Regional in situ CALVAL of satellite altimeter range at non-dedicated sites

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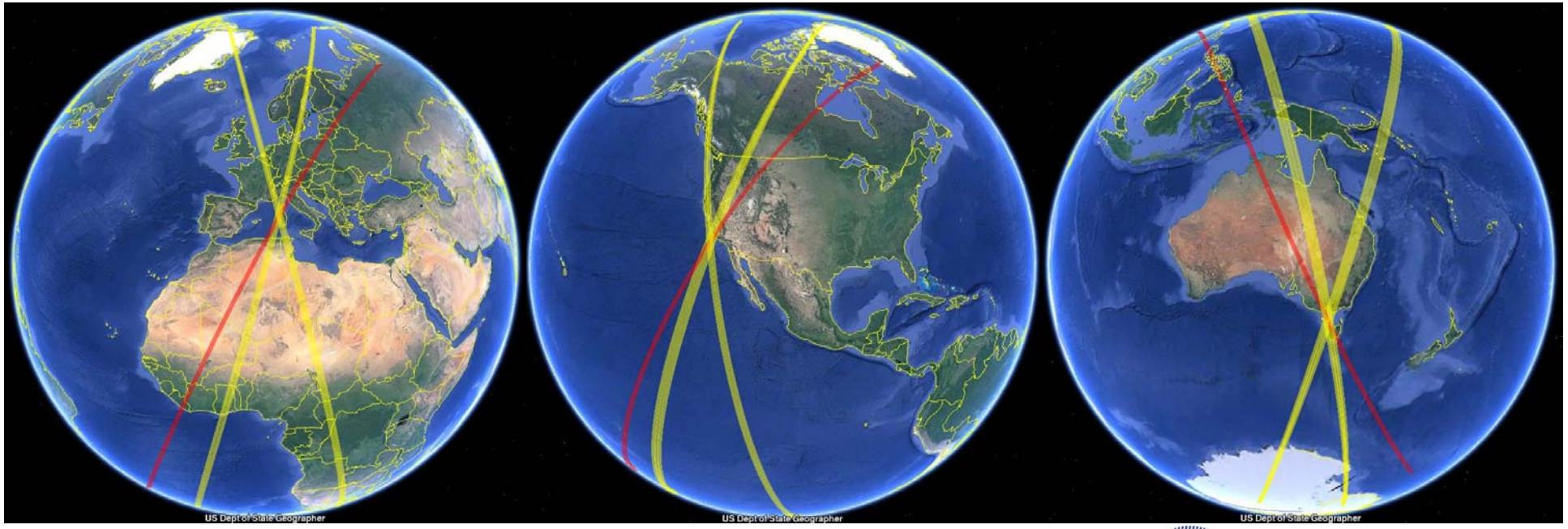


Altimeter SSH CALVAL

Main objectives:

✓ Altimeter performance: SSH stability (drifts), SSH bias between the altimetry missions

✓ Products improvement: Evaluation of new corrections and parameters (orbit, etc...)

Global CALVAL

✓ Intra/intermission comparisons:

→ at crossover points and along the tracks (boxes)

→ large patterns, geographically correlated errors, open ocean performance

✓ Comparisons to tide gauge global networks:

→ altimeter drifts, global coastal performance

Complementarity between all the methods

Local CALVAL

✓ Comparisons to georeferenced tide gauges at a few calibration sites:

→ altimeter absolute bias, drifts, geographically correlated errors, local coastal performance

→ limitation: only for the altimeters that fly over the calibration sites (mainly Jason suite)

Regional absolute CALVAL method

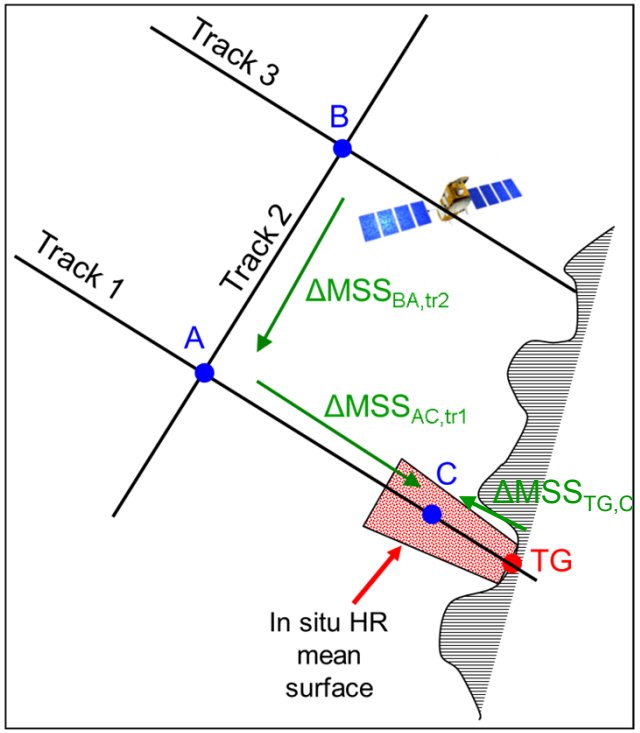
Combination of:

Local CALVAL: Direct comparison between altimeter and tide gauge SSH (point C).

- ✓ Only for satellite flying over the calibration sites.
- ✓ Directly comparable to the absolute bias estimates computed by the local in situ calval groups (Corsica, Harvest, Bass Strait, Gavdos...)

Offshore CALVAL: Computation of the bias on offshore passes (points A & B)

- ✓ Following a succession of accurate mean sea surface profiles, combining several missions
- ✓ Using a high resolution mean sea surface to link the *in situ* and altimetry SSH, when available (MSS otherwise)



Regional absolute CALVAL method

Generic method:

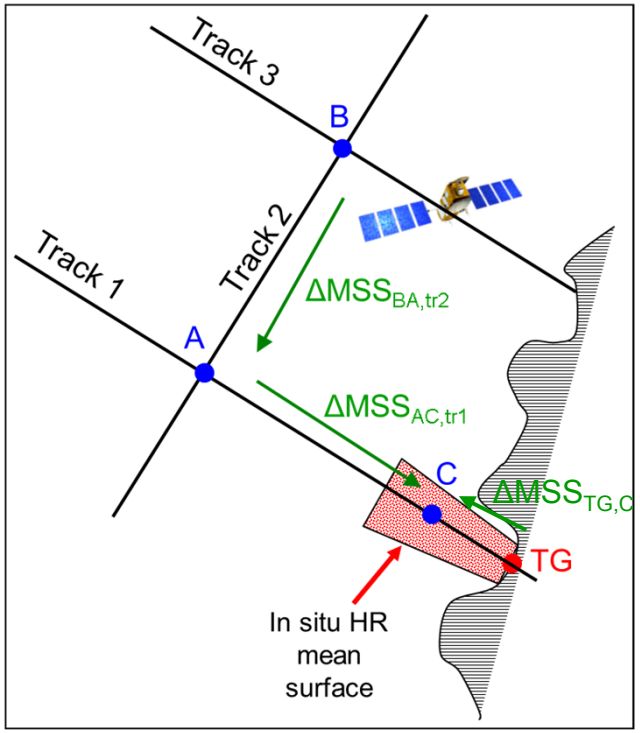
➔ **Calibration of missions on new orbits**

- ✓ After an orbit change (ex: interleaved TP & Jason-1, Envisat after October 2010, Jason-1 end-of-life)
- ✓ For orbits without dedicated calibration sites (ex: Sentinel-3).

➔ **Calibration of non-repetitive orbits**

- ✓ Missions on non-repetitive or drifting orbits (ex: CryoSat-2).

Applicable to any calibration site: Corsica, Harvest Platform, Bass Strait, Gavdos…



Regional absolute CALVAL method

Highly depends on:

- ✓ Good-quality SSH data (altimetry & tide gauge)
- ✓ Accurate mean sea surface profiles
- ✓ High resolution local mean sea surface (GPS survey) or accurate global MSS
- ✓ Ocean dynamics corrections: ocean tide and atmospheric effects between the offshore tracks and the coast

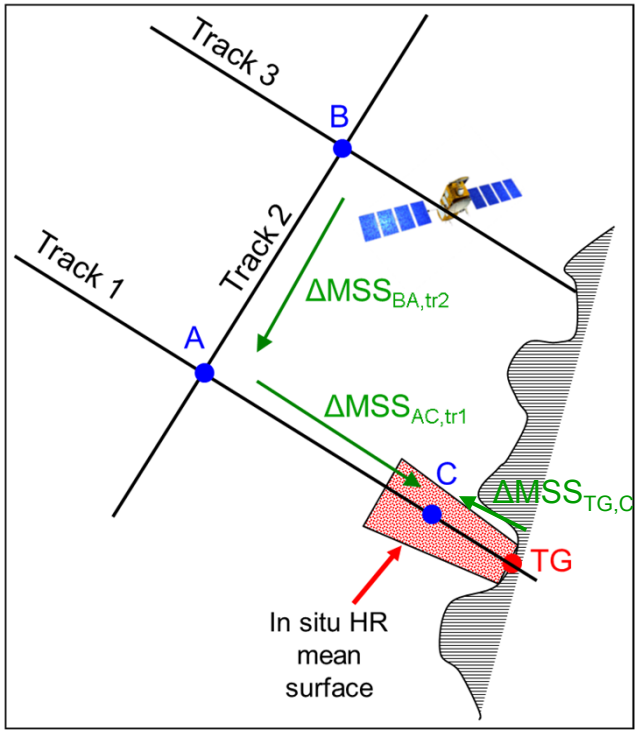
Implemented:

in Corsica (Senetosa & Ajaccio) for Topex, Jason-1, GFO, Jason-2, Envisat and SARAL/AltiKa

at Harvest for Jason-2, Envisat, SARAL/AltiKa

at Bass Strait for Jason-2, Envisat, SARAL/AltiKa

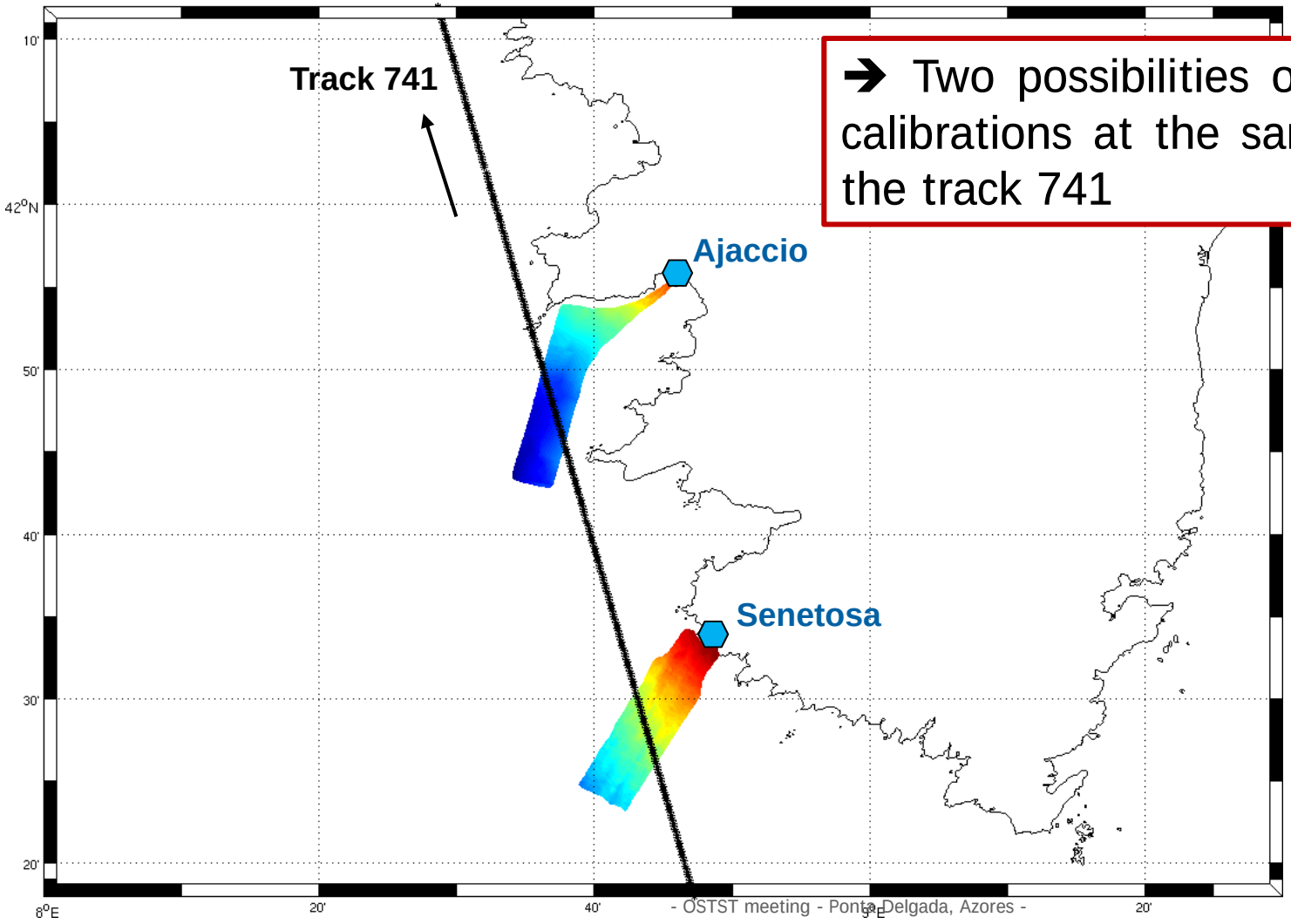
+ Sentinel-3 at the 3 sites (underway)



➢ Jan et al, 2003; Cancet et al, 2012; Bonnefond et al, 2017

Sentinel-3A CALVAL results

Sentinel-3A local absolute bias in Corsica

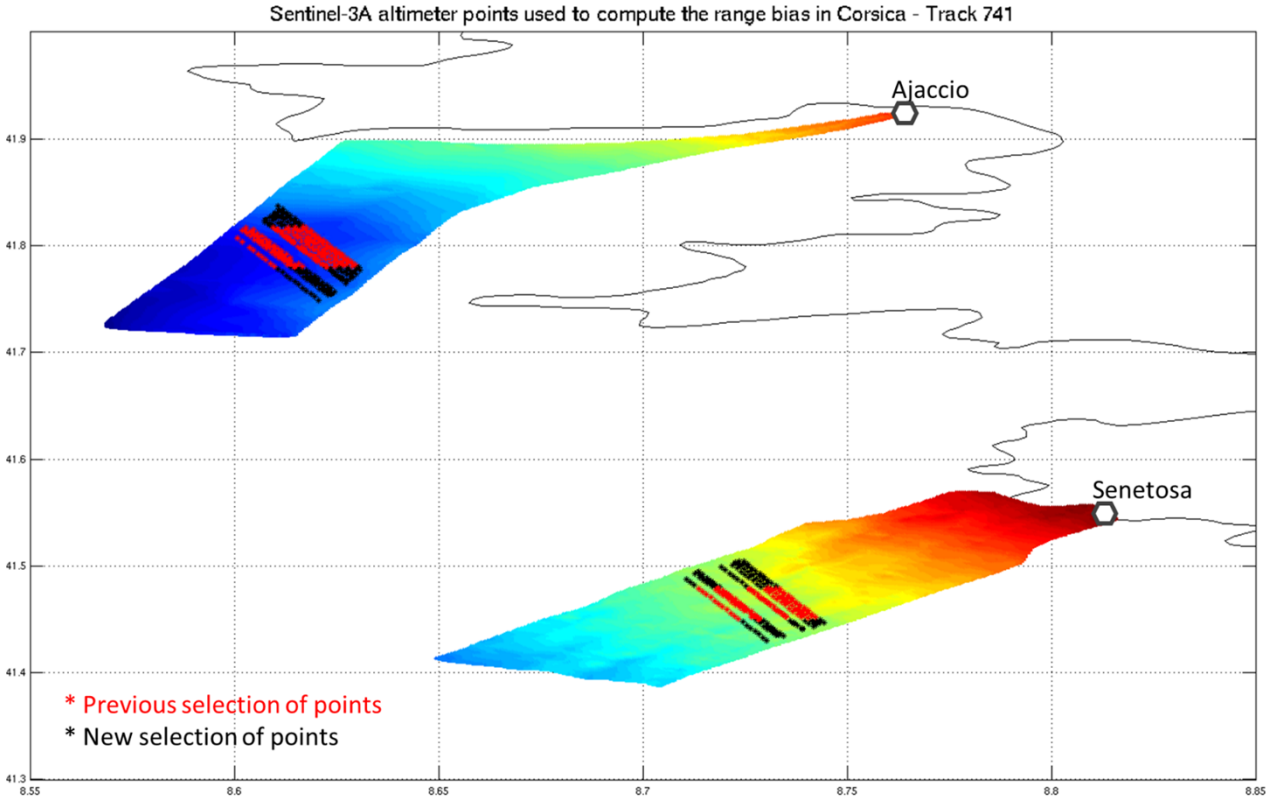


➔ Two possibilities of S3A absolute calibrations at the same time, along the track 741

Some improvements to the method for steadier biases

➔ Strategy for altimeter points selection on the high-resolution mean sea surfaces developped for longitudinal overflights (Jason, Envisat).

➔ Not well adapted to S3A ➔ New strategy, steadier results.



- New selection of the altimeter points for the absolute bias computation
- Smoothing of the high resolution (50m) in situ mean sea surface

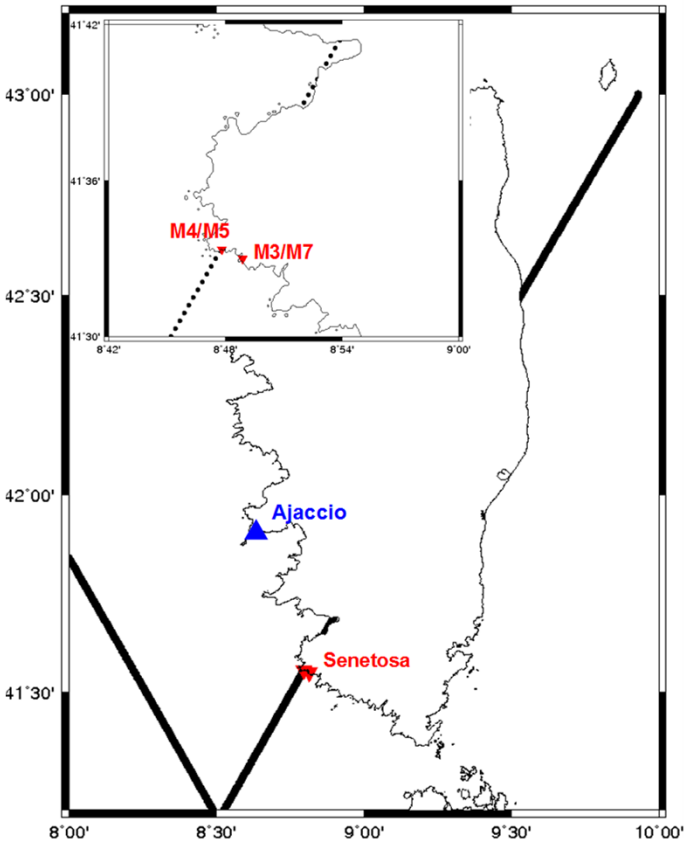
Sentinel-3A products used in this study

- NT-LAND: files S3A_SR_2_LAN_*
  - From cycle 1 to cycle 29
  - PB 2.33 reprocessing from S3 MPC ftp

	Sentinel-3A
Period	Cycles 1 – 29 03/2016 – 04/2018
Range	LRM (cycle 1) / SAR / PLRM
Ionosphere	GIM
Wet troposphere	Model (land contamination in radiometer correction)
Ocean tide	/
Wind and pressure effects	/

Tide gauge in situ data used in this study

- **Senetosa** (4 tide gauges maintained by CNES and OCA)
  - From 03/2016 to 05/2018 (most recent data)
- **Ajaccio** (1 tide gauge maintained by SHOM)
  - From 03/2016 to 06/2018 (most recent data)



Sentinel-3A CALVAL in Corsica

Sentinel-3A absolute local bias (mm) Track 741 PB 2.33 (MPC S3)	SAR			PLRM		
	Mean	Std	Nb of cycles	Mean	Std	Nb of cycles
Senetosa *(cycle 1 to 29)*	-3 ±5	24	28	-3 ±6	31	27
Ajaccio *(cycle 1 to 29)*	9 ±4	20	26	26 ±9	43	25

- **Cycle 1 in LRM (no PLRM)**
- **Senetosa**

  → Cycle 21 removed from the bias estimates time series (large SWH)
- **Ajaccio**

  → Cycles 22 and 29 removed from the bias estimates time series (large SWH)

→ In general, the largest bias values are linked with large SWH (SSB correction not optimal).

Sentinel-3A CALVAL in Corsica

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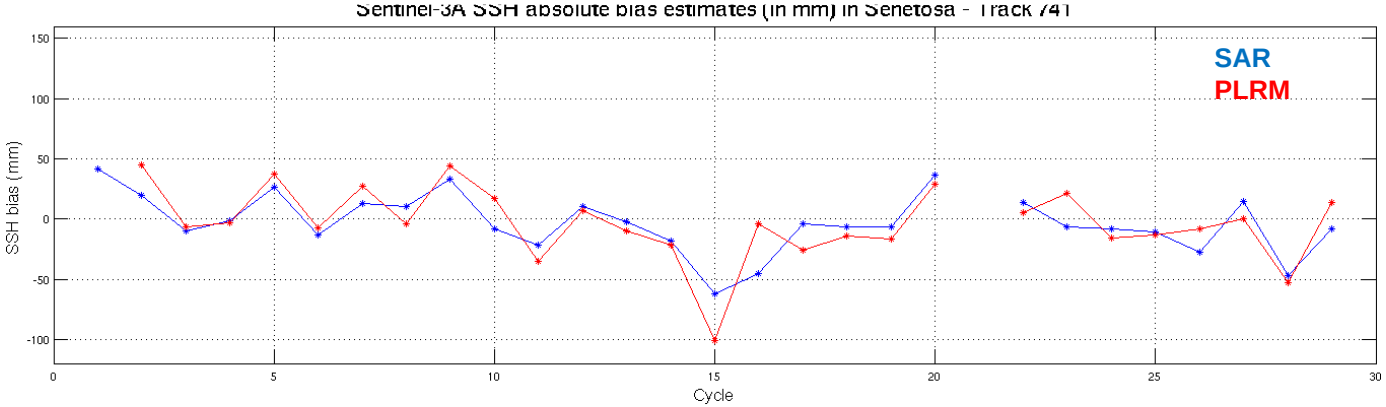
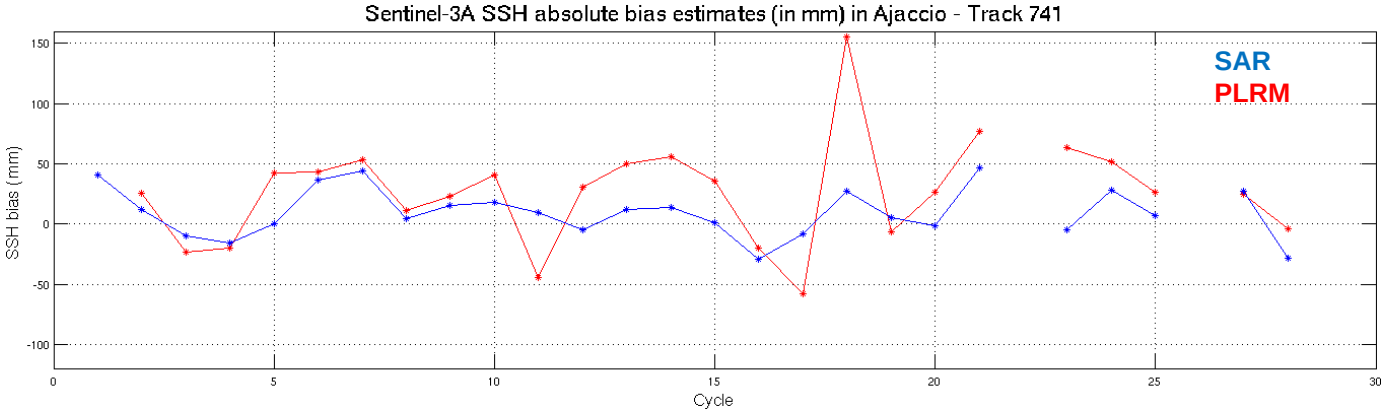




- More noise in PLRM bias estimates
- Very consistent results at both sites
- **Ajaccio**

Cycle 18: ~15 cm diff. between SAR and PLRM ranges.

When removing cycle 18 from the PLRM bias estimates:

Mean = 21 mm

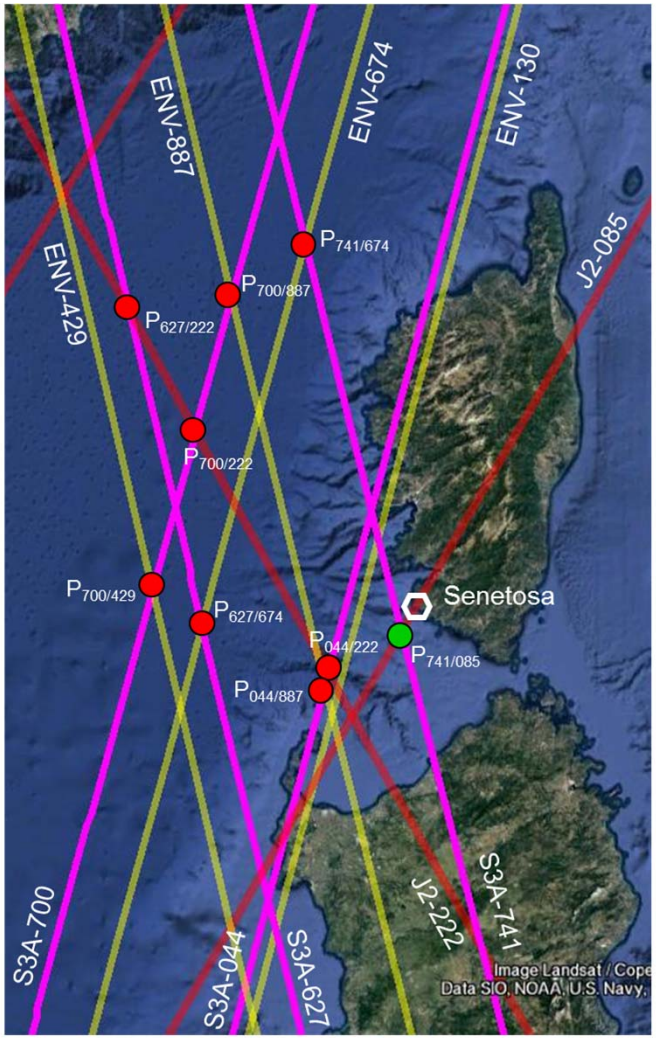
Std = 35 mm

Sentinel-3A regional absolute bias in Senetosa

Sentinel-3A absolute bias (mm) PB 2.33 (MPC S3) cycles 1 – 29	SAR			PLRM		
	Mean	Std	Nb of cycles	Mean	Std	Nb of cycles
Track 741 (local)	-3 ±5	24	28	-3 ±6	31	27
Track 741 X J2 085	-11 ±5	29	28	-10 ±7	37	27
Regional mean	**-7**	**27**	**28**	**-7**	**34**	**27**

→ Very stable results when considering this crossover, quite close to the Senetosa calibration site

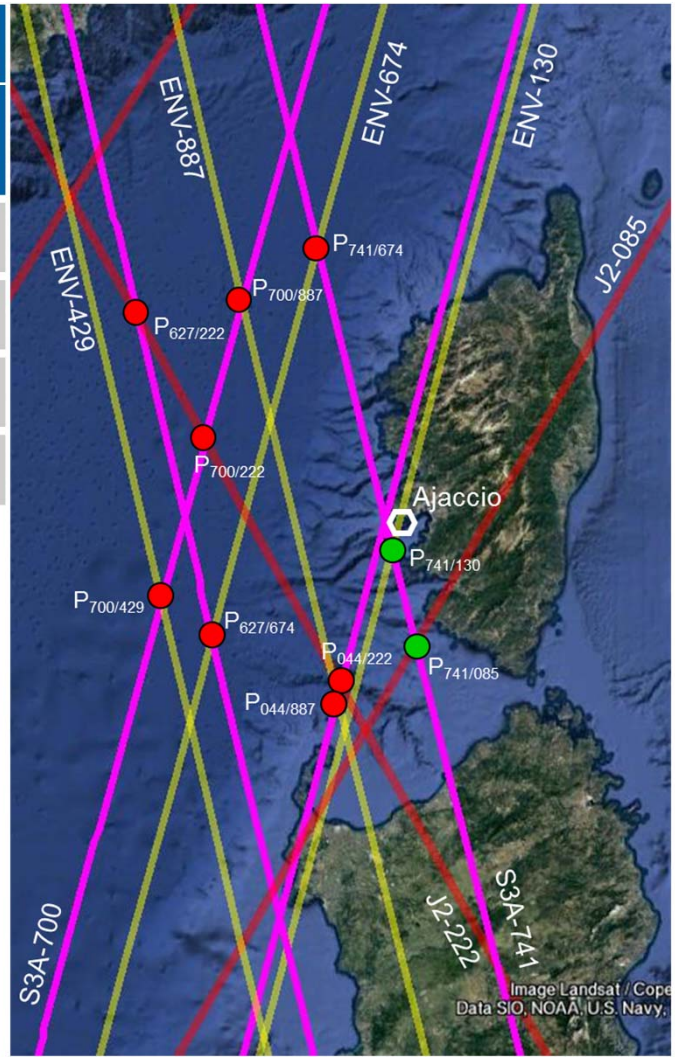
→ Need to use tide and DAC corrections to consider the other crossover points (work underway)



Sentinel-3A CALVAL in Corsica

Sentinel-3A regional absolute bias in Ajaccio

Sentinel-3A absolute bias (mm) PB 2.33 (MPC S3) cycles 1 – 25	SAR			PLRM		
	Mean	Std	Nb of cycles	Mean	Std	Nb of cycles
Track 741 (local)	9 ±4	20	26	26 ±9	43	25
Track 741 X Env 130	6 ±5	25	25	15 ±11	54	24
Track 741 X J2 085	17 ±5	27	27	17 ±8	39	26
Regional mean	**11**	**24**	**26**	**19**	**45**	**25**



→ Stable results at the Envisat crossover point in SAR mode

→ The bias increases at the Jason-2 crossover point, located farther from the Ajaccio calibration site (may undergo different atmospheric conditions).

➔ The use of the DAC correction may reduce this effect.

→ More variability in the PLRM mode, due to some few cycles with strong bias estimate values (not clear why).

Conclusions

- No significant S3-A range absolute bias in Corsica (+/- 1cm)
- Consistent results between local and offshore bias estimates for both sites
- Dependency of the SSH bias with the SWH

➔ **Need for a dedicated SAR SSB correction in the products**

Next steps

- Number of crossover points to be extended in Corsica (with tide and DAC corrections)
- Implementation at Harvest and Bass Strait
- Monitoring of the Sentinel-3B mission
  - Comparisons with the Sentinel-3A bias estimates during the tandem phase
  - Sentinel-3B mission on its own interleaved orbit