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Hydrology and Earth System Sciences
Discussions

Interactive comment on "On the representation of water reservoir storage and operations in large-scale hydrological models: implications on model parameterization and climate change impact assessments" *by* Thanh Duc Dang et al.

Anonymous Referee #2

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General comments:

This work contributes to literature on the representation of human interactions in hydrological model by demonstrating the importance of modeling reservoirs. Using the high-profile case of the Lancang / Mekong river basin, they calibrate a large-scale hydrological model (VIC), both with and without reservoirs. They show that while there exist parameter sets for which the model can be calibrated in both cases, the without-reservoir model compensate the absence of human-operated storage by artificially creating soil storage. Then they go on to investigate the reactions of both models

to climate change.

This is an interesting, timely and well-written piece of work that fits well within the scope of HESS. My comments are mainly at how the results are handled and interpreted:

1) While authors explain very well the consequences of the no-reservoir calibration in terms of structural model behavior, they do not show what that means for water resources appraisals. Indeed, both models are calibrated to have the same behavior downstream of 1 gauge. The crucial difference is that the model including reservoirs can be 1) validated at other (upstream) sites, and 2) validated with post 2005 dams (or the results can be extrapolated with new dams or new operating rules). This point is not really demonstrated.

2) Likewise, I disagree that the results from climate models are very different. Yes, there are some small difference, and authors do a good job of explaining them, but these differences are arguably small compared with the uncertainty surrounding downscaled climate projections. In fact, it is remarkable how robust the no-reservoir model results are with climate change.

3) I would advise authors to try and show how both calibrations differ at upstream gauges (where only the with-reservoir calibration would yield sensible results) where there is data, then carry on that comparison with climate change.

4) Alternatively (but this is probably more work), authors can focus on post-2005 years with the addition of new dams and look at the differences between both model at the outlet. And again look at how the two models differ with climate change then

5) Figure 8 is not very clear and could be replaced with curves comparing average monthly basinwide runoff for the two calibrations (and same for baseflow). This would show explicitly how the no-reservoir calibration compensates for the reservoirs. Alternatively, authors could map the dry / wet season cell-by-cell differences in baseflow / runoff between the two calibrations.

6) Figures 9 and 10 don't bring much and could be relegated to supplementary material to make place for new figures that can show the consequences of omitting reservoirs, e.g., as suggested in 3) and 4)

Detailed comments:

Figure 1.b: the scale, useful in 1.a, is missing.

Section 3.1.2: a short description of the version 4.2 of VIC's routing module would be helpful here. Recall that this research is useful for all large-scale hydrological models, not just for VIC experts.

Page 8, lines 2-9: there is a recent publication presenting a database of reservoir storage-area-depth relationships in Yigzaw et al (2018) there https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2017WR022040 could that affect your results in significant ways?

Page 9, lines 8-12: how many parallel processors are running? (l. 12) by runtime, do you mean the wall clock time or the total computational time used by all the processors (i.e. wallclock time times # of processors)? How do we know that 20 seeds are enough? And that the algorithm has converged after 250 function evaluations? Finally, what is the runtime for one run of VIC for that basin?

Page 14, lines 14-17: I disagree this is a real limitation, since proposing a universal rule system for reservoir operations is not an aim of this paper. Instead, a consequence of your work is that hydrological model calibration with reservoirs and a bespoke release rule means that the model still captures key hydrological processes once the release rules change (because there are new reservoirs / because reservoirs' purposes evolve). In contrast, if reservoirs are not represented to begin with, once the number and / or operations of reservoirs evolves, the model's hydrological parameters have to be recalibrated every time.

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