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Discussions

Interactive comment on "Using expert knowledge to increase realism in environmental system models can dramatically reduce the need for calibration" *by* S. Gharari et al.

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We would like to thank Dr. Gong for his short comment on our discussion paper (DP). We are glad that he sees the potential in our work and devoted attention to write this short comments on our work. We address the comments and suggestion one by one as below:

Line 1, page 14805. Missed a DOT before "The".

It is corrected.

The introduction about FLEX-TOPO is excessively verbose. A very simple introduction, a sketch figure, a parameter table and a few equations are enough.

The section3 is also too wordy, and the key points about the interface to "constrained-based sampling method" are not properly emphasized.

Firstly, about the explanation of the FLEX-TOPO model structure: usually explanations of models in scientific papers are rather insufficient and not enough to reproduce exactly the same model. Based on our past experiences it is very difficult to code even similar model such as HYMOD just by reading related papers. In our point of view, model structure [read architecture], model parameterization [read constitutive functions] and constraints should be clearly stated as they are part of the full hierarchical model development scheme. We tried to explain the basic ideas of why we went toward such type of model, what the exact assumptions behind any steps of the model are, what the components of each individual model are and how they are linked. Of course by just presenting the figures and tables one should be able to have an understanding of model but we see more power in explaining the model in words and phrases and their function accordingly as we would like to impose the hydrological constraints on parameter sets, fluxes or reservoirs.

Secondly, about emphasizing the key point "the constraint-based search method": as we mentioned earlier we tried to explain the model(s) from the scratch and keep it separated from the proposed search methodology. So we introduced this simple search algorithm in a companion technical note. In our point of view, to which the reviewer might disagree, the "search method" is just a tool but the more important story for us is how to use this tool, how to formulate the model structure based on hydrologically meaningful reasons and how to impose hydrological meaningful constraints on top of it. One might argue that the proposed search algorithm could be more efficient but our interest is rather in improving our knowledge about how the real system works [the hydrological science]. We strongly believe that the search algorithm is not specifically increasing our hydrological knowledge about our surrounding environment.

This is the first case study that uses the newly proposed "constraint-based" sampling method, so I suggest moving the core content of hess-2013-520 to this paper, and use FLEX-TOPO as an example.

As explained above, in our point of view the proposed search method is just one of the possible ways to solve the more interesting hydrological issue of "constraining". For us the heart of our work is constructing and formulating the models and constraints, while the search algorithm is just a tool which helps us in this regards. This search can be of course implemented in more efficient ways in any form.

Line 15, page 14818. I have three questions.

1. Is the NDVI data reliable? Please provide and check the quality information of your data.

We agree with Dr. Gong about his concern over the quality of NDVI data that we are using in building the constraints.

Any constraint which is introduced in this study is deterministic. To reduce this deficiency we tried to introduce conservative acceptance limit for each of the constraint based on our available information and expert knowledge on the limit of acceptability of each constraint. Further future studies can show the dependency and sensitivity of behavioural parameter sets, the ones that satisfies all the constraints, regarding each imposed constraint.

2. NDVI is an indirect indicator of ET, can you use ET data products such as MOD16-evapotranspiration? See http://www.ntsg.umt.edu/project/mod16

Any type of data can be used to construct or refine any of the constraints. The constraint can be refined both in their acceptance limit and temporal resolution. The comparison between transpiration can be downscaled to weekly or daily comparison if warranted by data. However ones should keep in mind that such high resolution observations as constraints will require enough process heterogenity in the model, i.e. the model structure should be complex enough.

Another problem might be the spatial resolution of data. It should be somehow that the difference between landscape can be captured by them. For example with evaporation data at a resolution of 250 meters or 1 kilometres it is almost impossible to distinguish wetland, hillslope and plateau differences in transpiration.

3. The "one sigma" constraint seems arbitrary. Please give some material to

support why you select "one sigma" as the bound. I think a more reasonable one is use the bound derived from the quality control information of the data product.

We agree with Dr. Gong. We do not want to go into more philosophical issues but in our point view any bound derived from data is also arbitrary as we do not know the true value. One sigma is therefore just our assumption, helping to define an limit of acceptability.

Line 2, page 14821. Do you have any literature to support the value "0.2" and "5"? Or just by your experience?

No, it is just a very conservative "expert guess" which limits the percolation of different landscape units to prevent "unrealistic" dynamics.

Line 3, page 14822. Why non-smooth? Could you give an example? Or a synthetic study that introducing constraints can make smooth objective functions becomes non-smooth?

We will change the sentence as follow: "Punishing the objective function(s) based on the number of unsatisfied constraints, however, may lead to non-smooth objective functions which potentially may cause instabilities in the search algorithm and/or create invalid results."

Once again we would like to thank Dr. Gong for his constructive comments on our manuscript.

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