Corsica: a multi-mission absolute calibration site

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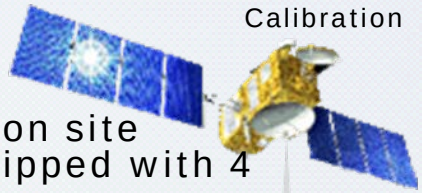
OSTST meeting – October 8-11, Boulder, CO

Corsica Calibration Site

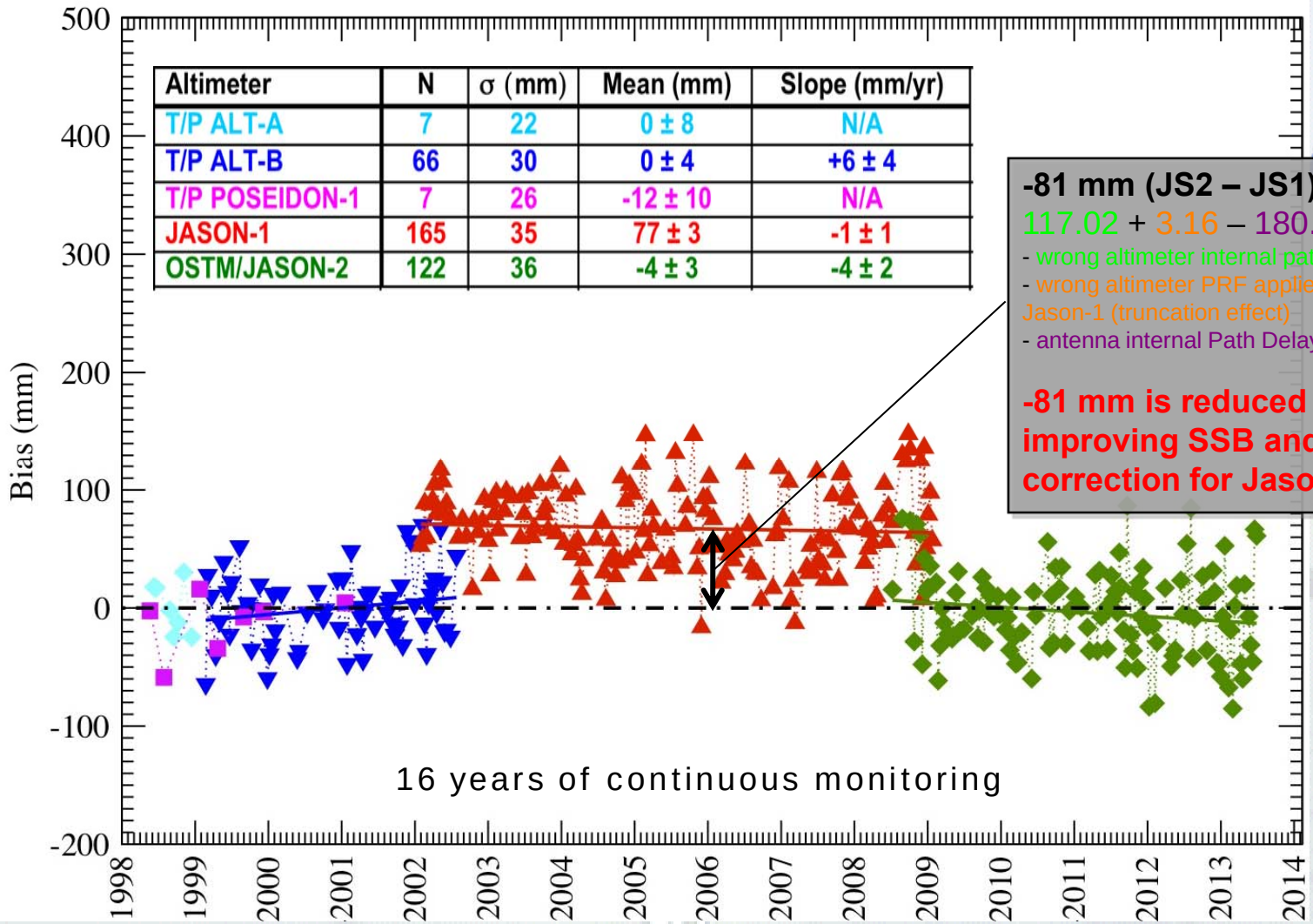
Corsica Absolute Altimeters Calibration



- Senetosa CNES calibration site established in 1998 (equipped with 4 pressure tide gauges.)
  - Supports continuous monitoring of Jason-2 (and formerly T/P and Jason-1)
- Open-ocean altimeter readings connected to tide gauges via detailed local geoid model
  - Derived from intensive GPS buoy and catamaran surveys along ground track. Extension to Ajaccio (2005) and Capraia (2004)
  - Open-ocean verification location for GPS zodiac deployments.
- Ajaccio configuration
  - Supports continuous monitoring of SARAL/ALtiKa (and formerly ERS-2, Envisat)
  - Fiducial point near Ajaccio equipped with GPS/FTLRS/DORIS.
  - Ajaccio radar tide gauge (SHOM) *New one since 2009/09/16 (moved on 2012/04/03)*

New: Some tracks of CryoSat-2 and HY2-A cross the geoids allowing absolute calibration

SITE DESCRIPTION



-81 mm (JS2 – JS1) to be compared to:

117.02 + 3.16 – 180.92 = **-60.74 mm**

- wrong altimeter internal path delay value used on Jason-1
- wrong altimeter PRF applied in the ground segment on Jason-1 (truncation effect)
- antenna internal Path Delay reference error

-81 mm is reduced to -71 mm when improving SSB and wet radiometer correction for Jason-1

BIASES TIME SERIES

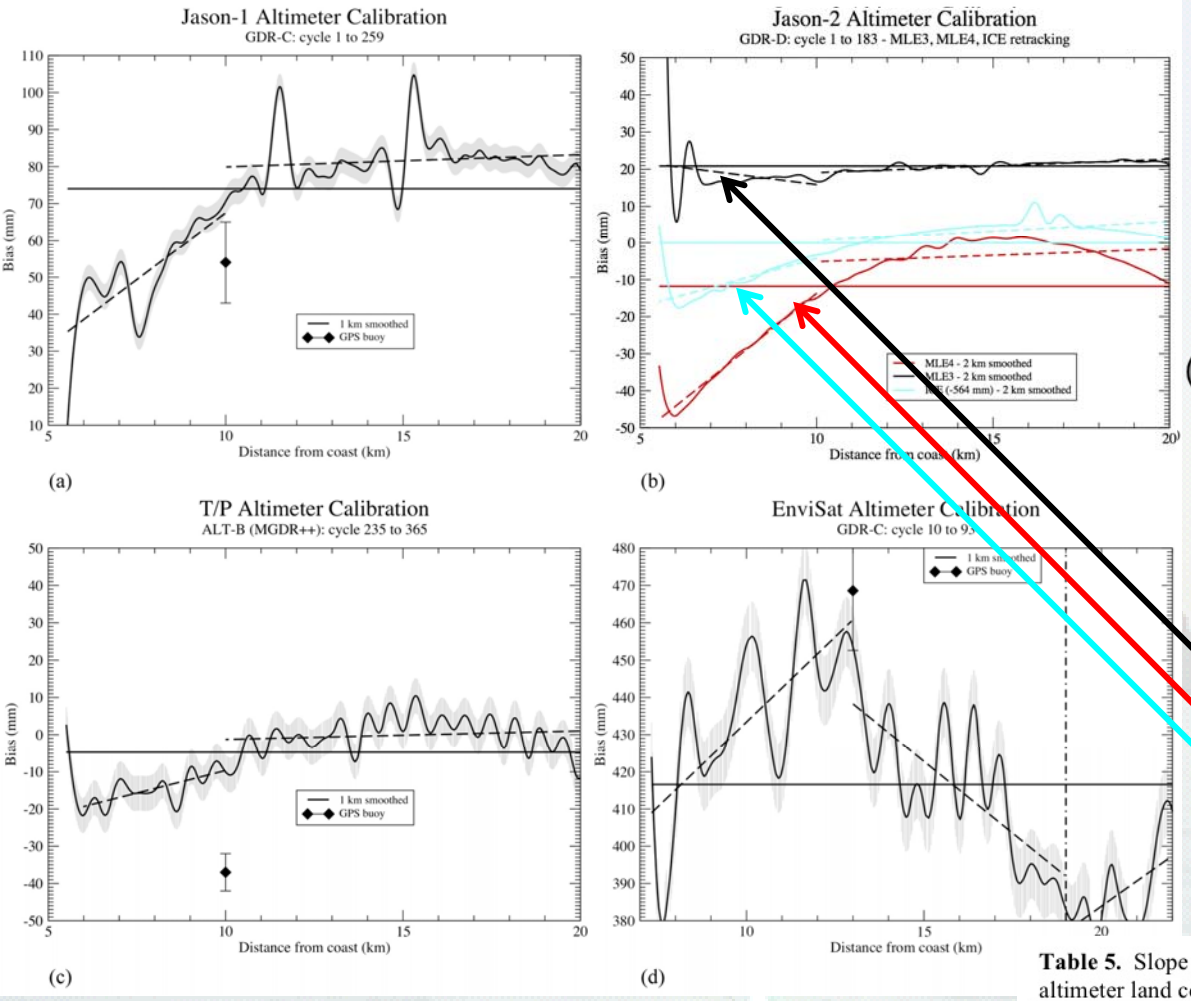
Products used (processed with NO altimeter land contamination effect):

T/P: MGDR + TMR replacement products + std0905 orbits (GSFC)

Jason-1: GDR-C (cycle 1 to 259)

Jason-2: GDR-D (cycle 1-183) MLE4 = -4 ±3 mm

Jason-2: GDR-D (cycle 1-183) MLE3 = +22 ±4 mm => ≠ by 26 mm (mainly SSB)



Bonnefond et al., **GPS-based sea level measurements to help the characterization of land contamination in coastal areas**, ***Advances in Space Research***, ISSN 0273-1177, 10.1016/j.asr.2012.07.007.

GDR-D provides different retracking that have not the same sensitivity to land

MLE3

MLE4

ICE

ALTIMETER CONTAMINATION

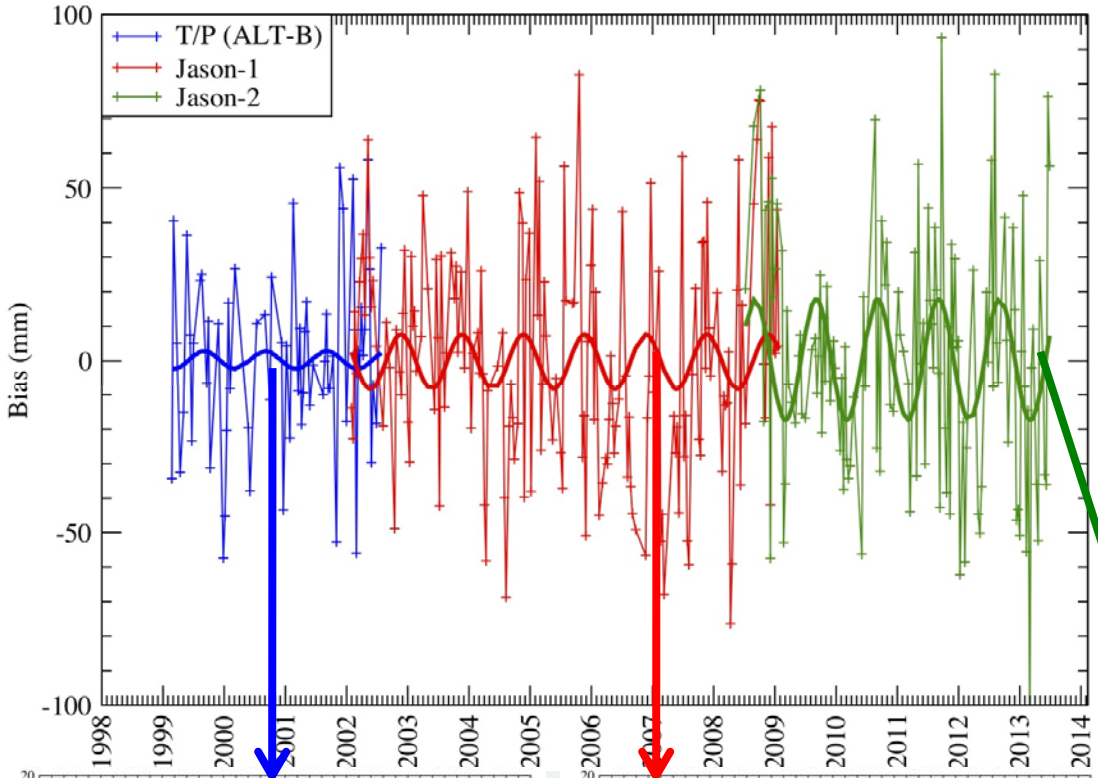
Integrated effect of the land contamination over the full set of data available

This effect is at the level of 8 mm/km. As typical sea surface slopes of 1–10 microradians lead to currents at the level of 0.1–1.0 m/s at mid latitude (Stewart, 2008), the estimated slope due to land contamination (8 microradians) can produce **artificial current of 0.8 m/s in the coastal areas (<10 km): about a gulf stream…**

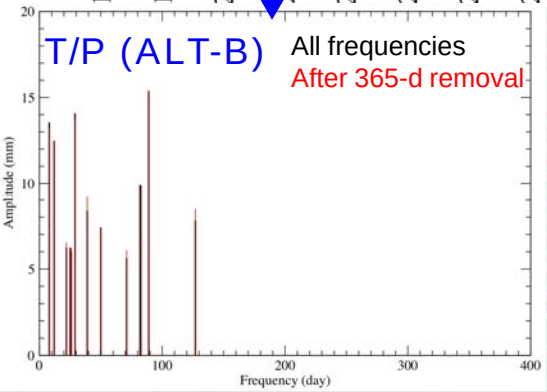
Table 5. Slope in the SSH and bias differences due to the altimeter land contamination (derived from Figure 7)

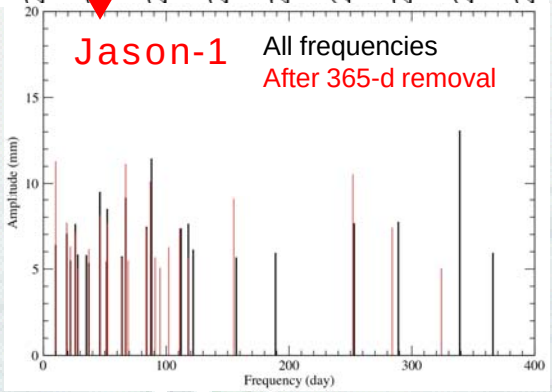
Site / Instrument	Slope (mm/km)	Bias differences* (mm)
Senetosa (5 km to 10 km)		
ALT-B (TOPEX/Poseidon)	+2.4	+4.6
POSEIDON-2 (Jason-1)	+7.2	+7.6
POSEIDON-3 (Jason-2	+8.6	+6.1
Ajaccio (RA-2, Envisat)		~+30
7 km to 13 km	+9.1	
13 km to 19 km	-7.7	
19 km to 22 km	+6.8	

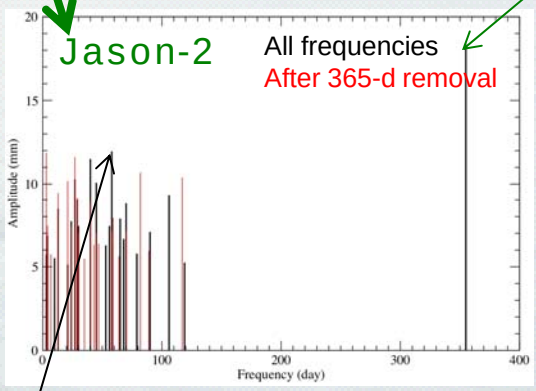
*estimated from the area where altimeter should not be contaminated: 10 km to 20 km at Senetosa and only at 13 km for Ajaccio (see text in the beginning of section 3.1.1 for details).



A clear annual signal of about 20mm in Jason-2 bias time series needs to be further investigated: Corrections?
=> Nothing seen from neither wet or iono corrections (using differences with model)



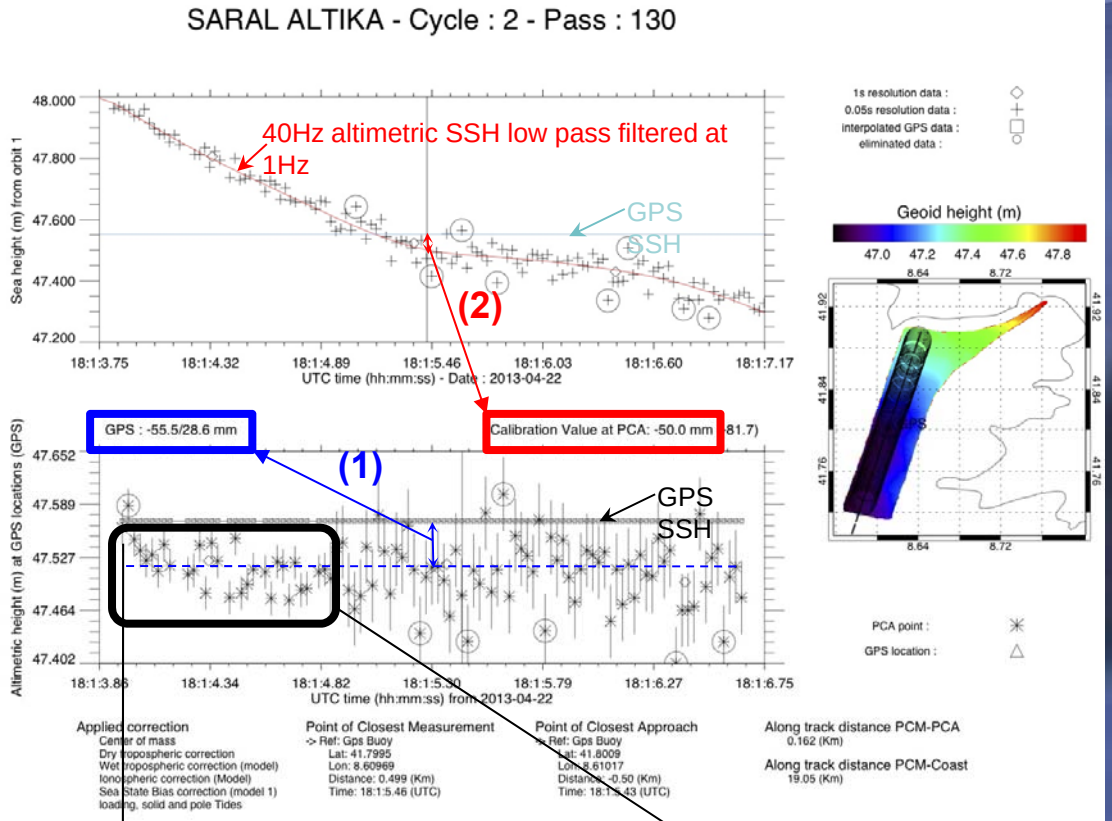


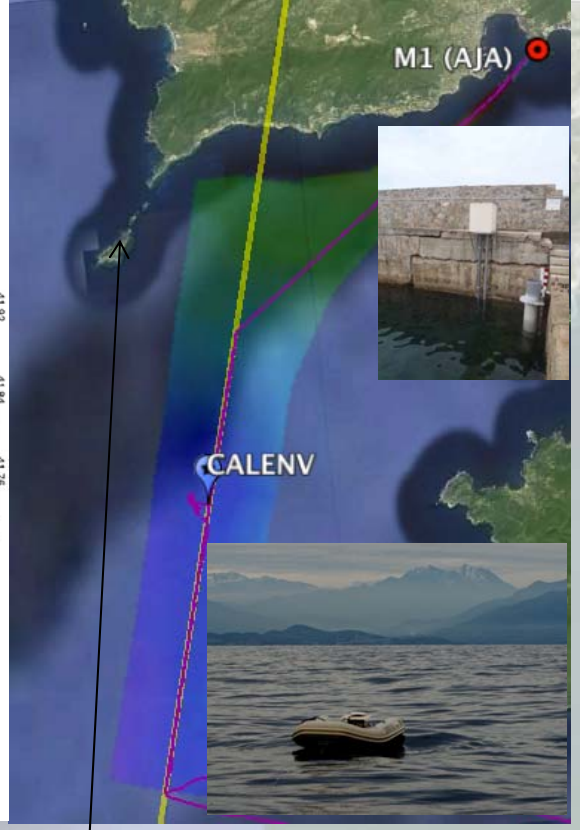


No clear 59-d neither annual signal (365-d) for neither T/P nor Jason-1

The 59-d frequency is clearly reduced when removing the annual signal (365-d)

FREQUENCY ANALYSIS





Corsica Absolute Altimeters Calibration

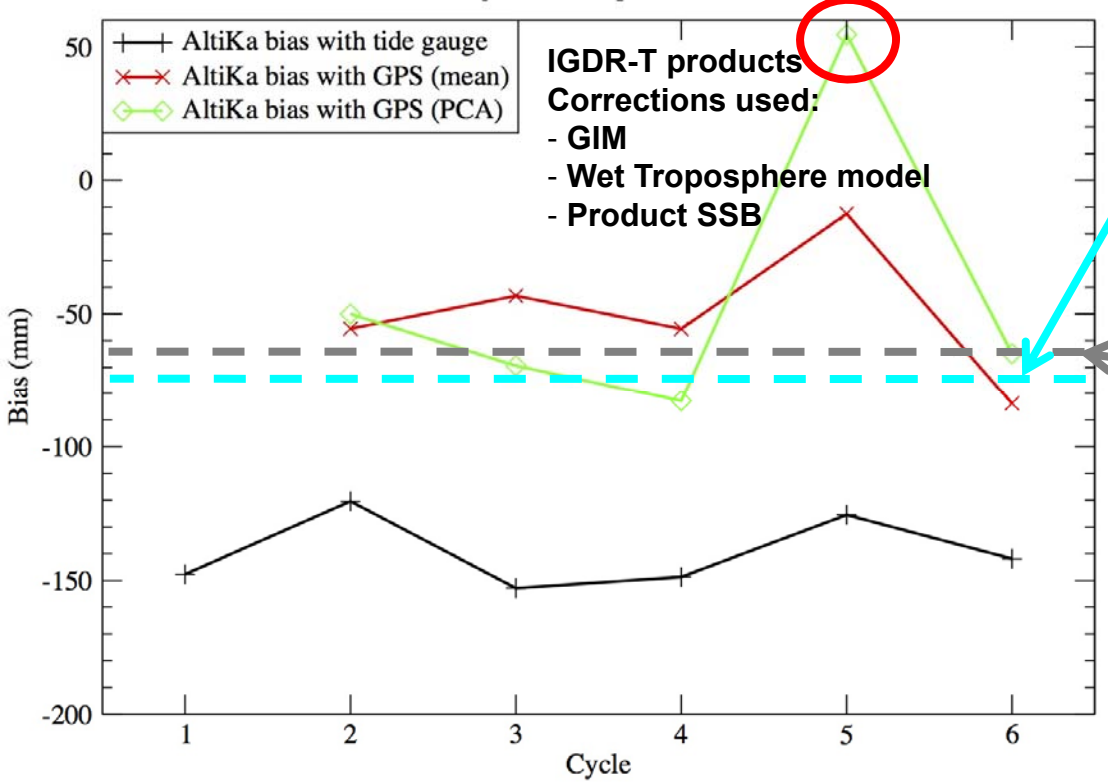
SARAL/AltiKa

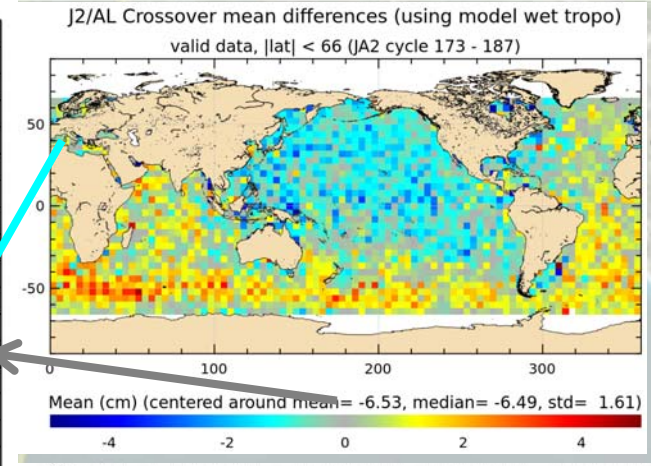
good 40Hz data up to 3km from coast

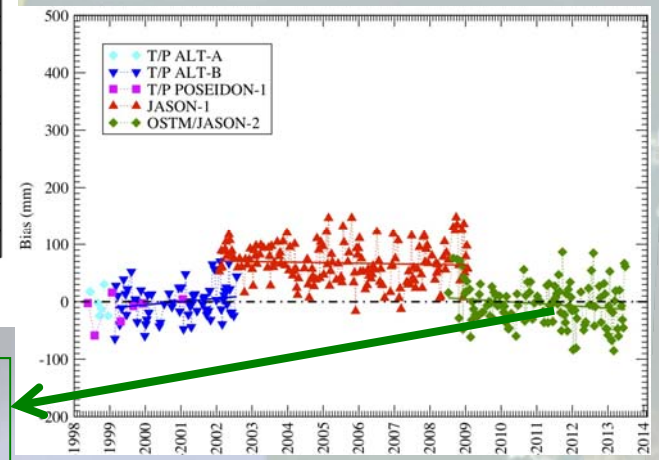
- First part protected by Sanguinaires islands shows lower standard deviation than in the open area
- Global standard deviation is also very low (28 mm) compared to typical Jason-2 one (~50-60 mm)

2 independent instruments to compute SSH bias:

- From **tide gauge**:
  - **(0) SSH from altimetry needs to be corrected from geoid**
- From **GPS measurement** (GPS aboard a zodiac located under the track, calenv):
  - **(1) Using geoid correction to average all the altimetric SSH** (noted mean in the following)
  - **(2) Computation at PCA = no need to correct from geoid** (noted PCA in the following)







Jason-2 bias absolute bias computed from Senetosa site is close to zero (-4 ±3 mm)

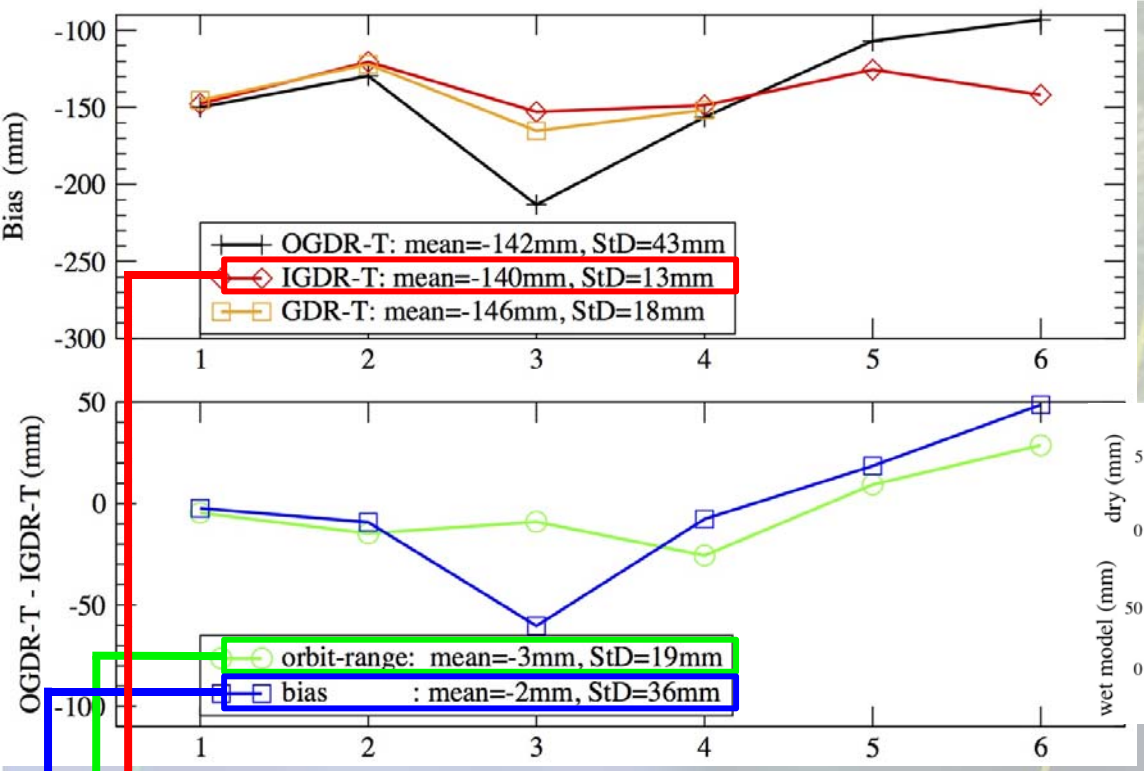
AltiKa absolute SSH bias should be close to the relative bias to Jason-2

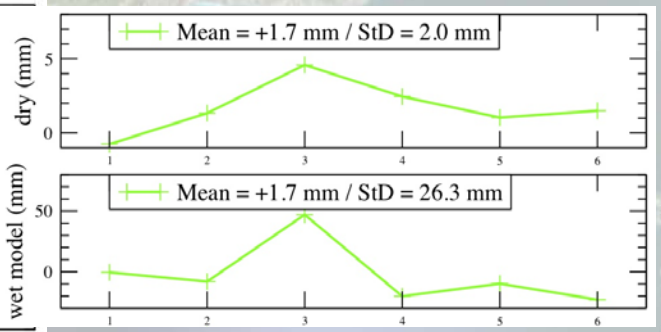
Averaged SSH bias (common cycles: cycle 2 to 6, without 5)

Tide gauge	GPS (mean)	GPS (PCA)	Xover
-141 mm (σ=14 mm)	-60 mm (σ=17 mm)	-67 mm (σ=14 mm)	~-65 mm

~-70 mm differences:

- **tide gauge instrumental bias (~-30 mm)**
- **oceanic signal from tide gauge to offshore (~-40 mm)**





OGDR-T / IGDR-T

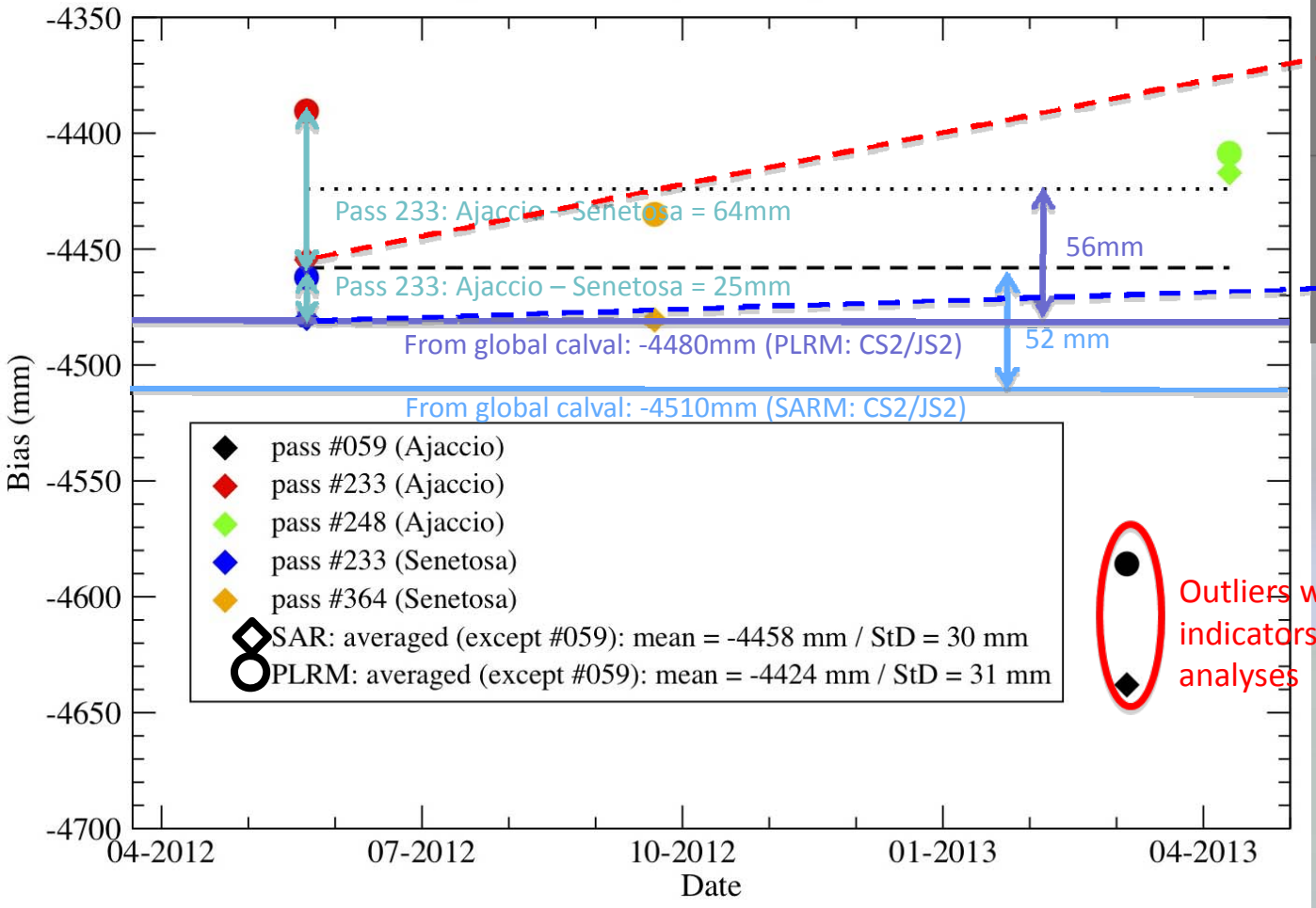
Very low standard deviation (13 mm) compared to typical Jason-2 one (~35 mm)

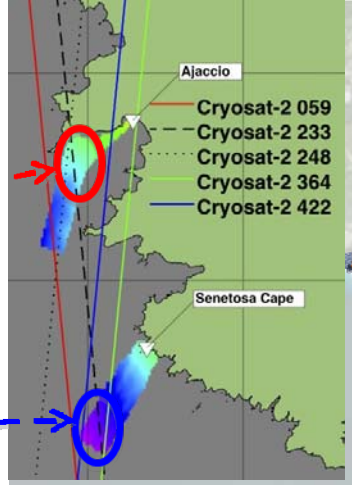
Mean radial orbit differences between DIODE and MOE (-3 mm). Stable over the 6 cycles (19 mm)

Differences between OGDR-T and IGDR-T SSH bias are due to dry and wet tropo and linked to differences between predicted and computed ECMWF model

CryoSat-2 Absolute Altimeter Calibration

Senetosa & Ajaccio: CNES reprocessed products (SARM/PLRM)





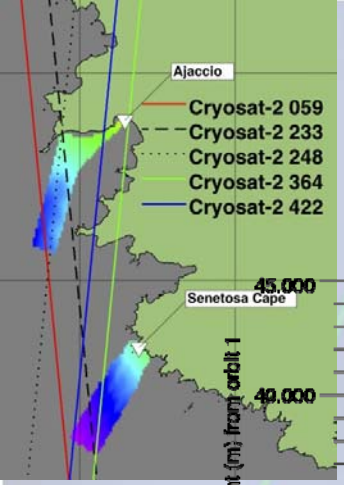
Corsica Absolute Altimeters Calibration

Outliers with no clear indicators from our analyses

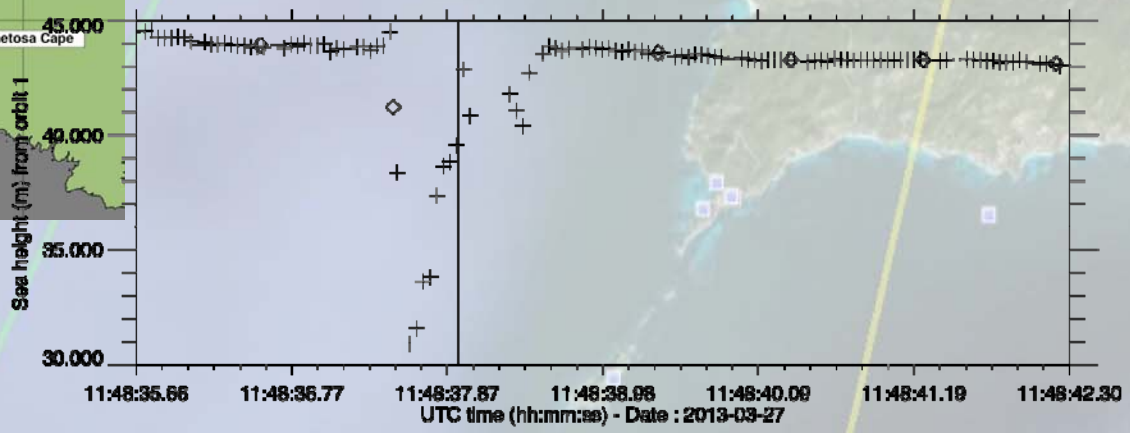
CryoSat-2

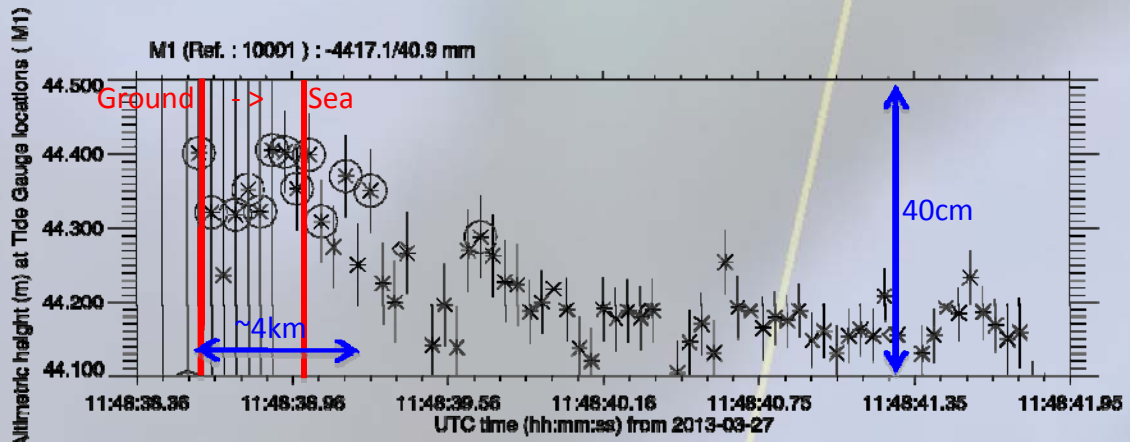
The huge value of the bias (~-4.5m) is due to the fact that the internal delay was not applied in the current CNES reprocessed products

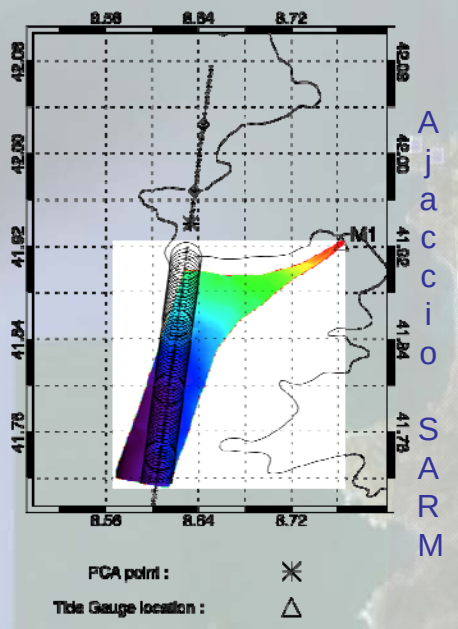
The standard deviation of the time series (~30mm) for either SARM or PLRM is at the level of Jason-2 one (35mm) even on this short sample.



CRYOSAT-2 SIRAL - Cycle : 41 - Pass : 248







Ajaccio SARM

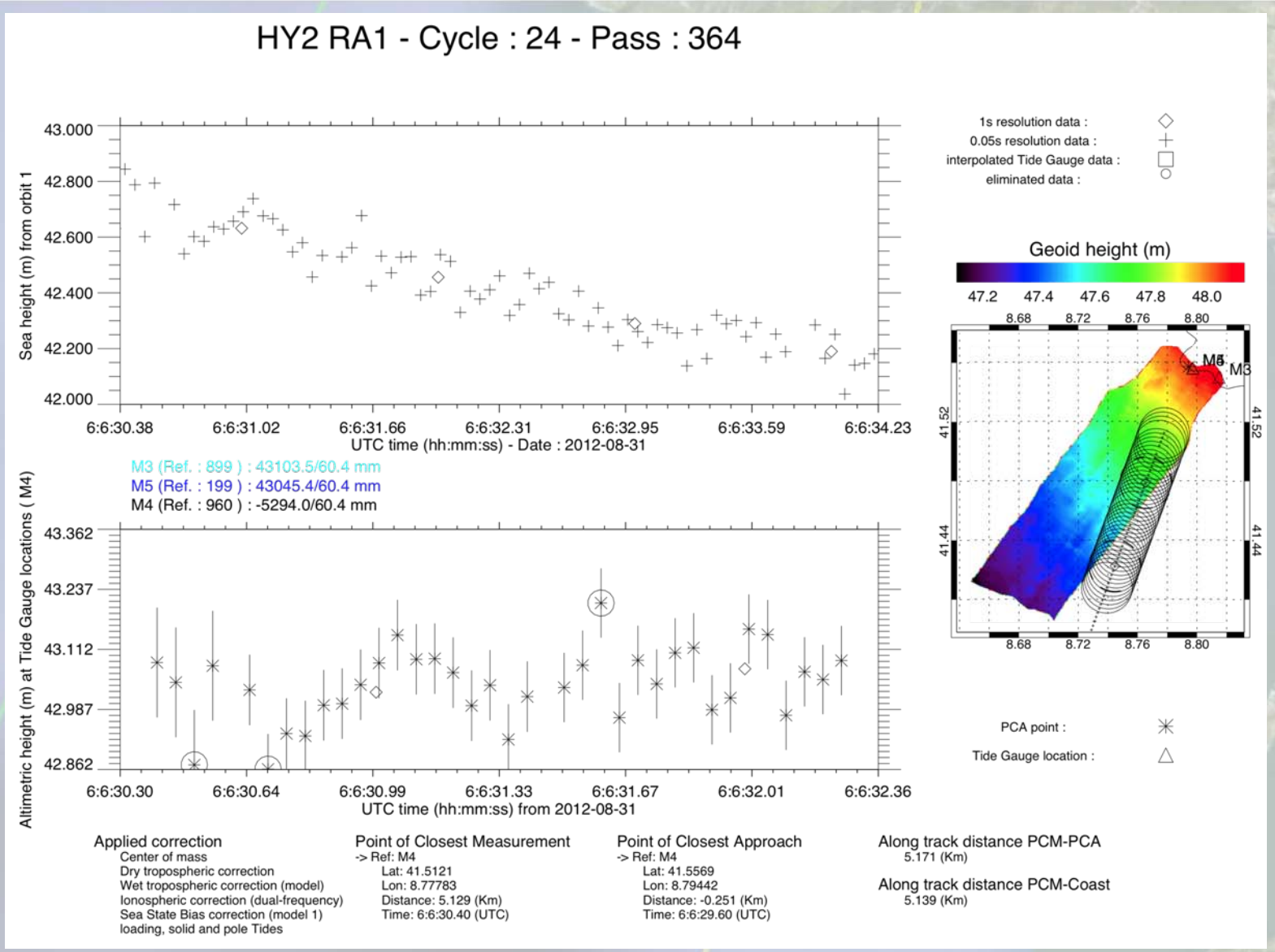
Applied correction
Center of mass
Dry tropospheric correction
Wet tropospheric correction (model)
Ionospheric correction (model)
Sea State Bias correction (model 1)
loading, solid and pole Tides

Point of Closest Measurement
-> Ref: M1
Lat: 41.9349
Lon: 8.63225
Distance: 10.90 (Km)
Time: 11:48:36.03 (UTC)

Point of Closest Approach
-> Ref: M1
Lat: 41.9398
Lon: 8.63291
Distance: -10.92 (Km)
Time: 11:48:37.95 (UTC)

Along track distance PCM-PCA
0.555 (Km)

Along track distance PCM-Coast
10.81 (Km)

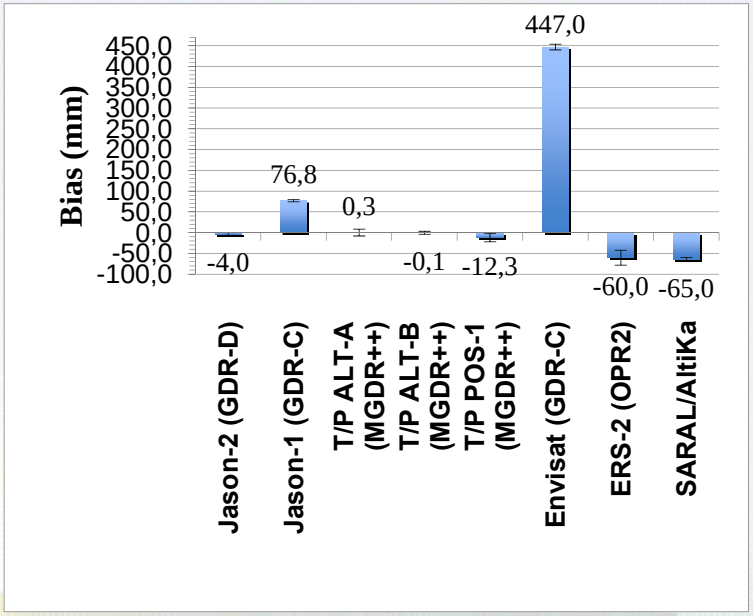


HY|2A

The huge value of the bias (~-5.3m) is due to the fact that the internal delay was not applied in the current CNES reprocessed products

The standard deviation of the high-rate (~60mm) is at the level of Jason-2 one on such sea state condition (SWH=~2m).

Calibration from Corsica



Absolute biases over the whole data sets:

- **Jason-2: -4 ±4 mm (GDR-D)**
- **Jason-1: +77 ±3 mm (GDR-C)**
- **T/P ALT-A: 0 ±8 mm (MGDR^{++})**
- **T/P ALT-B: 0 ±4 mm (MGDR^{++})**
- **T/P POS-1: -12 ±10 mm (MGDR^{++})**
- **EnviSat: +447 ±7 mm (GDR-C)**
- **ERS-2: -60 ±18 mm (OPR-2)**
- **SARAL: -65 ±5 mm (IGDR-T)**

Range:

Configuration of the Corsica calibration site offers a unique opportunity to test and validate new altimeter technology or modes and retracking algorithms

SARAL/AltiKa and CryoSat-2 (SARM) improves the data quality up to 3-4km from the coast (compared to ~10km for Jason)

SARAL/AltiKa bias stability (+5mm) for only 6 months with a repeatability of 35-d is equivalent to Jason ones over several years with a 10-d repeatability

Wet tropospheric corrections:

Jason-1&2

No significant drift detected from JMR/GPS and AMR/GPS comparisons.

Better agreement between GPS and coastal path delays (EPD) from AMR and JMR

EnviSat

No clear impact of the land contamination detected

Single site could not afford the GCE and local systematic errors
⇒Multiple calibration sites are needed

Corsica Absolute Altimeters Calibration

CONCLUSION