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Interactive comment on "Hybrid Neural Network – Variational Data Assimilation algorithm to infer river discharges from SWOT-like data" *by* Kevin Larnier and Jerome Monnier

Anonymous Referee #1

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In this paper, the authors developed a new method for river bathymetry and discharge estimation from satellite altimetry data. They firstly estimated river discharge from satellite-observed water elevation data by machine learning. Then, using the estimated discharge and water elevation, they performed the inversion of a hydrodynamic model to estimate bathymetry and other parameters by variational data assimilation.

General comments: Although the topic of this paper is suitable to NPG, I believe that this paper has some fatal flaws which cannot be fixed in the short period of time. I believe that the current version of the paper cannot be accepted.

First, the design of the authors' synthetic experiment is inappropriate. Their synthetic

observations were fully generated by hydrodynamic models with no observation and model errors. They may not consider the real satellite swath, and the temporal resolution of the data (daily) is much higher than the real satellite altimetry. I believe that they have too rich data to examine the potential of SWOT. The richness of the observation data significantly matters when the fully data-driven approach such as neural network is applied but the authors completely ignored this issue. I strongly recommend the authors to perform numerical experiments with more realistic data.

Second, the advantage of the proposed method is unclear for me. In my understanding, there are many methods to infer river discharge from water levels. The authors omitted to compare their neural network with those previous works so that I am not convinced that machine learning is necessary in this context. As the authors raised in section 1, there are many methods to perform river bathymetry by assimilating satellite altimetry observations into hydrodynamic models. In my understanding, some of them simply applied the flavors of Kalman filter and successfully inferred river bathymetry (and river discharge) using the real satellite data from ENVISAT, ICESAT, and JASON-2 (e.g., Breda et al. 2019 https://doi.org/10.1029/2018WR024010). The authors' method seems to be much more complicated than these previous works and I am not convinced that the complex processes are necessary. I strongly recommend the authors to perform many sensitivity analyses and to confirm the impact of each process on the performance of their method.

Specific comments: Major points: L113: section 2.1.3. should not be "In-situ data". The authors actually generated synthetic in-situ data by simulation. This is misleading.

L118: I believe that daily sampling data cannot be called "SWOT like" observations although it may be accepted in the previous papers.

L119: As mentioned above, the assumption of perfect observation is problematic.

L142-145: Why did you calculate Pearson correlation coefficient? The authors did not use this information in this paper.

L148-149: I could not understand why the authors excluded the data whose mean discharge is larger than 10000 m3. Since machine learning basically interpolates the data, it is generally recommended to make training data cover the wide range of state space. If they cannot have the access to those data, maybe they should not use fully data-driven approaches. Why should the authors choose the inappropriate experiment design?

L217, Table 2: I recommend the authors to use same metrics for Tables 1 and 2.

L440, Figure 10: How did the authors get the target of bathymetry (red dots)?

Minor points: L23: Maybe the authors can divide this paragraph around this line. This first paragraph is too long and includes several topics. L61: the estimations accuracy –> the estimation's accuracy L417: Please fix a typo ("Section ??").

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