**Hydrology and
Earth System
Sciences**

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Discussions

# *Interactive comment on* "Satellite radar altimetry for monitoring small river and lakes in Indonesia" *by* Y. B. Sulistioadi et al.

**Anonymous Referee #2**

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1 - General Comments

The manuscript presents a case study of the use of satellite radar altimetry from the Envisat RA-2 instrument for monitoring of water levels over small and medium rivers and lakes in Indonesia. The authors propose to use both geographic and waveform-shape filtering to determine useable altimetry data points and are able to retrieve water levels. The performance of different standard Envisat retrackers is also compared.

The work provides an extra case study on the timely topic of altimetry for inland water monitoring, in particular for smaller water bodies, which is within the scope of HESS. However, major revisions are needed before publication.

The manuscript also needs thorough proofreading for language before it is ready for

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publication. Some (not all) of the language and grammar points will be addressed in the technical corrections.

2 - Specific Comments

(These are also listed in the technical corrections with more detail)

While the methods are mostly clear and straightforward, some additional background/references are needed to justify some assumptions investigated, in particular relative to the "buffers" on lakes.

The major scientific issues in the paper resides in the interpretation of results with some conclusions being drawn from what is, in my opinion, insufficient data and should be more nuanced. This is in particular the case for the narrow river where no validation data is available.

More detail should also be given regarding the determination of the water level anomaly when more than one point is available during a satellite pass.

3 - Technical Corrections

Abstract

p. 2826 l. 4: "e.g." is probably not appropriate here, unless other reasons than the revisit time affect the temporal resolution.

p. 2826 l. 6: "for rivers" should be "to rivers"

p. 2826 l. 11: indicate the size of lakes here as you are indicating the size of the rivers

p. 2826 l. 12: I do not understand "corresponding to the appropriately waveform-retracked water level". Please clarify/rephrase

p. 2826 l. 18/19: It is unnecessary to repeat what the sizes are.

p. 2826 l. 20: What is meant by "reasonable accuracy". Please be more specific.

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p. 2826 l. 20: Please replace "the procedure" by "a procedure"

p. 2826 l.20: Why "or selection"? Do you mean "and selection"?

Introduction

It would be interesting to have a little more background regarding the different re-trackers, for example in which cases they tend to (or are expected to) produce similar/different results.

p. 2827 l. 6: either list a few reasons or leave out "for various reasons"

p. 2827 l. 7: "In contrast, despite... increasing." Rephrase sentence, confusing. The use of "despite" is incorrect.

p. 2827 l.12: "Space geodetic and remote sensing from space..." should be changed, "Space geodetic" cannot be a subject.

p. 2827 l. 17/18: "very limited if not none of them" Rephrase

p. 2827 l. 21: Please include more, older references than Fu and Cazenave.

p. 2828 l. 1: Replace "Even" by "While"

p. 2827 l. 28/p. 2828 l.1/2: These two sentences are contradictory. I understand what the authors are trying to say, but the first sentence should not present the footprint as a strong limitation for rivers <1km width as the next sentence claims that it is possible.

P. 2828 l. 4: "Therefore" should be changed, I think the authors mean "In spite of" or similar. Rephrase.

P. 2828 l. 9: Please define "specular characteristics" briefly.

p. 2828 l. 18: The term "model-free" is not used in this paper. If you wish to keep this, replace "; hence it is later.." by "(it is also called . . .)"

p. 2828 l. 18/19: Please simplify, the sentence can start as: "The Ice-1 retracker was

still . . ."

p. 2828 l. 20: Typo: ntil -> until

p. 2828 l. 21: Please replace "claimed" with "shown" or "was found to be" or similar.

p. 2828 l. 21: In their study, do Frappart et al. compare the same 4 retrackers as the current study?

p. 2828 l. 26: "after all" not appropriate here.

p. 2828 l. 29/p. 2829 l.1: confusing, rephrase.

Study area

p. 2829 l. 9: Rephrase

p. 2829 l. 12: Replace "oriented" with "is shown" or similar

p. 2829 l. 12/13: Confusing. Do you mean that the two study areas have different characteristics?

p. 2829 l. 15: Missing "The" at the beginning of the sentence.

p. 2829 l. 17: "declares" should be "makes"

p. 2829 l. 21/23: Please check for grammar

p. 2829 l. 23/24: Please remove "the" before "channel" and "land use"

p. 2830 l.2-8: Difficult to read, please check for grammar.

p. 2830 l. 9: Missing "The" at the beginning of the sentence.

p. 2830 l. 18: "counts" should be "is"

p. 2830 l. 19: "i.e." is unnecessary

p. 2830 l. 23: "included as" is unnecessary

Materials and methods

p.2831 l. 13: rephrase "averaged 18 range measurements per second" and explain more clearly that there is on-board averaging of the 1800 Hz waveforms.

p.2831 l. 13: once you have explained where the 18Hz waveforms come from (see prev. comment), you can remove the word "averaged"

p.2831 l. 17: Please explain what does "MWR SGDR" stands for.

p.2831 l. 20: "In addition . . . also" is repetitive, please pick one.

p.2831 l. 22: "cycles"

p.2831 l. 22/23: please correct "the Envisat" and "sites"

p.2831 l. 24: "geocentric" is not necessary

p.2831 l. 25: add "the" before "uncertain"

p.2831 l. 25: "this research" cannot be a subject in this context.

p.2832 l.5: I assume you mean "test" rather than "prove". If not please justify this objective.

p.2832 l.6: "on the Ice-1 as" should be "that Ice-1 is" or similar.

p.2832 l.9-14: Were these corrections performed by the authors? If not this paragraph is misleading, please modify.

p.2832 l.21: "imagery"

p.2832 l.26/27: description of the color composites is repetitive (cf. previous paragraph)

p.2833 l.3: Please explain the choice of buffer values as well as more background/references to justify this test. Do other studies exclude data points that are closer to the shore based on similar buffer values?

p.2833 l.6 : it is unclear what the river buffer is used for/how it is applied. What is the relevance of having a 5m buffer when the altimetry data points contain data averaged over 350m in the orbit direction?

p.2833 l. 20/21: I do not understand what is meant by: "different distance from projected radar footprint to the land surface", please clarify.

p.2834 l.14/15: rephrase.

p.2834 l.16 : What is meant by "mild outliers"?

p. 2834 Eq (1): Please replace "1.5(IQR)", parentheses are not necessary, please use multiplication symbol.

p.2834 l.22 : Please define all terms immediately after the equations at the latest. Also specify whether the IQR determined from in-situ or altimetry water levels.

Results and discussion

Please modify all verb tenses in results to be in past tense.

p.2836 l. 7: What is meant by "trend"?

p.2836 l. 8-19: With no validation, I would argue that the claim that the water level fluctuations obtained over the 54m river are "successful" is over-confident. In my opinion, the findings show that indeed, qualified waveforms can be retrieved, but that without any form of validation the performance cannot be assessed. Further research, perhaps field measurements, could be recommended for validation. Is there any other source of information which could be used? Perhaps some reference to the typical annual water level fluctuations, the seasonality etc.? As is, I do not think the data in Fig. 5 can be used to support the claim.

p.2836 l.15: This is incorrect, in Michailovsky et al., validation with in situ is carried out for the data extracted over the 40m river.

p.2836 l.19: What is meant by "remarkable accuracy"? Please be more precise.

p. 2837 l. 2: Why have only the Ice-1 results on Figures 6&7 after describing the use of all retrackers? I think the figures would benefit from having at least the in-situ (even as a light-colored line) in order to give some frame of reference.

p. 2837 l. 3-6: I do not think that figures 6&7 show the limits of widths/temporal resolution. It is known before hand that the altimeter has a 35-day repeat-period, figures are not needed to show this.

p. 2837 l. 6-10: Here the conclusion is presented before the result. Please reorganize the section so that you first present RMSE and r values. After this is when it is appropriate to conclude on the success of the monitoring, not before.

p. 2837 l. 10-15: I do not understand why this section is located here. Why not earlier when the results over the narrow river are discussed?

p. 2837 l. 16-20: One point which can be made from Table 2 is that more missing cycles can be expected over narrower rivers. Please be more specific when discussing results: for example what is the longest gap between satellite measurements at different river widths? What does this mean in terms of applications?

p. 2837 l. 20-25: Looking at Fig. 9, I guess you have more than one value on the same day in the different meanders. How were these averaged to a single value? Have you considered looking at the spread in the values from the same day in order to evaluate the hypothesis that the slope of the river has a negligible influence?

p. 2838 l. 16: Please check all values, if authors reported a range of widths and rmse values, keep these ranges in the table. Please modify to reflect this where appropriate. I also suggest adding Birkinshaw et al. (2010).

p. 2838 l. 20: If outlier-removal was done using in-situ data, I think it should be mentioned here.

p. 2838 l. 24: Please suggest ways in which you think improvements may be obtained.

p. 2838 l. 26: I think this is an interesting observation which should be highlighted: the case of each river is different due to the orientation of the rivers relative to the satellite ground tracks.

p. 2839 l.5: Fig. 11 appears to show that the ground track and the river do not actually intersect at the measurement locations. Is this correct? If so, what is the effect of using off-nadir points? And if the intersection is only over the floodable zone, what would you expect to get in the dry-season? It should also be stressed in the manuscript that the points are not at the same location (maybe include the maximum distance between the points).

p. 2839 l.7: Table 5 shows the WSE, not the water level anomaly.

p. 2839 l.8-11: This is the section where reference to Fig. 12 needs to be made.

p. 2839 l.8-18: I think reading Fig. 12 is not as straightforward as is stated in this section, and the "linear relation" (l.17) is most definitely not shown. Perhaps try to make larger bins for the rainfall data.

p. 2839 l.18-20: While I agree with the conclusion that current altimeters have limited capabilities for narrow rivers, I do not think that you can directly draw this conclusion from the findings considering the very limited data you are working with (this is in particular true as this is an off-nadir river).

p. 2839 l.26: Are these waveforms representative? How were they chosen, or do they all look similar within those zones?

p. 2839 l.26: I do not think "clearly" is appropriate here, in particular because all complex waveforms were specifically excluded for the rivers, which makes the comparison unbalanced.

p. 2840 l.21: I do not understand how this explains the lack of difference between the

different "buffer zones". Wouldn't it rather simply be because the return from the water surface of the lake is stronger than that of the surrounding terrain or do I misunderstand what you are trying to explain?

p. 2840 l.27: What is meant by "best match among the three lakes studied"?

p. 2841 l.1-12: These 2 paragraphs do not describe results and should be moved to the case study section unless the characteristics are directly linked to results in the text.

p. 2841 l. 20: Table 7 vs. Fig. 14: Upon rapid inspection, it is clear that even by using only a small subset of the 75 data points, the RMSE is much larger than 0.33. I assume this is because Fig. 14 is presented before outlier removal. If this is not the case, please check results, if it is, please indicate this clearly. A way to do this for example would be to change the color of the outliers to grey in Fig 14 for example. The values in table 7 do not correspond to those reported: Table 7 indicates that the Ocean retracker is the best with rmse=0.317. It is also unclear what "validated measurement" and "Merged" stand for in table 7.

p. 2841 l. 25: Use "not verified" rather than "inconsistent"

p. 2841 l. 29: Delete the sentence starting with "Two statistical..." and just include "(see Fig. 18 and 19)" at the end of the previous sentence.

p. 2842 l. 2: Please replace "complicated" by "inconclusive" or similar

p. 2842 l. 12: I do not think it is necessary to specify the geographic location. The finding simply states that Ice-1 is not always the best retracker. I also think the magnitude of the difference between the different retrackers should be discussed. Is this difference significant?

Conclusions

p. 2842 l. 22: The RMSE values should also be mentioned.

p. 2843 l. 1&6: As with previous comments, I do not think the results presented allow for the qualifier of "reasonably good". I do agree that because you identified "qualified waveforms", the potential is shown, and conclusions may also be drawn on frequency of monitoring, but that no proof of "reliability" has been made.

p. 2843 l. 12: words like "obvious" should be avoided, rather use "it was shown that the Ocean..."

p. 2843 l. 21: "On the other hand" is not appropriate here.

p. 2843 l. 22: For point (1): Since irregular/complex waveforms were discarded before any further processing, it is my opinion that this was not shown. Rather it is shown that by doing this, the classic retrackers can be used.

Additional Figure/Table comments

Table 4 & 8: Does the last line of the table correspond to the current study? If so write "current study" or similar rather than "Sulistioadi 2013".

Fig. 1 & 2: Any writing too small to read comfortably should either be made larger if relevant or removed from the map. The meaning of the letters and numbers in circles is also not explained, the reader can guess they are the location of the measurements but this should be easier to read. The labels for the measurement points should also be easier to pick out of the background, as they are the most important part of the maps.

Fig. 4: I do not understand the split after geographic masking. How can the retracking be carries out before the waveform selection is carried out?

Fig. 8, 14 & 15: These are the most interesting figures, please move the legends to avoid hiding any of the data. You may also benefit from using smaller icons.

Fig. 11: Very difficult to read text on the figure, white text in particular blends with the background image.

Fig. 12: Why does Fig. 12 go until 2010 when there is no more data from 2007?

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