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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Mapping (dis)agreement in hydrologic projections" *by* Lieke Melsen et al.

Anonymous Referee #2

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The paper titled "Mapping (dis)agreement in hydrology projections" is a very interesting study that aims to quantify the different sources of uncertainty in future hydrologic projections; these sources of uncertainty include climate model uncertainty, model structure uncertainty, and model parameter uncertainty. The authors show using 605 basins over the contiguous United States how future changes in annual mean runoff and discharge timing can be impacted by these three different sources of uncertainty. The paper is well structured and well written and should be published in HESS. However, I have a series of comments and questions that will need to be addressed prior to publication.

Main comments:

- I was very impressed with the depth of the introduction, methods, and results. However, I was disappointed by the discussion section. I believe that there are many things

that could (and should!) be discussed regarding the implications of this work that would be a missed opportunity to not include in the discussion section. For example, what is the physical explanation (if any) of why you get the results that you do? There is plenty of material in the results to enable this discussion and I believe it would be quite useful.

- Another topic of discussion is also another main comment. One of the underlying assumptions that is made in this and all offline studies that use GCM output as input to an offline hydrologic model is that the differences in hydrologic projections based on using different model parameters and hydrologic models does not impact the climate system (i.e., feedbacks). In other words, the precipitation and temperature that you are using from the GCM output depend on a land surface model that is contained within its original GCM; changing the model and parameters will directly change the temperature and precipitation you get... As a result, the most complete way to approach this type of study would be to use your approach in coupled GCMs. However, I completely understand why this is computationally not feasible when you are looking at all the different sources of uncertainty. That being said, I believe it is important to at least discuss this problem and mention how you believe the results might change if it were feasible to do this study "online" instead of "offiline". See the following paper for more background on this issue: "Milly, P. C., & Dunne, K. A. (2016). Potential evapotranspiration and continental drying. Nature Climate Change, 6(10), 946-949"

- Was the GCM output downscaled and bias corrected against the forcing used in the 1980-2008 simulations? I understand that it has indeed been bias corrected; however, bias correction is always done against some reference database; I would hope that that reference database is the one being used to force the 1980-2008 simulations. Please clarify. If it was not bias corrected against the forcings used for the 1980-2008 simulations, I am concerned that some of your signal in change in annual mean runoff could be attributed simply to discrepancies between the observed forcing and the "bias-corrected" GCM output.

- Using 5 years for spin-up is awfully low. Are you sure that this is appropriate? I would

have suggested cycling through the 1980 to 2008 a few times. Although this most likely does not disqualify the results, there should be some argument in the paper for why only 5 years appeared to be enough.

Other comments:

p4,l3: available moist?

- Section 3.1.2: "A larger parameter sample could therefore decrease the number of non-behavioural basins and even allow for a more stringent selection criterion." Maybe, but certainly not necessarily. Assuming that the LHS sample is robust, then your model parameters will already capture the details of the parameter space. I agree that given your relatively small sample size, there might be regions of the parameter space that you are disregarding. However, I suspect that it will be fairly minimal.

- Section 4: "Climate models disagree more in a more extreme scenario" - How much of this can be attributed simply to the disconnect between your models and the climate models themselves? (See issue regarding offline/online models above)

- "Furthermore, land-use and soil parameters have been kept constant for both modelling periods. Although it is very likely that land-use will change in the future as a result of climate change or population growth, there are currently no methods to quantify this change and translate that to parameter values for the employed hydrologic models." -> GCMs actually do currently account for land use change. Now to be fair, these changes are mostly due to offline studies that predict that land use will be in the future, however, this information is out there and could be used in theory within the hydrologic models.

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