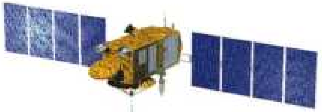
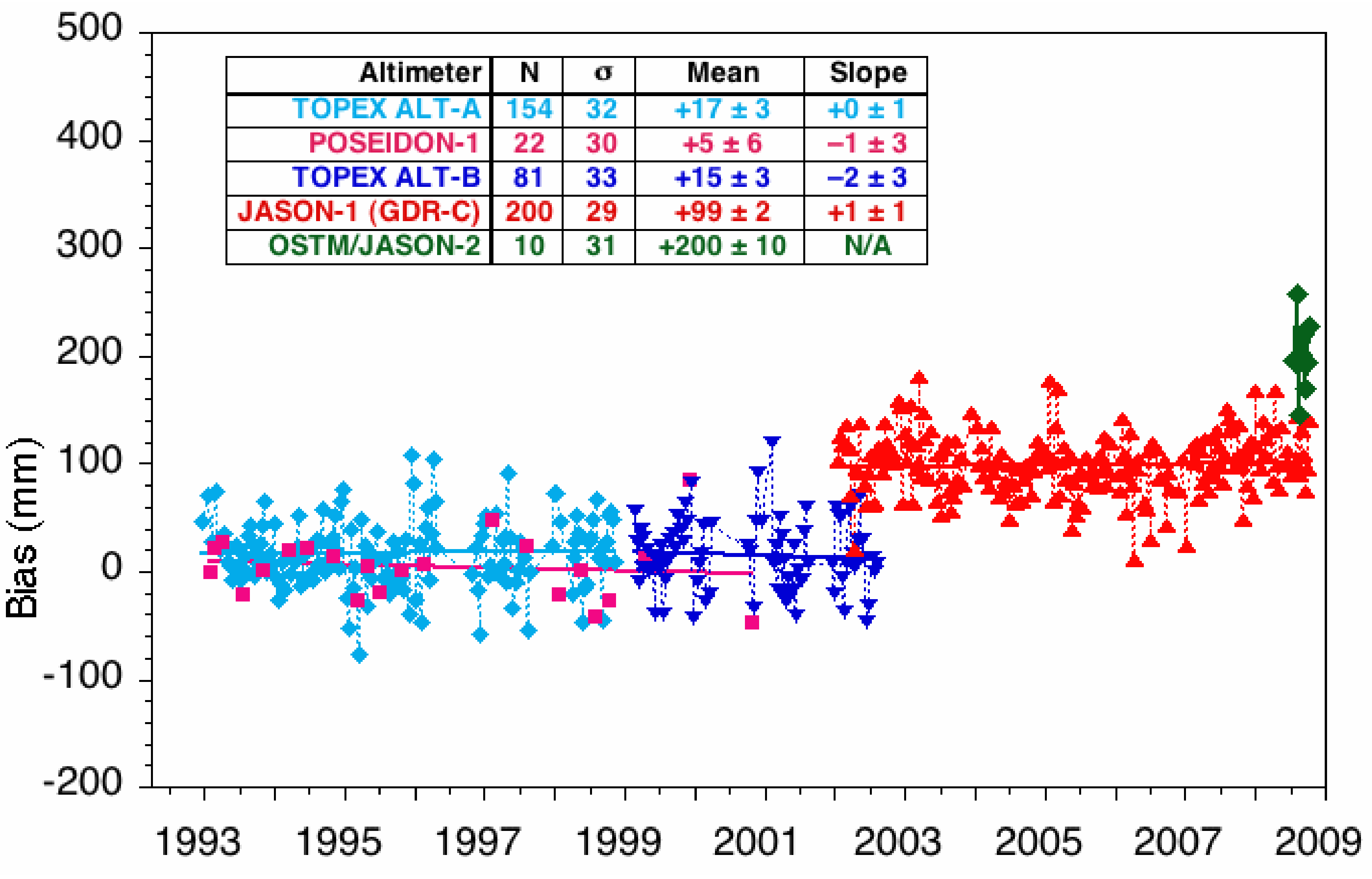
nd global calibration/validation: part 1, Monday, November 10



1600	HAINES Bruce	The Harvest Experiment: Calibration of the Climate Data Record from TOPEX/POSEIDON, Jason-1 and OSTM/Jason-2
1615	BONNEFOND Pascal	Absolute Calibration of TOPEX/Poseidon, Jason-1 ad Jason-2 Altimeters in Corsica
1630	WHITE Neil	In-Situ Calibration at the Bass Strait Site, Australia
1645	PAVLIS Erricos C.	Results From the Eastern Mediterranean Altimeter Calibration Network Š Emacnet
1700	2 short-oral PASCUAL Ananda & MERTIKAS Stelios	Performing Glider Missions Along Altimeter Tracks: What can we learn? & Recent Results for the Estimation of the Altimeter bias for the Jason Satellites Using Gavdos
1715	BROWN Shannon	Initial On-orbit Performance Assessment of the Advanced Microwave Radiometer and Performance Assessment of the JMR GDR-C Calibration
1730	All	Discussion

Current Harvest Time Series:
First SSH Calibration Results from OSTM



Altimeter	N	σ	Mean	Slope
TOPEX ALT-A	154	32	+17 ± 3	+0 ± 1
POSEIDON-1	22	30	+5 ± 6	−1 ± 3
TOPEX ALT-B	81	33	+15 ± 3	−2 ± 3
JASON-1 (GDR-C)	200	29	+99 ± 2	+1 ± 1
OSTM/JASON-2	10	31	+200 ± 10	N/A

Harvest sit aines et al.

Summary of Harvest Findings

- **Both Jason-1 and Jason-2 are reading SSH too high, by +10 and +20 cm respectively**
  - OSTM/Jason-2: +200 ± 10 mm (N = 10, σ = 31 mm)
  - Jason-1: +99 ± 2 mm (N = 200, σ = 29 mm)
- **TOPEX/Poseidon systems unbiased (< 2 cm)**
  - T/P ALT-B: +15 ± 3 mm (N= 81, σ = 33 mm)
  - T/P ALT-A: +17 ± 3 mm (N = 154, σ = 32 mm)
  - T/P POS: +5 ± 6 mm (N = 22, σ = 30 mm)
- **Relative SSH Bias (from Common Overflights) consistent with absolute estimates.**
  - Jason-2 — Jason-1 +97 ± 5 mm (N = 8, σ = 13 mm)
  - Jason-1 — T/P ALT-B +78 ± 8 mm (N = 16, σ = 32 mm)
- **SSH drift estimates for all 5 altimeter systems statistically indistinguishable from zero.**
  - Large drift (~1 cm/yr) seen in early (A) versions of Jason-1 GDR data absent in GDR-C
- **Primary source of Jason-1 and Jason-2 biases is altimeter**
  - Mean effect of orbit, ionosphere, wet/dry troposphere at 1-cm level or smaller
  - Consistent with "Orbit-Range" figures from common overflights
  - Evolution of SSB correction (e.g., from GDR-B to GDR-C) has large (~ 4 cm) impact on SSH bias
- **AMR slightly wetter (~5 mm) than JMR, but with questionable statistical significance**
- **Poseidon-3 Ku-ionosphere delay smaller (~10 mm) than Poseidon-2**
  - Poseidon-2 agrees better with GPS (GIM)
- **Role of geographically correlated errors under investigation**
  - 1-cm discrepancy between Δ "Orbit–Range" for Harvest (+95 mm) and global (+84 mm) analyses.

Harvest site, Haines et al.

Calibration from Corsica

Absolute bias 10 four common overflights:

Jason-2: +220 mm *(207 from Harvest)*
Jason-1: +147 mm *(110 from Harvest)*

The very high values of the bias need to be investigated because it is very different from the whole Jason-1 time series (see poster for details).

=> Can’t trust absolute values for this period for the moment: need further investigation

Relative bias from 10 common overflights:

Jason-2 - Jason-1: +72 mm *(97 from Harvest)* **(70 mm from orbit-range)**

Difference with global analysis (84 mm) comes from MOE orbit errors on some cycle

POE reconciles results: ~80 mm for orbit-range (84 mm from global analysis).

Corrections:

- **Wet tropo. from radiometers show a bias of -10 mm** (AMR-JMR) and **GPS confirms that it comes from JMR (dryer).** However **no drift detected from JMR/GPS** comparisons**.**
- **Dual Ionospheric corrections exhibit a bias of +12 mm** (Jason-2 - Jason-1). Compared to GIM the biases are respectively -2 mm and -14 mm for Jason-2 and Jason-1

Transition from GDR-B to GDR-C:

Large impact of SSB (-30 mm); JMR, POE and range corrections account for few mm

T/P MGDR+:

10 mm decrease of the T/P ALT-B bias compared to MGDR (-3 mm from TMR and -7 mm from orbit)

Jason-1 (GDR-C) - T/P (ALT-B, MGDR+): +85 mm (11 common overflghts)
(78 from Harvest)

Using retracked products increases T/P ALT-B bias by 13 mm

CONCLUSION

Corsica site, Bonnefond et al.

Conclusions

Data	Cycles	N	Mean Bias	Std Error
Jason-1 GDR-B	001-232	225	+96.8	2.5 mm
Jason-1 GDR-C	198-240	42	+95.3	5.3 mm
J1 GDR-C – J1 GDR-B	198-232	33	-19.0	2.2 mm
J2 IGDR-C – J1 IGDR-C	000-012	11	+70.6	9.7 mm
Jason-2 IGDR-C	000-010	11	+165.5	9.9 mm

Tasks remaining:

1. **Investigate any improvement in our ability to transform the tide gauge SSH to the comparison point.**
2. **Incorporate Mooring 2, Mooring 3 and subsequent buoy deployments (moorings to be recovered early Feb 2009).**
3. **Investigate altimeter bias with and without Burnie FTLRS data used to determine orbits. Do we see geographically correlated effects?**

Bass Strait site, Watson et al.

Coordinates for GVD5 based on ITRF2005 (1 year of data)

ITRF2005 Orbits (GSFC, Luthcke et al.)

JMR corrections (Desai model)

New Parametric SSB (ITRF2005-compatible)

Revised Gavdos GVD5 Height:	*21.7805 m*
Previous Gavdos GVD5 Height:	*21.7620 m*
Δh Correction to previous Bias :	**-0.0185 m**
Δh Correction due to TRF change:	**0.0246 m**
Correction due to Seasonal ΔSLA:	**-0.0080 m**
Δh due to ΔGDR from v.B to v.C	**(cycle dependent)**

REVISED JASON-1 BIAS: 107.5 ± 8 mm

Preliminary Bias Results for JASON-2

Pass 018:	2 cycles	258.0 ± 10	(formal)
Pass 109:	7 cycles	229.6 ± 47	(formal)
Weighted mean of 9:		234.6 ± 16* mm	

* Statistics of mean based on pass 109 only

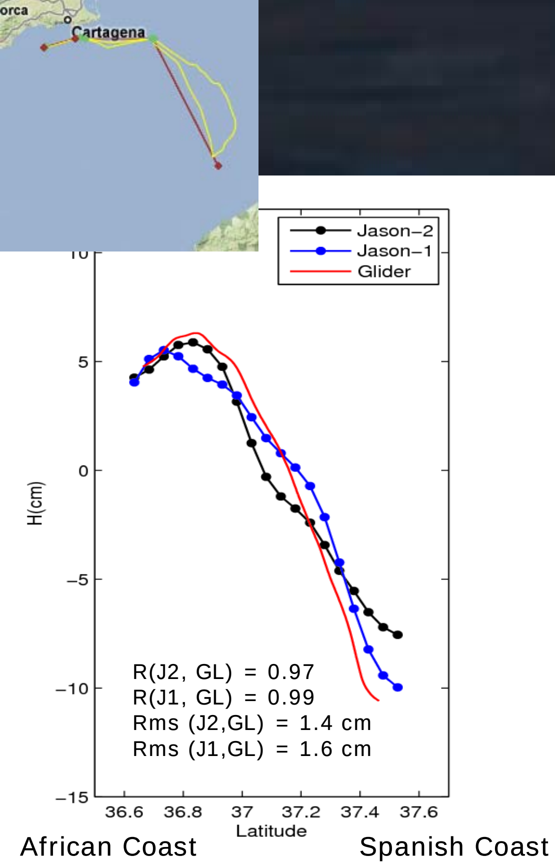
eMAC*net*, Pavlis et al.

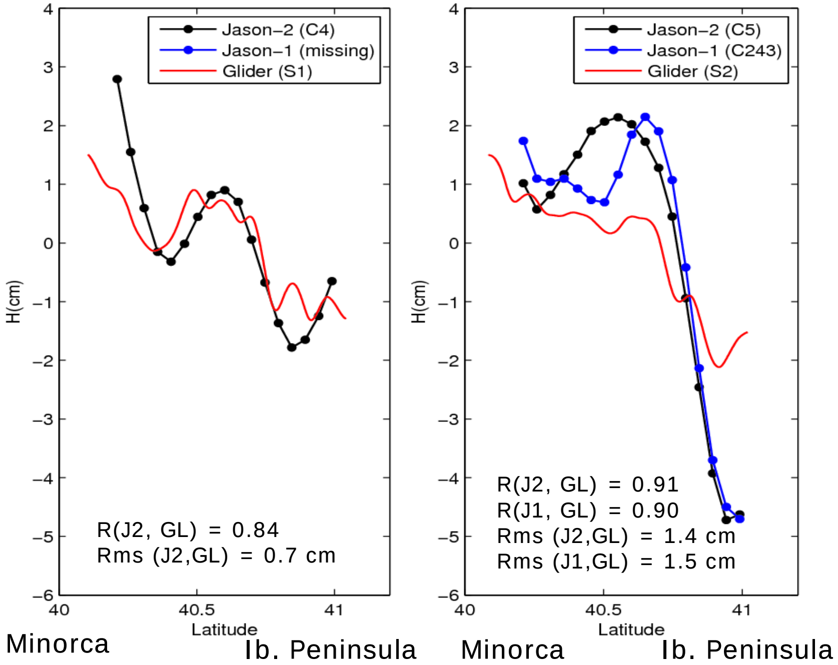
Conclusions

- The absolute bias of the Jason-2 altimeter between cycles No: 2-11 estimated B2 = 204.8mm ±19.4mm (20-Hz data).
- For Jason-1: B1= 115.6 mm ±42mm (1-Hz data) in the tandem period.
- Procedures have been standardized between Corsica, Harvest Platform and Gavdos.
- Gavdos is enhanced by another site RDK1 on the ground track (No.109) and in south Crete.
- Field surveys are being planned using survey boat, an ultra-sound height measuring device, a GPS and along ground tracks.

Gavdos site, Mertikas et al.

Jason-1 / 2 missions





Ongoing and future work:
Testing other MDT.
Applying specific altimetric algorithms (XTRACK/PISTACH/COASTALT) for coastal areas.

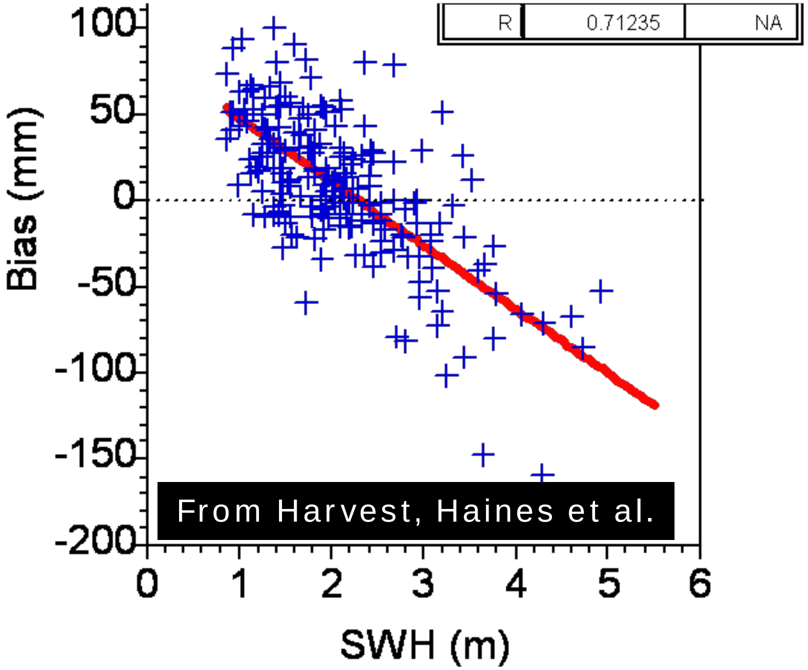
- ☐ Alboran Sea:
  - ■ Intense gradients.
  - ■ Very good correlation between altimetry and glider data.
  - ■ Jason-1 (IGDR) and Jason-2 (DUACS) ADT profiles correlate well (0.96).

- ☐ Balearic Sea:
  - ■ Weak gradients (large noise to signal ratio).
  - ■ Agreement between altimetry and glider data is lower.
  - ■ Strong variability in 10 days. Problem of synopticity with the glider data?
  - ■ Sensititivity to the ref. level in DH computation and mean dynamic topography.

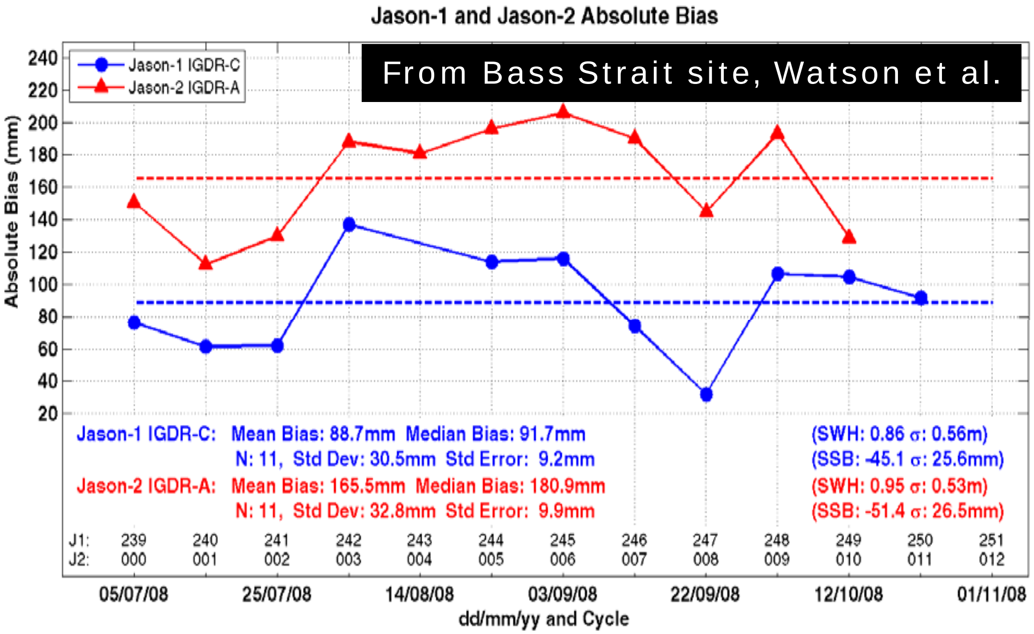
Glider missions, Pascual et al.

e in situ analysis key points:

- **Coherent signal (~ 60 days?) on both Jason-1&2 bias** time series for all calibration sites
- **~12 mm differences between GPS and JMR on coastal approach**
- **Differences between absolute biases up to few cm: GCE?**
- When **uncompensated from SSB absolute bias is 0 for ~2 m SWH**: a coincidence for all calibration sites?

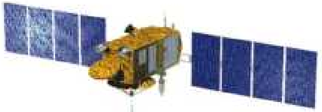


From Harvest, Haines et al.



From Bass Strait site, Watson et al.

Local and global calibration/validation: part 2, Tuesday, November 11



0830	DESAI Shailen	Global cross calibration and validation of the Jason-1 and Jason-2/OSTM data products.
0845	CHAMBERS Don	Cross-Calibration Of Jason-1 And Jason-2 Sea Surface Height
0900	PHILLIPS Sabine	Global Statistical Jason-2 Assessment
0915	ABLAIN Micha‘l	Jason-2 Cross-Calibration With Jason-1
0930	COMMIEN Ludivine	Statistical Quality Assessment of Jason-1 GDR Version C
0945	DETTMERING Denise	Multi-mission crossover calibration Š first results for Jason-2
1000	OLLIVIER Annabelle	Jason-1&2 / Envisat Cross-calibration
1015	All	Discussion

16:00 to 19:30: 26 posters on Local and global calibration/validation

Summary

- AMR is meeting performance expectations
- JMR GDR-C removes sigma0 drift, but some instability observed after recent safehold
- ARCS implemented for AMR will maintain stable calibration on Jason-2 GDRs
- Future plans and outstanding issues:
  - Add AMR coastal PD product to Jason-2 GDRs
    - Work on applying coastal algorithm to JMR/TMR coastal on-going
  - Use AMR to recalibrate APC for JMR and TMR
  - Potential 1-sec offset in JMR/AMR time tag (pointed out by G. Quartly and R. Scharroo after recent JMR S/C anomaly)
  - Update/Improve radiometer flags (radiometer specific rain/ice flag)
  - Address Jason-1 post-safehold instabilities

AMR and JMR, Brown et al.

Summary and Conclusions

- J2 Range measurements short relative to J1.
  - Ku-Band: 84 mm
  - C-Band: 131 mm
- Causes J2 ionosphere correction to be biased +8.4 mm relative to J1 ionosphere correction.
- Ku-Band range differences have apparent 0.25%*SWH relative scale between northern and southern hemispheres.
  - Requires further investigation to consider:
    - Orbit error as source e.g. use other POEs,
    - MSS errors.
- Differences of J2/J1 ionosphere corrections suggest a scale error in the differences of 30-50%.
  - Requires further investigation.
- Systematic “structure” (< 3K) in brightness temperatures (especially 34GHz) after Jason-1 cycle 242/243 safehold.
  - Being investigated.
  - Wet troposphere delay differences have standard deviation of 3-4 mm.

Jason-1&2 data products cross calibration and validation, Desai et al.

CONCLUSIONS

- Jason-2 & Jason-1 SSH agree quite well, other than an **80 ± 2 mm** bias (J2 SSH higher than J1)
- After using POEs or a 1 cycle-per-revolution orbit error removal scheme, mean standard deviation is **43 mm**.
- Standard deviation is increasing after Cycle 8
  - » Corresponds with a problem in Altimeter correction quality flags on Jason-2. A clue?
- Jason-1 GDR-C SSB model much better than GDR-B and removes the large geographically correlated bias jumps between TOPEX and Jason-1
  - » This assumes, however, that TOPEX models have also been corrected and no “official” record exists where this has been done

Don P. Chambers et al.

Jason-1&2 SSH cross, Chambers et al.

Conclusion

- Use of 11 Jason-2 cycles in tandem configuration with Jason-1
- Very good consistency between altimetric parameters of Jason-2 and Jason-1
- Improvement observed thanks to new JA2 radiometer (AMR) → more stable than JMR
- Parameter analysis reveal no particular behavior linked to use of different tracking modes (Median, Diode/DEM)
- Small differences observed (principally in C-band) likely linked to MQE editing criteria →
  - Do not impact SSH computation (talk M. Ablain)

Jason-2 statistical assement, Phillips et al.

Conclusion

- Parameter and SLA performances and consistency is very good between Jason-1 and Jason-2:

  ⇒In comparison, J1/J2 SLA consistency using POE from 6 cycles is comparable to the SLA consistency between Jason-1 and T/P during all the verification phase (21 cycles), using new orbit standards and similar retracking.

  ⇒ The very stable SSH bias between J2 and J1 (<0.2 cm RMS) allows us to link both MSL series very accurately.

- Additional Jason-2 cycles will not be useful to better analyze the Jason-2 SSH performances and the SLA consistency with Jason-1. From this Cal/Val point of view, and in order to better benefit from these both missions for scientific applications, Jason-1 satellite can then be moved to its new interleaved orbit as soon as possible.

Jason-1&2 cross calibration, Ablain et al.

Conclusion

- Good performances for crossover (1.2cm² variance gain) and along-track statistics (8cm²=7% of signal variance), for the reprocessed cycles and for the whole dataset regarding the orbit solution.

- New JMR calibration and orbit do not affect global Mean Sea Level. The new orbit solution impacts on the local slopes, but this effect can be corrected. Bias linked to JMR: -4.52mm. Orbit: -9.5mm

- GDR-Cs do not prevent from doing MSL studies.

Jason-1 GDR-C quality assessment, Commien et al.

Conclusions

Discrete Crossover Analysis

provides ...

- ... radial errors with high temporal and spacial resolution
- ... range biases as well as centre-of-origin shifts
- ... geographically correlated errors

is not limited ...

- ... to special missions
- ... to special orbit configurations (e.g. tandem flights)

shows ...

- ... good agreement in global mean range bias with results from other calibration methods
- ... a relative range bias between Jason-1 and Jason-2 of 7.9 cm

Multi-mission crossover calibration, Dettmering et al.

Conclusion

- **Envisat /Jason-2 are very consistent**
  - standard deviation of cross-over differences = 4,5 cm (IGDR) and 3.4 cm (GDR), which enables a precise cross calibration
- **Envisat is a useful third point of comparison between the Jason-1 and -2**
  - The geographically correlated biases between Envisat and Jason-2 are lower than with Jason-1.
  - High frequency content for Envisat Jason-1 and Jason-2 are very consistent at 1Hz and 20Hz, independently from the tracker used on Jason-2.
  - Concerning the 20Hz content, the comparison with other missions enables to notice a light coloration of the noise above 3Hz.
- **Jason-1 and -2 comparisons with Envisat GDR are very consistent**
  - This is encouraging for insuring a good continuity on the long term monitoring already initiated with Jason-1 since 2002.
- **This cross calibration shows that precise analysis can be performed even if the satellites are not on the same tracks**

Jason-1&2 / Envisat cross-calibration, Ollivier et al.

Some global analysis key points:

- **AMR** meet the requirements and is **better than JMR** when approaching the coast. Also **more stable than JMR**
- **Jason-2 Ionospheric correction biased by ~8mm** due to difference on Ku (84 mm) and C (131 mm) bands biases
- **POE improves standard deviation of SSH biases** (from 47 to 43 mm)
- **Great agreement of all parameters between Jason-1&2**
- **Jason-1&2 SLA show a very stable bias (±2mm)** over 6 cycles with POE, comparable to the whole T/P Jason-1 phase (21 cycles)
- **1.2 cm2 improvement on Xover with GDR-C**
- **Better agreement between Jason-2 & EnviSat** than Jason-1 & EnviSat: should allow to perform precise cross calibration even with Jason-1 on a different ground track