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Interactive comment on "Global change in flood and drought intensities under climate change in the 21st century" *by* Behzad Asadieh and Nir Y. Krakauer

Anonymous Referee #3

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This manuscript uses ISI-MIP streamflow simulations to explore the joint future of hydrological extremes (low and high flows). This is a quite relevant topic for HESS, but I have concerns about the novelty of the study, given the wealth of already published papers on hydrological extremes derived from ISI-MIP simulations. Furthermore, the statistical analysis is not (yet) convincing in my view – and choices are not justified (enough) – to bring the paper to a level where it could be published in HESS. All comments below have been initially drawn before I read comments from the two other referees, and I then added references to these in order to highlight common assessments or suggestions.

Major Comments

1. As mentioned above, and as already noted by Referee 1, there is little novelty in the topic and dataset used compared to previously published literature (especially to Giuntoli et al., 2015), and the little amount of novelty is not pushed forward in the manuscript. In my view, there are two new contributions: (1) the comparison between two contrasted RCPs, and (2) the quantification of absolute changes in high/low flow indices and their joint analysis. I agree with Referee 1 proposal to better highlight the manuscript's contributions, but I fear there are other issues that need to be tackled first.

2. The quantification of changes is, as already noted by the two other referees, first quite questionable in terms of wordings: high and low flow indices simply cannot be identified to flood and drought indices. Changes throughout the manuscript (including title) are therefore required. Furthermore, the authors consistently use the wording of streamflow in the manuscript, but I believe that the variable used is the (unrouted) runoff, as in previous related works on ISI-MIP data (Prudhomme et al, 2014; Giuntoli et al., 2015), and on the contrary to other works on (large) river basins (see e.g. Pechlivanidis et al., 2017; Vetter et al., 2017). This has serious implications for interpreting results in terms of floods and droughts (see the recent work by Zhao et al., 2017).

3. The normalization procedure is probably interesting for positive variables like streamflow, as it makes multiplicative factors symmetrical with respect to zero. Multiplying (resp. dividing) present-day values by 3 results in a value of 1/2 (resp. -1/2). However, the lack of experience with dealing with such an index makes it rather difficult to interpret values. The way values converge towards 1 or -1 is for example not intuitive. The reader should at least be accompanied through this kind of basic examples.

4. The joint analysis of changes in low flow and high flow indices is potentially attractive. However, I don't understand why the analysis is restricted to quadrants (cf. Figure 5) when all data are available for continuous assessments over the two indices (see Teuling et al., 2011a, b). This is in my view an oversimplification of the problem. You cannot identify with the quadrants a region with a small drought increase and a large flood increase (whatever that means). Moreover, the multi-model average is, as pointed out by Referee 1, potentially quite misleading. This is all the more problematic that there is a confusion (at least of the reader) when dealing with statistical significance. At several places in the manuscript, one may expect some tests for example on the sign of change within the multimodel ensemble (see the latest IPCC report), and not (only) the significance of changes between 30-year averages of future and present period for single models. Many detailed and interesting statistical analyses could be performed with this dataset by applying ANOVA techniques, and by for example deriving individual maps of GCMs/GHMs effects (in the ANOVA sense) on joint changes in low/high flow indices. This would avoid using latitude-averaged plots that do not convey in my view the most relevant information. For example, it is not possible on Figures 2, 3, and 4 to compare the spatial variance (along any given latitude) from the variance among GCMs/GHMs/combination of GCMs and GHMs (depending on the figure).

5. This also leads to my last major comment. I don't really understand why this study is restricted to only 5 GHMs. Statistical techniques are indeed available to take account of different sample sizes in ANOVA contexts (see for example Giuntoli et al., 2015). Furthermore, there is no justification in the manuscript on the choice of these specific 5 GHMs, and this has already been pointed out by Referee 1. This thus appears as a subjective and therefore negative choice for building confidence in results from this "ensemble of opportunity".

Specific comments

1. P1L16: percentage with respect to what period?
2. P2L14: Please make explicit what you mean by "impact". The hierarchy of impacts (for example in terms of monetary loss) is indeed highly dependent on the anthropogenic system under study.
3. P2L19: I believe this is about "average runoff". Please specify.
4. P5L21: The normalization is announced and summarized here whereas it is described only much later on (P6 L3 ff.). Please reorganize the paragraphs.
5. P6L12-14: This is hardly understandable. Please consider giving the actual equations.
6. P7L15-19: These figures are redundant with Table 1. Please rephrase.
7. P8L5, "with high agreement": Could you explain what you mean exactly here?
8. P8L19, "fluctuations": Again, what do you mean here? Fluctuations in time, latitude, other? Please specify.
9. P8L23, "mean": over space, latitude? Please be more specific.
10. P9L8, "statistically different": What is the test used here? Please be more specific on your statements.
11. P10L11, "statistically significant": see above.
12. P11L16-17: This final sentence is rather ambiguous and wrongly suggests a 200

Technical corrections

1. P2L3, “to be intensified”: please rephrase
2. P2L8, “dictation”: please rephrase
3. P4L11: “increase”
4. P6L17, “remained”: please rephrase
5. P8L14, missing “in” after “flux”

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