

Review of “Historical and Projected Changes in Temperature–Precipitation Compound Hot and Dry Extremes across Africa Based on CMIP5 and CMIP6 Ensemble Simulations”

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General comments

This work assesses current and projected trends in hot-dry compound events across the African continent, utilizing CMIP5 and CMIP6 climate model ensembles. The evaluation covers the full set of RCP and SSP scenarios, respectively, across three main periods: historical (1975-2005), near-future (2035-2065), and end-of-century (2070-2100). The authors find an overall increase in the frequency, duration, and magnitude of compound events, primarily driven by a homogenized temperature increase across the continent. Spatial patterns, however, are largely determined by precipitation variability. The systematic analysis reveals regional differences in seasonality and scenario dependence. These results contribute to the understanding of compound hot-dry extremes for Africa, a region underrepresented in current studies. Therefore, I find this manuscript suitable for publication in NHESS. Nevertheless, some points require clarification before acceptance. Please find my detailed comments below.

Specific comments

Sections 1-2

- **Analysis of monthly events:** While using monthly data is computationally efficient and standard for climatic averages, it may not fully capture short-duration, high-impact compound events (e.g., a week-long heatwave coinciding with a dry spell) that have devastating agricultural and socio-economic impacts. I understand the authors’ decision to analyze longer events, but they should consider including a discussion of relevant previous studies on this topic.
- **1144:** I suggest starting a new paragraph when introducing CMIP5.
- **1232:** The statement, “*Following established methodology in the compound extremes literature (Zscheischler and Seneviratne, 2017; Manning et al., 2019; Bevacqua et al., 2022), compound hot-dry events are defined as months simultaneously satisfying two conditions...*”, is not fully accurate, as not all cited references define monthly compound events. Please revise the statement.

Section 3.1

- **Figure 1:** This figure compares observed and modeled mean annual changes. Since the study focuses on extreme temperature-precipitation events, a validation approach better suited for evaluating extremes (i.e., the tails of the distributions) is recommended. Models that accurately simulate average conditions can still perform poorly for extreme events. Relying solely on mean trends may provide an incomplete or misleading picture of model skill. I advise extending the model validation to assess performance regarding extremes rather than just the mean climate.
- **I305:** The text states, “*The Sahara emerges as the most rapidly warming region ($0.23^{\circ}\text{C decade}^{-1}$)*”, but this is not reflected in the observations, only in the CMIP ensembles. Please clarify.
- **I312:** The statement, “*Both CMIP5 and CMIP6 ensembles reproduce the broad spatial pattern of continental warming with notable fidelity*”, is not entirely accurate over the Sahara and southwest Africa. Do the authors have an explanation for the warming hole over Angola, the Democratic Republic of Congo, and parts of Zambia? Acknowledging this discrepancy is necessary.
- **I320-321:** The text says, “*with West Africa experiencing the strongest positive trends ($3.24\text{ mm decade}^{-1}$)*”. This is most pronounced in CMIP6, somewhat in CMIP5, but is not exactly true for observations, where the whole Sahel region shows a wetting trend. Please clarify.
- **I324:** The claim, “*Central and northeastern Africa show significant moistening*”, is not clearly supported by any single dataset. Observations show a lack of wetting in Central Africa (CAF); CMIP5 shows weak trends for Northeast Africa (NEAF) and Southeast Africa (SEAF); and CMIP6 shows the largest trends over CAF and West Africa (WAF). Please correct or clarify this statement and specify which dataset you are referring to.
- **I341:** Do the authors mean “... and during austral spring (SON) in western Southern Africa”? Figure S4 shows West Southern Africa (WSAF) has larger temperature trends than East Southern Africa (ESAF). Please verify.
- **I354-364:** I suggest moving these lines up before presenting the results of supplementary Figures S1-S4 for better flow. The authors are already discussing results from panels (g-h) showing regional-averaged values, so they just need to cite them appropriately. This would also allow the supplementary seasonal analysis to close Subsection 3.1.
- **General comment for Section 3.1:** Please clearly indicate which dataset (e.g., observations, CMIP5, or CMIP6) you are referring to for the stated trends.

Section 3.2

- **l381:** Does “*Under continued high emissions*” refer to the highest emission scenarios? Please specify.
- **l389:** Start a new paragraph when discussing precipitation projections to create a more balanced text.
- **l394:** The statement, “*Southeast Africa presents the strongest wetting signal*”, is inaccurate. The largest changes in precipitation occur in NEAF. It would then make sense to continue with, “*In contrast, southern African regions (WSAF, ESAF)...*”.
- **l400:** For clarity, add “*by 2070-2100*” to the sentence about maximum Saharan warming during JJA.
- **Section 3.1 & 3.2:** Please start new paragraphs for the precipitation changes to clearly separate them from the temperature changes.
- **l408-409:** The statement, “*Madagascar experiences year-round drying, with the strongest during DJF (−5 to −12%)*”, is not accurate for DJF and MAM, particularly for CMIP6. Please revise.

Section 3.3

- **Figures 3 and 4:** I strongly advise using the same units for panels (a-h) and (i-j). Please make the appropriate changes to the text. For example, l433 states, “... (WSAF) experiences compound frequencies of 0.26–0.41 months per year (CMIP5) and 0.33–0.43 months per year (CMIP6)...”. It would be more natural to use the same units as in the figures (months/year, with values between 1-5 months/year) in both the text and the figures.
- Include panel numbering in the text whenever appropriate throughout the manuscript.
- **l339:** The phrase “*compound frequencies*” is vague. Perhaps the authors mean “*increases in compound frequency*”?
- **l444-445:** The text notes that Tropical African regions show consistently lower compound frequencies. This also applies to the Sahara (SAH). Why was it not mentioned here?
- **l463-464:** The difference between CMIP5 and CMIP6 projections for WSAF is marginal, as stated (“*though the difference is modest*”). This does not seem relevant for the discussion, as it is just one scenario, in one period, and one region. I suggest reconsidering its inclusion.
- **l467:** The number “*0.10–0.16 months per season*” does not coincide with Figure S13. Please check and correct.

- **l469-471:** The statement, “*In MAM, elevated compound frequencies extend across the Sahel and southern Africa, with end-century values commonly exceeding 0.08–0.14 months per season...*”, is not true for CMIP6. Please clarify if only CMIP5 values were considered or correct the statement.

Section 3.5

- **l630-632:** The text states, “*MDG exhibits pronounced scenario sensitivity, transitioning from moderate vulnerability under low emission pathways to high vulnerability under strong warming.*” This information is not evident in Figures 7 or 8. Please cite the specific figure and panel to support this claim. The same applies to other parts of the manuscript.
- The last paragraph of this section appears more suitable for the Conclusions.

Section 4

- Please include figure references where appropriate. The paper highlights a good number of results, but it is difficult to pinpoint their origin.
- **l735-737:** The text mentions that West Africa experiences compound frequency increases from 0.08–0.15 months yr^{−1} at mid-century to 0.11–0.22 months yr^{−1} by 2070–2100 under high emissions. According to Figure 3, NEAF and SEAF show similar mild increases, and NEAF even has lower trends. Why did the authors only mention WAF?

Technical corrections

- **Title:** I suggest trimming the title to: *Historical and Projected Changes in Compound Hot and Dry Extremes across Africa Based on CMIP5 and CMIP6 Ensemble Simulations*. The words “Temperature–Precipitation” do not add additional information.
- **Methods Section:** I recommend condensing the Methods section to better highlight the main results (e.g., 2.2, 2.3 and 2.5 subsections).
- **l236-239 and l244-247:** These lines are repeated. Please correct.
- **Figures 3-6:** Fix the panel labeling; the labels overlap with the figure corners.
- **Subregions:** The eight African subregions (from Iturbide et al. 2020) are not presented in the figures. I strongly suggest updating the figures to include these subregions (perhaps drawn over or instead of the country outlines). Also, include abbreviations for each region in the text or the caption of the first figure where they appear. In l302, the manuscript mentions nine subregions; please correct this to eight.
- **Figures 1-4:** The order of regions presented changes from Figures 1-2 to Figures 3-4. I suggest using a consistent order to help readers follow the results more easily.