Comparing Sea Level Time Series from Altimetry and Brazilian Tide Gauges

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Objectives

Both, tide gauges and altimeter satellites observe the sea level – pointwise and along profiles respectively. Comparison of the sea level time series from tide gauges and altimetry helps:

- to improve the knowledge of global and regional sea level rise,
- to connect and unify national height systems, and
- to evaluate the long term stability of altimeter sensors.

The relative comparison, performed with the hourly registrations of two Brazilian tide gauges (Ilha Fiscal and Cananéia) is based on a reorganization of Topex-Poseidon altimeter data and a new differential ocean tide correction.

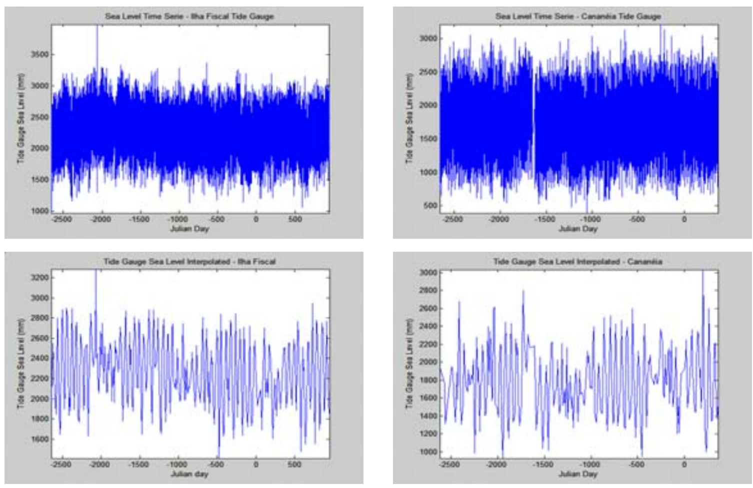

Figure 2

Tide Gauge Data

The tide gauge hourly registrations (Figure 2 upper panel) were resampled to the same epoch of the altimeter events by cubic interpolation (Figure 2 lower panel). The original hourly values have a linear trend of -14 mm/year at Ilha Fiscal and 0.2 mm/year at Cananéia.

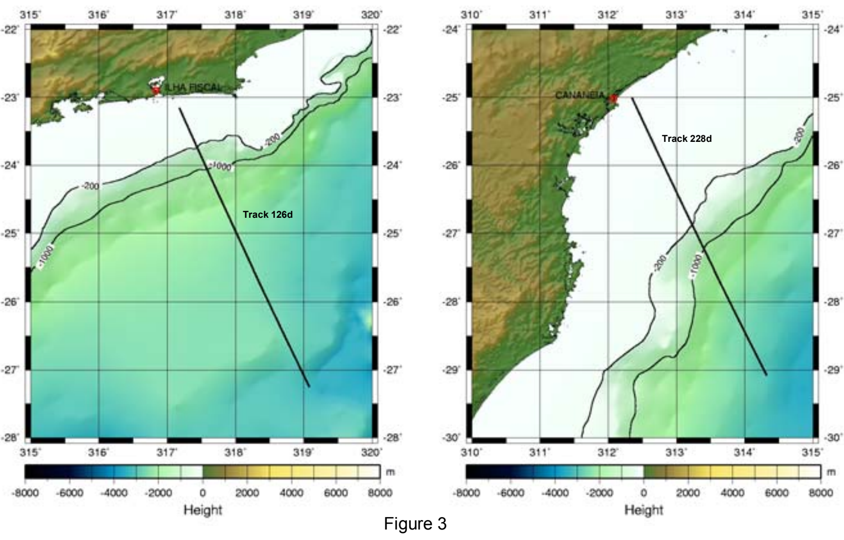

Figure 3

Reorganization of Altimeter Data

Figure 3 shows the Topex-Poseidon sub-satellite tracks located near the tide gauges of Ilha Fiscal (left side) and Cananéia (right side).

Sea Surface Height Anomalies (ssha) for Topex-Poseidon from the DGFI database were used. These ssha are related to small bins located along the track, convenient for performing time series analysis. The data spans a period of approximately 10 years, from September 1992 to August 2002 (cycles 1 to 364). Each bin is a few kilometers long in a way to have at least one altimetric measurement for each cycle. In this way it is possible to generate time series of ssha for all the bins used. For each track 71 bins were selected, their spatial distribution is shown in Figure 3.

As the tide gauge data have hourly sample rate and are not corrected for the inverse barometer effect, ocean tide and inverse barometer corrections were removed from the altimeter data.

Outlook

Precise geocentric positioning associated with leveling allows the link of the tide gauge zero point to a geocentric reference system, allowing an absolute comparison between altimetry and tide gauge time series.

Monitoring tide gauges by GPS positioning can give some information about possible vertical crustal movements allowing the separation between apparent and true sea level changes.

Using altimeter and additional tide gauges data may help to improve knowledge of sea level temporal evolution – in this case it is necessary to consider the spatial variability of the sea surface between tide gauges and satellite measurements.

Final Remarks

The application of the differential ocean tide correction improved the correlation coefficients and the standard deviation between the time series.

It is important to point out the high correlation achieved when using tide gauge hourly registrations.

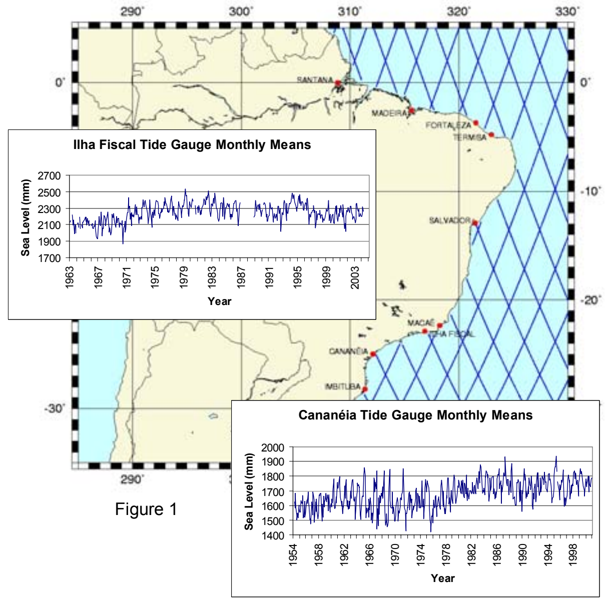

Figure 1

Tide Gauge Stations - Overview

Figure 1 shows a map with the location of some tide gauges stations in Brazil. Two tide gauges are of interest due to the long time series availability, coincident with the available period of the altimeter data and position related to the T/P tracks.

The tide gauge located at Ilha Fiscal (Rio de Janeiro) has continuous records since 1963 until July 2004 (except for a gap of 46 hours in 1994). The tide gauge located at Cananéia (São Paulo) has records since 1954 until December 2000, digital data since 2001 are not yet available.

For both tide gauges hourly sampling values, daily and monthly means are available at the UHSLC (University of Hawaii Sea Level Center) database.

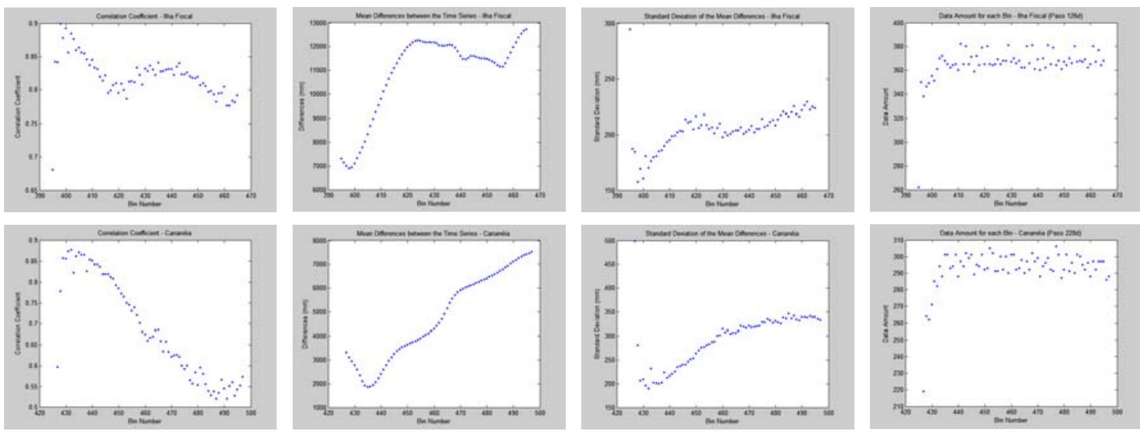

Figure 4

Preliminary Comparison – Altimetry and Tide Gauge

Figure 4 shows a preliminary comparison between the time series of altimetry and tide gauges (interpolated to the altimeter events) for each bin. The graphs show the correlation coefficient between the time series for each bin located along the sub-track, the mean difference between the series, the standard deviation of the mean differences and the number of data available for each bin. Upper panel results for Ilha Fiscal and lower panel for Cananéia.

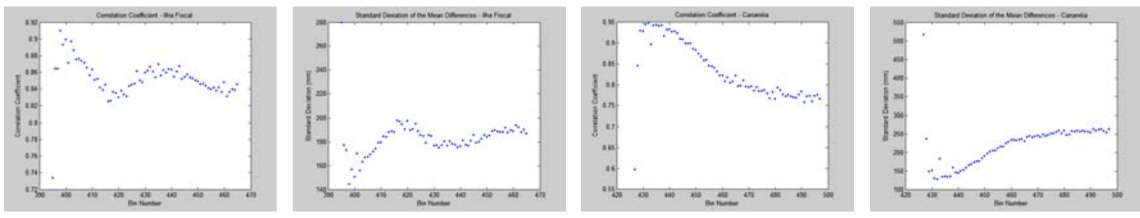

Figure 5

Differential Tide Correction

In order to account for local sea level variations, differential tide corrections were computed and applied to the altimeter data. The differential correction was derived by tidal analysis for both, the tide gauge registrations and the time series of ssha at every bin.

Tidal analysis was performed by the response method (Cartwright and Ray, 1990) which is well suited to separate individual tidal constituents (e.g. M_2 and S_2).

Figure 5 shows the results after applying the differential ocean tide correction. The values for correlation coefficient and standard deviation were improved.

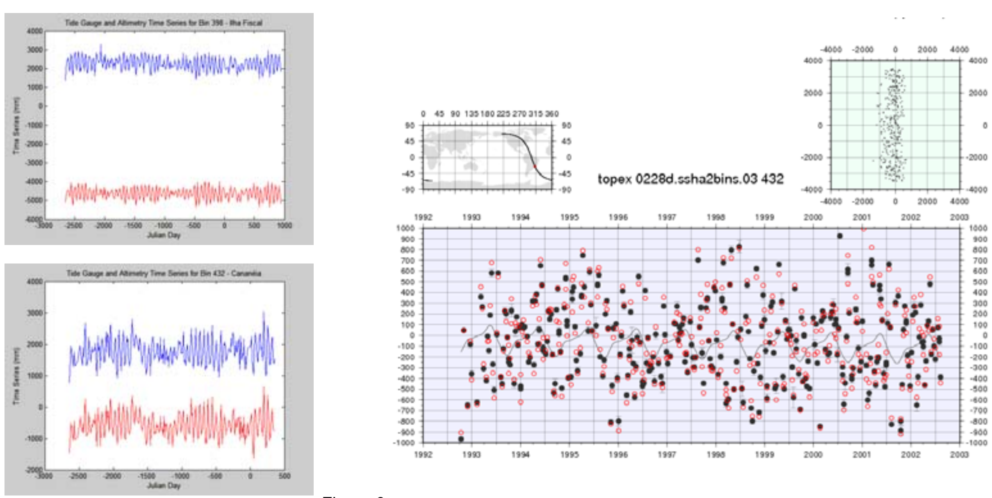

Figure 6

Figure 6 shows the bins with higher correlation between the time series of altimeter data and tide gauge registrations. For Bin 398 (Ilha Fiscal) the correlation coefficient is 0.91 and the standard deviation of the differences is 144.3 mm. For Bin 432 (Cananéia) the correlation coefficient is 0.95 and the standard deviation is 126.7 mm.