

**Title:** Climate variability can outweigh the influence of climate mean changes for extreme precipitation under global warming

**General comments:**

The authors have highlighted that changes in precipitation variability may contribute more significantly to the frequency of extreme precipitation events than changes in mean state of precipitation under global warming scenarios in fully coupled Earth System Models (ESMs) of CMIP6. Additionally, they suggest that the reduction of aerosol emission could potentially increase the frequency of extreme summertime precipitation events over Asia, though there remains some model uncertainty.

This manuscript is well-organized, and provides valuable insights into the connection between changes in precipitation variability and the frequency of extreme precipitation events under global warming. It also highlights the importance of aerosols in the frequency of Asian extreme precipitation events under global warming scenarios. However, the manuscript has some unclear points that could benefit from further clarification. I hope my comments will help enhance the quality of this manuscript.

**Specific comments:**

1. L33–34:

Could you clarify how Asian aerosol emissions affect Arctic temperatures and the Australian monsoon? Local aerosol emission could result in direct radiative forcing through advection and could occur teleconnection pattern through forced Rossby waves. It would be great to clarify this part to justify next sentence about the impact of aerosol emission on local and remote regions.

2. L75–90:

This part is a little bit confusing, making it difficult to understand the method. I have a few questions and suggestions for clarification:

- 1) What is meant by “single-model initial-condition large ensembles” in this section?
- 2) From “the second step ~ “, did you remove the annual cycle from your definition of ‘variability’?

3) You defined an extreme event as one that exceeds the 0.999<sup>th</sup> quantile (~99.9<sup>th</sup> percentile) in one instance and then used a different definition of extreme events as those that exceed 99<sup>th</sup> percentile elsewhere.

I recommend clarifying this part of the methodology for the readers.

3. L130–138:

The authors described the overall features of daily precipitation variability driven by anthropogenic forcings. However, they presented results from only three models and particularly highlight NorESM, which has the weakest response of variability to doubled CO<sub>2</sub> levels. Is there specific reason why the authors chose to display results from only these models?

Furthermore, the authors mentioned that “these changes correlate with changes in the SD.”, providing only a range of correlation coefficients from 0.22 to 0.49. I am curious about which region’s variability could be explained by changes in the SD. I recommend including a spatial map to show the correlation between changes in SD and variability.

4. L157–167:

The authors highlighted the important role of precipitation variability in the frequency of extreme precipitation events. Do you have any thoughts on which timescale of variability (or which physical phenomena) is associated with this?

5. L182–184:

Is there figure for this example about ACCESS-ESM1-5?

6. L196–199:

This part is difficult to understand, specifically how the authors extracted the effect of aerosols from the difference between SSP3-7.0 and SSP1-2.6. Could you explain more details in why this difference represents the effect of aerosols?

7. L209–216:

Does this part mean that CanESM5 and ACCESS-ESM1-5 show more reasonable response of precipitation extreme frequency to aerosol emission change?

8. L220:

Could you explain why the authors chose these regions?

9. L226 –230:

ACCESS-ESM1-5 doesn't seem to be widen across different GWL.

**Technical corrections:**

1. L14:

2020-2040 → 2020–2040

2. L28, L29:

Chen et al. (2021) → (Chen et al., 2021)

Samset (2022) → (Samset, 2022)

3. L31, L33:

emissions(... → emissions (

temperatures(... → temperatures (

4. L82:

‘ ‘ → “

5. L97:

timeperiod → time period

6. L121:

asses → assess

7. L124:

Typo? year2000

8. L144:

test test → test

9. L191:

B2, B3 → B2, and B3

10. L237:

CanEMS5 → CanESM5