Review of HESSD Manuscript

'On the need for bias correction in regional climate scenarios to assess climate change impacts on river runoff'

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Dear Authors, dear Editor,

Please take my apologies for fulfilling my review obligation so late, urgent issues kept jumping in my way. Nevertheless I have reviewed the work, and my conclusions and comments are as follows:

1. Scope

The topic of the work is within the scope of HESS.

2. Summary

With the proposed work, the authors pursue, from the angle of view of hydrologic impact assessment, the question whether Bias Correction (BC) of climate model output (GCM/RCM) is really necessary if the model output deviates from reference observations. More specifically, they pursue the questions i) whether bias-corrected GCM/RCM output used in hydrological models (HM) leads to more realistic simulations, ii) what the predicted impact of climate change on discharge-based hydrological indices is and iii) whether this climate change signal is affected by BC. The study is conducted in two catchments (one in Quebec, one in Bavaria), with a range of SRES/GCM/RCM configurations, BC of precipitation (Local intensity scaling) and air temperature (additive adjustment), downscaling, four HMs, with a reference period 1971-2000 and the projection 2041-2070. The indices range from characterization of mean flow and low flow to high flow, timing of spring flow is also investigated.

The results are analyzed and discussed by comparing the above indices i) for bias-corrected (BC1) and non-bias-corrected (BC0) simulations, ii) for simulation and projection periods. Question iii) is addressed by performing a Wilcoxon test evaluating whether climate change signals based on BC0 or BC1 simulations/projections belong to the same distribution or not.

With respect to i), BC generally improves agreement of hydrological observations and simulations, however sensitivities with respect to season, model, region and signature can be observed (high flow is affected differently as e.g. low flow). Question ii) is mainly answered in combination with iii), stating that the impact of BC on climate change signals strongly depends on the representativeness of the underlying model chain ensemble (averaged signals from large ensembles are generally less affected by BC than small ensembles) and varies with the index under consideration.

The authors conclude that BC does not add much value to hydrological indicator-based assessment of climate change impact, and that other parts of the model chain (e.g. choice of the meteorological or hydrological models) are the main causes of predictive uncertainty.

3. Overall ranking

The overall ranking is **'Minor Revisions'**

4. General evaluation

The study has been done thoroughly, the methods are appropriate and all conclusions are supported by the data. I particularly welcome that the authors state at p.10227/line 18-24 that results of

Climate Change Impact Studies should be provided with and without BC to give the end user information about the impact of BC.
There is only one point I want to raise: What would be a justification for adopting the second of the proposed viewpoints in the conclusions (It is safe to use BC)? If we follow the principle of parsimony, then adding a model component without a clear justification and clear benefit with the only justification that it is safe to use makes no sense.

5. Minor comments

10206/18: This sentence suggests that BC is done on the output of HMs (which is not the case). I suggest reformulating this.

10208/13: You may want to add here
Haddeland, I., Heinke, J., Voß, F., Eisner, S., Chen, C., Hagemann, S., and Ludwig, F.: Effects of climate model radiation, humidity and wind estimates on hydrological simulations, Hydrol. Earth Syst. Sci., 16, 305-318, 10.5194/hess-16-305-2012, 2012.

10210/14: Please explain in mire detail how the deltas are usually calculated. Also the passage '… to modify observed meteorological data..' can be misunderstood (the observations are not corrected) → Please reformulate.

10210/28: Please note that the new reference for Ehret et al. (2012)
Ehret, U., Zehe, E., Wulfmeyer, V., Warrach-Sagi, K., and Liebert, J.: HESS Opinions "Should we apply bias correction to global and regional climate model data?", Hydrol. Earth Syst. Sci., 16, 3391-3404, 10.5194/hess-16-3391-2012, 2012.

10211/8: 'Additive factors' is impossible (either additive or multiplicative) → please reformulate

10214/1-4: Please explain the method to derive 7LF2 in more detail. I did not understand it.

10217/1-4: Briefly explain the interpolation method for the observations. Was this also done with SCALMET?

10217/10 and table 1: What are the perturbations of the CRCM and RACMO model runs? Perturbations of the Pilot GCM or the RCM?

10221/9: Instead of 'complexity', I suggest 'realism' (as the justification of distributed models is not to increase complexity, but realism)

10222: Header of section 3.2: I suggest 'Does bias correction of atmospheric forcing provide a more consistent representation of river runoff?' to make clear what is corrected.

10242/fig 7: For easier interpretation, I suggest to add indicators of the ensemble means.

Yours sincerely,
Uwe Ehret