

Interactive comment on “Hierarchical Sensitivity Analysis for Large-scale Process-based Hydrological Modeling with Application in an Amazonian Watershed” by Haifan Liu et al.

Anonymous Referee #3

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This study offers a fine-grained analysis of sensitivities of simulated evapotranspiration and groundwater contribution to climate, model parameters and subsurface stratigraphy (what the authors called model uncertainty). A lot of work is involved here and rich results have been presented. I think overall the results are interesting and offer a great deal of insight about how these models function, which also are hypotheses about how the natural systems function (note: hypotheses not conclusions). These sensitivities could guide future research and model development, e.g., previous studies have rarely studied the impacts of soil thickness. The authors presented analysis of sensitivities at hourly level, at spatially-distributed gridpoint scale, and river reach scales, which I have not seen elsewhere. This rich set of analysis gave me some

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useful things to think about, e.g., how climate has delayed sensitivity on the groundwater, and how vertical and horizontal parameters exert different controls baseflow. I think this paper will be a valuable contribution to HESS. However I would like to point out a few issues that should be addressed: Major issues

1. The overall motivation should be improved. It should not be "there lacked of research utililizing quantitative and representative global sensiltvity analysis" (line 59-61). I mean yes this is a gap but the primary objective should be to understand uncertainty sources and provide insights to physical processes that control ET and baseflow.
2. Section 2.2 should be greatly shortened, or moved to Supporting Information. It's way too long right now.
3. Conversely, some figures deserve more discussion, e.g., Figure 7 – I do not think it is the thickness right under the river cells, it's about overall thickness and how much water from the watershed concentrates to the channels. This hypothesis can be tested; Figure 9 – headwater vs stem river cells. Figure 11 – not really discussed much.
3. How the authors came up with the six climate scenarios are not described. How could you have these different scenarios?
4. Figure 4 is a big mess. A cleaner representation such as a boxplot is required.
5. The authors need to tone down the description of the hourly sensitivity especially around night. There may be many assumptions baked into how daily precipitation is disaggregated into hourly which influenced these results. I doubt how robust this is.
6. Although not required, it will be nice to demonstrate the results for a year rather than 180 days. The annual cycle tells us more things.
7. the soil thickness should not be called "numerical model" uncertainty, but "subsurface stratetigraphy".

Some minor points:

- line 82, Michigan state → Michigan or the state of Michigan
- A relevant citation for this paragraph: Ji et al., 2019, 10.1029/2018WR023897
- line 126. the model tool → the modeling tool
- line 122, drainage network was formed → formed
- line 287-292 paragraph— Brunke et al. 2016 is relevant to discuss 10.1175/JCLI-D-15-0307.1
- line 307– on what machine did you run these many simulations and how much time did it take?
- line 323 → has little influence on spatially-averaged ET. (I believe for different cells it has a more prominent impact)
- line 326 → temporally dependent →

time-dependentline 331 "greatly decreasing"?? awkward phrasing.line 356 – accumulation over time? Maybe also due to seasonality? we don't know for sureline 366, remove "through this investigation".line 354 – river flow always occurs hours later than the rainfall process — what if the rainfall isn't large enough to trigger a response?line 347-348– circular logic and tautology

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