Responses to the comments of Reviewer 2

by Florian Ruff and Stephan Pfahl

We would like to thank the reviewer for the additional helpful comments and suggestions to improve the manuscript! This document addresses all comments of the reviewer. The reviewers' comments are repeated in black and italic with the abbreviation RC. Our responses are given in blue with the abbreviation AC (author comments).

1 Comments of the Reviewer

RC: ***Overview of manuscript**: estimates of extreme values based on observations contain large uncertainties due to (i) errors due to finite length of record, (ii) spatial inhomogeneities in data, and (iii) trends due to climate change. I would add a fourth source of uncertainty, namely a user's subjective choices for EV modelling (type of extreme value distribution, and parameter fitting methods). This article shows how ensemble forecasts can avert the set of problems affecting observation-based estimates, however, the forecasted values may contain a new source of uncertainty due to model errors in representing precipitation processes.*

I would like to thank the authors for their responses to reviewer #2 of the original manuscript. The revised manuscript is of a high standard in terms of science and clarity and contains some very interesting new information. It is suitable for publication, though might be improved by considering the comments below, before finalising the manuscript.

AC: Thank you very much for your additional helpful comments! We addressed all comments in a revised version of the manuscript.

1.1 Major comments

RC: *Both the Abstract and the final section could be improved by a full, clear statement on all the problems with observational-based estimates of extreme quantiles, and on the other hand, a new potential problem concerning ensemble forecast bias, as described in "Overview of manuscript" above (which is largely distilled from the Introduction of manuscript).*

These two sections might be improved by emphasising how future work on understanding the cause of large-scale bias between EPS and observations at extreme quantiles, especially in the tropics, is required.

AC: Thank you very much for this comment. We emphasised the problems of observation-based estimates and the model bias in both the abstract and the discussion and added a sentence on the importance of future work on understanding the model bias.

1.2 Minor comments

RC: Lines 44-50: the authors may wish to include a fourth limitation: users make subjective choices for EV modelling to extrapolate records to longer return periods.

AC: Thank you, we added a sentence regarding this additional limitation.

RC: Line 50: add a reference after the text "climate change", e.g. Fischer et al. (2014), or IPCC sixth assessment report?

AC: Thank you, we added the reference.

RC: Lines 156, 167 and 177: change "31th" to "31st"

AC: Is changed.

RC: Line 264: replace "Figs 2 and 2" with "Figs 2 and S2"

AC: Thank you, has been changed.

RC: Line 274: most statistical software packages include bias corrected MLE methods. For example, the "mle.tools" package in R provides users with much better parameter fitting than basic MLE. Statisticians have worked on the problem of MLE bias for decades (mle.tools is based on a paper by Cox and Snell from 1968) yet their solutions are rarely used in meteorology. The bias corrected version of MLE will produce similar results as the basic MLE for 66-year REGEN records extrapolated to 100 yr return levels, so this comment is not material for this article, but perhaps the authors might get benefits from using bias corrected MLE in future work?

AC: Thank you very much for the additional tool box and the information about the bias corrected MLE methods. We will definitely keep this in mind and consider a possible use in future work.

RC: Line 337: this is usually described as a thick tail, rather than a "long and thin tail".

AC: Thank you, we changed the description.

References

Fischer, E. M., Sedláček, J., Hawkins, E., & Knutti, R. (2014). Models agree on forced response pattern of precipitation and temperature extremes. *Geophysical Research Letters*, *41*(23), 8554-8562.