Absolute Calibration of TOPEX/Poseidon, Jason-1 and Jason-2 Altimeters in Corsica

Latest results

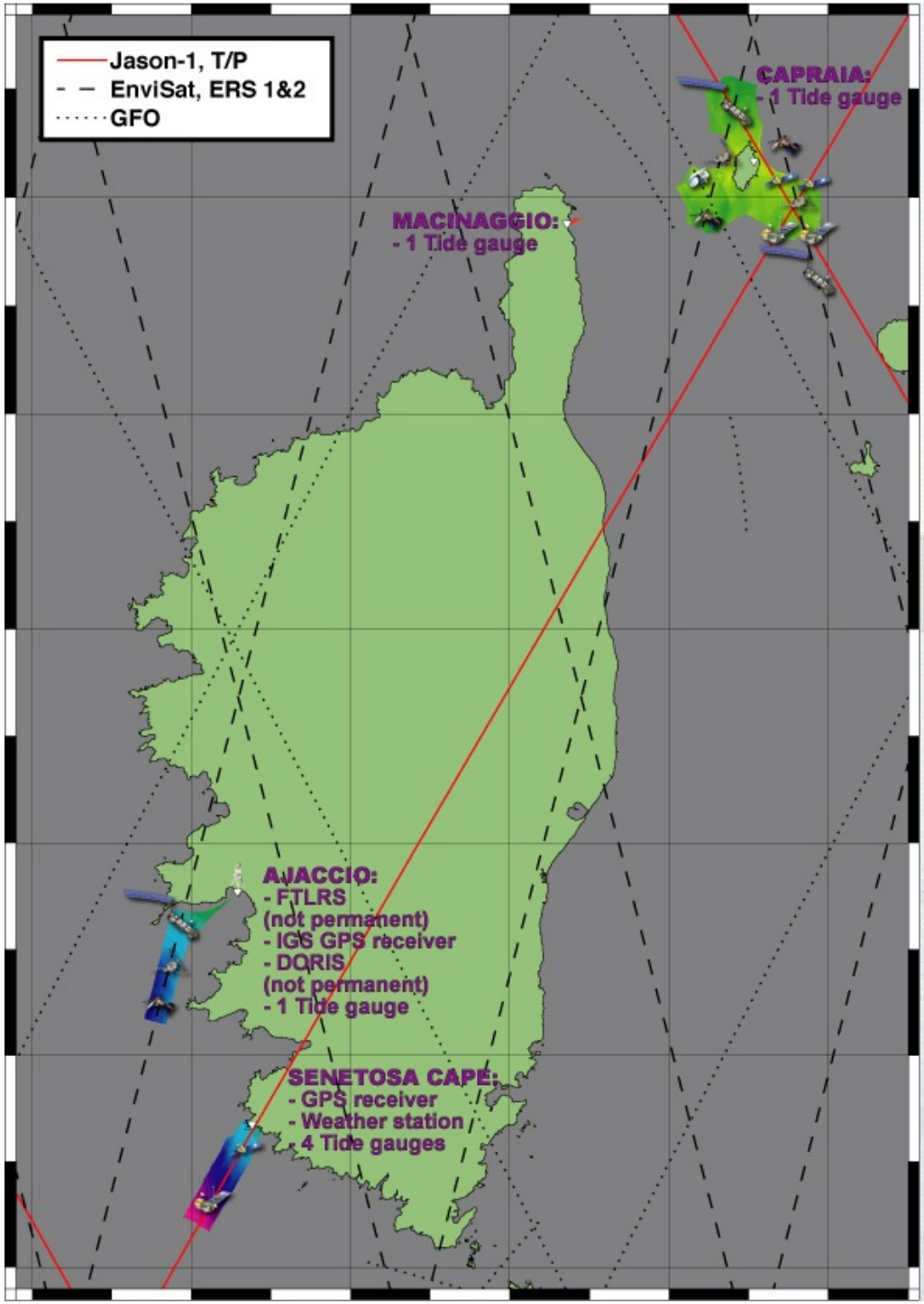
P. Bonnefond[(1)], P. Exertier[(1)], O. Laurain[(1)], S. Bijac[(2)], M. Cancet[(2)] and J. Chimot[(2)]

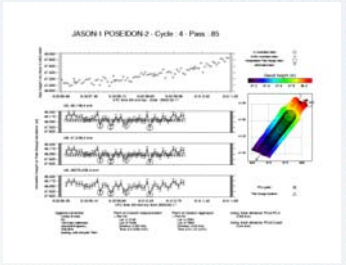
[(1)]OCA/GéoAzur, Grasse, France

[(2)]NOVELTIS, Ramonville, France

OSTST Meeting

Lisbon, 18-20 October 2010



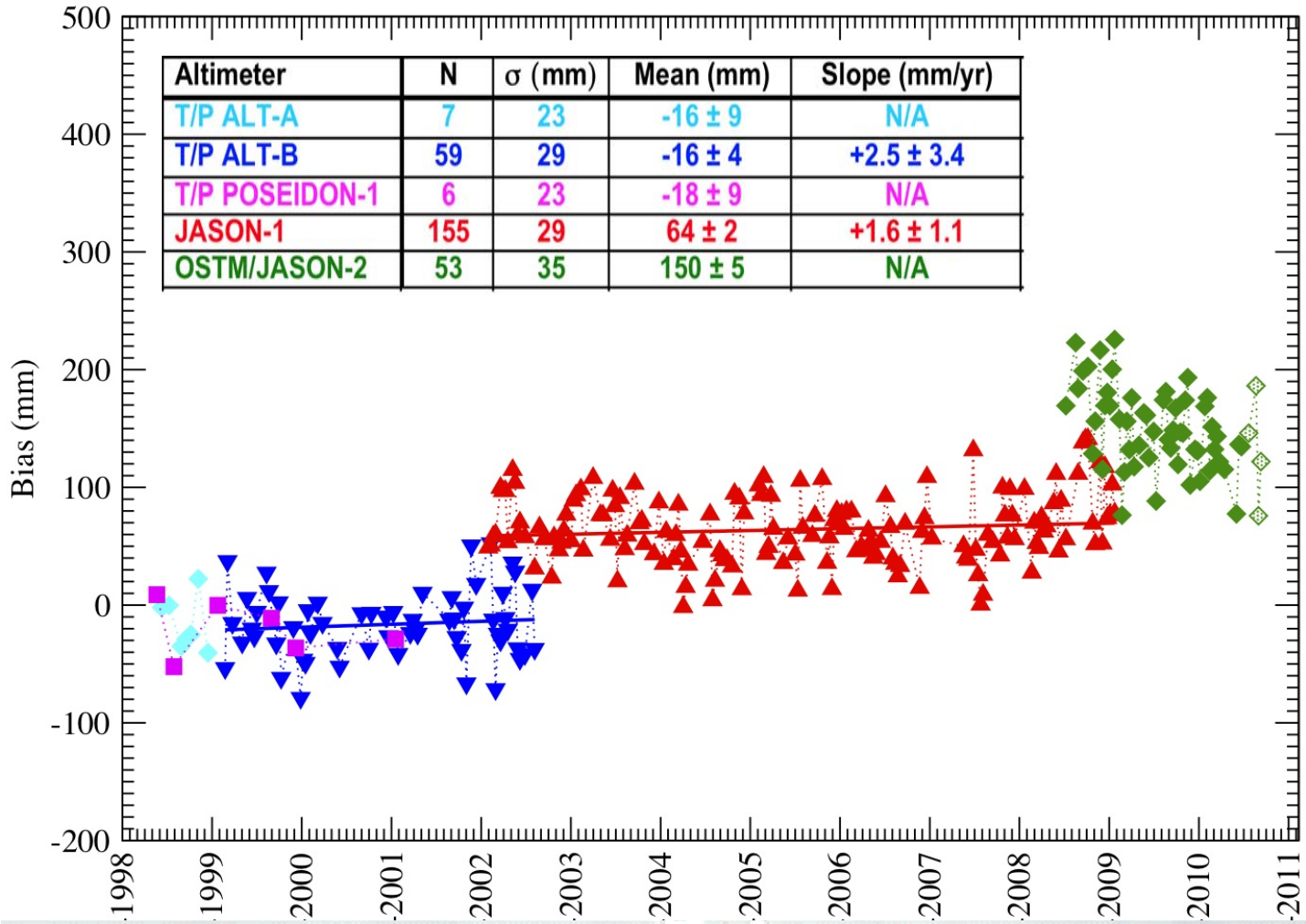


Corsica Absolute Altimeters Calibration

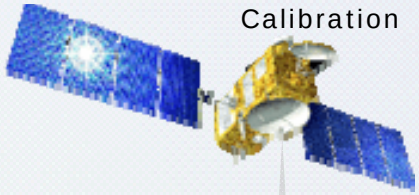
Corsica Calibration Site

- **OCA/CNES calibration site established in 1998**
- Supports continuous monitoring of Jason-1&2 (and formerly T/P)
- **Employs distributed configuration**
  - Fiducial point near **Ajaccio** equipped with a **tide gauge** and **GPS/FTLRS/DORIS**.
  - **Senetosa** coastal site (along ground track) equipped with **tide gauges and GPS**.
  - Open-ocean verification points for **GPS buoy deployments**.
- 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)**
  - EnviSat, ERS, GFO, Jason-1&2.

SITE DESCRIPTION



Corsica Absolute Altimeters Calibration



BIASES TIME SERIES

Products used:

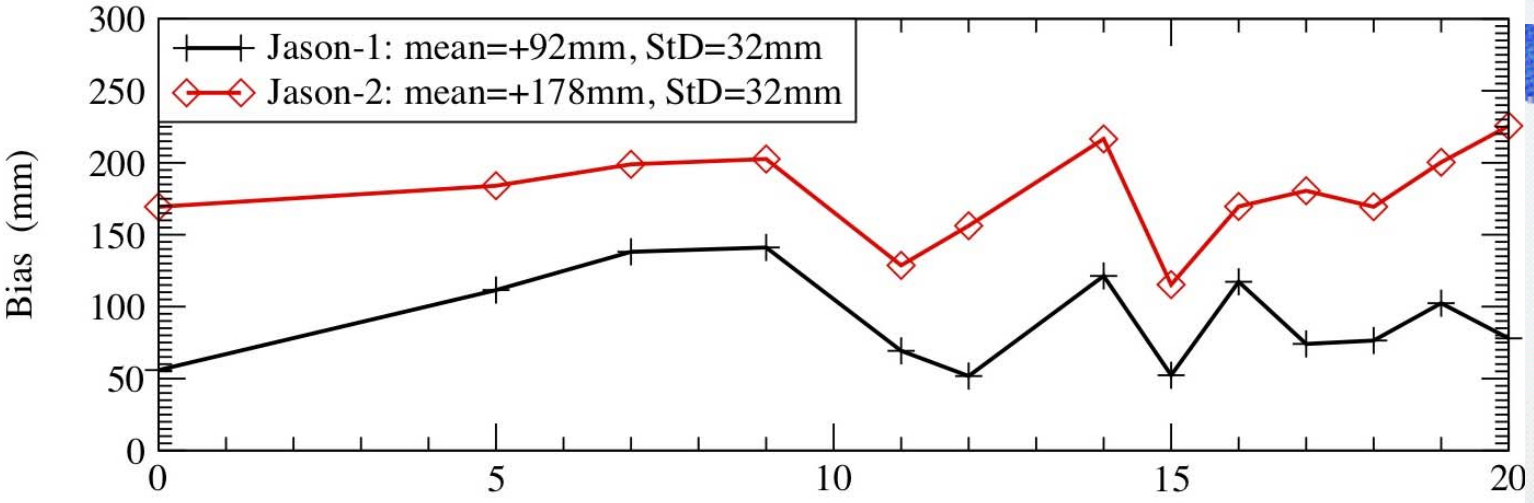
T/P: MGDR + TMR replacement products + std0905 orbits (GSFC)
-7 mm **add -4 mm** **add -5 mm**

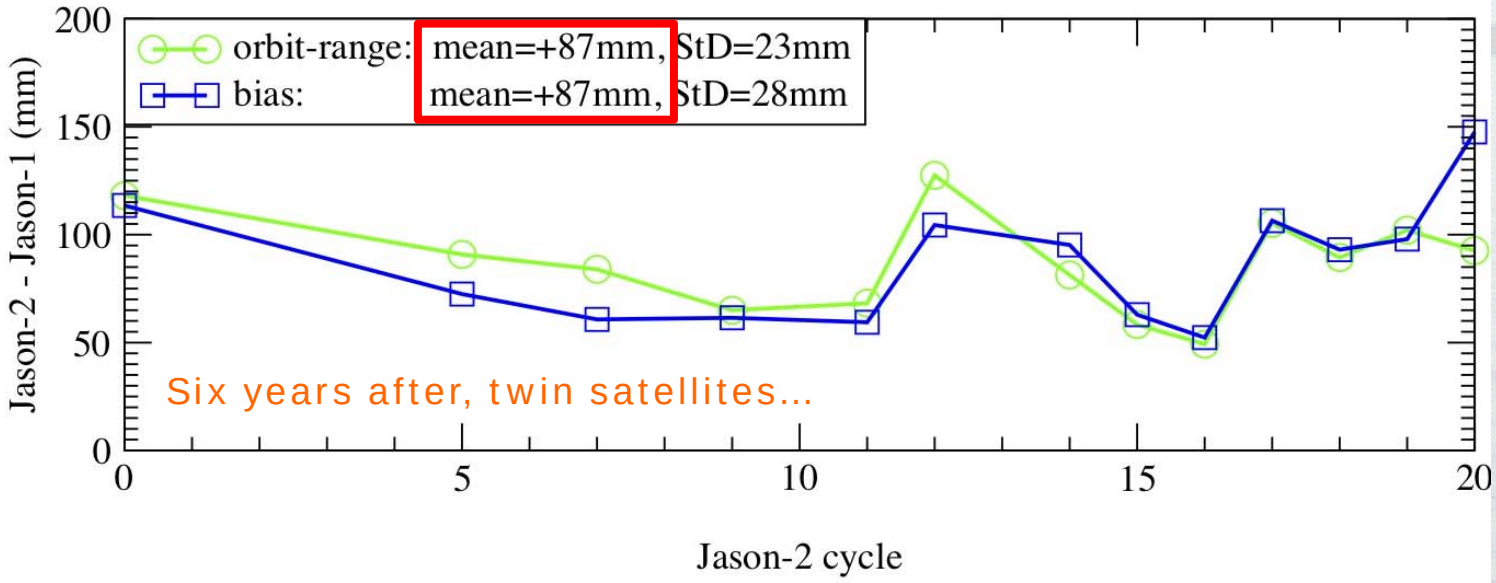
Jason-1: GDR-C (cycle 1 to 259)

Jason-2: GDR-C (cycle 0 to 74)

Jason-1&2 altimeter calibration

Senetosa pass 085: Orbit - Range compared to biases differences (GDR-C)

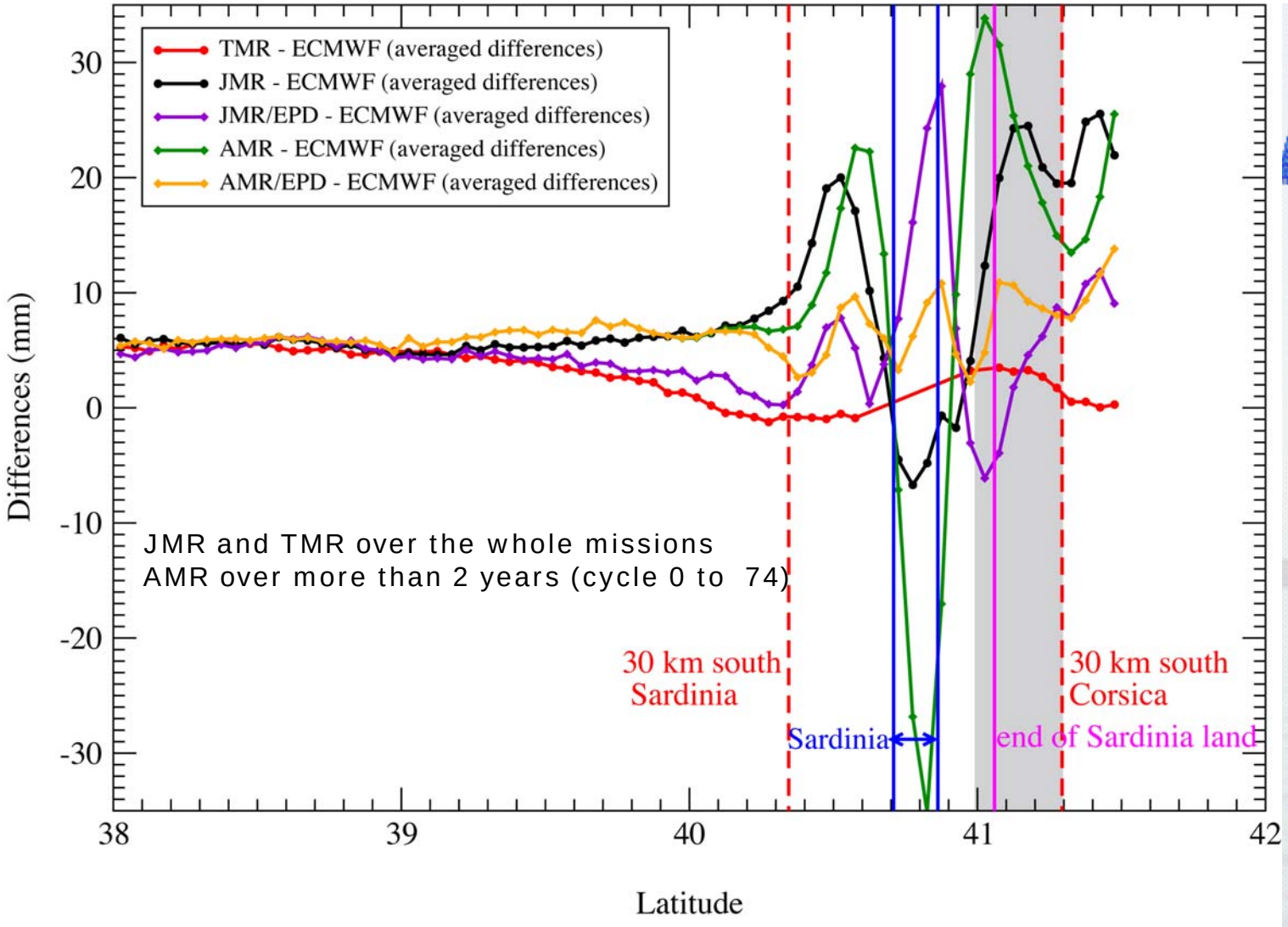


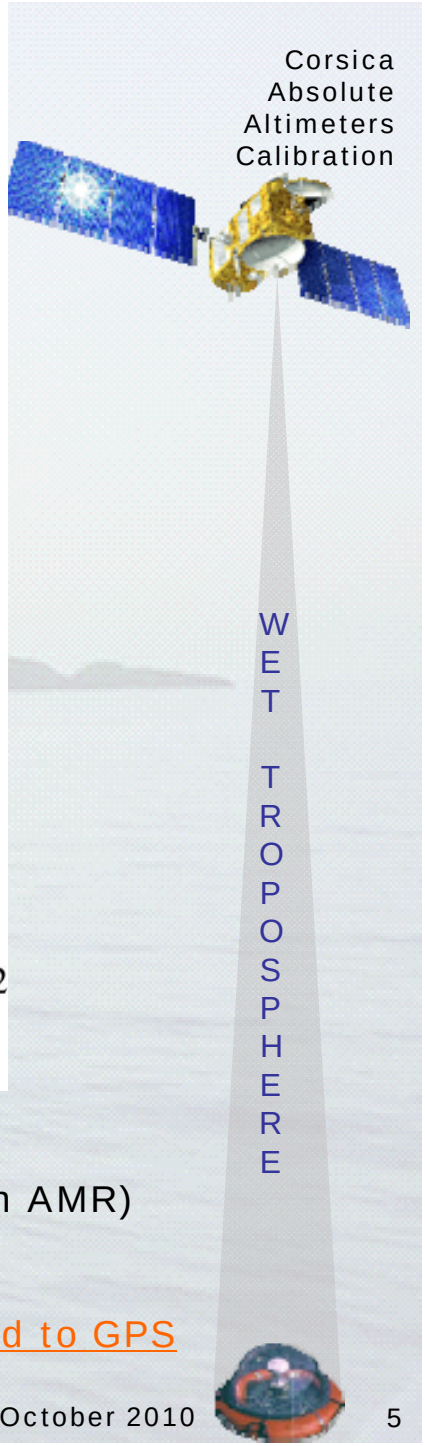


Corsica Absolute Altimeters Calibration

FORMATION FLIGHT PHASES

Almost the same relative bias between T/P and Jason-1, and between Jason-2 and Jason-1.
Same results obtained with differences of absolute biases.
However, FFP give more insights on the corrections and the geographically correlated errors.

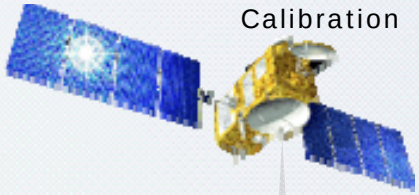




AMR and JMR exhibits strong jumps and drops due to Sardinia overflight
The Enhanced Path Delay products reduce these effects (more visible on AMR)
TMR is less affected by land contamination...

However, both AMR and JMR EPDs show an improvement when compared to GPS

Calibration from Corsica



Corsica Absolute Altimeters Calibration

Absolute biases over the whole data sets:

Jason-2: +150 ±5 mm
Jason-1: +64 ±2 mm
T/P ALT-B: -16 ±4 mm

Relative biases over common overflights:

Jason-2 - Jason-1: +87 mm (+87 mm from orbit-range)
Jason-1 – T/P: +84 mm (+80 mm from orbit-range)

Corrections:

Wet tropo. from radiometers show a bias of -5 mm (JMR dryer), close to 0 with EPDs
GPS shows that both AMR and JMR are dryer at the Corsica approach
No significant drift detected from JMR/GPS and AMR/GPS comparisons**.**
Better agreement between GPS and coastal path delays (EPD) from AMR and JMR
=> Jason-2 bias increases by ~10 mm (=> +160 mm, *176 from Harvest***)**
=> Jason-2 bias increases by ~13 mm (=> +77 mm, *87 from Harvest***)**

Orbits:

Millimetric impact of the latest set of orbits
(std0905 and std1007 from GSFC and rlse10a from JPL)

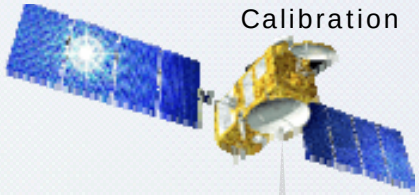
T/P MGDR+:

9 mm decrease of the T/P ALT-B bias compared to MGDR (-4 mm from TMR and -5 mm from orbit)

Using **LSE retracked products increases T/P ALT-B bias by 16 mm (=> zero bias)**
and induces **a slope of 9 mm/yr**

CONCLUSION

Corsica Absolute Altimeters Calibration



JASON-1&2 CORRECTIONS

Jason-2 – Jason-1 (corrections):

Correction	Mean (mm)	Standard Deviation (mm)
Dry Tropo.	-0.1 (-0.2)	2.7 (2.9)
Wet Tropo. (radiometer)	-5.6 (-11.3)	6.0 (6.5)
Wet Tropo. (ECMWF)	0.0	0.5
AMR - ECMWF	*23.8*	*15.1*
JMR - ECMWF	*29.4*	*14.4*
AMR – GPS	*11.7*	*11.6*
JMR - GPS	*16.9*	*10.0*
Iono. (dual frequency)	+7.6 (+9.4)	23.6 (22.1)
Iono. (GIM)	0.0	0.0
JS2 - GIM	*-5.6*	*19.1*
JS1 - GIM	*-13.2*	*17.6*
SSB	-2.7 (-2.4)	5.8 (4.9)
Solid Tides	+0.1	0.7
Loading	0.0	0.0
Pole Tide	0.0	0.0
Total	**-0.7**	

(from IGDR)

Main contribution comes from Wet tropospheric (~-6 mm) and Ionopheric (~+8 mm) corrections
Better agreement between GPS and Enhanced path delays from AMR and JMR (mm)

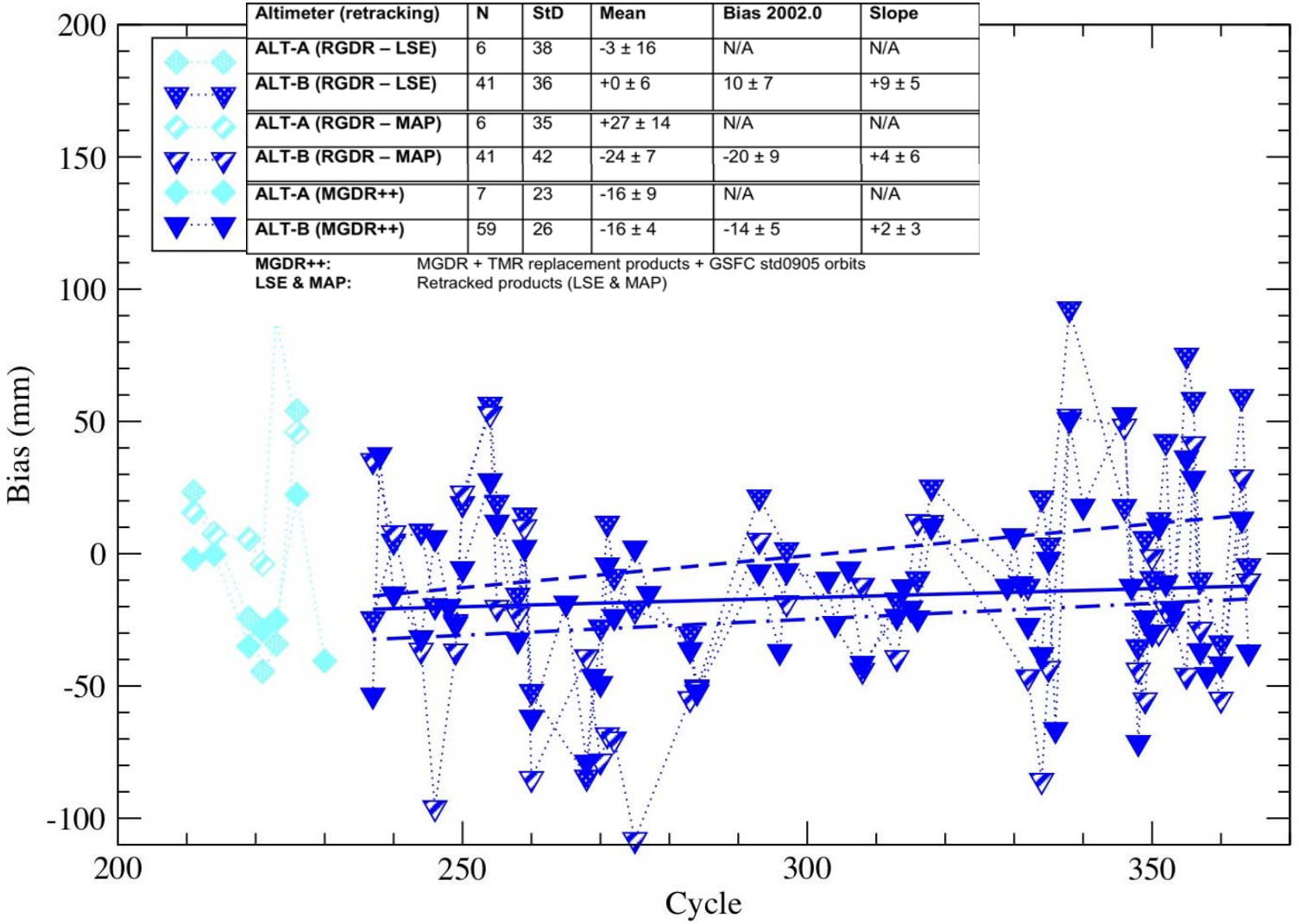
Other environmental parameters:

- SWH: Mean = -1 cm StD = 23 cm
- Wind Speed: Mean = +0.6 m/s StD = 0.6 m/s

Analysis of the T/P retracked products

Altimeter (retracking)	N	StD	Mean	Bias 2002.0	Slope
ALT-A (RGDR – LSE)	6	38	-3 ± 16	N/A	N/A
ALT-B (RGDR – LSE)	41	36	+0 ± 6	10 ± 7	+9 ± 5
ALT-A (RGDR – MAP)	6	35	+27 ± 14	N/A	N/A
ALT-B (RGDR – MAP)	41	42	-24 ± 7	-20 ± 9	+4 ± 6
ALT-A (MGDR++)	7	23	-16 ± 9	N/A	N/A
ALT-B (MGDR++)	59	26	-16 ± 4	-14 ± 5	+2 ± 3

MGDR++: MGDR + TMR replacement products + GSFC std0905 orbits
LSE & MAP: Retracked products (LSE & MAP)

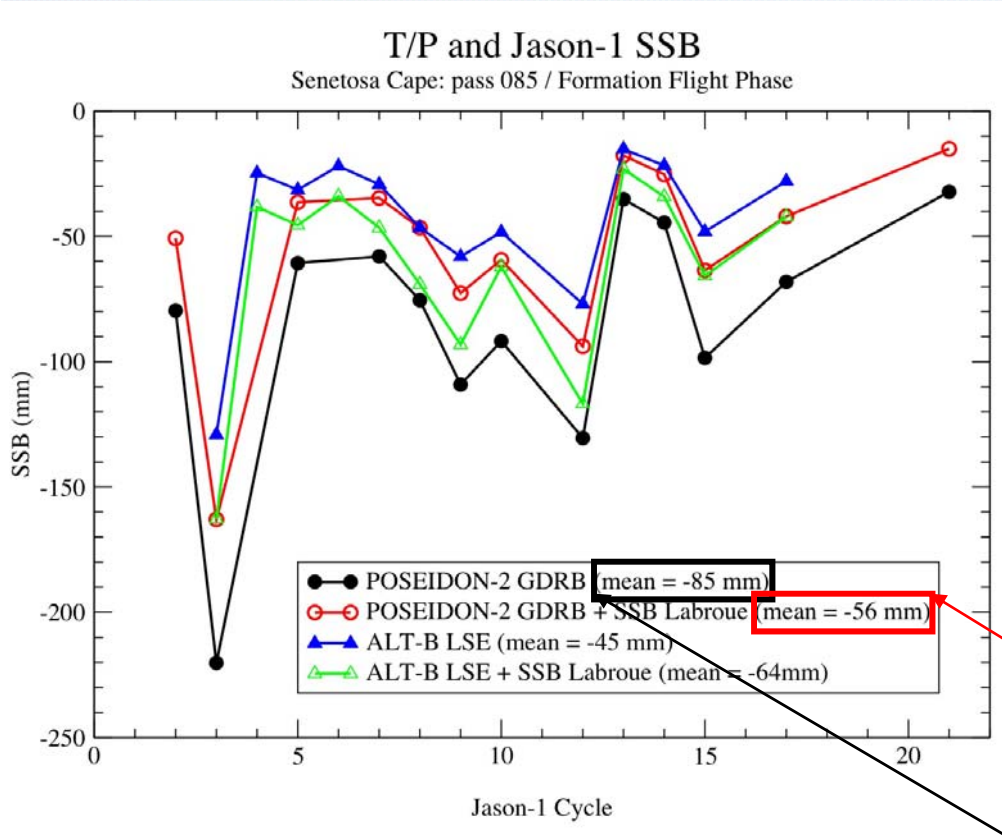


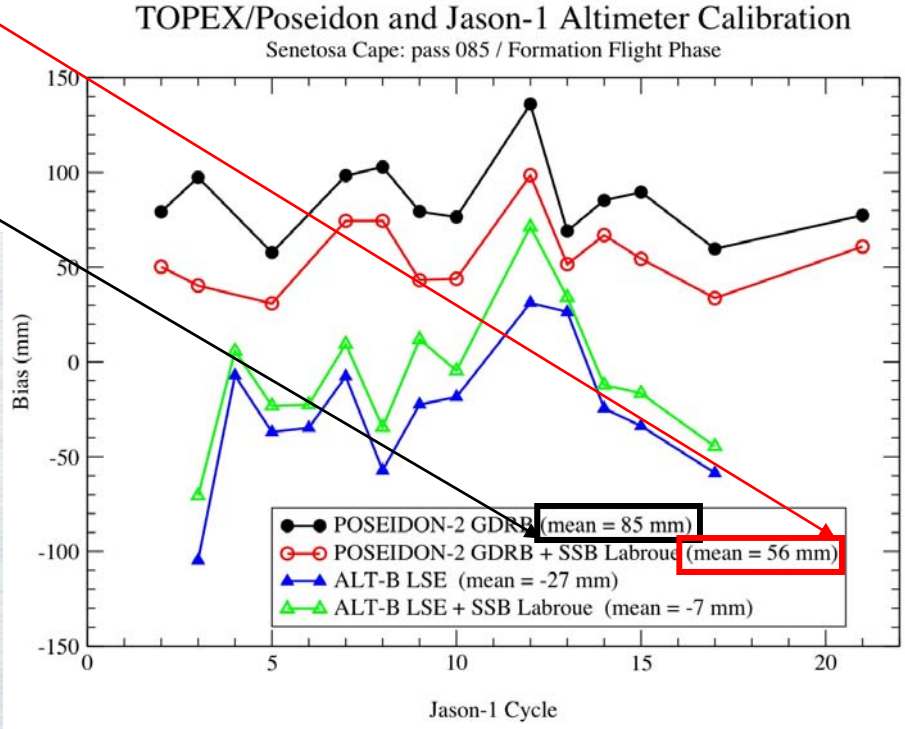
T/P BIASES

Main impact, using **LSE**:

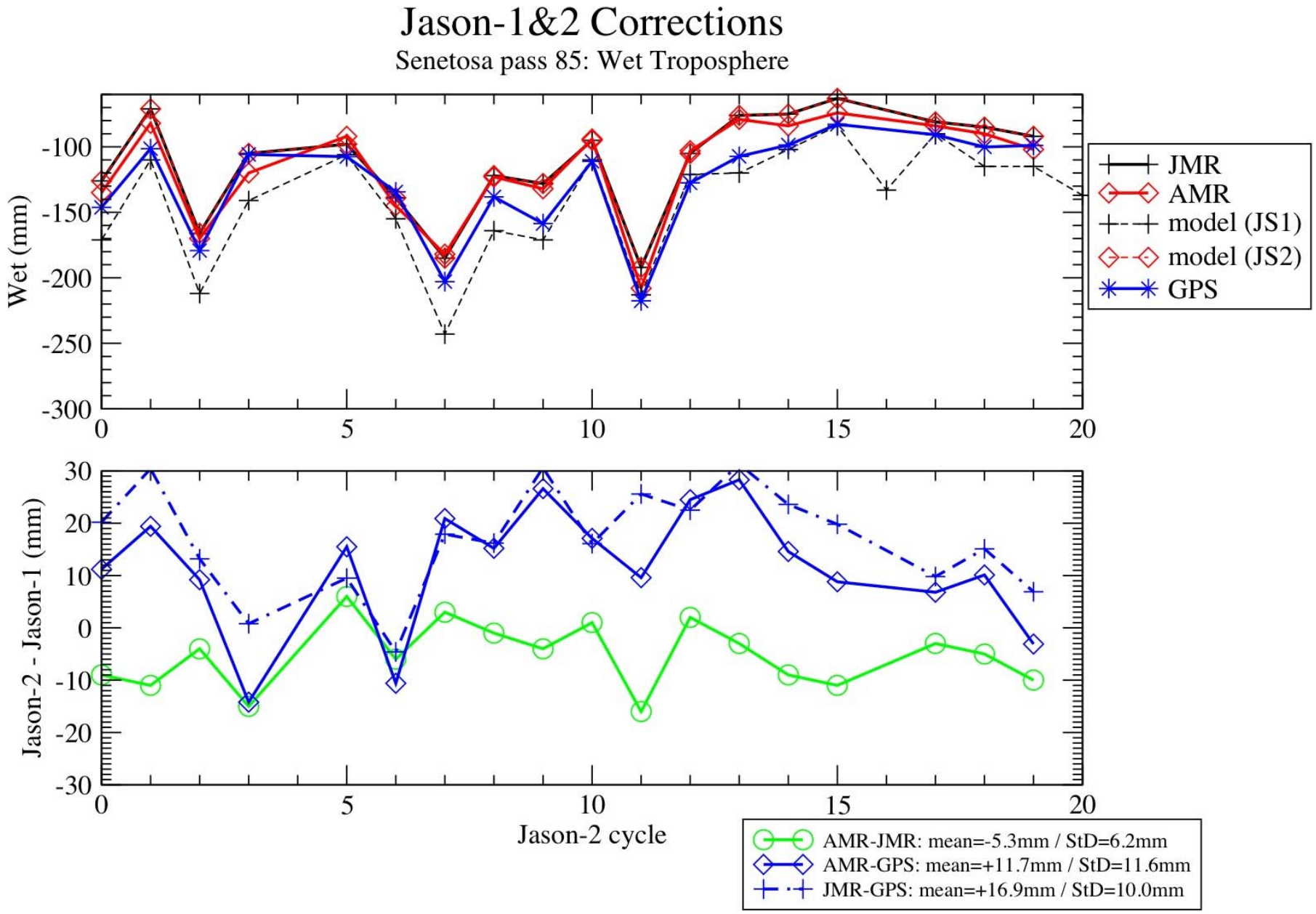
- the T/P (ALT-B) **bias is increased by 16 mm** (from negative to zero)
- the **standard deviation is increased by 25 mm** (square root)
- the **slope** is huge **+9 mm/yr…**

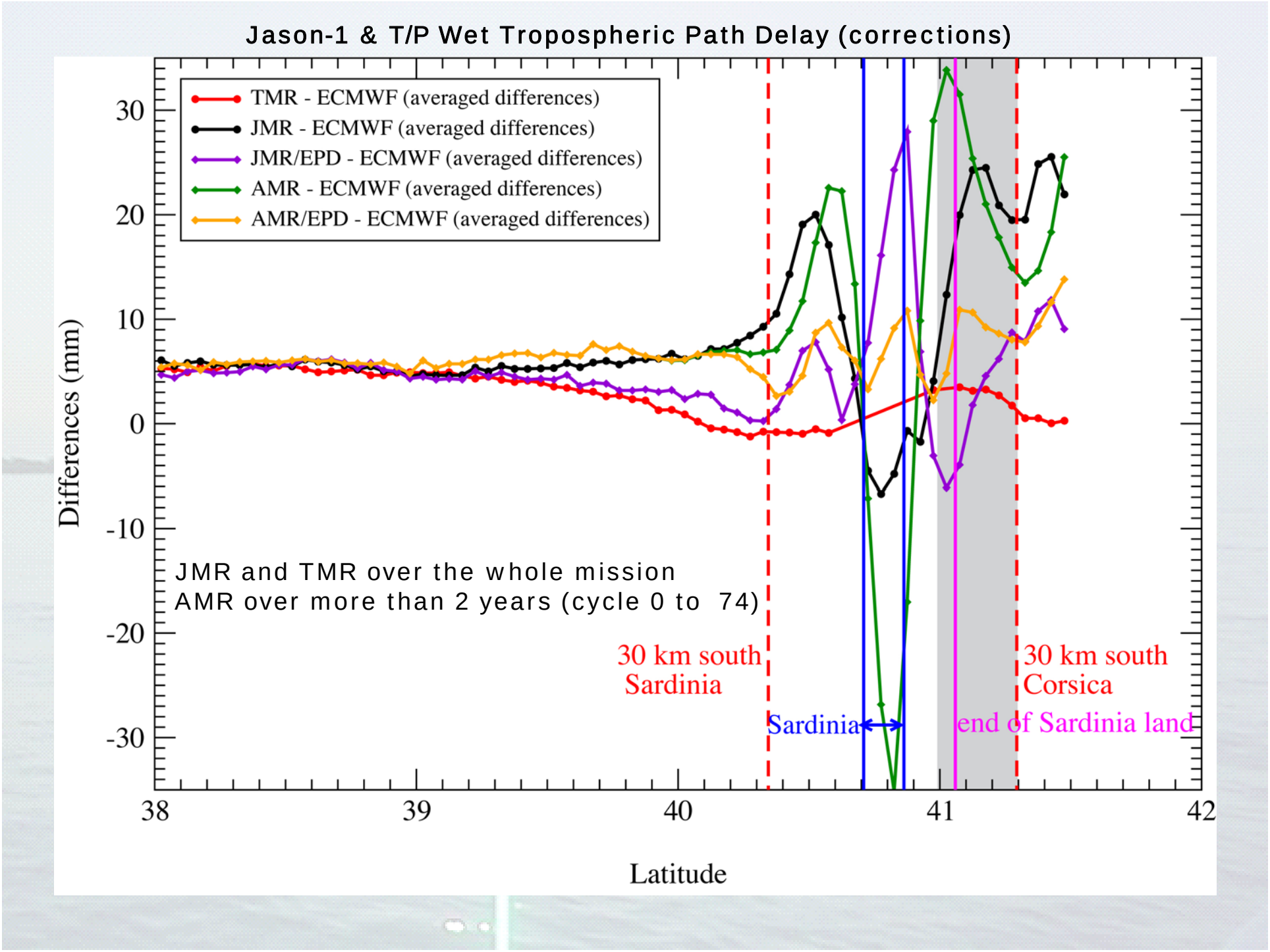
Jason-1 (GDR-B/MLE4) and T/P (RGDR/LSE) SSB





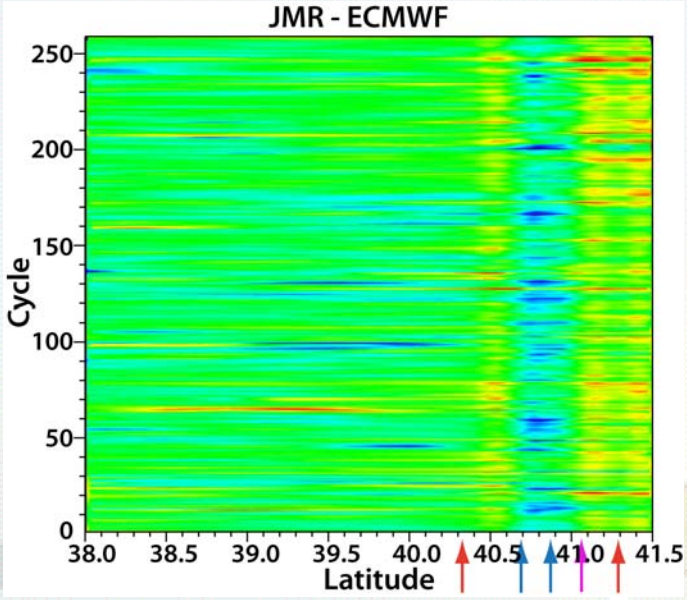
Jason-1&2 Wet Tropospheric Path Delay (corrections)

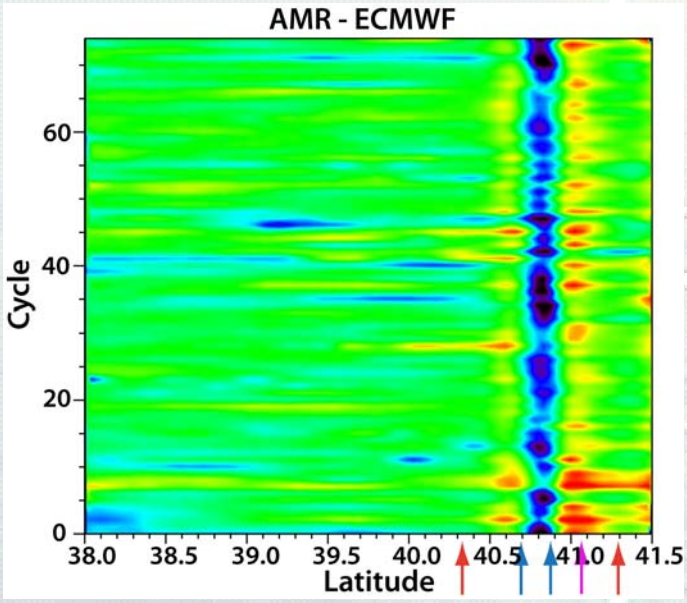



Jason-1 & T/P Wet Tropospheric Path Delay (corrections)
TMR - ECMWF (averaged differences)
JMR - ECMWF (averaged differences)
JMR/EPD - ECMWF (averaged differences)
AMR - ECMWF (averaged differences)
AMR/EPD - ECMWF (averaged differences)
Differences (mm)
30
20
10
0
-10
-20
-30
38
39
40
41
42
Latitude
JMR and TMR over the whole mission
AMR over more than 2 years (cycle 0 to 74)
30 km south Sardinia
Sardinia
30 km south Corsica
end of Sardinia land

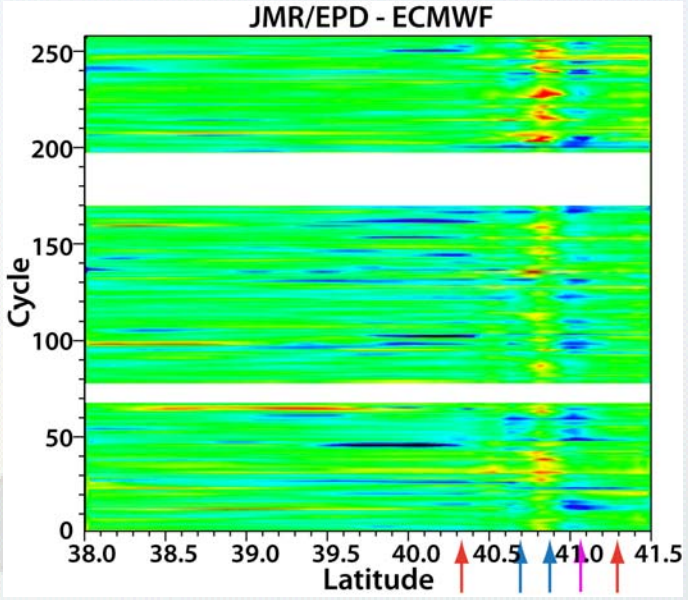
Jason-1, Jason-2 Wet Tropospheric Path Delay (Whole set of available products)

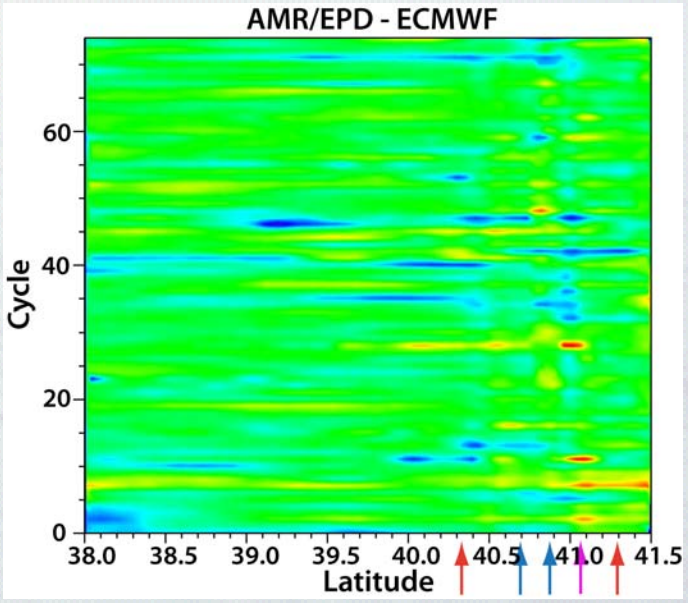
Original Path Delay (GDRC)



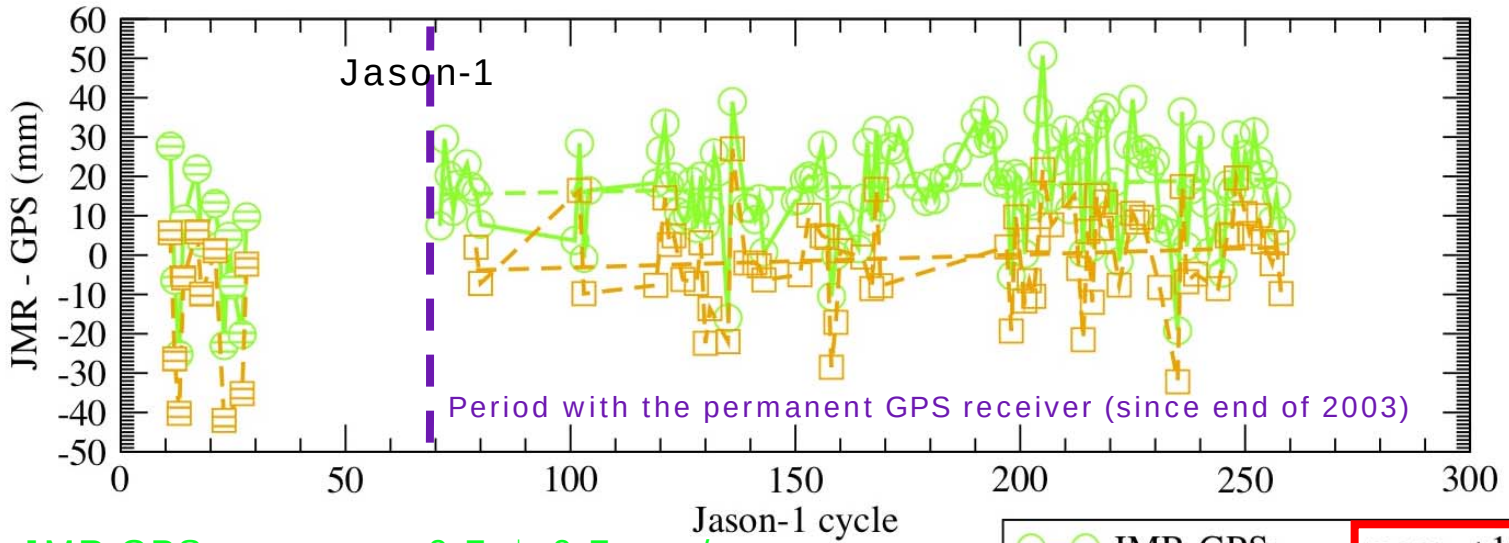


Enhanced Path Delay (Brown et al.)



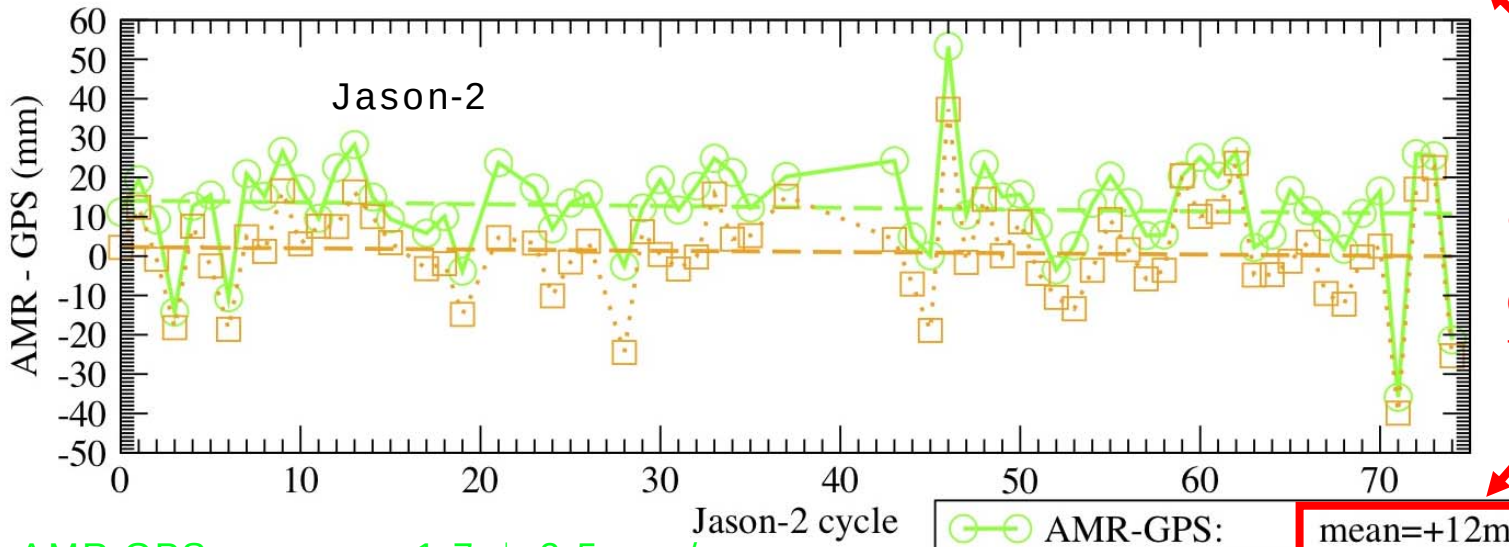


Jason-1&2 Wet Tropospheric Path Delay (corrections)
Whole set of available products



JMR-GPS: +0.7 ± 0.7 mm/yr
JMR/EPD-GPS: +1.0 ± 1.0 mm/yr

JMR-GPS: mean=+18mm / StD=12mm
JMR/EPD-GPS mean=0mm / StD=12mm

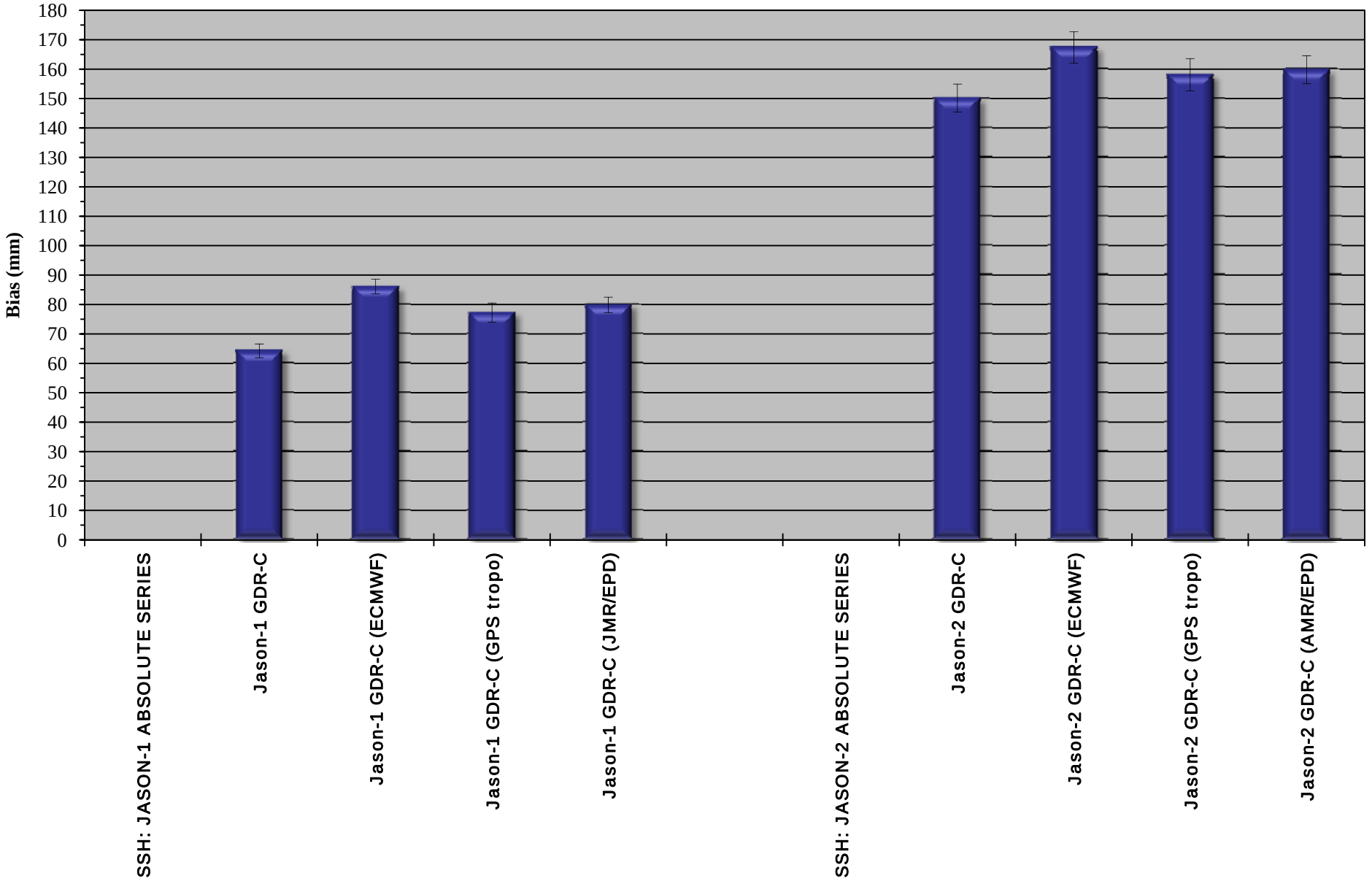


AMR-GPS: -1.7 ± 2.5 mm/yr
AMR/EPD-GPS: -1.1 ± 2.5 mm/yr

AMR-GPS: mean=+12mm / StD=13mm
AMR/EPD-GPS mean=+1mm / StD=13mm

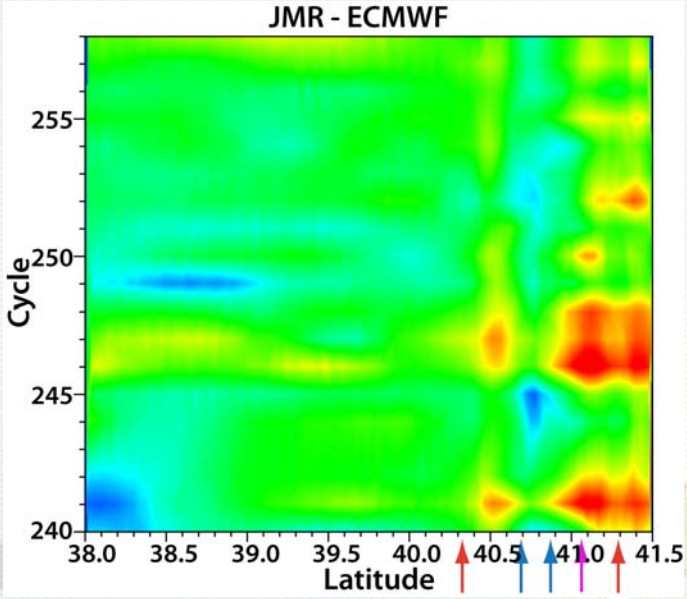
Better agreement between GPS and EPD for JMR and AMR

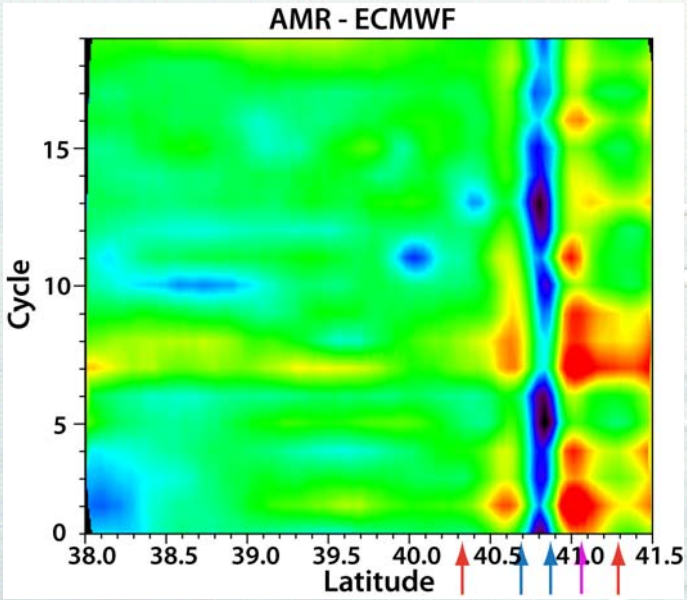
Jason-1&2 biases with different Wet Tropospheric Path Delay (corrections)



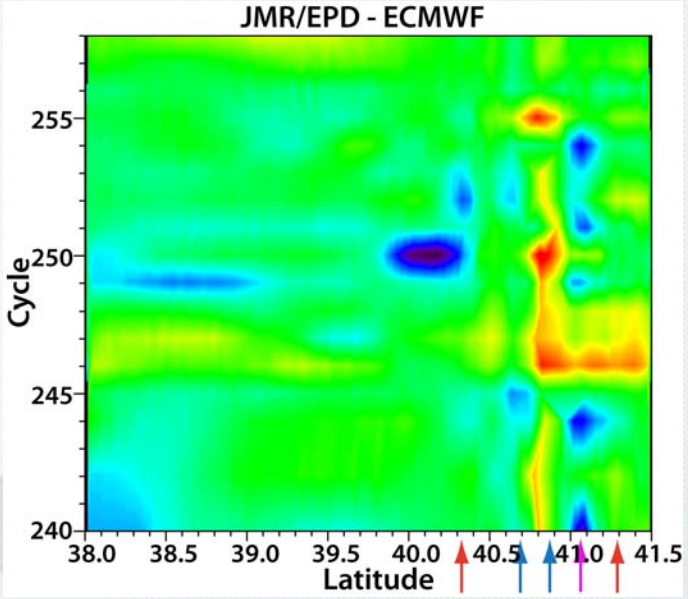
Jason-1, Jason-2 Wet Tropospheric Path Delay (Formation Flight Phase)

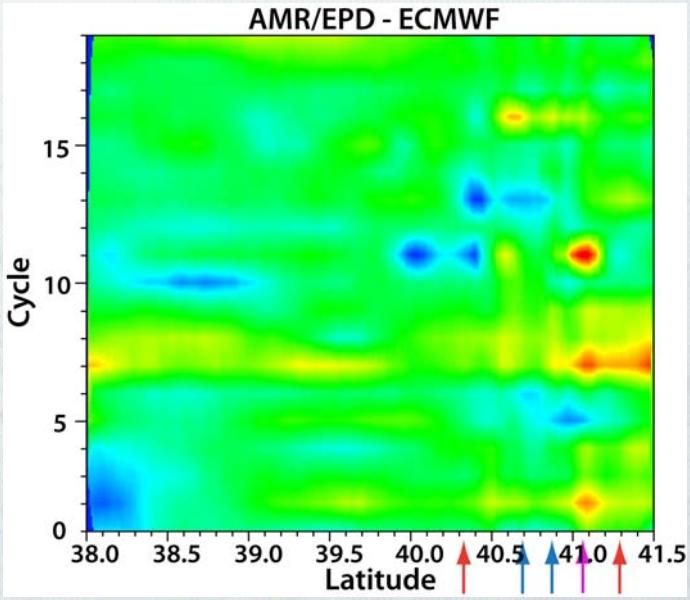
Original Path Delay (GDRC)



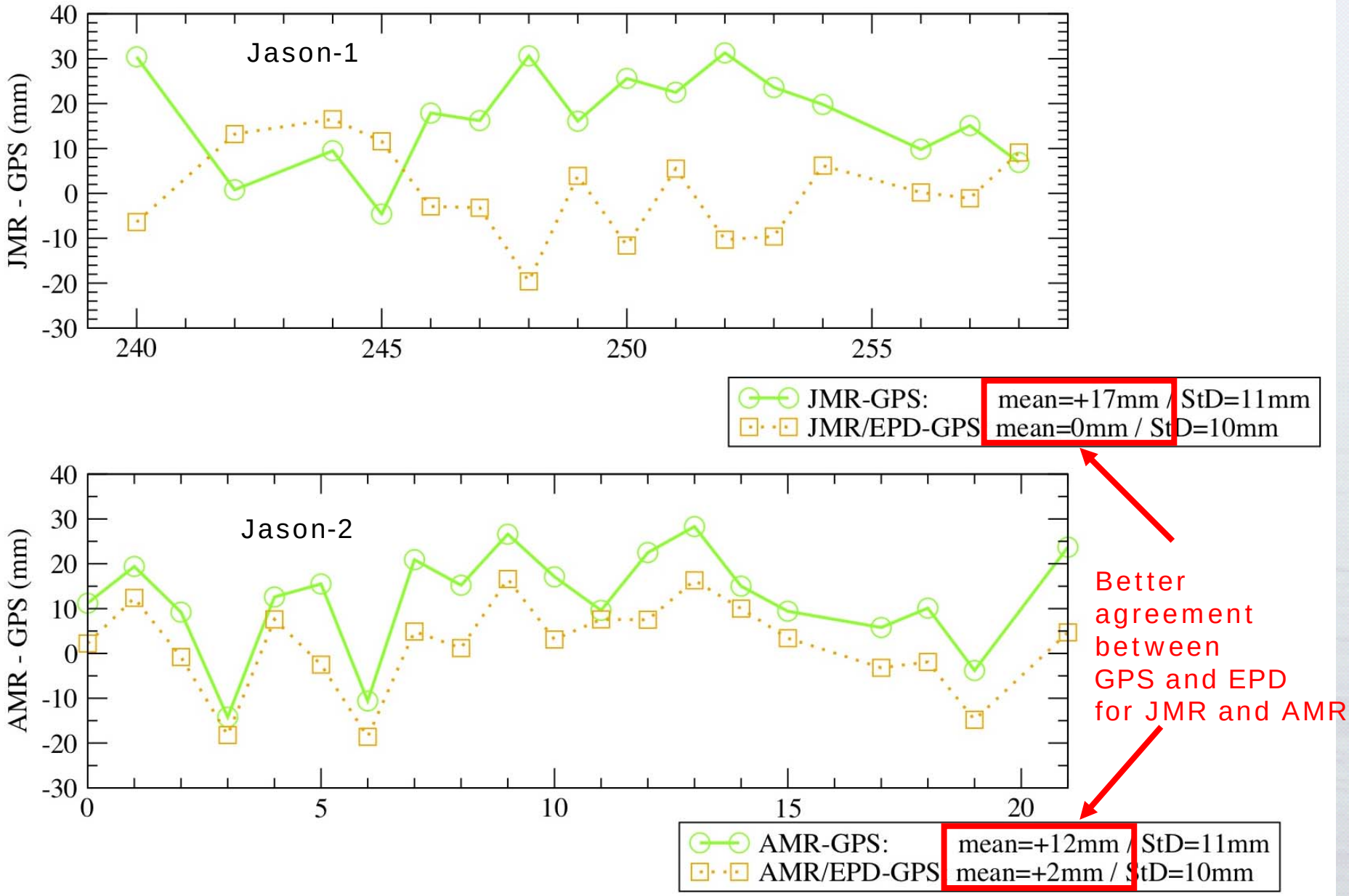


Enhanced Path Delay (Brown et al.)

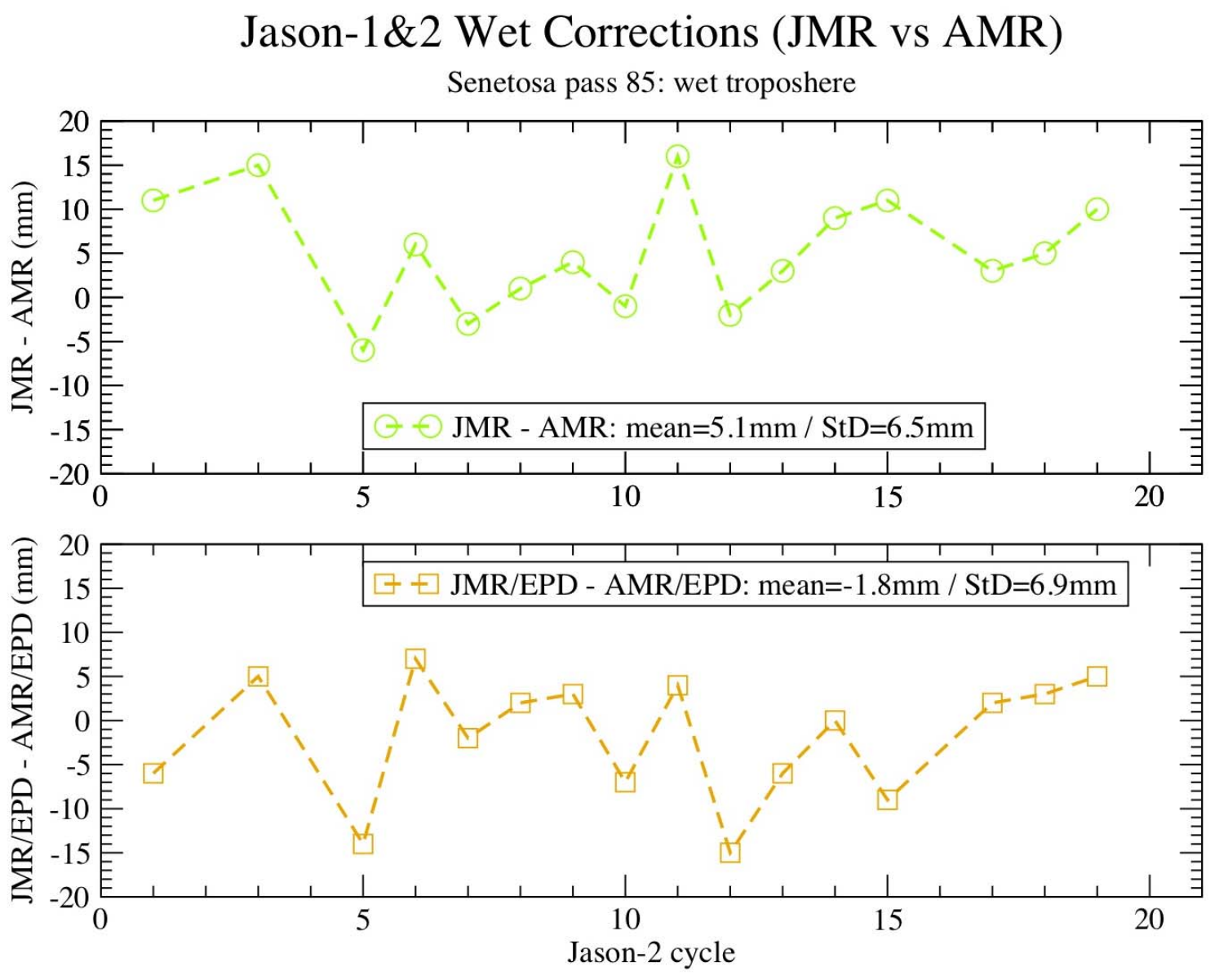




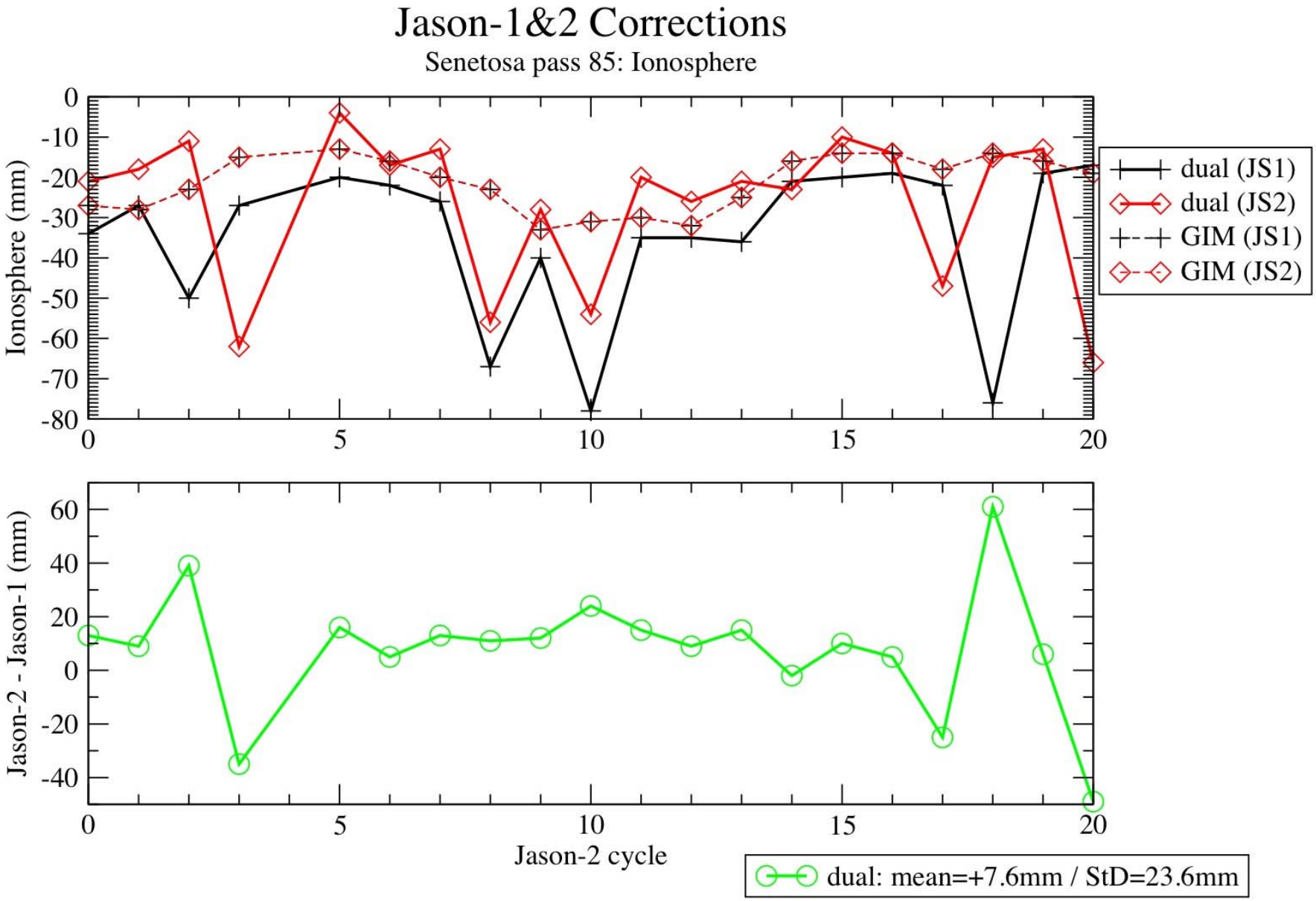
Jason-1&2 Wet Tropospheric Path Delay (corrections)
Formation Flight Phase



Jason-1&2 Wet Tropospheric Path Delay (corrections)
Formation Flight Phase

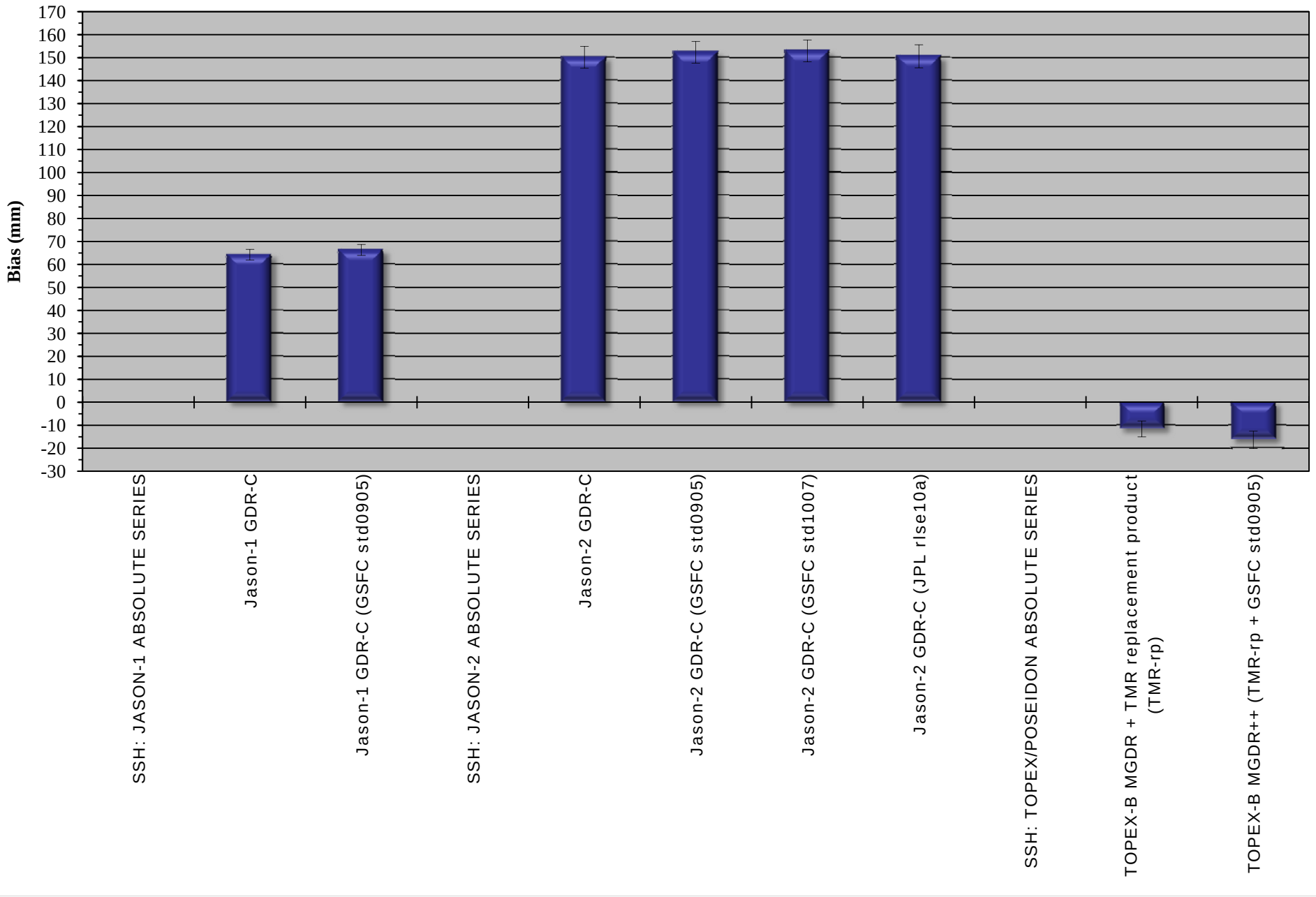


Jason-1&2 Ionospheric Path Delay (correction)

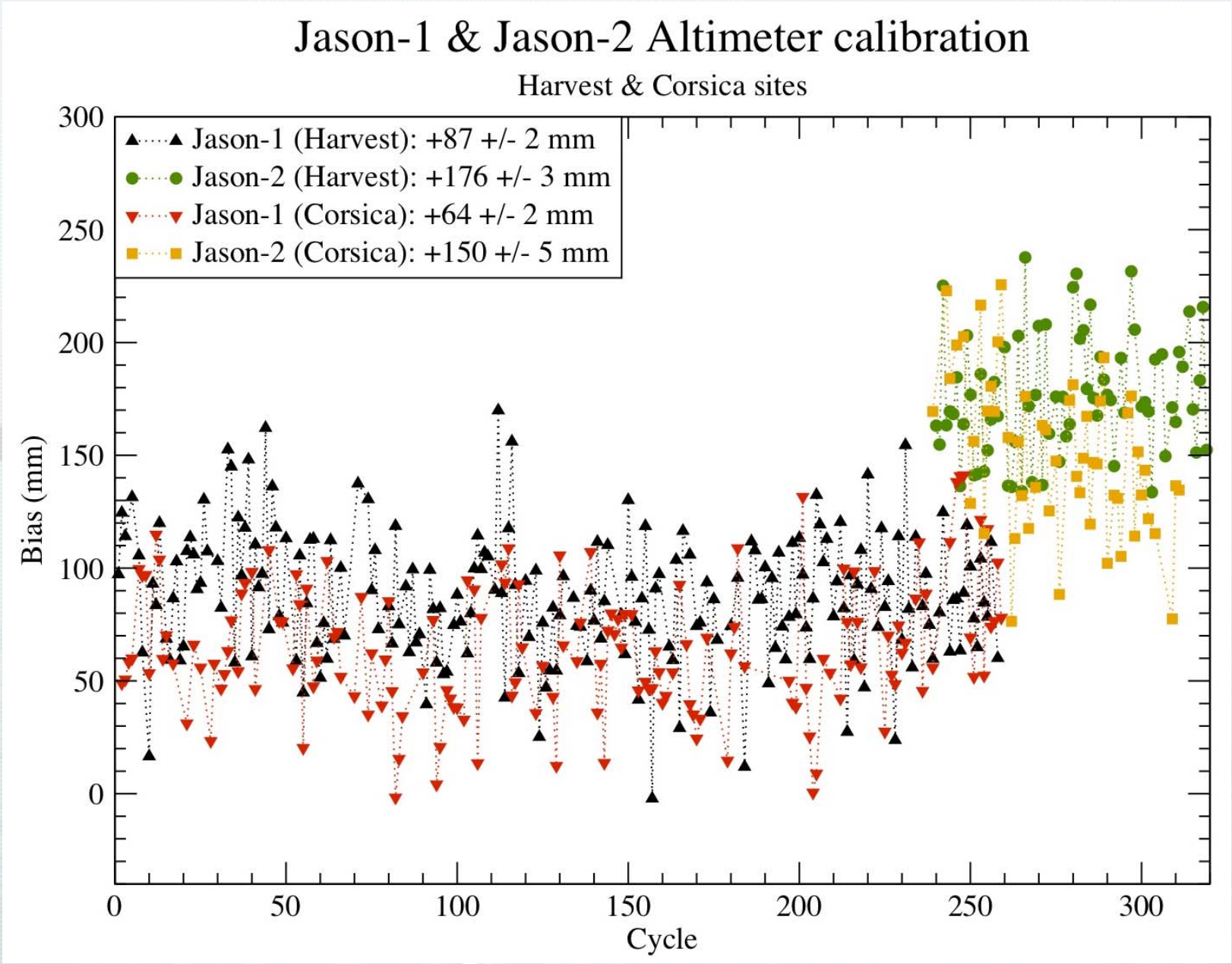


Jason-1&2 absolute bias from different POEs

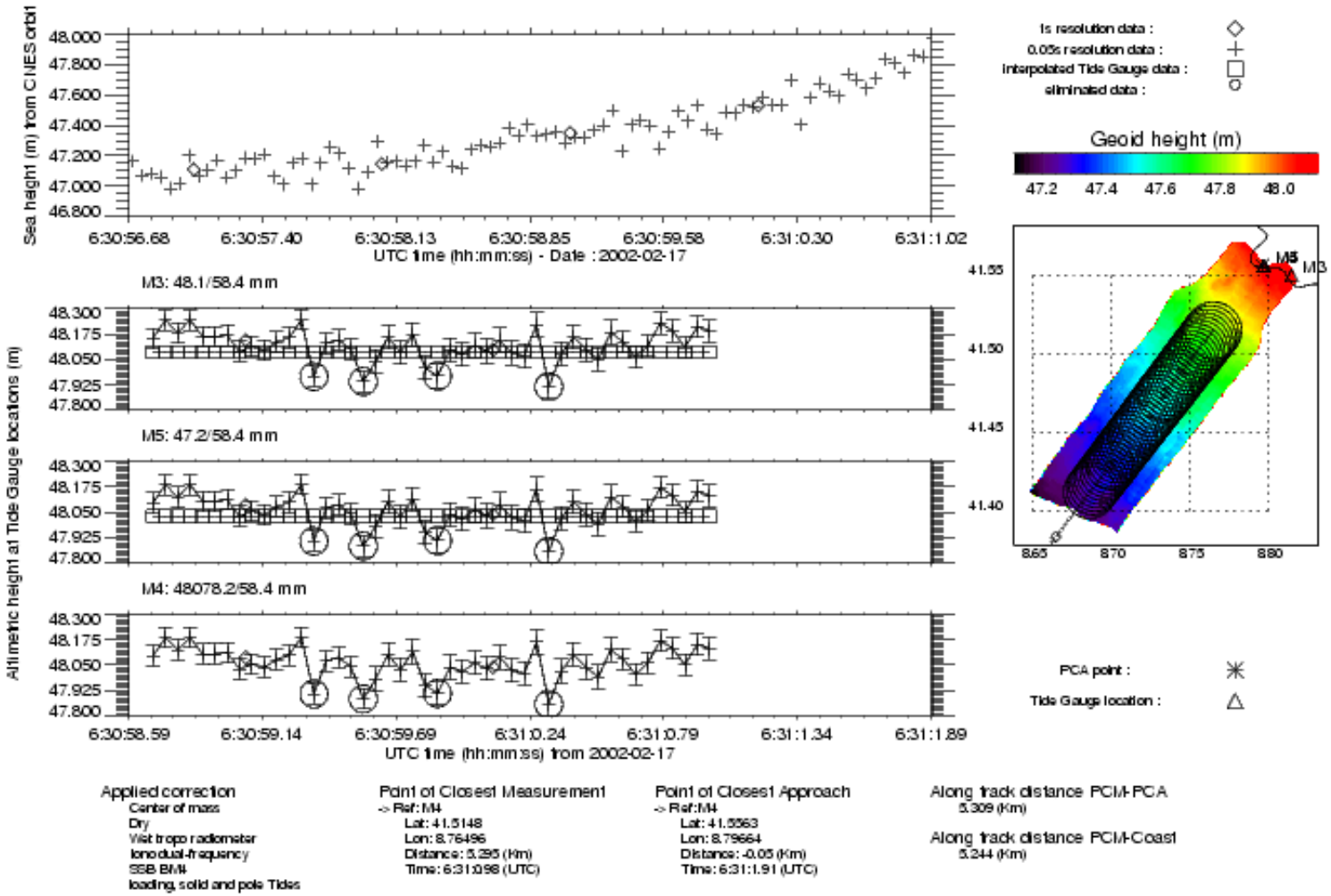
Small impact (mm) on the absolute value



Jason-1 & Jason-2 absolute bias from Harvest and Corsica



Methodology



Applied correction
- Center of mass
- Dry
- Wet tropo radiometer
- Ionodual-frequency
- SSB BM4
- loading, solid and pole Tides

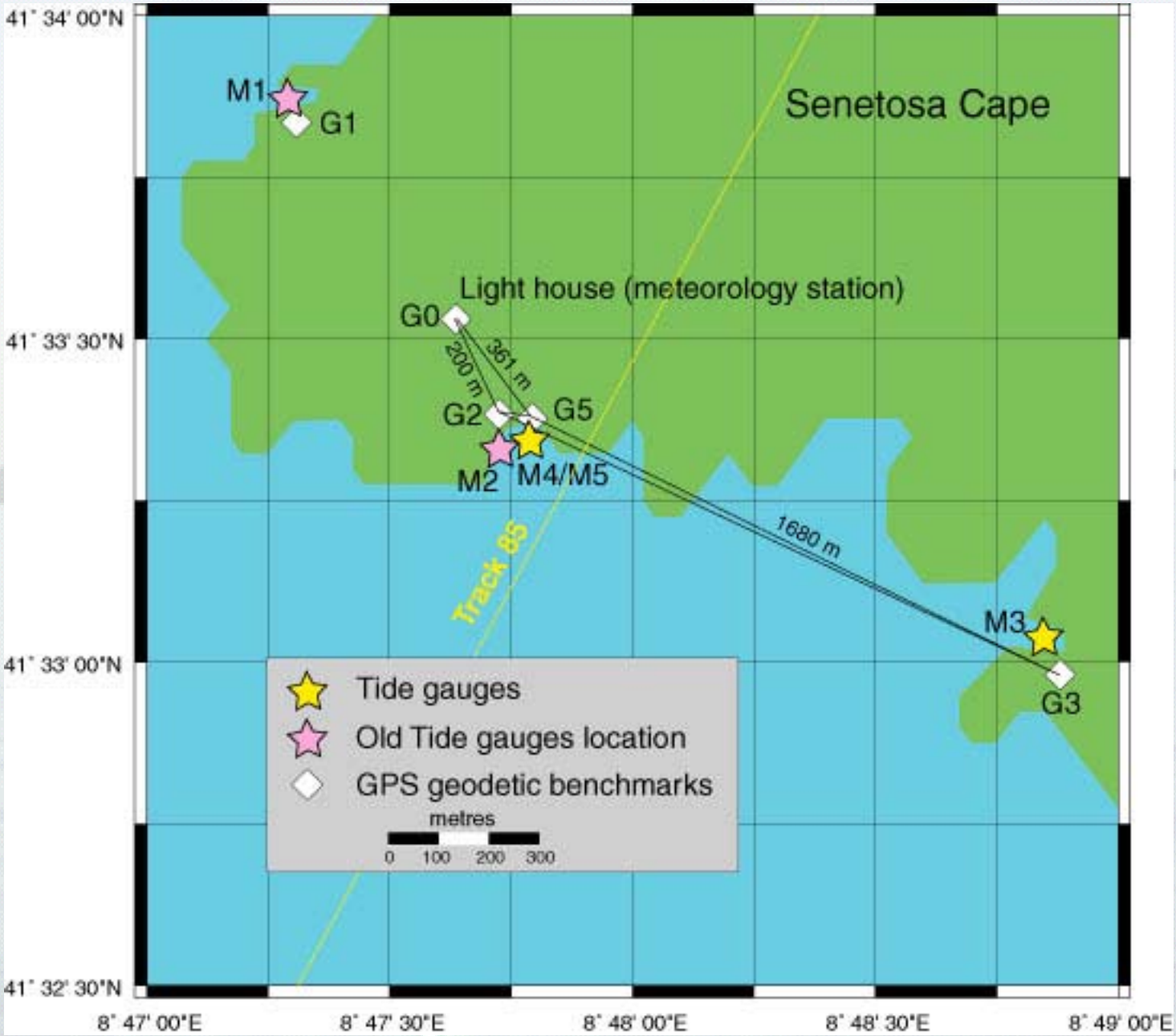
Point of Closest Measurement
-> Ref: M4
- Lat: 41.5148
- Lon: 8.76496
- Distance: 5.295 (Km)
- Time: 6:31:0.98 (UTC)

Point of Closest Approach
-> Ref: M4
- Lat: 41.5563
- Lon: 8.79664
- Distance: -0.05 (Km)
- Time: 6:31:1.91 (UTC)

Along track distance PCM-PCA
5.309 (Km)

Along track distance PCM-Coast
5.244 (Km)

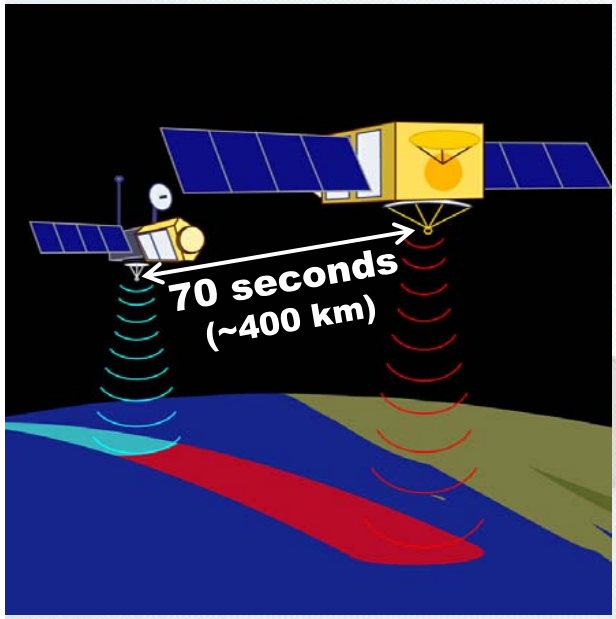
Senetosa Situation

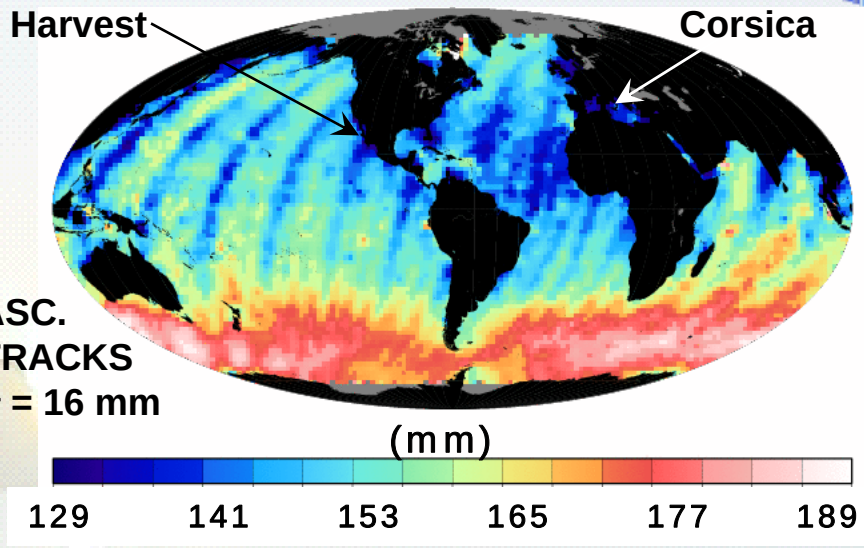


A unique opportunity to cross compare all the corrections and the derived Sea Surface Height

Systematic sea-surface height errors revealed by flying Jason-1 in formation with TOPEX/POSEIDON (for ~200 days)

Corsica Absolute Altimeters Calibration

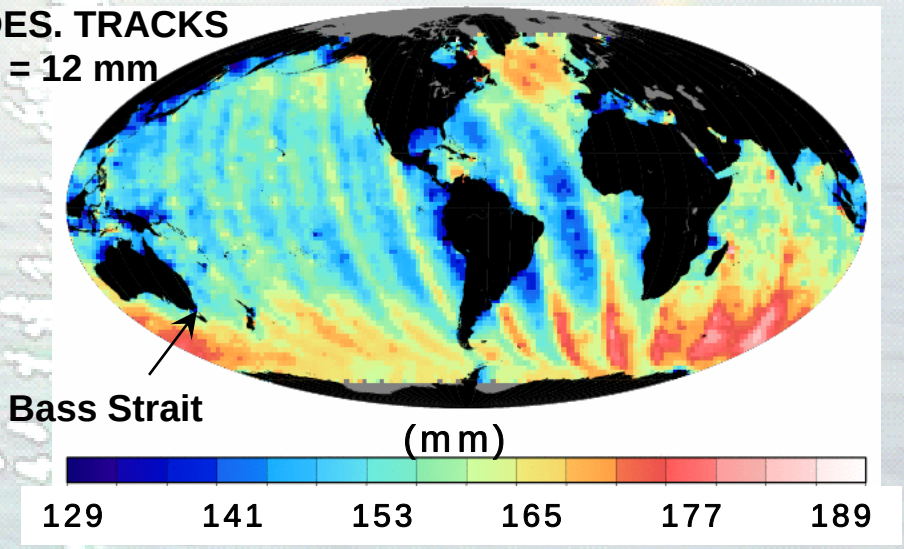




FORMATION FLIGHT

Same strategy for the first six month of OSTM/Jason-2 mission

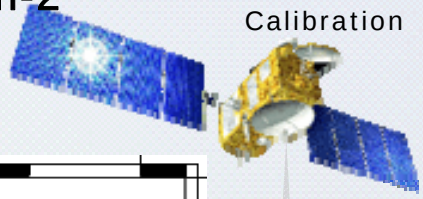
Jason-2 has been placed ~60 seconds behind Jason-1



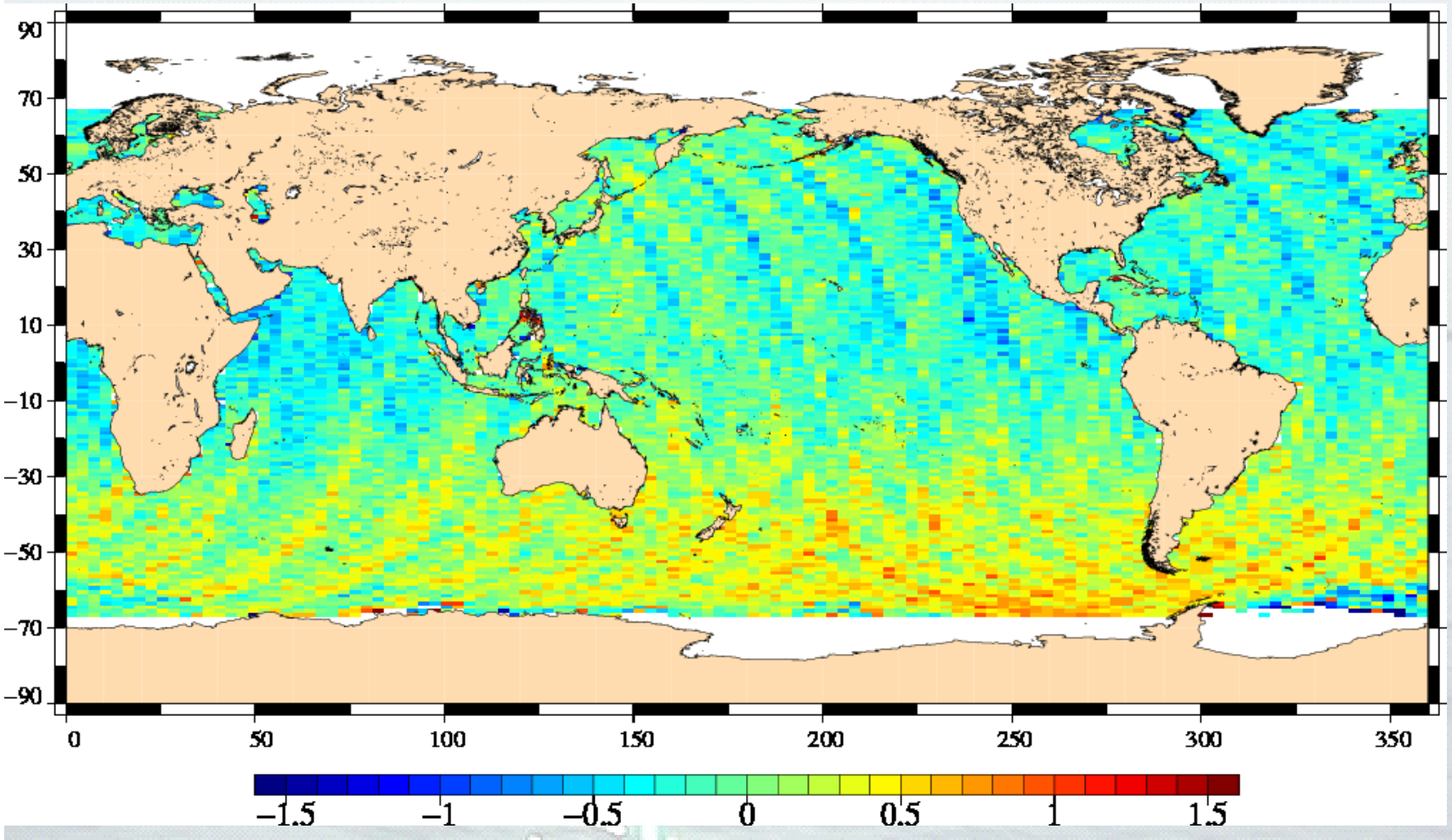
A unique opportunity to cross compare all the corrections and the derived Sea Surface Height

Systematic sea-surface height errors revealed by flying Jason-2 in formation with Jason-1 (for ~200 days)

Corsica Absolute Altimeters Calibration



FORMATION FLIGHT



SLA Differences (mm)