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Comment on wcd-2022-53

Paul-Arthur Monerie

Community comment on "Future changes in the mean and variability of extreme rainfall indices over the Guinea coast and role of the Atlantic equatorial mode" by Koffi Worou et al., Weather Clim. Dynam. Discuss., https://doi.org/10.5194/wcd-2022-53-CC1, 2022

Review of "Future changes in the mean and variability of the extreme rainfall indices over the Guinea coast and role of the Atlantic equatorial mode" by Koffi Worou, Thierry Fichefet, and Hugues Goosse.

The authors assess the future evolution of precipitation characteristics (*e.g.*, extreme rainfall events) and the effects of changes in the Atlantic equatorial mode on Guinea coast precipitation variability and on rainfall indices. The topic is relevant for the scientific community and could help understanding better future changes in precipitation over West Africa.

I have several concerns that should be assessed before considering the study for publication.

- The novelty of the work is unclear. All results on changes in precipitation extremes have already been shown in the literature, and the section on the effects of the Atlantic Equatorial mode is not convincing. Please explain better what is the novelty of the study.
- The introduction is too long, and its structure could be revised, with the information streamlined to provide a summary of the literature. For instance, information from Bichet and Diedhiou (2018), Odoulami and Akinsanola (2017), and Kpanou et al. (2018) is for different seasons (*g.*, AMJ, JAS), for different periods, and different metrics. Information seems also contradictory, with Odoulami and Akinsanola (2017) stating that there is a negative trend in extreme events (relative to the 95th percentile) over the Guinea coast while Kpanou et al. (2018) state that the number of such events has increased over some of the West African countries (Ivory coast, Togo, and Benin).
- The authors have used monthly SSTs to compute the AEM index. Please explain how monthly variabilities in SSTs could lead to changes in the variability of rainfall extremes.
- Method: The authors defined an anomaly as robust when 50% of the models present a significant regression coefficient. However, this low value could be eventually obtained by chance and would not show robustness in the results. The authors should revise this threshold, using the two-thirds threshold used for the sign of the EnsMean. Data have been linearly detrended. However, it is shown that anthropogenic aerosols have strong effects on West African precipitation and have driven a part of the 1970s-1980s drought and of the precipitation recovery (*e.g.*, Herman et al., 2020, Hirasawa et al. 2020; Monerie et al. 2022). Removing a linear trend will thus not allow considering the

full effect of the anthropogenic activity on West African precipitation. The authors should check the robustness of the results using other methods, such as estimating the forced response using the ensemble mean (see for instance Ting et al. 2009).

- The authors argue that future changes in the variability of the Atlantic equatorial mode would have significant effects on future variability in precipitation extremes. However, the authors should that there is no relationship between the Atlantic equatorial mode and the precipitation indices over land (Figure 5). How could it then be possible that changes in the Atlantic equatorial mode could impact precipitation extremes over land? Please explain. Here I strongly disagree with the comments on lines 326-327, and 336-337, which are not supported by the results. Would averaging precipitation over the box be useful to extract a significant signal in the relationship with the Atlantic equatorial mode?

  It is highlighted in the conclusion that "extreme rainfall anomalies related to one standard deviation of the AEM under the present-day conditions are barely significant over the Guinea coast". Please note that those anomalies are not significant, not barely significant.

In the abstract, it is stated that "the decreased variability of the AEM in a warmer climate leads to a reduced magnitude of the rainfall extreme response associated with AEM". (i) This will be more about a weaker effect of the AEM than because of a reduced variability of the AEM, because the AEM index is standardized, and Figure 8 shows reduced effects of the AEM for one standard deviation. (ii) It is argued in the introduction that the EAM effect on rainfall is stationary. This is here contradictory to the comments of the authors, please comment. The authors show the change in the regression patterns of the JAS extreme rainfall indices associated with the standardized JAS AEM SST index (Figure 8). It would be best to also know if the regression coefficient is significant over the 2080-2099 period (*i.e.*, as for figure 5 but for the period 2080-2099). This would help understand the results of the authors.

Ting, M., Kushnir, Y., Seager, R., & Li, C. (2009). Forced and Internal Twentieth-Century SST Trends in the North Atlantic, Journal of Climate, 22(6), 1469-1481. Retrieved Nov 4, 2022, from https://journals.ametsoc.org/view/journals/clim/22/6/2008jcli2561.1.xml

Herman, R.J., Giannini, A., Biasutti, M. *et al.* The effects of anthropogenic and volcanic aerosols and greenhouse gases on twentieth century Sahel precipitation. *Sci Rep* **10**, 12203 (2020). https://doi.org/10.1038/s41598-020-68356-w

Monerie, P., Wilcox, L. J., & Turner, A. G. (2022). Effects of Anthropogenic Aerosol and Greenhouse Gas Emissions on Northern Hemisphere Monsoon Precipitation: Mechanisms and Uncertainty, Journal of Climate, 35(8), 2305-2326. Retrieved Nov 4, 2022, from https://journals.ametsoc.org/view/journals/clim/35/8/JCLI-D-21-0412.1.xml

Hirasawa, H., Kushner, P. J., Sigmond, M., Fyfe, J., & Deser, C. (2020). Anthropogenic

Aerosols Dominate Forced Multidecadal Sahel Precipitation Change through Distinct Atmospheric and Oceanic Drivers, Journal of Climate, 33(23), 10187-10204. Retrieved Nov 4, 2022, from https://journals.ametsoc.org/view/journals/clim/33/23/jcliD190829.xml

Additional comments

Lines 33-35 are about future changes in heavy precipitation trends, but the following part of the paragraph (lines 35-39) is about the total wet day rainfall and rx5day. There is therefore no rationale for the "for instance" of line 36. Lines 38-39: What "could be" mean here in terms of confidence?

Lines 40-47: What the authors are trying to demonstrate is not clear. Is there a spatial inhomogeneity in changes in rainfall indices, or is it about the complexity of changes in precipitation characteristics, that will be rainfall indices-dependent? Please rephrase the text to show the main point of the paragraph more clearly.

Line 48: Is this information obtained from observations?

Lines 61-69: Do the authors note a relationship between bias in the different rainfall indices and bias in seasonal mean precipitation?

Line 71 and Line 72: "anthropogenic emission of greenhouse gases", and "the shared socioeconomic pathway scenarios". Please name the scenarios

Line 74: The sentence is about RX1day and RX5day while the previous sentences are about extreme events. Please be clearer.

Line 77: "RCM-CMIP5" Please define and explain.

Lines 75-79: Are the results also model-dependent?

Line 80: Does "These simulations" refer to Akinsanola and Zhou (2019)? Please be more specific.

Line 89: both enhanced.

Lines 94-96: The increase in air moisture following Clausius Clapeyron explains a part of the seasonal mean increase in water vapor. I am puzzled about how the increase in water vapor, following Clausius Clapeyron could lead to a change in precipitation variability. Do the authors mean that it would be due to a change in variability of the temperature (SSTs) that would lead to different changes in air moisture?

Line 103: Please replace "More" with ", where"

Line 107: "warming and cooling", is that following a north/south dipole? Please be more specific.

Lines 113-114 could be shortened, removing "The first mode…indicates a strong", and removing ", and", in line 115.

Line 115: Is it the "total variability" in Guinea coast rainfall? What is the time scale considered for the variability? (*e.g.*, daily, interannual?).

Line 116: Is it about the wind convergence?

Line 124: "variability of the AEM". Is it the daily variability? Please be more specific throughout the text.

Lines 205-215: The authors could add sentences to explain briefly why the authors are using these metrics.

Lines 225-230: Are the changes in rainfall indices following the changes in seasonal mean precipitation (sign and pattern)?

Line 225: "simulated by climate models". The authors are not showing the results for each model individually in Figure 1. Please change it to "shown by the CMIP6 ensemble mean".

Line 230: “observations”. Shown where?

Lines 236-246: Are these results model-dependent?

Figure 1: It would be helpful to have the observation with contours.

Lines 261: There are plenty of references on the change in seasonal mean precipitation over West Africa and over the Sahel. Please acknowledge the literature.

Lines 272-273: Is the change in RX1day consistent with the shortening of the rainy season over the western Sahel?

Figure 3: The pattern of R10mm is very similar to the pattern of PRCPTOT (Figure 3). The authors could comment on the possible strong role of R10mm in the total change in precipitation. Does R10mm provide a similar result for the number of rainy days?

Line 285: What is the timescale used for computing the standard deviation here?

Lines 311-312: As for the precipitation indices, result sensitive to how the forced response was removed? (*e.g.*, a linear trend here)

Line 314: “total wet-day precipitation index” does not show significant differences over land in Figure 5.

Line 364: “weakened variability”. What is the considered time scale?

Line 375-377: Are differences between periods significant? How would this be consistent with Figure 5 which shows no robust effects of the tropical Equatorial mode on precipitation extreme over land?