Interactive comment on “On the importance of multiple-component evaluation of spatial patterns for optimization of earth system models – A case study using mHM v5.6 at catchment scale” by Julian Koch et al.

Anonymous Referee #1

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1 Summary

The paper presents a new metric that evaluates the spatial pattern of hydrologic model and earth system model. The new metric, SPAEF, is multi-objective and consists of three components: spatial correlation, coefficient of variance ratio (simulation to observation), and histogram matching. The paper demonstrated mHM hydrologic model calibration by applying this metric to simulated ET distribution (or latent heat flux) against remote sensing data over 2,500 sq-km catchment in Denmark and compared the calibration performance against the use of other metrics. The paper shows that updated parameterization improves ET spatial pattern over use of the previous model parameters.

2 Comments

Goals of this paper, which is to propose a new evaluation/calibration metric that quantifies the accuracy of spatial pattern of the earth system model, is good fit for GMD. Overall, I, as hydrologists who do modeling work, enjoyed reading the manuscript with great interest. My main comments below are regarding how this metric and calibration strategy could be applied to other models than mHMs, which might be hard to estimate spatially distributed parameters. My recommendation would be minor revision (if you can justify not performing additional simulations I mention in comment 4.

1. To promote the metrics invented here, acronym of the metric is better pronounceable. Also, I would consider the metric name in Title. Just suggestion.

2. Please describe the weakness of two other metrics you evaluated besides SPAEF clearly.

3. The paper stated that spatial pattern of the model outputs depends at least on 1) process parameterizations (i.e., model equations), 2) accuracy of climate forcing (spatio-temporal pattern), and 3) parameter regionalization scheme (how parameters are distributed in space). I agree with these, but I speculate that spatial pattern is regulated in the first order by transfer function forms that convert soil/vegetation data to parameter values. Maybe mention this?

4. While mHM has a very unique regionalization scheme called multi-scale parameter regionalization scheme (calibrate the coefficients of transfer functions that...
compute parameter values from distributed geophysical data), making it easy to
regionalize the parameters at any scales, all most all the other models do not
have such a scheme. Therefore, it seems to be difficult to perform distributed
model calibration presented in this paper for the other models. How applicable is
this calibration strategy to the other models?

5. However, I still think this is an unique calibration strategy that combines spatial
pattern and temporal pattern metrics, but meantime, I thought there need for
more calibration experiments to understand the values of spatial pattern metrics
for calibration purpose. I wish that there would have been results from 1) stream-
flow only calibration and 2) spatial pattern metric only calibration, showing skills
of both ET spatial pattern and streamflow simulation. This way, the paper could
show real value of this spatial pattern calibration. Does streamflow only cali-
bration produce worse ET spatial pattern than the streamflow and ET combined
calibration? Does spatial pattern only calibration produce worse streamflow sim-
ulations than the case streamflow is not used for calibration?

6. Contrast to hydrologic models, earth system model community do not have cali-
brate the parameters though Land surface model community started to pay more
attention to calibrations/sensitivity analysis. Therefore, the presentation of this
paper is more related to hydrologic model application. However, spatial pattern
metrics could be used for model evaluation purpose. For example, would it be
possible (or worthwhile) to use this for evaluation of meteorological fields from
climate models against observation or reanalysis grid.

3 Minor comments or specific line by line comments

• I found a few typos – mayor-> major (P2, Line 2), patter->pattern (P5, Line 20).

• P5, Line3-4. I am not sure if I understand this sentence. Do you mean
soil/vegetation properties by “these”.

• P5. Q in KGE equation is incorrect. It should be $\mu_{sim}/\mu_{obs}$. Also, correct expla-
nation in Line 14.

• P6, Line1-9. I think this paragraph is better fit after P5, L18.

• P9, Line6-7. Use of spatial pattern metrics as objective function converge faster
than streamflow derived objective function. That seems to make sense be-
cause spatial pattern is by large determined by fixed transfer function forms and
soil/vegetation properties in the mHM. It would be nice to mention the reason if
you know.

• P10, Line10-14. I think this is good points to discuss, but I think it would be nice
to discuss constrains from transfer function form (regularization equations).

• P11. Line 22. This number of iteration for convergences should depend on model
choice and also regionalization scheme. So it is better not to generalize the
conclusion here (I think).

• P11. Line26. I don’t understand why it is reasonable given the parameterization
of the mHM? Please elaborate a little more.

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2017.