Comment on egusphere-2022-412

Anonymous Referee #1

Referee comment on "Assimilation of Transformed Water Surface Elevation to Improve River Discharge Estimation in a Continental-Scale River" by Menaka Revel et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-412-RC1, 2022

General comment:

In this research, the authors performed data assimilation (DA) experiments to explore the capacity to improve daily river discharge within current limitations of global hydrodynamic modeling. For this purpose, the water surface elevation (WSE) from satellite altimetry was assimilated in a configuration of three experiments, the direct (absolute values), the anomalies and the normalized anomalies. The authors also evaluated the capability of these DA experiments in some scenarios, for instance when some parameters/forcing (river bathymetry and runoff) of the hydrodynamic model are biased, as well as conditions when river bathymetry is calibrated. The results showed that, in general, the normalized DA performance was the best, improving the daily discharge estimates in up to almost 60% of the stations evaluated, compared to the simulation without DA. These results considering the current limited conditions of the global hydrodynamic models (e.g. without calibration).

The major contribution of this research is the evaluation of these experiments and scenarios, providing adequate knowledge and insights in terms of how DA techniques could be used to improve discharge estimates, which fits with the perspectives of SWOT missions for example. In general, this work is worth publishing in the Hydrology and Earth System Sciences journal, however, it needs "moderate revisions". Some suggestions for revisions are as follows.

Moderate comments:

- The article is well written and follows a logical order. Although it is a bit long, an average reader can follow the reading, however at a certain point there are more experiments than initially described. For example, the evaluation of DA under biased runoff and river bathymetry conditions; DA under calibrated river bathymetry conditions; DA using the runoff forcing of a bias-corrected model. That is why I recommend the authors to describe more explicitly these experiments in section 2.6.
- Regarding the selection of virtual stations (VSs) for assimilation or validation, the justification is a bit vague, even though this may be important for the performance of the experiments, so I recommend improving this point.
- In sections 3.1.1, 3.1.2 and 3.1.3 take care with the description of the time series in figures 4, 5 and 6, respectively. There is a confusion between the description of the gauges results. For example, line 315 describes the Santos Dumont station on the Purus river, however the series in Figure 4d are from a gauge on the Juruá river. This confusion occurs for the stations Gaviao (Juruá) and Manacapurú (Amazon) in Figure 5, and in all the gauges in Figure 6. This was probably an involuntary error in the preparation of the figures, please correct.
- Experiments that assimilate absolute (direct) values, anomalies and normalized anomalies are referred to by the acronyms Exp. 1, Exp. 2 and Exp. 3 respectively, however throughout the manuscript both nomenclatures are used. I suggest that only one be adopted to improve the readability of the text. Even so that the information can be quickly abstracted by the reader these experiments could be called DIR_DA, ANOM_DA and NORM_DA for example.
- Since the authors have used a localization method in the DA scheme, I suggest reinforcing the discussion on how this might affect discharge estimates due to assimilation of WSE within or outside the influence coverage of the VSs.
- Could you discuss a bit about to what do you attribute the lower efficiency of flow estimates in the upper Solimoes River ? efficiency of the CaMa-Flood model ? selection of VSs ? localization ? large uncertainties in the VSs data in that region ?

Specific comments (Line-by-line comments):

Introduction:

- 35: It is more accurate to say, "River discharge records can be used...".
- 42: I would say that also these simulations (of GHMs) have been used to complement observed records.
- 48: If we go deeper we could say that these forcing factors can also be rainfall and climatic variables.
- 50: I would say: "Given the current limitations of GHMs and in-situ measurements, ...".
- 57: This sentence mentioning the SWOT mission seems a bit loose, you should rework it to integrate it with what you want to mention above.
- 62: Typo: "combining" instead of "combing".
- 83: This statement describes information repeated in the previous one, perhaps you could combine them.

Methodology:

- 124: In this sentence you can already start reporting on the period of DA experiments (2009-2014).
- 215: Why wasn't the SURFEX-TRIP model outputs used since it also belongs to WRR2?
- 236: To reference these annual average rainfall values you can cite Builes-Jaramillo & Poveda, 2018; Espinoza et al., 2009. (https://doi.org/10.1029/2017WR021338 and https://doi.org/10.1002/joc.1791)
- 237: Please specify what you mean by large number of observations, perhaps this is valid for remote sensing observations because it is a large basin with strong hydrological signals, hence the citation of Fassoni-Andrade et al. 2021.
- 249: You could elaborate a little more on this sentence. Why these virtual stations could affect the estimates using assimilation? this exclusion of 3% was by a visual analysis of the series only? these stations are located in some particular place in the Amazon, maybe rivers with a small width?
- Sections 2.7.1 and 2.7.2 could be merged, as it could confuse the reader. The main objective of this research is to evaluate the performance in simulating daily discharge but here also the performance of WSE will be evaluated. This merged section could be called "observational data" since the altimetry data has also been used for validation.

Results:

- 294-296: This sentence seems to be repetitive with the previous one, you could merge them.
- 302: It would be appropriate to refer to Figure 4b in this sentence.
- 309: The time series for the Santos Dumont station is not shown in Figure 4d. Instead, a station on the Juruá River is shown. See my major comments above.
- 325: The information in parentheses should go in the methodology section.
- 330: "WSE performance decreased…" instead of "WSE decreased…".
- 332: The Gavião and Manacapuru gauges do not correspond to Figures 5c and d.
- 351-352: None of these described gauges correspond to figures 6c, d and e.
- 412: I think there is a typo, please delete "3.2.1.".
- 8: It is not possible to distinguish gauges inside or outside the coverage area of the altimetric satellites. Could you differentiate them somehow?
- Table 3. I have noticed that some values in this table do not correspond exactly to those described. For instance, in the first column (All and r) in the table, the values are 0.74, 0.85 and 0.84 for experiments 1, 2 and 3 respectively. While in the description the values are 0.73, 0.84 and 0.83 (L. 431, L. 415 and L. 439 respectively).
- 452: As shown in Figure 9, the BIAS values are only positive, so I recommend describing somewhere (probably methodology) that the index is an absolute value of

BIAS.
- Figure 9: It is a bit difficult to differentiate the VSs that were used for assimilation and validation. Perhaps it could be improved by changing the symbology from "o" to "*", increasing the size of the maps by reducing the space between them and decreasing a little the size of the station symbols so that they do not overlap too much. This is just a suggestion.
- Section 3.3: Please detail how in this experiment you have generated the realizations of the set for assimilation.Was it with the same perturbation as for the WRR2 models?
- 476-478: The end of this sentence sounds strange, I suggest to redo it or delete this last part from "...,direct DA (Exp 1)...."

Conclusions:

- 624: Typo, it's HTESSEL not HTEESSEL (same for L.541, 542 and 544).