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Interactive Comment

Interactive comment on "Swath altimetry measurements of the mainstem Amazon River: measurement errors and hydraulic implications" *by* M. D. Wilson et al.

M. D. Wilson et al.

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The authors would like to thank both reviewers for their constructive comments and feedback, which have allowed the manuscript to be improvement. Referee comments are in italics, followed by author response/ manuscript modifications.

Referee 1:

The manuscript addresses an important new method of measurements that has the potential to improve step-wise the information content of hydrological observations. The Surface Water and Ocean Topography (SWOT) mission is planned to be launched in

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Discussion Paper

2020. It will provide the first routine measurements of water surface elevations in two-dimensional space. It is still in the future, but there is no doubt that it will come. Therefore it is important to develop a background of new methods, and to understand their possibilities and limitations. The authors present a virtual-reality experiment simulating the spatio - temporal sampling scheme of SWOT for the River Amazon. The experiment employs the numerical flow routing model LISFLOOD-FP. The water surface elevation errors derived from the SWOT characteristics were added to water levels simulated by the hydraulic model. The scientific approach and applied methods are suitable for a problem. The authors refer to the latest work related to the subject of their research. I have some concerns regarding the presentation of the research. Sentences are too long and the description is not always clear (see the specific comments). Otherwise, the structure of the paper is good.

Thank you for your comments – SWOT indeed has the potential to provide improved information for hydrology, and it is important that algorithms are developed and tested ready for use with data when acquired (the main rational for the research presented in this paper). Where appropriate, we have restructured some of the longer sentences, used tables for values to increase readability (see attached) and improved descriptions as suggested.

There are some aspects of the paper that need improvement. The question arises if there were any real observational data used in the experiment, or was it only a model to-model comparison? Another question is on the applicability of the approach. The authors test it on the River Amazon. It would be useful for the reader if a list of rivers where SWOT could be successfully applied were to be given. The answer to this question would also specify how wide the possible audience of this paper might be. The other points concern the assumptions of additivity of a noise related to SWOT measurements and a perfect knowledge of channel friction and bed elevation. These are very strong assumptions. The authors are asked to expand on those issues and provide some estimates of outcomes resulting from a situation where those assumptions

HESSD
11, C4704–C4710, 2014

are not met.

Observational data were used in the sense that the LISFLOOD-FP model was developed and calibrated for a past flood event (1995-1997) by Trigg et al. 2009 (RMSE now stated in section 4.1). However, these observational data are very limited with respect to surface water elevation and lack both spatial and temporal details – that is, of course, the reason for the development of SWOT in the first place. The model allows a highly detailed representation of the water surface and so is good as starting point for the assessment of details which may be resolvable by SWOT. Regarding the applicability to other rivers – we have tried to incorporate this issue in the discussion. The results are most applicable to large, lowland rivers with low temporal variability. As stated in the paper, however, further research is required to assess smaller rivers. The comparison between the Solimões and Purus Rivers is useful in this context – the Purus had markedly lower accuracy due in part to the narrower width of the river. It is likely that other, narrower, rivers would have further reductions in accuracy, but this would need to be assessed. The assumption of perfect knowledge of channel friction and bed elevation is a necessary element to allow the quantification of error which is contributed by SWOT observations of the water surface – which is the main focus of the paper. In reality, we acknowledge that this perfect knowledge would not be the case, and again state in the conclusions that further work is required to assess the relative importance of each of these. We feel that it is beyond the scope of the current work to test these factors as that would take the focus away from the assessment of potential SWOT observations.

I found the description of SWOT observations very difficult to understand. The sentence (page 9408, lines 18-19) saying: "500m SWOT errors were downscaled to 100m resolution" is an example of a lack of precision in the description. Downscaling is an operation that can produce a serious error that has not been taken into account in the further discussion. It would be useful if the authors could provide a scheme of their virtual experiment that would include all the steps involved in matching the hydraulic *model to the remotely-sensed data.*

We have revisited this section and tried to improve clarity. “Resampling” more closely reflects the procedure used rather than “downscaling” and the sentence has been modified accordingly. Readers are referred to Rodriguez 2014 for details of the Fourier transform for error generation. A schematic is a good idea and has been included as a separate figure (see attached).

Specific comments: page 9408, lines 1-3: It is not clear how the LISFLOOD-FP was validated. Page 9412, lines 24-27: It is not clear to me how the errors are reduced by averaging. That reasoning assumes that there is no bias.

The LISFLOOD-FP model as applied was developed by Trigg et al. 2009 and readers are referred to this paper for a full validation. The overall RMSE accuracy for model validation was 1.26 m and 1.42 m for the Solimões and Purus rivers, respectively. This is now stated in section 4.1. It is true that errors will only reduce through averaging if there is no bias – however, this is a valid assumption in this case as we have not introduced a bias component to the error modelling, since it is not part of the design requirement for SWOT. However, for clarity, we have stated “assuming no bias” at the end of section 4.1.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 9399, 2014.

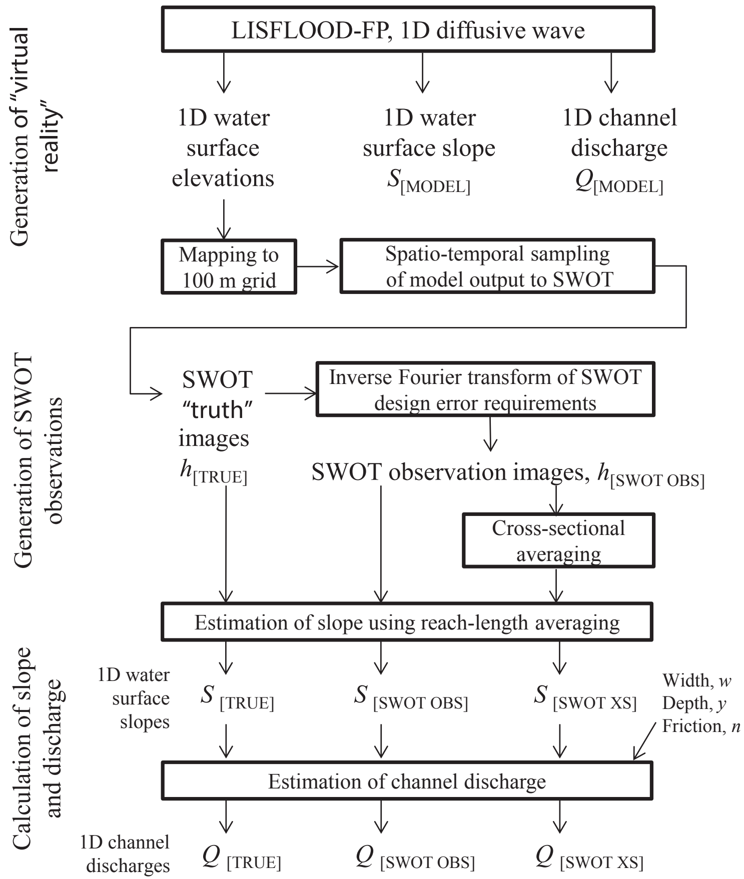
Generation of "virtual reality"
LISFLOOD-FP, 1D diffusive wave
1D water surface elevations
1D water surface slope $S_{[MODEL]}$
1D channel discharge $Q_{[MODEL]}$
Mapping to 100 m grid
Spatio-temporal sampling of model output to SWOT
Generation of SWOT observations
SWOT "truth" images $h_{[TRUE]}$
Inverse Fourier transform of SWOT design error requirements
SWOT observation images, $h_{[SWOT\ OBS]}$
Cross-sectional averaging
Calculation of slope and discharge
Estimation of slope using reach-length averaging
1D water surface slopes
$S_{[TRUE]}$
$S_{[SWOT\ OBS]}$
$S_{[SWOT\ XS]}$
Width, w
Depth, y
Friction, n
Estimation of channel discharge
1D channel discharges
$Q_{[TRUE]}$
$Q_{[SWOT\ OBS]}$
$Q_{[SWOT\ XS]}$

Fig. 1.

		Water level	Minimum	Maximum	Mean	Standard deviation
Solimões	Slope (cm/km)	Low	0.15	9.57	1.37	1.53
		High	0.69	7.43	2.19	0.95
	Discharge (m^3/s)	Low	19,765	32,068	26,346	2,137.9
		High	69,918	116,030	99,783	9,372.3
Purus	Slope (cm/km)	Low	-0.12	4.99	0.5	1.02
		High	0.17	3.01	0.52	0.35
	Discharge (m^3/s)	Low	-2,649	5,314	958	1,276.4
		High	6,665	19,276	13,466	2,958.9

Fig. 2.

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			Reach length (km)		
	Error		5	10	20
Solimões	$S_{[\text{SWOT OBS}]}$	cm/km	2.55	0.91	0.33
	$S_{[\text{SWOT XS}]}$	cm/km	0.72	0.26	0.09
	$Q_{[\text{SWOT OBS}]}$	m^3/s	34,180	18,900	7,190
		%	48.5	26.1	9.7
		E	-1.92	0.23	0.89
	$Q_{[\text{SWOT XS}]}$	m3/s	15,670	5,950	1,960
		%	22.2	8.3	2.6
		E	0.46	0.93	0.99
Purus	$S_{[\text{SWOT OBS}]}$	cm/km	2.57	0.9	0.31
	$S_{[\text{SWOT XS}]}$	cm/km	1.05	0.37	0.13
	$Q_{[\text{SWOT OBS}]}$	m^3/s	9,682	5,211	2,795
		%	130.9	67.9	35.1
		E	-8.17	-0.92	0.57
	$Q_{[\text{SWOT XS}]}$	m^3/s	5,764	3,189	1,493
		%	76	40.9	19.1
		E	-1.34	0.44	0.88

Fig. 3.

HESSD

11, C4704–C4710, 2014

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