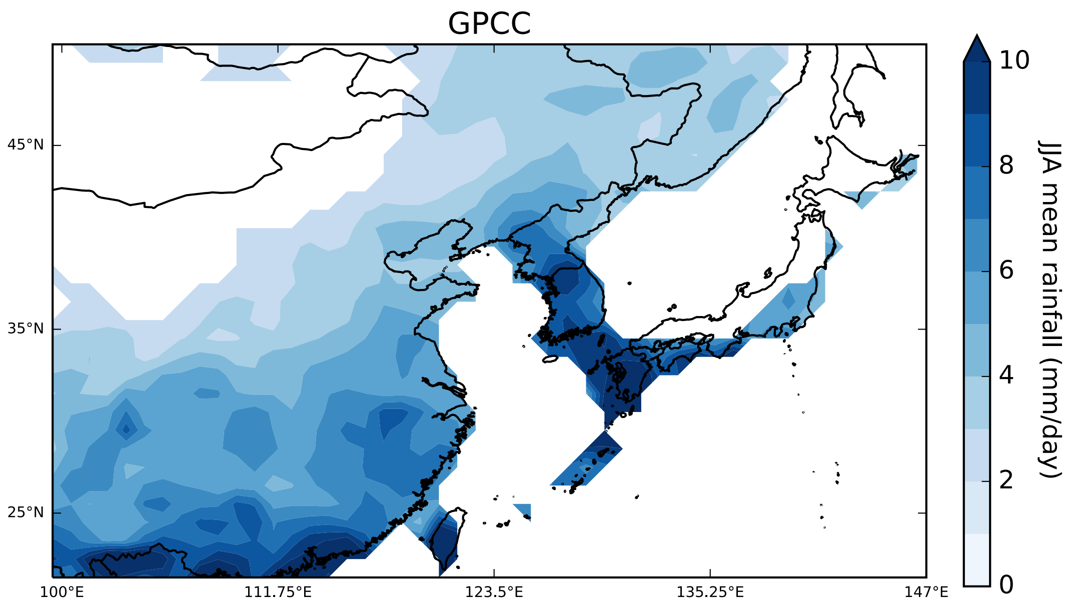

Figure 3. Spatial distribution of EASM averaged over the period 1995-2014 (GPCC data).

(3) As the focus is the EASM, the EASM domain could be defined more appropriately, taking into account many proposed definitions in previous studies.

We adapted now the definition for monsoon domain following the IPCC AR6 (JJA minus DJF mean rainfall exceeding a threshold of 2mm/day).

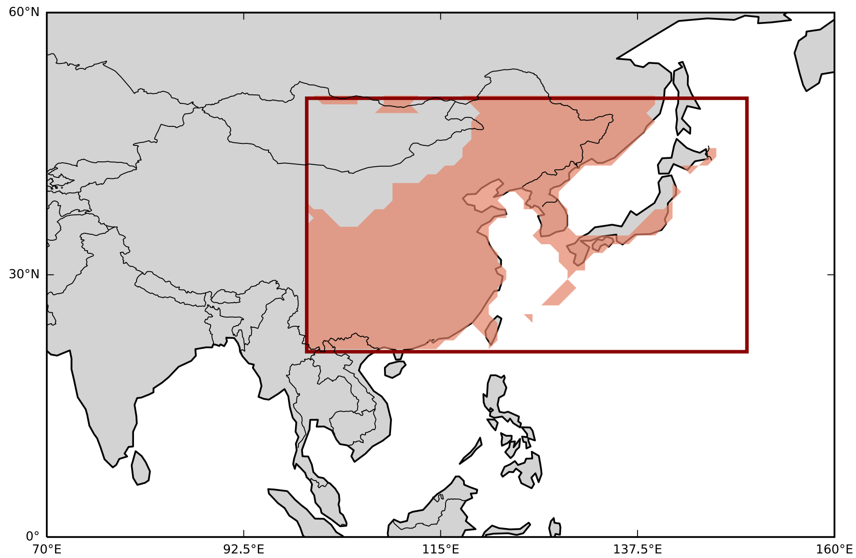

Figure 4. East Asian summer monsoon area within 20-50°N and 100-150°E as covered in the revised manuscript.

(4) Significance test for projected changes needs to be included. These limitations in methods weaken the robustness of the results.

We added significance checks following the IPCC AR6: The signal is classified as robust, where >=66% of models show change greater than the variability threshold and >=80% of all models agree on sign of change.

Secondly, no physical understanding is provided at all. The study focuses on model simulated change in regional mean EASM precipitation, but no physical understanding of EASM change is provided.

We added a discussion regarding the changes in the mean circulation and the underlying physical dynamics. We also provide the MME changes of TOP6 model in 850hPa wind.

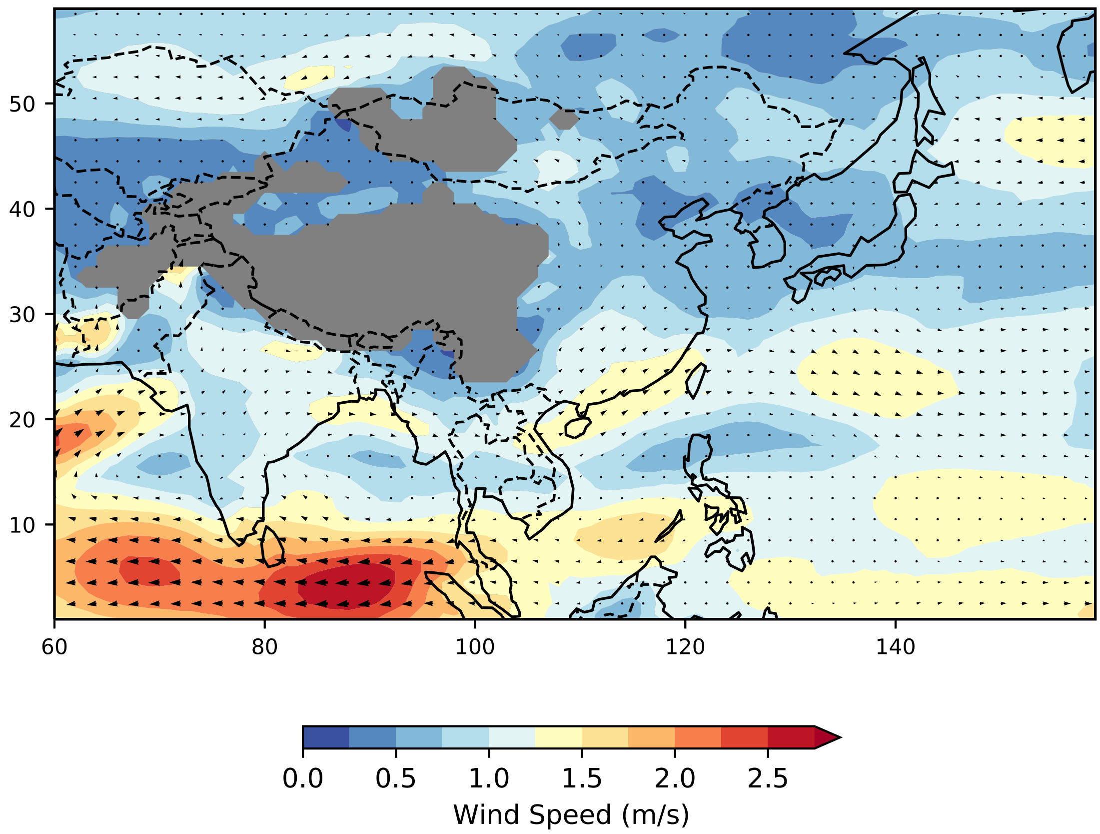

Figure 5. Changes in wind vectors at 850hPa and wind speed (m/s) for 1995-2014 for the CMIP6 models with best performance regarding EASM (TOP6 Multi-model mean).

Most importantly, the scientific question needs to be refined in order to improve our current knowledge about EASM change. There have been plenty of papers investigating the future changes of EASM covering a wide variety of aspects, including process-based projection, spatial pattern of precipitation change, thermodynamic and dynamic processes of monsoon precipitation change, changes in monsoon duration, northern boundary, extremes (see a few references below and references therein). For example, based on CMIP6 multi-models, there is dynamic-based projection of EASM rainfall and variability (Xue et al., 2023), projection of monsoon rainfall and duration with thermodynamic and dynamic understanding (Moon and Ha, 2020; Ha et al., 2020). Overall, these studies so far have provided a relatively robust understanding of future EASM change based on GCMs. The current study, unfortunately, does not add improvements in our current knowledge. Thus, the authors need to evaluate carefully the current knowledge gap regarding EASM change and refine the scientific questions to be investigated.

References:

Xue, D., Lu, J., Leung, L.R. et al. Robust projection of East Asian summer monsoon rainfall based on dynamical modes of variability. Nat Commun 14, 3856 (2023). https://doi.org/10.1038/s41467-023-39460-y

Moon, S., Ha, KJ. Future changes in monsoon duration and precipitation using CMIP6. npj Clim Atmos Sci 3, 45 (2020). https://doi.org/10.1038/s41612-020-00151-w

Ha, K.-J., Moon, S., Timmermann, A.,& Kim, D. (2020). Future changes of summer monsoon characteristics and evaporative demand over Asia in CMIP6 simulations. Geophysical Research Letters,47, e2020GL087492.https://doi.org/10.10

To our knowledge, none of the listed or other existing studies provides insights regarding the interannual variability and associated extremely wet seasons (while extremes on other scales have been discussed). Besides, no other study provides the projections for the monsoon region over China specifically, which is of high relevance for policy makers. Besides, most of these studies regarding future projections lack a model selection process that is tailored for the specific EASM region.

However, we are delighted to add a further section regarding the wet bulb temperature projections over the region in the revised manuscript.