Comments to the manuscript submitted to HESS

A Novel Objective Function DYNO for Automatic Multivariable Calibration and Application to Assess Effects of Velocity versus Temperature Data for 3D Lake Models Calibration

Below few minor comments/suggestions to improve the paper. I strongly recommend the authors to revise the English language as I found some typos (missing spaces, wrong singular/plural verbs) and some passages to be improved, especially in the Abstract, Introduction and Methods. Figures are ok but some "transparency" boxes from the png (my guess) are visible so please consider improving the quality or changing the figure format.

Title: Please synthetize the title: my suggestion:

A Novel Objective Function DYNO for Automatic Multivariable Calibration of 3D Lake Models

L19-20: "by comparing the result of using DYNO to results of calibrating to either temperature or velocity observation only" please rephrase

L27-33: please revise the English form and make it less general. An example: "*Hydrodynamic models simulate the hydrodynamic and thermodynamic processes in lakes and reservoirs*": not really, "hydrodynamic models" is a very wide definition for models that can be used to simulate either hydrodynamics only or hydro-thermodynamics (as for Delft3D), and to different water environments, not only lakes. This is just a formal comment and applies to the entire Introduction, please avoid generalized and rough statements as well as repetitions.

L30: The authors say that hydrodynamic models simulate specific water quality variables. What do they mean with "specific water quality variables"?

L46: "some" water variables. I'd say all of them! If the model is 1D, all variables will be 1D. Also in this case, please be more precise: "spatial" is very general, 1D models typically consider the vertical dimension, so what they don't provide is the horizontal spatial distribution and in general they can't capture the 3D processes (e.g. circulations, 2D waves…).

L66-75: The authors could be interested in reading this work https://doi.org/10.1016/j.envsoft.2021.105017 and references therein where some of the issues mentioned in this paragraph are addressed in a manual calibration of Delft3D in a lake.

L85-90: a little confused, please revise English form.

L100: etc → among others; desire → require

L108: "*A key challenge for automatic calibration of multi-variable calibration problems is in defining a suitable objective function to calibrate multiple variables simultaneously*": please remove some "calibrations", e.g.: A key challenge for automatic calibration of multi-variable problems is in defining a suitable objective function.

L110: varying → vary

L118: Anticipate MOO to the first time it is mentioned (L113). Does SOO refer to the optimization methods mentioned in lines (105-112)? If yes, please anticipate SOO as well.

Tab.1 check spaces

L164: (e.g. calibrating temperature and…) we got that the authors are dealing with multi-variables problems and in particular with temp and vel. Please revise the paper critically and remove repetitions.

Sect.2.3: I see that the point of this work is not the simulation of one specific case study, but since the name of the section is "Study site and data" the authors could at least include the name of the lake and a few morphological characteristics (e.g. where it is located, how deep and large it is) and then refer to Xia et al. 2021 for all other details. Also what year was simulated should be reported for completeness (in the text and in fig. 1).

L189: just a curiosity, why are the names of the station A1, B1-4? Does this A1 station mean something different than the others?

L211-212: "the water utilities′ employees and consultants": some specification is missing here... maybe Singapore?

L234: Secchi depth: what about the space-time variability of this parameter? Delft3D allows to consider both variations, as transparency is not a constant and uniform feature of water. Did the authors consider this possibility?

L237: please consider moving here the sentence in lines 228-230.

L241: Model parameter(s) in table caption

Tab.2: Why didn't the authors include the coefficient of free convection, whose value greatly affects the modeled temperature? The default value in Delft3D is 0.14 but it strongly modifies the thermal profile when tuned.

L261: Have the authors considered normalization of RMSE by the standard deviation instead of the mean and why did they eventually chose the mean as normalization factor?

L272-273 and Eq.11: It looks to me that there is a power of 2 missing in eq.11. The referred papers (starting from Beletsky et al. 2006) present this formula with the module of the difference between observations and models (at the numerator) and the module of the observations vector (at the denominator) both to the power of 2, and then everything under the square root. If the authors prefer to use the Euclidean norm instead of the module it is fine with me, as ||x||_2 = |x| in R^2,

but the power of 2 should be maintained anyway, right? I checked the codes uploaded on github and I see a **2 in the computation of the Fourier norm, but please double check the equation, the code and the references.

L280: “being summed them” remove them

Sect.2.6.1. This paragraph seems like an advertisement of PODS and is highly technical. I'm not sure it is adequate to the wide audience of HESS. The authors could consider limiting the acronyms to those that are really needed (e.g. do we really need to know that “*DYCORS inherits the dynamic coordinate search idea from DDS (Tolson and Shoemaker, 2007) to improve its effectiveness and efficiency for high dimensional problems*”?) and try to clarify a bit. What does RBF surrogate mean? Maybe the authors could consider merging sect 2.6.1. and 2.6.2. and try to explain things in easier terms (and referring to publications for high-technical details), eventually splitting some very long sentences.

Figure2 and commenting text: two aspects are not completely clear to me:

1) how does the RBF surrogate model interact with the new fitness F and how does it then communicate to worker-i such that the latter can run a new hydrodynamic simulation? I believe that lines 318-320 are crucial here. The authors could consider expanding these two lines as it seems to me they are taking for granted too many things.
2) how are workers-p related one another? Are all steps M1-M6 performed independently on each processor?
   If yes, how do they communicate at the end to define the best solution found?
   If not, do M1-M6 steps consider all trials from workers-p within ψ? And how does M6 discriminate to which worker-i it should communicate the new X?

Table 4 and commenting text: a “good model” range for Fn should be between 0 (perfection) and 1. How do the authors comment such large values of Fn? Their best solution Cali-borh gives almost 2, while the Cali-Vel, which should minimize only Fn, gives almost 3!

L395: missing dot before Figure3?

L421: overestimated → overestimation

L433-434: Latin Hypercube Designs (LHD) is mentioned here for the first time. Please specify what it is used for in the methods section.

L456: “only the best solution in each of the optimization iterations are plotted” → is plotted

L462 please change the asterisk with standard math notation

Figure5 and 6 Please make the axis labels consistent between the two figs. fvel(X) and ftem(X) should be fine for fig. 5 (if I got correctly that only the best K is plotted), while ftem(X|K) and fvel(X|K) should be fine in fig. 6

Figure 6: please improve the readability of the number inside the darkest hexagon by either changing the darkest color or modifying the color of the number (e.g.) yellow. Please note that there is a missing C in (c) in the figure legend.

I would have expected the darkest hexagons to be the closest to the origin. Why isn't it like that? What is the hexagon containing the final solution? The authors could consider highlighting it e.g. with a bold colored contour line.

L485: represent (remove s)

L534: please correct, which one is better than the other? N2 better than N1?

L537: like→ likely?

L565: helps to improve the calibrate of → calibration