Long term monitoring of the ENVISAT RA-2 drift with the GLOSS/CLIVAR "fast" sea level data tide gauge network

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OBJECTIVES

The long term monitoring of the ENVISAT RA-2 bias is known as the RA-2 relative range calibration. The objective of this relative calibration is to estimate drifts of the altimeter along time with a long term monitoring of ENVISAT bias to a tide gauges network.

The purpose of this poster is to present the results of the RA-2 relative range bias computed by CLS between cycles 13 and 28 of ENVISAT and to show the method's efficiency with results on TOPEX, on which drift has already been estimated.

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Problematic

The usefulness of a tide gauge data network for calibrating satellite altimetry systems (in particular Topex/Poseidon) has clearly been shown by [Mitchum, 1994; Mitchum, 1998] and others [Cazenave et al., 1999]. These authors proposed to use the WOCE tide gauge data set as an independent system to follow possible drifts and bias of an altimeter system over time.

The basic idea is that tide gauges provide independent measurements of sea surface height variations, and differences between tide gauges and altimetry should not have any drift or bias over long time scales. An operational approach is included in a routine long-term monitoring activity of ENVISAT.

The problem is to compare ENVISAT data with tide gauges which are not under ENVISAT tracks. In order to run this monitoring, CLS has developped and is maintaining a specific processing chain named CALAMAR : CALibration Altimétrie MARégraphie (Altimetry Tide Gauges Calibration).

Methodology

The method developped and maintained at CLS (CalAMar) can be summarized in 4 main steps :

- Processing and filtering of the tide gauge data,
- Processing and filtering of the altimetry data,
- Selection of the several types of data to compare,
- Computation of statistics

The processing of tide gauge data itself can be divided in several steps :

- Download of the data at the UHSLC
- Conversion on the UHSLC to CLS NetCDF data with some validations
- Filter the short wavelengths (semi-diurnal and diurnal) : low-pass filter (Demerliac filter [Bessero, 1985]
- Filter the long wavelengths (weekly to annual) : specific algorithm (adapted from [Cartwright and Eden, 1973])
- Remove the mean according to the CLS01 Mean Sea Surface (tide gauge zero is arbitrary : CLS01 MSS corresponds to the 1993-1999 period, so for each tide gauge the mean of the tide serie computed during this 7 years period is removed from the serie).

Altimetry data is directly extracted from the GDRs available at CLS.
The processing of altimetry data can be divided in several steps :

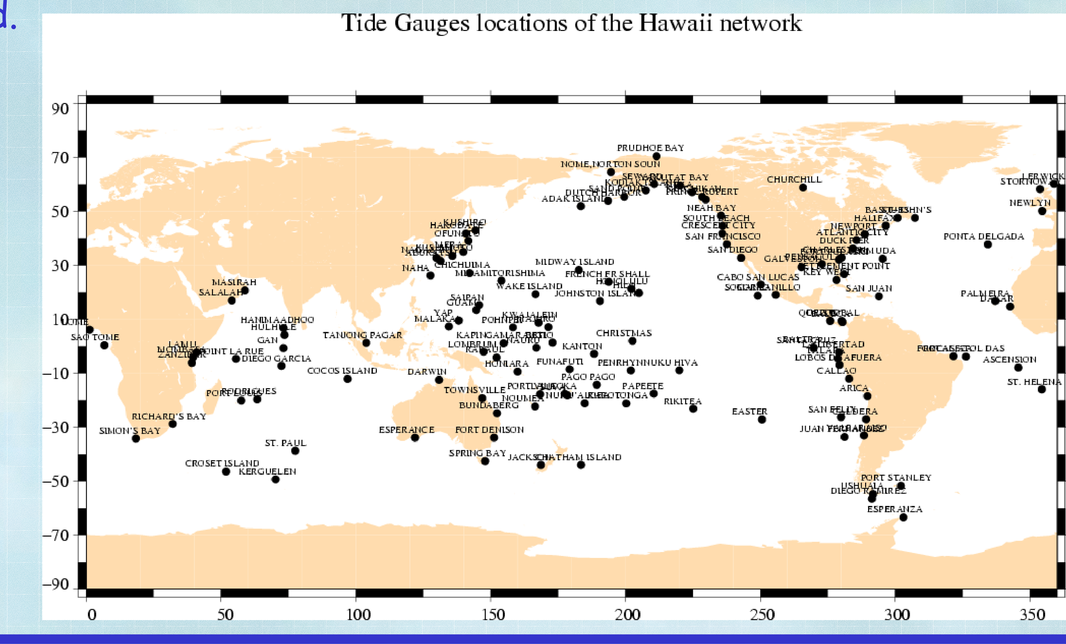
- Two types of corrections are applied :
  - ✓ Instrumental corrections
  - ✓ Geophysical corrections
- An along-track filtering is done:
  - ✓ To reduce measurement noise
  - ✓ To improve the data accuracy used in shallow water and near coastlines
- The computation of the Sea Level Anomalies takes into account :
  - ✓ A correction from tides (FES2002, [Lefèvre, 2002])
  - ✓ Different atmospheric corrections whether ones want to evaluate them

Inventory of the used tide gauges

The tide gauge network used in the study is known as the GLOSS/CLIVAR "fast" sea level data. It was formerly known as the WOCE "fast" sea level data. Data is distributed as hourly, daily, and monthly values.

This network is one of the main activities of the University of Hawaii Sea Level Center (USHLC). It is supported by the NOAA Climate and Global Change program. This network gathers about 140 tide gauges which are sometimes available since more than 10 years.

This tide gauge network provides near real time data (varying from a few days to several weeks of delay which is a period of time in accordance with the delivery of main altimeter GDRs). This data is coming from numerous countries over the world. Thus, it is heterogeneous and needs careful validation before processing. This data is relatively referenced.

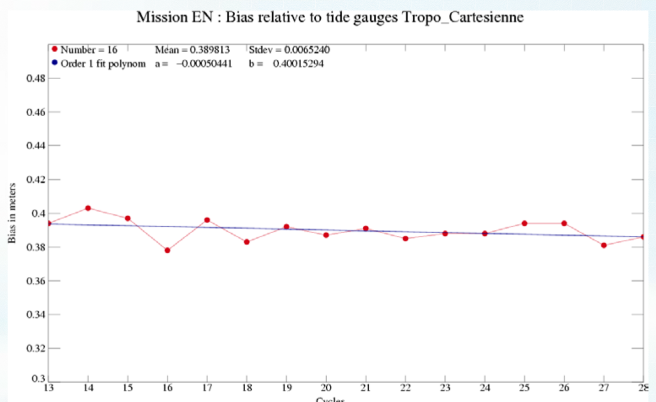


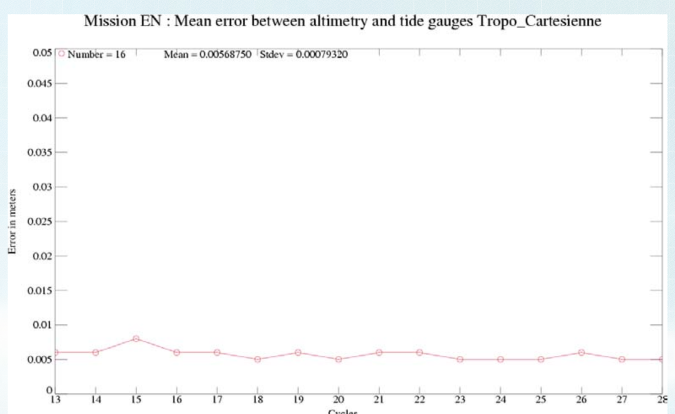
Satellite corrections

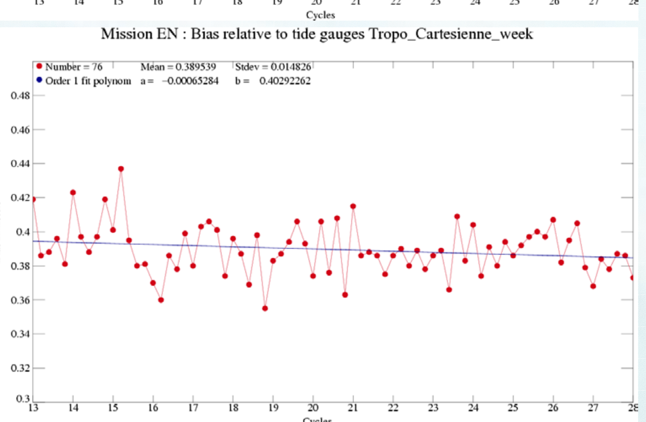
Several corrections were applied to retrieve SSH from ENVISAT.

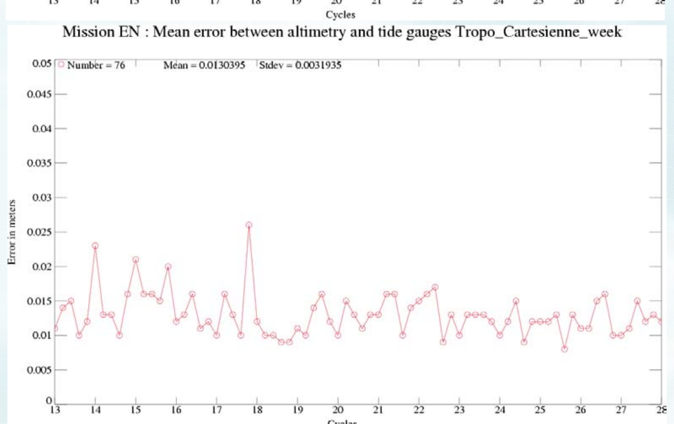
Acronym	Description
TRO_SEC	Dry Troposphere correction (ECMWF)
TRO_HUM_RAD	Radiometer wet troposphere correction
IONO_FILTR	Filtered ionospheric correction
SSH_INTERP	Sea Surface Height interpoled (ORB-DALT)
MAR_TER	Terrestrial tide
MAR_POL	Ocean tide
MSS_CLS01V1	Mean Sea Surface computed by CLS inn 2001
BEM_NPARAM_CMA	Non parametric bias in main band

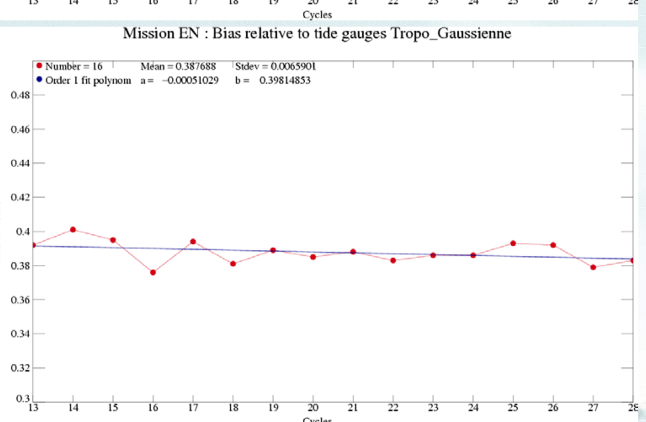
Values of the bias

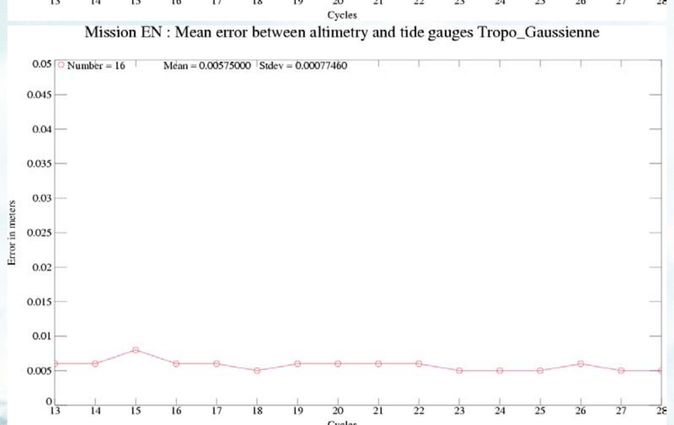


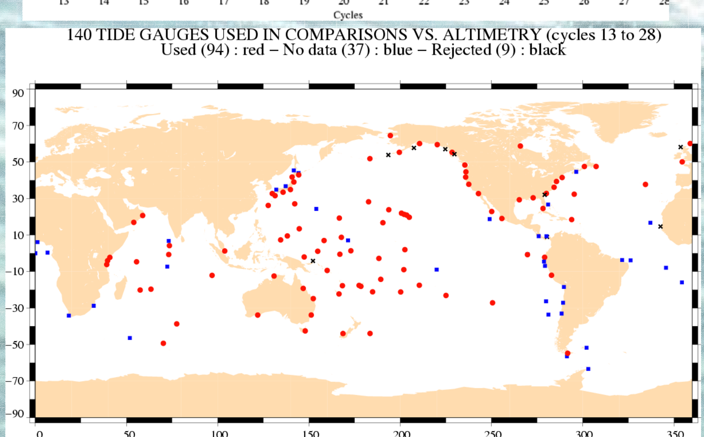












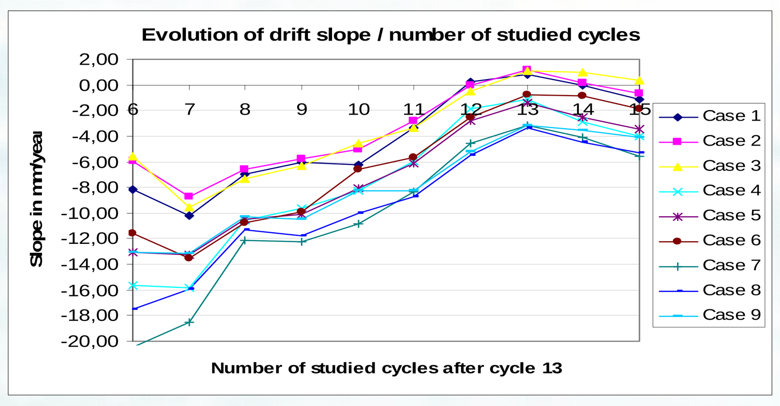
Troposphere corrections were both used to estimate a possible drift between them.
To see the influence of the lack of points in estimating the drift by cycle, we also studied the drift by week.

The drift at this point is estimated to be about -5mm/year but this value should should be considered with much precaution as it still changes at each cycle : the number of points on ENVISAT is maybe still too low to actually reach a good estimation of the drift.

Improvements

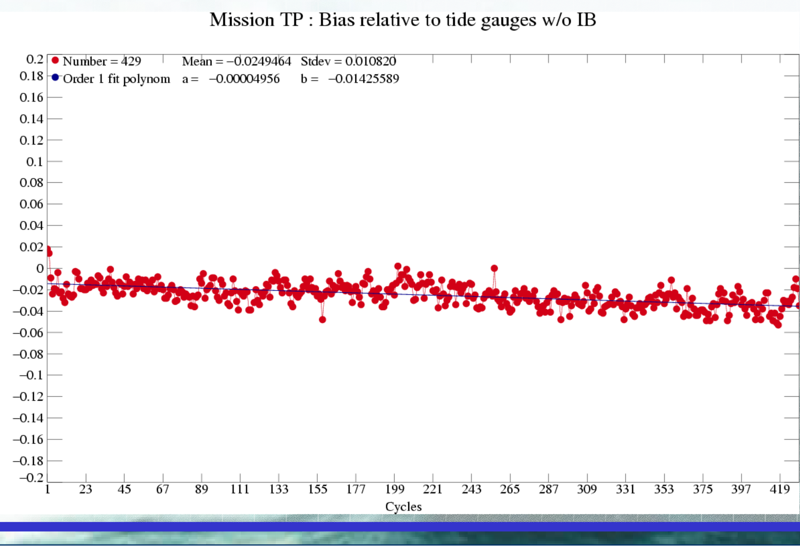
The bias estimation mainly depends on two parameters STD_Max and COR_MIN. As the couple determined for TOPEX by Mitchum was (0.1,0.3), some « bracketting » was done around these values for ENVISAT to find out the drift estimation most stable along time. Thus sensitivity to new data in drift estimation has been studied.

Definition of cases		COR_MIN				
		0,1	0,3	0,5	0,7	0,9
STD_MAX	0,14					
	0,12	1	2	3		
	0,1	4	5	6		
	0,8	7	8	9		
	0,6					



Validation results on TOPEX

In order to validate the chain on another mission,TOPEX data was used, and the found drift was -1.9 mm/year which is a known Result (cf. Marine Geodesy,.



References

- **Bessero, G.**, Marées, Service Hydrographique et Océanographique de la Marine, Brest, 1985.
- **Carrere, L.**, and **F. Lyard**, Modeling the barotropic response of the global ocean to atmospheric wind and pressure forcing - comparisons with observations, *Geophys. Res. Let.*, *30* (6), 8-1 to 8-4, 2003.
- **Cartwright, D.E.**, and **A.C. Eden**, Corrected Tables of Tidal Harmonic, Geophys. J. R. Astr. Soc., 17 (5), 619-622, 1973.
- **Cartwright, D.E.**, and **R.J. Tayler**, New Computations of the Tide-Generating Potential, Geophys. J. R. Astr. Soc. (23), 45-74, 1971.
- **Cazenave, A.**, **K. Dominh**, **F. Ponchaut**, **L. Soudarin**, **J.F. Crétaux**, and **C. Le Provost**, Sea Level Change from Topex/Poseidon altimetry and tide gauges, and vertical crustal motions from DORIS, G. Res. Let., 26 (14), 2077-2080, 1999.
- **Dorandeu, J.**, and **P.Y. Le Traon**, Effects of Global Mean Pressure variations on Sea Level changes from TOPEX/POSEIDON, J. Atmos. Oceanic Technol., 16, 1279-1283, 1999.
- **Hernandez, F.**, and **P. Schaeffer**, The CLS01 Mean Sea Surface: A validation with the GSFC00.1 surface, pp. 14, CLS, Toulouse, 2001.
- **Lefèvre, F.**, Modélisation de la marée océanique à l'échelle globale par la méthode des éléments finis avec assimilation de données altimétriques, pp. 87, CLS, Ramonville Saint-Agne, 2002.
- **Lefèvre, F.**, **F. Lyard**, **C. Le Provost**, and **E.J.O. Schrama**, FES99 : a tide finite element solution assimilating tide gauge and altimetric information, *J. Atm. Oceano. Tech.*, *19* (9), 1345-1356, 2002.
- **Mitchum, G.**, Comparison of TOPEX sea surface heights and tide gauge sea levels, J. Geophys. Res., 99 (C12), 24541-24554, 1994.
- **Mitchum, G.**, Monitoring the stability of satellite altimeters with tide gauges, J. Atm. Oceano. Tech., 15 (3), 721-730, 1998.

Prospects

- **Incertitude on drift due to the lack of data on a recent mission like ENVISAT => self improvement with time**
- **Necessity to provide a estimation of error on the estimated drift**
- **Crossvalidation on more missions**
- **Stability has to be improved as each appearing cycle currently has a real impact on statistics, whatever the COR_Min and STD_MAX parameters**

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