Hydrol. Earth Syst. Sci. Discuss., 10, C6392–C6396, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C6392/2013/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "On the lack of robustness of hydrologic models regarding water balance simulation – a diagnostic approach on 20 mountainous catchments using three models of increasing complexity" *by* L. Coron et al.

L. Coron et al.

laurent.coron@irstea.fr

Received and published: 19 November 2013

Answer to Editor

NB. The editor comments have been repeated here and are written inside < < > > symbols.

———

< < 1) Can you differentiate between the effect of using periods with different weather conditions on average and being outside of the calibration conditions for certain parts of the simulation period? > >

This question was investigate with the help of the testing tools presented in Coron et al. (2012, WRR). These tools include

- the Generalised Split Sample Test procedure (GSST), which allows for a very large number of split-sample tests over a wide range of transfer conditions (see Fig. 3 in Coron, 2012, WRR);

- a Model Robustness Criterion (MRC), which emphasise the loss in models efficiency from between calibration and validation conditions (the errors compared being computed on the same period) (see Eq. 4 in Coron, 2012, WRR);

- graphical tools, where MRC is plotted against the relative evolution of climate conditions, e.g. we look for possible correlation between a change in mean rainfall and an increase in model errors (see Fig. 4 in Coron, 2012, WRR);

The work on an Australian set (Coron, 2012, WRR) later extended to a French set Coron, 2013, PhD) showed that the situations where parameters are transferred between independent periods but with similar climate characteristics can indeed be differentiated from the situations where parameters are transferred between climatically contrasted period. Changes in mean temperature and precipitation were often found to be explanatory variables for changes in our robustness criteria (MRC), however different situations were found on different catchments, sometimes remaining unexplained.

To date we remain unable to bring further contribution on the actual causes of model robustness issues. Yet, we progressed on the understanding of the decisive role of water balance adjustment on these robustness issues. We therefore aimed at presenting ours findings with this paper, and more precisely sharing our surprise regarding the little impact of changing the calibration period, which results in a "parallelism effect" between the curves of volume error variations.

< < 2) As far as I understand one single best parameter set has been calibrated per period, catchment and model. How much could this have affected results and might it be possible to obtain more robust results by allowing for several 'best' parameter sets using some type of Monte Carlo approach? > >

A single best parameter set was indeed kept at the end of each calibration and was tested against the entire period. Using a Monte Carlo like approach for selecting several 'best' parameter sets could indeed be used in these tests to investigate the question of equifinality between parameter sets. We could indeed face a situation where two sets provide similar efficiency scores during the calibration period but are not at all equivalent with respect to their ability to provide accurate simulations on other periods.

However, implementing a Monte Carlo like approach in the testing work reported in the paper would only be relevant for the Cequeau model.

The Mouelhi formula has a single parameter and therefore no equifinality issues can occur. The situation is slightly different for GR4J-CemaNeige, which has 6 optimiseed parameters. However, the model parsimony limits the risk for multiple optima when objective functions such as NSE or KGE are considered. It is likely that a Monte Carlo approach would lead to selecting very similar parameter sets, which are all close to the overall efficiency optima. Therefore no real diversity would be created and the interest of the Monte Carlo implementation would be reduced.

This being said, it might happen by chance that (independently from the calibration method) the best parameter during calibration is less transferable to a validation period than a slightly sub-optimal parameter during calibration. Furthermore, considering the almost systematic volume error observed during the temporal transfer of parameter sets, it is even likely that we would find a statistical improvement for using averaged

simulations from several sub-optimal sets (rather than true optimal sets as currently done).

To summarise, using several 'best' parameter sets using some type of Monte Carlo approach will indeed impact the robustness measures discussed in the paper and could be relevant for the Cequeau model. However, there is a risk that such use leads to seemingly smaller transferability issues but that this gain in robustness would in reality be an artefact of the true issue: the model over-fit to mean volume during calibration, combined with its difficulties to reproduce mean volumes on other periods. Unfortunately, simply reducing the weight on the volume fit in the objective function is not the solution to the volume errors highlighted in the paper (we tested this). Indeed, it solely impacts the vertical positioning of the θ curves illustrated on Fig. 4 but not their shape.

< < 3) For mountainous catchments variations with elevations are important. Therefore, please describe which lapse rate you used for temperature and precipitation and how many elevation zones where used in the different models. > >

The Mouelhi formula includes no module dedicated to snow simulation.

The CemaNeige snow module is run at daily time-step (similarly to GR4J). CemaNeige is computed over 5 elevation layers of equal area. The daily forcings on each elevation layer are obtained by aggregating the data from the SPAZM reanalysis (data available on 1x1 km cells). The outputs from CemaNeige are then aggregated to feed GR4J which is a lumped model

Finally, the soil moisture accounting (SMA) part of the Cequeau model is computed on a topography-based mesh. The number of cells in this mesh is adjusted to the catchment size and topography (for the 20-catchment set used this work, this number ranges from 10 to 30). As for CemaNeige, the forcings on each cell are obtained by aggregating the data from the SPAZM reanalysis.

Complementary information on these aspects has been added in the revised version of the paper.

———

END

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/10/C6392/2013/hessd-10-C6392-2013-supplement.pdf

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 11337, 2013.