



EGUsphere, referee comment RC1
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Comment on egusphere-2022-10

Anonymous Referee #1

Referee comment on "Multi-dimensional hydrological-hydraulic model with variational data assimilation for river networks and floodplains" by Léo Pujol et al., EGU Sphere, <https://doi.org/10.5194/egusphere-2022-10-RC1>, 2022

General Comments

The manuscript presents the development of a multi-dimensional hydrological-hydraulic model. The model is calibrated/optimized using the variational data assimilation approach. Enhancing the computational efficiency of multi-dimensional river routing is important in the field of hydraulic modeling. Furthermore, it is important to investigate on state-parameter estimation utilizing the assimilation approach to identify the optimal parameters for obtaining better estimates of the physical variables of hydrodynamics. The authors describe a scientifically sound approach for performing multi-dimensional hydrologic-hydraulic modeling and calibrating model parameters using variational data assimilation. However, the manuscript lacks the reasoning and purpose for multi-dimensional hydrologic-hydraulic modeling over 2D modeling of the entire river length (a lot of commercial software are available for such 2D modelling). On the other hand, it is unclear how the combination of VDA with multi-dimensional modeling will increase the capacities of estimating physical variables. The use of several acronyms and mathematical formulae with no physical relevance impeded the intelligibility of the work considerably. Some specific and technical comments are provided to enhance the text that will be published in Geoscientific Model Development.

Specific Comments

- In the introduction, the authors did not clearly mention the motivation and the objective of the study. The authors mentioned "high resolution accuracy and fast computation times" but they introduced many studies on the matter in the next paragraph (L70-79). Authors should present more focused science questions.
- It is a bit confusing why the authors combined the multi-dimensional modelling with multi-source data assimilation methods over full 2-D modelling.
- The authors should explain the reason for using variational data assimilation method over ensemble data assimilation methods.

- It is not clear from the text in which temporal scale the parameter optimization is performed?
- What are the difference between parameter optimization (i.e., VDA) between 1D and 2D cases.
- Can the methods shown in the manuscript be applied for all spatial scales? A discussion of the spatial resolutions 1D or 2D river segments are needed for fully utilization of the methods developed in this manuscript.
- In the synthetic experiment, the authors discuss only scenarios with no lateral flow (e.g., surface and subsurface runoff) but it is better to have some discussion with lateral flow case.
- Many of the mathematical equations found in the main text are repeated in the appendices. So, I would like to suggest the authors to use the equations in the appendices to help them explain the main text more clearly. Authors can reduce the number of repeating equations by doing so.
- Is it possible for the model to modify the dimensionality on a temporal scale? When a flood occurs in one river reach, the flood is simulated using a 2D mesh, while in other cases, a 1D method is employed. If this is true, how will the model determine the flooding times?
- In section 3.3.1, the authors present a observing system simulation experiment (twin experiment) where a virtual observation is assumed. When they used virtual observations to calibrate the model parameters, they assumed the observations are available in all the river pixels and all the time. The availability of observations for all the river reaches in all the time may not be reasonable. To assess the validity of methods the authors should test more realistic scenario by assuming either spatial or temporal discontinuity.

Technical Corrections

- L60: What does "precipiton" mean
- L73 It is not easy to guess local 2D 'zooms'. Please elaborate on it.
- L83 SWE is not defined before
- Tabel 1: what is "sources available" better to explain it in the caption
- L113: What do SW means, "shallow water"?
- L129:]0,T] reads [0,T]
- Eq (1): doesn't U, F, G, S_g , and S_f be introduced?
- Section 2.2.4 does not contain in any title
- L201-204: do x_i and t refers to location and time, respectively?
- L211: What are Q_r and Q_d
- Eq(9): latter part of Eq(9) is missing.
- Figure 6: The authors can include the x, y axis in the panel (b). Is it possible to show an example of WSE variation at the 1D-2D mesh boundary? Display the legend in the center panel (blue/red lines on the hydrograph). This statement applies to all similar figures.
- L332: What is the reference discharge for calculation of NSE.
- Figure 12: Explain the area zoomed in caption, what are the two-river section shown in the focused area, explain them in the caption.
- L415: What is SMS meshing tool mean?
- L499: What is PET standard for?
- L500: What is SMASH?