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

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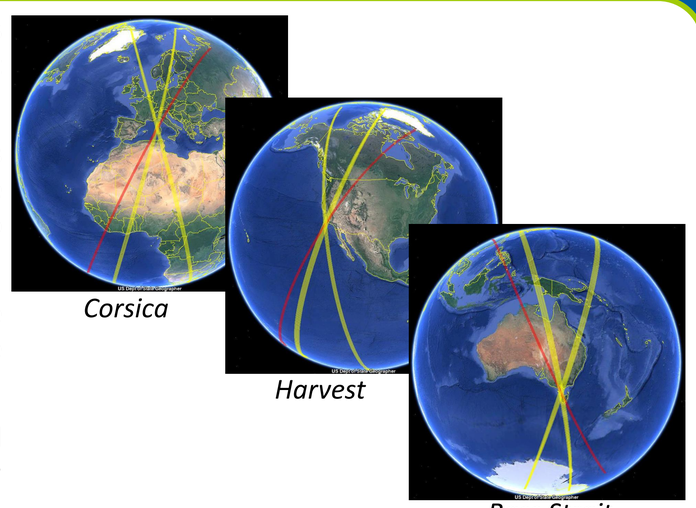
Introduction

In situ calibration ensures **regular and long-term control of the altimeter sea surface height** (SSH) time series through comparisons with independent records. Usually, in situ calibration of altimeter SSH is undertaken at specific CALVAL sites through the direct comparison of the altimeter data with in situ data.

However, 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 both on overflying passes and on satellite passes located far away from the calibration site. In principle this extends the single site approach to a wider regional scale, thus **reinforcing the link between the local and the global CALVAL analyses**. It also provides a means to maintain a calibration time series through periods of data-outage at a specific dedicated calibration site.

The regional method was initially developed at the Corsican calibration sites of Senetosa and Ajaccio. It was then successfully implemented at the Californian site of Harvest and at the Australian site of Bass Strait, in close collaboration with JPL and the University of Tasmania, respectively. The method was used to compute the altimeter biases of Jason-1, Jason-2, Envisat and SARAL/AltiKa at all these sites.

These recent studies gave the **first Envisat and SARAL/AltiKa absolute bias estimates at non-dedicated sites using the same method**, and showed high consistency with the analyses of the global CalVal teams and the work of the in situ CalVal teams. The method is now used to monitor the CryoSat-2 and **Sentinel-3** missions.



The regional CALVAL method: combining absolute and offshore in situ validation techniques

ABSOLUTE CALVAL: Direct comparison between the altimeter SSH and the tide gauge measurements (point C on *Figure 1*).

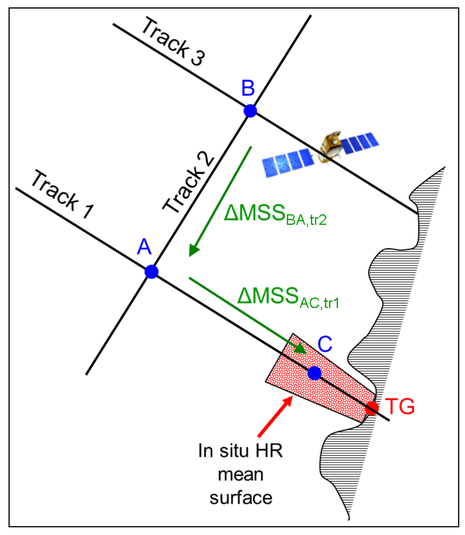
- Only for satellite flying over the calibration sites.
- Directly comparable to the absolute bias estimates computed by the local in situ calval groups (Corsica, Harvest, Bass Strait, Gavdos…)

OFFSHORE CALVAL: Computation of the bias on offshore passes

- 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)

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
- Accurate ocean tides and atmospheric effects between the offshore tracks and the coast



GENERIC METHOD:

➔ **Calibration of missions on new orbits**

The regional CALVAL method can be used to compute the bias:

- After an orbit change (ex: interleaved TP, Jason-1, Jason-2, Envisat, Jason-1 and Jason2-end-of-life, SARAL)
- For orbits without dedicated calibration sites (ex: Sentinel-3).

➔ **Calibration of non-repetitive or drifting orbits** (ex: CryoSat-2).

Applicable to any sites: Harvest Platform, Bass Strait, Gavdos…

$$bias_{alti,tr3}(t) = (SSH^{alti}_{B,tr3}(t) - dyn_{B,tr3}(t)) - (SSH^{gauge}_{TG,tr1}(t) - dyn_{TG,tr1}(t)) + (\overline{SSH}^{insitu}_{TG,tr1} - \overline{SSH}^{insitu}_{C,tr1}) + (\overline{SSH}^{alti}_{C,tr1} - \overline{SSH}^{alti}_{A,tr1}) + (\overline{SSH}^{alti}_{A,tr2} - \overline{SSH}^{alti}_{B,tr2})$$

Figure 1: *Generic diagram of the regional in situ calibration method*

Sentinel-3A regional CALVAL in Corsica

ABSOLUTE CALVAL CONFIGURATION FOR SENTINEL-3A IN CORSICA

The Sentinel-3A orbit provides a unique opportunity to compute absolute calibration estimates of the mission at the two sites in Corsica at a few seconds of interval.

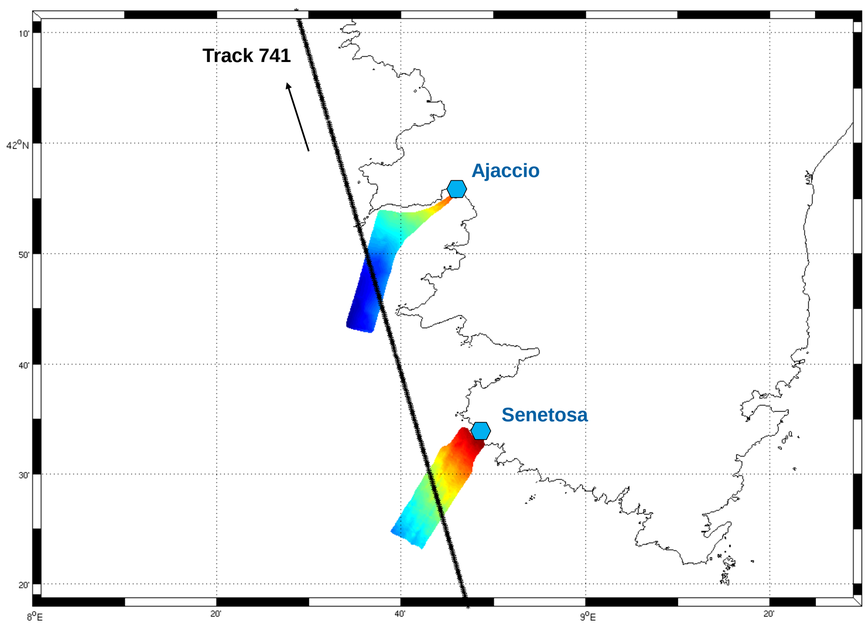


Figure 2: *Sentinel-3A track 741 at the two calibration sites in Corsica (Senetosa and Ajaccio). The colors show the high-resolution mean sea surface estimated locally with GPS surveys.*

➔ The configuration of the Sentinel-3A track 741 is specific as it crosses the high-resolution mean sea surfaces in the transversal direction, contrary to the Jason/Envisat tracks that cross the surfaces in the longitudinal direction. This requires specific tuning of the regional calval method, which is still on-going.

SENTINEL-3A ALTIMETRY DATA

- IPF 06.7 reprocessing from cycle 5 to cycle 19 (S3 MPC NTC L2 land product)
- Range: SAR and PLRM
- Wet troposphere: ECMWF model (land contamination in radiometer correction)
- Ionosphere: GIM

SENTINEL-3A ABSOLUTE BIAS IN CORSISA

Sentinel-3A absolute bias (mm) Cycles 5 to 19 (S3 MPC) Track 741	SAR			PLRM		
	Mean	Std	Nb of cycles	Mean	Std	Nb of cycles
Senetosa	19	28	15	7	41	15
Ajaccio	2	43	15	10	63	15

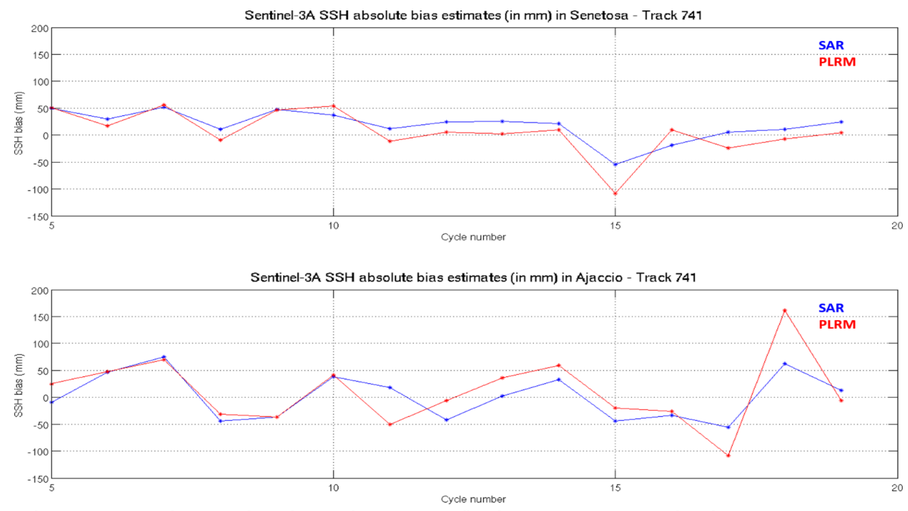


Figure 3: *Sentinel-3A absolute bias estimates on track 741 at the two calibration sites in Corsica (Senetosa and Ajaccio). The SSH bias was estimates both for SAR and PLRM ranges.*

➔ The Sentinel-3A absolute bias is of about 1 cm, which is consistent with the global calval results.

➔ As expected, the PLRM range estimates show higher variability than the SAR range.

➔ A few events (cycles 15, 17 and 18) must be further investigated (on-going analysis).

NEXT STEPS

- Once the tuning of the method fully operational in Corsica, the next step will be to **exploit the regional potential** of this CALVAL technique. Figure 4 shows the crossover points where the Sentinel-3A bias will be estimated for the two calibration sites. Tracks from Jason-2 and Envisat missions will be considered to transfer the offshore Sentinel-3A sea surface height information to the tide gauges.
- Then, the **Sentinel-3A bias estimates will be computed at the Harvest and Bass Strait calibration sites.** Comparisons will be made with the results obtained by the local Calval groups with their own methods.
- The **Sentinel-3B mission** will also be monitored with the same technique.
- During the **tandem phase with Sentinel-3A**, comparisons of the bias estimates computed for the two missions at a few-second interval will be made.
- Then, the Sentinel-3B mission will be monitored on its own orbit (interleaved).

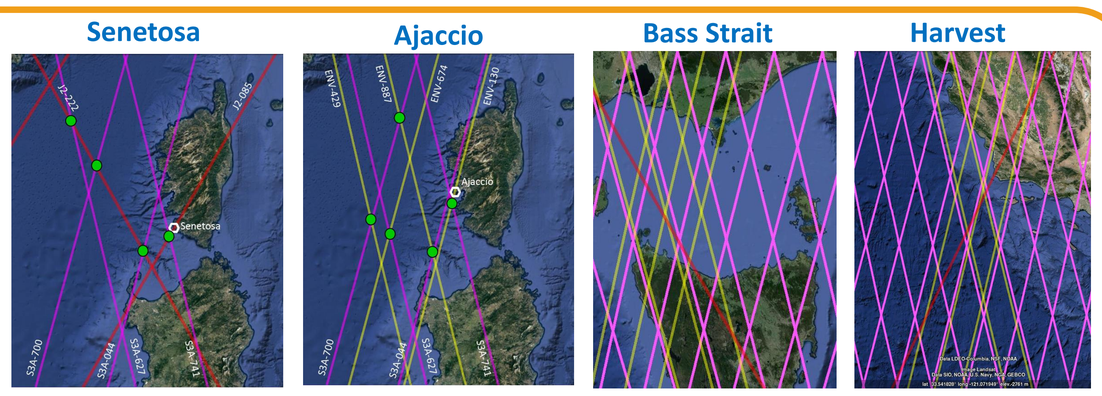


Figure 4: *Sentinel-3A ground-tracks (pink) at the three calibration sites. The Jason nominal tracks are in red and the Envisat nominal tracks are in yellow. The green dots at Senetosa and Ajaccio show the identified crossover points for the application of the regional Calval method.*

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