Regional CALVAL of Jason-2 and Envisat in Corsica and at Harvest

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Regional CALVAL method

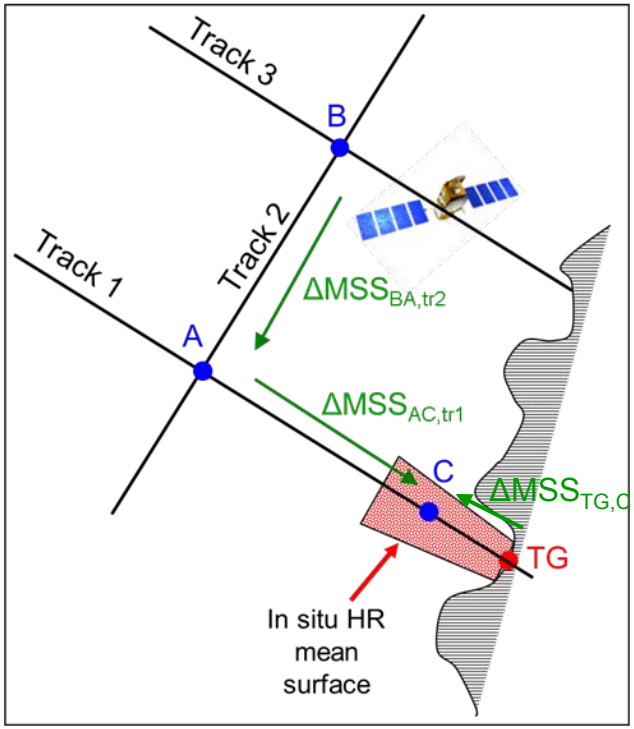
Combination of:

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

- ✓ Only for satellite passes 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



Regional CALVAL method

Generic method:

➔ **Calibration of missions on new orbits**

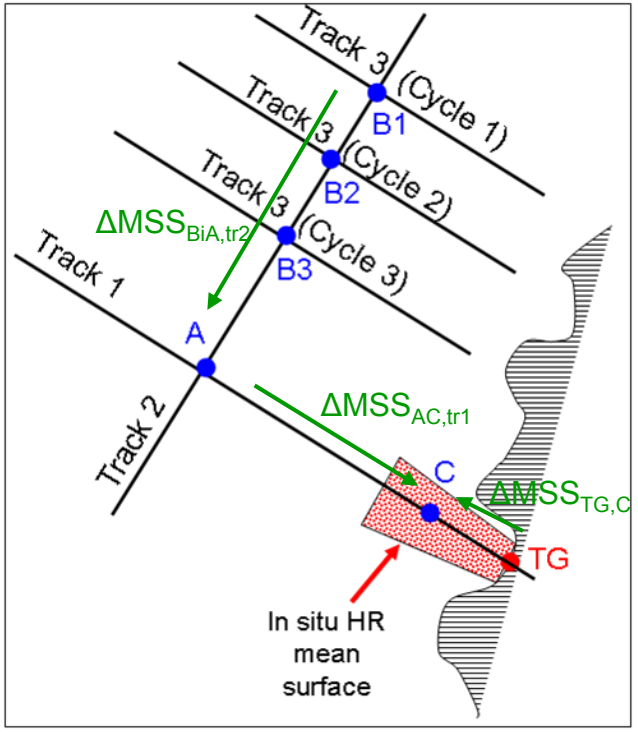
✓ After an orbit change (ex: interleaved TP & Jason-1, Envisat after October 2010)

✓ For orbits without dedicated calibration sites (ex: Sentinel-3).

➔ **Calibration of non-repetitive orbits**

✓ Missions on non-repetitive or drifting orbits (ex: Cryosat, Jason-1 end-of-life).

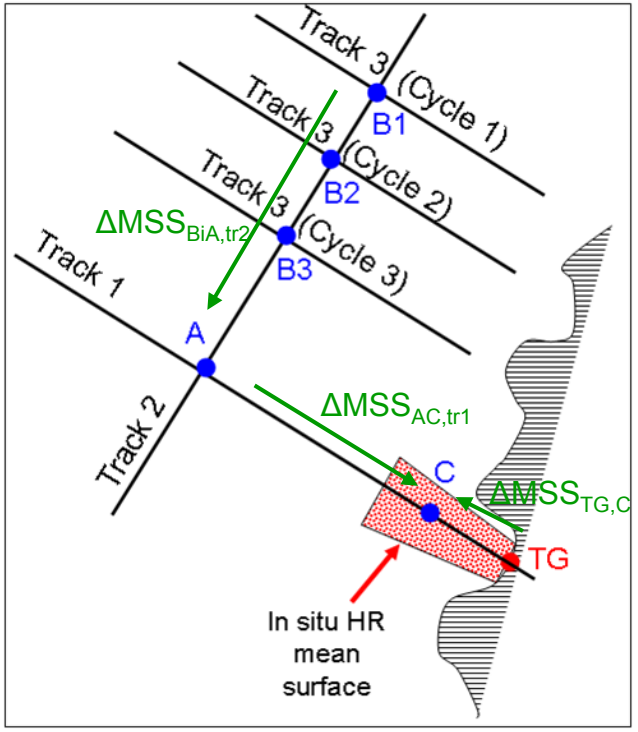
Applicable to any calibration site: Corsica, Harvest Platform, Bass Strait, Gavdos...



Regional 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 passes and the coast



Previously implemented in Corsica (Senetosa & Ajaccio) for Topex, Jason-1, GFO, Jason-2 and Envisat

- ✓ Jan et al, 2003
- ✓ Cancet et al, 2012

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

Verification of the altimeter SSH stability

- Jason-2 (GDR-D)
- Envisat nominal orbit (GDR-C v2.1)
- Envisat drifting orbit (2010+, GDR-C v2.1)

at the calibration sites of

	Dedicated to
Corsica	
• Senetosa	*TP/Jason-1/2*
• Ajaccio	*Envisat (nominal orbit)*
Harvest	*TP/Jason-1/2*

Corsica site

Ajaccio (SHOM):

✓ 1 tide gauge since 2002

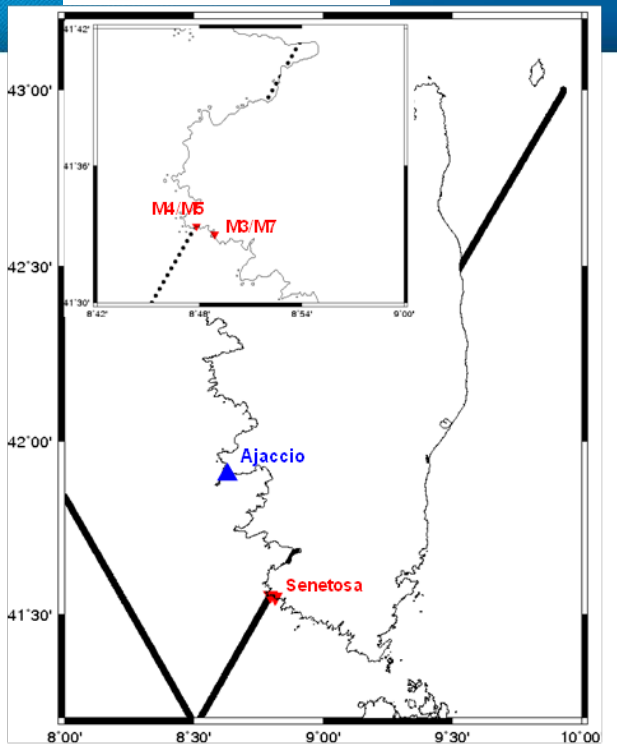
Senetosa (OCA/CNES):

✓ 4 tide gauges (2 couples of twin instruments) since 1998

➔ **Careful editing (NOVELTIS/OCA)**

→ Many outliers removed

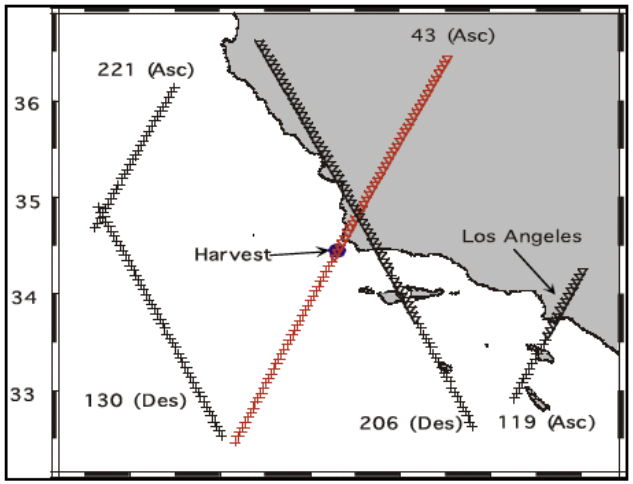
→ **Ajaccio:** 1.5 year of bad-quality data *(April 2008 – Sept. 2009)*



Harvest site

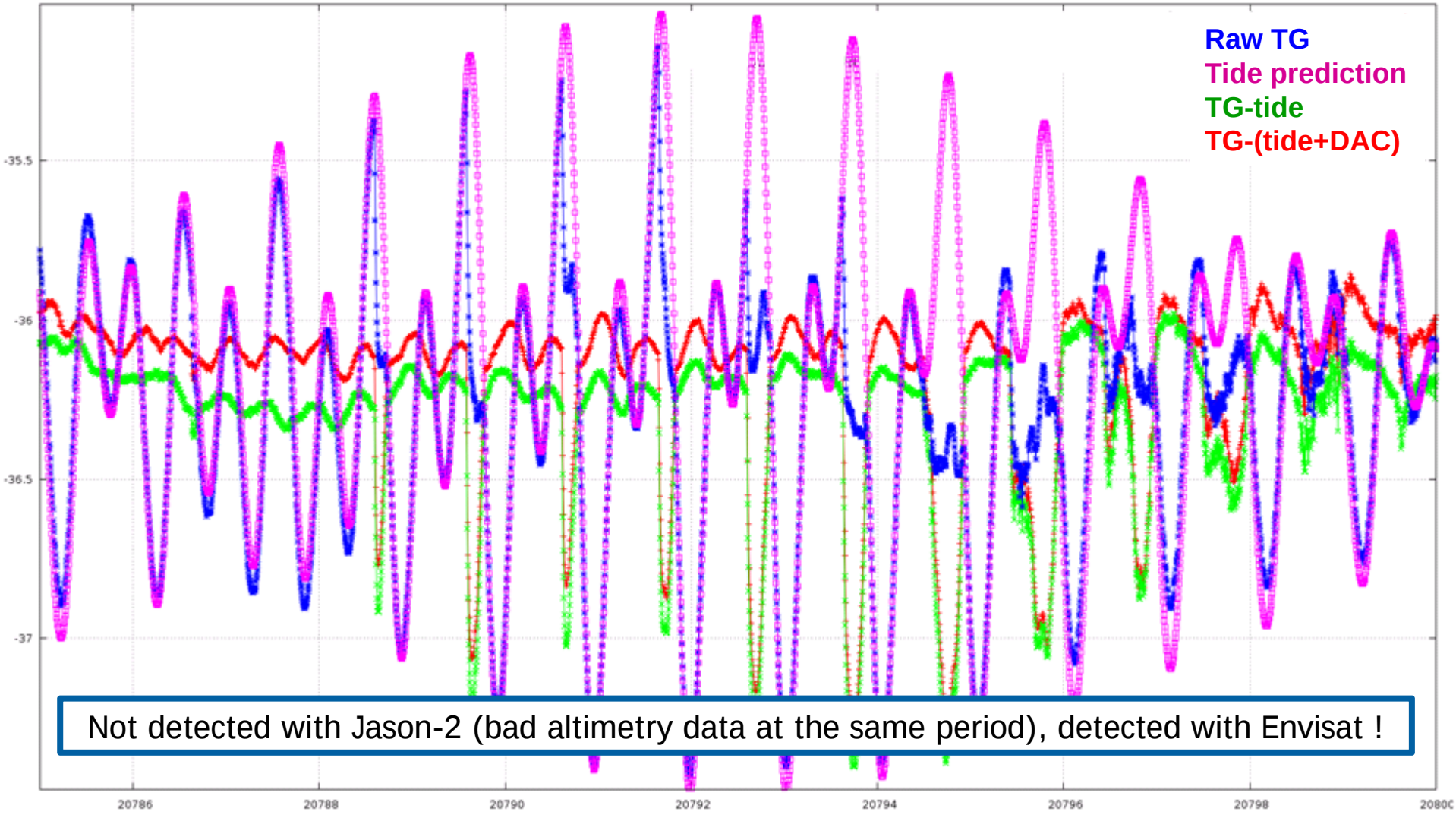
✓ Tide gauge SSH time series entirely reprocessed and checked between 2002 and 2012 *(Many thanks, Bruce !)*

✓ A few dubious periods removed



(Haines et al, 2012)

Example of a period identified as « suspect » at Harvest – December 2006



Not detected with Jason-2 (bad altimetry data at the same period), detected with Envisat !

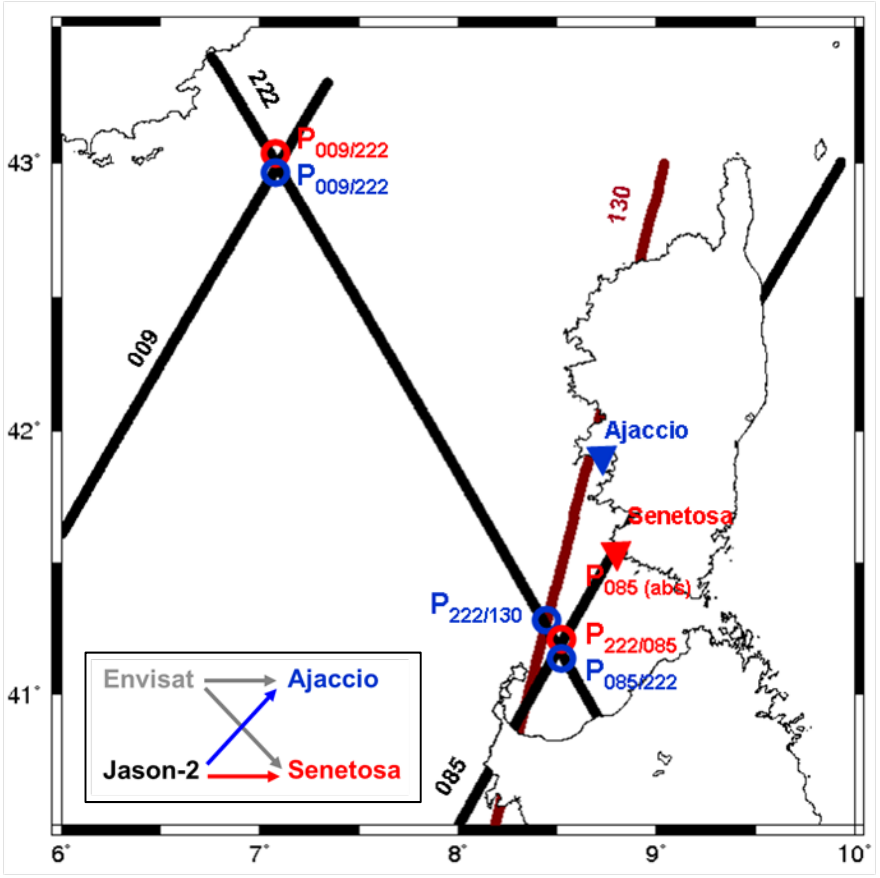
	Jason-2	Envisat	Envisat 2010+
Product version	GDR-D	GDR-C v2.1	GDR-C v2.1
Period	Cycles 1-153 07/2008 – 08/2012	Cycles 7-93 06/2002 – 10/2010	Cycles 93-113 10/2010 – 04/2012
Ionosphere	GIM	GIM: only correction available for the whole mission (S-band loss)	
Wet troposphere	• **Corsica:** ECMWF model (land contamination) • **Harvest:** Radiometer (S. Brown)	ECMWF model, following recommendation not to use the radiometer correction provided in the GDR-C products	
Tides	• **Corsica:** COMAPI regional model (CNES) • **Harvest:** FES2004		
DAC	High resolution global simulation (LEGOS)		

The comparisons with the OCA and JPL results were systematically performed in the same conditions of corrections.

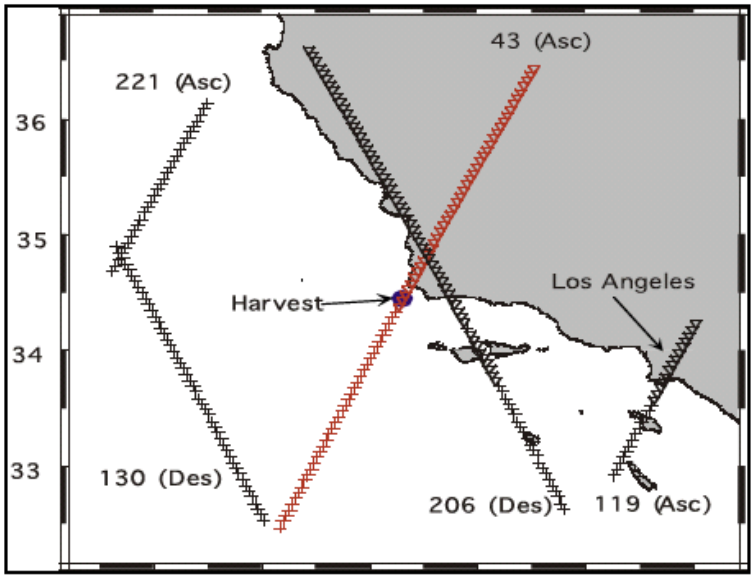
Jason-2 calval

GDR-D products ➔ bias expected ~0

Corsica (Senetosa & Ajaccio)



Harvest

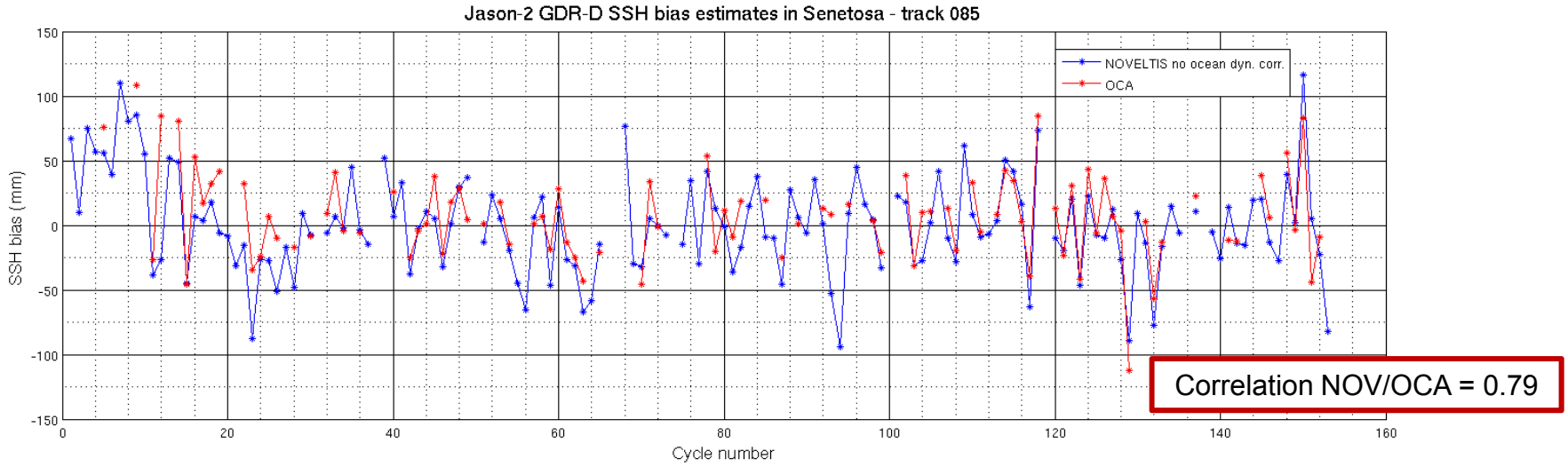


(Haines et al, 2012)

Jason-2 calval in Corsica

Jason-2 bias (cm) Cycles 1 to 153 (GDR-D)	No ocean dynamics correction			With ocean dynamics correction (global DAC + COMAPI tide)		
	Mean	Std	Nb of cycles	Mean	Std	Nb of cycles
Track 085 (absolute method)	0.0 ± 0.3	3.8	143	-0.2 ± 0.3	3.9	143
Regional bias in Senetosa (mean)	-0.7	4.1	146	-1.0	4.1	146
Regional bias in Ajaccio (mean)	-0.2	3.8	97	1.7	4.0	99
OCA absolute bias in Senetosa	0.7 ± 0.4	3.5	95	/		

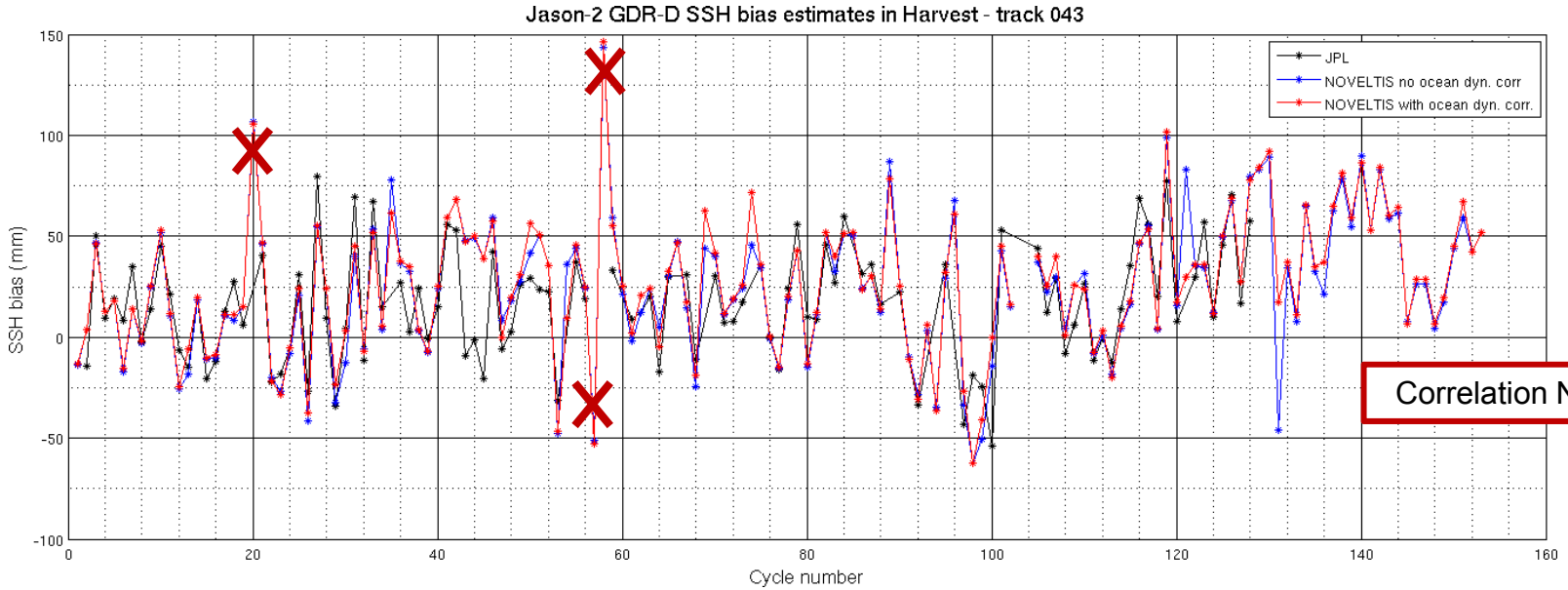
???



Correlation NOV/OCA = 0.79

Jason-2 calval at Harvest

Jason-2 bias (cm) Cycles 1 to 153 (GDR-D)	No ocean dynamics correction			With ocean dynamics correction		
	Mean	Std	Nb of cycles	Mean	Std	Nb of cycles
Track 043 (NOVELTIS)	**2.4 ± 0.3**	**3.2**	**148**	**2.5 ± 0.3**	**3.1**	**148**
Track 043 (NOVELTIS) common cycles with JPL *(cycles 1 to 128)*	**1.8 ± 0.3**	**2.9**	**109**	**1.9 ± 0.3**	**2.9**	**109**
Track 043 (JPL) *(cycles 1 to 128)*	**1.6 ± 0.3**	**2.8**	**109**	**/**	**/**	**/**



Correlation NOV/JPL = 0.83

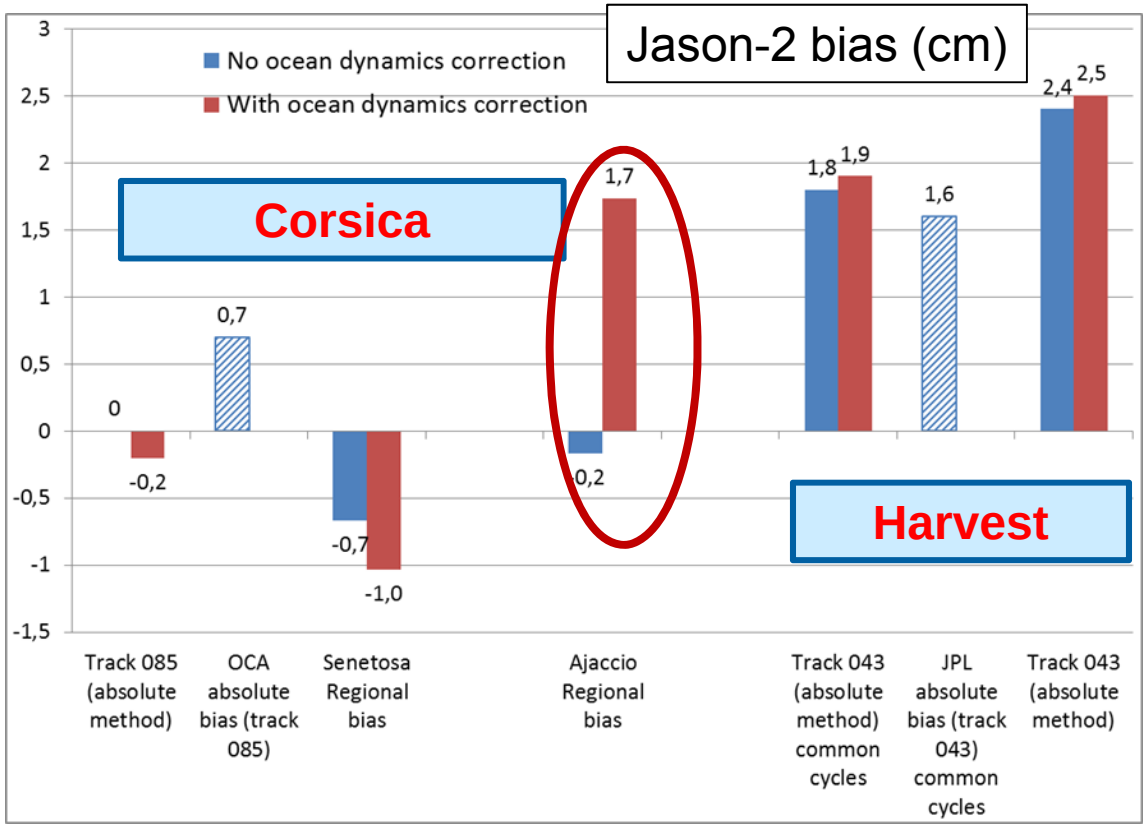
Jason-2 calval in Corsica and at Harvest

- ✓ Jason-2 GDR-D regional bias estimates close to 0 as expected
- ✓ Very coherent results at both sites
- ✓ Very good agreement with the other groups results (OCA & JPL)

+ First implementation in a region characterized by **rough ocean conditions**

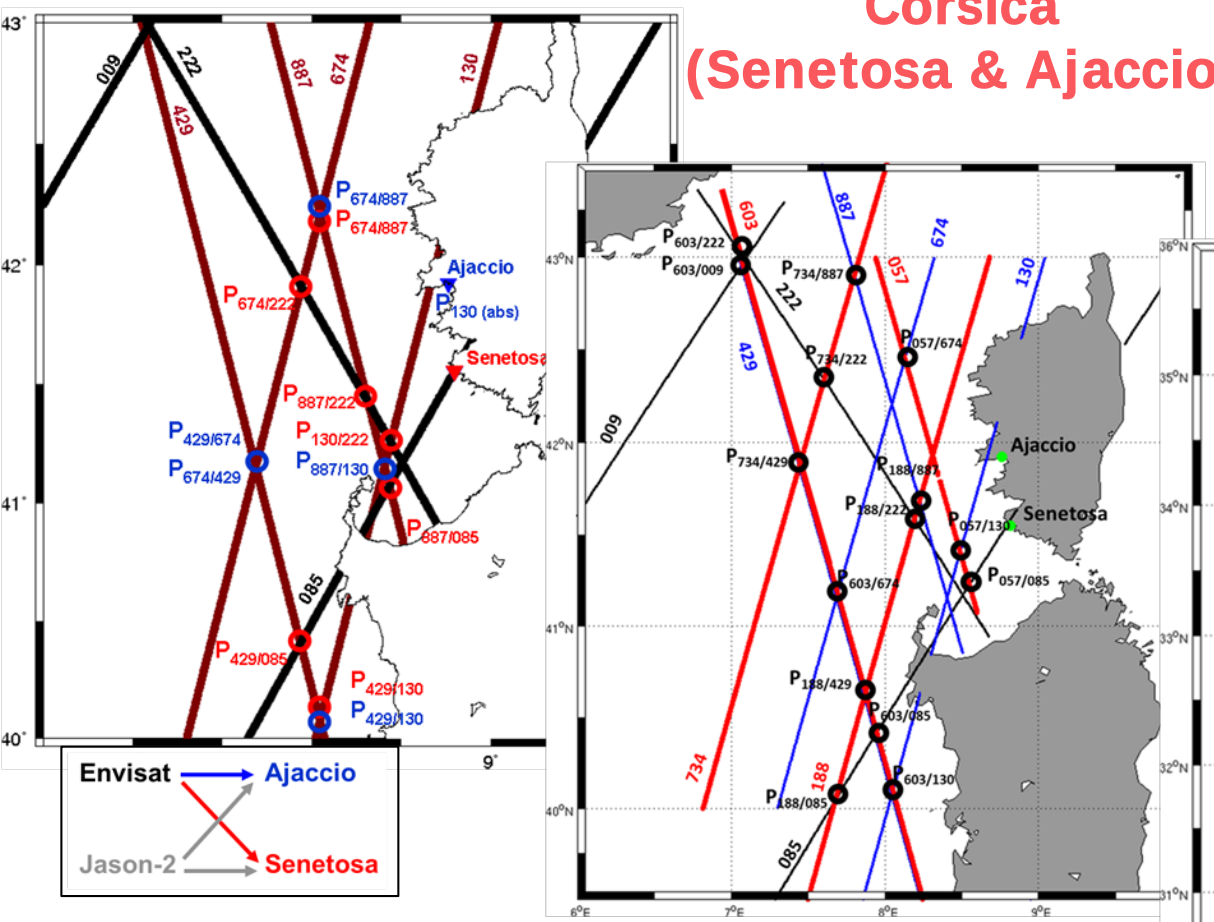
+ Confirms the **weirdness of the results in Ajaccio**

→ *Tide model ? Tide gauge ? Specific local tide signal ?*

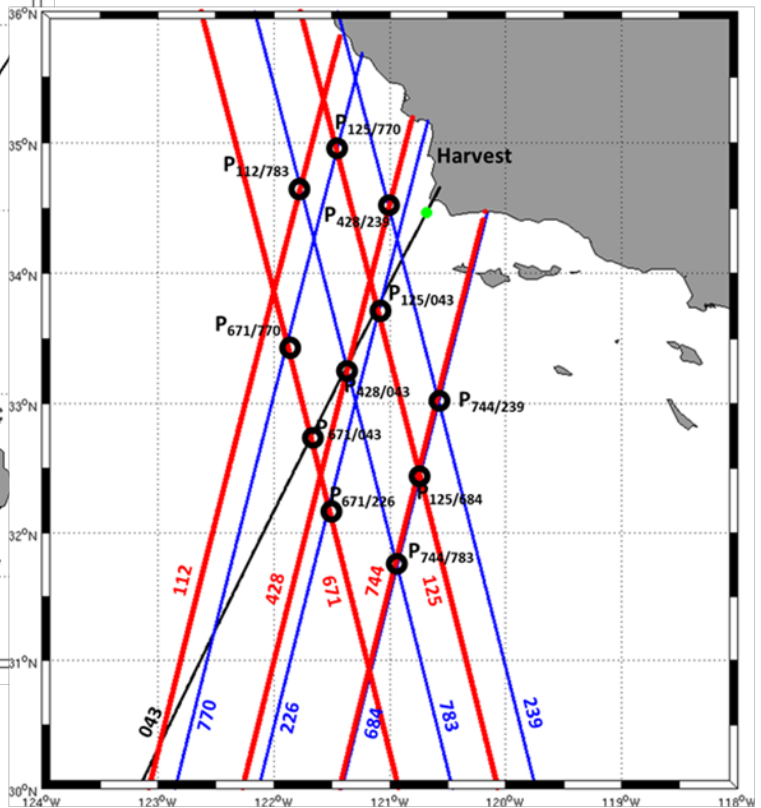


Envisat calval (nominal and drifting orbits)

Corsica (Senetosa & Ajaccio)



Harvest

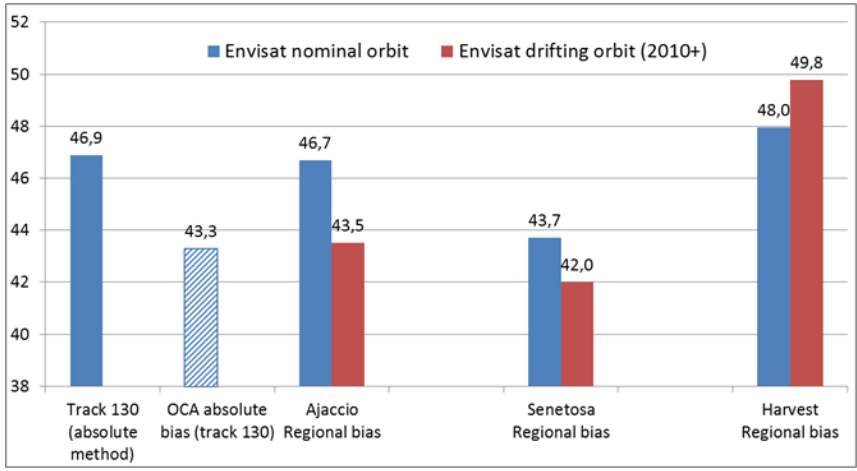


Envisat calval (nominal and drifting orbits)

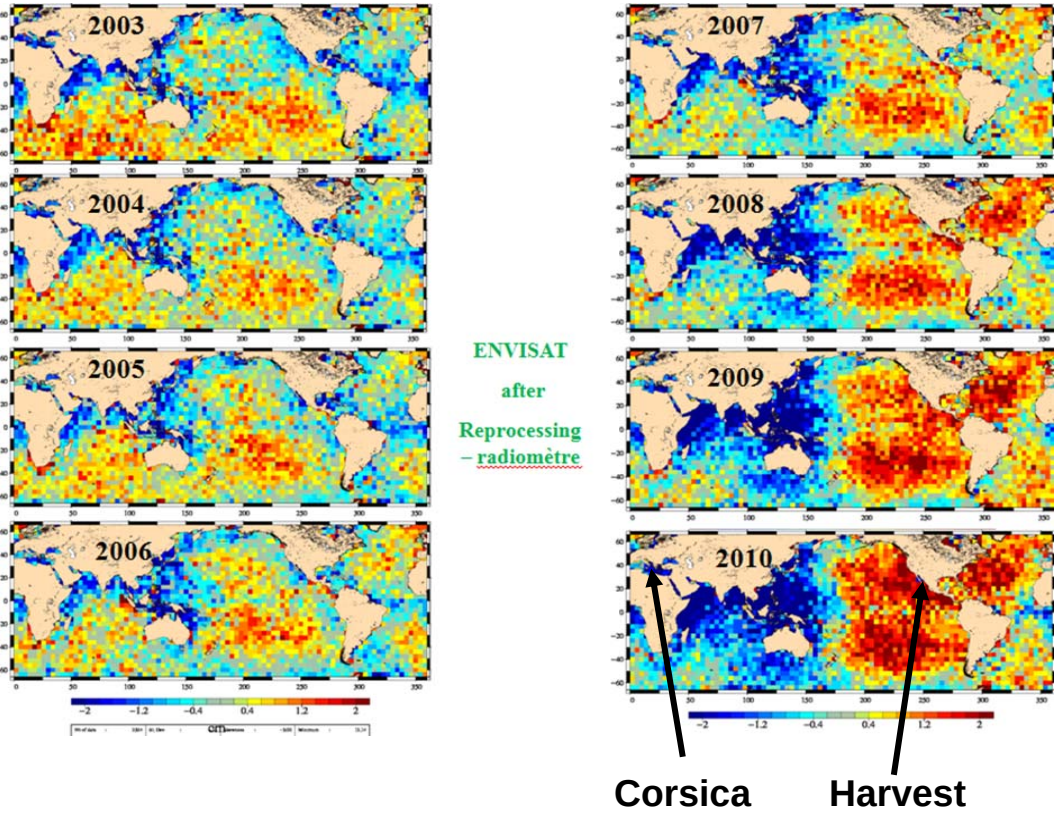
Envisat bias (cm) CORSICA	No ocean dynamics correction			With ocean dynamics correction		
	Mean	Std	Nb of cycles	Mean	Std	Nb of cycles
Absolute bias in Ajaccio (tr130)	46.8 ± 0.8	5.5	52	46.9 ± 0.9	6.2	52
OCA absolute bias in Ajaccio	43.3 ± 0.7	3.1	18	/	/	/
Regional bias in Ajaccio (mean)	45.6	4.7	56	46.7	5.0	56
Regional bias in Ajaccio (mean) – 2010+	42.3	3.9	15	43.5	3.8	15
Regional bias in Senetosa (mean)	44.0	4.1	80	43.7	4.2	81
Regional bias in Senetosa (mean) – 2010+	41.6	4.5	17	42.0	4.3	17

Envisat bias (cm) - HARVEST With ocean dynamics correction	Mean	Std	Nb of cycles
Regional bias (mean) – Nominal	48.0	7.3	80
Regional bias (mean) – 2010+	49.8	6.5	17

- ✓ Land contamination effect in OCA's results
- ✓ Again, tide at Ajaccio in question
- ✓ Decrease of the bias in Corsica, increase in Harvest, including after 2010

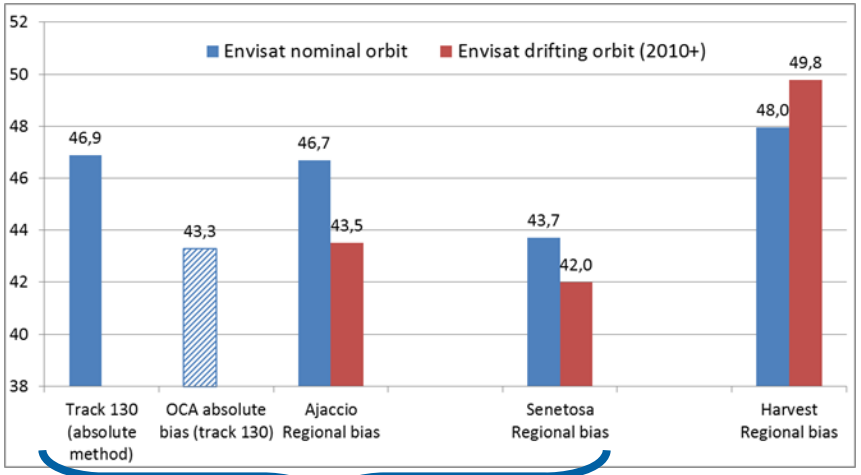


Synergy with the global CALVAL



GDR-C orbit effect :

East (Corsica): bias decreases
West (Harvest): bias increases



Envisat GDR-C v2.1 products vs Jason-1 with GDR-D orbit *(from A. Ollivier)*

Conclusions

- ✓ Regional CALVAL = Link between the local and global cal/val methods
  - → Consistency with the other groups
    - ➢ At the local scale: OCA and JPL results
    - ➢ At the global scale: CLS results
- ✓ Stability of the Jason-2 GDR-D products
- ✓ First absolute calibration of Envisat in Harvest !
  - → East/West drifts of the Envisat GDR-C orbit
- ✓ First absolute calibration of the Envisat drifting orbit (2010+)

Perspectives

- ✓ First absolute calibration of Envisat in Bass Strait
- ✓ SARAL/AltiKa
- ✓ Any other current or future mission

Generic method: can be implemented anywhere, for any mission !