Comment on egusphere-2022-10
Anonymous Referee #2

Referee comment on "Multi-dimensional hydrological–hydraulic model with variational data assimilation for river networks and floodplains" by Léo Pujol et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-10-RC2, 2022

This study proposes an integrated hydrological and multi-dimensional hydraulic modeling approach that is capable of handling multi-variate optimization problems of high dimension using multi-source data. The new multi-D hydraulic computational model was coupled to the formerly developed hydrological model (GR4H) in a semi-distributed setup, called DassFlow2D-V3. The topic is of high importance to the hydraulic and hydrology community, particularly under the massively growing high-resolution data or products obtained by remote sensing. However, the novelty of the work seems to be exaggerated. The basis of the proposed hydrologic-hydraulic model was already developed by Monnier et al. (2016) and Santos et al. (2018) and as the authors acknowledge, this work presents an upgrade to the above setting with respect to a new multi-dimensional hydraulic computational model. Furthermore, although the authors have described the capabilities of similar models (L50-70), the need for and the striking advantage of the proposed framework over the competing models have not been demonstrated. The manuscript also lack the underlying science questions that need to be outlined clearly. Further technical and editorial comments are listed below to consider before manuscript can be published in Geoscientific Model Development.

Major comments

- The material presented in section 2 is hard to follow in many parts: too many acronyms and multiple cross-references to other sections not presented, yet. Also, the figures are not referred to as they appear in the order presented. The authors are invited to carefully review the manuscript for a clearer and smoother presentation.
- L215-217: It seems only some parameters were calibrated in the integrated model, but the authors should describe the reason behind this choice.
- L240: Why did not you consider the square root of the current objective functions to
make their unit tangible and comparable to the unit of the estimating variables, e.g., Q?
- Section 2.4: It is not clear what the implication of “variational” is in the VDA framework.
- L334-338: You have repeated this experiment setting for at least three times in the manuscript. The same issue is seen in other parts. The authors are highly recommended to avoid repeating the same material, but with different toning, as well as to confine the results section to what are really the results. Currently, the results sections includes material related to the details of different experiments that should be stated in section 2.
- I am maybe missing something, but from the results it looks like the proposed new modeling framework does not that remarkable advantage in comparison to the formerly developed models of the same purpose. The authors should clearly highlight the distinct advantages of the proposed framework based on the reported results.
- To evaluate the accuracy and efficiency of the proposed model, the authors should expand their test cased to real-world river basins of small of medium size (< 1,000 km²) and compare the reproduced hydrographs with observations at multiple points across the basin. Currently, it is really difficult to judge about the applicability of the model as well as the relative advantages relative to the other competing models.
- The authors should also discuss the computational cost of the proposed model. Obviously, this issue would be interesting in case of real-world medium size basins, not the very simple virtual experiments considered in this study. In summary, the author should discuss if their model has the potential of application in the flood forecasting systems at a country or continent scale.

Minor comments

- Figure 1 needs improvement, and a reader cannot easily grasp the illustrated conceptual meshing approach.
- L7: virtual experiments instead of “academic”?
- L42: “a” key to...
- L84: SWE not defined before in text.
- Table 1: The citations are numbered in this table, while they are not labeled in the reference list.
- L109: VDA not defined before.
- Section 2.2.4 lacks a title.
- L230: the aim here is to ... please fix. The manuscript needs several other English proofing instances that the authors should take care of them.
- Figure 6: What is the blue time series in the second panel?