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Interactive comment on "Using hydroclimatic extremes to guide future hydrologic predictions" *by* S. K. Oni et al.

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This paper describes interesting research work done by the authors on the sensitivity of model parameter calibration, when this calibration is based on short time periods or based on years which are more wet or more dry than average. The authors furthermore show the impact of climate change based on an ensemble of climate models, and discuss the importance of parameter calibration based on years that are closest to the future climate conditions. The semi-distributed conceptual hydrological model PERSiST was considered, applied on a headwater boreal catchment in Sweden. Hydrological impacts considered are mean monthly flows. I fully agree with the authors that, prior to any hydrological impact analysis of climate change, the hydrological model need to be tested for their performance to make extrap- olations beyond the range of historical conditions considered during traditional model calibration and validation.

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Climate scenarios indeed most often lead to meteorological conditions that are more extreme than the historical ones. Let me propose the paper by Refsgaard et al. (2014), for an extensive discussion on that issue and for an overview of approaches. The authors may consider that paper for their literature review.

Response: Thank you for your comments and the literature suggestion. We will use the suggested literature to further improve he introduction.

The authors, however, do not explicitly show how this can be done. They show the sensitivity of the model parameter calibration to the type of years used for calibration, but I am not convinced that calibration based on either more wet years or more dry years (or years with other conditions), depending on the future projected conditions, is the way to go. Historical periods show strong temporal variability, and, most likely, this will also be the case in the future. The climate scenarios lead to changes, but strong natural temporal variability (with wet and dry years) will continue to happen also in the future. This means that the hydrological impact model needs to be calibrated to long time periods such that it is able to deliver accurate results both for wet and dry years. Separate calibration for dry years only or wet years only does not appear to be useful to me.

Response: We agree with you those calibrations to long term periods are still useful (as we can see in literature) but our argument here is not against the use of long term data in our modelling exercises. However, it is unequivocal that long term simulations only give us average system behaviour and in most cases we miss the extreme wet and dry conditions. This has led to under-prediction under the present day condition and the uncertainty can be amplified further when projected into the future. What we are trying to do here is to use the historical wet and dry years as a proxy to quantify the uncertainty in projecting extreme conditions that might even become more common in the future. So, there is a need to use modelling analyses based long term versus dry/wet years as a way of getting more insights on how to quantify predictive uncertainty in hydrologic projections.

Other comments: The title, abstract and introduction put a high focus on “extremes”, but it is unclear from the paper what exactly is meant by these extremes. I assume that it refers to the dry and wet years considered. These are annual averaged conditions, but the term extremes is often used in the context of shorter duration rainfall and flows (e.g. daily peak flows, low flows). I suggest to clarify this better from the start of the paper. To avoid that the reader is misled by the title, I suggest to omit the term extremes and revise the title accordingly.

Response: Thank you for your suggestion here. The title and abstract will be revised accordingly and the term ‘extremes’ will be amended in the introduction and other parts of the manuscript to remove ambiguity.

Climate model simulations were taken from the EU ENSEMBLES project, which became outdated. This is OK given the methodological focus of this paper, but the paper also concludes on the future climate and flow projections for the study catchment.

Since some years, newer generation (CMIP5 based) RCM runs are available, based on the latest generation of greenhouse gas scenarios (RCP based; the ENSEMBLES RCMs are based on CMIP3 and the more than 15 years old SRES greenhouse gas scenarios). In addition, only one SRES scenario (A1B) was considered by the ENSEMBLES project.

Response: We agree that the climate models used here are based on CMIP 3 rather than newer CMIP 5. However, since the focus of this study is to quantify the uncertainties in hydrologic projections using extreme dry and wet conditions, we think this should be ok here. We would like to also emphasis that this is a follow up study on other climate related studies we recently carried out in the region where we similarly used this CMIP3 (e.g. Oni et al. 2014, 2015; Jungqvist et al., 2014; Teutschbein et al., 2015). Otherwise, using CMIP 3 or CMIP 5 won’t make so much difference to fulfil the objectives of this study in as much as we used ensemble of RCMs to constrain the uncertainty.

A quantile mapping bias correction method was applied. I assume this was done on a monthly basis, but this is unclear from the text (the reader is referred to the literature). The quantile mapping bias correction method may disturb the temporal sequence (correlations, persistence) of the time series values. It is unclear whether this type of check / validations were performed by the authors.

Response: Yes, this was done on monthly basis and will be made clearer in the manuscript text. We thought of shorten this section considerably in this paper as we have had about four other papers recently (e.g. Oni et al. 2014, 2015; Jungqvist et al., 2014; Teutschbein et al., 2015) where we used this data and described the bias correction process in detail. However, since each study appears to be stand alone and independent of others, we will also expand this section in this paper for better clarity to readers.

Lines 144 – 145: "The best parameter sets (top 100) were selected based on highest NS statistics...and other performance metrics...": It would be useful to indicate how this selection was done; how the different metrics were weighted or combined to select the best parameter sets.

Response: These will be revised in the manuscript for further clarification. Thanks

Lines 156 – 157: "The...projected future climate series from ensemble of climate models...were used to project future extremes using different goodness-of-fit met- rics.": I do not understand how the goodness-of-fit of future extremes can be evaluated.

Response: We will clarify this better in the manuscript. However, what we're trying to say here is that we drove the hydrological model (PERSiST) with bias corrected RCM series based on different performance metrics highlighted above.

Line 180: "bias correction helped to reduce the uncertainty": this is true for the historical period, but it is not necessarily the case for the future period

Response: Yes, we agree with you here. We were referring to historical period here

and not necessarily the future. We will revise this statement in the revised manuscript for better clarity

For the results considering only dry years and only wet years, such as in Figure 2 and Figure 3, I assume these results are shown for all the dry or wet years averaged, but this is unclear from the text.

Response: Yes, you are right. We will make this clearer in the caption of those figures in the revised manuscript.

Results shown in Figure 3: It is unclear whether the “Ensemble mean” result is after or before bias correction.

Response: This is after the bias correction. This will be corrected on the manuscript figure caption.

Regarding the validation of the climate model simulation results for historical conditions (control runs), next to the cumulative distribution function of monthly values (and related bias correction): given the focus of this study on wet and dry years, it would be useful to validate the performance of the climate model simulation results in describing the wet-dry year variability.

Response: We believe this has been done on different occasions in the manuscript e.g. Fig. 4 and 8. Any attempts to present the result in more formats will only repeat what we are currently presenting in this study.

Caption Table 1: change “ENSEMBLE” to “ENSEMBLES”

Response: This will be corrected. Thanks for taking note of this omission.

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