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Interactive comment

Interactive comment on "Uncertainties and their interaction in flood risk assessment with climate change" *by* Hadush Meresa et al.

Anonymous Referee #1

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General comments:

The manuscript investigates the uncertainty contributions from different components of the modeling chain in future flood magnitude of four Irish catchments. Using ANOVA, the study considers several sources of uncertainty: GCMs, bias-correction, hydrological model parameter, and extreme value distribution and their interactions. Although the manuscript is generally well written and figures are clear, I think it ends up being merely descriptive and is somewhat incomplete as it does not tackle the reasons why uncertainty varies across catchments. In fact, the main finding I retained after reading the paper was that hydrological model parameter is the least important source of uncertainty (I also don't think there is novelty in stating that sources of uncertainty vary across catchments as emphasized in the conclusions). As the authors noted in the

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Discussion paper

manuscript, the number of catchments analyzed is small, therefore results do not allow to pinpoint aspects that can further our understanding of why uncertainty shares vary across catchments. The authors themselves write in the final phrase of the conclusions something that I think they should have tackled in their work: "Future work to better understand the link between the key components of the cascade of uncertainty and catchment characteristics is therefore recommended".

In my opinion, this work could improve through the following:

- The authors could take the advantage of having scrutinized three variables (Temperature, Precipitation, and runoff) in the control period, using observed data, to select model runs that behaved better, and use them to estimate future magnitudes. This would provide valuable information, because though limited to few catchments it would show the value of forming constrained chains of models and to assess how these compare to the original "big ensemble of runs" in terms of the uncertainty that is associated to return periods of future floods. For instance, once the best bias correction methods are identified (e.g. Figure 4, or L. 431 DGQM, SGQM), these could be used to form a constrained ensemble. This could affect results in uncertainty shares and, importantly, wold help reducing the uncertainty.

- Avoid the word risk (In the title too). What is done in this paper does not deal with flood risk, but rather with changes in future flood magnitude.

- A word of caution on the return periods of 100 years, based on periods of 30 years. Extrapolation of extreme value fits to a domain well outside the range of the reference period (30-yrs) may itself add considerable uncertainty to the estimate. Extreme values are already hard to sample for their rare nature. I would limit return periods to 30yrs to avoid calculation of return values for return periods exceeding the record length. This aspect should be at least discussed.

- Scenarios. Multiple SSP scenarios are employed at one stage, but they are not considered among the different shares of uncertainty (e.g. Fig 13). The authors should justify this choice.

- Use of variables: variables are used both at daily and at monthly scales. When dealing with events that have short onset and duration like floods. Possibly, I suggest using the daily time scale at all times.

Please find notes on text and figures below.

Technical corrections: L. 30 - Would avoid word “significant” (strong statistical connotation). L. 34 - are shifting -> have shifted L. 53-57 - I would add Shepherd et al. 2018. L. 69-71 - It is stated that “an important step [. . .] contribution of different components of uncertainty and their interaction to be quantified and partitioned to help scientists and decision makers better navigate the cascade of uncertainty”. The authors could hint or provide examples on how this information could be used to “better navigate the cascade of uncertainty” and why it is helpful/important. L. 115-130 - Could this go into the introduction? L. 225 - From this sentence it seems like for a given catchment a single distribution is not sufficient to sample extreme events. I think this is misleading as the practice is to test several and then choose the one that fits best. In this case you employ multiple distribution types to assess the uncertainty that is brought about by this source of uncertainty. L. 230-232 - I would swap order in sentence to respect that of the equations that are listed below. L. 239-240 - The assessment of future high flows using multiple scenarios has been done, the authors might add Giuntoli et al. 2018. L. 266 - Why not daily? L. 275-280 - Possible reasons behind the variety of projected changes? L. 285 - Please add “in the range of” after “to be”. L. 290 - Please justify the choice of 30000 as number of parameter sets. L. 338 - Reference to Figure 12: I think showing the median does not add much, it is also hard to see it on the figure. L. 375 - “We examined future flood risk”. I would rephrase with something like “we examined changes in future flood magnitude”. (In line with what is written at line 459). L. 394-395 - I would attenuate the sensational tone of the sentence. L. 397 - I counted one. L 404 - It this stated “results suggest that rather than being the same across catchments” - I don’t think anyone has ever presumed that sources of uncertainty remain constant across catchments, and there are studies in the literature showing this already. Please reformulate. L. 464-465 - rather than “that the dominant sources of unc. vary on a cathment basis” I suggest writing “our results show how dominant sources of unc. may vary on a catchment basis”. I don’t find the end of the sentence convincing provided that two adjacent catchments can have entirely different hydrological processes that contribute to flood generation - and in turn different shares of uncertainty sources.

References: Shepherd, T.G., Boyd, E., Calel, R.A. et al. Storylines: an alternative approach to representing uncertainty in physical aspects of climate change. Climatic Change 151, 555–571 (2018). https://doi.org/10.1007/s10584-018-2317-9 Giuntoli, I., Villarini, G., Prudhomme, C. et al. Uncertainties in projected runoff over the conterminous United States. Climatic Change 150, 149–162 (2018). https://doi.org/10.1007/s10584-018-2280-5

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