

Can bias correction methods improve the statistical characterization of extreme rainfall compound events in climate simulations?

I believe the work in the manuscript is useful, but is very weakly presented. If I guess correctly, the premise is simple: Estimate χ and RP for each of two episodes of 4-7 days (Loire, Ahr) in ERA5 'observations', then compare to the equivalent for CMIP6 simulations (historical, 1992-2021) with different bias corrections to see which bivariate correction method is most effective. Then, a check is performed to verify that the statistical evolution with climate change (i.e. four ~30-yr blocks, 1992-2100) within each uncorrected simulation is not distorted by the bias correction. However, it took me a long time to extract this from the manuscript.

Note that I do not comment on the mathematical correctness of the paper, and leave other reviewers to do this (i.e. I saw no red flags in this regard, but am not the appropriate person to spot these).

Once the manuscript is re-written, further issues may become apparent.

Major comments

1. The writing is often unclear (e.g. throughout the Abstract and Introduction). Throughout, the authors should rewrite sentences to express what they intend, and consider removing material to tighten the structure and clarify their message. My impression is that the manuscript would be clearer and more accessible if about 50% of its current length.
2. The motivation behind studying the two chosen events is clear (i.e. they were impactful), but the authors should explain why these two events are statistically useful and representative – from this perspective, they appear arbitrary.
3. A Discussion section is not present, but is needed. The results need linking back to the literature in the Introduction.

Detailed Comments on the manuscript

Abstract

From L4, the abstract was entirely unclear on a first read. After reading the paper, I can understand its intent, but it still fails to describe the work. Illustratively, specifics need to be added (e.g. ERA5, CMIP6), key results need to be stated not '*the results show*'. The research questions are vague and need to be made specific, or consider replacing them with a result (e.g. Estimates of χ and RPs for two historical flooding episodes (Loire, Ahr) in ERA5, each arising from the co-occurrence of two events, are compared to equivalent extremes in CMIP6 simulations (historical, 1992-2021) with different bias bivariate corrections. XX and YY replicate ERA5 value most closely. ZZ and AA best preserve the trend of change through in the uncorrected CMIP6 models (e.g. trend has the same sign for 8 or 10 models).

Introduction

L16 – Starts with flooding, not extreme precipitation. This is logical jump. Please rephrase.

L16-23 – The abstract states that two 'extreme precipitation' events are analysed, yet that is not how the two events here are portrayed. This is confusing. Please rephrase.

L24 – The sentence starting "The two previously" is repetition. Remove.

L24-25 – 'primordial' is too strong a word here. Work has been done on compound events and their change with climate, including tail dependence, in climate models (e.g. Bloomfield et al 2023 - <https://doi.org/10.1016/j.wace.2023.100550>; Hillier et al, 2025 - <https://doi.org/10.1002/JOC.8763> or Manning)

L39-43: To allow for potential biases in climate models, work to date usually quotes change within a model (i.e. relative change from present to future periods of the same simulation). I can see how the

characteristics of a distribution (e.g. of temperature) could potentially affect conclusions drawn in this way, but this needs to be explicitly clarified; the text implies that future time periods in climate models are directly compared to a reference (e.g. reanalysis).

L50-54: I can accept this finishing point, but not because the writing gets me here. The text on page two needs revising so that it convincingly brings the reader to this point.

L65-66: – Sentence unclear and need to be rewritten.

L76: ‘Closer to observations’? Specify the observations used to ground-truth the CMIP6 data.

L74 – 86: There is an excess of detail in examples here, obscuring your point. I suggest you re-write and simplify to clarify the text.

L93-94 – RQ1 is not phrased as a research question, and it is not clear what exactly ‘*enhance the realism of*’ means.

L96 – RQ2 is not phrased as a research question. At this point the text has still not explained what the ground-truth will be for the climate change signal that they seek to examine the preservation of.

L102-117 – Using χ and RP good in that it follows standard procedure, but why the GPD (e.g. not GEV)? This section needs to acknowledge that the GPD is one approach. Also, it is unclear if ‘copula’ implies one has been selected for the tail already or if a suitable one will be selected later – e.g. Manning (2024) - <https://doi.org/10.1016/j.wace.2024.100673>). Reading later, this is clarified on p10, but is an example of how this text is hard to penetrate for someone not intimately familiar with the topic. In other words, the work could be made much more readable to a wider audience.

L118 – ‘... in detail’.

L127 – ‘struck’ not ‘stroke’.

From here, comments are less detailed.

Data & Events

Remove the repetition between Sections 2.2 & 2.3 and the Introduction.

L175 – Show the analysis, at least in an appendix, or give sufficient detail for it to be reproduced. Reproducibility is the critical minimum for published science.

Methodology

Section 3.1 – There seems to be repetition here from the Introduction. I suggest only having information in one place.

L299 – Use of ‘event’ is confusing, referring to both the component parts of the events, and the events themselves. Consider use of ‘episode’ for the Seine/Loire and Ahr 4-7 day windows in which events occur (e.g. as Hillier, 2025)

L304 – Sentence including ‘not detailed’ is not needed. Suggest delete.

L306-312 – Inclusion of selected detail from here into the Abstract and Introduction would help to clarify those sections, which currently lack sufficient specifics to be understandable.

Design of Experiments

Section 4.1 – Example of verbose explanation, where being concise would improve the explanation.

Fig. 2 – For the sake of red-green colour blind readers, please use some other distinction. Light/dark grey, long/short, or dotted & Dashed lines, even open or filled circles.

Results

Figs 3 & 4 – Other than visually, please provide some way of quantifying the similarity/difference between ERA5 and the options to say something about which is best.

Fig. 6 – Suggest including CDF-t as a dotted black line (i.e. please find a way to also include them). If I've understood, it's desirable to have a trajectory through time close to the uncorrected case. If you mean 'the same' rather than 'similar', change this and make the explanation in the text clearer.

L507 – Consider putting this in methods for clarity. This is an example of how key pieces of information are dotted throughout the text, and often not easy to find. Also, how are you defining 'the same' here? Of the same sign? The same shape?