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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.

V. Pedinotti et al.

vanessa.pedinotti@gmail.com

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> The abstract is too long and has many unnecessary information. For example, I think the following parts can be removed: - which are typically employed in Land Surface Models (LSM) for global scale applications. - a trans-boundary river, which is the main source of fresh water for all the riparian countries. In addition, geopolitical issues in this region can restrict the exchange of hydrological data, so that SWOT should help improve this situation by making hydrological data freely available. In a previous study, the model was ïnËĞAËŻrst evaluated against in-situ and satellite derived data sets within the framework of the international African Monsoon Multi-disciplinary Analysis

(AMMA) project. P4478.L13: the word "indeed"

Corrected in the text.

> The word "indeed" appears repeatedly (16 times in the manuscript), and sometimes it is not necessary. Please remove the word when not needed. P4478.L15: "which might have locally significant errors." The term "locally significant errors" is ambiguous. It's better to say "significant errors at local scale".

Corrected in the text.

> Furthermore, the scale indicated by "local" may be different for different researchers. Please clarify what the "local" mean in this study. It can be read as "basin-scale" or "reach-scale". This was correcetd to "grid scale". P4479.L8 & Section 5.4: Continental reservoir It's not clear what the "continental reservoir" means. It might be misunderstood as large lakes or any kind of large water bodies.

Corrected to "... shows skill in simulating the maxima and minima of water storage anomalies, especially in the groundwater and the aquifer reservoirs."

P4479.L9: "Results obtained in this preliminary study demonstrate SWOT potential for global hydrologic modeling, especially to improve model parameters." > This statement is generally true, but I think it's too optimistic given that this manuscript only performs Observing System Simulation Experiment. It's better to say that further studies (e.g. considering multiple error sources and difference between synthetic and real observations) are obviously needed to achieve the SWOT's application stated in the abstract.

Changed to "The application of the assimilation method in the framework of an Observing System Simulation Experiment allows to evaluate the skill of the EKF alogorithm to improve hydrological model parameters and demonstrate SWOT promising potential for global hydrology issues. However, further studies (e.g. considering multiple error sources and difference between synthetic and real observations) are needed to achieve the evaluation of the method."

P4480.L8: “1-dimensional” What the 1-dimensional means here? Is it 1-spatial-dimension along river stream, or a point data with a time-series dimension?

1-dimensional means that the discharge gives a 1-spatial-dimension information along river stream.

P4480.L9: “but such data do not give any information about runoff and lateral inflow.” > It’s better to say “any DIRECT information” because we can guess the amount of runoff or lateral inflow from gauged discharge.

Corrected in the text. Indeed, Runoff and lateral inflow can be guessed assuming that the river parameters are well defined and that the contribution of groundwater to the river is known which is generally not the case.

P4480.L19: “current remote sensing technology spatial resolution does not resolve small scale land water dynamics” > It’s better to say “current satellite altimetry” because high-resolution observations of water area are already available (i.e. LANDSAT, Synthetic Aperture Radars, etc).

Corrected in the text.

4480.L29: “Several studies are thus currently being performed over geographically diverse basins” > Please put references for the “several studies”.

The line was removed.

P4481.L26 “the Brahmaputra river” and related parts > Please use large capital for an individual river name (i.e. the Brahmaputra River, the Niger River). P4482.L12 qmodelling. > Please correct the typo.

Corrected in the text.

P4483.L15: might not give the best results locally (for a particular basin). > This is true, but some studies showed that empirical equation does not work well even within one basin and significant error can be found at sub-basin scale or reach scale (e.g. Miller

et al., 2014, Yamazaki et al., 2014).

Added in the text.

P4483.L29: “the reason will be explained” > Please clarify in which section “the reasons are explained”.

Corrected in the text to “Section 4.1”.

P4485.L5: The modelling of the Niger basin by CHSs thus requires a good description of climate conditions, especially of rainfall, and : : : > It is stated in the previous sentence that the modelling complexity comes from different climate zones existing in the Niger Basin, therefore I think it’s better to write that infiltration and evaporation from floodplain is also very important in addition to rainfall for modelling the Niger River.

P4485.L18: a saturated fraction “fsat” P4485.L26: a simple groundwater reservoir “G (kg)” P4486.L3: a prognostic flood reservoir, F (kg), > If the symbols for variables (e.g. fsat and G, F) are not used in other parts of the manuscript, these symbols don’t have to be shown. Same correction may be needed for other variables.

Corrected in the text.

P4486.L2: TRIP RIM > Does this mean “TRIP RRM”?

Yes, this was corrected in the text.

P4486.L13: The TRIP schematic concept is presented on Fig. 2 and more details can befound in Pedinotti et al. (2012). > It’s better to move this sentence at the start of the explanation of TRIM RRM in ISBA. Readers may understand the model easier by reading sentences with the Provided Figure. P4487.L25: Remote sensing opens the possibility of estimating the river width by direct measurements and the critical bankfull height by indirect algorithms. > Better to provide references such as [Pavelski and Smith, 2008; Yamazaki et al., 2014; Durand et al., 2010]. P4488.L23: wider than 100 m (requirement) > Better to say “(mission requirement)” instead of “(requirement)” for

non-expert. P4489.L11: in needed > Should it be “is needed”? P4490.L9: absolute water level > It’s difficult to guess the difference between “absolute water level” and “free surface water elevation”. May be it’s better to say “water depth”.

Corrected in the text.

P4490.L9: Thus, in real-time DA applications, the direct comparison between SWOT and ISBA-TRIP water levels will not be straightforward and will need further investigation.> Please make a discussion about the impact of this assumption. It can be a limitation of applying the method developed in this study to a real-observation case.

For example, the assimilation and comparison of water elevation anomalies could be considered (added in the text).

P4491.L18: has a significant impact on the hydrological variables over the Niger basin. > It’s better to clarify “impact on SIMULATED hydrological variable” given the impact assessment on actual hydrodynamics is still difficult due to uncertainties in model physics and parameters.

Corrected in the text.

P4492.L25: requires a bigger storage capacity > It’s better to say “disc (or memory, or computational) storage capacity”. River model also has storage component, thus storage capacity might be misunderstood as model variable.

Corrected in the text.

P4493.L11: a Gaussian distribution, centered in 0 with a standard deviation, _bt of 20% of the average value of the Manning coefficient over the river. > I’m not sure whether this assumption for the initial prior Manning’s coefficient is feasible. Because there is no ground-truth for Manning’s value, the initial value may be totally different (can be biased globally and/or locally) in the real situation. Please at least discuss the possible impact of the initial Manning’s value estimation, and if possible please do additional experiment to check its impact on assimilation results.

The EKF filter makes the asumption that the modeling error vector describes a gaussian distribution centered in 0 and this is why the modeling error is described this way in this study. However, the limitations of this asumption are described later and it is suggested to use a particle filter in order to consider more realistic modelling errors. The standard deviation of 20% derives from the sensitivity tests which were done in Pedinotti et al. (2012) and showing the impact of the Manning coefficient on the simulation. Moreover, Decharme et al. (2011) estimated that it was a resonnable range of uncertainty for this parameter.

P4493.L19: H = SoM > What is “o” between S and M?

The “o” in algebra describes the combination of two functions. For any variable x, SoM(x) is equal to S(M(x)).

P4496.L5: the Manning coefficient relative error (averaged over the river) > Is it reasonable to average relative errors over the basin? Is some point has positive relative error and another point has negative ones, they are cancelled out.

The expression of the relative error is wrong in the paper. The relative error is : |n-ntruth|/ntruth. This relative error, described as is, can not be negative. This was corrected in the text.

P4496.L25: a noise with a frequency of about 20 days > This is obviously the signal from orbit cycle, thus it’s strange to call it “noise”. It’s better to use another word (such as jump?)

Corrected in the text.

P4497.L12: reaching up to 9 m at Lokoja (for an 8 m averaged river depth). > I cannot get this message. It seems two gauges are lacking in Figure 11. Thank you for this remark, it seems that two figures disappeared while editing the article in the discussion version. The fact that is pointed here is that the correction of the water level due to DA can be considerable since it is higher than the mean river depth over the river.

P4499.L15: the model simulates ïn floodplains (25%) > It's difficult to guess that the sentence means. Please say, for example, "flooding in 25% of the grid area".

Corrected in the text.

P4501.L15: This study is promising since, to our knowledge, no large scale assimilation applications exist > This statement is generally true, but please note that further studies on model physics and parameter retrieval are needed to apply the developed method to "real observation" further than OSSE.

The application of the developped method requires further investigation on the assimilation filter and a better representation of observation and modeling errors. However, it is not sure wether the model physics must be improved or not for its application with real data. Moreover, in real conditions DA methods could be used as indicators of missed crucial processes (mostly related to water levels) in the model. It is thus really difficult to make a pronostic about the level of physics that is needed for real conditions applications.

The retrieval of several parameters through single DA application could be possible assuming that the correlations between all the variables are well represented in the model and that all related main physical processes are considered by the model. Of course, further investigation is needed to confirm or not this asumption.

Figure 2 Caption: > The figure shows "water flux calculation in TRIP RRM in ISBA", but not for "The TRIP model" itself.

Corrected.

Figure 4 > Can you also show the prior Manning's value before assimilation and posterior Manning's value as well as the true value?

Fig. 1 was added to the text and shows the spatial distribution of the Manning coefficient for the truth (a), for the background (b), for the 1-day subcycle (c) at the end of the assimilation period (December 2003) and for the 3-day subcycle (d) at the end of the

assimilation period (December 2003). We see that the DA allows to retrieve the general patterns of the Mannin coefficient, especially for the extreme values of the background. Moreover, the values downstream of the river seem to be better corrected which can be expected due to the cumulated corrections upstream of the river. Please note that the caption for the figure in the discussion is not complete due to limited space and will be completed in the manuscript.

Figure 7: Caption > Please describe what the colored line (black and blue) represent.

Coreected in the text.

Figure 11: > Two gauges are missing.

Corrected.

Figure 16b > Please clarify that the blue and red lines are not shown because flooded fraction is zero Added in the text.

Figure 18 Caption > Please use "floodplain" instead of "flood". Flood is too ambiguous. Corrected. Tables 2 and 3. > Please use the consistent effective digits.

Corrected.

[References] Durand, M., E. Rodrigues, D. E. Alsdorf, and M. Trigg (2010), Estimating river depth from remote sensing swath interferometry measurements of river height, slope, and width, IEEE Geosci. Remote Sens. Lett., 3(1), 20–31, doi:10.1109/JSTARS.2009.2033453. Miller, F. M., T. M. Pavelsky, and G. H. Allen (2014), Quantifying river form variations in the Mississippi Basin using remotely sensed imagery, Hydrol. Earth Syst. Sci. Discuss., 11, 3599–3636. Pavelsky, T. M., and L. C. Smith (2008), RivWidth: A software tool for the calculation of river widths from remotely sensed imagery, IEEE Geo-sci. Remote Sens. Lett., 5(1), 70–73, doi:10.1109/lgrs.2007.908305. Yamazaki, D., F. O ' Loughlin, M. A. Trigg, Z. F. Miller, T. M. Pavelsky, and P. D. Bates (2014), Development of the global width database for large rivers, Water Resour. Res., 50, doi:10.1002/2013WR014664.

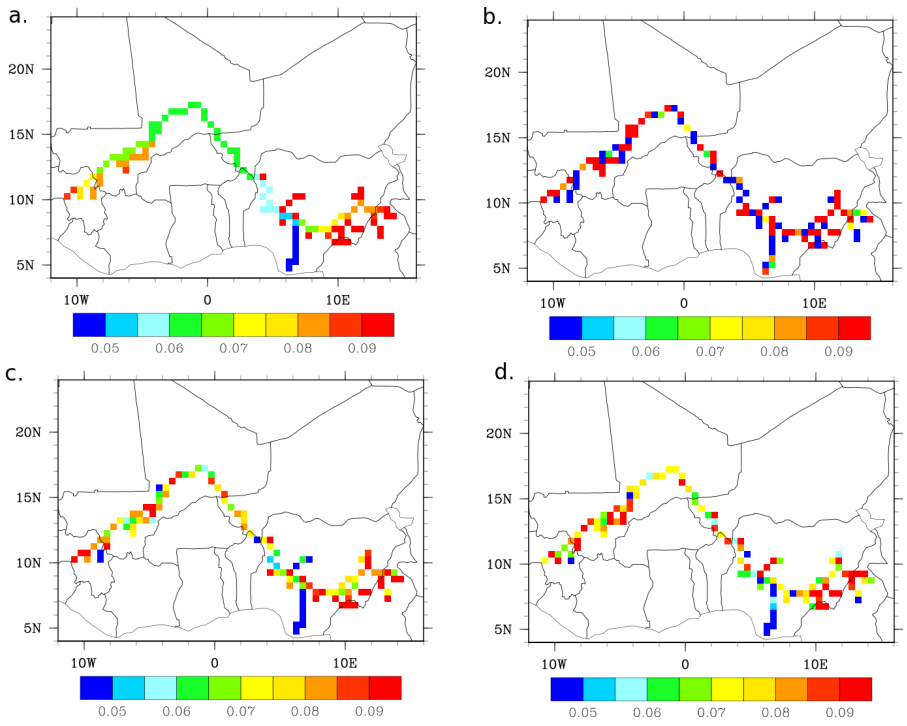

Fig. 1. The Manning coefficient distribution a)for the truth, b)for the background, c)for the 1 day-subcycle assimilation and for the 3-day subcycle assimilation (d).