Characterizing the quality of river water level time series derived from satellite radar altimetry: Efforts toward a standardized methodology

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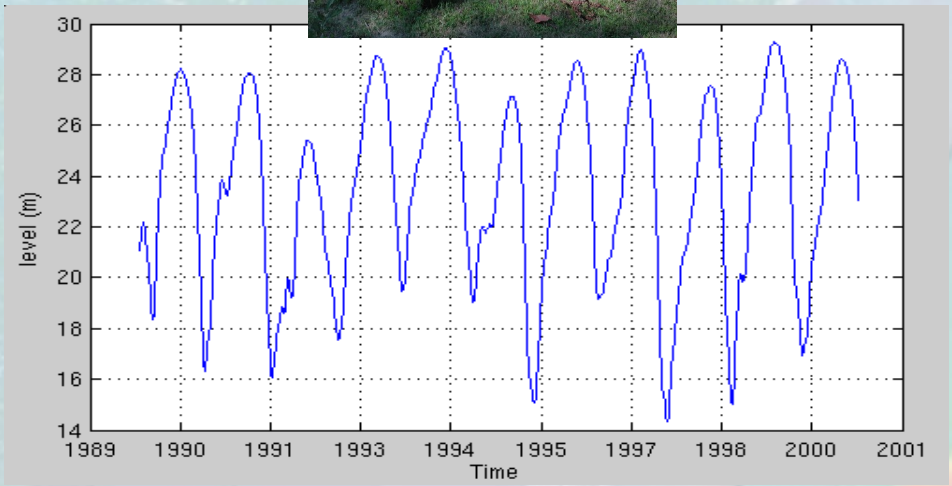
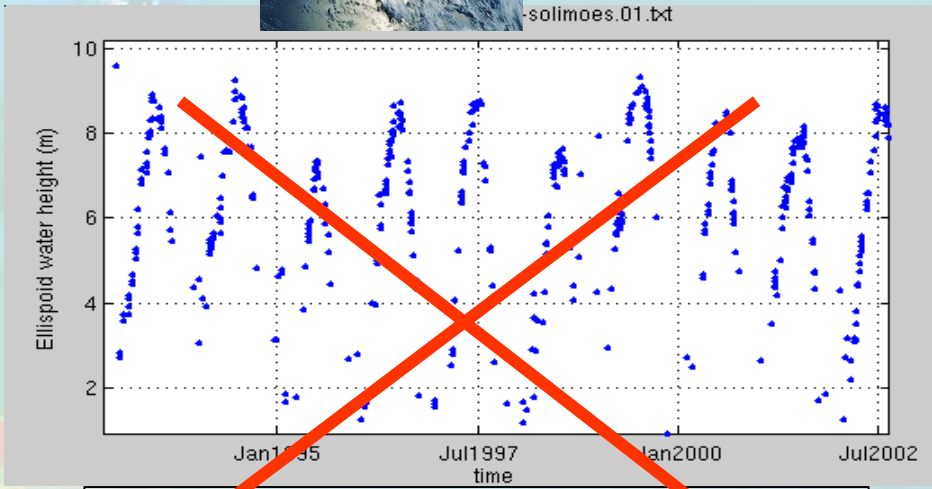
“Quality” of river water level time series derived from satellite radar altimetry

- **Introduction:**
  - **Expectations by hydrologists**
  - **Building time series of water levels from satellite radar altimetry**
- **“Quality” of sampled measurements (*accuracy + effective sampling frequency*)**
  - **Method for quantification of the “Quality” : accuracy and effective sampling period**
  - **Influence of river width**
  - **“ex ante” quantification of the accuracy**
- **“Accuracy” of reconstructed river water level time series**
  - **Oversampling : building a “continuous” time series from satellite sampling**
  - **Coupled influence of measurement accuracy and effective sampling frequency and influence of river hydrology**
  - **Method for characterization of the quality of oversampled time series (reconstructed daily time series)**
  - **“ex ante” quantification of the accuracy**

“Quality” of river water level time series derived from satellite radar altimetry

Introduction (1/3) - Expectations by Hydrologists



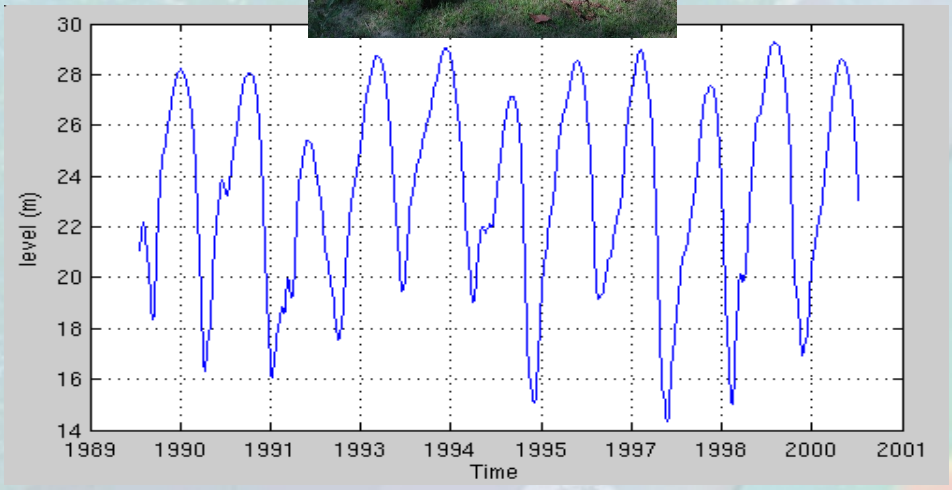


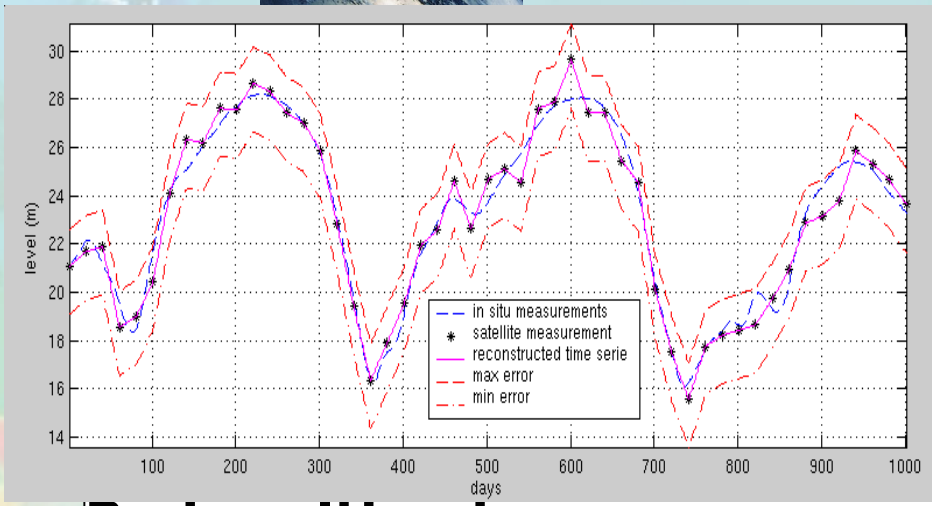
In situ measurements :
- twice a day,
- accuracy : ~3 cm

Radar Altimetry measurements :
- 10 to 35 days (theoretical),
- accuracy : unknown

"Quality" of river water level time series derived from satellite radar altimetry

Introduction (2/3) - Expectations by Hydrologists





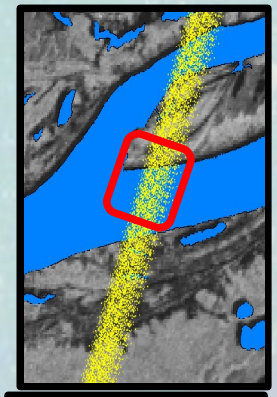
In situ measurements :
- twice a day,
- accuracy : ~3 cm

Radar altimetry measurements
- 10 days or 35 days
- with quantified accuracy
- reconstructed daily time series
- with quantified accuracy

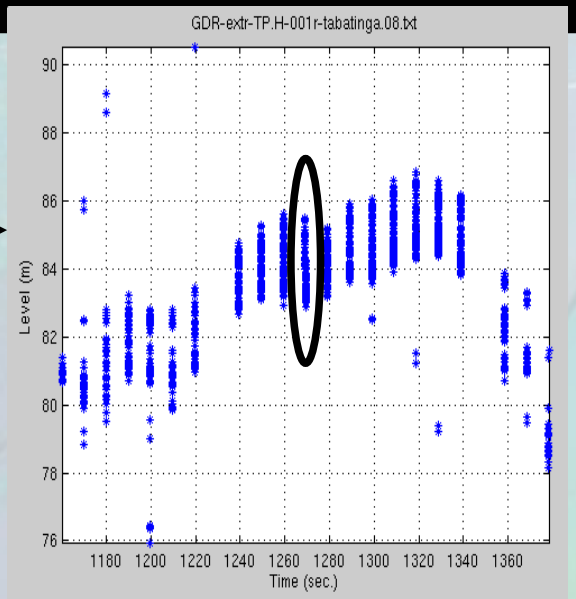
Methods to characterize the "Quality" of water levels from radar altimetry
- ***accuracy and effective sampling frequency of radar altimetry***
- ***Reconstruction of daily time series ;***
- ***Resulting accuracy of daily time series***
- ***Factors affecting the quality of reconstructed time series***

“Quality” of river water level time series derived from satellite radar altimetry

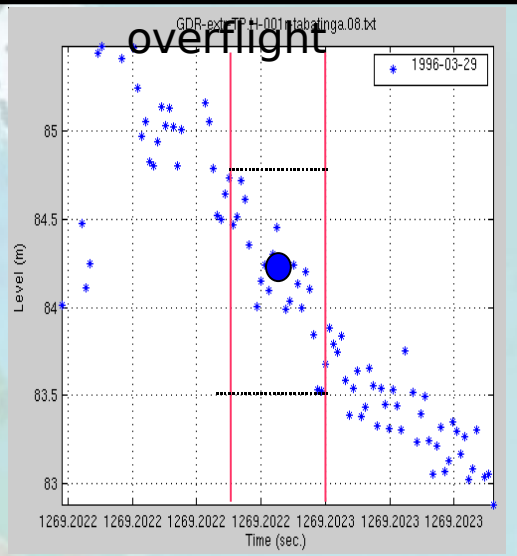
Introduction (3/3) - Building time series of water levels from satellite radar altimetry

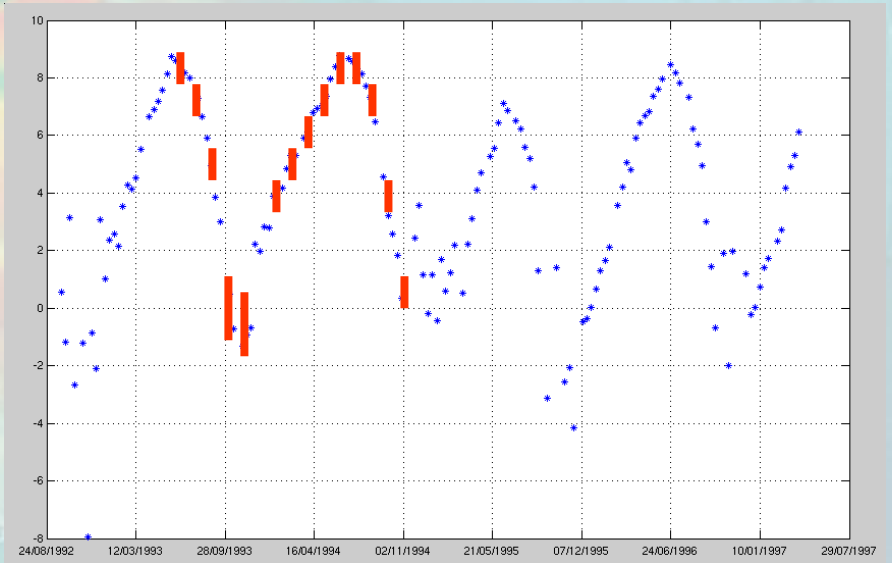


Topex/Poseidon
track 63



overflight





Satellite

Retracking Algorithm + corrections

Window size

Selection of a unique value per cycle

CAUTION : Internal dispersion of radar altimetry measures within the window during a cycle is not a quantification of the error

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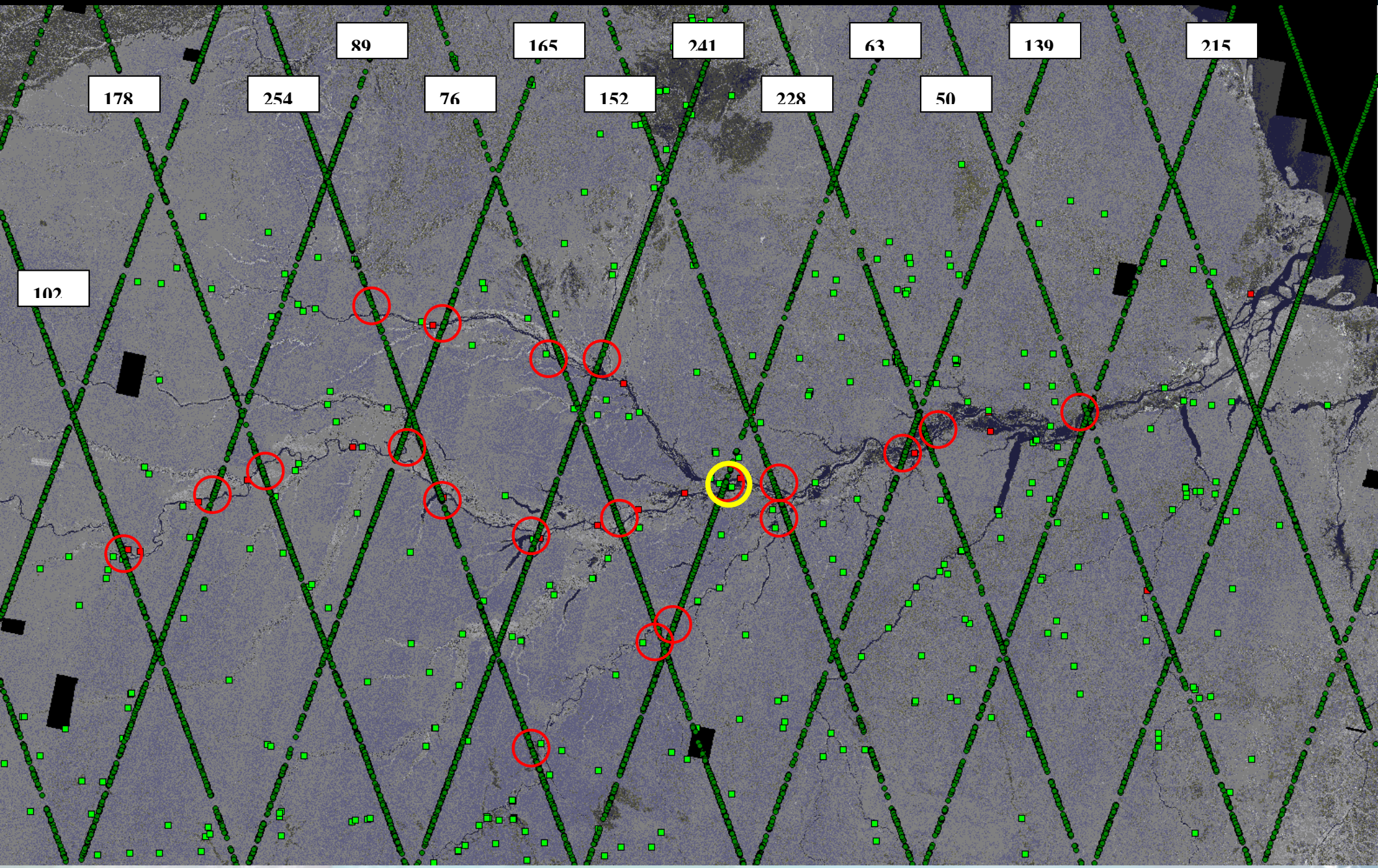
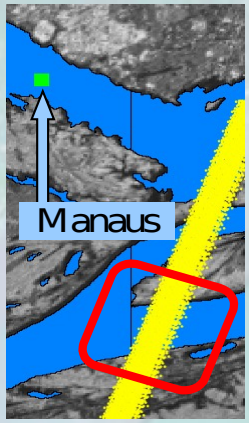
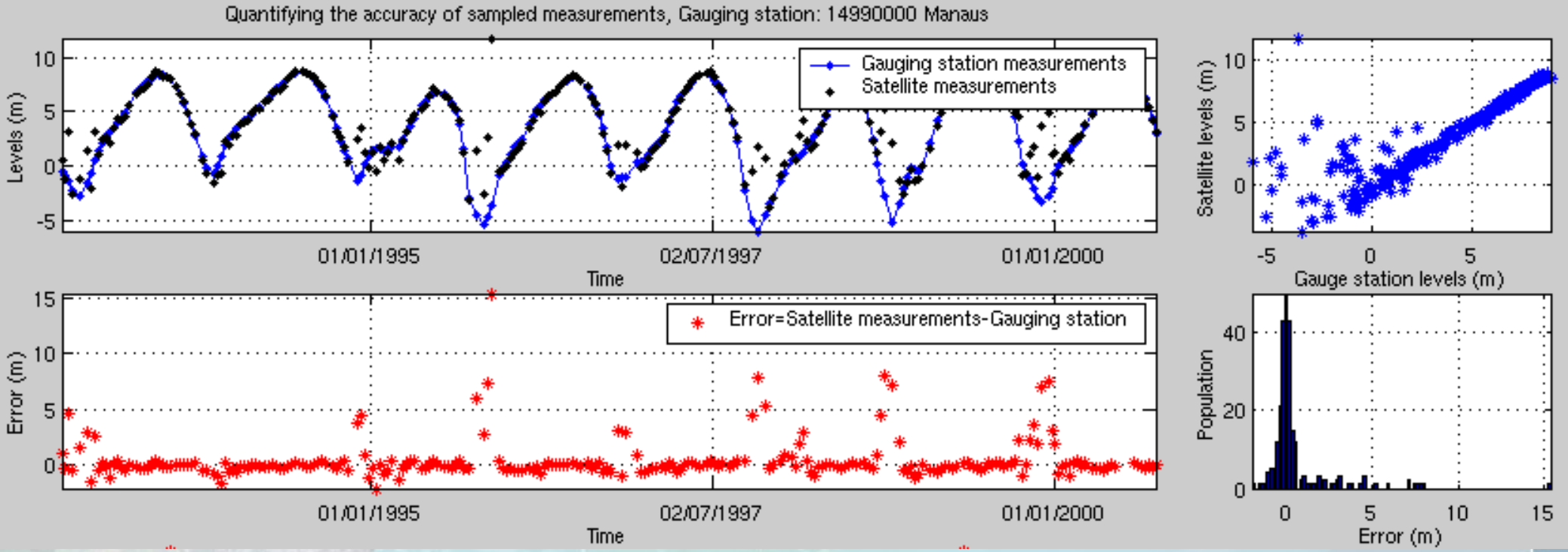


“Quality” of river water level time series derived from satellite radar altimetry

Solimões River; Topex Poseidon; Track 63



Radar Altimetry Data / In situ data



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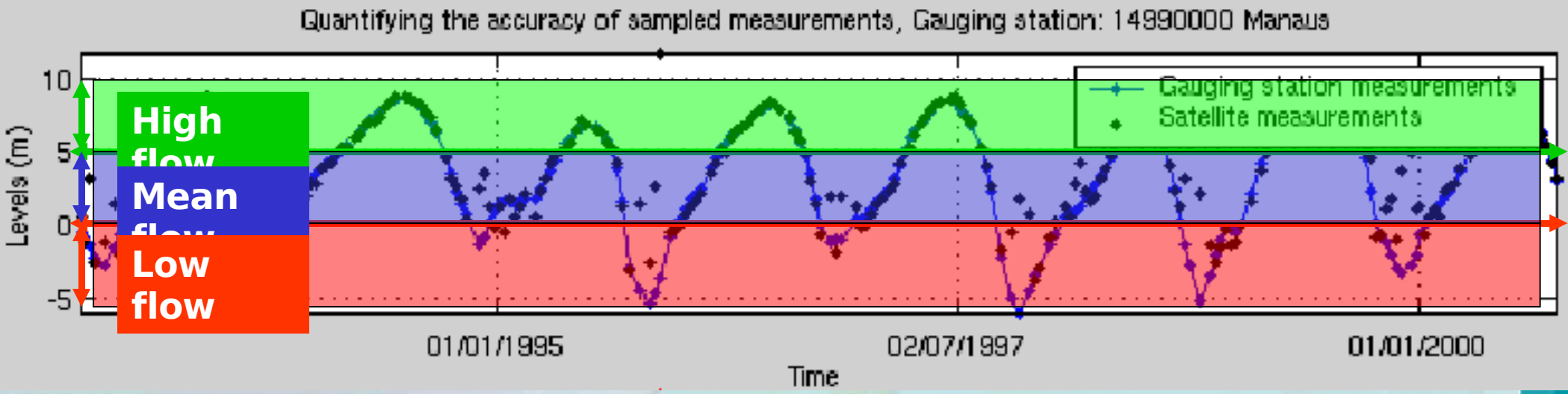
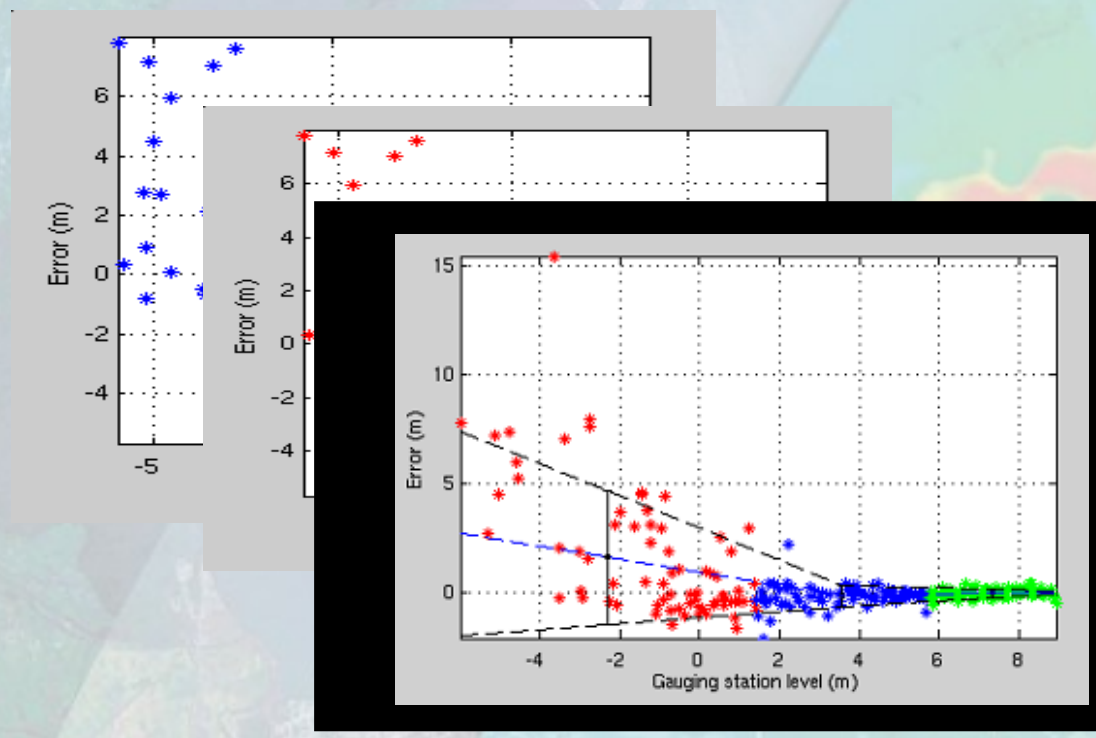
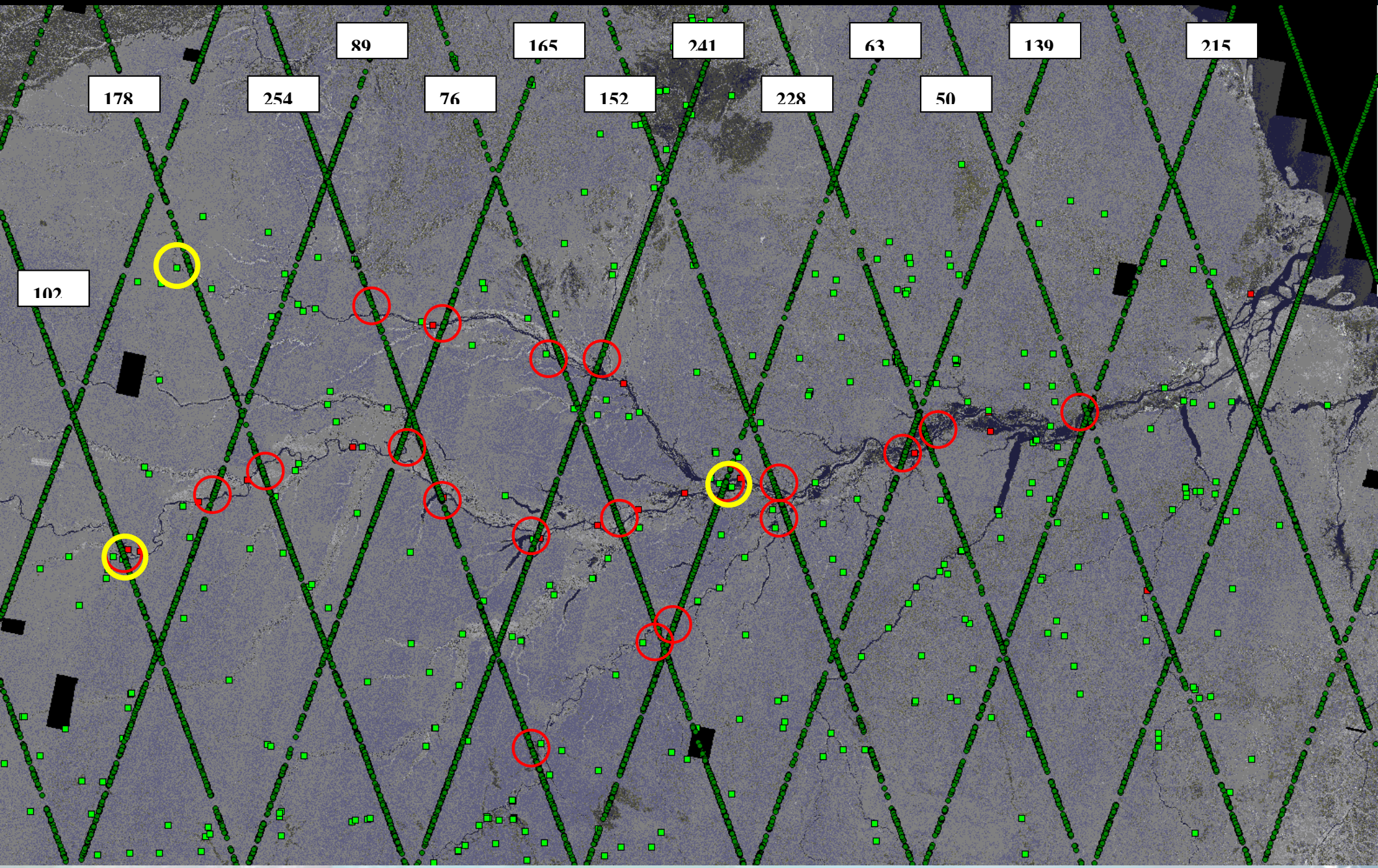




Accuracy of Topex Poseidon on Solimões river (track 63)

(m)	Zmin	Zmean	Zmax	RMS	Mean error		stand. dev.
Global	*-6.00*	*1.47*	*8.93*	**1.88**	0.44	+/-	1.83
High flow	*5.76*	*7.35*	*8.93*	**0.20**	0.00	+/-	0.20
Mean flow	*1.43*	*3.59*	*5.76*	**0.50**	-0.12	+/-	0.49
Low flow	*-6.00*	*-2.30*	*1.43*	**3.42**	1.63	+/-	3.03

“Quality” of river water level time series derived from satellite radar altimetry



"Quality" of river water level time series derived from satellite radar altimetry

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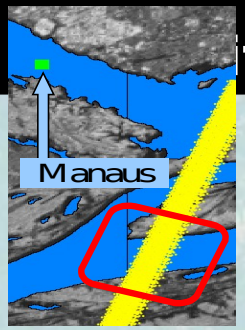
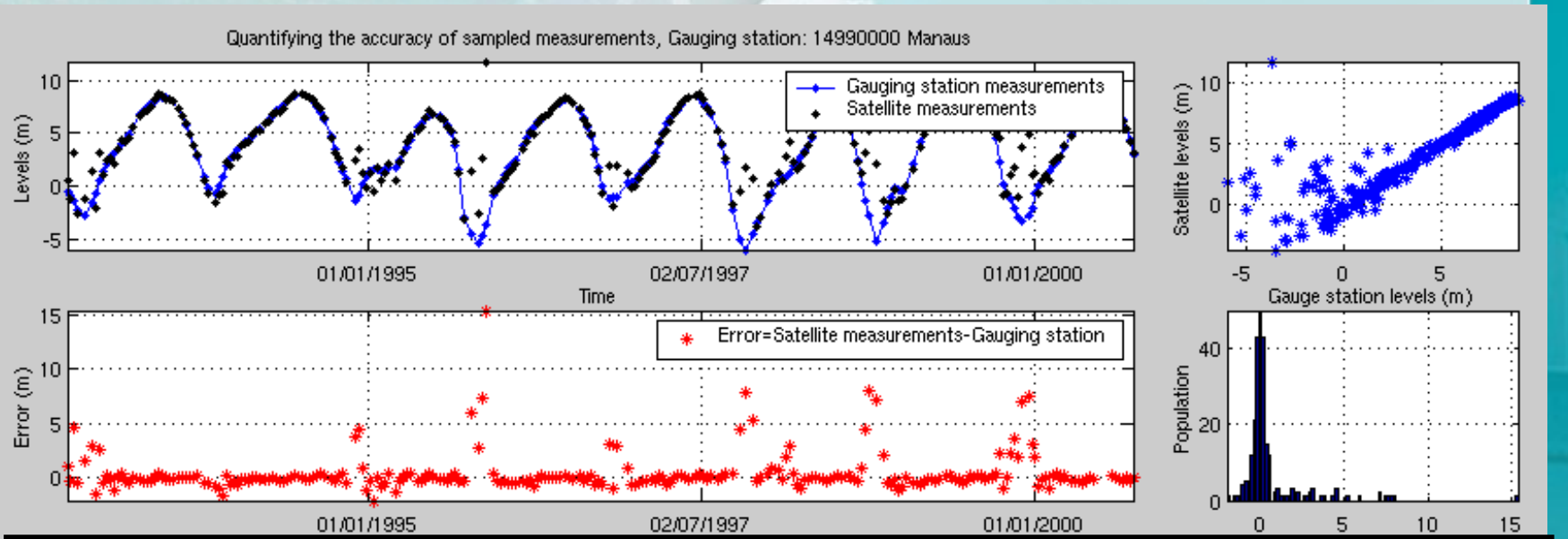
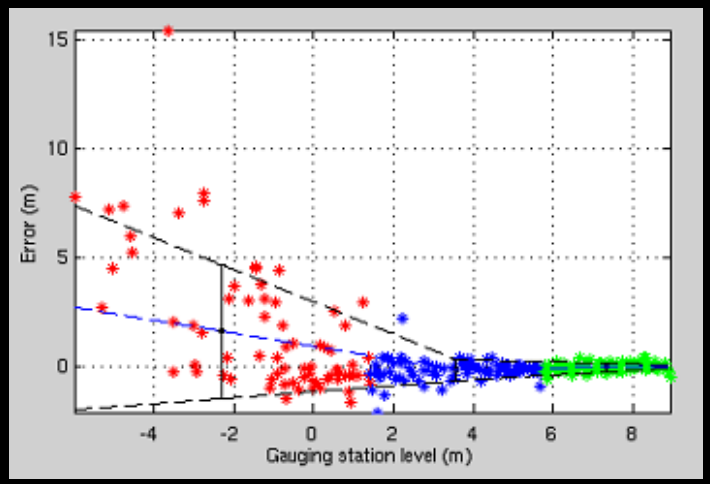


Satellite / gauging station

Error

Error structure





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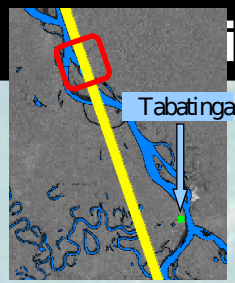

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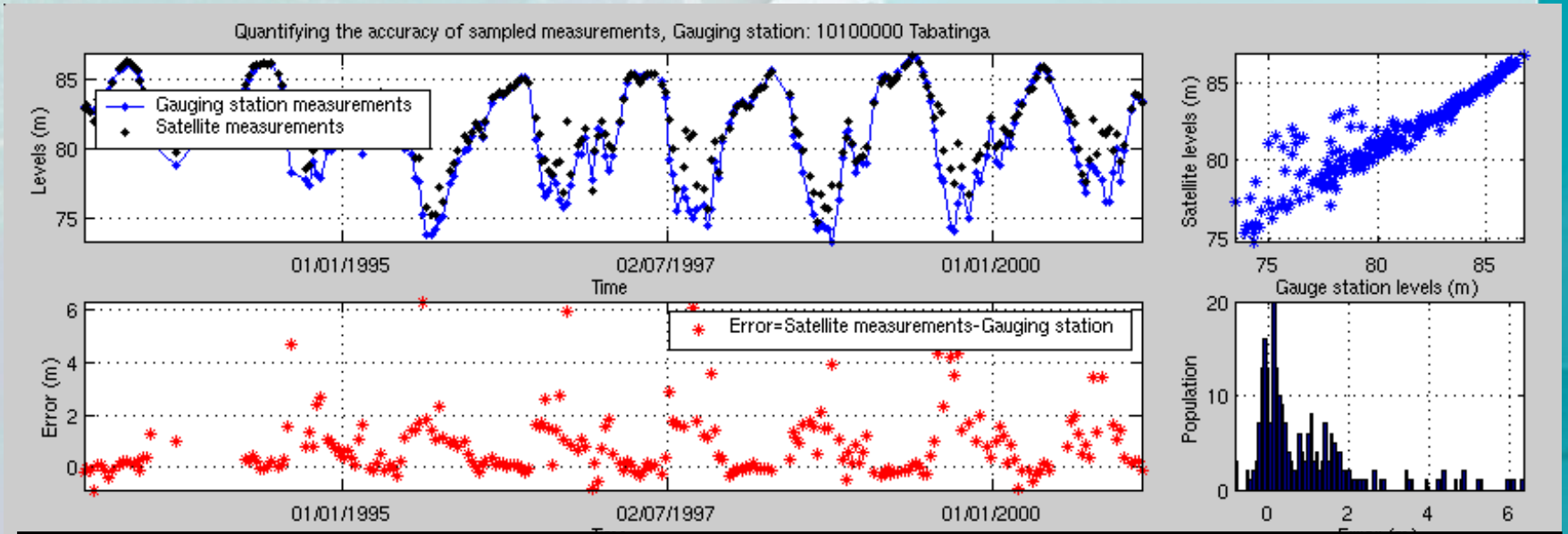
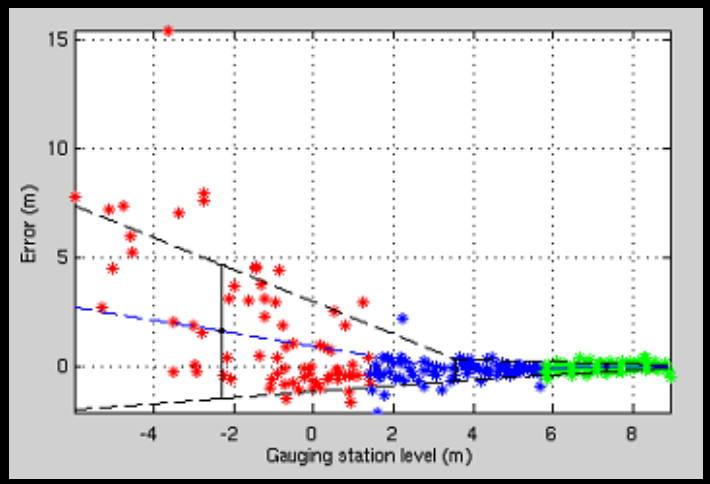
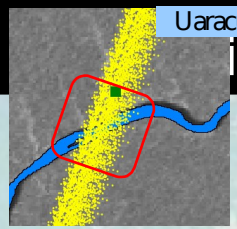




Accuracy of T/P on Solimões river (track 102 Tabatinga)

(m)	Zmin	Zmean	Zmax	RMS	Mean error		stand. dev.
Global	73.41	80.05	86.69	1.56	0.84	+/-	1.31
High flow	83.44	85.11	86.78	**0?2**	0.00	+/-	0.20
Mean flow	79.17	81.30	83.44	**0.86**	0.53	+/-	0.68
Low flow	73.09	76.13	79.17	**2.60**	2.08	+/-	1.57

"Quality" of river water level time series derived from satellite radar altimetry



ification of the accuracy of radar altimetry measurements

Satellite / gauging station

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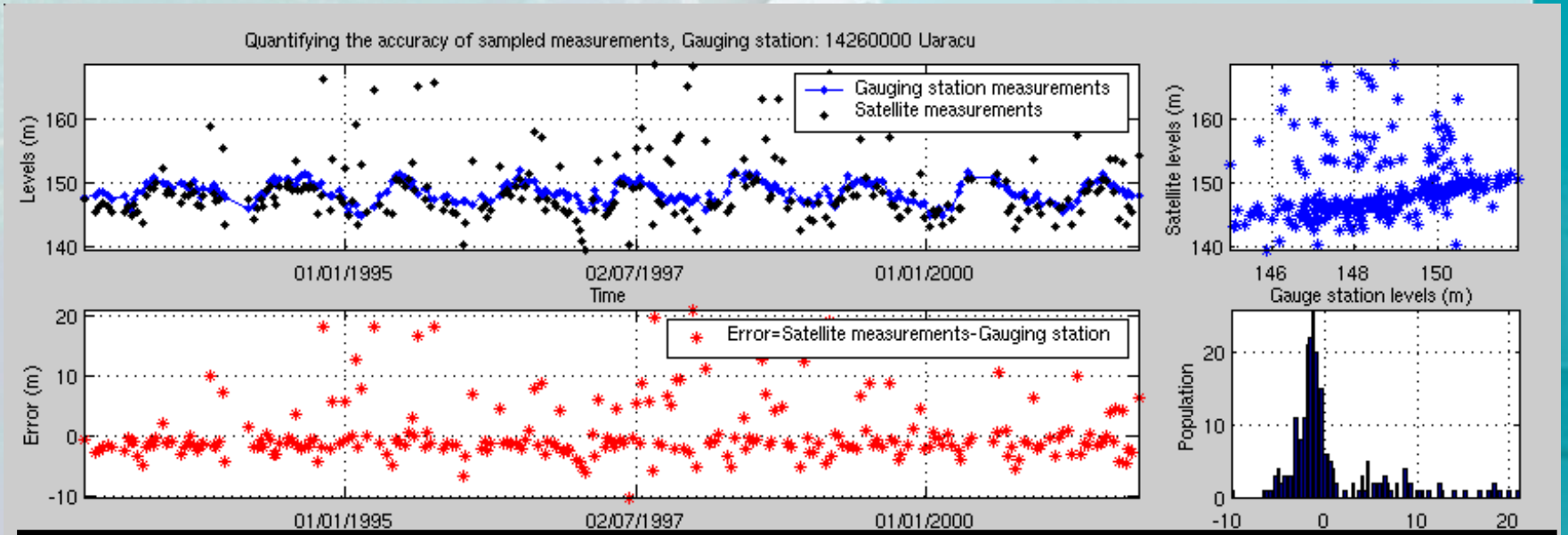
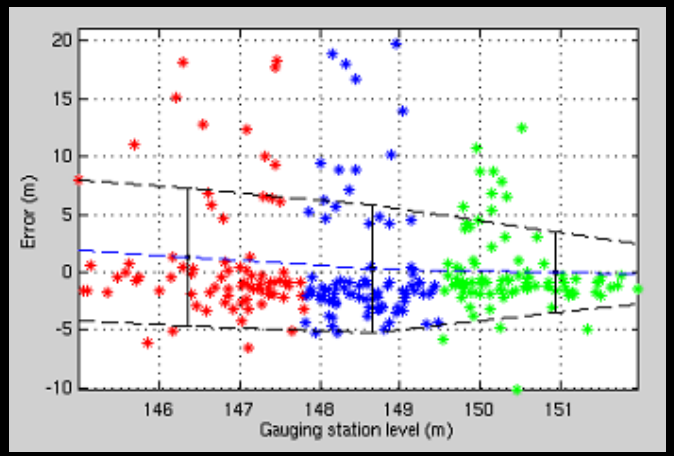
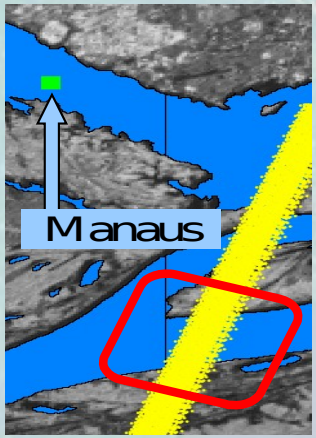


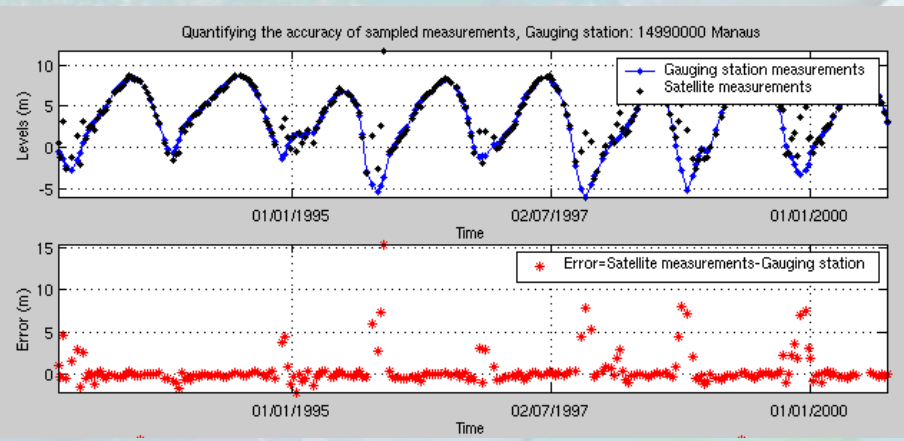


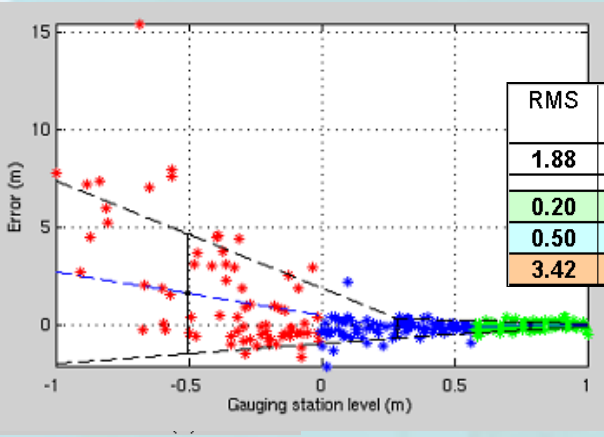
Accuracy of T/P on Uaupes river (track 13 Uaracu)

(m)	Zmin	Zmean	Zmax	RMS	Mean error		stand. dev.
Global	145.01	148.49	151.97	5.11	0.50	+/-	5.09
High flow	149.51	150.94	152.37	**3.52**	0.00	+/-	3.54
Mean flow	147.81	148.66	149.51	**5.52**	0.29	+/-	5.54
Low flow	144.91	146.36	147.81	**6.02**	1.28	+/-	5.92

“Quality” of river water level time series derived from satellite radar altimetry







RMS	Mean error		stand. dev.
1.88	0.44	+/-	1.83
0.20	0.00	+/-	0.20
0.50	-0.12	+/-	0.49
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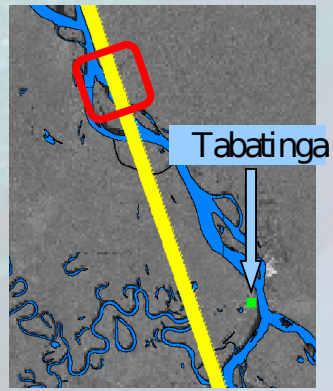

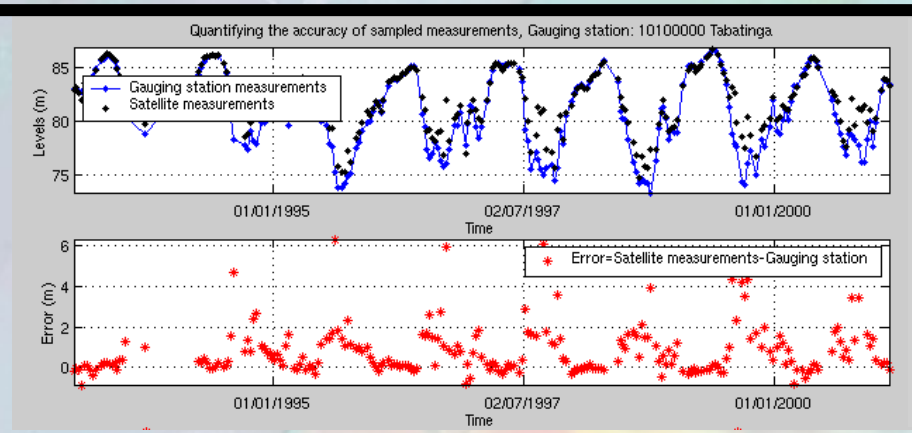

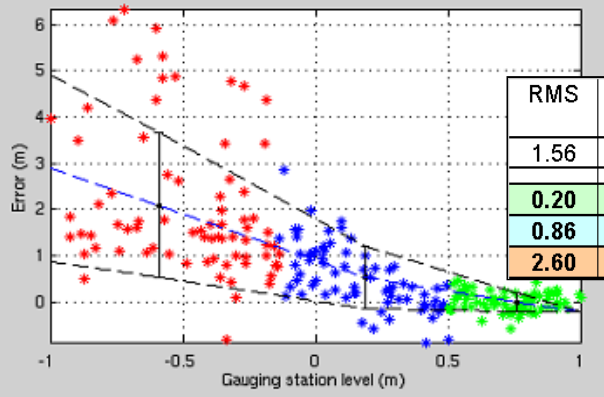

RMS	Mean error		stand. dev.
1.56	0.84	+/-	1.31
0.20	0.00	+/-	0.20
0.86	0.53	+/-	0.68
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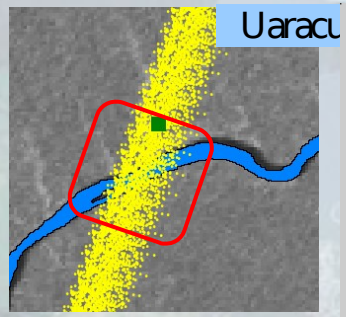
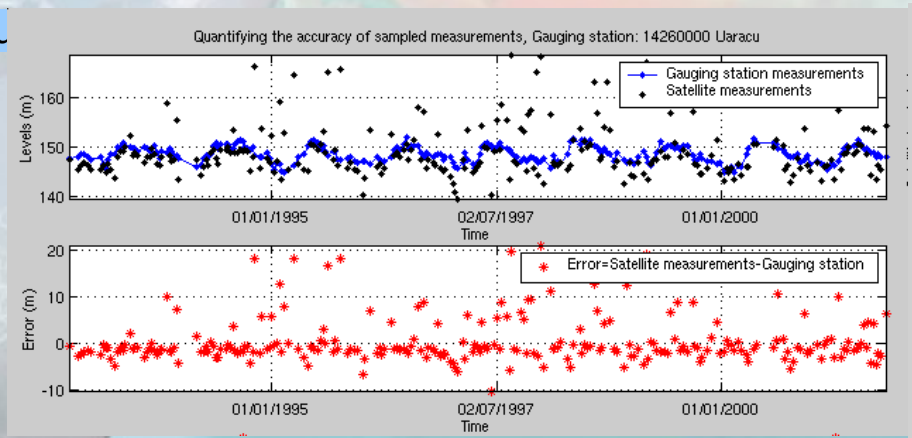
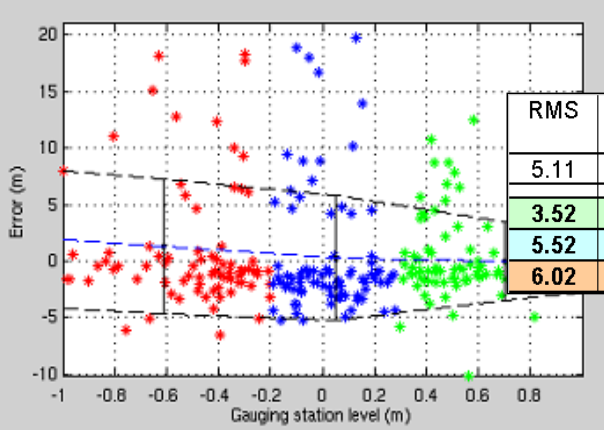
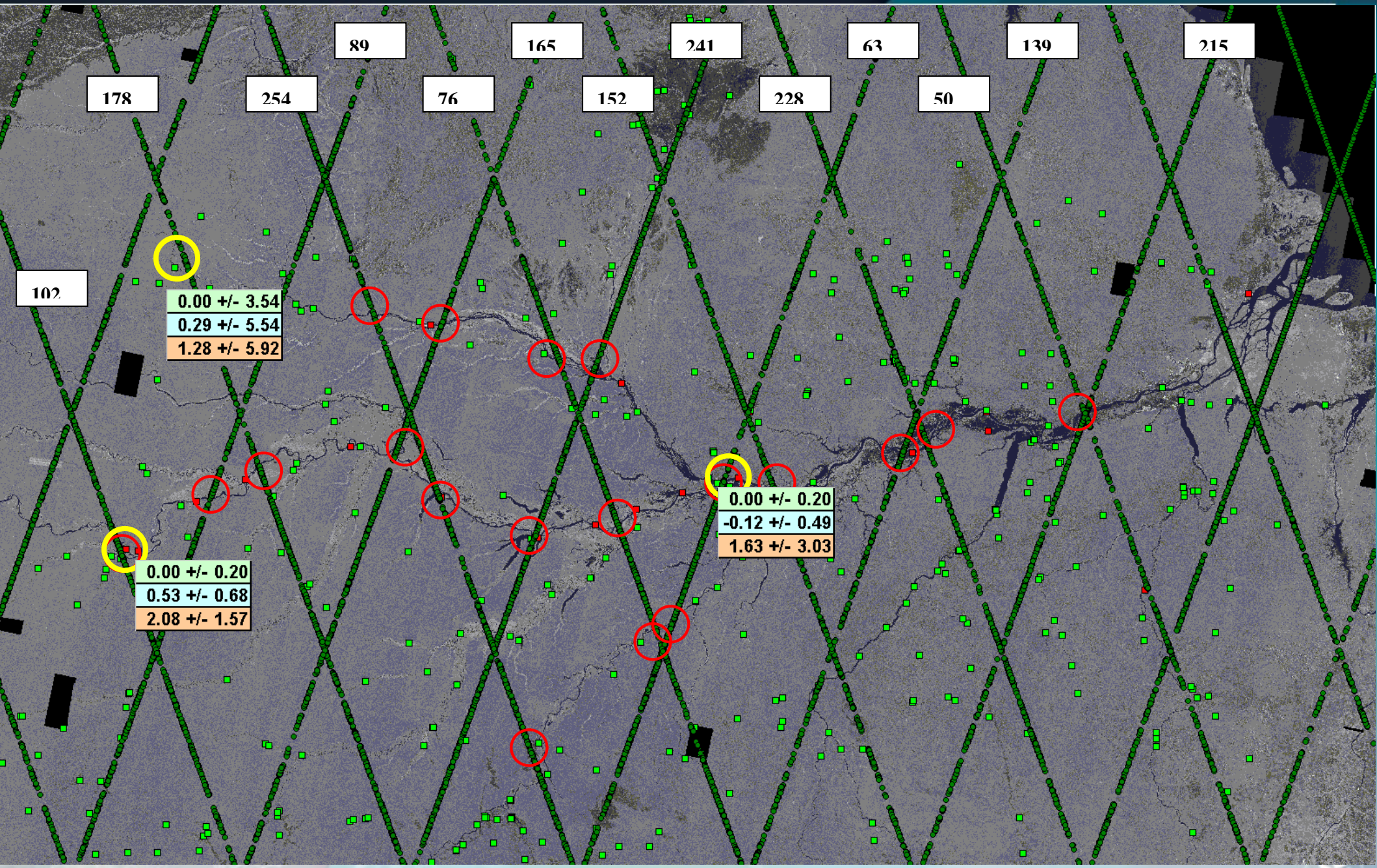






RMS	Mean error		stand. dev.
5.11	0.50	+/-	5.09
3.52	0.00	+/-	3.54
5.52	0.29	+/-	5.54
6.02	1.28	+/-	5.92

“Quality” of river water level time series derived from satellite radar altimetry



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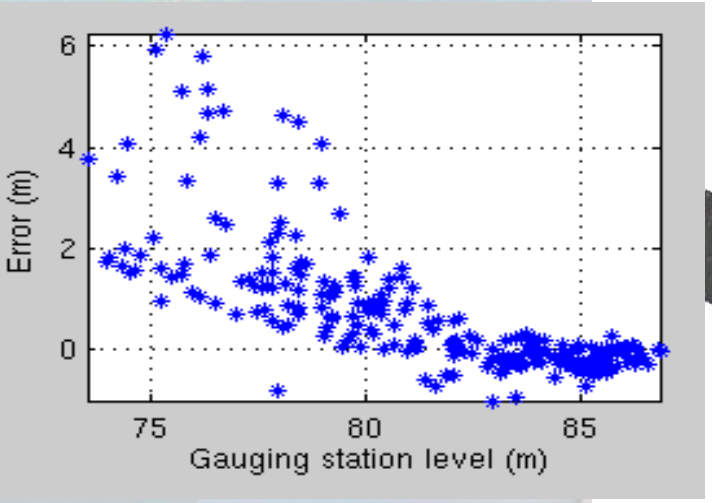
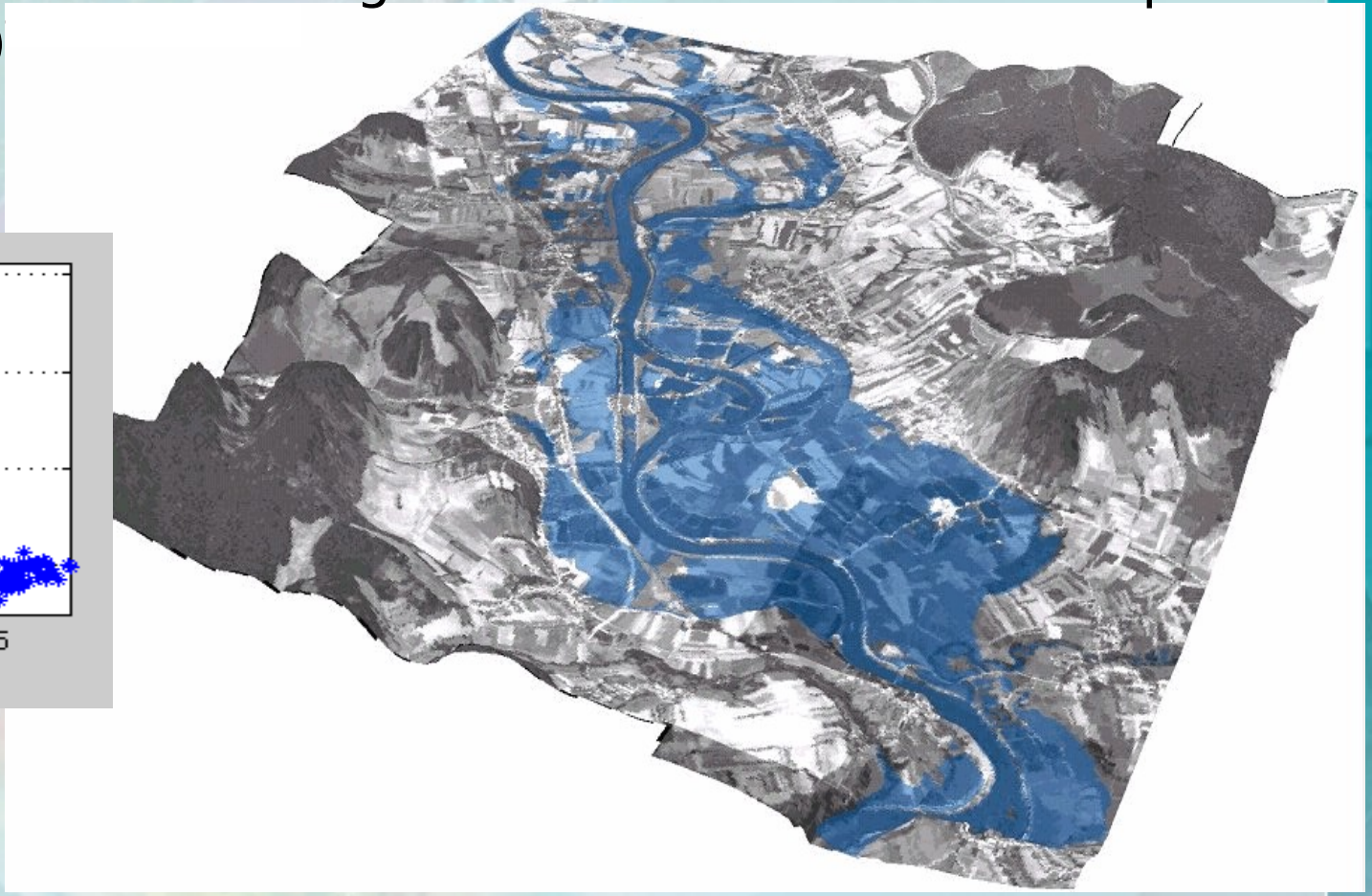
Influence of river width on radar altimetry accuracy

- Lower accuracy at low river stage is related to the area of open water (river width)





- Statistical analysis is under way to correlate accuracy and river width

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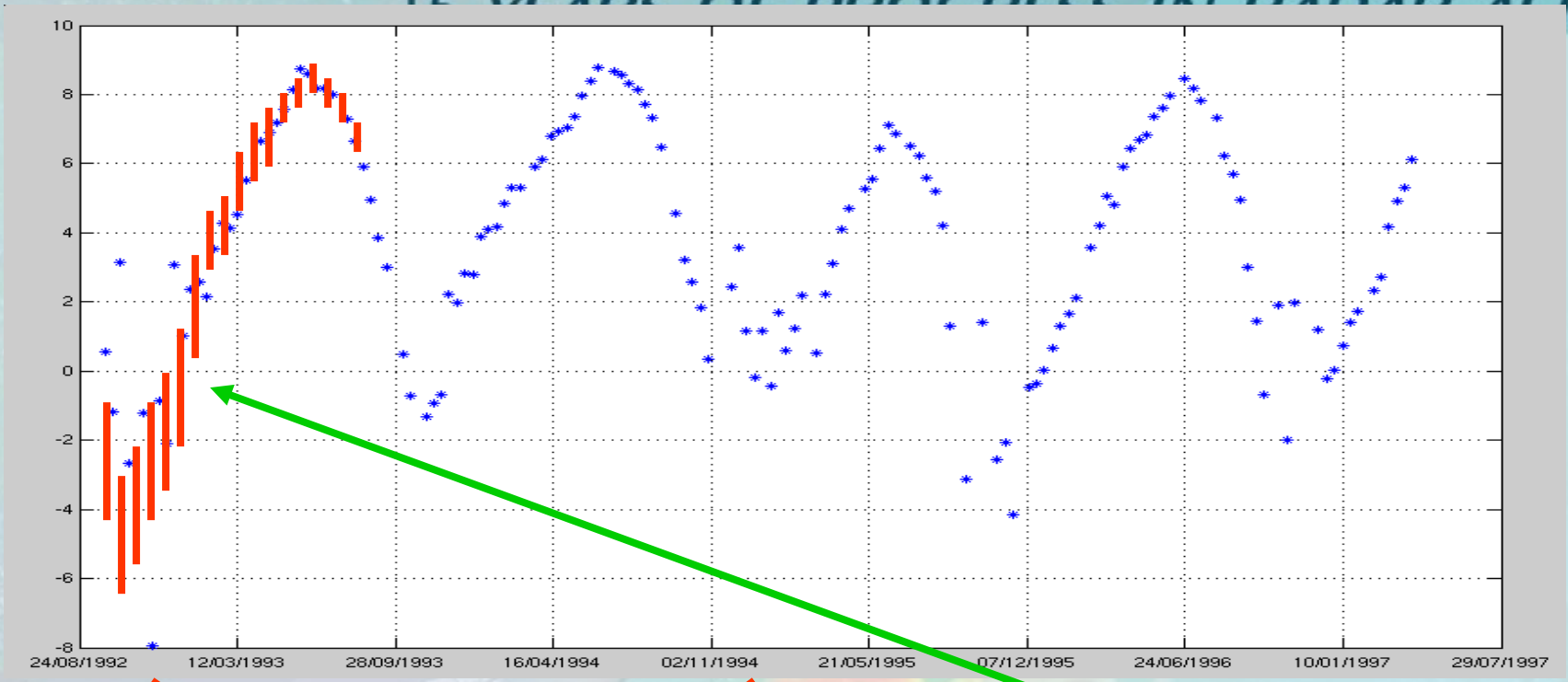

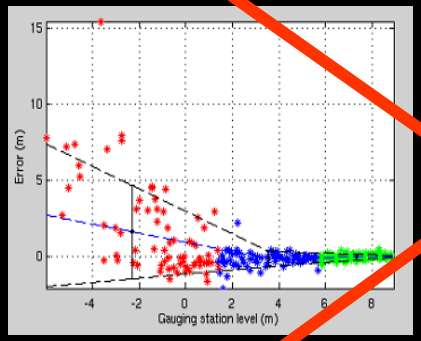

Accuracy of Topex Poseidon on Solimões river (track 63)

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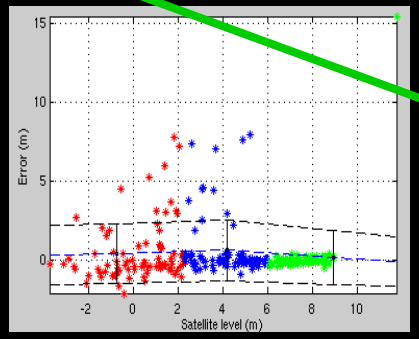

Uncertainty of Topex Poseidon on Solimões river (track 63)

(m)	Zmin	Zmean	Zmax	RMS	Mean error		stand. dev.
Global	-3.75	1.01	11.76	1.88	0.44		1.83
High flow	6.10	8.93	11.76	**1.70**	0.21		1.70
Mean flow	2.27	4.18	6.10	**2.00**	0.65		1.90
Low flow	-3.75	-0.74	2.27	**1.92**	0.46		1.88

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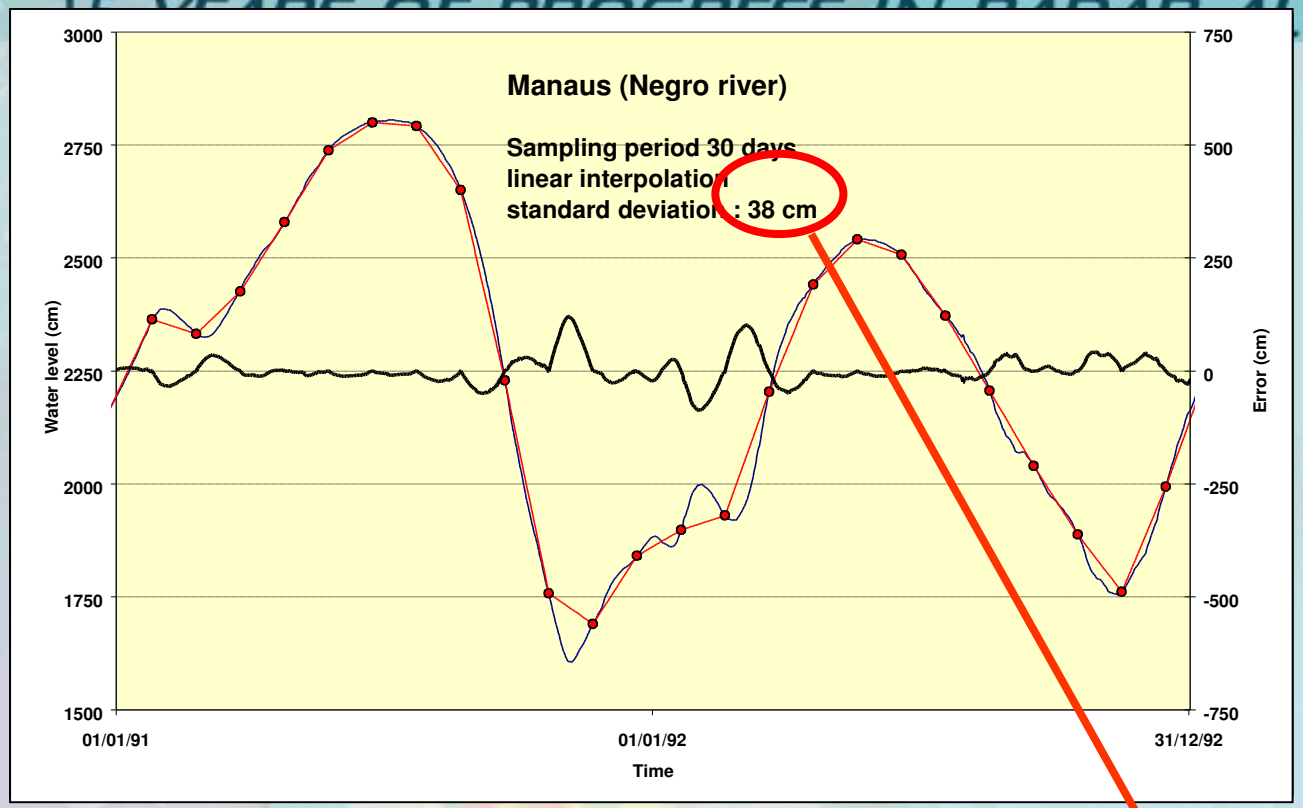
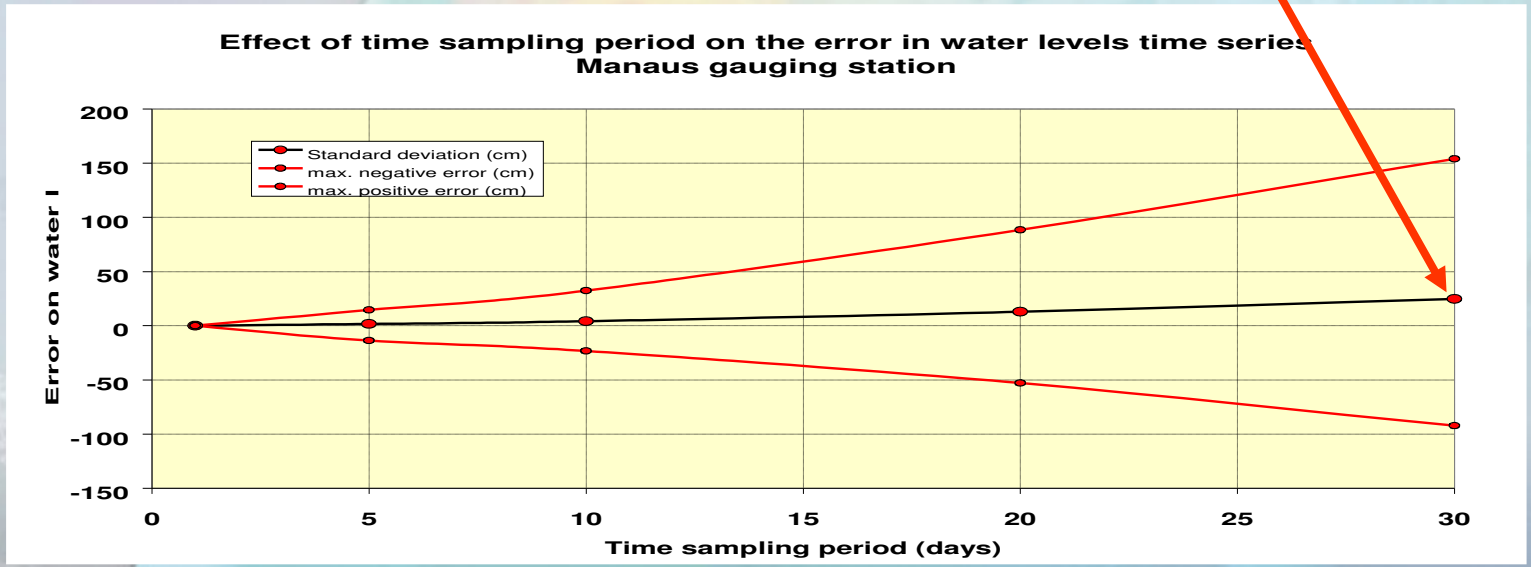
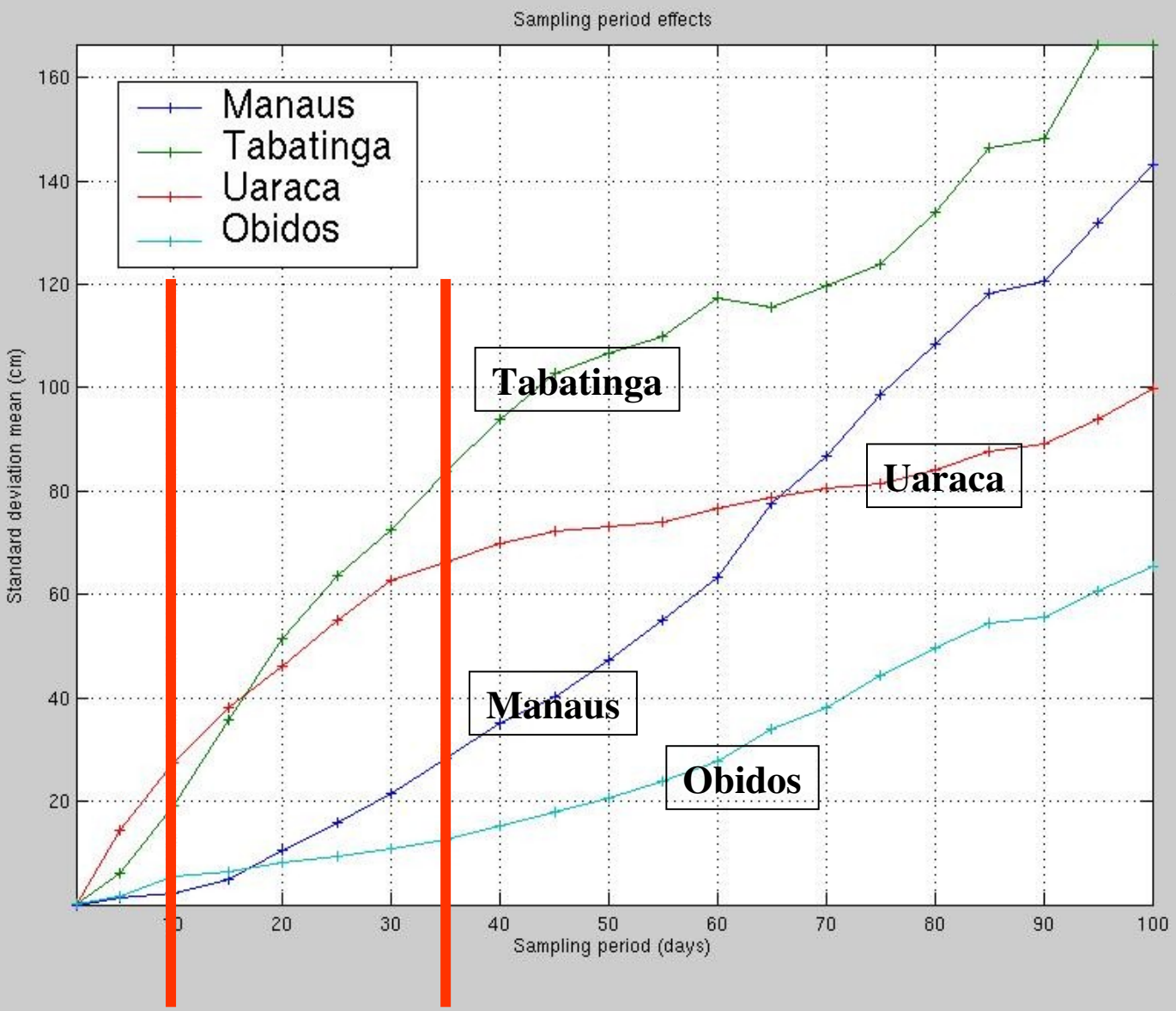
A.1 Effect of time sampling and sampling period

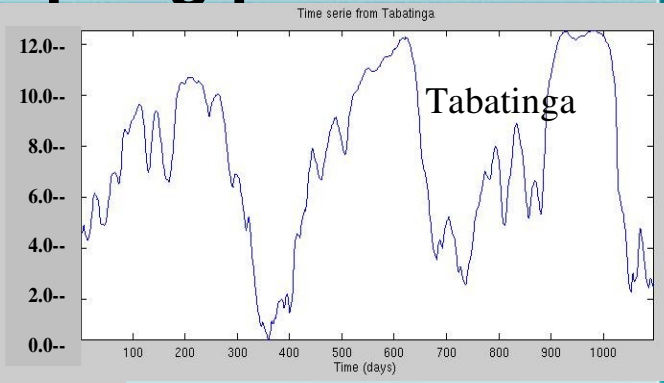


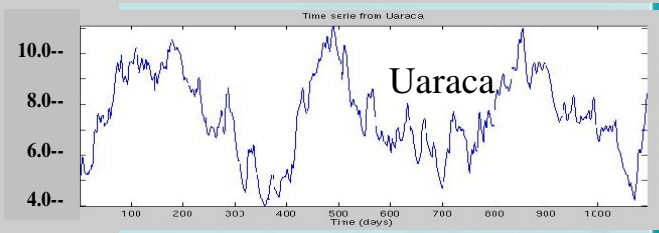


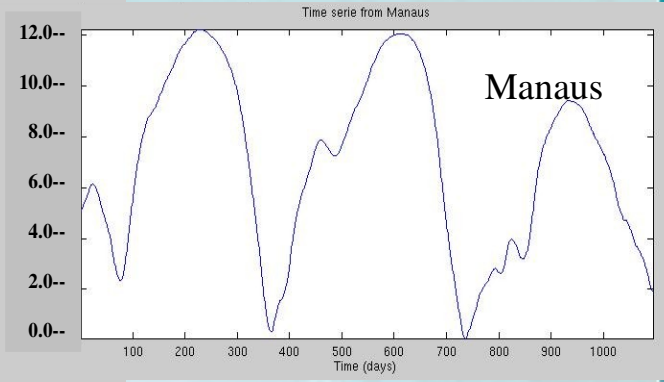
“Quality” of river water level time series derived from satellite radar altimetry

A.1 Effect of time sampling and sampling period



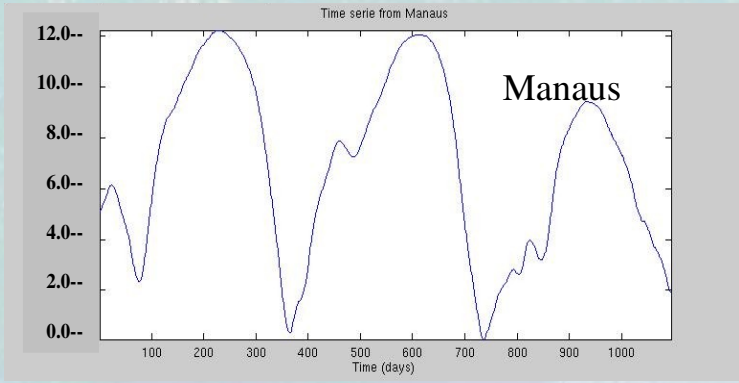


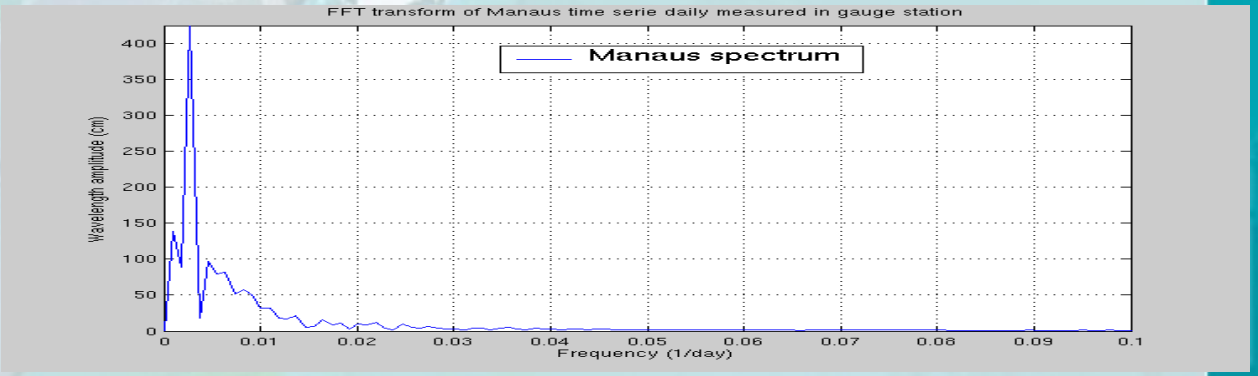


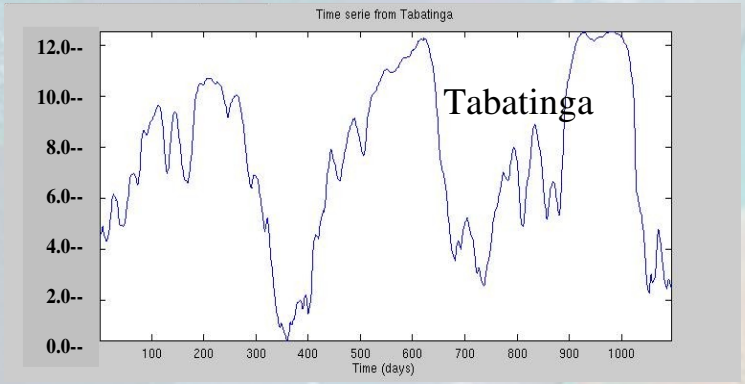


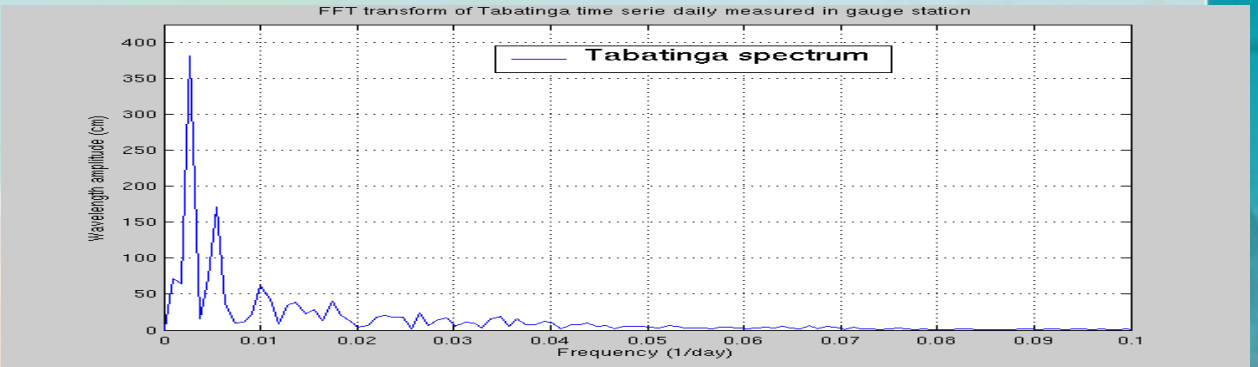
“Quality” of river water level time series derived from satellite radar altimetry

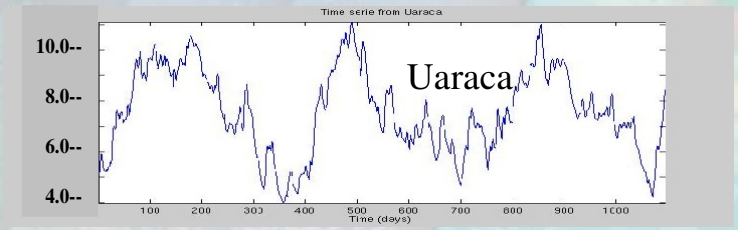
Spectral analysis of river water level time series

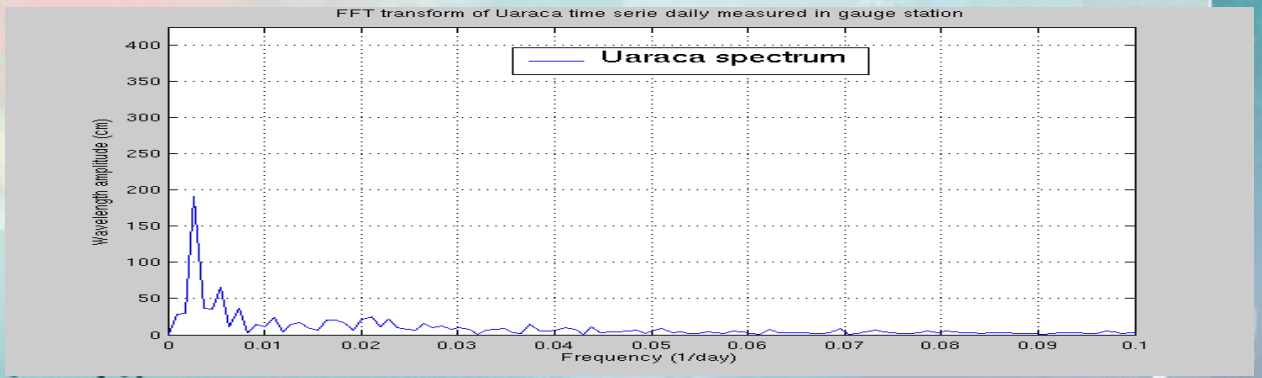








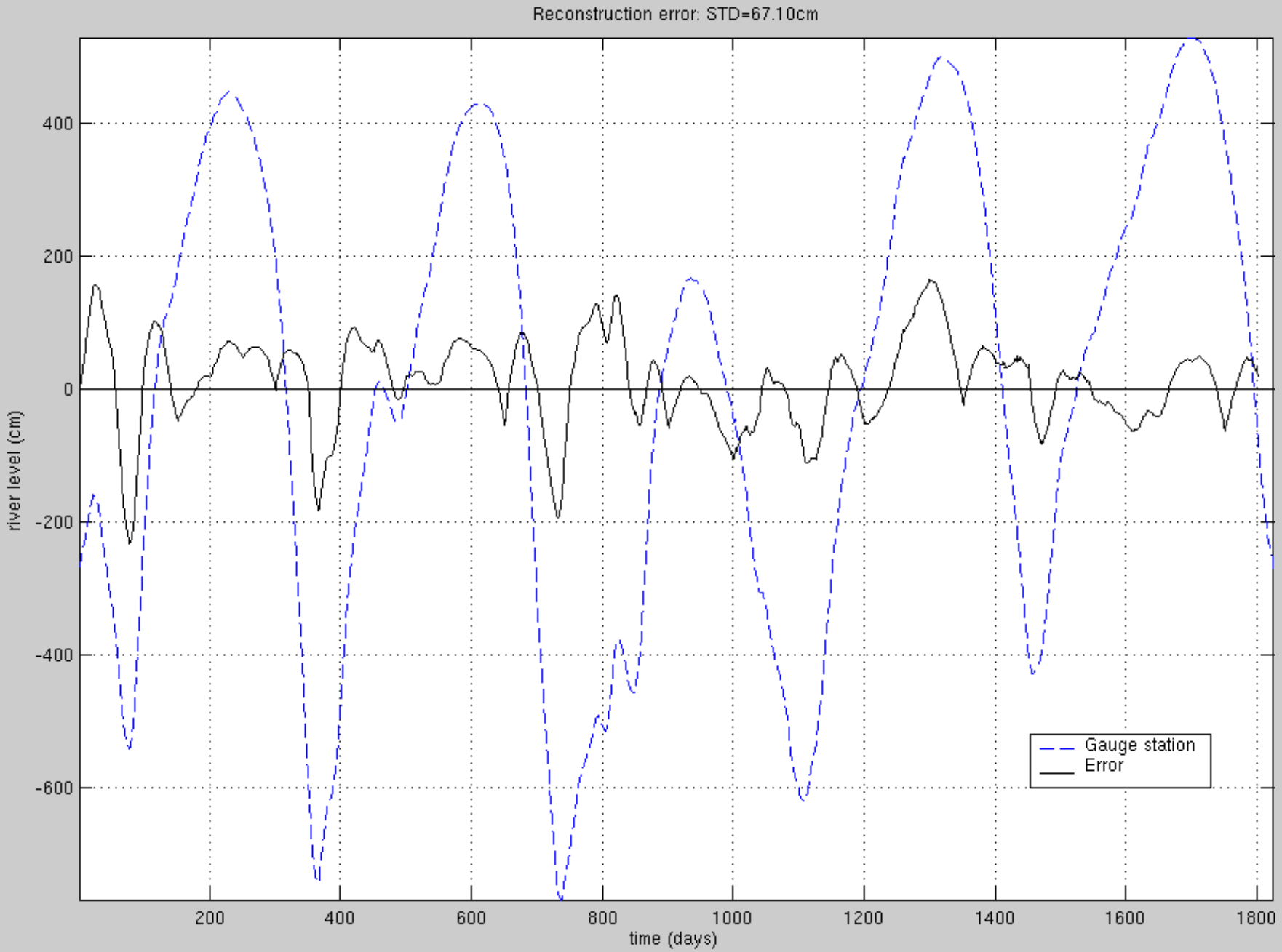




“Quality” of river water level time series derived from satellite radar altimetry

- **Introduction:**
  - Expectations by hydrologists
  - Building time series of water levels from satellite radar altimetry
- **“Quality” of sampled measurements (*accuracy + effective sampling frequency*)**
  - Method for quantification of the “Quality” : accuracy and effective sampling period
  - Influence of river width
  - “ex ante” quantification of the accuracy
- **“Accuracy” of reconstructed river water level time series**
  - Oversampling : building a “continuous” time series from satellite sampling
  - Coupled influence of measurement accuracy and effective sampling frequency and influence of river hydrology
  - Method for characterization of the quality of oversampled time series (reconstructed daily time series)

“Quality” of river water level time series derived from satellite radar altimetry

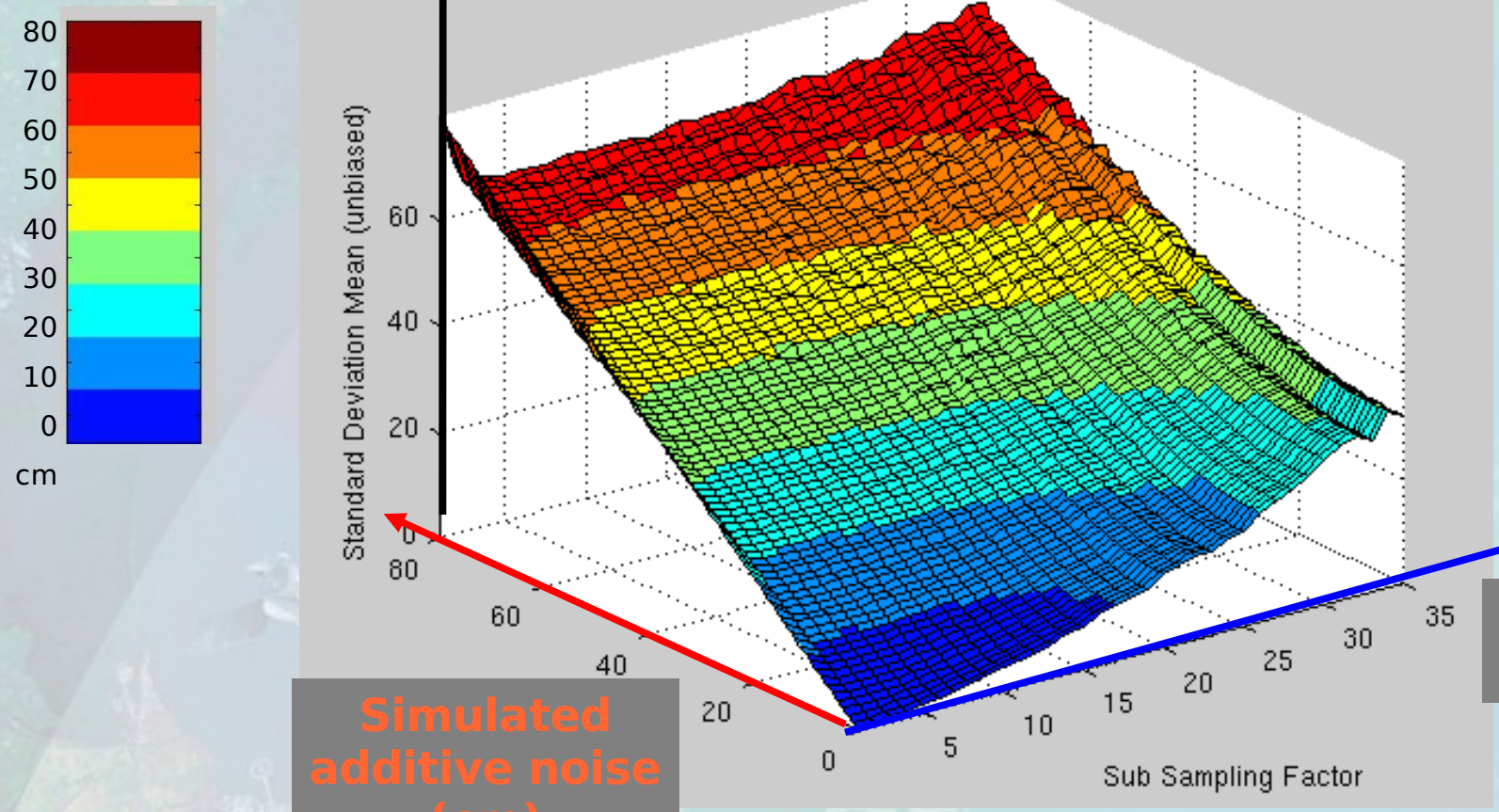


"Quality" of river water level time series derived from satellite radar altimetry

Coupled influence of measurement accuracy and effective sampling frequency

Coupled effects:

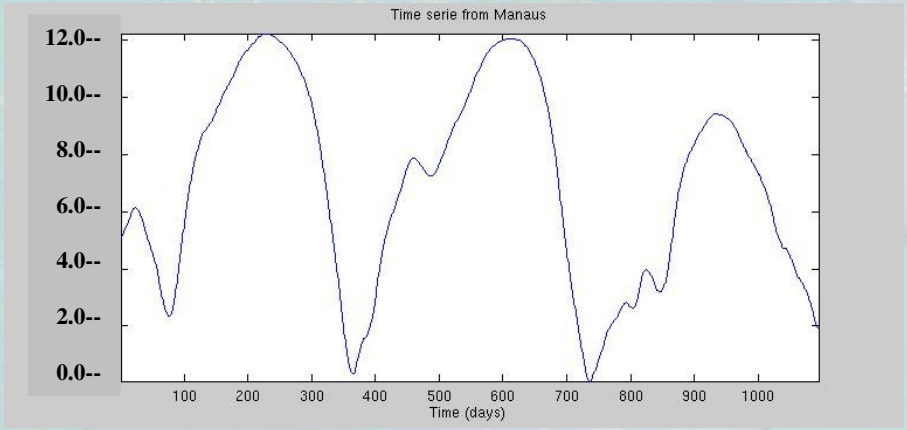
RMS error (cm)



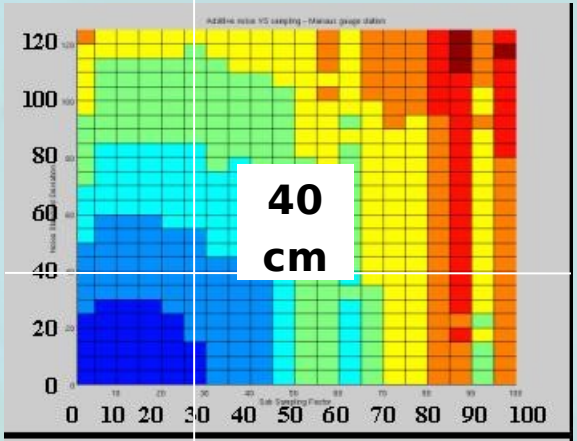
Simulated additive noise (cm)

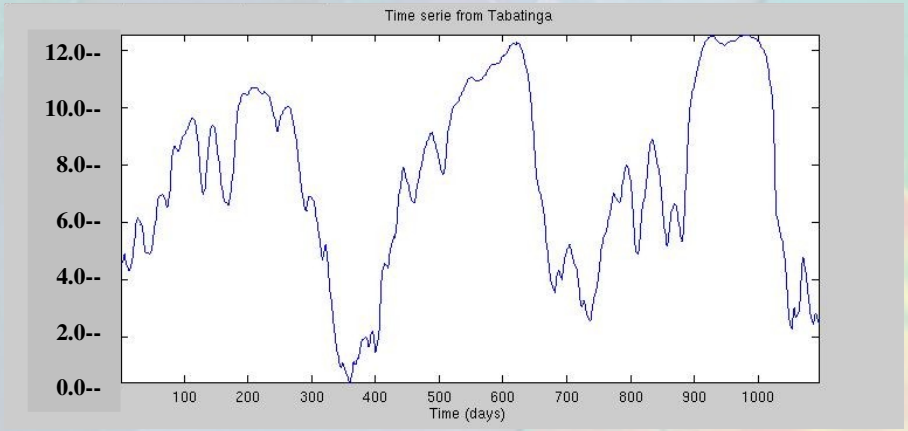
Sampling rate (days)

“Quality” of river water level time series derived from satellite radar altimetry

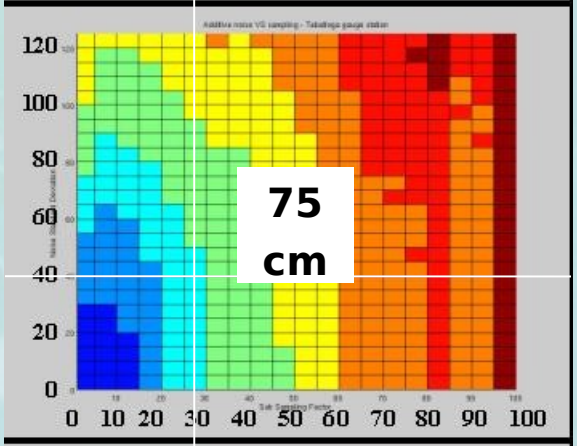


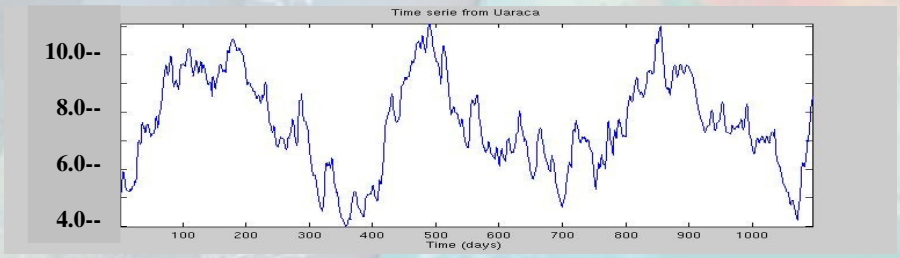
Manaus



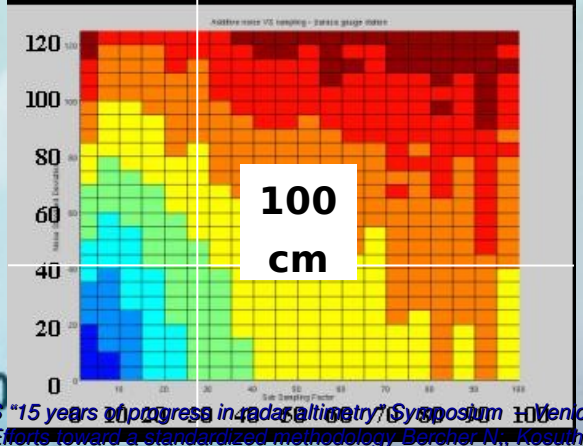


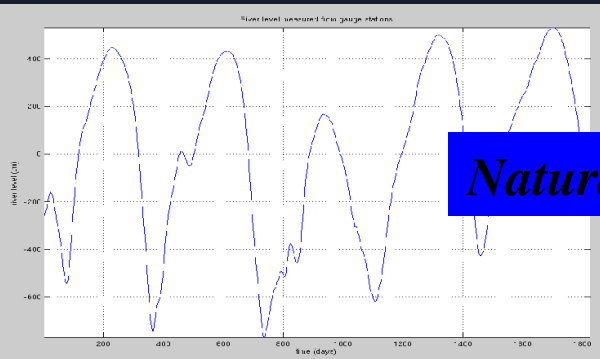
Tabating a



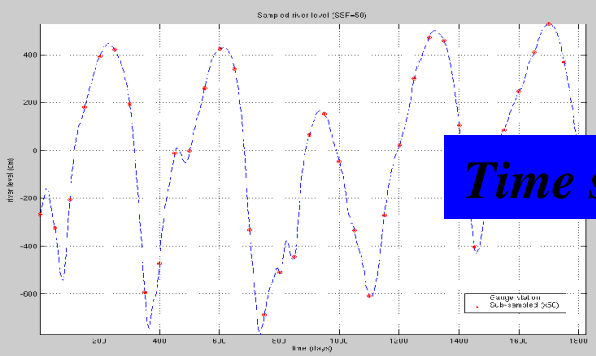


Uaraca

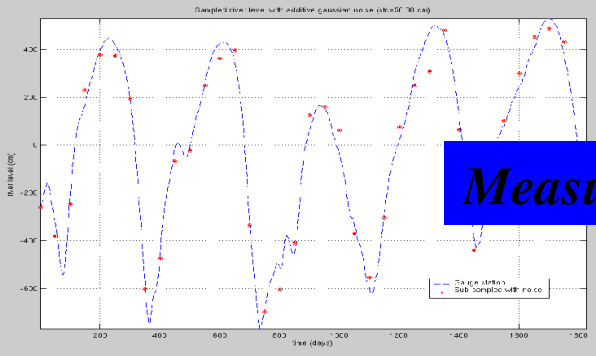




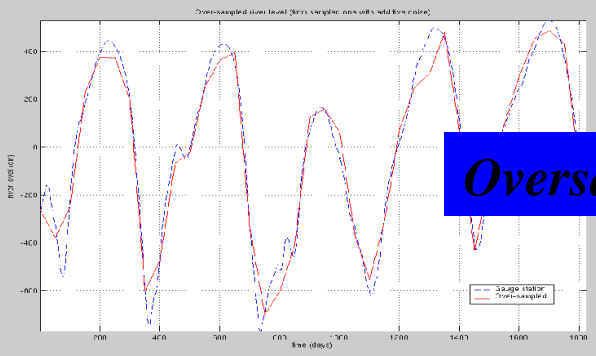
Natural hydrological signal



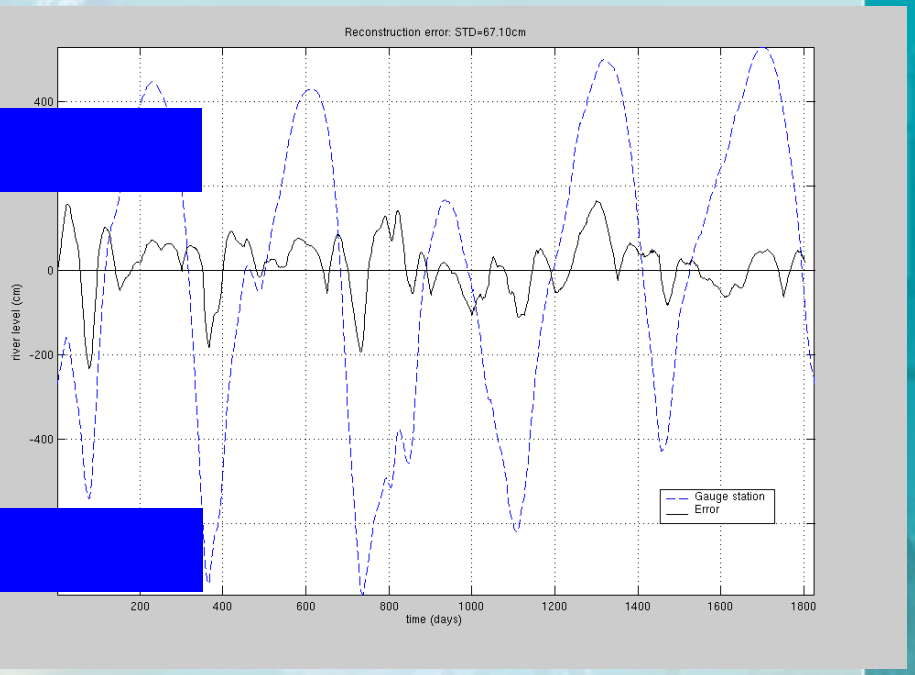
Time sampling period



Measurement Accuracy



Oversampling (interpolation) method



Quality of the river water level time series from Satellite radar altimetry depends on 4 elements

"Quality" of river water level time series derived from satellite radar altimetry

- **Introduction:**
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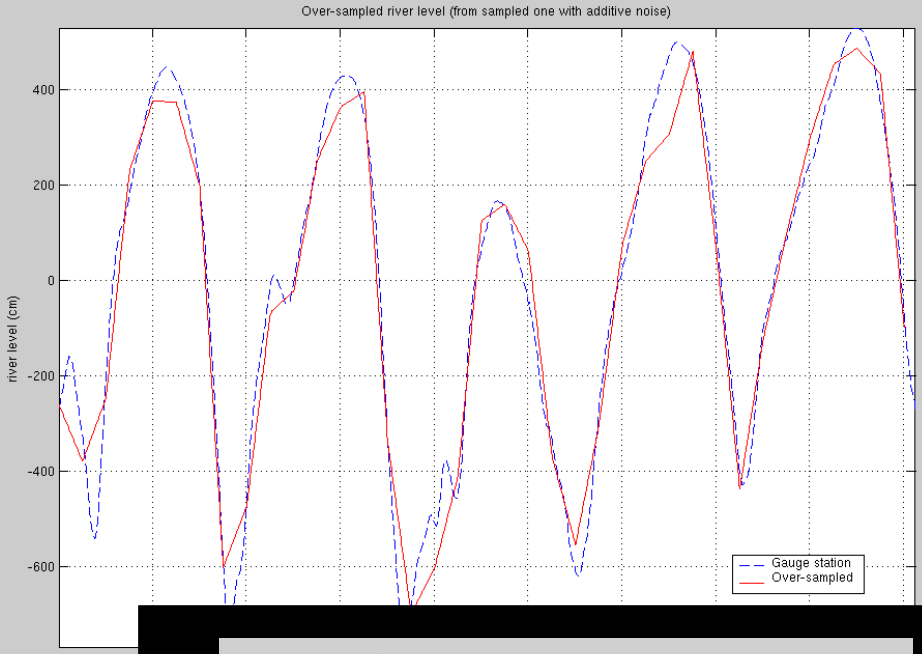
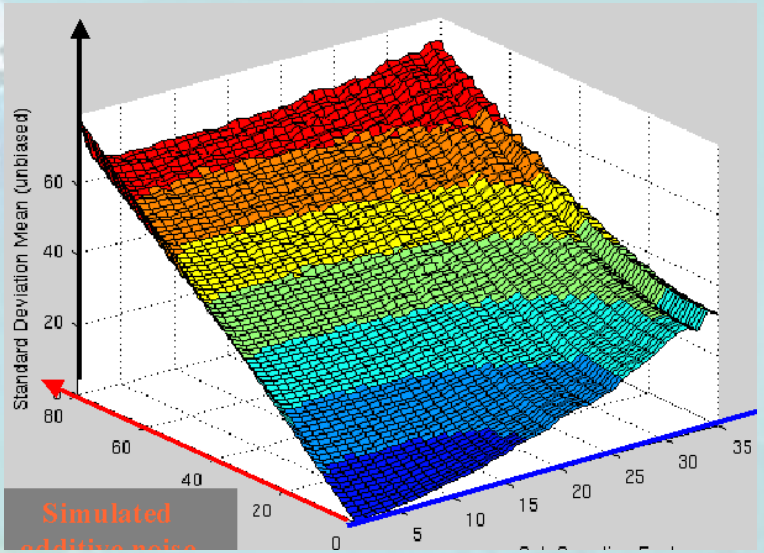
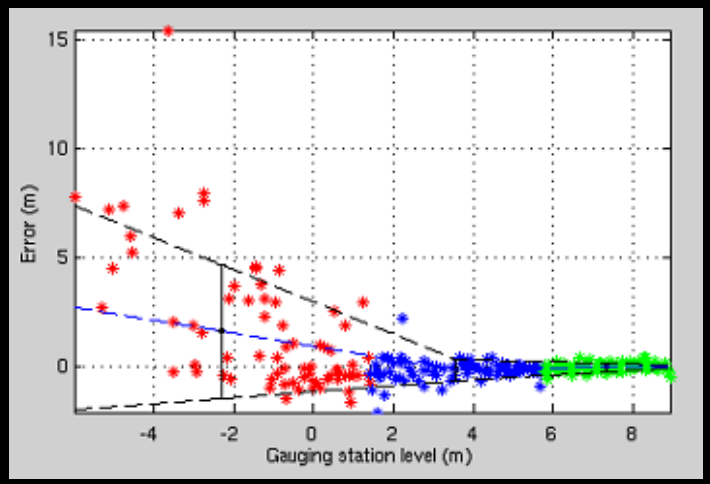
“Quality” of river water level time series derived from satellite radar altimetry

Method for characterization of the quality of oversampled time series







Accuracy of Topex Poseidon on Solimões river (track 63)							
(m)	Zmin	Zmean	Zmax	RMS	Mean error		stand. dev.
Global	*-6.00*	*1.47*	*8.93*	**1.88**	0.44	+/-	1.83
High flow	*5.76*	*7.35*	*8.93*	**0.20**	0.00	+/-	0.20
Mean flow	*1.43*	*3.59*	*5.76*	**0.50**	-0.12	+/-	0.49
Low flow	*-6.00*	*-2.30*	*1.43*	**3.42**	1.63	+/-	3.03

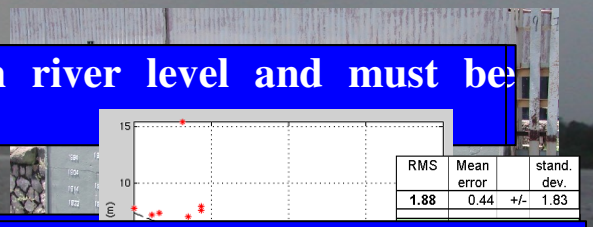
“Quality” of river water level time series derived from satellite radar altimetry

Conclusions & Future

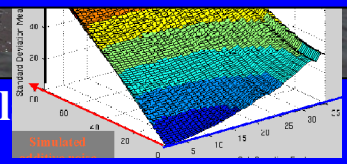
1. **Dispersion** of satellite measurements **is not an estimate of the error** of these measurements

2. ~~(Satellite K + retracking Algorithm V) measures (river R on section S) with an accuracy of XXcm~~
   The error cannot be represented by a single number (rms)

3. **Error is not gaussian.** **It is structured** in relation with river level and must be represented by a variable error mean and standard deviation



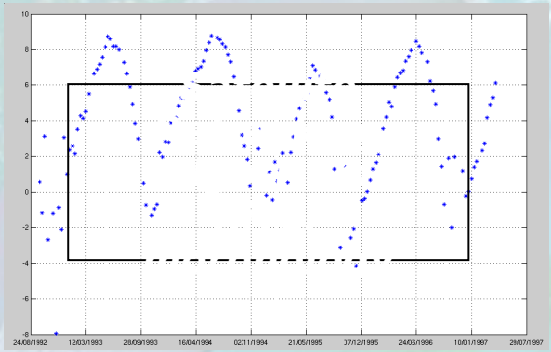
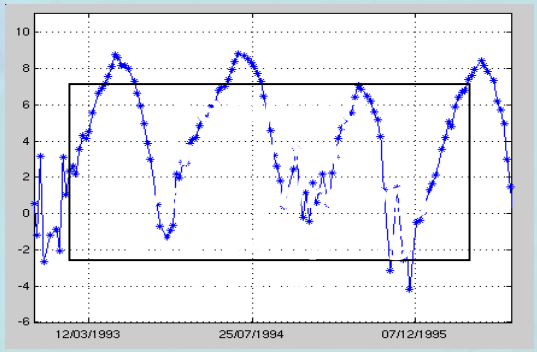
1. Both **effective sampling frequency** and **accuracy** of satellite measurement influence the accuracy of reconstructed daily time series .



5. A method is available for characterization of the quality of water level from radar altimetry.
   It can be applied :
   - To quantify the uncertainty of near real time radar altimetry data
   - To compare the accuracy of various retracking algorithms
   - To identify the impact of factors such as : river width, river hydrology, …

“Quality” of river water level time series derived from satellite radar altimetry

Methods to characterize the Quality

	Quality of Satellite data	Accuracy of reconstructed time series
		
Access to all in situ data	**operational**	**operational**
Access only to past in situ data	**operational**	**operational**
Access to no in situ data	**Statistical approach**	**Statistical approach**