Gelati et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2017-341

Response to Referee #1

Our responses to the comments of Referee #1 are organised as follows: comment 1.x from Referee #1; authors' response to 1.x and proposed changes in the manuscript, where added text is formatted italic green. Page and line numbers refer to the first submission. Added references are reported at the end of this document.

1.1 Comment: The study aims to assess the impacts of the uncertainties of atmospheric forcing to the hydrological output of a land surface model. Four different meteorological datasets were used to drive the LSM model. Outputs were validated against point river discharge measurements and remotely sensed soil moisture and leaf area index. Forcing uncertainty was quantified for all combinations of forcing and output variables.

I commend the authors for their high quality research. Their study address highly relevant research within the scope of the journal. The manuscript is well structured and the presentation of the experimental design, models and data is excellent. Considering these, my suggestion to would be to be published after addressing some minor comments:

1.1 Response: We thank Referee #1 for her/his review of the manuscript and useful comments, which we address in the following.

1.2 Comment: Page 2 – Line 26: I assume spatial scales are expressed in exponents

1.2 Response: Yes, we made a typographical error. We propose replacing "(101–102 km)" with "*(10^1–10^2 km)*".

1.3 Comment: Page 5 – Line 22: please define the finer spatial scale.

1.3 Response: To better characterise the spatial scales addressed by the sub-grid snow-vegetation-soil composite columns, we propose adding on page 5, line 23:

"[…] at a finer spatial scale than the one imposed by the atmospheric forcing. *In this study we use 12 columns within 0.5° latitude/longitude grid cells. The size of model grid cells is determined by the atmospheric forcing spatial resolution.*".

1.4 Comment: Page 6 – Line 20: The adjustment of just one of the forcing variables (precipitation) leads to physical inconsistencies (Haddeland et al, 2012; Sippel et al, 2016). Authors could elaborate on this.

1.4 Response: We agree this is an important aspect of bias correction. We propose adding the following paragraph in Section 6.1, on page 16, after line 20:

"*Limitations of (and alternatives to) bias correction methods adjusting a sub-set of the forcing variables or not involving statistical moments beyond the mean are discussed by Haddeland et al. (2012) and Sippel et al. (2016).*".

1.5 Comment: Page 7 – Line 10: Information regarding the impact of bias adjustment on large scale hydrological outputs are documented by Hagemann et al, 2011; Muerth et al, 2013; Papadimitriou et al, 2017.

1.5 Response: We agree on referring to recent research on the hydrological impacts of model-based atmospheric forcing bias correction. Thus, we propose adding in Section 1 ("Introduction"), on page 2, line 24:

"The experiments of Guo et al. (2006b) found that atmospheric forcing uncertainties affect LSM hydrological simulations as much as uncertainties stemming from the models themselves. *AGCM-based atmospheric forcing may be bias-corrected to better reproduce observed climatology, thus introducing an additional layer of input uncertainty (Hagemann et al., 2011; Muerth et al., 2013; Papadimitriou et al., 2017).*".

1.6 Comment: Page 7 – Line 5: Replace "extrapolated" with interpolated or simply re-mapped.

1.6 Response: We agree and propose replacing "extrapolated" with "*interpolated*".

1.7 Comment: Page 7 - Section: Atmospheric reference datasets. The atmospheric reference datasets that are used for comparison with the forcing are not, in some cases, independent. For example air temperature of WFDEI and PGF are bias corrected using datasets and compared against CRUv3.21. Several additional state of the art meteorogical datasets exist and could be used, like for example:

- The Berkeley Earth Surface Temperatures (BEST) (Rohde et al, 2013)
- NASA Goddard's Global Surface Temperature Analysis (GISTEMP) (Hansen et al, 2010)
- Global Historical Climatology Network (Lawrimore et al, 2011)
- Global Soil Wetness Project dataset (GSWP3) (Yoshimura and Kanamitsu, 2013)

Authors could reflect on that.

1.7 Response: We agree that inter-dependencies between forcing and reference atmospheric datasets may be a limit of our study. We also would like to stress that the extensive use of CRU data is motivated by its relatively high update frequency (currently updated to January 2017) and resolution (0.5°), which make this dataset attractive for land surface modelling. Moreover, since PGF and WFDEI are based on different reanalyses, their bias corrections yield different sub-diurnal variabilities. To account for these observations and to point at other existing state-of-the-art atmospheric datasets, we propose adding the following paragraph at the end of Section 6.1, on page 16, after the additional paragraph proposed in response 1.4:

"*Some of the used reference atmospheric datasets are not independent from the forcing. For example, CRU air temperature is used as reference and to bias-correct WFDEI and PGF forcing. The use of CRU data is motivated by its relatively high update frequency and resolution (0.5°), which make this dataset attractive for land surface modelling. Moreover, since PGF and WFDEI are based on different reanalyses, their bias corrections yield different sub-diurnal variabilities. However, to reduce dataset interdependencies, future work on the evaluation of forcing uncertainties may benefit from using a wider ensemble of state of the art meteorological datasets, among others: the Global Soil Wetness Project (GSWP3) forcing dataset (Yoshimura and Kanamitsu, 2013); the Goddard Institute for Space Studies Temperature (GISSTEMP) analysis (Hansen et al., 2010); the Global Historical Climatology Network temperature dataset (Lawrimore et al, 2011); The Berkeley Earth Surface Temperatures (BEST) dataset (Rohde et al., 2013); and the Multi-Source Weighted-Ensemble Precipitation (MSWEP) dataset (Beck et al., 2017b).*".

References

We propose citing all references suggested by Referee #1 and adding the following:

Beck, H. E., van Dijk, A. I. J. M., Levizzani, V., Schellekens, J., Miralles, D. G., Martens, B., and de Roo, A.: MSWEP: 3-hourly 0.25° global gridded precipitation (1979–2015) by merging gauge, satellite, and reanalysis data, Hydrology and Earth System Sciences, 21, 589–615, doi:10.5194/hess-21-589-2017, 2017b.