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Discussions

Interactive comment on "Hotspots of sensitivity to GCM biases in global modelling of mean and extreme runoff" *by* Lamprini V. Papadimitriou et al.

Anonymous Referee #2

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General comments:

This paper examines the impact of GCM biases on estimates of mean runoff as well as extreme low and high flows. The authors examine a small ensemble of GCMs (3 models) and use one land-surface model, the Joint UK Land Environment Simulator (JULES) model. It is well known that biases in GCM output, particularly precipitation and temperature impact hydrological model simulations as the authors state. The premise of this paper is to examine the impact bias correction has on modeled runoff for the forcing variables needed to run a model in energy balance model. They highlight that precipitation has the largest impact on runoff, but also that other variables impact runoff in a potentially significant manner.

I find the paper needs substantial English editing before it would be acceptable for

publication. Additionally, the text of the paper offers little thoughtful discussion of the results, it generally just restates values from tables or general patterns in the Figures. I also find some of the results to be highly suspect, the authors need to recheck their model simulations very closely. Overall, the idea of a systematic examination of bias correction on model runoff is interesting, but the execution is lacking. Therefore I recommend rejection.

Specific comments:

1) Throughout the article: 1) abbreviations of variable names; 2) acronyms; and 3) units, are 1) hard to follow or inconsistently used (e.g. runoff is RF instead of R, and then grid cell runoff is interchanged with Q, which is typically used for stream discharge); 2) not defined before use such as MSBC; or 3) not used properly (e.g. Table 3). This goes along with the need for substantial English editing for clarity, grammar, etc.

2) The design of the experiments in the partial bias correction assessment could be done differently to increase their utility. For example, it is unrealistic to think users are going to bias correct every variable except temperature. I think an iterative addition of variables from no bias correction would show more useful results. Stepping through bias correction for only P, only P and T, only P, T and humidity, etc. may be more useful. This would show the added value of additional bias correction over the previous iteration.

3) Many of the sections just restate values from Tables and Figures without any discussion and/or insight given.

a) Section 4.1 is very long for the simple task of stating that the bias correction works, yet it just steps through the figures and does not discuss why the remaining biases are where they are.

b) Section 4.2 is interesting, the authors should see Gutmann et al. (2014) for further discussion on changes in bias correction statistics across spatial scales.

c) There is no discussion of the differences between raw and bias corrected in section 4.3 or the regions where the raw fields are better than the observations forcing. This has implications for bias correction to observed products. We may be actually making things worse in regions with poor quality or uncertain observations.

4) The results in section 4.5 and 4.6 should be investigated in much more detail. Specifically, there seems to be a large response to bias corrected humidity in the boreal forest regions across all of North America (Figures 8-10). Why and how does this happen? I'm questioning that a change in humidity could increase runoff by up to several tenths of a mm/day, or potentially up to 100 mm/year. That is a significant fraction of the annual precipitation in many of these regions. The differences between raw and the observations (Fig. 3) show only modest corrections, roughly 0.01 to 0.1 g/kg, is that enough extra water, or what else changes in the system? Is the bias correction creating supersaturated conditions, which then condenses on the trees and creates canopy throughfall and increased surface water input? Does the model forest use less water if it is more humid?

From Figure 9 and Table 3 in the NEU region, a 4% change in humidity results in an astounding 25% increase in runoff, for an extreme sensitivity to humidity of 6.25x. Also, the sensitivities (elasticities) to temperature stated on page 13, line 18 are very large as well. Elasticity work across the US and China (e.g. Fu et al. 2007; Vano et al. 2012) show potentially less sensitivity to temperature depending on the region and model. Finally there has been much work on precipitation sensitivity that is not referenced at all and used as a comparison point (e.g. Sankarasubramanian et al. 2001).

This past work should be discussed in the context of this study and used as checks on these simulations for realism.

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