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Discussions

Interactive comment on "Does the weighting of climate simulations result in a more reasonable quantification of hydrological impacts?" *by* Hui-Min Wang et al.

Anonymous Referee #3

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This study applies different combinations of bias-correction (BC) and model weighting (MW) to post-process climate and hydrological projections in two catchments. Both BC and MW are receiving sustained attention in the community, and so far only few studies combine both. What is important to stress, is that although the underpinnings of these two approaches are quite different, their aim is arguably quite similar: close the gap between simulations and observations. This leads me to comment on the two main findings of the study:

Finding 1: "when using raw GCM outputs with no bias correction, streamflow-based weights better represent the mean hydrograph and reduce the bias of annual stream-

flow" P1L19-20: in my view, this is a natural consequence of applying MW, and in a way, it means that MW is used to correct for/mitigate climate model biases.

Finding 2: "when applying bias correction to GCM simulations before driving the hydrological model, the climate simulations become rather close to the observed climate, so that compared to equal weighting, the streamflow-based weights do not bring significant differences in the multi-model ensemble mean" P1L21-23: my interpretation is that employing successively two techniques with the same purpose makes the second technique redundant. Reducing the biases in the climate simulations, and then applying MW, makes it extremely difficult for the MW to discriminate between good and poor models. I recognise that BC is applied to the climate simulations and MW to the hydrological simulations, but since all the climate simulations are run through the same hydrological model, calibrated presumably with the forcing dataset also used to perform the BC, the differences in the streamflow simulations are minimal (as shown in Figure 3c and especially 4c). This lack of differences explains why the different weighting methods lead to similar results under current climate (the simulations are almost the same, so how they are combined makes little difference).

Overall, I suggest shifting the focus from current climatic conditions (for which no climate model and hence MW or BC is necessary) to future conditions (which rely on climate model simulations, which may need BC/MW). In my view, the focus is currently too much on the current conditions. For instance, in the abstract, the authors write "when applying bias correction to GCM simulations before driving the hydrological model, the climate simulations become rather close to the observed climate". This is true because of the nature of bias-correction, and was shown in previous studies (e.g., Hakala et al., 2018). What the grey area in Figures 3d and 4d tells us, however, is that under future conditions, there is substantial spread among the hydrological simulations, although the driving GCM simulations have been bias-corrected (likely because of the different sensitivities of the climate models).

Is there any way to apply MW based on these projected changes, and not based on

the streamflow simulations under current climate? In other words, are some of these projections more reliable than others and/or are some projections interdependent, and should be downweighted?

In summary, my impression is that Finding 1 is relevant but quite foreseeable. I think that Finding 2 is to a great extent due to the experimental design, in particular to the decision to apply BC and MW successively. I encourage the authors to rethink how to best combine MW and BC, for instance by using different periods and/or criteria for the MW.

Suggested reference

Hakala, K., Addor, N. and Seibert, J.: Hydrological modeling to evaluate climate model simulations and their bias correction, J. Hydrometeorol., 19, 1321–1337, doi:10.1175/JHM-D-17-0189.1, 2018.

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