Use of the Corsica site to compute altimeter biases for Jason-2, Jason-1 and ENVISAT: Absolute and Regional CalVal methods

M. Cancet[1], J. Chimot[1], S. Bijac[1], P. Bonnefond[2], O. Laurain[2], E. Jeansou[1], F. Lyard[3], E. Bronner[4]

[1]*NOVELTIS, Toulouse, France* - [2]*OCA/GEOAZUR , Grasse, France* - [3]*OMP/CNRS/LEGOS,Toulouse,France* - [4]*CNES,Toulouse,France*

Corresponding author: mathilde.cancet@noveltis.fr

CONTEXT

In situ calibration enables regular and long-term control of altimeter sea surface heights using *in situ* measurements. Consequently, this type of calibration is independent of other altimetry missions. Usually, the in-situ calibration of the altimeter sea surface heights is done at the vertical of a specific CalVal site by direct comparison of the altimeter data with the *in situ* data. NOVELTIS has developed a regional Calval technique which aims at increasing the number and the repeatability of the altimeter bias assessments by determining the altimeter bias on satellite passes located far away from the CalVal site. The strong interest of this principle is to extend the single site approach to a wider regional scale; the number of calibration opportunities is thus multiplied.

This regional Calval method can be used either considering several passes of the same mission, or combining several missions. In the frame of this study, coastal and off-shore biases were computed in Senetosa, for the Jason-2 and Jason-1 missions, on both original and interleaved orbits in the case of Jason-1. The absolute Calval method was also applied to the Envisat mission in Ajaccio. Finally, the impacts of the ocean dynamics were estimated in the case of the Jason-2 mission, considering the tidal signal and the dynamical atmospheric effects.

METHOD

Absolute method

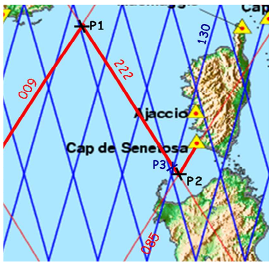
Direct comparison between the altimeter SSH and the tide gauge measurements.

It can only used for satellite passes flying over the calibration sites

→ Jason-2 pass 085 in Senetosa (in red on the map)

→ Envisat pass 130 in Ajaccio (in blue)

These results are **comparable to the bias estimations in Harvest, Bass Strait, Gavdos,…**



Regional method

Computation of the bias on off-shore passes, at crossover points:

→ considering passes of the same mission

→ combining several missions

It transports the offshore SSH to the calibration site **following a succession of accurate MSS profiles** in order to take into account the spatial MSS gradient between the offshore crossover point and the calibration site.

The **ocean dynamics** (circulation, tides and atmospheric effects) differential signal between the offshore passes and the coast also influences the bias estimation.

RESULTS

Jason-2 altimeter biases in Senetosa

Configuration:

- GDR-C products
- 74 cycles
- No tide nor dynamical atmospheric corrections

Weighted bias (cm)	Jason-2 64 cycles		Jason-2 74 cycles		64 → 74
	Mean	Std	Mean	Std	
Pass 085	18.2	3.3	18.8	3.4	+0.6cm
Pass 222 (P2)	16.7	2.5	17.7	2.5	+1.0cm
Pass 009 (P1)	14.8	3.3	16.0	3.3	+1.2cm

→ From 64 to 74 cycles: **increase in the mean bias**, due to changes in the MSS profiles (more cycles, stabilization of the mean profiles)

→ **Decrease in the bias** of about 3cm **between the coast** (pass 085) **and the offshore altimetry data** (pass 009): Ocean dynamics differential effects ? Stability of the MSS profile used to compute the bias ?

Tide effect:

- 2 tide model corrections available in the GDR-C products: FES2004 and GOT00.2
- Harmonic analysis on the tide gauge data (66 waves)

Weighted bias (cm)	Jason-2 – 64 cycles GOT00.2 tide correction		Jason-2 – 64 cycles FES2004 tide correction	
	Mean	Std	Mean	Std
Pass 085	18.2	3.5	18.0	3.6
Pass 222	16.8	2.8	16.8	2.9
Pass 009	14.9	3.7	14.7	3.7

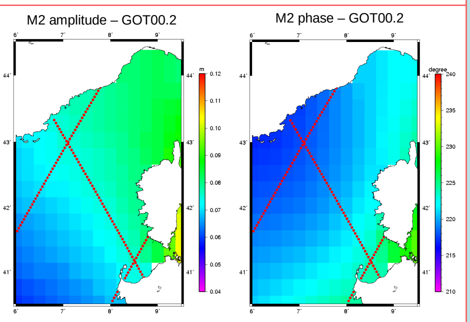


Fig.1: Amplitude and phase of the GOT00.2 M2 wave in the area of the Senetosa calibration site. The red dots superimposed represent the Jason-2 altimeter point positions.

→ **Low amplitudes** (9cm) and **homogeneous phases** (difference of about 5° between the offshore pass and the Senetosa site)

→ **No clear impact of the tide correction** on the off-shore bias

Dynamical atmospheric effects:

Weighted bias (cm)	Jason-2 cycles 1 to 64 with TUGO dynamical correction	
	Mean	Std
Pass 085	18.1	3.1
Pass 222	16.5	2.5
Pass 009	15.3	3.6

- TUGO global simulation for both altimetry and tide gauge data

→The dynamical atmospheric effects **do not totally explain the gap** between the offshore and coastal biases.

→ Would a **regional correction** better see the offshore dynamics ?

Jason-1 altimeter biases in Senetosa

Configuration:

- GDR-C products
- 259 cycles on the original orbits
- 45 cycles on the interleaved orbits
- No tide nor dynamical atmospheric corrections

→ **Decrease in the bias** between the coast and the offshore altimeter data, such as for Jason-2

→ **Not visible** in the results computed **with the GDR-A products:**

- **More cycles** (longer period) and consequently **different MSS profiles**
- **Better retracking and corrections** (wet tropo, SSB) **in the GDR-C products**

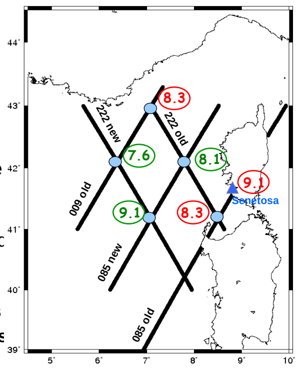


Fig. 2: Jason-1 biases (cm) on the original and interleaved orbits

ENVISAT altimeter bias in Ajaccio

Configuration:

- Absolute : pass 130
- GDR-A, B & B with new POE products
- Cycles 23 to 80
- No tide nor dynamical atmospheric corrections
- Several ionosphere corrections tested

NOVELTIS

	Ionospheric correction used	Mean bias (cm)	Standard Deviation (cm)	Number of data	Period
GDR_A	RA2	41.6	3.5	15	Cycle 23 to 40
	DORIS	39.6	2.9	15	Cycle 23 to 40
	GIM	40.9	2.9	15	Cycle 23 to 40
GDR_B	RA2	43.1	3.1	25	Cycle 41 to 68
	DORIS	42.5	2.6	25	Cycle 41 to 68
	GIM	43.3	2.7	25	Cycle 41 to 68
GDR_B + New_POE	DORIS	45.9	2.5	12	Cycle 69 to 80
	GIM	46.3	2.5	12	Cycle 69 to 80

OCA

	Bias (mm)	Standard deviation	Number of data
GDR-A			
Dual frequency	421 ± 8	31	16
DORIS	409 ± 8	31	16
Model (GIM+IRI95)	407 ± 17	30	3
GDR-B			
Dual frequency	418 ± 7	23	11
DORIS	422 ± 7	25	12
Model (GIM+IRI95)	431 ± 7	26	12
GDR-B + new POE*			
Dual frequency	NA	NA	NA
DORIS	486 ± 13	36	8
Model (GIM+IRI95)	494 ± 13	36	8

* without long period gravity drift

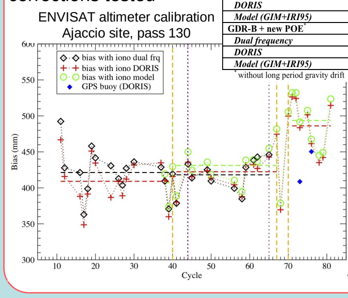


Fig.3: ENVISAT bias estimation in Ajaccio on pass 130 considering different ionosphere corrections (courtesy P. Bonnefond)

→ Difference of 1cm for the GDR_A and GDR_B products and almost 3cm for the GDR_B + New_POE products;

→ The mean bias values are weaker with DORIS (between 39.6cm and 45.9cm).

CONCLUSIONS

Decrease in the bias between the coast and the offshore passes for both Jason-2 and Jason-1 missions (on the original and interleaved orbits) - Not seen in the Jason-1 GDR-A products.

Weak impact of the tide and dynamical atmospheric corrections on the bias in this region.

Would be interesting to use the **same regional method on other *in situ* Calval sites** in order to understand these results

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