

***Interactive comment on* “Land Surface Model Representation of the Mutual Information Context between Multi-Layer Soil Moisture and Evapotranspiration” by Jianxiu Qiu et al.**

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Dear authors,

First, I would like to thank you for your advice to us. I appreciate it.

Indeed, simpler models are expected to condense information within fewer inter-variable relationships. By doing so, the outputs tend to become more sensitive to the inputs that remain considered; in other words, mutual information between the remaining variables increases. Taking GLEAM as an example — which I would recommend

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the authors not to call a 'land surface model' but a 'remote sensing evaporation model', or similar (see literature on this) — the model follows the assumption that the main constraints on potential evaporation can be captured by the soil moisture signal. This implies that the relation between soil moisture and evaporation in GLEAM will be tighter than in nature; in reality, multiple other variables constrain stomatal conductance that are either neglected or implicitly assumed to co-vary with soil moisture. As CLSM and Noah use a more inclusive and comprehensive Ball–Berry model, their sensitivity to soil moisture is lower and likely closer to nature.

In my view, a more relevant question — especially for an evaporation retrieval model — is whether this simplification is valid in terms of the accuracy of the final evaporation output.

My first advisor, once told me that simpler models should be prioritized if their output is equally accurate. Getting the right results for the right reasons is in fact crucial for land surface models when they are designed to make future projections in a non-stationary environment, but not for retrieval methods like GLEAM that simply aim to produce an accurate historical data record. For the latter, what arguably matters the most is whether the selected input variables are observable. There again, the importance of making a distinction regarding the type of model and their purpose in the paper.

If the authors had chosen to look at the sensitivity of evaporation to radiation instead, they would have encountered very similar findings: because GLEAM uses a Priestley and Taylor simplification, the output will be more sensitive to radiation than in land surface models. This is again a given. The real question is whether the accuracy of the output is significantly affected by the simplification being taken. Like for the soil moisture stress function, this simplification also has some reasoning behind: other inputs required by Monteith's formulation (e.g., wind, vapour pressure deficit) are not

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easily available from remote sensing. This for an evaporation retrieval model like GLEAM is crucial, but unimportant for land surface models like Noah or CLSM which are designed to run on climate model input or reanalysis.

Consequently, I have the feeling that the story would be more compelling if it had embraced a discussion on the degree these models can be simplified and still be comparable in terms of outputs. In that sense, for instance, I would advise to take a step back and show the in situ versus model validation results of ET and soil moisture. The authors might perhaps find that GLEAM performs worse than the land surface models. However, if they find the opposite, I would rather call this a success story on how simpler formulations can outperform more complex models, rather than merely highlighting that the physics in simpler models are more rudimentary, which is something we can all agree with.

Good luck with the review.

Best regards,
Diego

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