**Hydrology and
Earth System
Sciences**

Discussions

# Interactive comment on "Assimilation of satellite data to optimize large scale hydrological model parameters: a case study for the SWOT mission" by V. Pedinotti et al.

**Anonymous Referee #3**

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General Comments:

The manuscripts presents a synthetic study designed to evaluate the potential for using future SWOT water elevation measurements in order to recover Manning's coefficient through a data assimilation framework. While the assumptions made are too restrictive for method to be directly applicable to real-data situations, the study presents an interest to the hydrological community.

The manuscript is generally well written and provides good background and motivation for the study.

C1741

It is my opinion that he manuscript is suitable for publication in HESS after minor revisions.

Specific Comments:

While the hypothesis is acknowledged as being simple, the fact that the Mannings number is the only parameter to be perturbed is quite restrictive and more emphasis should be placed on this, in particular in the discussion/conclusions. In large, sparsely monitored basins for example, the input precipitation errors are typically large and will have significant impact.

In the presentation and discussion of the results, more emphasis should be placed on the fact that the same model is used to generate observations and carry out the assimilation making the improvements on roughness, level, flow and storage which are all presented in different sections highly correlated. More discussion of the physical representativeness of these results should be included (for example how would the improvements on flooding look if the initial bankfull depth is incorrect?) These are only mentioned in passing in the discussion and I think the manuscript could benefit from expanding on these. The term "prediction" is used a few times, but no experiment/results regarding the predictive performance of the assimilation are shown.

General language comments (some instances are addressed in the technical corrections): please review the manuscript for the (frequent) use of the following: "such", "indeed", "also" and "thus".

Technical Corrections

-Abstract

p. 4478 l. 13-15: Please rephrase "might have locally significant errors". The problems of parameter estimation occur across all scales and these errors rather "typically" occur.

p. 4478 l. 18: replace "so that" with "and"

C1742

p. 4479 l. 1: please replace "leads" by "led"

p. 4479 l. 4: I would recommend removing: "despite potential problems related to equifinality" as this is vague and no particular problem with equifinality were identified in the study.

p. 4479 l.6-9: "prediction" see general comments

-Introduction

p. 4479 l. 14: "such" is not appropriate here since no impact studies are mentioned previously.

p. 4479 l. 15: I suggest you replace "over and under" by "above and below"

p. 4479 l. 16-19: Please rephrase. This sentence is a bit confusing/long.

p. 4479 l. 20: insert "the" before "huge"

p. 4479 l. 23: replace "but also" by "and"

p. 4480 l. 10: Please simplify the sentence; the verb does not match the structure of the sentence. I suggest something like: "However, hydrologically complex areas such as wetlands or floodplains are better represented as three dimensional processes and cannot be adequately..."

p. 4480 l. 12-17: The link between these sentences should be made clearer. Perhaps specify that you are writing about different types of surface water monitoring?

p. 4480 l. 25: Replace "concerning" by "For"

p. 4480 l. 29: Remove "thus"

p. 4481 l. 2: "geomorphologies"

p. 4482 l. 8: replace "he" by "they"

p. 4482 l. 12: typo "qmodeling"

p. 4482 l. 17: Input data such as precipitation should be included in the list as it tends to be one of the major sources of uncertainty.

p. 4483 l. 5-7: Please specify what type of data was used to evaluate the model and whether the model was calibrated.

p. 4483 l. 10-11: Consider merging the two sentences.

p. 4483 l. 17: "spatially distribute" awkward, please rephrase

p. 4483 l. 18-20: The results sensitivity analysis would be relevant here, especially in order to justify the stated objective of improving Manning's coefficient in the next paragraph.

-Study domain and model description

p. 4484 l. 24: replace "thus" with "and"

p. 4485 l. 23: missing "resolution" at the end of the sentence?

p. 4487 l. 9: replace "this" with "the $\beta$"

p. 4487 l. 22: "could be considered" is not strong enough in my opinion, the other effects are very important and "should be considered" would be more appropriate

p. 4487 l. 25-27: please provide references.

-Satellite observations

p. 4489 l.5-8: I recommend removing "Indeed, here" and merging the two sentences: "It is assumed that the state of the system as well as the error statistics of the model and observations are known which will not be the case..."

p. 4489 l.8: remove "also"

p. 4489 l.9: reorder words: "since it allows for the quantification ... modeling before launch"

p. 4489 l.11: typo: "in" -> "is"

p. 4489 l.11: remove "indeed"

p. 4489 l.18-20: Missing verb. Perhaps "The . . . results are generated . . ."

p. 4489 l.23: "and/by assimilating" rather than ", assimilating"

p. 4490 l.5: I think that ", in addition to" should simply be "and" if I understand the sentence correctly

p. 4490 l.9: The problem of water level/surface elevation/depth will be present for all applications using real data, not only real time. More discussion should be included on the impact of neglecting this.

p. 4490 l.12: Is this out of the scope of an OSSE or simply of this study?

p. 4490 l.20: "earth's rotational speed"

p. 4491 l.7: repetition, replace with: "investigated within the DA framework"

-Data assimilation schemes

In section 4.1 different combinations of terms (roughness/manning's coefficient/manning's roughness coefficient) are used to describe the same thing. I recommend unifying the terminology for more clarity.

p. 4491 l.19: remove "indeed" and commas

p. 4491 l.25: remove "indeed". "Hydrodynamic models" cannot be the subject here, "modelers" could.

p. 4492 l.6: I think there are more problems than just a scale issue. How accurate is this linear relation to width? I think it is important to clearly acknowledge that the initial value of the roughness used would be very uncertain in a real case (especially for an uncalibrated model).

C1745

p. 4492 l.15-18: I do not understand the relevance of the variability of the correction of the coefficient in the context of this study: since the SWOT observations are generated using a constant "true" Manning, the assimilation-estimated Manning would have no reason to benefit from this. What was the reason for the choice of the 2-day time window?

p. 4493 l.12: Is 20% error Manning's realistic considering typical variations between streams?

-Results

p. 4496 l.5: an absolute relative error should be used in order to carry out averaging.

p. 4497 l.15: typo? "differs"

p. 4497 l.25: Is there any proof for the physical link between the width and the influence of the roughness? I can think of two other possibilities:

- the hypothesis of linear relation between width and roughness means that the 20% std will lead to a larger absolute error on the roughness for wider rivers

- it is not necessarily related to width as any errors (occurring or corrected) upstream will have an impact on the downstream portion of the river as well (and rivers just happen to typically be wider downstream)

p. 4498 l.14: Please include some discussion of why the impact on flow is smaller than for levels. Shouldn't this be expected since the Manning's roughness is in fact updated through level measurements?

p. 4498 l.15: I disagree that a "seasonal variability" is seen for the assimilation results, rather it appears that the open loop run is closer to the "truth" during the dry months leaving little room for improvement (this is more or less what is then written on line 20 regarding sensitivity to Manning's roughness, but the separation of this in 2 paragraphs is confusing)

C1746

p. 4498 l.19: It is unclear what you mean by "noisy", is this the same 20-day "noise" from the level observations?

p. 4499 l.13: Please rephrase to avoid using the word "results" 3 times

p. 4500 l.19: list what you mean by "continental reservoirs" here to avoid confusion.

p. 4501 l.2: I agree that there is typically a lack of data for monitoring of these storages. However, I think it should be pointed out that the physical representativeness of the modeled values is not guaranteed, specifically because of the lack of monitoring data.

-Discussion

Considering that the assimilation corrects the Manning's number, I recommend discussing the improvement on this parameter before the impact on levels.

p.4502 l.9: "degradation of the error estimates": please explain what you mean. Isn't the discussion here about improving these estimates? The fact that they are no longer Gaussian is not a degradation. Or do I misunderstand your meaning?

p.4503 l.8 : what would be the impact of assimilation windows of different lengths?

p.4503 l.17-20 : Is this not a repetition of the discussion from p.4503? This paragraph would fit better after the discussion of the Gaussian observation error and other sources (f.ex. precipitation etc.).

-Conclusions

I think the conclusion would benefit from having some information removed. For example it is unnecessary to repeat why Manning's number was the chosen parameter (p4503 l. 24-p.4604 l.4)

p.4505 l.10: "Another perspective...": the organization here is confusing as the previous sentence is about results and not perspectives. The conclusion should be reorganized so that this follows the suggestion of further work with different error models, and

C1747

so that the first part of this paragraph directly follows the assertion that the assimilation experiment provided good results (somewhere around p.4504 l.17).

p.4505 l.21: "the/run" typo?

-Figures

Fig.4: typo in legend "input"

Fig. 8, 13 & 18: missing y axis labels

Fig.10: y axis should be unitless

Fig.11: appears to be missing two locations

Fig. 14: Please correct numbering

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