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Geoscientific Model Development Discussions

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 new metric that evaluates the spatial pattern of hydrologic model and earth system model. The new metric called SPAEF is multi-objectives, 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 2500 sq-km catchment in Denmark and compared

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the calibration performance against the use of the other metrics. The paper show that updated parameterization improves ET spatial pattern over use of the previous model parameters.

2 Comments

Goals of this paper, which is to propose 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 metrics and calibration strategy could be applied to the other model 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 mulit-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) streamflow 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 calibration produce worse ET spatial pattern than the streamflow and ET combined calibration? Does spatial pattern only calibration produce worse streamflow simulations than the case streamflow is not used for calibration?

6. Contrast to hydrologic models, earth system model community do not have calibrate 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 μ_{sim}/μ_{obs}. Also, correct explanation 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 because 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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