Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2017-208-RC2, 2017

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "The effect of GCM biases on global runoff simulations of a land surface model" *by* Lamprini V. Papadimitriou et al.

Anonymous Referee #2

Received and published: 25 May 2017

General comments:

This paper examines the impact of bias correction on global uncoupled land-surface model (LSM) simulations using GCM data as inputs. They step through an observation-based simulation, and two GCM simulations using raw GCM inputs and a bias correction simulation that corrects all seven variables required to run an LSM that solves the surface energy balance. They find the bias correction scheme removes nearly all bias from all seven variables and the subsequent LSM simulations closely match the observation-based simulation.

They then step through six simulations where they remove bias correction from one variable at a time (e.g. precipitation or temperature) to examine the impact of bias correction for that specific variable. Findings highlight that precipitation and temperature

are the most important variables to bias correct, as expected. However, radiation is also found to have high sensitivity and should be corrected as well. Surface pressure and wind speed generally have little impact and can almost always be neglected. I appreciate the literature review to place the sensitivities found here in the context of other studies.

Extra time is spent examining humidity, as extreme sensitivity across higher latitudes in the northern hemisphere is found in the LSM (JULES in this paper). They attribute the extreme sensitivity to reduced ET in high humidity environments, and direct condensation and deposition of water vapor into the snowpack in these regions.

Overall, this paper is logically organized and generally easy to follow. I think it will be ready for publication in HESS after the authors address my comments.

Comments:

1) The specific humidity discussion is much needed to explain the extreme sensitivities in the JULES model. I believe it should be expanded in the main text, with the figures in the supplemental material moved to the paper. Additionally, examination of relative humidity for supersaturated conditions should be done for an example grid cell or the entire Northern European region.

Figure S.4 and the discussion in Section 4.4 imply that the raw GCM runs are too humid and have supersaturated conditions in high latitudes in the northern Hemisphere. I'm a bit surprised by this, thus it is worth checking in more detail by looking at relative humidity over a larger spatial region in the raw GCM output.

What GCM data are used to force JULES? That is a key detail I cannot find in the paper. Was it the lowest sigma level of the GCM, or the 10-m/2-m diagnosed variables from the GCM? It is possible (although maybe not likely) that the issue could stem from the use of JULES while the GCMs use a different LSM and that mismatch could be at the root of these results.

Finally, some detailed examination of how JULES treats vegetation and snowpack versus the LSMs in the GCMs may also give some insight into this issue. These regions are primarily boreal forest, which are sometimes difficult areas to model in winter, particularly surface fluxes into/out of the snowpack (e.g. Chen et al. 2014). Is it possible to distinguish between condensation and deposition in the JULES output? That may give additional insight into JULES behavior.

2) Discussion in sections 3.1 and 3.2 can be shortened to make room for the expanded discussion of the specific humidity biases. These add little value to the paper in my opinion.

3) The bias correction procedure needs more detail discussed. The authors mention the issues of keeping variables physically consistent when performing bias correction across many variables. However, they do not discuss the basic checks that are still necessary and should be performed when bias correcting many variables. For example, limiting humidity to prevent supersaturation conditions in the bias corrected fields when correcting temperature and specific humidity.

References: Chen, F., et al. (2014), Modeling seasonal snowpack evolution in the complex terrain and forested Colorado Headwaters region: A model intercomparison study, J. Geophys. Res. Atmos., 119, 13,795–13,819, doi:10.1002/2014JD022167.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2017-208, 2017.