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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Large scale hydrological model river storage and discharge correction using satellite altimetry-based discharge product" *by* Charlotte Marie Emery et al.

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Our replies to all the comments made by the reviewer can be found below. We thank the reviewer for all the comments and suggestions that helped to improve our manuscript.

1 Major comments:

1.The objectives stated in line 5 and 6 of the abstract and those stated lines 23 -24 of page three are different. In my opinion, the paper demonstrates

quite clearly that the assimilation improves results, but actually focuses in the difference between localization methods more than the importance of altimeter data as a source for reducing uncertainties.

Authors' reply: We completely understand the reviewer point of view and we agree that our objectives were not well described. What we want to do in this study is to show the contribution of nadir altimetry (punctual measurement) at the continental scale of a large catchment. Because of this context, the use of localization is required. Those two aspects (use of satellite-derived discharge and localization) are both equally important. Following the similar remark from the first referee, we will reformulate the paragraph in the introduction to highlight the importance of these two objectives. To homogenize the manuscript, we will also modify the abstract accordingly.

2.The description of the altimetry based discharge product section (2.3.1) is quite in depth, however, it should really include a brief statement about QA/QC from the data source's literature. The instrument precision is provided, but the reader has no idea what sort of error that translates to in terms of discharge.

Authors' reply: The quality assurance has been made by Paris et al., (2016) by constraining the rating curve coefficients within a physical range of values. They also conducted a sensitivity analysis that shows a small sensitivity of the coefficient estimation to first guess of the coefficient values. The quality check was done by comparing over a validation time period the satellite-derived discharge to the model discharge used to derive rating curve over a calibration period. Discharge was also compared to some in situ gages. Satellite-derived discharge is of course heavily correlated to the model accuracy. Overall, a comparison to 51 in situ measurements led to a mean Nash-Sutcliff coefficient (NS) around 0.8 and a Normalized Root Mean Square Error

(NRMSE) around 10% over the validation period (Table 8 in Paris et al., 2016). However, for upstream basins, results are not as good as for the main tributaries. Overall, when compared to MGB outputs and in situ time series), the mean NS is equal to 0.7 and the mean NRMSE to 10% (In the same paper Paris et al., (2016), a similar study has been led on the water elevations). This information have been added to the manuscript.

3. ***Page7 line 30-32 I'm curious what portion of virtual stations were associated with an adjacent cell.***

Authors' reply: 19% (69 out of 367) of the VS have been associated to an adjacent cell. We will add this information in section 2.3.1 ("Altimetry-based discharge product").

4. ***Section 2.3.2, this draws further questions about the objective of the study. The authors point out that in situ data was not used in the assimilation. In my opinion, a comparative run with assimilated in situ data could help demonstrate the value of altimeter data, if that is the primary focus.***

Authors' reply: We agree with the reviewer. But the objective of this study is not to show that the remote-sensed data is better for data assimilation than the in situ data. We want to show the contribution of the altimetry when used alone (with the objective to use it on ungaged catchment or with few up-to-date in situ gage time series). Then, in the present study, the in situ data are used as an alternative source of data to validate the assimilation results. Therefore, we have not added an experiment assimilating only in situ data.

5. ***Page 24 lines 13-16, I think this should be clarified to be within topological limitation, (i.e. "should be impacted by all upriver observations").***

Authors' reply: Thank you for this suggestion. We will replace "should be impacted by all available observations" by "should be impacted by all upriver observations".

6. ***Page 24 line 19, This manuscript hasn't made a case to support the inclusion of discussion of the groundwater time constant as a major control on discharge. Please include information on this in the results section.***

Authors' reply: This is true. However, to follow another remark from the first reviewer, this paragraph will be rewritten and will not mention the "groundwater time constant" anymore.

7. ***Page 24 lines 23-32, I think the authors need to be really careful assigning usefulness of these other altimeter mission for their assimilation protocol. The ENVISAT contemporary missions and those after, are likely to provide data quality that could allow for the construction of additional discharge data, but the casual mention of these missions doesn't really address the feasibility building rating curves and discharge data from them. The biggest issue here is the inclusion of earlier mission, and the citation provided. To my knowledge there has been only marginal success using pre-ENVISAT data on rivers. Using ERS 1-2 or TOPEX would most likely only work on the main channel if at all. In Tourian et al., (2017), the authors specifically mention that these earlier mission were not included because of poor inland performance.***

Authors' reply: Thank you for this remark. We will delete in this paragraph references to pre-ENVISAT missions.

2 Minor comments:

1. Page 6 line 23, crosses the river stream is redundant.

Authors' reply: You are right. We will replace the expression by "crosses the river".

2. Page 23 line 2 "to correct directly the discharge" should be to directly correct the discharge.

Authors' reply: Thank you for noticing this mistake. We will replace "to correct directly the discharge" with "to directly correct the discharge".

References

- Paris, A., Paiva, R. C. D., Silva, J. S. D., Moreira, D., Calmant, S., Garambois, P.-A., Collischonn, W., Bonnet, M.-P., and Seyler, F. : Stage-discharge rating curves based on satellite altimetry and modeled discharge in the Amazon basin, Water Resources Research, 52, 2016.

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