ALTIMETRY BIASES IN THE AMAZON BASIN : THE CONCERN OF RETRACKING ALGORITHMS FOR NON-OCEANIC CALVAL SITES (PART OF THE FOAM/TOSCA PROJECT)

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Abstract :

Altimetry is now widely used in the computation of water level time series in the major hydrological basins. Combining the series obtained from different missions is a major concern when dealing with long term, climatic records of the water level in these basins, and consequently, long term records of the continent/ocean exchanges. Such a combination requires that the bias specific to each mission is known. in the case of continental waters, the biases mostly come from the retracking algorithm selected to compute the water levels. In the frame of the TOSCA/FOAM project, we levelled > 30 gauges in the Amazon basin by means of GPS campaigns (both in static and cinematic modes), to build up a reference of daily absolute levels throughtout the basin. Comparing altimetry-derived time series of water level with the aforementionned reference, we determined the mean biases of the ENVISAT and Jason-2 missions, in the specific case of ICE-1 retracking algorithm, and ICE-3 (PISTACH project) for Jason 2.

Motivation:

Knowing the altimetry bias of the various altimetry datasets (i. e. missions and tracking algorithms) is of major importance 1- to enable putting together series coming from various datasets and 2- to enable the computation of slope of the water line. However, the large spread of the errors in the altimetry measurements of the river levels makes that the standard procedures developped for the oceanic domain and based on a limited number of ground experiments cannot be applied to determine the altimetry bias over rivers. Therefore, we have developped an alternative method, based on the analysis of a large number of cases. Besides, it is worth noting that errors in altimetry measurements over rivers rely mostly on the range determination, parameter which is very little assessed in oceanic calibrations.

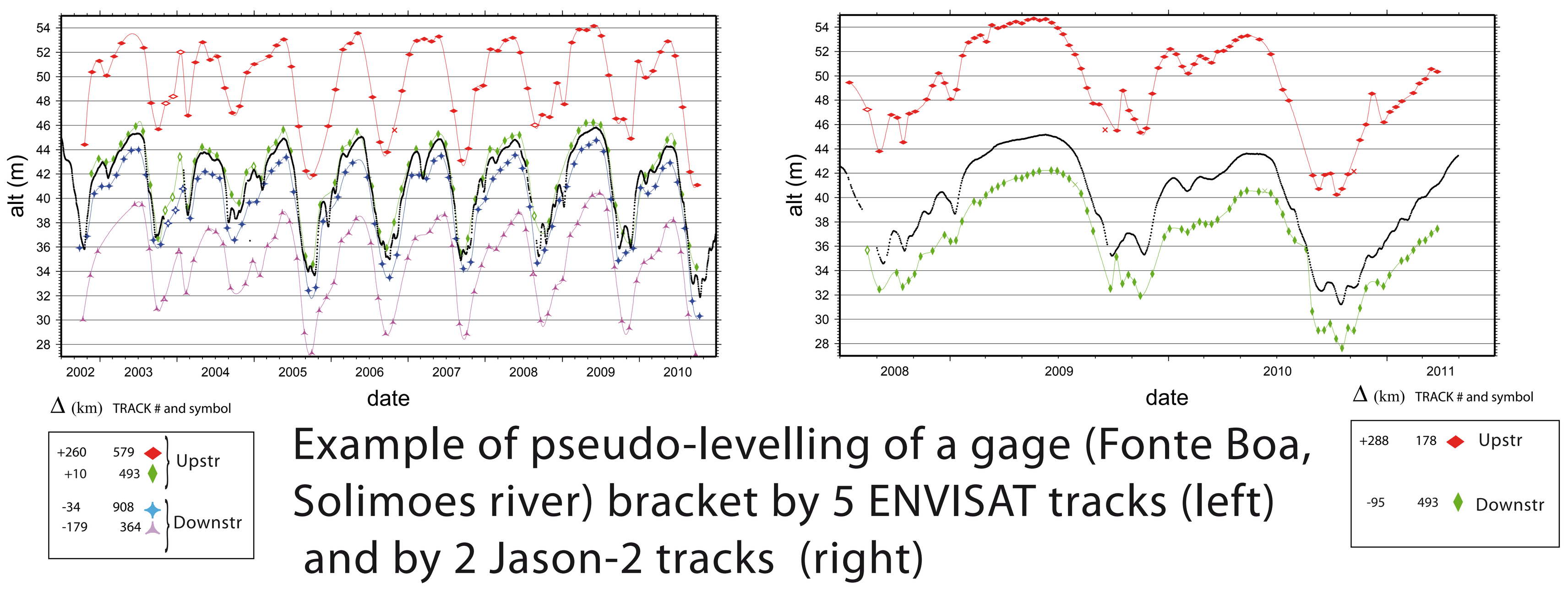
Method

The method developped to compare water levels derived from satellite altimetry (called hereafter virtual stations, SV) with ground truth heights is :

- We levelled the gauges by GPS
- We computed the altimetry time series by means of VALS (homemade sofware developped to process altimetry data for hydrology)
- We solve the system in b (bias), and slope model {u,v,w,ω,ϕ} made of the following observation equations of pseudo-levelling for each altimetric measurement:

$$b = A(t_i) - (R(t_i) + N_0 + \Delta_i\,[u + v \sin(\omega t + \phi) + w\Delta_i] \qquad \text{Eq. 1}$$

with $A(t_i)$ the altimetry height at date t ,
$R(t_i)$ the gage reading at the same date
N_0 the GPS level of the gauge zero
Δ_i the signed distance between the gage and the ith measurement (opposed sign whether the altimetry series is upstream or downstream the gauge).
Distances were digitized on JERS SAR images posted on GoogleEarth



Example of pseudo-levelling of a gage (Fonte Boa, Solimoes river) bracket by 5 ENVISAT tracks (left) and by 2 Jason-2 tracks (right)

In the example shown above, the difference in absolute gage heights is due to the difference in the gage zero resulting from different altimetry bias between ENVISAT (*ice-1*) and Jason-2 (*ice-3*)

Results :

We performed the fit for 36 gages, and discarded 5 of them because of the presence of falls in the reach.

The mean bias for ENVISAT, with retracker *ice-1* is : **1.04 ± 0.21 m**

The mean bias for Jason-2, with retracker *ice-1* (GDR's) is **0.64 ±0.33 m**

The mean bias for Jason-2, with retracker *ice-3* (PISTASH's) is **0.58 ± 0.34 m**

Direct comparison of the Jason-2 series obtained with the *ice-1* and *ice-3* retrackers (77 pairs) result in a relative bias of : **0.052 ±0.12 m**

This value is consistent with the difference between the two separate biases aforementionned.

Together with the first value of the biases for the rivers, of primary interest for hydrology, this study shows that these biases vary with the mission (ENVISAT vs Jason-2) and with the retracking algorithm *(ice-1* vs *ice-3*), and that values significantly different from oceanic ones are evidenced.

The large dispersion found around the mean value of the different biases is problematic, suggesting that the bias is not actually constant. First, this large spread around a mean value may be a limitation of the method. The method requires that a model of spacial and temporal variations of the slope is defined. As shown in Eq-1, we assumed linear variations of the slope along strike the reach and temporal oscillations. Really might be more complex, in particular when the reaches were several hundreds of km long.

Second, the backscattering environnement of the SVs may contribute to the variation in altimetry bias. If the error made by the ICE/OCOG algorithms in retrieving the two-way travel time in the echo waveform is related to the shape of the echo, it is likely rather constant for a given SV but may vary significantly from one SV to another one. Besides, it is worth noting that the dispersions are of the same order of magnitude than the differences between altimetry and gauge series. This suggests that the dispersion in the bias values is also partly due to the error in the series themselves (unfortunately, this remark includes the gauge series...).

For this work, we **levelled 35 gauges** within the Amazon basin, along the Solimoes-Amazon, Madeira and Negro rivers (including the Branco and Uaupes tributaries of the Negro river). The table is available on request to Daniel Moreira at: **daniel.moreira@cprm.gov.br**

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