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Interactive comment on "Downsizing parameter ensembles for simulations of extreme floods" *by* Anna E. Sikorska-Senoner et al.

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We thank you for your positive feedback and your suggestions for improving our manuscript. Below we provide our replies (in *italic*) to the detailed comments of this reviewer and list the changes that will be made in the revised version of the manuscript (in blue).

Referee's general comments: The contribution provides an interesting approach to the selection of representative parameter sets for continuous hydrological modelling in the framework of derived flood frequency analyses considering uncertainty. The methodology is quite clear and plausible. The manuscript is well written and concise. I have only some minor comments for improvement (see detailed comments).

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Authors' Reply (AR): We thank reviewer 2 for the positive feedback on our manuscript.

Referee's detailed comments:

1. Line 129: : : : "selected in step (d)" should read "selected in step (b)".
   AR: this will be corrected in the text in the revised manuscript.

2. Line 196: It is not clear to me how Q5, Q50 and Q95 are obtained? For each parameter set there is one of such quantiles. Are they averaged over all parameter sets or are they estimated as double quantiles (quantiles from the set of quantiles)?
   AR: Q5, Q50 and Q95 are estimated for each simulation point of sorted annual maxima in the frequency space, i.e. over all parameter sets. Hence, quantiling is done on each point of the sorted annual maxima and not on the entire simulation resulting from a single parameter set. To clarify this issue, an additional text will be included in the revised manuscript:
   "The 5%, 50% and 95% quantiles of these ensembles are computed at each j-th point in the frequency space, resulting in quantiles Q5, Q50 and Q95 over the entire simulation period. . ."

3. Line 344: I would suggest to put the figure A2 with the study region also in the main text.
   AR: thank you for this suggestion. This figure will be moved into the main text in the revised manuscript.

4. Line 446: I think the bias is "highest" for the ranking method and not "lowest".
   AR: yes, this is correct. Thank you for spotting this typo!

5. Figures 7-10: I assume the "blue" range is bounded by the infimum and supremum, here coming from the 0.05 and 0.95 quantiles, meaning only 90% of the possible range are covered. What are the boundaries for the "grey" range? Is it

covering 100%. May be this need to be indicated in the figure caption.
AR: It is correct that the blue band is the coverage of the range bounded by the infimum and supremum parameter sets, i.e. 90% predictive intervals. The grey range corresponds to the band estimated using all 100 parameter sets. To clarify this issue, we will include additional explanation in the figure captions.

6. Limitations: This study uses sufficient long hourly discharge time series of 25 years for calibration on extremes. Often the hourly records are much shorter (e.g. 5 to 10 years) and a calibration on extremes is not feasible this way. Then, the calibration is done alternatively on observed flood statistics, for which often longer records are available, using synthetic rainfall as input. In this case the proposed procedure is hardly possible. Please discuss.
AR: we agree that we are in a lucky situation when the hydrologic model can be calibrated with a continuous time series of more than 20 years. Yet, if such long time series are not available, other calibration procedure could be used (e.g. based on signatures) or model parameters could be required from regionalization approaches. The way, the model is calibrated is not relevant for the selection methods as long as at least 100 parameter sets can be derived (and that can well represent rare floods). We will add the following text in the limitation section in the revised manuscript:
"Despite the calibration of a hydrological model lies beyond the scope of this paper, it is assumed that (at least) 100 parameter sets of a hydrologic model can be made available for selecting the representative parameter sets. For that purpose, a hydrological model should be calibrated with observed data of a long enough record that covers rare floods so that rare floods could be realistically simulated. Note that for that purpose, a continuous hydrologic model does not necessarily require continuous calibration data and it could also be calibrated to discrete data (e.g. using hydrologic signatures (Kavetski et al. 2018)). If no observed data or only very short records are available, model parameters can be acquired

through regionalization approaches (see the work of Brunner et al. (2018a) for an overview of regionalization methods). The developed methods are of use for applications when a hydrologic model should be employed for simulations of rare floods. If the use of a hydrologic model is not possible, i.e. neither information for calibration nor sufficient information for parameter regionalization is available, these methods cannot be applied."

7. Appendix A. This appendix is not really necessary from my point of view.
   AR: thank you for this suggestion. As both reviewers suggested to remove it, this appendix will be removed from the revised manuscript.

References

Brunner, M. I., Furrer, R., Sikorska, A. E., Viviroli, D., Seibert, J., and Favre, A. C.: Synthetic design hydrographs for ungauged catchments: a comparison of regionalization methods, Stochastic Environmental Research and Risk Assessment, 32, 1993–2023, https://doi.org/10.1007/s00477-018-1523-3, 2018a.

Kavetski, D., Fenicia, F., Reichert, P., Albert, C.: Signature-domain calibration of hydrological models using approximate Bayesian computation: Theory and comparison to existing applications. Water Resources Research, 54, 4059–4083. https://doi.org/10.1002/2017WR020528, 2018.

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