

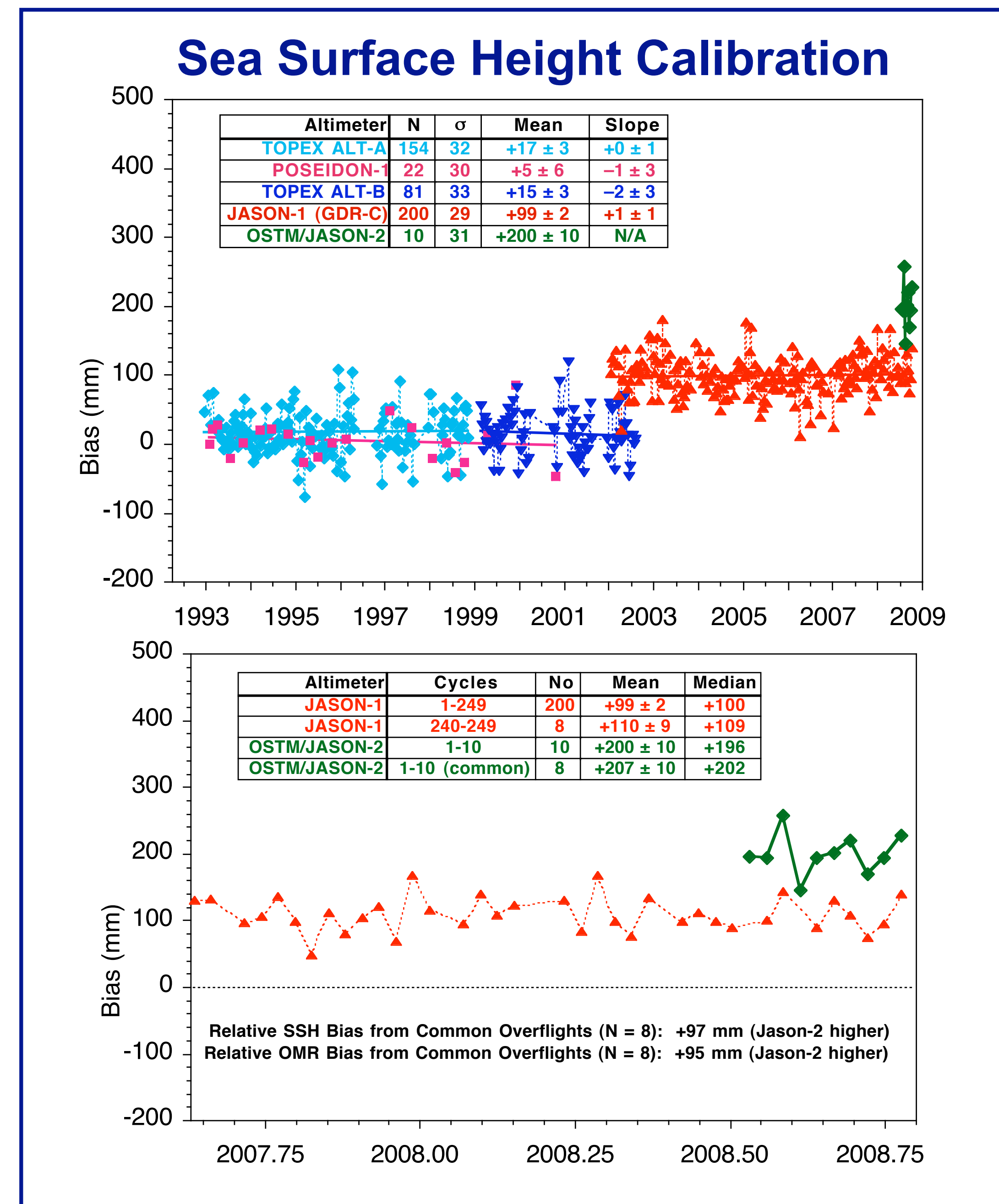
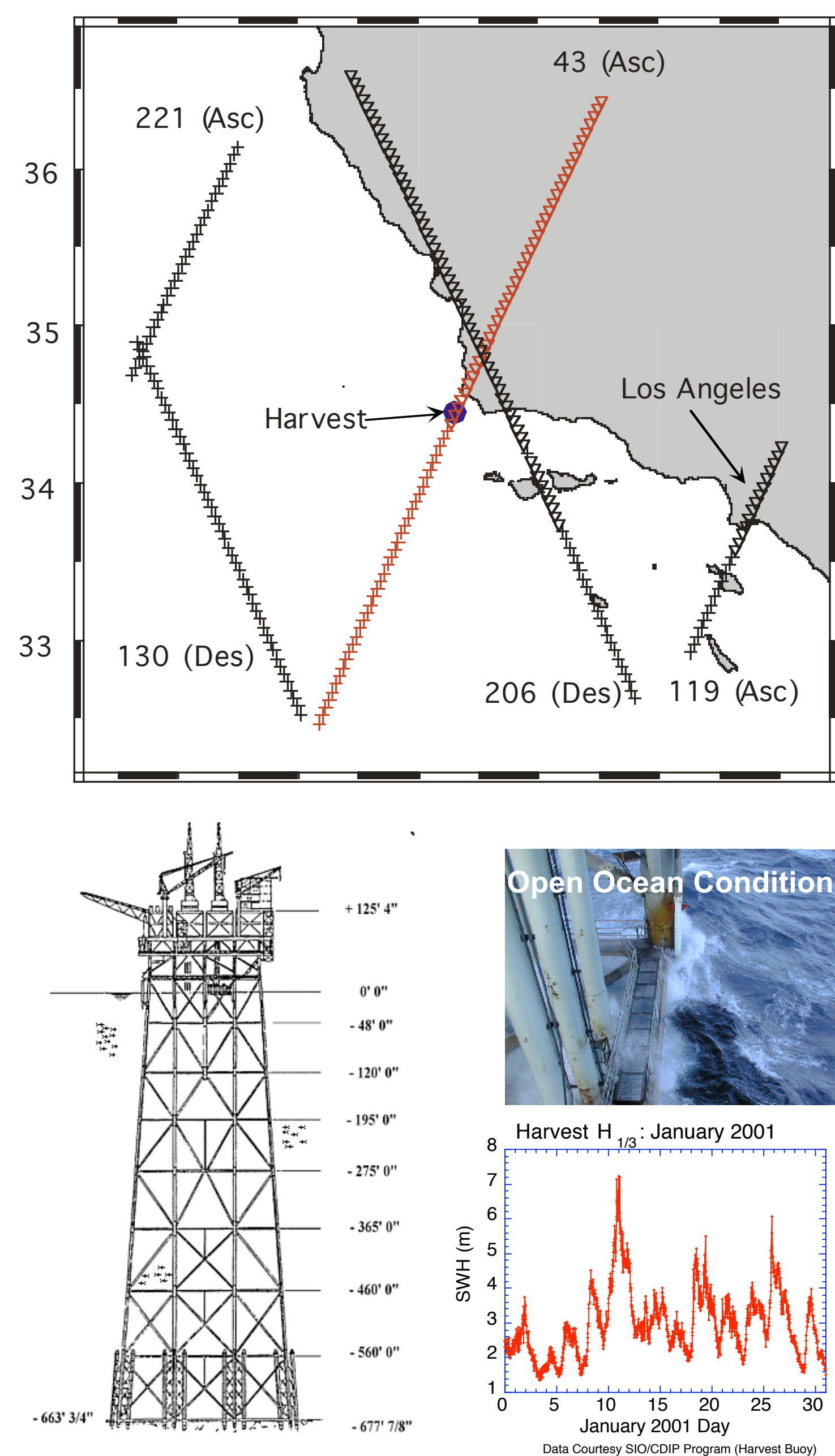
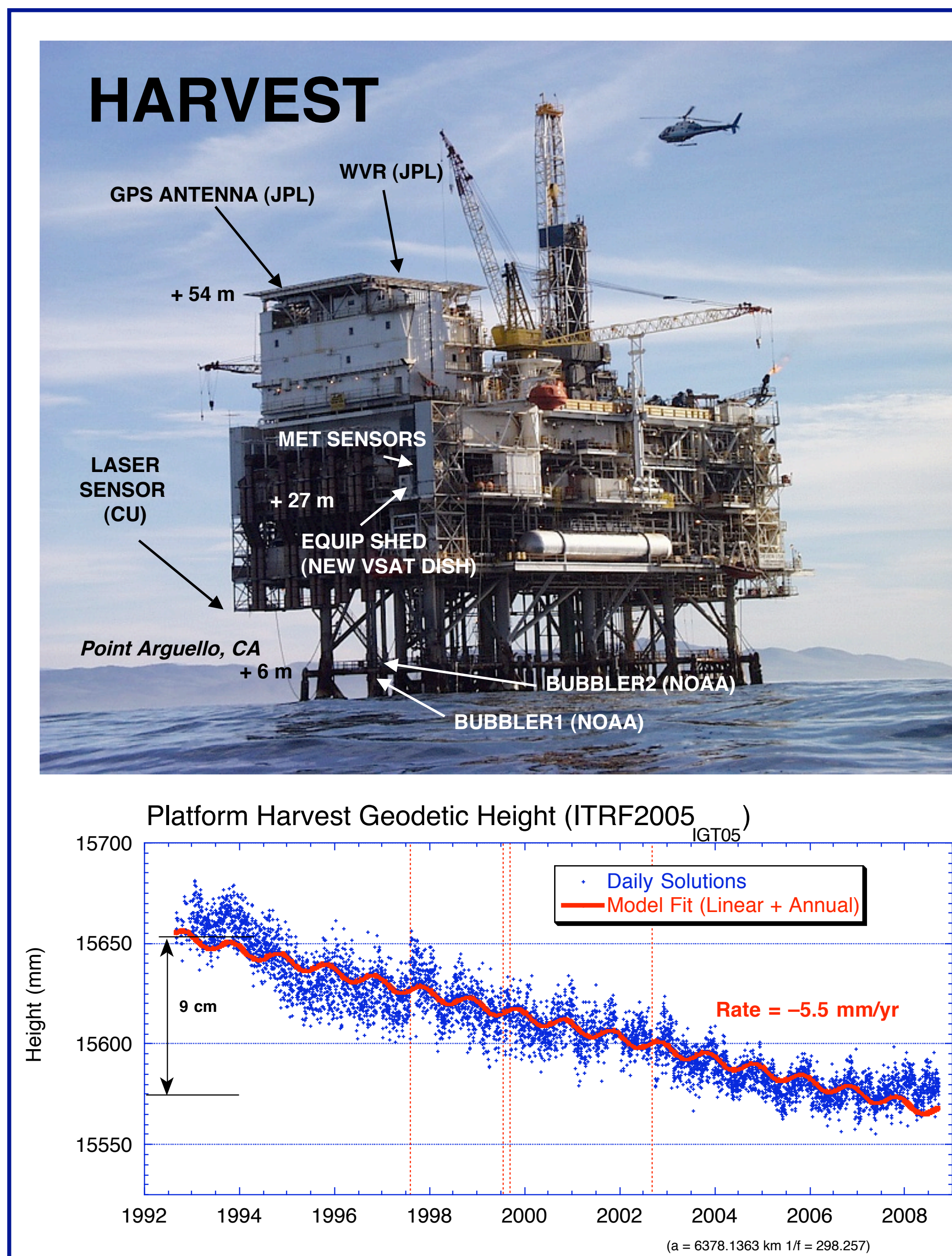
The Harvest Experiment: Calibration of the 16-yr Climate Record From TOPEX/POSEIDON, Jason-1 and OSTM/Jason-2



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Abstract

We present 16 years of continuous altimeter calibration results from the dedicated in-situ experiment hosted on the PXP Harvest Oil Platform. These results provide a basis for the absolute calibration of the long-term sea-level record from the combined TOPEX/POSEIDON (1992–2006), Jason-1 (2002–), and OSTM/Jason-2 (2008–) missions. Located about 10 km off the coast of central California near Point Conception, the Harvest platform sits in 200-m of water near the western entrance to the Santa Barbara Channel. Originally developed in 1991 as the NASA prime calibration site for TOPEX/POSEIDON (T/P), the Harvest Experiment features carefully designed collocations of space-geodetic and tide-gauge systems to support the absolute calibration of the altimetric SSH and its constituent measurements. Our evaluation of the Jason-1 data focuses on the latest version (C) of the Geophysical Data Records (GDR). Using initial releases of the GDR-C data and associated correction files, we find that the Jason-1 GDR-C SSH measurements at Harvest are erroneously high by 99 ± 2 mm (one standard error, $N = 200$, $\sigma = 31$ mm). The long-term drift in the SSH measurements is $+1 \pm 1$ mm/yr, and is thus statistically indistinguishable from zero. We also report early results from the initial OSTM/Jason-2 overflights of the platform, the first of which occurred on July 13, 2008. Based on the Interim GDRs, these results indicate that the Jason-2 SSH measurements at Harvest are erroneously high by 200 ± 10 mm ($N = 10$, $\sigma = 29$ mm).

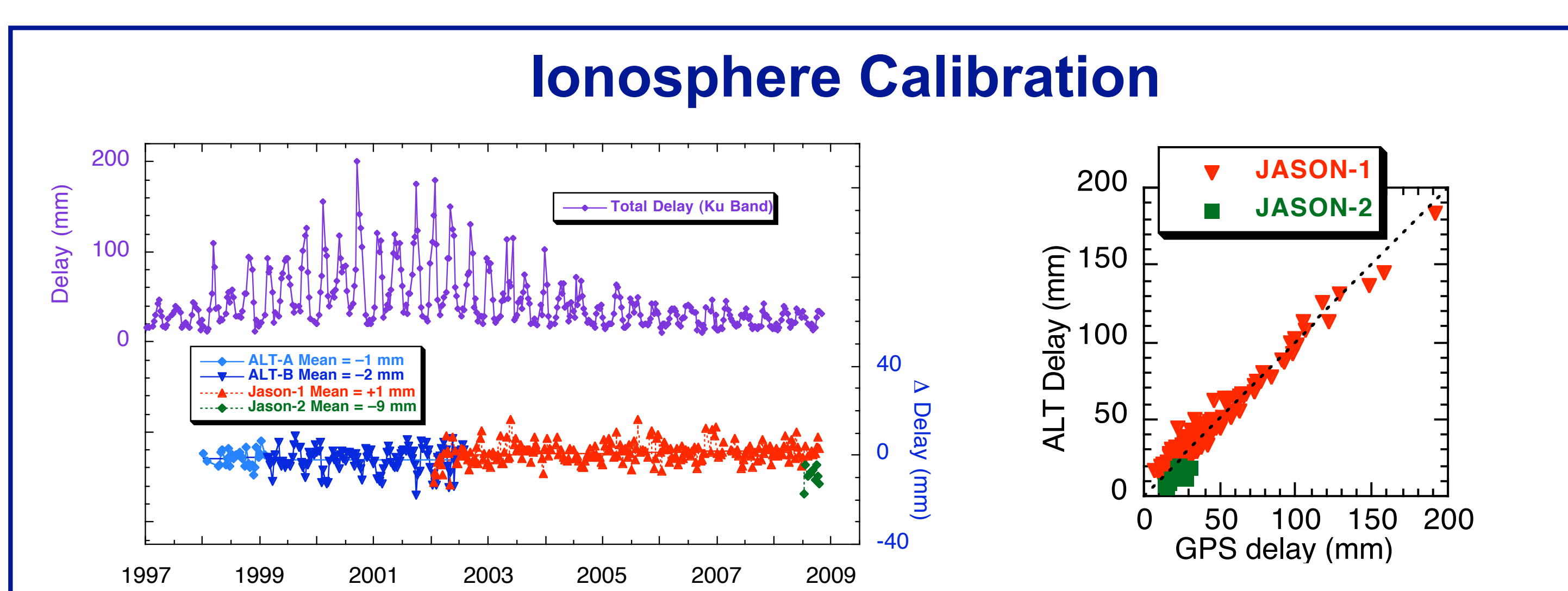
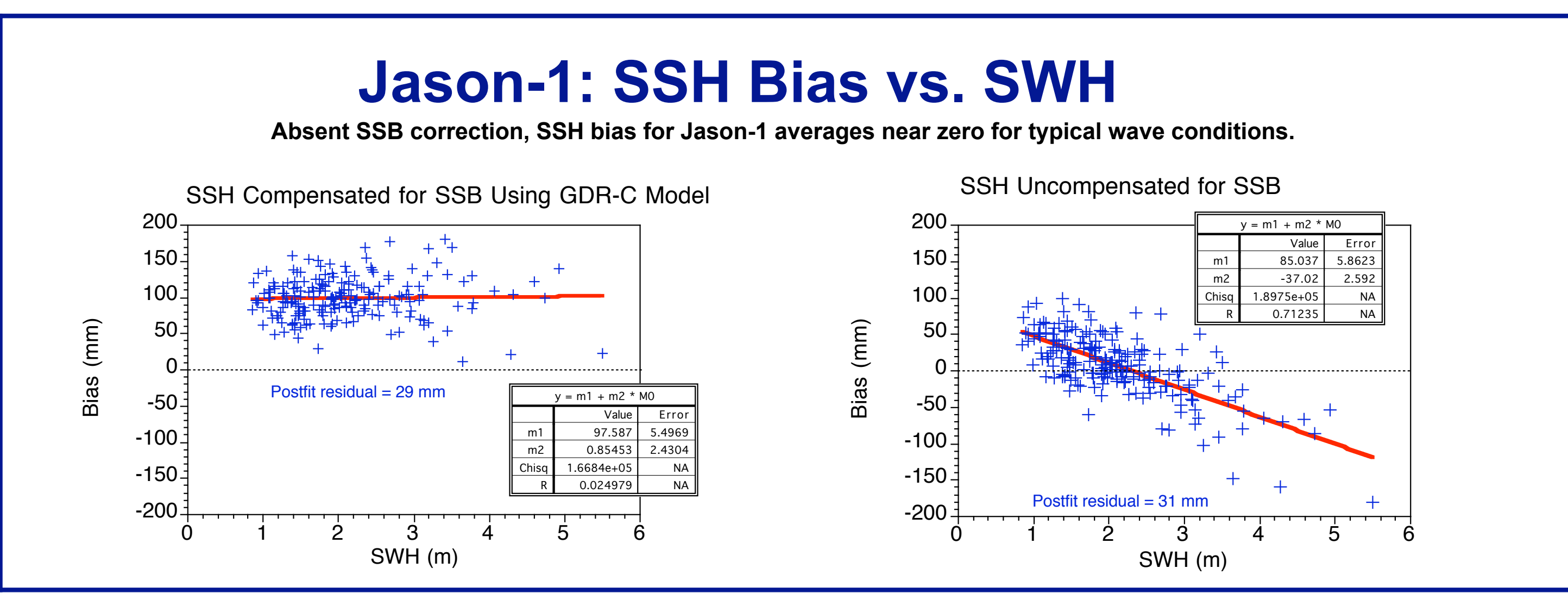
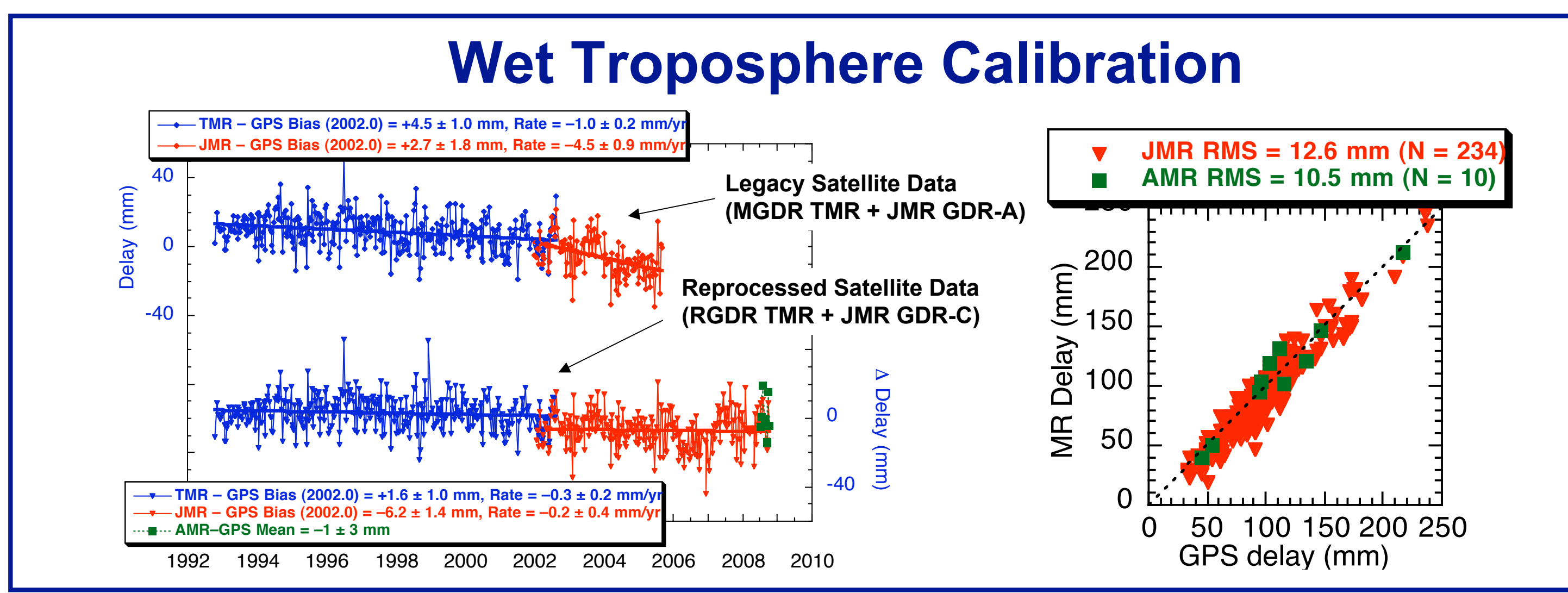
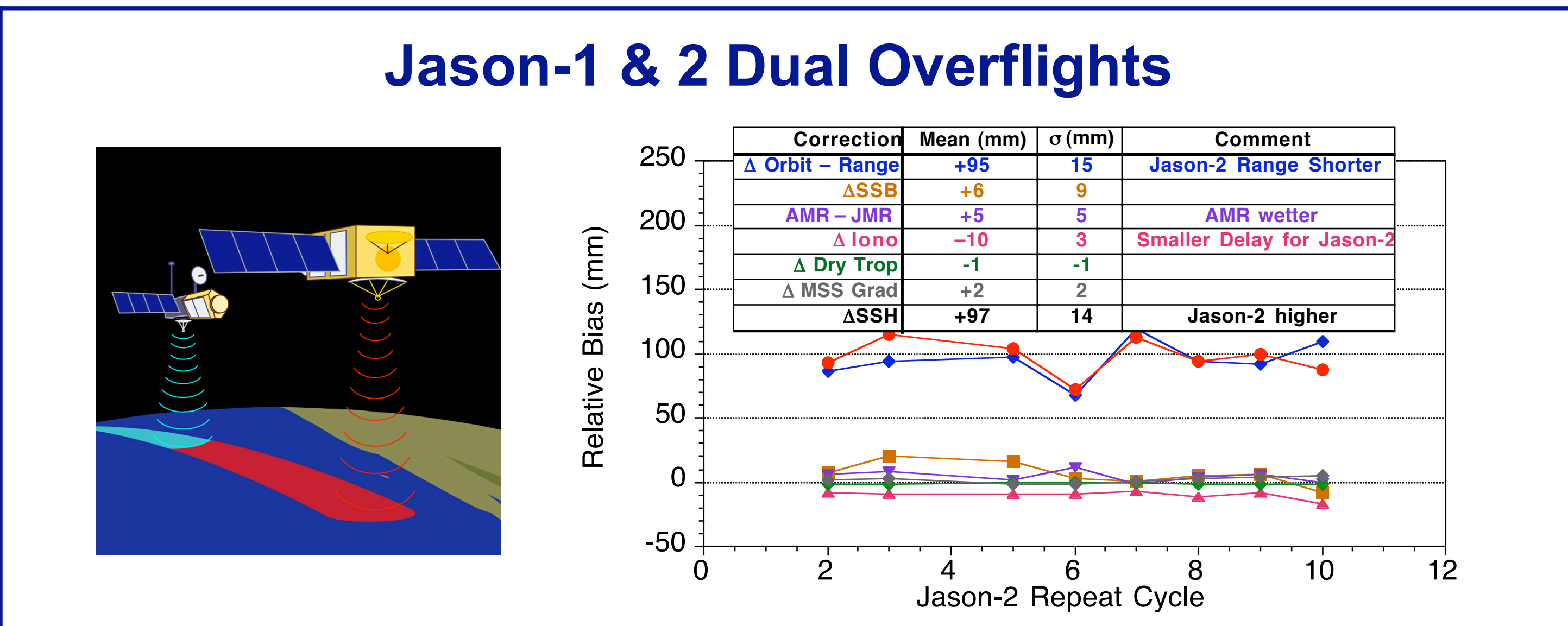


Conditions for Tandem Overflights

Jason-2 Cycle	Jason-1 Cycle	UTC Date	Local Time	SWH (m)	Wind (m/s)	POS-3 Mode	Comments
1	240	13-Jul-2008	10:21	1.1	2.4	SGT	Poor ALT quality
2	241	23-Jul-2008	08:20	2.1	1.2	Median	
3	242	02-Aug-2008	06:18	2.2	8.2	DIODE/DEM	
4	243	12-Aug-2008	04:17	1.9	8.0	Median	Jason-1 safehold
5	244	22-Aug-2008	02:15	2.7	6.7	DIODE/DEM	
6	245	01-Sep-2008	00:13	3.5	9.2	Median	
7	246	10-Sep-2008	22:13	2.0	6.0	DIODE/DEM	
8	247	20-Sep-2008	20:11	2.0	9.0	Median	
9	248	30-Sep-2008	18:09	1.0	6.0	Median	
10	249	10-Oct-2008	16:08	5.5	15.0	Median	
11	250	20-Oct-2008	14:06	2.4	10.9	Median	
12	251	30-Oct-2008	12:04	1.2	9.8	Median	

Harvest Closure Analysis: Assumptions for Altimeter Leg

Model	TOPEX/Poseidon	Jason-1	OSTM/Jason-2
Orbital Height	GSFC TVG ITRF2005p	GDR-C	IGDR
Altimeter Range	Ku (MGDR)	Ku (GDR-B/C)	Ku (IGDR)
Wet troposphere	Brown et al. repro (for RGDR)	GDR-C	IGDR
Dry troposphere	MGDR	GDR-B/C	IGDR
Ionosphere	MGDR; Ku (ALT), DORIS (POS-1)	GDR-B/C	IGDR
Sea-state bias	MGDR	GDR-C table (but corrected SWH)	IGDR



Summary of Harvest Findings

- Both Jason-1 and Jason-2 are reading SSH too high, by +10 and +20 cm respectively
- OSTM/Jason-2: $+200 \pm 10$ mm ($N = 10$, $\sigma = 31$ mm)
- Jason-1: $+99 \pm 2$ mm ($N = 200$, $\sigma = 29$ mm)
- TOPEX/Poseidon systems unbiased (< 2 cm)
- T/P ALT-B: $+15 \pm 3$ mm ($N = 81$, $\sigma = 33$ mm)
- T/P ALT-A: $+17 \pm 3$ mm ($N = 154$, $\sigma = 32$ mm)
- T/P POS: $+5 \pm 6$ mm ($N = 22$, $\sigma = 30$ mm)
- Relative SSH Bias (from Common Overflights) consistent with absolute estimates.
 - Jason-2 - Jason-1: $+97 \pm 5$ mm ($N = 8$, $\sigma = 13$ mm)
 - Jason-1 - T/P ALT-B: $+78 \pm 8$ mm ($N = 16$, $\sigma = 32$ 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-2 agrees better with GPS
- Role of geographically correlated errors under investigation

Harvest Contributions

- Existing 16+ year record, direct overflight geometry and location of tide gauges, GPS, WVR, buoys and ancillary sensors make Harvest a unique international resource for measuring sea level from space.
- Precise and long-term tie with global terrestrial reference frame.
- Coincident observations of satellites in formation flight (T/P + Jason-1, and Jason-1 + OSTM).
- Excellent characterization of systematic errors from long-term observation and redundant measurements.
- Segregation of various potential contributors to drift (e.g., Altimeter, Radiometer)
- Open-ocean environment tests measurement system in typical operating conditions
- Important contributor to the growing network of active, dedicated calibration sites serving Jason/OSTM and oriented along the original TOPEX ground track:
 - Corsica, Bass Strait, Gavdos, Ibiza....