Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC1
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Comment on hess-2021-601

Anonymous Referee #1

Referee comment on "A novel objective function DYNO for automatic multivariable calibration of 3D lake models" by Wei Xia et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-601-RC1, 2022

This paper presents a new objective function for automatic calibration of 3D hydrodynamic models based on water temperature and velocity data. The case study is a tropical lake, where the authors tested their DYNO+PODS for calibrating a Delft3D model against a subset of previously simulated 3D flow and temperature fields from a run assumed to be the "truth". I strongly appreciate this approach as it provides the full control of the optimization. Moreover, as the authors stressed many times (maybe too many, a lot of repetitions could be avoided), the use of velocity data together with water temperature is not so diffused yet in the field of lakes hydrodynamic modeling but it is crucial to have consistent results and realistic flow fields. Hence I welcomed the authors effort in quantifying how important it is.

Optimization algorithms as well as suitable objective functions for calibrating complex models are needed in the wide environment of hydrological numerical applications. I enjoyed the reading of the manuscript, which is well written and clearly structured. I appreciated how the authors describe their DYNO and tested its performances. Some clarifications are required, in my opinion, to make the optimization part (which is not the focus of the manuscript but still a key part of it) more accessible to the wide public of HESS, but in general I believe this work is worthy for publication on HESS after some minor revisions.

I'd like the authors to consider deepening the analysis on two more aspects which I believe worth a little discussion:

- Computational costs: Addressing this aspect is mandatory in a paper on optimization algorithms. The authors make some general considerations here and there, but maybe a dedicated paragraph would be more appropriate. My questions:
  - How many (real) runs of the hydrodynamic model were necessary to get the final

solution for e.g. each trial/each configuration of Dyno (temp, vel, both)?
    - What is the computational cost (wall clock time) of these tests? e.g. how much time compared to the error?
- Application to real data from observations: The authors auspicate that future users will test the DYNO against observations and so do I. So my questions are:
    - Are there any constraints in the time/space frequency of the observations? In order to calibrate e.g. their Delft3D lake model to some temperature profiles and some current measurements, how should this data be? E.g. should temp and vel be simultaneous/in the same locations/same depths? As far as I understood, this is indeed the case of the data used in the authors' application, but this is not that common in standard monitoring schemes, where data are sparse and often not simultaneous. So basically, does this optimization (I guess this applies to PODS rather than DYNO) handle sparse observation?
    - Did the authors test their DYNO+PODS by changing e.g. the sampling time or the number of locations of their "truth"? I guess the more data the better, but I'd greatly appreciate some discussion on this. Is there an optimal number of locations/time frequency which gives a satisfactory calibration?

Attached are few minor comments/suggestions to improve the paper.

Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2021-601/hess-2021-601-RC1-supplement.pdf