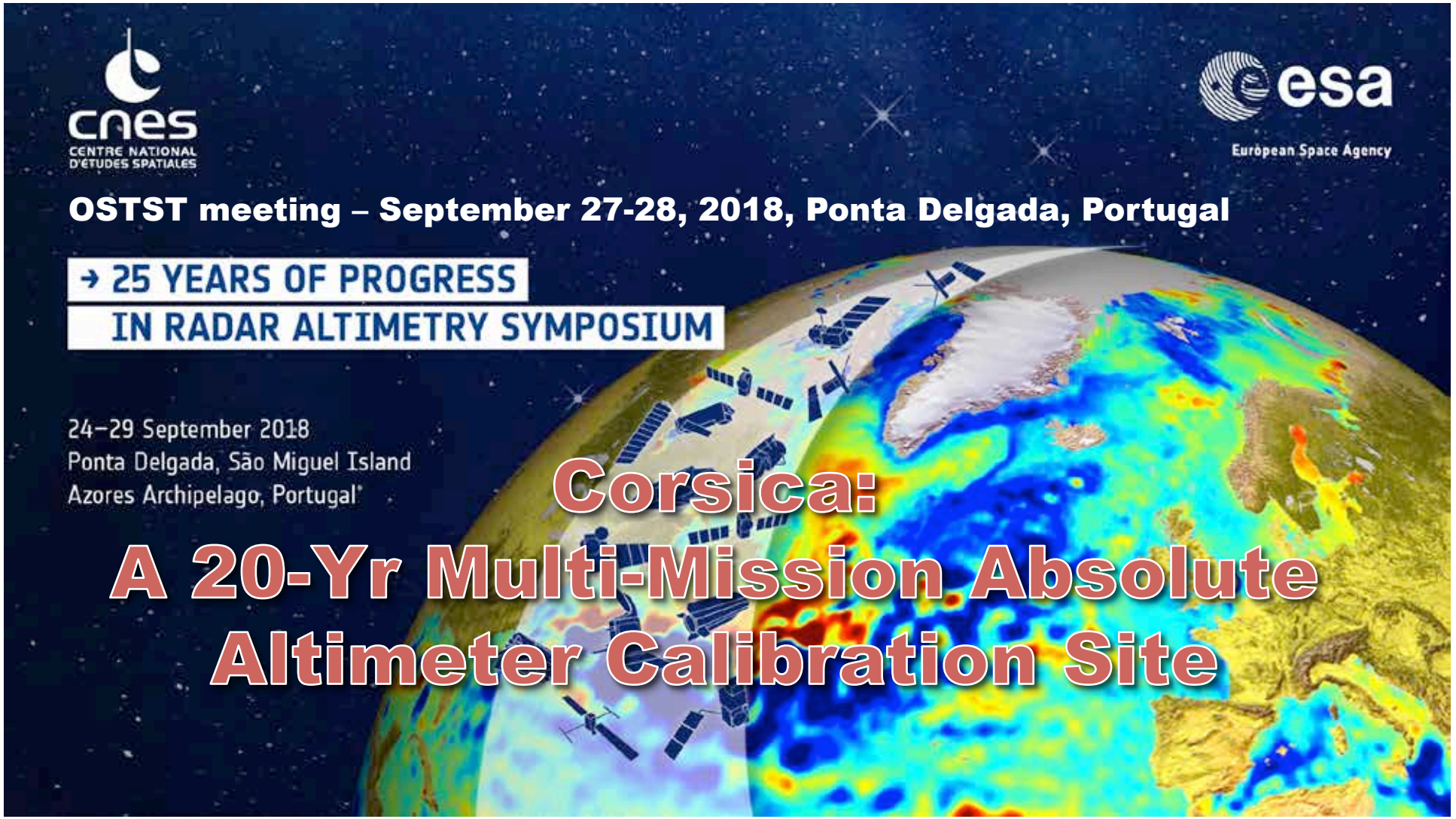

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[1]Observatoire de Paris/SYRTE, Paris, France

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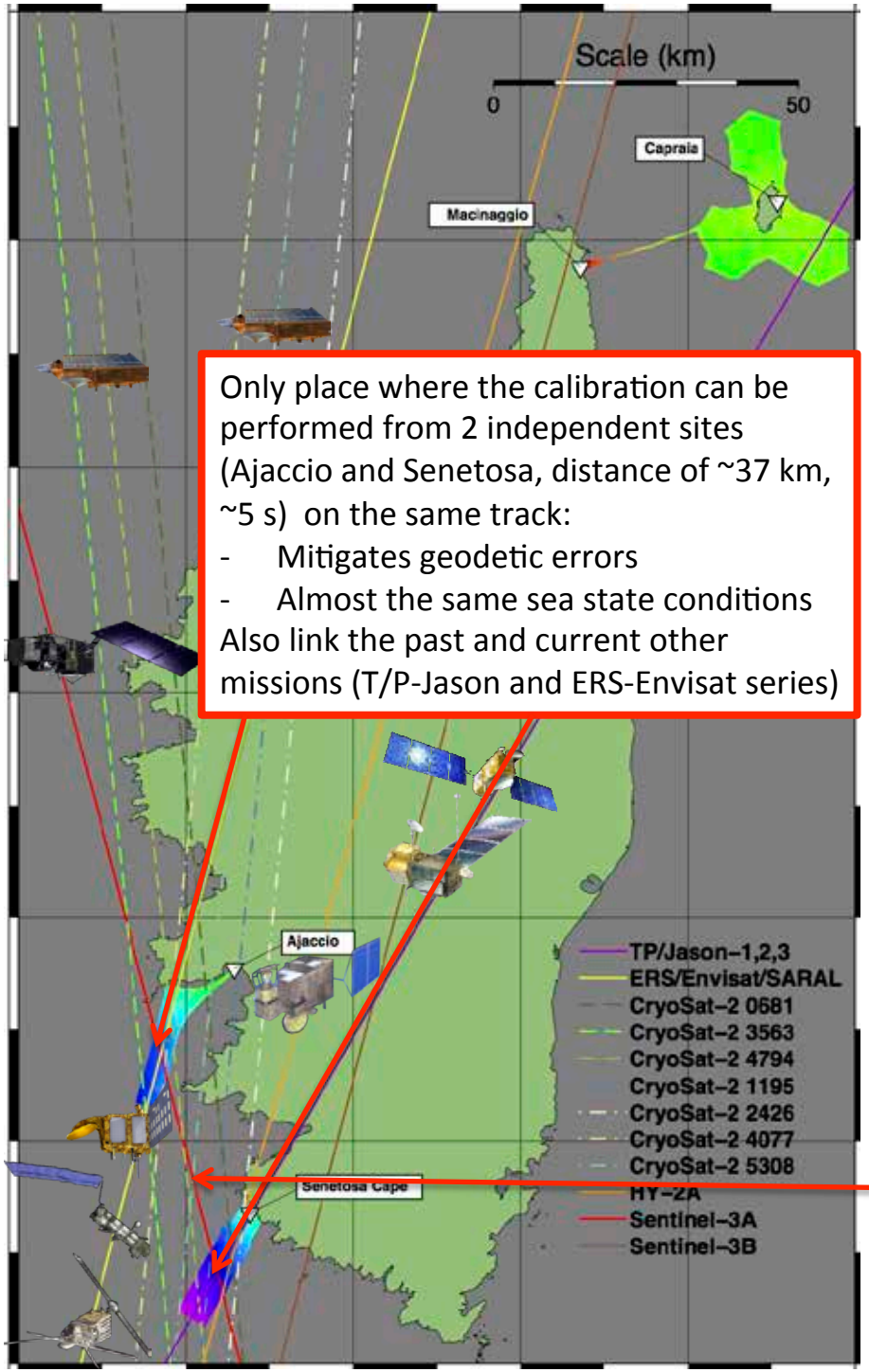
l'Observatoire de Paris | SYRTE

Systèmes de Référence Temps-Espace

GeoAzur TERRE - OCÉAN - ESPACE

Corsica Multi-mission Calibration Site



Only place where the calibration can be performed from 2 independent sites (Ajaccio and Senetosa, distance of ~37 km, ~5 s) on the same track:
- Mitigates geodetic errors
- Almost the same sea state conditions

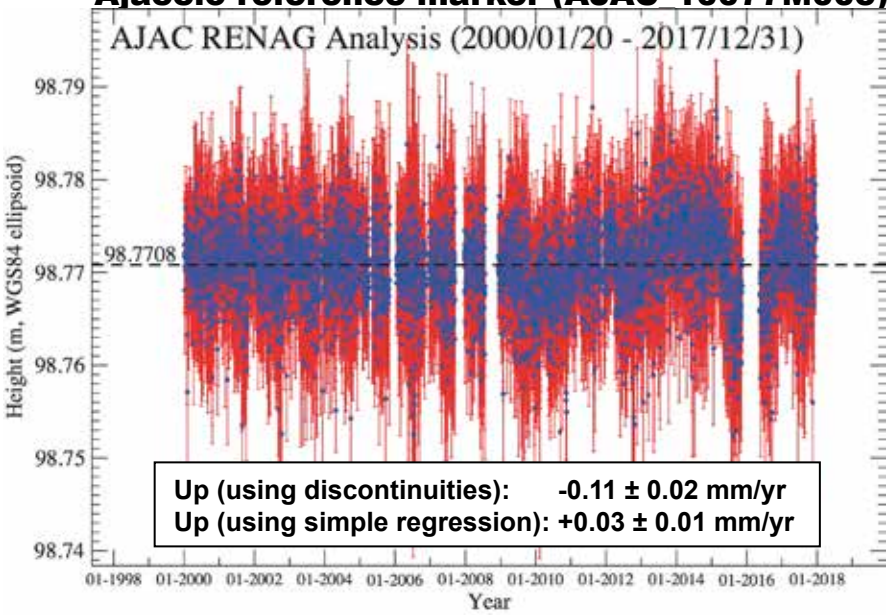
Also link the past and current other missions (T/P-Jason and ERS-Envisat series)

- **Senetosa CNES calibration site** established in 1998
  - Supports continuous monitoring of Jason-2&3 (and formerly T/P and Jason-1)
  - Equipped with 4 pressure tide gauges leveled to the permanent GPS receiver
- **Ajaccio configuration** established in 2000
  - Supports continuous monitoring of SARAL/ ALtiKa (and formerly ERS, Envisat)
  - Fiducial point near Ajaccio equipped with GPS/ SLR(FTLRS)/DORIS.
  - Equipped with a radar tide gauge (SHOM) leveled to the permanent GPS receiver
- **Corsica multi-mission calibration site: existing facilities also used for CryoSat-2, HY-2A and Sentinel-3A**
- **Open-ocean altimeter readings** connected to tide gauges via detailed **local geoid model**
  - Derived from intensive GPS buoy and catamaran surveys along ground track (in 1999 for Senetosa). Extension to Ajaccio (2005) and Capraia (2004)
  - Open-ocean verification locations for GPS-based SSH measurement systems deployments.
  - **Planned connection of the Ajaccio and Senetosa local geoids along the Sentinel-3A track**

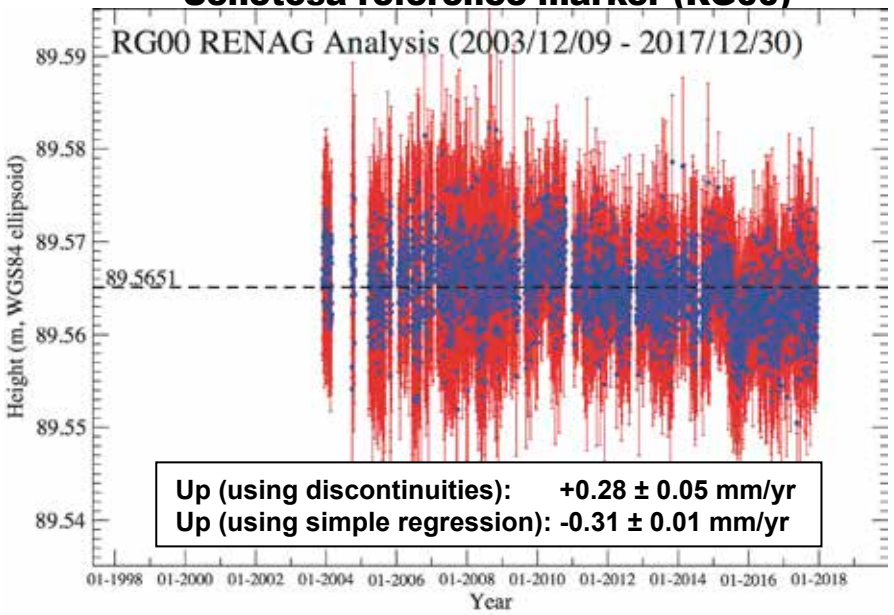
Update of the geodetic datum (1/2)

It sometimes takes time to clean out our closet…

Ajaccio reference marker (AJAC_10077M005)



Senetosa reference marker (RG00)



In the frame of the RENAG project (http://renag.resif.fr) a **complete reanalysis of the GPS coordinates has been performed** for the Ajaccio (AJAC) and Senetosa (RG00) reference markers **in the ITRF2014 reference frame**.

In terms of absolute vertical coordinates these new solutions have changed our historical references:

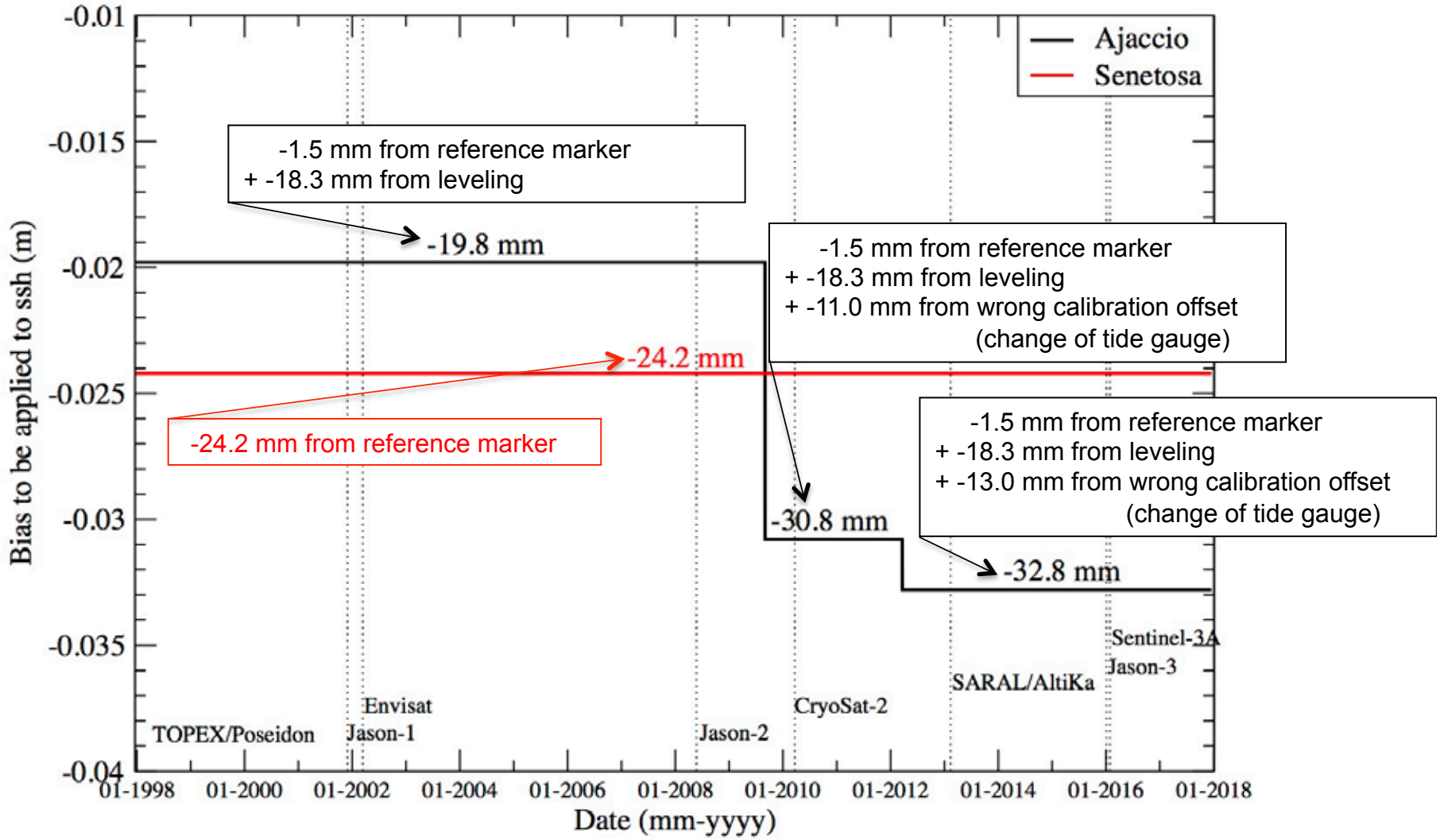
• 98.7708 m for **Ajaccio** (AJAC) => **-1.5 mm when compared to our historical reference** (and -0.7 mm compared to official ITRF2014)

• 89.5651 m for **Senetosa** (RG00) => **-24.2 mm when compared to our historical reference** (and -4.5 mm compared to a solution computed recently with GIPSY/JPL over the same period)

The small values of the velocities and the opposite signs within a very short distance (~37 km) suggest that there is **no vertical geophysical motion over this area**. We then considered in this study a zero velocity for both sites. Over the whole studied periods, 1998-present for Senetosa and 2000-present for Ajaccio, it will lead to a possible error of respectively ~6 mm and ~2 mm.

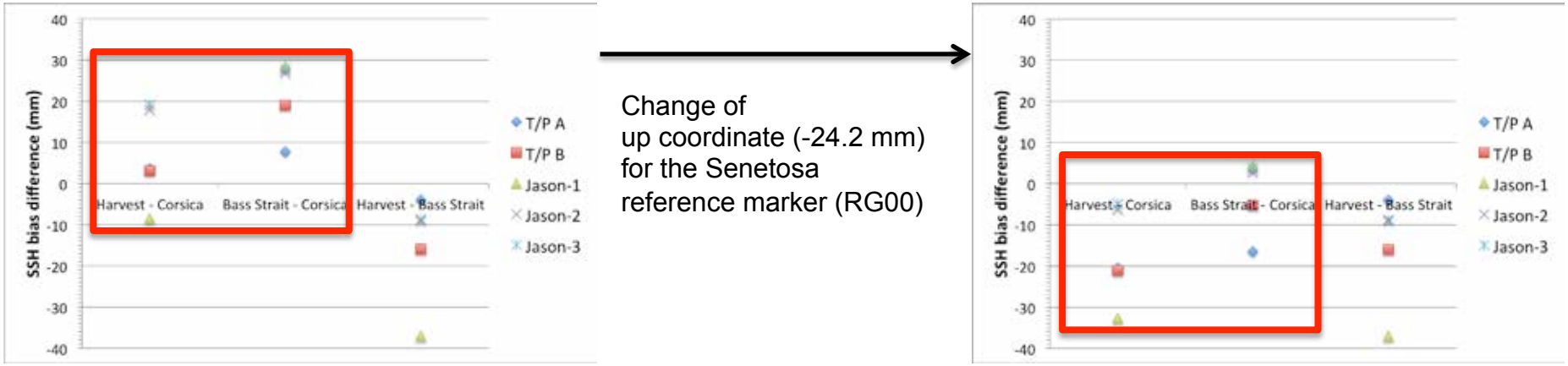
Update of the geodetic datum (2/2)

It sometimes takes time to clean out our closet…



The SSH biases for all the missions have been recomputed based on these geodetic datum changes (presented in poster #168 @ 25YPRA)

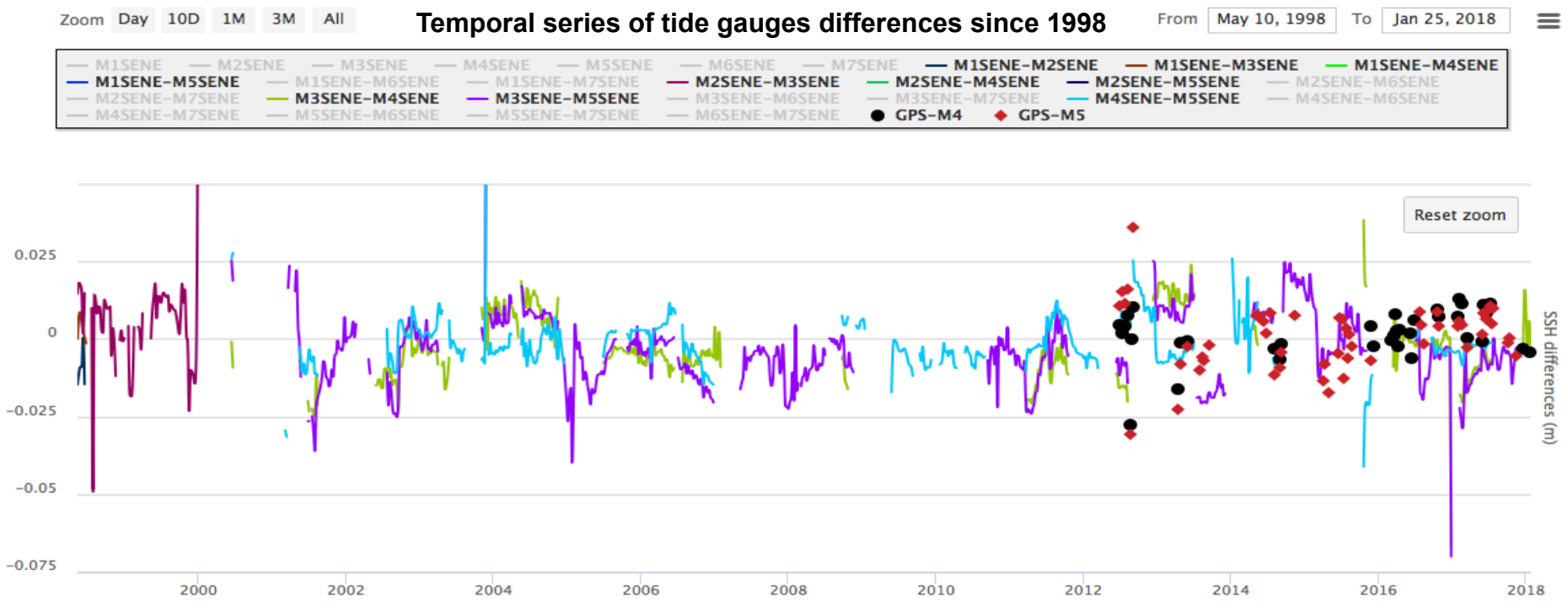
Impact of the geodetic datum update



The update of the up coordinate (-24.2 mm) for the Senetosa reference marker (RG00) improves the consistency with Harvest and Bass Strait for all the altimeters (T/P-A&B, Jason-1,2,3). Comparisons are based on OSTST 2018 results for both Harvest and Bass Strait.

Absolute calibration accuracy at the cm level is still a challenge…

Stability of in situ measurement system
Comparisons with independent measurements

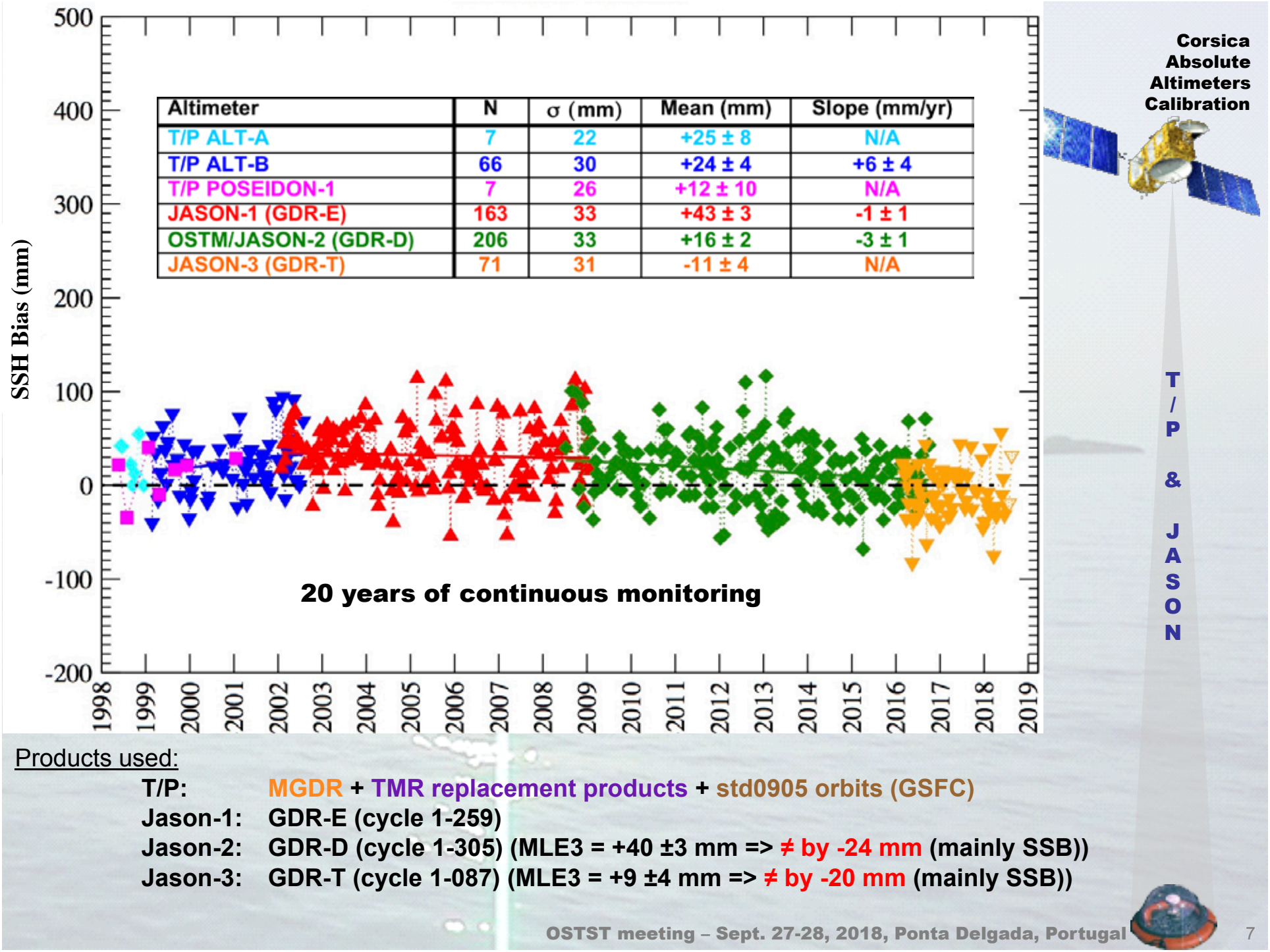


Average differences at the few millimeters level with ~1 cm standard deviation

Stability of the differences better than ~0.1 mm/yr

GNSS system for measuring SSH

Type of comparaison	Mean (mm)	σ (mm)	Drift (mm/yr)	Number
between tide gauges since (1998)				
M3SENE-M4SENE	-1.7	11.7	+0.09 ± 0.02	319680
M3SENE-M5SENE	-3.4	12.7	+0.14 ± 0.02	538488
M4SENE-M5SENE	-1.1	7.7	-0.04 ± 0.02	410724
between GNSS et tide gauges (since 2012)				
GPS-M4SENE	1.9	7.7	+1.40 ± 0.63	42
GPS-M5SENE	0.3	10.5	+0.63 ± 0.81	62



Altimeter	N	σ (mm)	Mean (mm)	Slope (mm/yr)
T/P ALT-A	7	22	+25 ± 8	N/A
T/P ALT-B	66	30	+24 ± 4	+6 ± 4
T/P POSEIDON-1	7	26	+12 ± 10	N/A
JASON-1 (GDR-E)	163	33	+43 ± 3	-1 ± 1
OSTM/JASON-2 (GDR-D)	206	33	+16 ± 2	-3 ± 1
JASON-3 (GDR-T)	71	31	-11 ± 4	N/A

Products used:

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

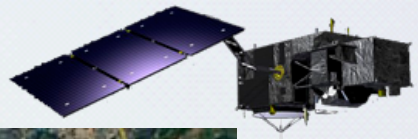
Jason-1: GDR-E (cycle 1-259)

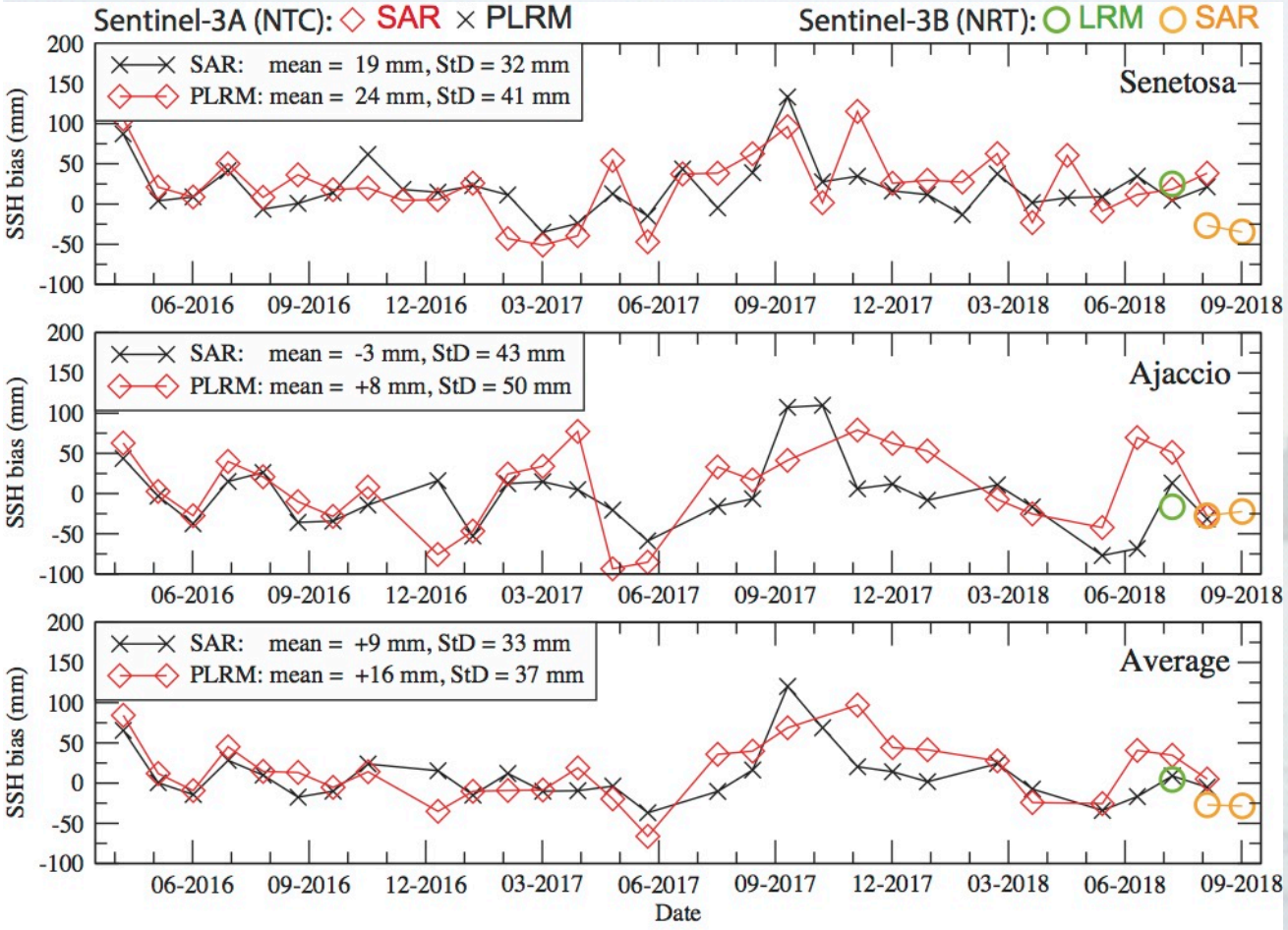
Jason-2: GDR-D (cycle 1-305) (MLE3 = +40 ±3 mm => ≠ by -24 mm (mainly SSB))

Jason-3: GDR-T (cycle 1-087) (MLE3 = +9 ±4 mm => ≠ by -20 mm (mainly SSB))

Absolute SSH biases (PDGS: SARM & PLRM)

Corsica Absolute Altimeters Calibration





SENTINEL | 3 A & B

The averaged Sentinel-3A SSH bias (NTC products) for both locations is:

- SAR: +9 ± 6 mm

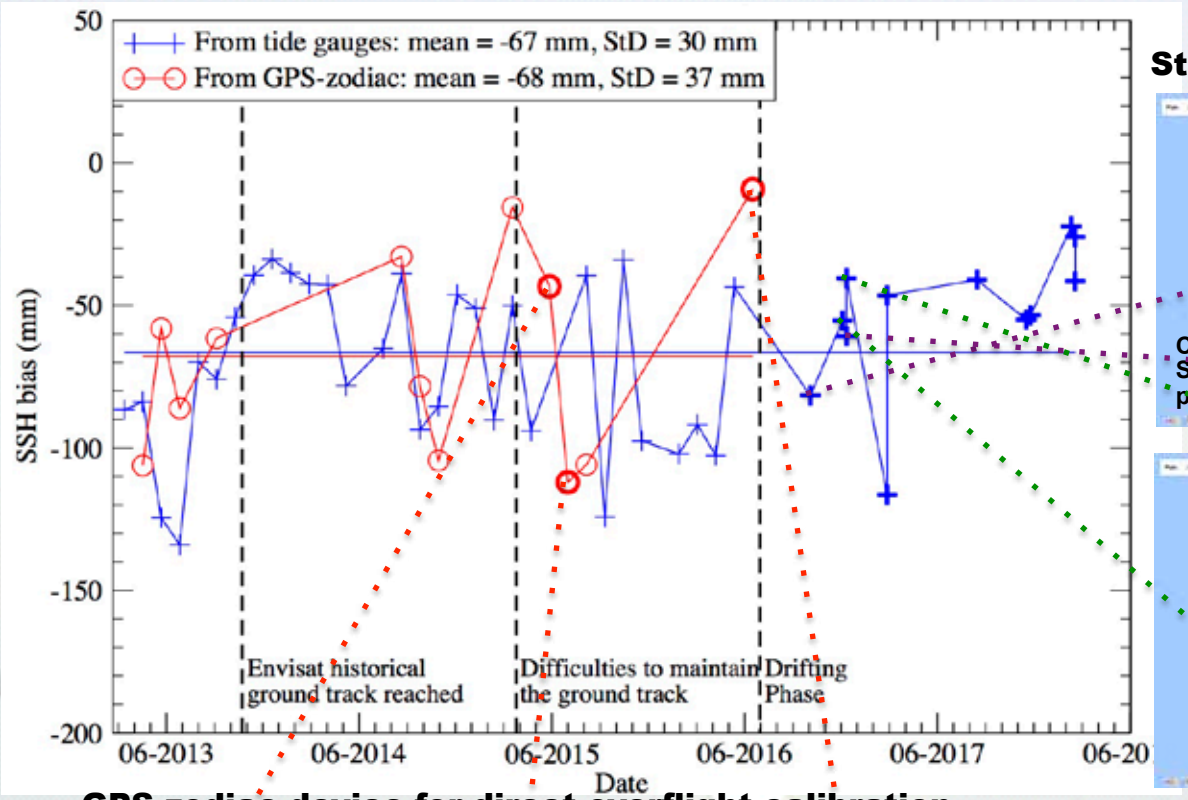
- PLRM: +16 ± 7 mm

Recent studies using the transponder installed in Crete show that the SAR range bias is 0 ± 12 mm (Mertikas et al., 2017) and 8 ± 12 mm (Garcia-Mondejar et al., 2017), so our results are in very good agreement.

For Sentinel-3B SSH bias (NRT products) in tandem with Sentinel-3A:

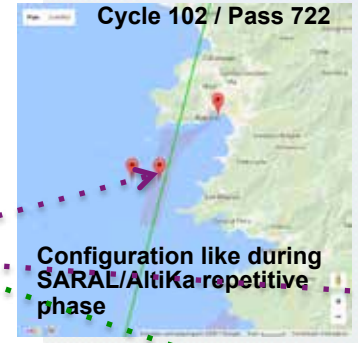
- LRM: +4 mm (first cycle)

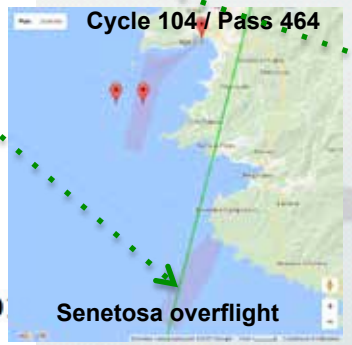
- SAR: -28 mm (2 cycles)

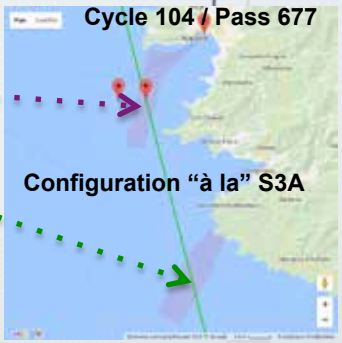


Standard tide gauge calibration

Corsica Absolute Altimeters Calibration







GPS-zodiac device for direct overflight calibration

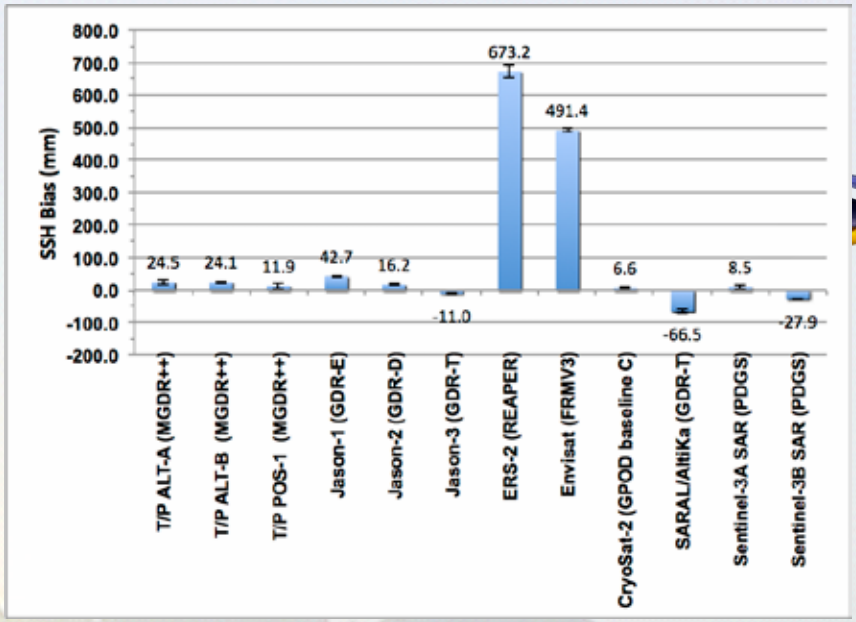
SARAL/ALTIKA

Using **either indirect (tide gauges) or direct (GPS-zodiac) calibration/validation approach gives similar SSH bias, respectively −67 ± 5 mm and −68 ± 11 mm**. Even during the Drifting Phase, we can continue to monitor the SSH bias using both approaches with a good agreement compared to the whole time series and a period close to the initial one: 36 days in average compared to the 35-day repeat period during the nominal phase, but not evenly distributed.

Calibration from Corsica

Absolute SSH biases over the whole data sets:

- T/P ALT-A: +25 ±8 mm (MGDR++)
- T/P ALT-B: +24 ±4 mm (MGDR++)
- T/P POS-1: +12 ±10 mm (MGDR++)
- Jason-1: +43 ±3 mm (GDR-E)
- Jason-2: +16 ±2 mm (GDR-D)
- Jason-3: -11 ±4 mm (GDR-T)
- ERS-2: +673 ±19 mm (REAPER)
- Envisat: +491 ±6 mm (FRMV3)
- CryoSat-2: +7 ±5 mm (GPOD baseline C)
- SARAL: -67 ±5 mm (GDR-T)
- S3A SAR: +9 ±6 mm (PDGS, NTC)
- S3B SAR: -28 ±6 mm (PDGS, NRT)



Corsica Absolute Altimeters Calibration

CONCLUSION

These new SSH biases are based on a complete update of Ajaccio and Senetosa geodetic datum and the most recent reprocessings of altimetry data sets.

Main findings:

Jason-1 reprocessing (GDR-E):

- Message from last years: a wrong standard dry troposphere correction for cycle 1-150 in some coastal areas (step of 8 mm before/after cycle 150).

Jason-2:

- Nothing to declare, waiting for GDR-E or F…

Jason-3:

- A very stable SSH bias of -11 mm

Sentinel-3A&B:

- Sentinel-3A (NTC): a very stable SSH bias of +9 mm for SAR
- Sentinel-3B (NRT): first 3 cycles shows a SSH bias statistically close to Sentinel-3A time series

CryoSat-2:

- Re-processing of the whole CryoSat-2 data (SAR, baseline C) gives a very stable SSH bias of +7 mm

SARAL/AltiKa:

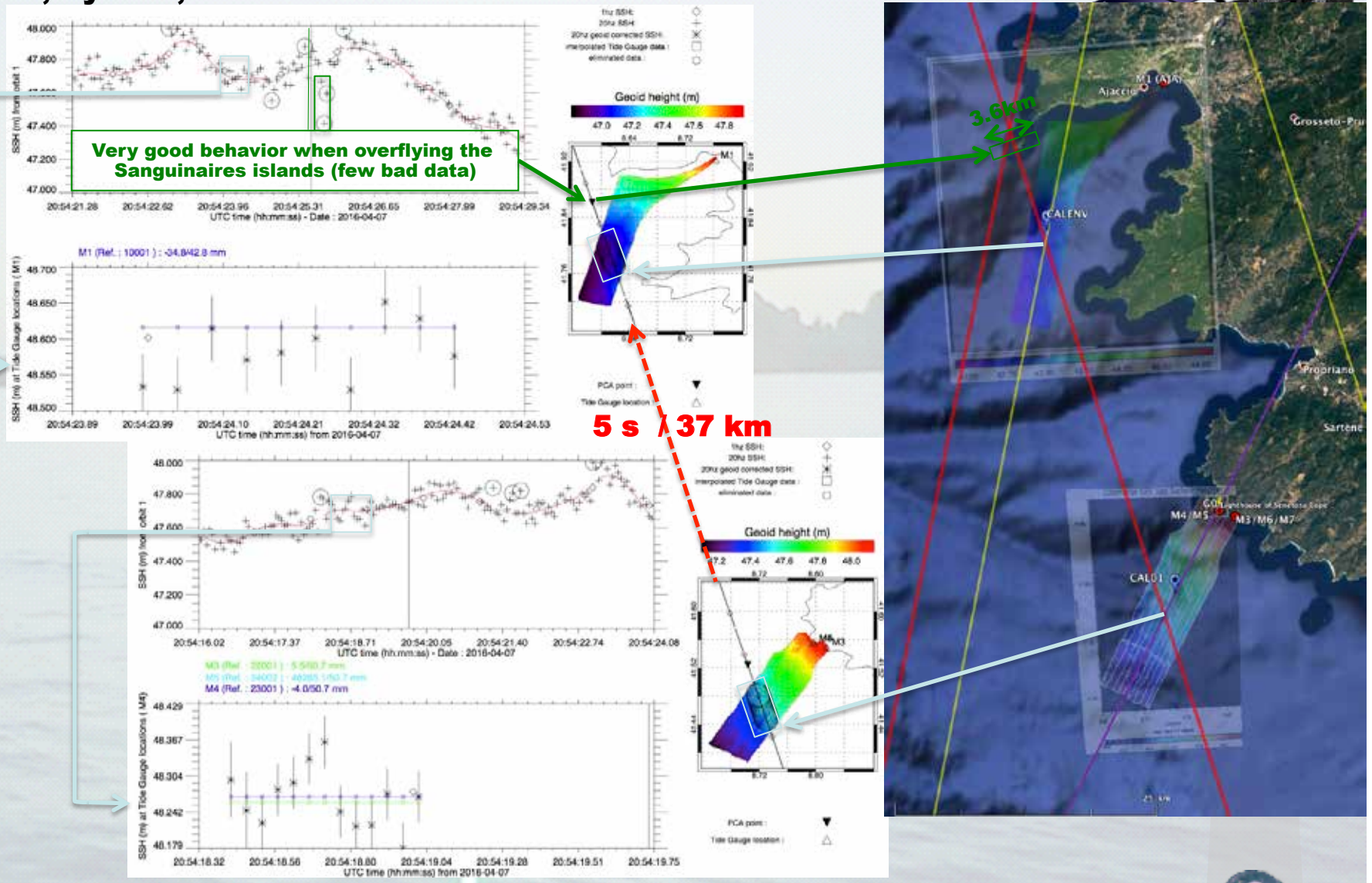
- The SSH bias monitoring can continue during the drifting phase and is stable

Backup slides

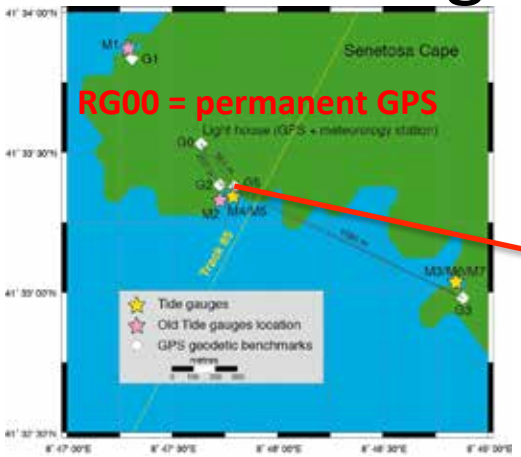
Processing (use the latest homogeneous NTC data set from PDGS: PB 2.27)

Corsica Absolute Altimeters Calibration

Sentinel-3A, SAR mode
Pass 741, Cycle 2, 2016-04-07 20:54

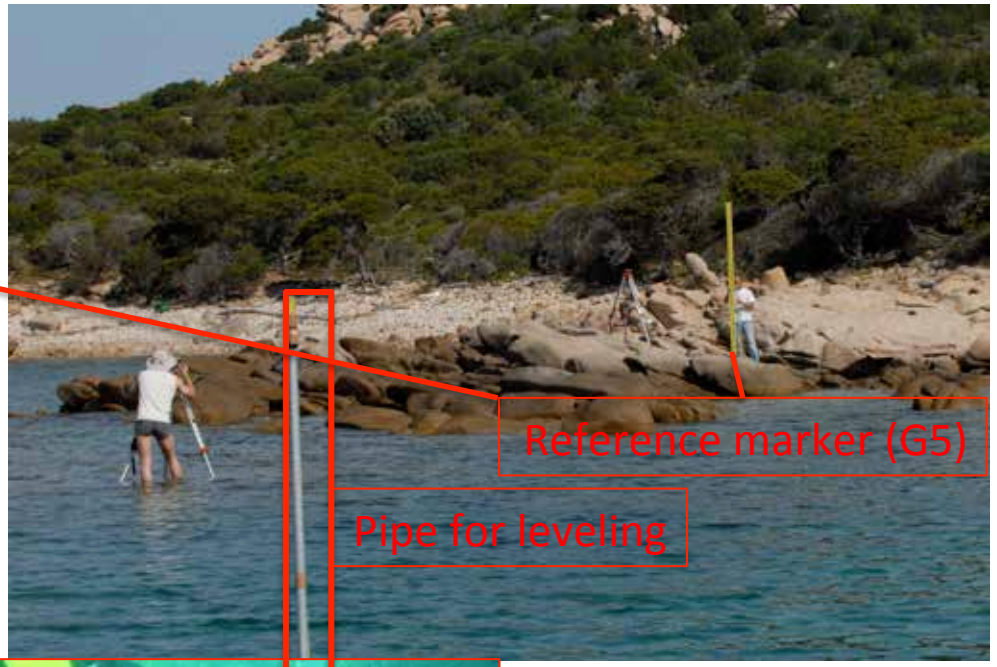


Stability of the geodetic reference
Leveling of the in situ instruments

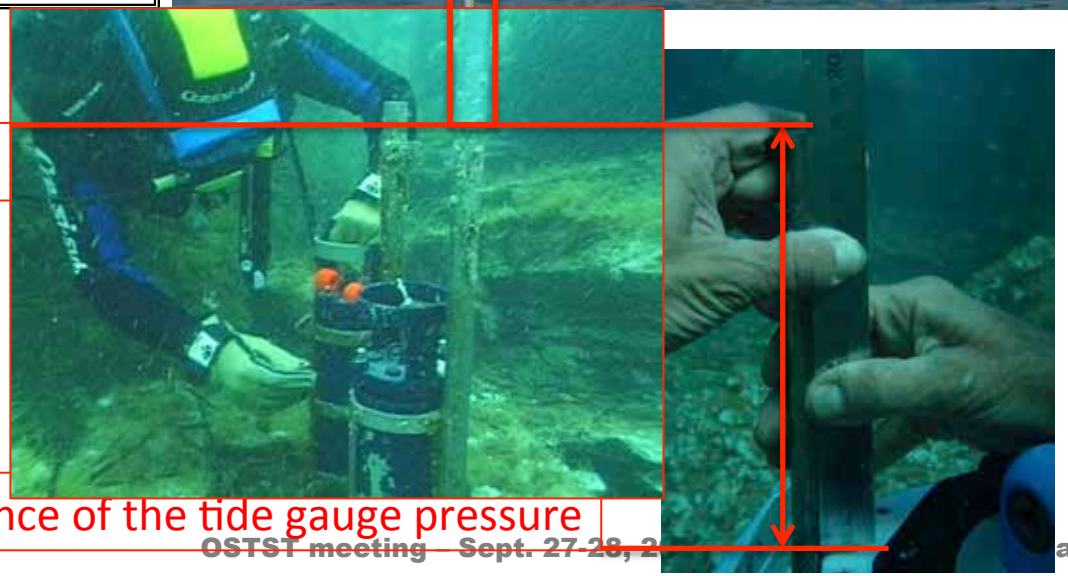


	Leveling 2009 (m)	Leveling 1998 (m) Leveling 2001 (m)	Differences (mm)
G5 --> M4	-4.5166	-4.5169	0.3
G5 --> M5	-4.4986	-4.4990	0.4
G3 --> M3	-5.5583	-5.5585	0.2
G2 --> G5	-3.0531	-3.0535	0.4
G0 --> G2	-38.7550	-38.7560	1.0

Less than 1 mm differences even after 10 years



Reference of the tide gauge mount



Reference of the tide gauge pressure

Tide gauges are installed by pair:
M4/M5 (photo) on one side of the bay
M3/M7 on the other side