P. Exertier, P. Bonnefond, O. Laurain and F. Barlier
Observatoire de la Côte d'Azur - CERGA, Grasse, France
Pascal.Bonnefond@obs-azur.fr
Y. Ménard (CNES), E. Jeansou (NOVELTIS) and A. Orsoni (IGN)
Centre National d'Etudes Spatiales, Toulouse, France
B. Haines (JPL)
Pasadena, California, USA

Latest News from the Absolute Calibration Site in Corsica

Abstract

The double geodetic site in Corsica (Aspretto/Ajaccio-Senetosa) is used in an operational mode to calibrate the TOPEX/Poseidon altimeters. The main goal is to control the geodetic installations that have been performed since 1997 in view of Jason-1 mission.

Senetosa is located under the T/P ground track N° 85 and since 1998, three tide gauges have been installed and linked to ITRF 96 using GPS and leveling. Besides, Two GPS campaigns (1998 and 1999) have been performed to measure the marine geoid slope from the coast to 20 km off the Senetosa cape. In this area the geoid slope can reach 6 cm/km. During the last winter, the very big storms over Europe have destroyed one of the tide gauge site (M2). It has been displaced in a more protected area in June 2000 and two tide gauges (M4 and M5) have been installed at the new site, very close together (<30 cm), in order to better monitor data. These new tide gauges have been leveled relatively to a new GPS marker (G5).

T/P altimeters calibration has been performed from cycle 208 to 282 (GDR-M) in the framework which will be used for Jason-1; all parameters (orbit, corrections, …) are listed and discussed in the poster. Results for ALT-A, ALT-B and SSALT bias are presented and discussed. They are then very close to Harvest ones which make us very confident for using Corsica site for Jason-1 calibration.

Introduction

The double geodetic Corsica site (Aspretto-Senetosa, Plate 1) is dedicated to the absolute calibration experiment in the framework of the Jason-1 mission. While Aspretto (near Ajaccio) will be used to concentrate satellite tracking techniques (SLR, DORIS, GPS) to locally improve orbits, Senetosa permits the realization of the closure equation (tige gauges / altimeter). The particular contribution of Senetosa is to determine altimeter bias with 10 Hz altimetric data (GDR-Ms) from 20 km off-shore to the coast using only coastal tide gauges. For doing this, a local marine geoid has been determined using kinematic GPS (see "Leveling the Sea Surface using a GPS Catamaran" poster). Three permanent tide gauges (AANDERAA, Plate 1 and Photo 1) have been installed since may 1998 with a 5 min data sampling rate. In 2000, two of them have been displaced in a more protected area (M4/M5) and placed close together to better monitor tide gauges behavior. This redundancy allows the continuous determination of altimeter bias by limiting the impact of tide gauges period of outages or erroneous data. At the begining of this year a meteorological station has been installed near the light house.

The slight degradation of Side A and finally the use of Side B of ALT altimeter (since cycle 236) gives us the opportunity to check the Corsica site in the frame of linking altimetric missions. We first present the "1- Calibration Process" (method and corrections) and the "2- Impact of Environment Parameters" such as SWH and geoid slope. "4- Calibration Results" are then discussed. Finally, "4- Capraia side project" is presented.

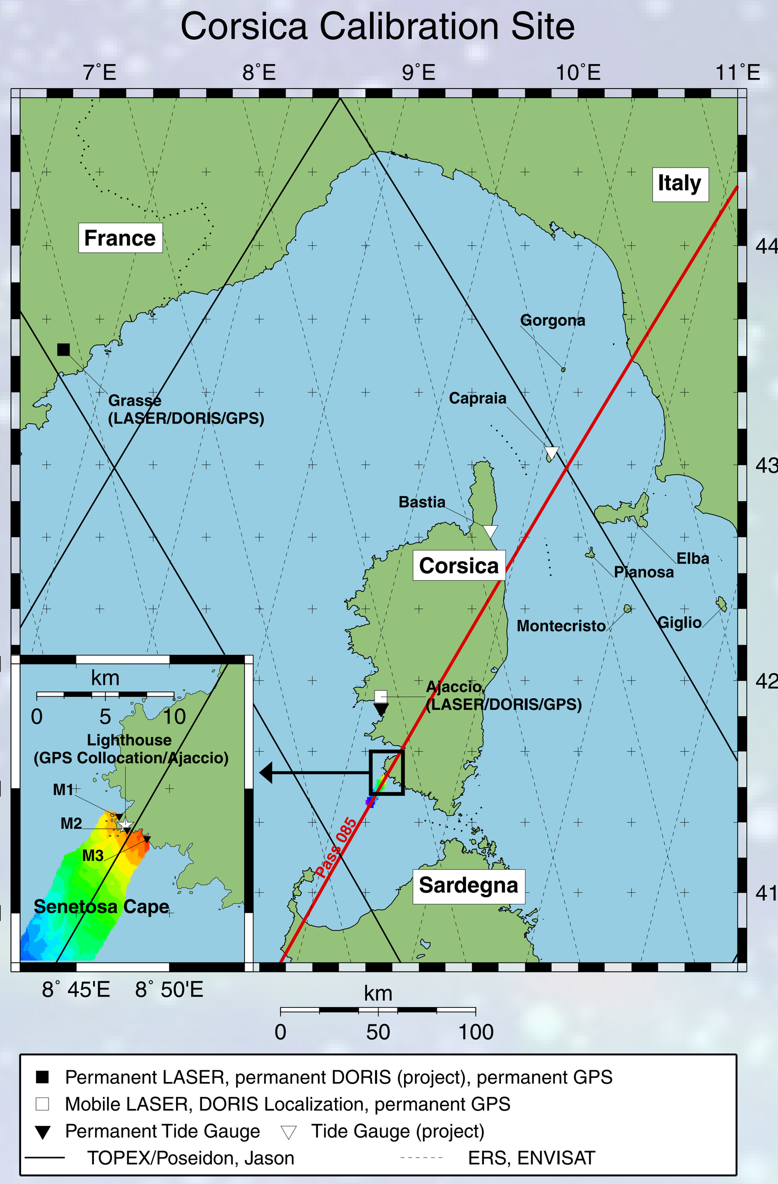


Plate 1. Configuration of the Corsica site.
Contour map represents the geoid heights determined from Catamaran GPS measurements.

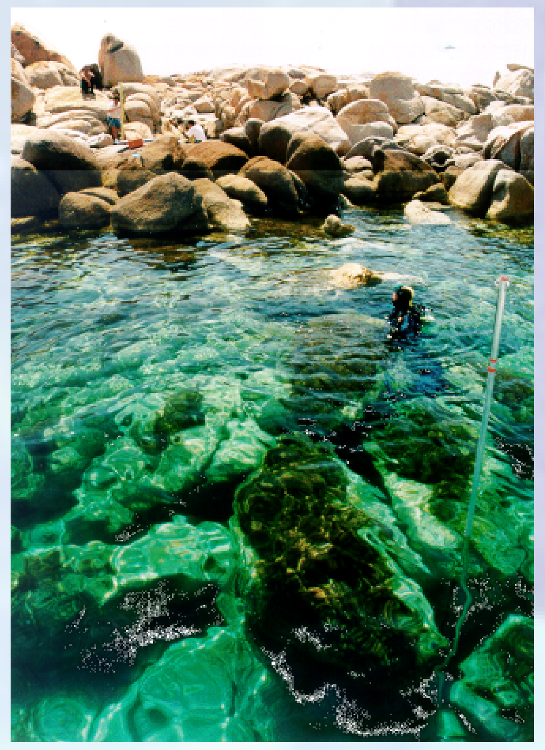


Photo 1. Tide gauge leveling at M3 location.

1- Calibration Process

Figure 1a illustrates the calibration process. In a first step, 10 Hz altimetric sea heights (upper panel) are corrected from geoid slope by computing the sea height differences from the altimetric data location to each tide gauge location (Figure 1a, 3 lower panels). At each altimetric data location, the mean geoid height is computed inside the footprint area (Figure 1a, left panel) which size is defined by the formula given in *Chelton et al.* (1989). At the tide gauges locations the geoid heights are constant and have been determined by the mean of GPS sea heights of the 99 Catamaran campaign.

In a second step, tide gauges data are linearly interpolated for each 10 Hz altimetric data time (Figure 1a, 3 lower panels). The mean values of sea height differences, and the associated standard deviations, are then computed ($H_{altimeter} - H_{tide\ gauges}$) for each tide gauge. This gives the estimated impact of altimeter range bias on the sea height determination. Altimeter bias is thus defined in the following as the difference between altimetric determination and "in-situ sea height".

The corrections used for altimetric sea heights determination are listed at the bottom of Figure 1a and an example of their time evolution on the overflight time scale (few seconds) is given in Figure 1b. They follow the recommandations of the AVISO handbook [*AVISO*, 1996] allowing users to use our bias determination in agreement with their sea level determination. NASA orbits have been used for this study.

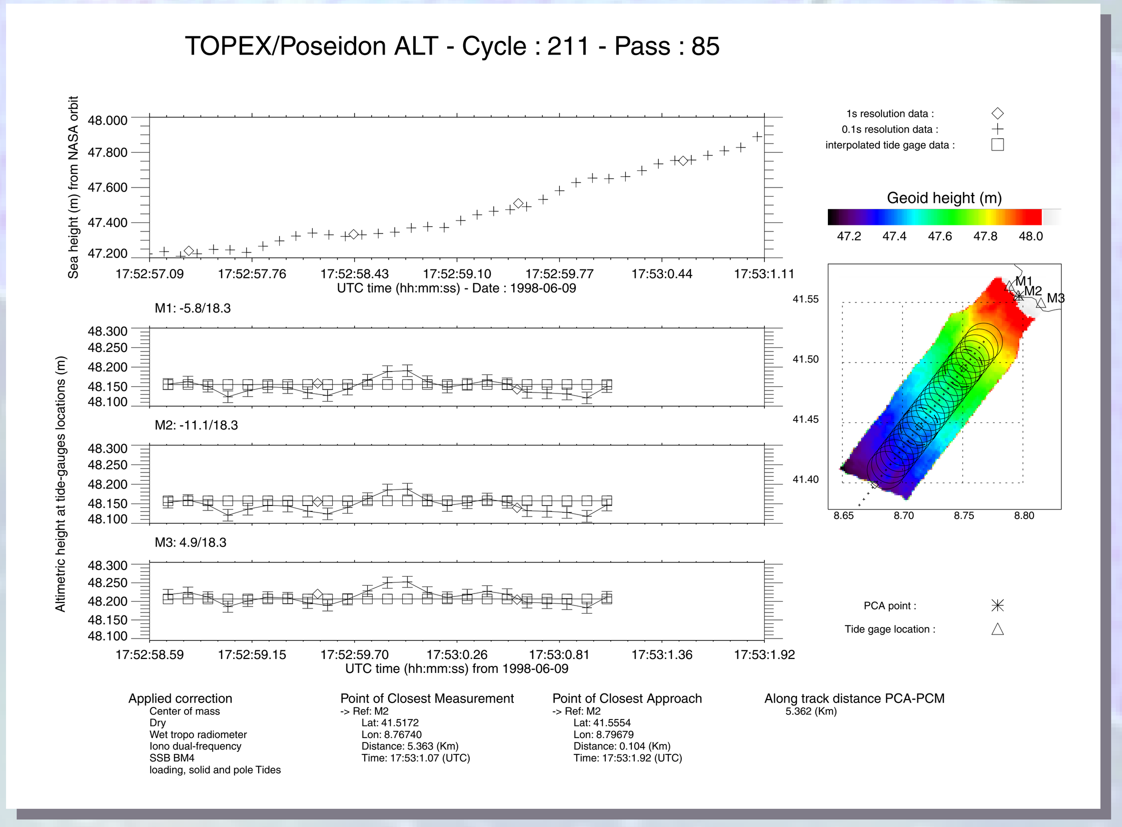


Figure 1a. Calibration process for cycle 211.

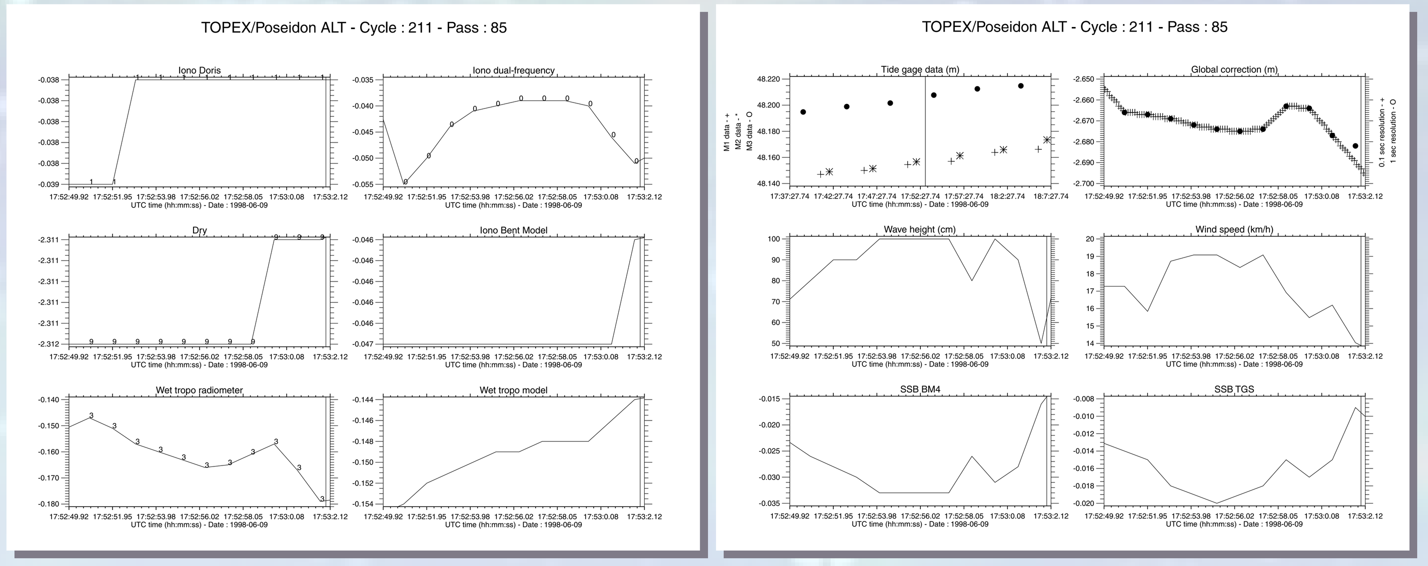


Figure 1b. Altimetric corrections for cycle 211.

2- Impact of Environmental Parameters

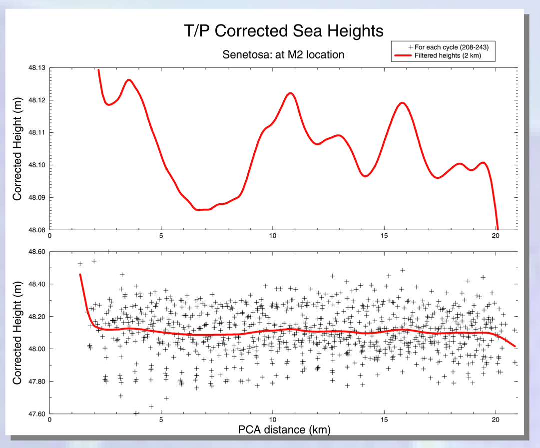
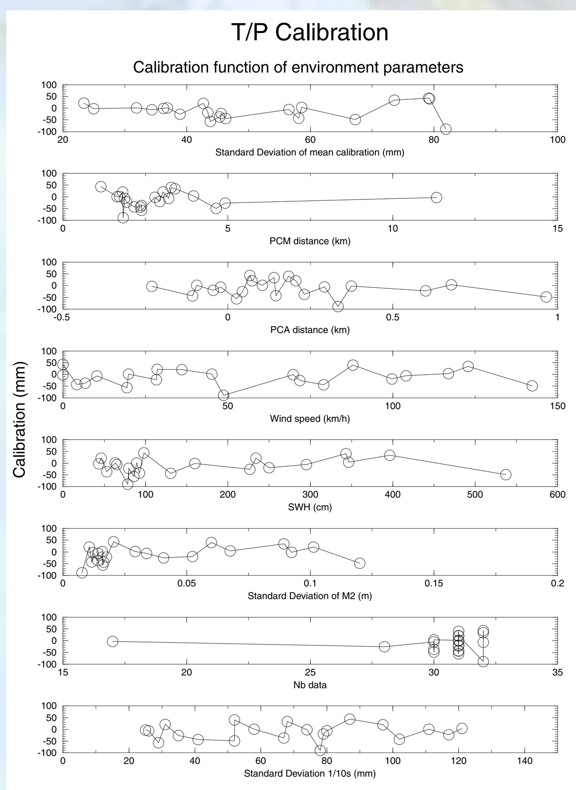


Figure 3. T/P Sea heights (1/10s) corrected from geoid slopes at tide gauge (M2) location.
- Red lines correspond to filtered heights using low-pass filter with 2 km cutof f.
- Upper panel is a zoom for filtered heights.

In this part we want to study the possible correlation with some parameters linked to the calibration process. Figures 2a and 2b give respectively the calibration value (bias) and its standard deviation as a function of (from top to bottom):
- Point of Closest Approach (PCA) distance (across-track, negative for west)
- Point of Closest Measurement (PCM) distance
- Wind Speed
- Significant Wave Height (SWH)
- Standard deviation of tide gauge measurements
- Number of 10 Hz altimetric data used
- Standard deviation of 10 Hz altimetric data.

No clear correlation have been evidenced except for very low wind speed (and then SWH, cycle 241). Tide gauges data dispersion and across track distance seems to have very low impacts. The standard deviation of bias determination seems to be mainly due to 10 Hz altimetric data precision (at least half part).
On the other hand, the geoid gradient determined during the 99 GPS Catamaran campaign seems to well represent what T/P altimeter "sees". Figure 3 shows the corrected sea surface heights profiles at M2 location as a function of along-track PCA distance. The observed signal which represents differences between geoid grid and mean T/P sea heights (over 1 year) have a standard deviation of 1 cm. The main part of the signal seems to be linked to coast vicinity, probably due to corrupted altimetric signal. This leads us to limit the altimeter data processing to those at more than 5 km along-track distance from PCA (see Figure 1a).



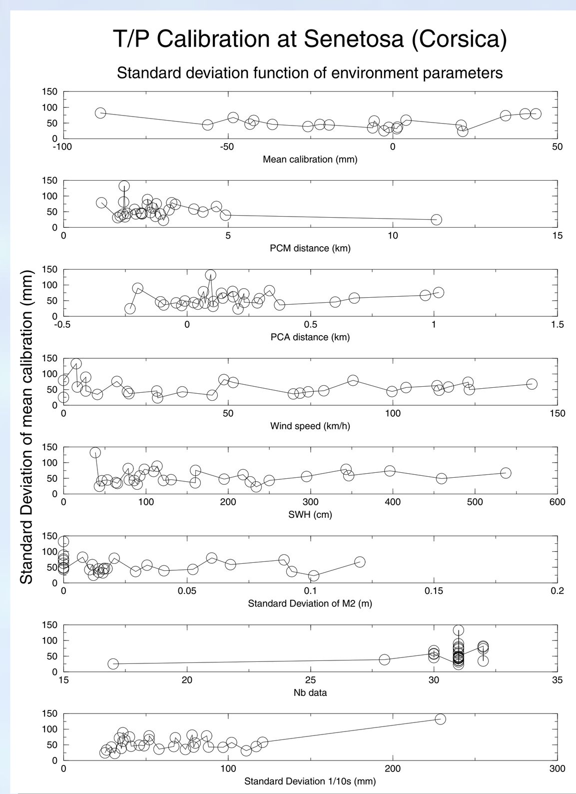


Figure 2. Calibration results as a function of parameters.
- (a, left) for Calibration (bias).
- (b, right) for Standard deviation of bias determination.

3- Calibration Results

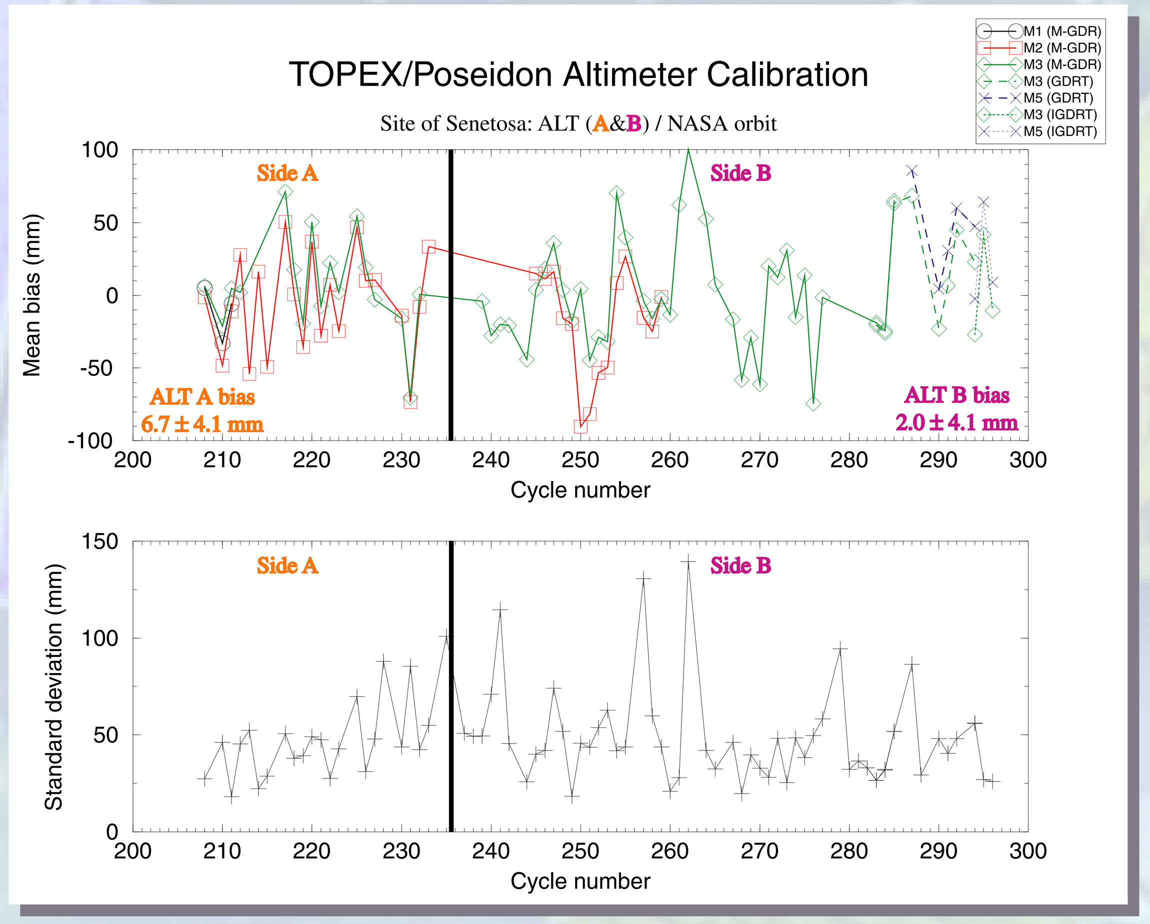


Figure 7. T/P ALT altimeter bias using NASA orbits for cycle 208 to 296.
- Upper panel shows the mean values per cycles for each tide gauge.
- Lower panel shows the standard deviation of corrected altimetric sea heights.
- M-GDR from Aviso. GDRT and IGDRT from PODAAC.

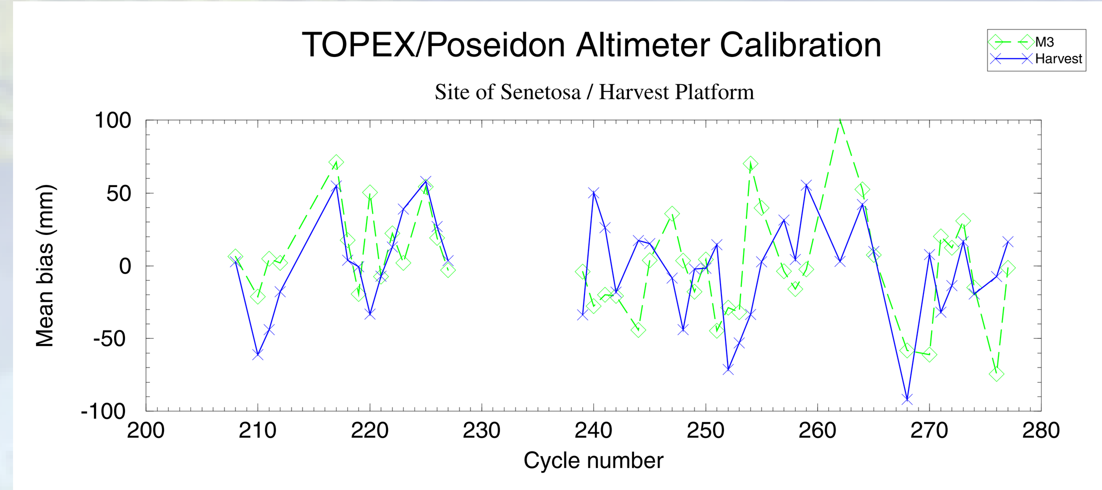


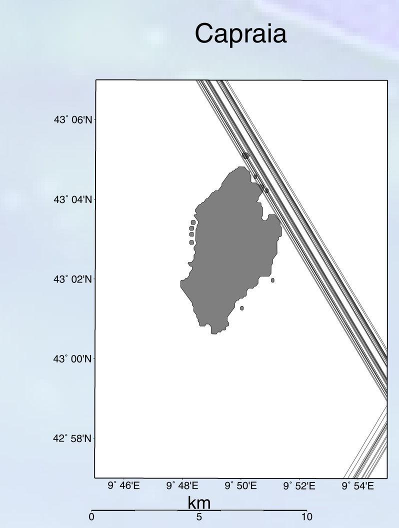
Figure 8. T/P bias at Harvest and Senetosa for common cycles.

Figure 7 shows calibration results for ALT altimeter (Side A&B). In the upper panel, bias determinations per cycle are plotted for each tide gauge location. Results between tide gauges are coherent within 1 cm. Statistics on the plot are given for M3 tide gauge which provides the longer and the more homogeneous time series. Difference between ALT-A (6.7 mm) and ALT-B (2.0 mm) is under the level of significance.
The lower panel shows the standard deviation for each bias determination which mainly reflects the standard deviation of 10 Hz altimetric data. The mean value of this standard deviation is 48 mm.

SSALT bias has been also determined for 6 cycles given a value of 18.6 ± 10.8 mm.

Figure 8 shows comparison for ALT-A and ALT-B bias between our results and the Harvest ones, for common cycles (43). Standard deviation and bias values are in very good agreement, notably for ALT-B which has a longer time serie: for ALT-A (14 values), 14.2 ± 7.1 mm and 2.7 ± 9.0 mm respectively at Senetosa and Harvest; for ALT-B (29 values), -3.2 ± 7.1 mm and -4.0 ± 6.2 mm respectively at Senetosa and Harvest.

4- Capraia side project



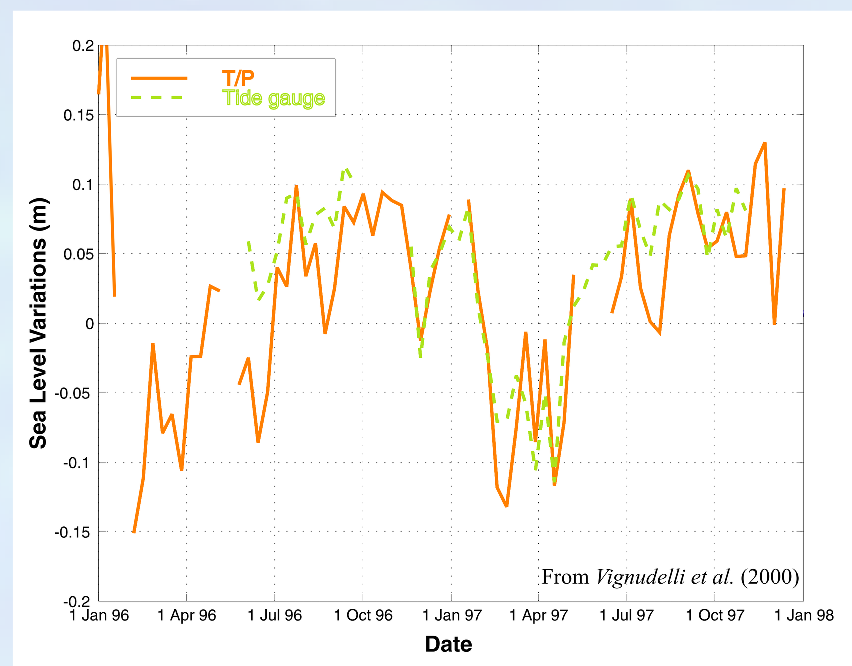


Figure 8. T/P and tide gauge sea level variations at Capraia from *Vignudelli et al.* (2000).

The italian island of Capraia is located at the north-east of Corsica (Plate 1). The vincinity of TOPEX/Poseidon pass number 85 offers the great opportunity to realize the altimeter calibration about 40 seconds after the Senetosa overflight. Moreover, a triple crossover (T/P-T/P and ERS-TP) is located near the island and should permit to link the very recent (ERS and T/P) and future altimetric missions (EnviSat and Jason). Finally, multiplying the number of calibration sites permits to limit the impact of systematic errors (geodetic link, sea state behavior, geoid, etc).

Since 1996, tide gauge data exist showing a good consistency with T/P measurements (Figure 9). We have engaged a cooperation with italian institutes and we hope to realize the necessary geodetic links (tide gauge, marin geoid, etc) before Jason-1 launch.

References

AVISO/CALVAL, "Side B TOPEX Altimeter Evaluation", AVI-NT-011-317-CN, 1999.
AVISO/Altimetry, "AVISO User Handbook for Merged TOPEX/Poseidon products", AVI-NT-02-101, Edition 3.0, 1996.
Bonnefond, P., P. Exertier and F. Barlier, Geographically correlated errors observed from a laser-based short-arc technique, 104 (C7), *J. Geophys. Res.,* 15885-15893, 1999.
Chelton, D. B., et al., Pulse compression and sea level tracking in satellite altimetry, *J. Atmospheric and Oceanic Tech.*, Vol 6, No 3, 1989.
Vignudelli, S., P. Cipiollini, M. Astraldi, G. P. Gasprarini and G. Manzella, Integrated use of altimeter and in situ data for understanding the water exchanges between the Thyrrenian and Ligurian Seas, 105 (C8) *J. Geophys. Res.,* 19649-19663, 2000.