Response to Editor Comments for HESS Discussion Article

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Sulistioadi, et al., 2014

Satellite Radar Altimetry for Monitoring Small River and Lakes in Indonesia

1. General Comments

The authors gratefully thank the editor for her critical comments and suggestions. These comments and suggestions are vital in improving the quality of this manuscript, as the authors desired. In the following section, each comments are addressed. The manuscript has been revised according to the changes listed here.

2. Specific Comments

Issues	Solutions/Explanations
Need more detailed information on the methods used and the assumptions adopted in the analysis	• How to select waveforms ✓ The following detail has been added into the revised version (section 3.4 paragraph 2): "In practice, we displayed the standard waveform shapes (Brown-like, specular, flat-patch) with another window showing waveform shapes from each measurements along with their IDs. Then we noted down the IDs of measurements that matched waveform shapes for further processing. We consider this study as a preliminary development of a novel concept, thus we planned to develop automatic qualification process in the near future, such as the one done by Dabo-Niang (2006), through pattern recognition and waveform shape geometry computation." • How to define the ranges ✓ The following sentence has been added into section 3.1 paragraph 1: "We used the 18 Hz re-tracked range to infer the water surface elevation" ✓ In addition, we also refine the sentence that explains about the corrections
Many statements are vague	• Reasonable accuracy • Similar accuracy as shown by other studies is not enough • Be specific on the level of accuracy presented in the paper ✓ We have removed all vague statements and presented the original values or results in the manuscript.
Level of information and quality of presentation is below the level required for publication in HESS Clear explanation for methods	• Only present the conclusion if solidly backed-up by analysis. Do not conclude any non-validated results ✓ In the revised version of this manuscript, we have re-arranged the way we came into the conclusion. We are now emphasizing the successful retrieval of water level anomaly

Issues	Solutions/Explanations
	from satellite altimetry on medium-sized river and small lakes. ✓ In addition, we emphasize that satellite altimetry has a potential in retrieving the water level anomaly for small rivers, as indicated by the results in the upstream part of the Mahakam River and very small river of Karangmumus • Properly address each major concerns expressed by the reviewers ✓ We have carefully addressed each concerns presented by the reviewers in a set of response separated from this letter • The method should be reproducible by the readers ✓ We added more details on the research procedure in various sections. Our method should be now reproducible
Re-arrange the manuscript	• Keep only important information in the manuscript ✓ Some tables have been removed and kept as supplementary materials. The manuscript now contains only important information.
Language and grammar	• Improve the language and grammar ✓ The language and grammar for the whole manuscript have been thoroughly reviewed with the assistance from a peer
Consider to re-submit a technical note	• Option to change the submission into technical note ✓ We still tend to submit this work as a research material, especially since we are developing an auxiliary procedure to enhance satellite altimetry processing for inland water studies. This study is just the beginning of our work. In the near future, we consider to improve the waveform processing to deal with smaller water bodies and submit a paper as the continuation of this work

Response to Anonymous Referee #1 for HESS Discussion Article

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Sulistioadi, et al., 2014

Satellite Radar Altimetry for Monitoring Small River and Lakes in Indonesia

1. General Comments

The authors gratefully thank the 1st anonymous referee for his/her critical comments. These comments and suggestions are vital in improving the quality of this manuscript, as the authors desired. In the following section, each comments are addressed. The manuscript has been revised according to the changes listed here.

2. Specific Comments

Issues	Solutions/Explanations
Retrieval of water level fluctuation of a river as narrow as ~54 m without validation	This issue is also raised by the anonymous referee #2. We have carefully reviewed the manuscript and revised any statement that implies "successful altimetry measurement (including validation) of the small river (width 54 m)". We emphasized in the text that the water level fluctuation was potentially observed rather than actually "measured and validated". In addition, in the conclusion section, we mentioned it as "potentially observable". Based on prior experience, we found that water is like a mirror to radar even though the along track resolution at 18 Hz is on the order of 370 m.
Delineating the boundary for the 54 m width river	We explained that measurements of the river and lake width are carried out through (1) visual interpretation of Landsat-7 and Landsat-8, **or** (2) medium-scale (1:50,000) topographic maps released by the Indonesian Geospatial Agency. So, when Landsat imagery was not be able to definitively provide detailed boundaries between water bodies and land surface, we determined the boundaries and the buffer based on the topographic maps.
Process of selecting the waveform shapes for different water bodies and if the approach can be automated	The process was manual in this study. The standard waveform shapes (Brown-like, specular, flat-patch) were displayed along with another window showing waveform shapes from each measurements along with their ID. The IDs of measurements with matched waveform shapes were noted then processed further. We planned to possibly automate this process as demonstrated by Dabo-Niang (2006). This is one of our future study topics and we see it potentially successful through the pattern recognition and waveform shape geometry sorting.

Issues	Solutions/Explanations
Why need to prove the merit of Ice-1	The main argument is that all four standard re-trackers were not intended to measure inland water. They range from ocean, ice sheet and sea ice studies. In addition, satellite altimetry processing might be different depending on geographical regions, on meteorological conditions, and on hydrologic dynamics of the water bodies. So far, only Frappart et al (2006) evaluated the performance of those four re-trackers for monitoring inland water in a different geographical region, we argue that our study is novel, to further call attention to the presumably comfortable opinion that Ice-1 is that best Ku-band nadir radar altimeters for inland water level height retrieval.

3. Technical Corrections

Page	Line	Issues	Solutions in the revised version of manuscript
		Abstract	
2826	12	"Over-water" radar waveform	"Over-water" term has been removed while keeping the original meaning of the sentence. The sentence has been re-phrased into: "… using satellite altimetry through careful selection of waveform shapes that correspond to the re-tracked water level."
	19	Reasonable accuracy	Replaced with "good accuracy", followed by the actual RMS Error and correlation coefficient
	1-25	Minor changes suggested to explicitly expressing major challenge addressed in this study. Also need to pose research question related to inter re-trackers comparison	Thank you for your suggestion. We have included a brief summary on the major challenge addressed by this study, and as suggested presented the research question related to re-trackers comparisons for water bodies with different geographical regions, meteorological conditions, or hydrologic dynamics.
		Introduction	
2827	5-10	"less important"	Thank you for comment. The authors reflected the situation in the most *developing countries*, where satellite-based hydrological monitoring is rather seen as luxuries instead of needs. However, the authors realized that the manuscript did not specify the context of this section. As a result, we inserted a sentence "This is particularly true for developing countries, e.g. Indonesia" (section 1 paragraph 1).
	10-15	Reliable water level	Again, this statement is in the context of developing countries, where a lot of rivers are not gaged at all. We

Page	Line	Issues	Solutions in the revised version of manuscript
			have revised the text accordingly (section 1 paragraph 1). In addition, the term "reliable" has been replaced with "complementary".
2828	15	Legresy and Remy (1997)	Thank you. It has been added in the References.
	20	ntil	Done: until.
	29	Not clear why incorporate RS & GIS	Additional discussion has been added in section 1 paragraph 6 & 7
2829	1	And therefore, and …	This sentence has been revised along when revising previous page (starting from line 26)
		Study Area	
	3,6	are	Replaced with "were"
	9	This study takes place…	Replaced with "This study was conducted…"
	11	Short distance	Replaced with "close proximity"
		Materials and Methods	
2831	17/20	Define RA2/MWR SGDR	Definition has been added at the first instance. Radar Altimeter-2 (RA-2)/Microwave Radiometer (MWR) Sensor Geophysical Data Record (SGDR) (hereafter, RA-2/MWR SGDR)
2832	5-10	Need to re-arrange the placement of the hypotheses to be tested, e.g. into introduction	Hypotheses regarding comparison of standard re-trackers has been added to the end of the Introduction section.
	21-24	The text that explains color composite is confusing	The same concern is raised by referee #1 This paragraph has been merged with the following paragraph (line 25-29) and re-arranged accordingly
	26-27	To avoid repetitive information	This paragraph has been merged with the previous paragraph (line 21-24) and re-arranged accordingly
2833	3	Choice of buffer values and how the buffers used Also raised by referee #2	From previous research, it is known that the presence of variable land cover (e.g. vegetation in the riverbank, lakeshore or coastline, as well as islands or sandbanks within the river or lake) affect the returned radar signal in altimetry measurement (e.g. Deng and Featherstone, 2006; Berry et al, 2005). Specifically, Sarmiento and Khan (2010) found that altimetry-measured water level from lake area closer to the lakeshore had shown larger errors compared to those with further distance. This study intends to see if there is any different effect caused by different distance from the satellite footprint center to the lakeshore. There was no specific consideration in determining the buffer distances other

Page	Line	Issues	Solutions in the revised version of manuscript
			than to see any difference should the distance be greater. Neither this nor other studies exclude data points near the lakeshore. Instead, this study compares data points based on gradual distance increment.
	18-21	Un-clear sentence	Revised to: "influenced by other surface within the projected radar footprint."
	21-22	Check the grammar	Revised to "…lakeshore should be enough considering that…"
2834	2	Specular shape needs explanation	The definition of specular "characteristics" was also questioned by the referee #2. The following sentence has been added into section 1 (introduction) along with the introduction of satellite altimetry for inland waters: "Specular refers to a reflection characteristic where a signal is reflected into one direction, thus match the reflection by a mirror (e.g. Torrance and Sparrow, 1967). In the context of radar signal processing, this is the mechanism when the radar signal hits very calm/smooth water surface, thus presenting a peak in a return signal power, as represented by the shape of the waveform."
	11	Further explain why complex and non-classified waveforms were disqualified	We have added additional explanation as follows: "Range measurements that carry complex and non-classified shapes were disqualified considering that the mixture of water, vegetation and or shoreline (i.e. that produces complex and non-classified waveform shapes) may lead to inaccurate elevation measurements as compared to the radar signal returned by water-dominated surface."
	11	Categorized or qualified	This sentence has been revised into "Some examples of actual waveform that classified into "Brown-like", specular, flat-patch, as well as complex and non-classified shapes are presented in Fig. 3."
	15	Most value range	The whole sentence has been revised to "Although the altimetry measurements that carry non-qualified waveform shapes had been excluded, some measurements are still far beyond the mean and median value."
	20/25	Definition of WSE	Added after the equation
		Results and Discussions	
2836	7-8 9-12	Claims on water level retrieval of small river	Thank you for the comment. We have: • Removed "regardless the width of the river", line 7-8.

Page	Line	Issues	Solutions in the revised version of manuscript
			• Mentioned a clear "cutoff" on the river width, e.g. successful on river width 200–800 m, potential for river width 40-200 m • Moved the explanation for the small river to the end of the section and mentioned explicitly the class of river (e.g. possible or potential on river width < 200 m).
	14-20	Claims on water level retrieval of small river	This issue is also raised by the referee #2. The paragraph at line 13-22 has been revised. The authors realized that the measurement of very small rivers in this study **speculated** the potential of satellite altimetry to monitor such small rivers. The two paragraphs (line 3 to 22) have been revised accordingly so we discussed the results from each class of rivers (i.e. small (< 200 m width) and medium sized (200-800 m width)) separately.
	14-20	Delineating river boundary for the narrow channel (~54 m width)	This issue has been addressed in "Specific Comments" at the beginning of this response.
2837	29	"actually" is redundant	Removed
2839	15-16	Add legend to Fig 12	The legends for TRMM Precipitation and WL Anomaly have been added into Fig 12.
	16-19	Modify the TRMM data in Fig 12	We tried to bin the data and visually evaluate the linearity, but ended up with better result with the original data spread
2840	4-6	Rewrite the sentence	Replaced with: "Up to now, a systematic and verified classification of waveform shapes especially for inland waters does not exist, except the early development such as presented by Dabo-Niang et al. (2007). Hence, further study on this subject is warranted."
	8	Table 6, determine buffer	In the previous section, we have changed the terms "buffer" with masks for different distances. The number of distance ranges (3) is now explicitly mentioned.
		Figures	
Fig	8	Legend blocks the WLA	We have revised the plot accordingly
Fig	12	No legend	Added

Response to Anonymous Referee #2 for HESS Discussion Article

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Satellite Radar Altimetry for Monitoring Small River and Lakes in Indonesia

1. General Comments

The authors gratefully thank the 2nd anonymous referee for his/her critical comments. These comments and suggestions are vital in improving the quality of this manuscript, as the authors desired. In the following section, each comments are addressed. The manuscript has been revised according to the changes listed here.

2. Specific Comments

Issues	Solutions
Some additional background or references are needed to justify some assumptions investigated relative to the "buffers" of the lake	We realized that the **hypothesis** on the influence of distance between satellite altimetry footprint center and the lakeshore **was not well-posed** in the introduction part and only mentioned briefly in the Method Section (p. 2833). A paragraph that discusses this matter, along with some background references has been added into the Introduction Section of the revised manuscript. References: Sarmiento and Khan (2010) studied the Great Slave Lake (GSL) and found that Jason-1 performed worse measurement over areas within 20 km "buffer" distance to the coastline, as compared to TOPEX/Poseidon measurement within 10 km distance to the coastline.
Interpretation of results with conclusions being drawn from insufficient data, in particular the case of narrow river where no validation data available	The same concern was posed by the first referee. The offered solutions are to re-phrase all related statements regarding the altimetry measurement on virtual station UM03 that has the 54 m-width river. We emphasized now that the water level fluctuation was potentially observed rather than actually "measured and validated". In addition, in the Conclusion Section, we mentioned it as "potentially observable". The same situation happens to the measurements on the Karangmumus River.
Need more detail in determining the water level anomaly when more than one point is available during a satellite pass	The most critical process was outlier removal, which then followed by averaging. We have now provided more explicit explanations in Method Section of the revised manuscript to further clarify this issue.

3. Technical Corrections

Page	Line	Issues	Solutions in the revised version of manuscript
		Abstract	
2826	4	"e.g." is not appropriate	The sentence has been revised to: "(i.e. satellite revisit period)
	6	For river	Replaced with "to rivers"
	11	Indicate the size of lakes	Herdendorf (1982) and Chang (1987) defined the large lakes as those with surface area greater than 500 km^2. In addition, Berry et al. (2005) also limited their study to lakes with extent greater than 500 km^2. However, we limit our definition into 1000 km^2
	12	Confusing sentence	Re-phrased the sentence to: "… using satellite altimetry through careful selection of waveform shapes that correspond to the retracked water level."
	18-19	Do not repeat the river size	We refrain from repeating size definition
	20	What is "reasonable accuracy"?	Replaced with "good accuracy", followed by the actual RMS Error and correlation coefficient
	20	"the procedure"	Replaced with "a procedure"
	20	Identification or selection	Replaced with "identification and selection"
		Introduction	
		More background regarding different re-trackers	Additional discussion regarding the background for each retrackers has been added
2827	6	"for various reasons"	Deleted
	7-9	"In contrast, despite …"	Sentence re-phrased to "The installation and operation of in situ measurement such as permanent gauging is often considered as costly and not important. This is especially true for developing countries, specifically for Indonesia. However, the interest for continuous satellite-based monitoring of hydrologic bodies, including narrow or small rivers, is increasing"
	12	Space geodetic	Replaced with "space geodesy"
	17-18	"very limited if not none of them"	Replaced with "most of them"
	21	Earlier references for altimetry for inland waters	Line 21-26 re-arranged into one complete sentence
2828	1	"Even"	Replaced with "While"
	1-2	Contradictory sentences.	The whole paragraph has been revised to improve the

Page	Line	Issues	Solutions in the revised version of manuscript
		Consider re-phrasing	flow of the sentences
	4	Therefore	The sentence has been removed to fit the new flow of sentences
	9	Describe “specular characteristics”	The following sentences have been added into line 10: “Specular refers to a reflection characteristic where a signal is reflected into one direction, thus match the reflection by a mirror (e.g. Torrance and Sparrow, 1967). In the context of radar signal processing, this is the mechanism when the radar signal hits very calm/smooth water surface, thus presenting a peak in a return signal power, as represented by the shape of the return waveform.”
	18	“hence, it is later called”	Replaced with (model-free retracker)
	19	“This algorithm…”	Removed
	20	“ntil”	Replaced with until.
	21	“claimed”	Replaced with “found”
	21	Frappart et al (2006)	Yes. They compared the four re-trackers as this study
	26	After all	Replaced with “So far”
2829	29/1	“This led to…”	The flow of the sentence has been re-arranged
		Study Area	
	9	Rephrase	Replaced to: “This study focuses on …”.
	12	“oriented” and bridge sentence to further explanation on the characteristics	Replaced to: “These regions, shown in Figs 1 and 2, represent different geomorphology, climate and anthropogenic situations, which are described as follows”
	15	Missing “The”	Added
	17	declares	Replaced with “makes”
	21-23	Grammar check	Revised
	23-24	“the”	Removed
2830	2-8	rewrite	Rewritten
	9	Missing “The”	Added
	18	Counts as	Replaced with “is”
	19	i.e.	Removed
	23	Included as	Removed
		Materials and Methods	
2831	13-16	Explain how to get 18Hz data	The preceding process of obtaining 18Hz data has now been provided
	17	Explain MWR/SGDR	Added
	20	In addition	Removed

Page	Line	Issues	Solutions in the revised version of manuscript
	22	cycles	Sentence removed along with the table
	22-23	The Envisat and sites	Sentence removed along with the table
	24	geocentric	Removed
	25	the	Added
2832	5	prove	Replaced with “test”
	6	On the Ice-1 as	Replaced with “that Ice-1 is”
	13-14	corrections	The sentence has been revised to reflects corrections applied by the authors
	21	image	Replaced with “imagery”
	21-24	Repetitive description on Landsat color composite	The same concern is raised by referee #1 This paragraph has been merged with the following paragraph (line 25-29) and re-arranged accordingly
	26-27 to ln 1	Repetitive description on Landsat color composite	This paragraph has been merged with the previous paragraph (line 21-24) and re-arranged accordingly
2833	3	Choice of buffer values and background studies or references to justify this test	From previous research, it is known that the presence of variable land cover (e.g. vegetation in the riverbank, lakeshore or coastline, as well as islands or sandbanks within the river or lake) affect the returned radar signal in altimetry measurement (e.g. Deng and Featherstone, 2006; Berry et al, 2005). Specifically, Sarmiento and Khan (2010) found that altimetry-measured water level from lake area closer to the lakeshore shown lower performance compared to those with further distance. This study tries to see if there is any different effect caused by different distance from the satellite footprint center to the lakeshore. There was no specific consideration in determining the buffer distances other than to see any difference should the distance is greater. Neither this nor other studies exclude data points near the lakeshore. Instead, this study compares data points based on gradual distance increment.
	6	The use of river buffer	The river buffer determined in this study was not used to test the effect of different buffer distances as those in the lake areas. The buffer was solely developed to accommodate any errors related to geo-referencing and projection in the preparation of satellite imagery and topographic maps. The authors realized that the buffer magnitude (5 m) is not relevant with the 350 m satellite ground track interval
	20-21	Unclear sentence	Revised into: “influenced by other surface within the

Page	Line	Issues	Solutions in the revised version of manuscript
			projected radar footprint."
2834	14-15	Need to rephrase	Although the altimetry measurements that carry non-qualified waveform shapes had been excluded, some measurements are still far beyond the mean and median value.
	16	Mild outlier	The following definition has been added: Mild outlier or minor outlier refers to data value beyond the 1.5 quartile away from the nearest quartile
	Eq 1	1.5(IQR)	Replaced with "1.5 x IQR
	21-23	Definitions of equation	The variables have been defined right after the equation. A note describing how IQR determined has also been added
		Results and Discussions	
2836	7	Trend	Replaced with "fluctuation"
	8-19		The paragraph at line 13-22 has been revised. The authors realized that the measurement of very small rivers in this study **speculated** the potential of satellite altimetry to monitor such small rivers. The two paragraphs (line 3 to 22) has been revised accordingly and specifically discuss the results from each classes of rivers (i.e. small (< 200 m width) and medium sized (200-800 m width)).
	15	River width in (Michailovsky, 2012)	Revised into "40 m"
	16	"…without validation"	", also without validation" has been removed
	19	remarkable accuracy	Replaced with quantities revealed by the original article
2837	2	Why Figure 6 & 7 only show Ice-1 retracker?	We removed Figure 6 & 7 since we consider them not important. In addition, Figure 8 presents the merged data from these two virtual stations.
	3-6	Figures 6 & 7 do not directly correlated with the statement	We removed the first sentence since it is well known, has been mentioned in the beginning of the paper, thus not necessary to repeat in this section.
	6-10	Need to re-arrange the sequence of this section	We have rewritten the whole paragraph (line 3-19) and moved it into the end of section 4.1 (used to be 4.2)
	10-15	Need to re-arrange the sequence of this section	We have rewritten the whole paragraph (line 3-19) and moved it into the end of section 4.1 (used to be 4.2)
	16-20	Need more specific when discussing results	The idea to expose the longest gap between satellite measurements is greatly appreciated since it is well correlated with the applications of this research. We have added an extra figure for data gaps and discuss this matter in the revised manuscript.

Page	Line	Issues	Solutions in the revised version of manuscript
	20-25	Averaging the water level on the same cycle done and consider the spread of water level in each cycle	Our responses are the following: ✓ First of all, the two meanders were observed by different Envisat satellite passes. Therefore, the day of altimetry observation occurs always different between these two virtual stations. This situation enhance the temporal resolution for this particular location. ✓ The slope of the river was checked through SRTM elevation data (described at p 2838 line 2-3), the magnitude is about 10^{-5} (1 cm/km). This magnitude was also confirmed by Sassi et al (2010), who used similar value as the estimated bed slope for hydraulic modeling for this area. According to Fig. 9, the longest distance between in-situ gage and satellite altimetry footprint is about 10 km, thus maximum height difference is 10 cm. Since overall range of water level fluctuation for this area was up to ~8 m, we decided that this offset range (10cm/8m = 1.25%) is negligible. ✓ It is interesting however, to have a closer look at the spread of water level in the same cycle and evaluate above assumption in the river with steeper slope.
2838	16	Double-check all values. Keep all river width and ranges in the table. Add Birkinshaw et al. (2010)	All values have been double checked and revised accordingly. The study by Birkinshaw et al. (2010) has also been included
	20	Mention if outlier was removed by in-situ data	The outlier removal did not make use of in-situ data.
	24	Mention possible improvement	Will include the following text into the revised version of this article: “Among the improvements are using other altimetry missions (e.g. Jason-1, ICESat), detailed evaluation of retracked water elevation within a cycle and compare them with actual river slope.”
	26	Need to highlight the observation about river orientation relative to satellite ground tracks	We have included a short note about this in the conclusion section.

Page	Line	Issues	Solutions in the revised version of manuscript
2839	5	The ground track does not intersect with the river	The satellite ground track may deviate up to 1 km at both directions (east and west). That explains why the data point in the Karangmumus River (which significantly zoomed in the IKONOS imagery) looks far away from its "theoretical ground tracks". In this research, we only considered altimetry measurements with center-of-projected-footprint that fall within the water body. Thus, no off-nadir data are involved. Therefore, no qualified measurement is located in the floodplain that might be dry during non-flood situation.
	7	WSE instead of WLA	The WSE in Table 5 has been replaced with WLA
	11	Reference to Fig 12	Reference to Fig. 12 has been added at the beginning of the sentence.
	8-18	Interpreting the plot, linear relation	Re-evaluated. The sentence has been revised. The strength of the sentence has also been reduced.
	18-20	Should not conclude with very limited data	The word "conclude" has been replaced by "indicates". The rest of the sentence has been revised accordingly.
	26	Sampled waveforms in Fig 13 representative?	Fig 13 shows some examples of waveform shapes that are different with those retrieved from river. We are trying to say that these shapes are only present in the lakes and were not found in the river. In addition, these shapes are not the majority of the returned signal from the lakes, thus excluded from further processing due to our "qualification system".
	26	clearly	Replaced with "we suspect" since we did not do any quantification about this "distinguished waveform shapes".
2840	21	Reasoning for complex result on buffer distance	We removed this speculation due to the absence of supporting data and background studies.
	27	"best match…"	It was a typo. This term has been removed in the revised manuscript
2841	1-12	The two paragraphs do not describe the results	The two paragraphs have been removed.
	20	Double check the RMS Error value, especially for Lake Matano. Seems like the RMS Error is much higher than 0.33 m	There was a systematic data processing and plotting error involved in preparing Table 7, Figure 14 and 15: ✓ There was a period (before October 2002, we suspect as a spin up period) when the altimetry measurement data were offset constantly from their mean. Now, these data have been discarded from the processing.

Page	Line	Issues	Solutions in the revised version of manuscript
			✓ The solid line that represents the in-situ measurements was including the water level anomaly that was not used to validate the satellite altimetry measurements (i.e. higher interval of background in-situ measurement). As the result, the in-situ water level looked very smooth, thus the difference between the altimeter- and in-situ measured points looks more contrast and impressed the reader that the error was significant. The revised manuscript is now presenting only in-situ water level anomaly that used to validate satellite altimetry measurement only. As a result, Table 7, Figure 14 and 15 have now been revised accordingly and no longer involve outliers. ✓ There are slight changes on the numbers in Table 7, but overall, the general results of the inter comparison of the retrackers remain the same Explanation for terms ✓ Validated measurement refers to satellite altimetry measurements that were evaluated against the in-situ measurements ✓ Merged refers to the combination of satellite altimetry measurements in all distance ranges. For more familiar term, we changed term "merged" with "all"
	25	In-consistent	Replaced by "cannot be verified".
	29	Un-necessary sentence	The last sentence in line 29 has been removed while adding "(see Figs. 18 & 19)" at the end of the previous sentence ends at line 29.
2842	2	complicated	Replaced with "inconclusive".
	12	Geographic location	Geographic location has been removed
	12	Discuss the magnitude of difference between re-trackers	Additional discussion has been added to address differences among the retrackers
		Conclusions	
	22	Include RMS values	We mentioned RMS value in line 22
2843	1	Reasonably good	We revised the sentence and presented the number of qualified waveforms to support the potential of satellite altimetry observation of small rivers.
	6	reliability	Revised along with previous suggestion

Page	Line	Issues	Solutions in the revised version of manuscript
	12	It is obvious though	Replaced with “This study also indicates …”.
	21	On the other hand	Removed
	22	Selection of waveform shapes allow the use of classic/available re-trackers	The recommendation has been rephrased to reflect the statement
		Tables and Figures	
Table	4 & 8	Sulistioadi (2013)	Replaced with “Current Study”
Figs	1 &2	Small writing, explanation of the number in the circles, highlight the label for measurement points	As suggested, we have improved the readability of Figures 1 & 2.
Figs	4	Split after geo-masking	We have revised the flowchart to reflect the process. Yes the detailed geographic masking is done after waveform selection.
Figs	8,14,15	Re-arrange the legend not to block the data	Fixed
Figs	11	Text not readable	Fixed
Figs	12	Plot goes to 2010 but no data	Fixed