Clipperton expedition on altimetry side

Ocean observation site exploration

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15 YEARS OF PROGRESS IN RADAR ALTIMETRY

Since 15 years, altimeters improve the observation and the understanding of the ocean circulation. The precision on sea level is estimated to several cm. By using a set of satellites on different orbits, it becomes possible to quantify movements at smaller scales than the ones recovered by one satellite due to a denser distribution. Nevertheless, mixing satellites data requires precise techniques of calibration to merge different time series. Errors measurements relative to each satellite has to be taken into account. One calibration technique consists in comparing satellite sea level data to tide gauges, real and local data. Some sites are dedicated to the altimeters calibration. Could Clipperton become such a site?

The Clipperton expedition was organized by the Jean-Louis Etiennes' team between dec 2004 and april 2005. The main objective was to build an ecological inventory of the atoll located in the Pacific ocean (10.2°N, 109.3°O). We've noticed that 4 altimeters passes flight at less than 5km from this atoll (Jason-1, ENVISAT et GFO) This offers a good configuration for the ocean studies from space like the altimeters Calibration/validation to measure the sea level. Clipperton was thus equipped with 2 tide gauges and a set of instruments to control the local geophysical conditions. **The goal is to estimate the potential of the site for altimeters inter-calibration. It has been also thought as a potential observatory for ocean environment.** The atoll is on the water masses influenced by El Niño phenomena. First results encourage the idea of the benefits that can be extracted from a combined use of satellites and in situ data. They highlight the crucial knowledge of the marine geoid. We present a first feedback to the Clipperton expedition.

Altimeters over Clipperton

The radar signal backscattered at the sea surface is not (or less) perturbed by land points as it's for coastal zones where many tide gauges are installed.

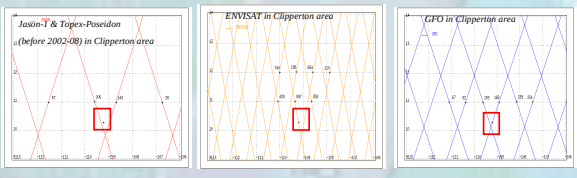
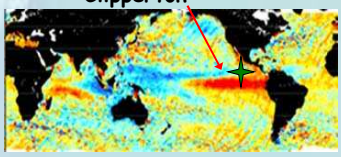


Fig 1: Satellites configuration

Clipperton



Instruments:

- 2 tide gauges
- -1 weather station
- positioning system for instruments with GPS

An observatory for the ocean?

First results place the Clipperton tide gauges as good candidates to see surface warm water masses in Pacific Ocean moving from East to West during El Nino events.

Technique: Comparison tide gauge / altimetry data.

Method: Starting from sea level anomalies map from the altimetry AVISO data base, strong variations of sea level have been detected (jan to march 2005) (+/-10 to 25 cm). Is it observed with the tide gauge at Clipperton? Anomalies and their error have been compared respectively.

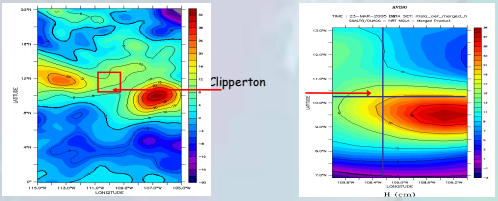
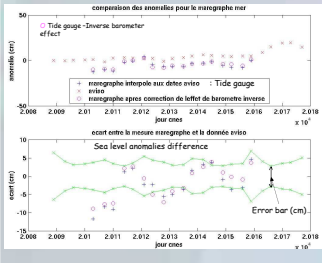


Fig.2: 2005-03-12, Near-real time Maps of Sea Level Anomalies, Maps of Sea Level Anomalies Merged (cm). Available on AVISO www.jason.oceanobs.com.

Anomalies from tide gauge and AVISO

For data homogeneity: Tidal signal filtering applied + Inverse barometer effect is removed



Results: (fig 3, tab1) Sea level anomalies for tide gauge and data from AVISO (combination of satellites data). Error bar includes precision given by AVISO (5cm) and the tide gauge one (~1cm). Measures are in the error bar with a score slightly upper than 50%. Note that tide gauge complete the AVISO map providing a more local dynamic information.

Explanations of the differences:

-Different spatial resolution local sea level and AVISO map (0.5° map).

-Particular ocean dynamic due to the atoll included in the tide gauge time series only different mean sea level

-Seasonal effects included

Table 1

Error budget and mean diff.	AVISO	Tide Gauge	Total error	Mean diff tide gauge / AVISO
cm	+-5	+-1	+-5.1	-1.7

Feasibility of the site for altimeters calibration?

The feasibility study is completed by the sea surface height computation for all the available satellites passes during the mission, independently to AVISO data base.

Method: Along track sea surface height. High frequency measurements are computed from the generic frequency directly provided in the altimeter data (1Hz) . It represents 300m for Jason-1, Envisat and 6km for GFO). This method produces satellites data on points nearer the tide gauge than if the 1Hz data are used. Geoid is strongly influent in this area. EGM96 model and GRACE observations have been used to estimate its slope along and across the satellite passes. Results are presented after the geoid correction estimation (tab.2,3)

Table 2

Satellite	Geoid slope (cm)	Distance tide gauge / satellite (km)
Jason-1	11.68	5.402
GFO	-4.7	1.635
ENVISAT	68.1 or -1.4	0.640

Table 3 : Relative bias cross satellites

Relative bias (cm)	Jason-1 – GFO	Jason-1 – ENVISAT	ENVISAT - GFO
Number of satellite cycles	5	3	2
After geoid correction	11.5	11.39	18.81

Important effect of the geoid on the sea surface height computation: (fig4)

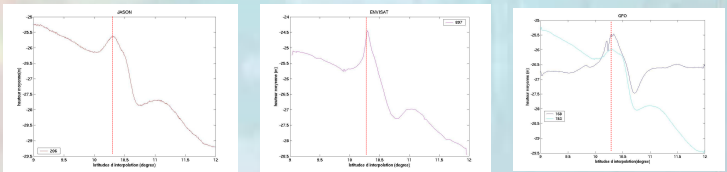


Fig.4: Approximation of the geoid slope with means sea level from our alitmetry treatments

Results answer to one question sprang out from the Clipperton mission. They show that Clipperton is a good potential ocean observation site. Tide gauge and altimetry have seen the strong sea level anomaly event and results are coherent in term of error bar. Regarding to the detection of strong sea level anomalies (like strong ocean events), the combination of satellites and tide gauges is fruitful and complementary (fig2).

The data sets cover a very short time period. Nevertheless, results for JASON-1 and GFO are coherent. They show the potential of the site for a use in altimetry calibration. It's not yet possible to conclude for ENVISAT, because of a lack of data on this period (see poster OSTST-for ENVISAT calibration in Corsica).

It's now necessary to know more precisely the geoid variations in this area and the geodetic referencing of the tide gauge for a use in altimeters calibration.

This preliminary study needs to be completed but it shows that there is an interest to get longer tide gauges time series at Clipperton, in particular, to observe the local dynamics and the geodetic events. The major and real difficulty is logistics because the site is very hardly accessible and not autonomous in energy.

Venice (Italy), 13 > 18 March 2006

Links: www.jason.oceanobs.com, www.jeanlouisetienne.fr/clipperton/default.cfm, **www.clipperton.fr**

NOV-3452-SL-3688