In-Situ Calibration Results from Bass Strait

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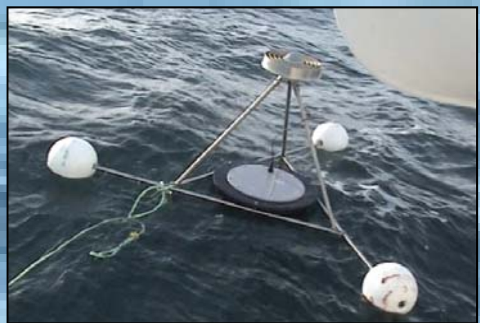

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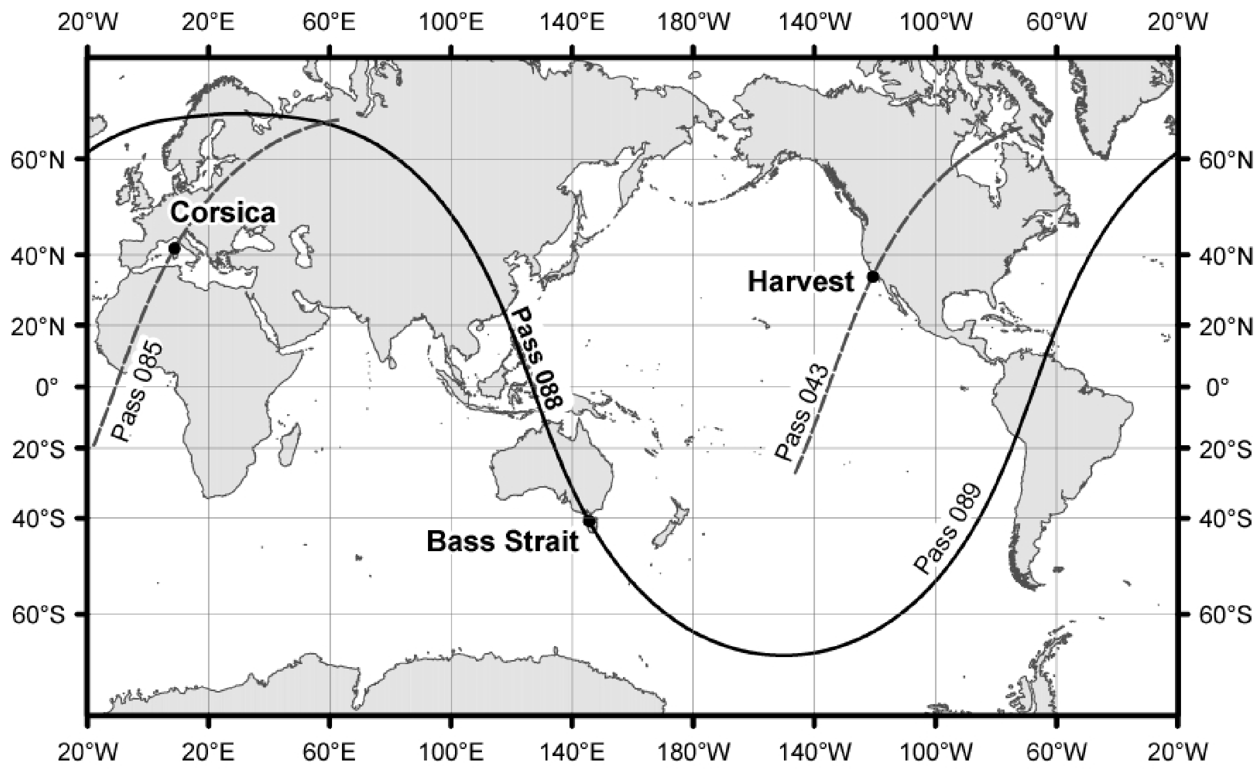
Jason-1 and OSTM/Jason-2
OST Science Team

Updated Results
Seattle OSTST Meeting
June 2009

Overview

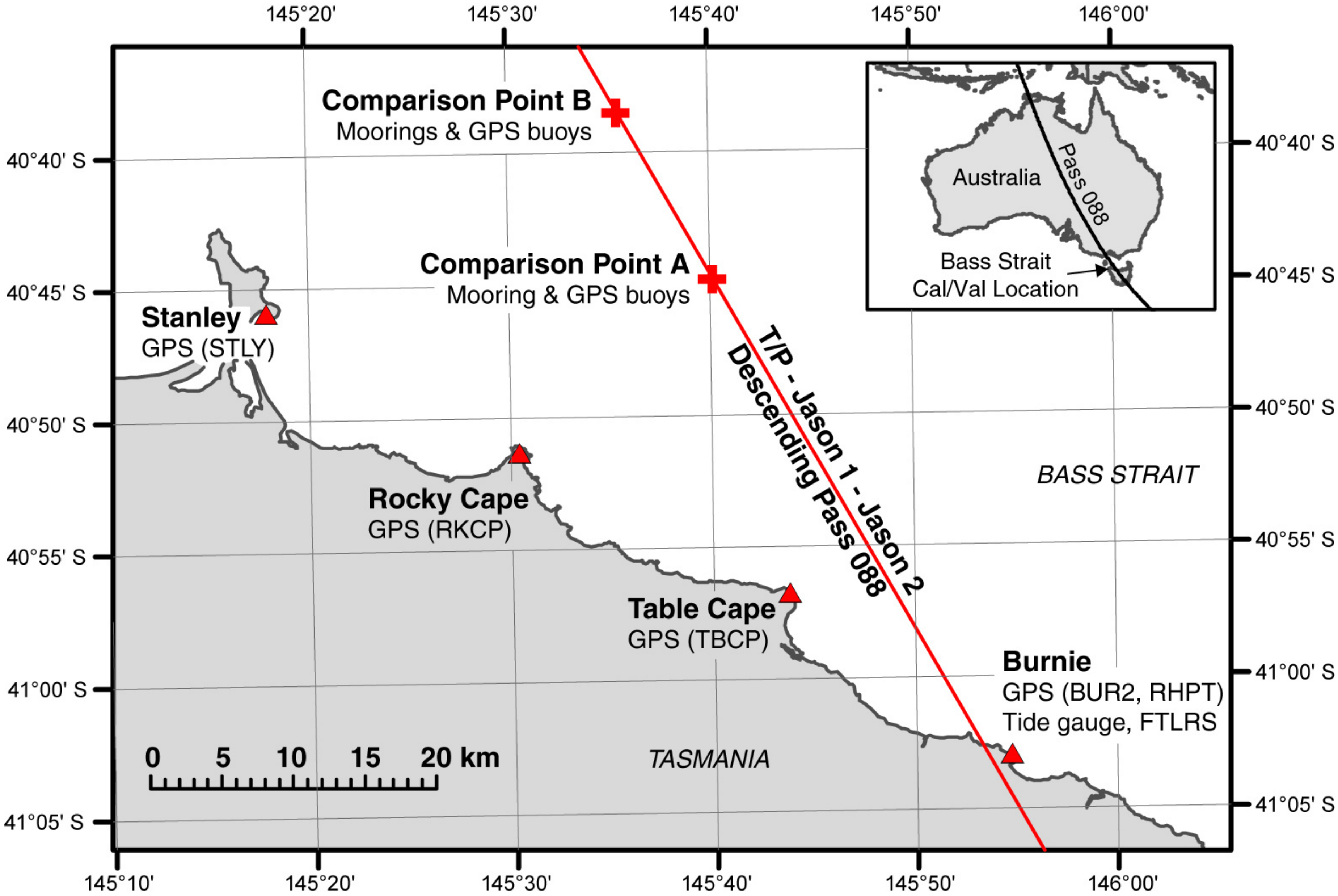
- Bass Strait is an absolute calibration site that adopts a purely geometric technique. The method is centred around the use of GPS buoys to define the datum of high precision ocean moorings.
- Mooring SSH also used to correct tide gauge SSH to the comparison point.
- Altimeter vs mooring SSH and tide gauge SSH to determine absolute bias.



Bass Strait Calibration Site

1. The comparison point has been moved further offshore to avoid land contamination of the radiometer.
2. Different buoy design, longer deployment duration.
3. New tide gauge and collocated CGPS.
4. New inland CGPS site on bedrock (~5km from the gauge).
5. New episodic GPS at Stanley to minimise baseline length to GPS buoys.
6. Three new ocean moorings (two consecutive six month deployments and one twelve month deployment spanning the previous two).
7. FTLRS campaign (assess benefit of additional southern hemisphere SLR).

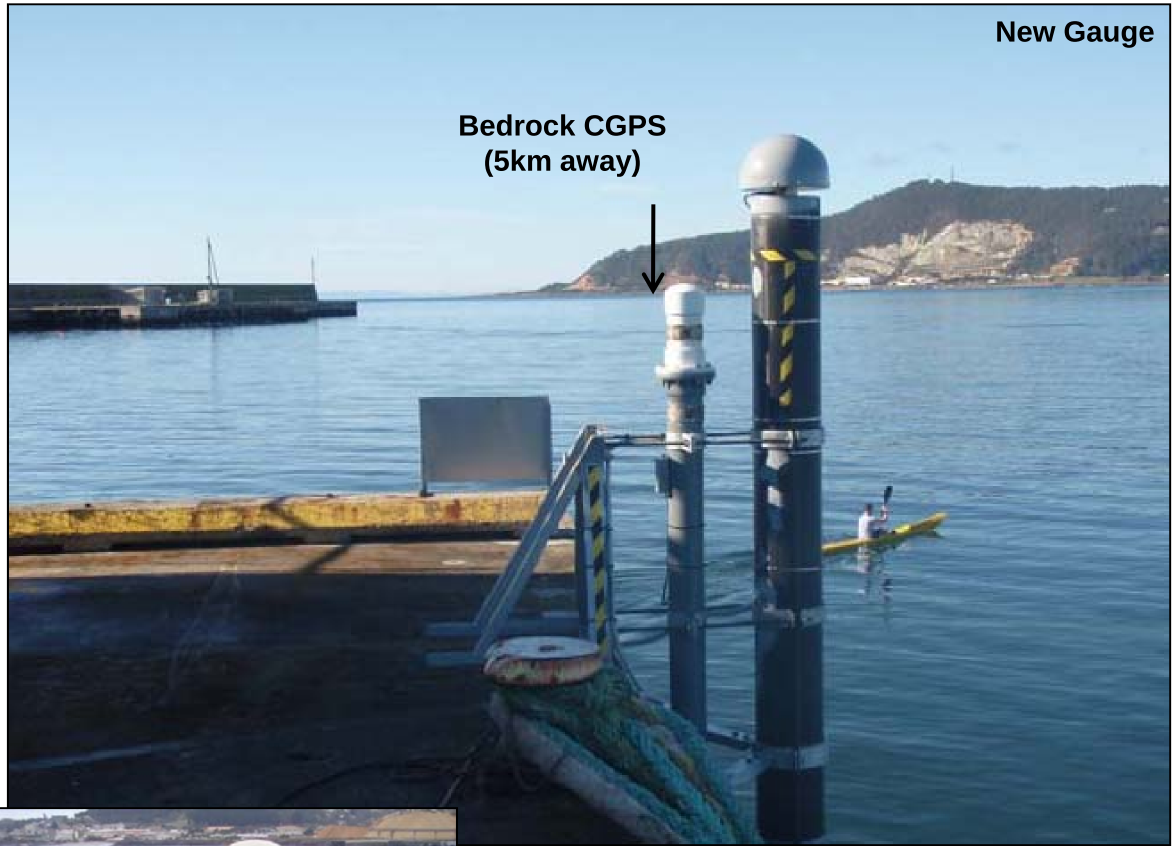
Bass Strait Calibration Site

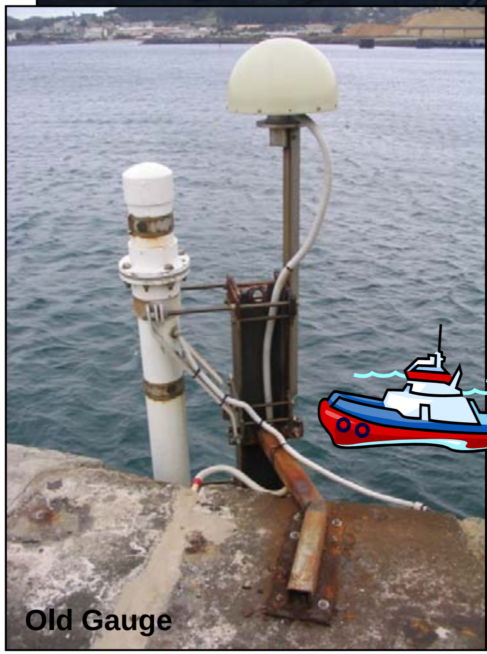


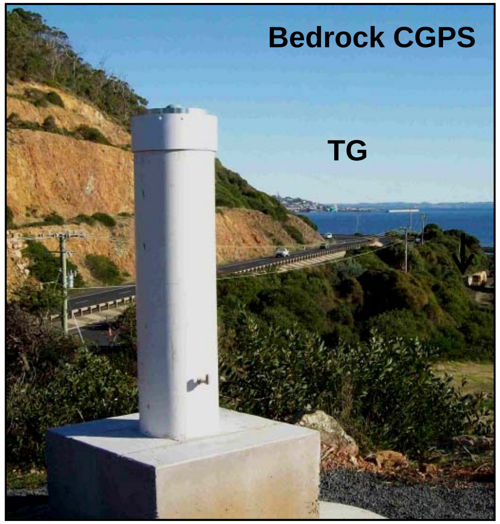
Instrumentation:

Tide Gauge

- Tide gauge is part of the Australian baseline array, provision for a radar gauge to be installed later in 2009. Run by the Australian National Tidal Centre (NTC).
- Collocated CGPS at TG.
- Bedrock CGPS ~5km away at Round Hill (RHPT).
- Data from both GPS sites archived at Geoscience Australia



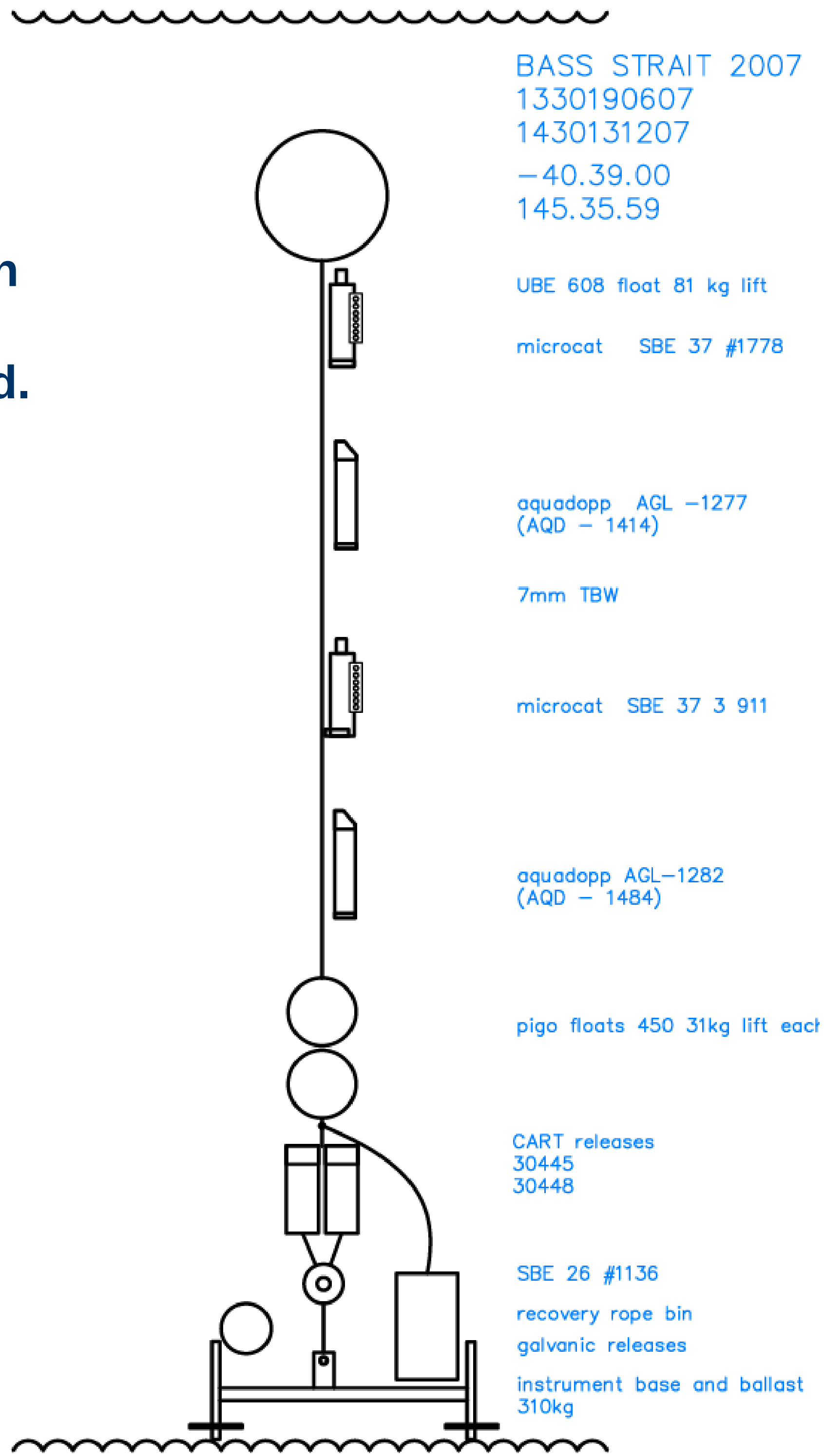




Instrumentation:

Ocean Moorings

- Two ocean moorings deployed January 2008 in ~50 m water depth (Mooring 1 and 2). On retrieval of Mooring 1, Mooring 3 was deployed. Final retrieval February 2009.
- Instrumentation includes high accuracy pressure gauges, Seabird TS meters and current meters.
- Local atmospheric pressure determined using high resolution Australian LAPS model.
- Final mooring SSH time series determined using all three mooring datasets.
- The datum of the mooring-derived SSH is determined using episodic GPS buoy deployments.



Instrumentation:

GPS Buoys

- Moved on to Mk III wave rider buoy design. New design lifts antenna above water level whilst minimising tilt. Design prevents loss of lock caused by breaking waves as experienced with the Mk II design.
- Two buoys deployed at comparison point, tethered horizontally to anchored boat.
- Episodically deployments, 8 in total, each for 8-10 hours duration. Data at 1 Hz with final deployment 2 Hz.
- Buoys used to solve for mooring datum, NOT purely for alt bias or geoid determination.

Instrumentation:

FTLRS

- Part of our NCRIS/AUSCOPE project has been to trial the FTLRS in Burnie during 2007/08.
- French and Australian Campaign ran from 01-Dec-2007 to 17-Apr-2008, observing a total of 660 over flights from 10 different satellites.
- Site was located in the city of Burnie, ~10km from the tide gauge site. FTLRS co-located with temporary GPS.
- Has been an important project to further build Australian SLR capability.
- Results to date show limited improvement to GDR orbits with the inclusion of FTLRS data – perhaps due to the proximity of the Mt Stromlo tracker?

Results:

Preview

1. **Summary statistics: GPS buoy SSH / Mooring SSH / Tide gauge SSH**

2. ***Verification Phase*: Jason-1 GDR-C (239-259), Jason-2 GDR-C (000- 020)**

   Absolute biases, relative bias, differences in corrections

3. **Jason-1 GDR-C (001-259)**

   Absolute bias, impact of compensating for SSB

4. **Jason-1 GDR-C with/without JMR update (228-259)**

5. **OSTM/Jason-2 IGDR-C (000-034)**

6. **OSTM/Jason-2 GDR-C with/without AMR update (000-026)**

Results:

GPS Buoy / Mooring / Tide Gauge

- **Our reference frame is defined by daily global analyses of 2x40 station networks of CGPS stations in GAMIT software, with ITRF2005 realised using GLOBK and a well defined set of stabilisation sites. We consider this analysis state-of-the-art within GAMIT (VMF1, ECMWF ZHD, non tidal ATML).**

  [Reference: Tregoning and Watson (2009), Atmospheric Effects and Spurious Signals in GPS Analyses, *J. Geophys. Res.,* in press]

- **Eight GPS buoy deployments completed to define the datum of the mooring (~8-10 hours each – 2 buoys deployed each time). Kinematic processing of 1 Hz buoy data in Track and Grafnav. Subsequently smoothed for comparison against mooring.**

Results:

GPS Buoy / Mooring / Tide Gauge

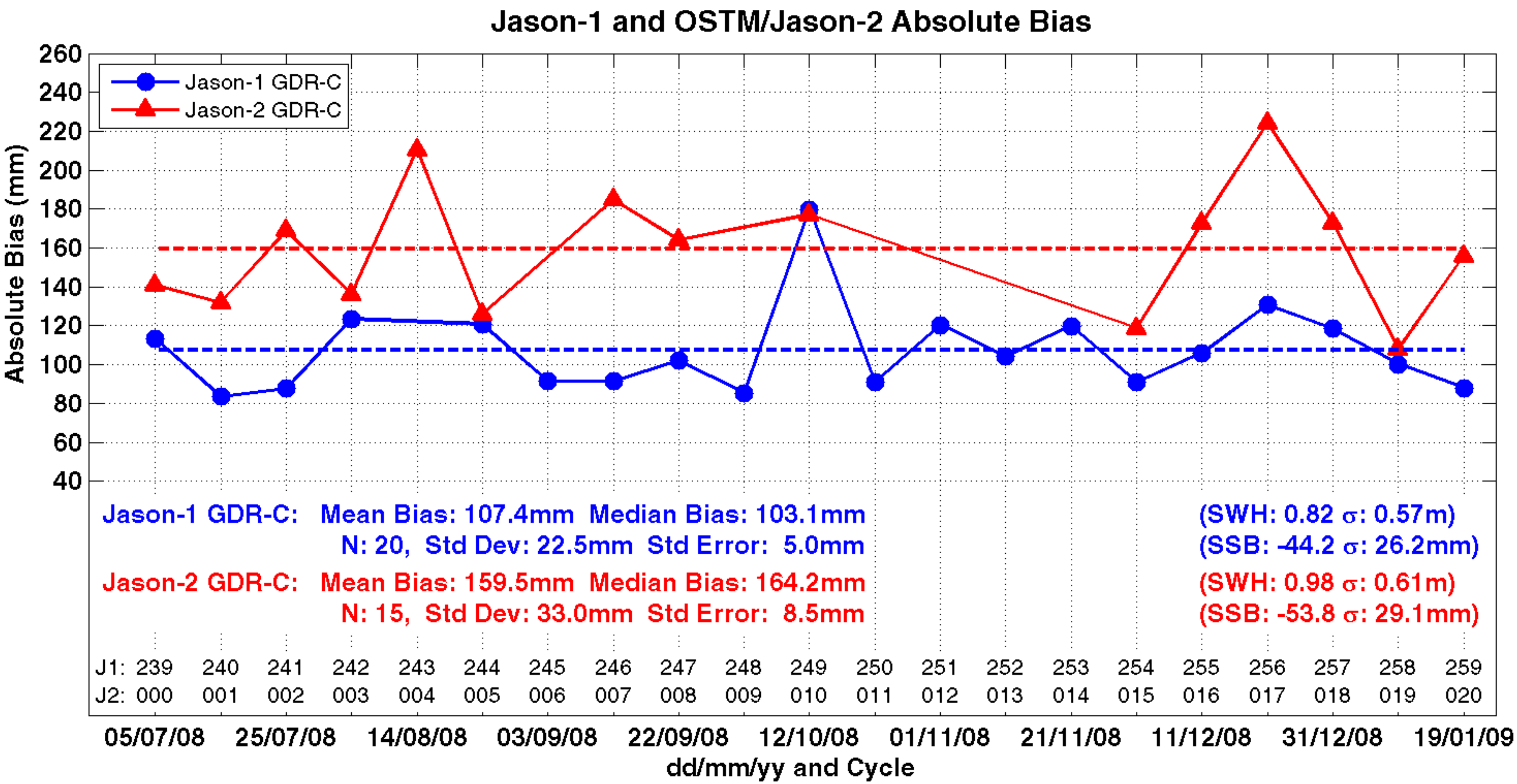
- **Between buoy comparison (B1 and B2 from 8 deployments):**
  - ➢ Typical separation between buoys ~10-20 m.
  - ➢ Mean (B2 SSH – B1 SSH) ~ 5 mm, std dev ~ 5 mm.

- **Defining the datum of the mooring:**
  - ➢ The mean of (buoySSH – mooringSSH) defines mooring datum
  - ➢ Final std dev of (buoySSH – mooringSSH) = 21 mm. N = 840.
  - ➢ Assuming independent estimates each hour, N = 70, std err of mean = 2.5 mm.

- **Transforming the Tide Gauge onto the mooring datum:**
  - ➢ Std dev of difference (mooringSSH – tgSSH) = 102 mm.
  - ➢ Difference dominated by tidal diffs at M2 (amp=126 mm) and N2 (amp=29 mm).
  - ➢ Non-tidal residual has std dev = 37mm.
  - ➢ Tide gauge can be transformed onto the mooring datum by adding a tidal prediction of the difference (mooringSSH – tgSSH).

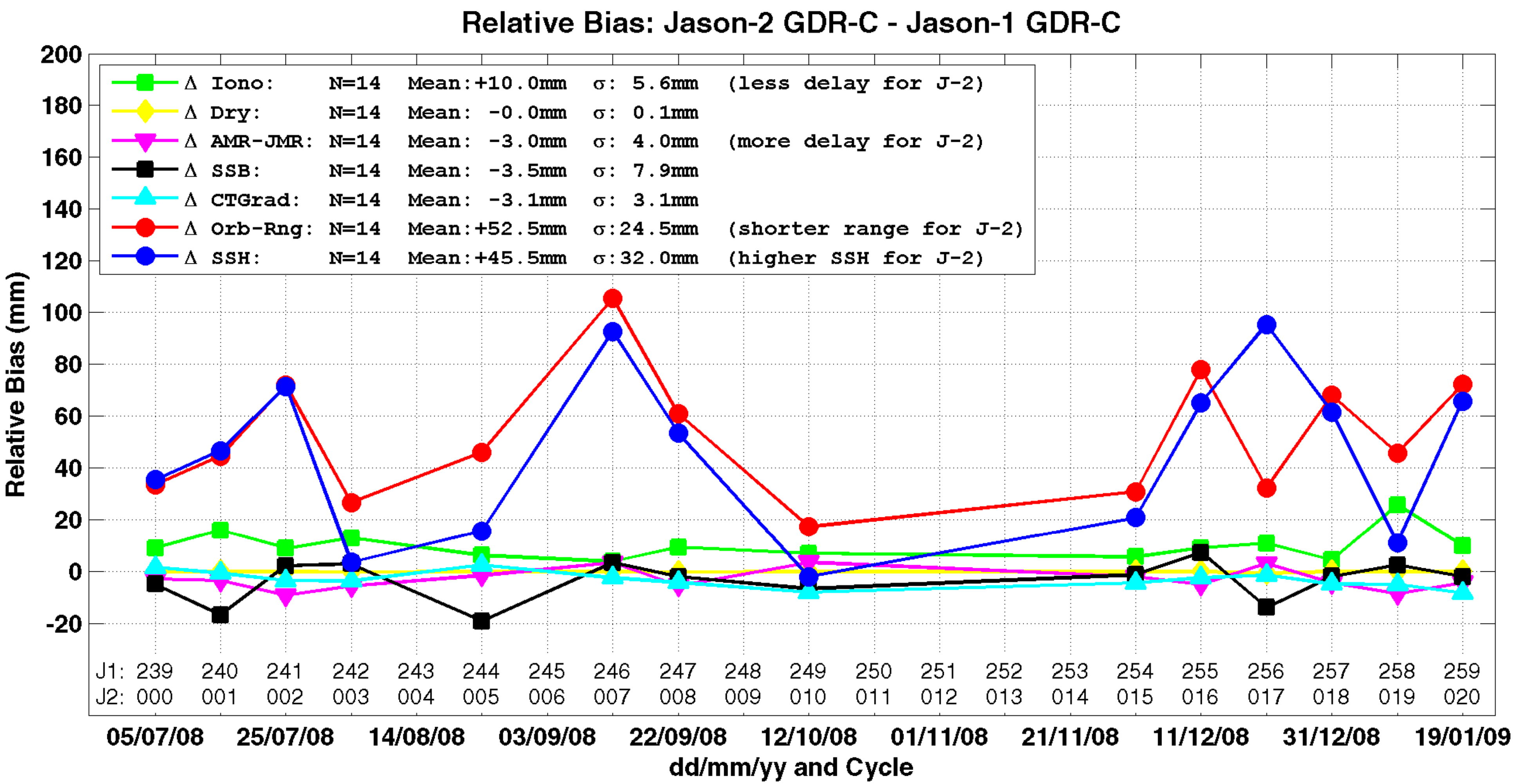
Results: VERIFICATION PHASE

J-1 GDR-C vs OSTM/J-2 GDR-C



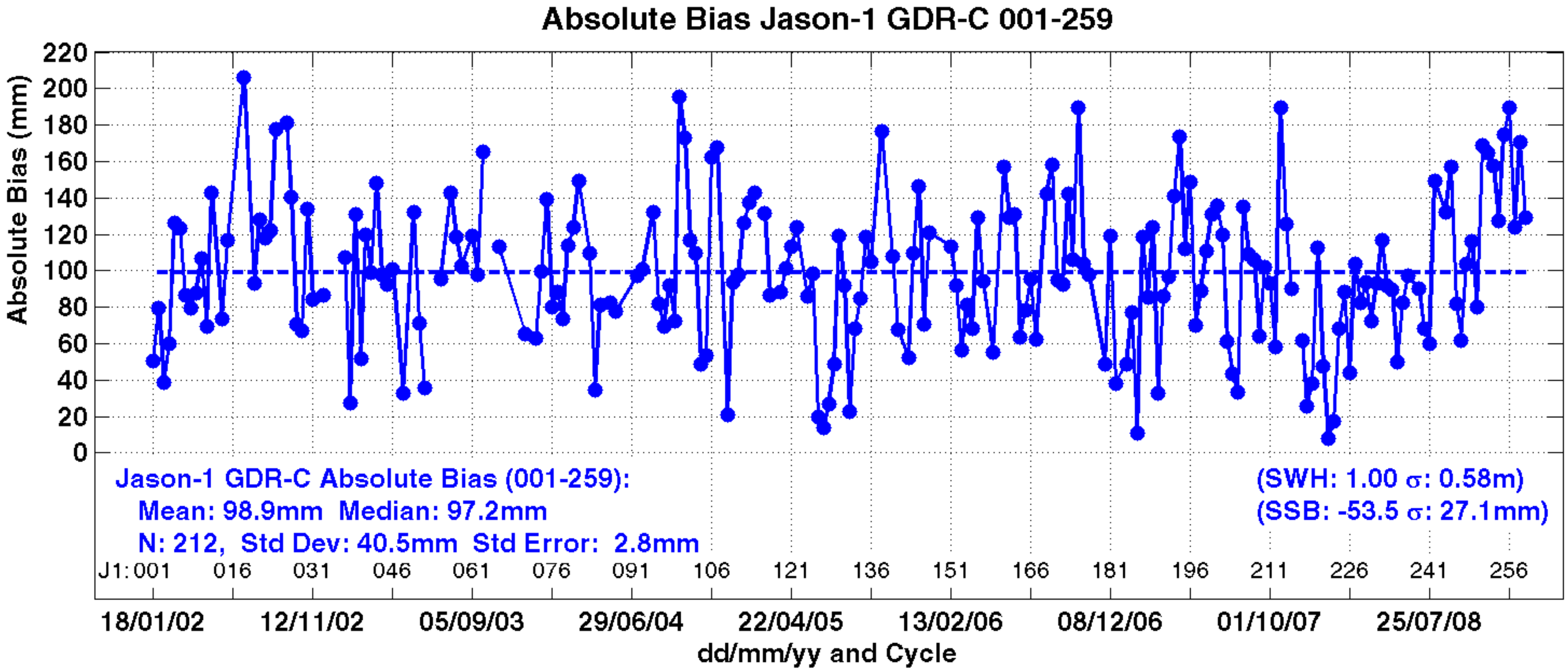
Results: VERIFICATION PHASE

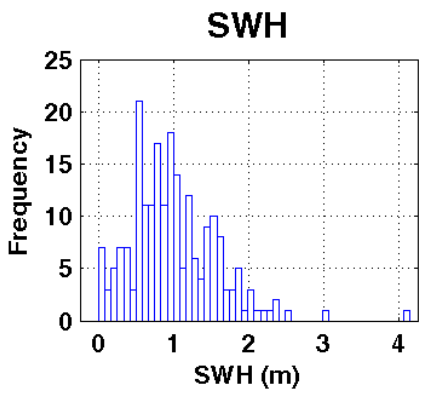
J-1 GDR-C vs OSTM/J-2 GDR-C

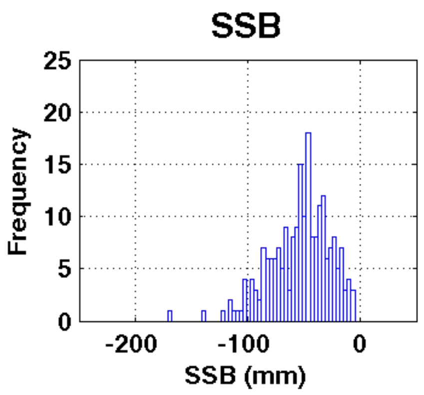


Results: ENTIRE JASON-1 MISSION

J-1 GDR-C cycles 001-259







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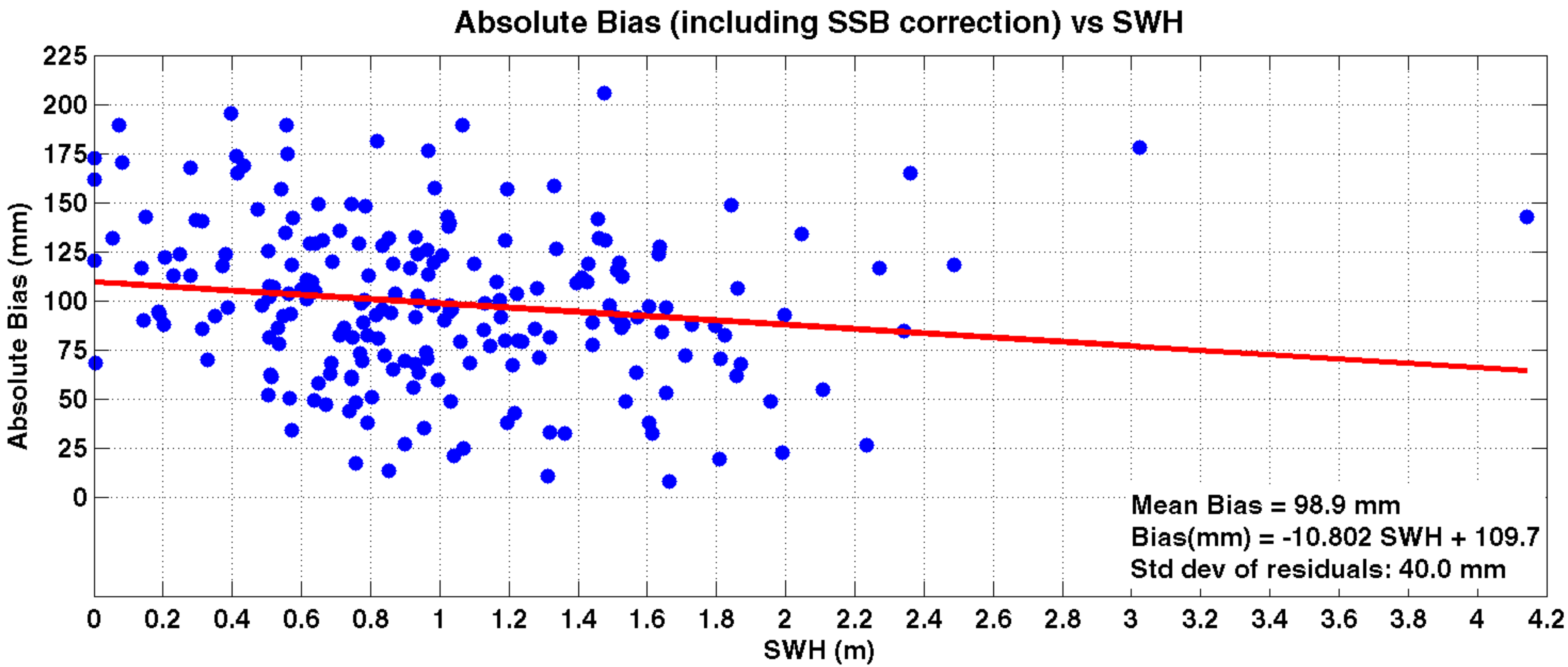
J-1 GDR-C cycles 001-259 – Bias vs SWH



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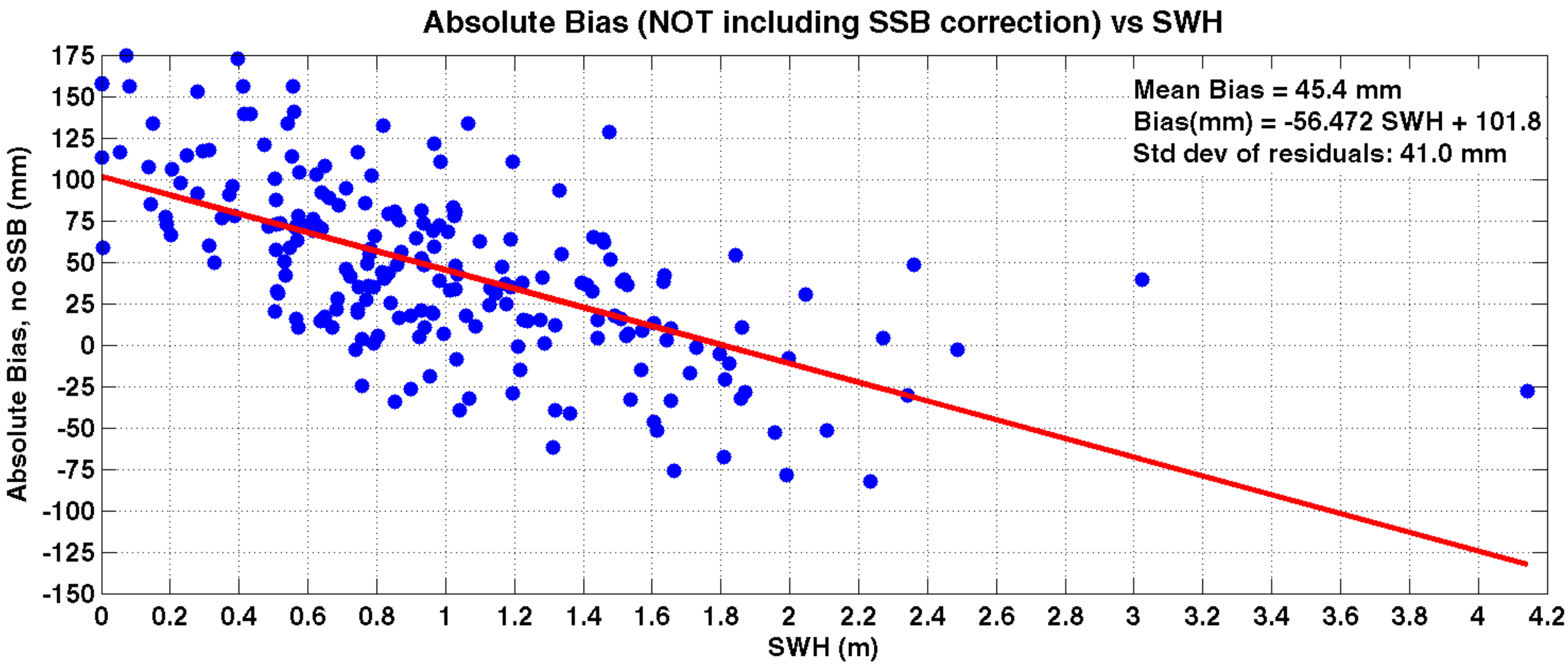
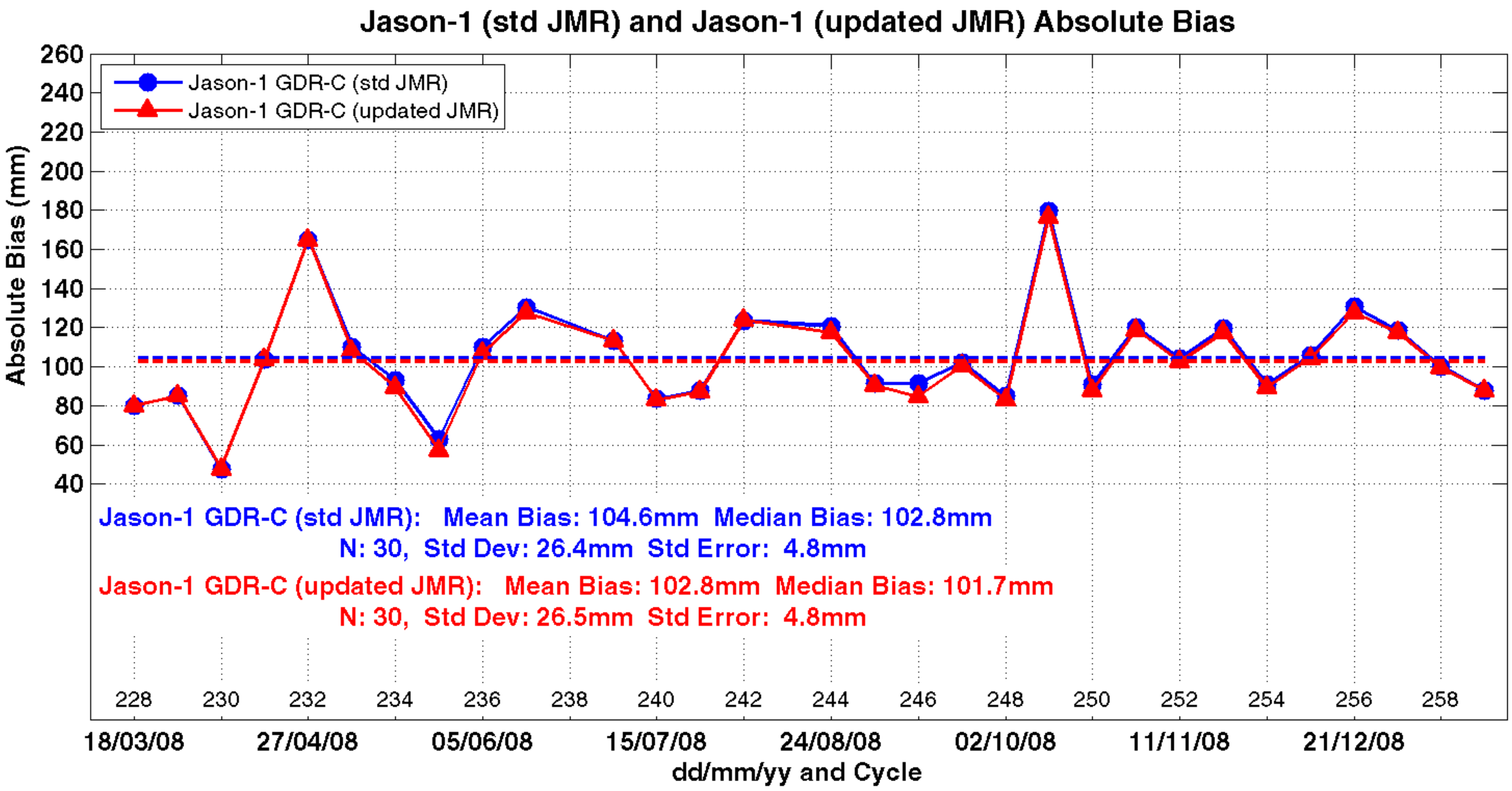


Results: JASON-1 MISSION

J-1 GDR-C with/without updated JMR



Results: JASON-1 MISSION

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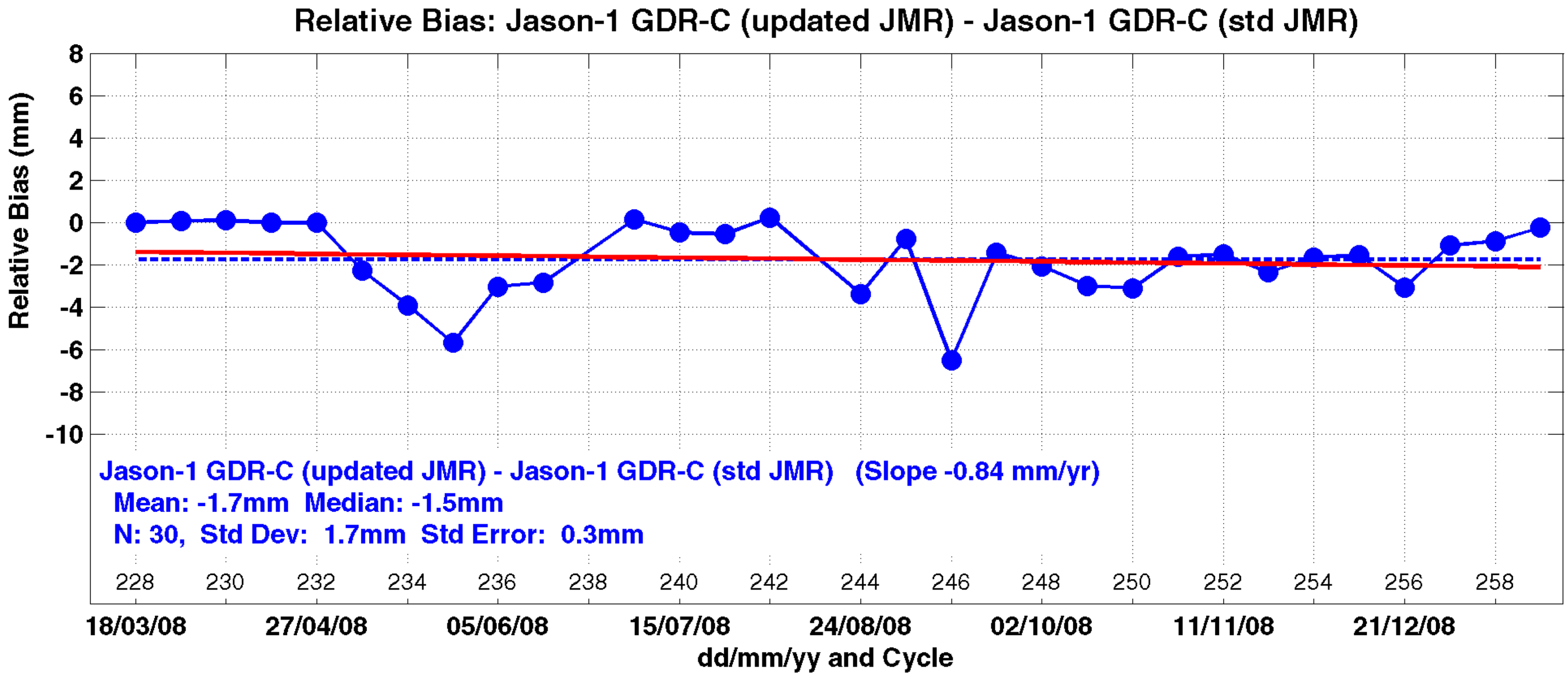
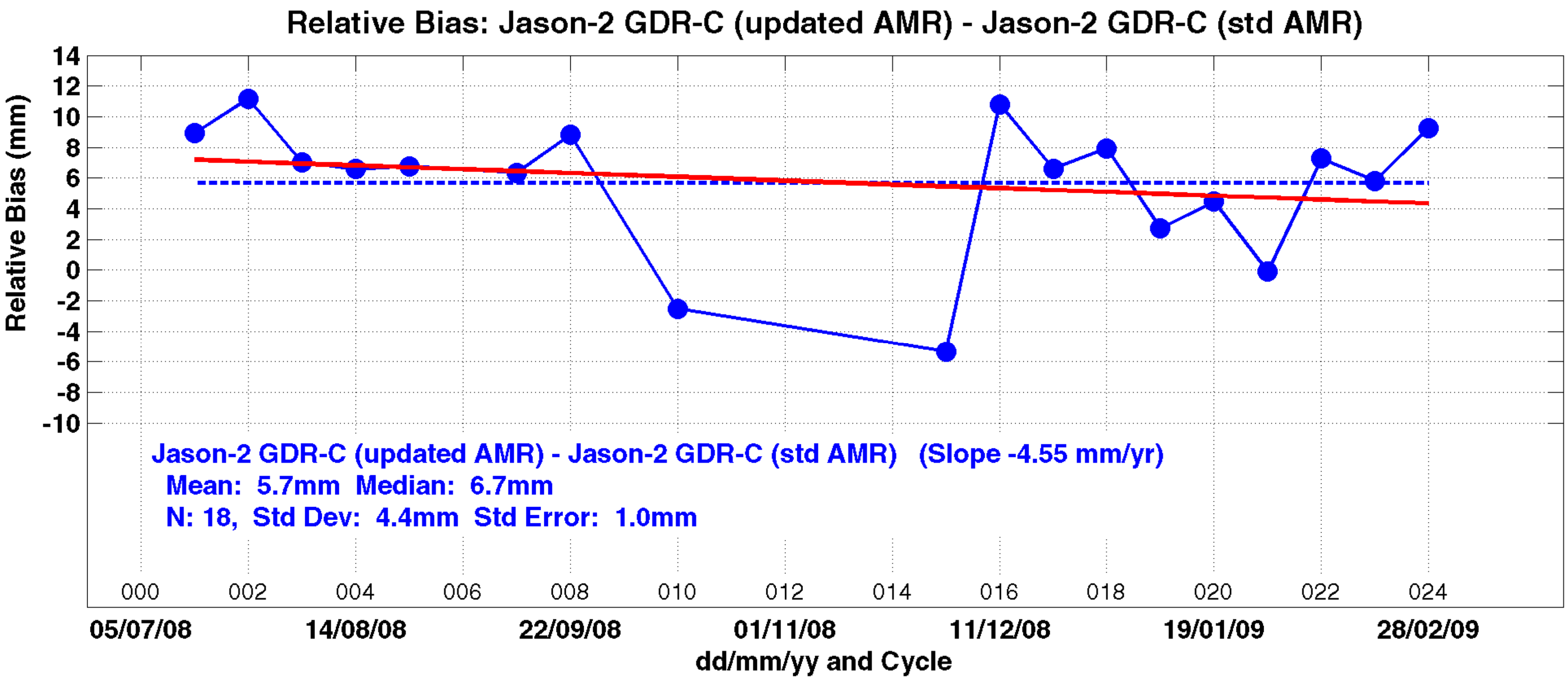
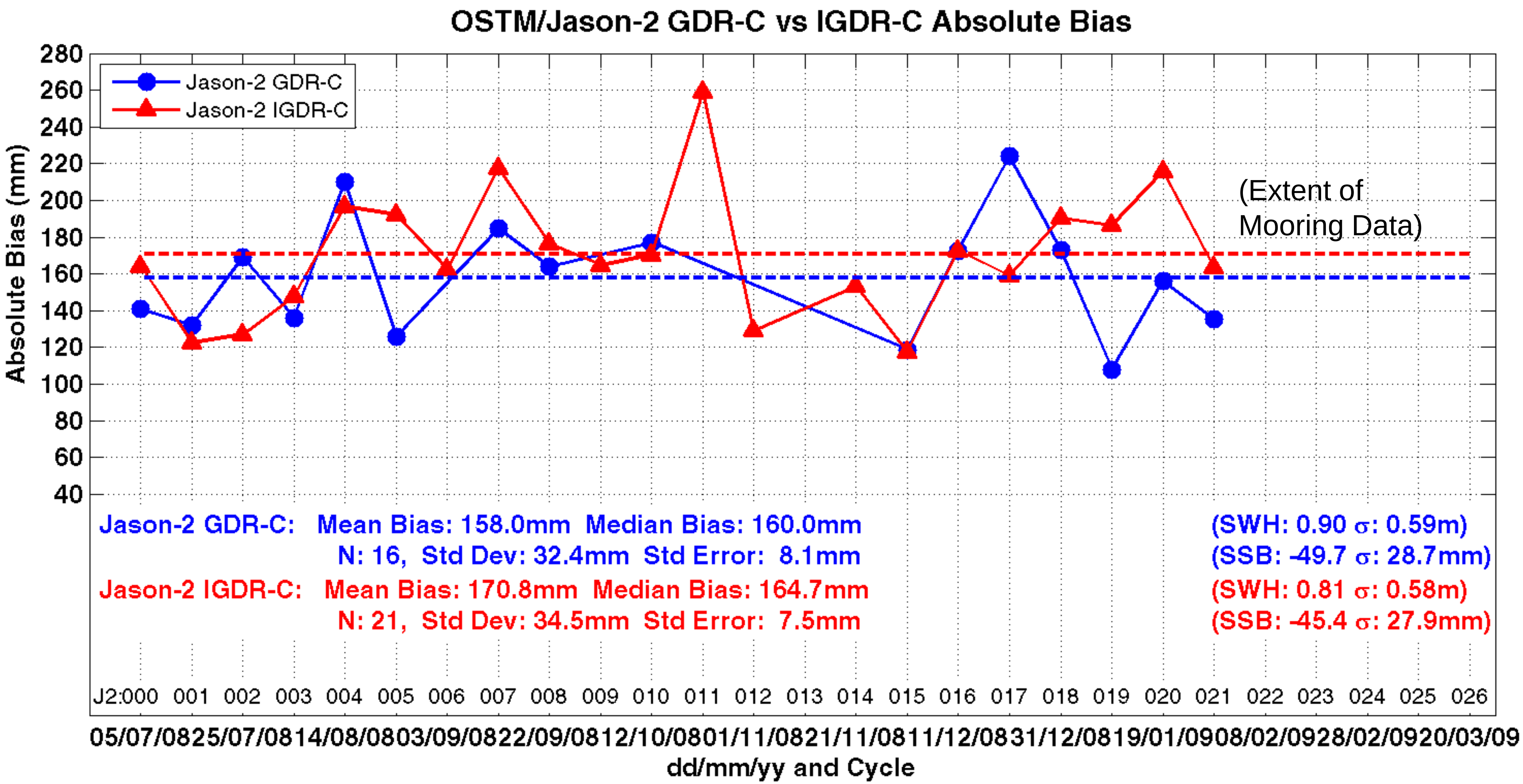


J-2 GDR-C with/without updated AMR



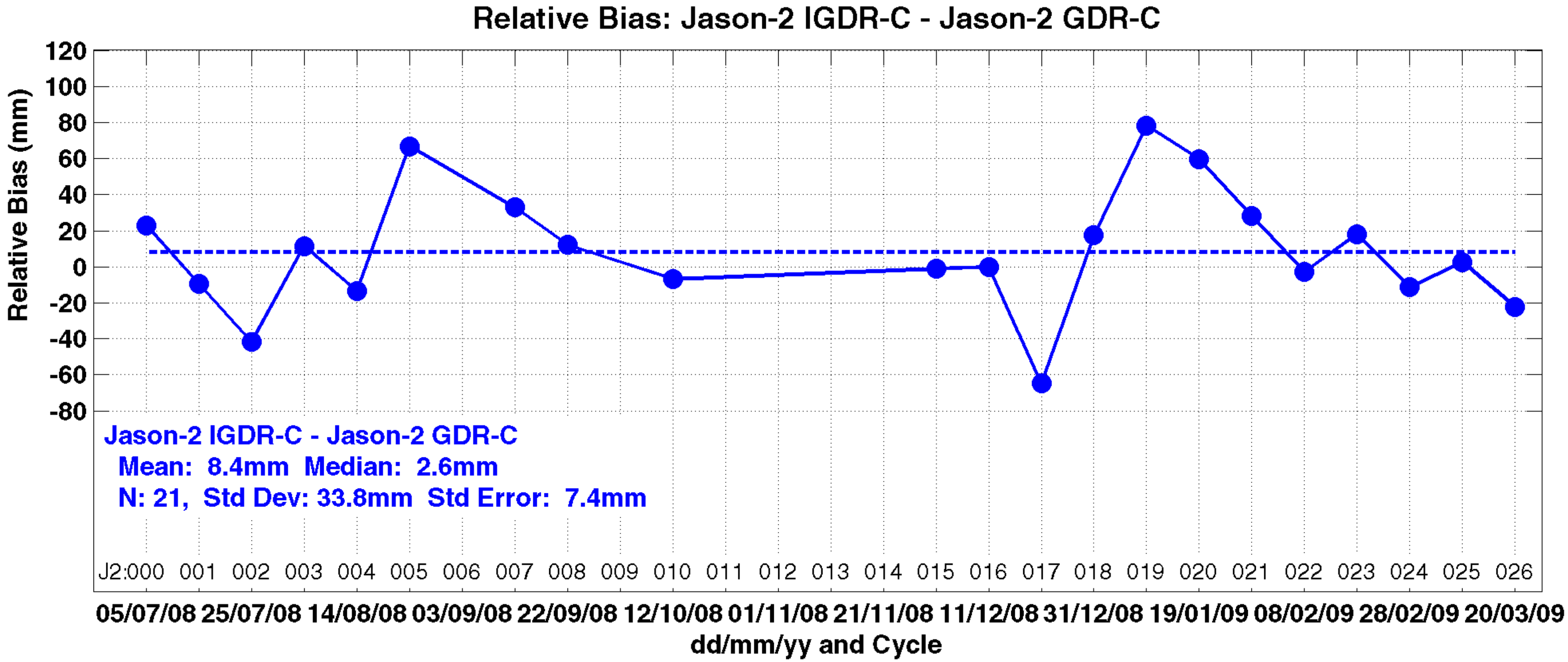
Results: OSTM/JASON-2 MISSION

J-2 IGDR-C vs GDR-C



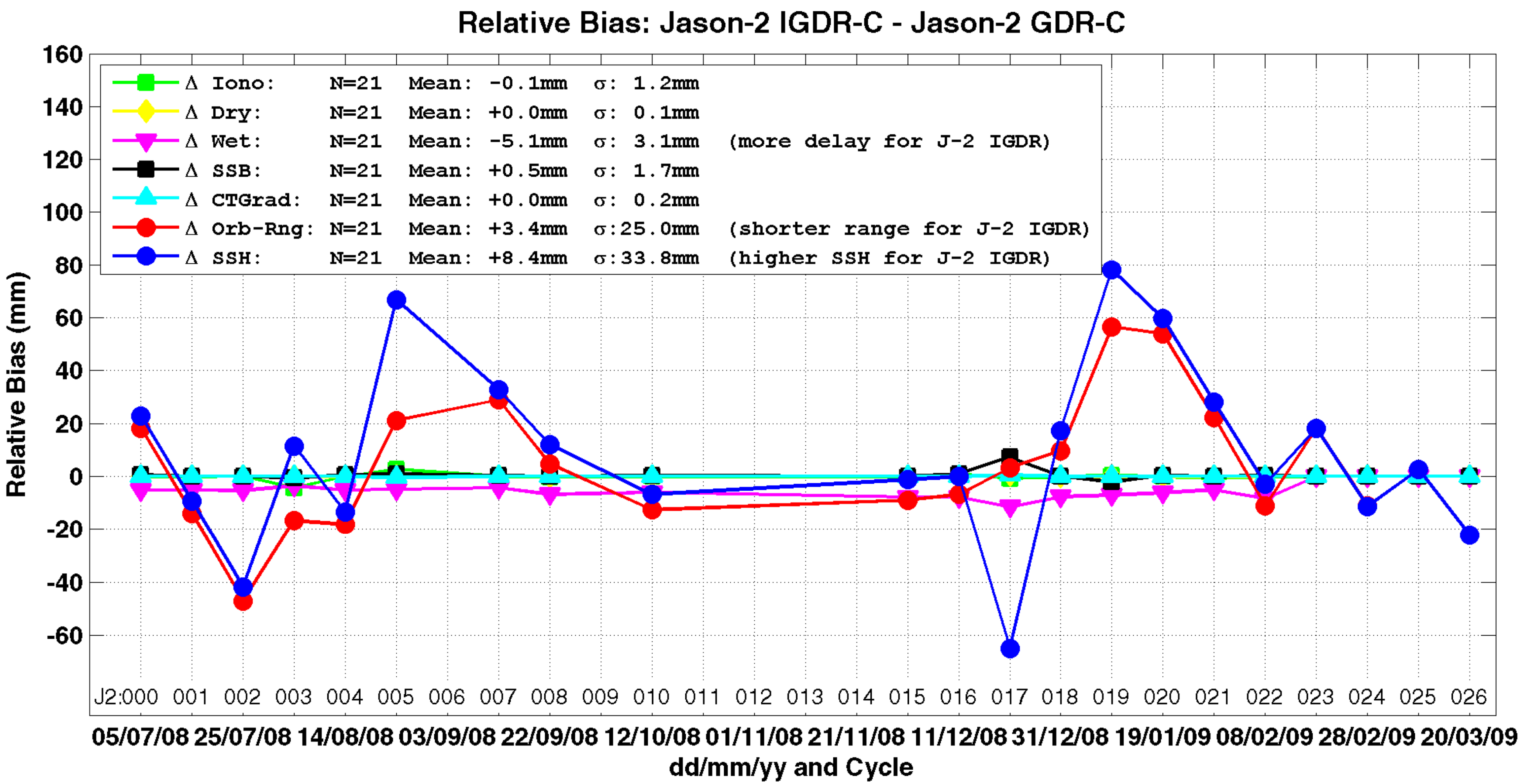
Results: OSTM/JASON-2 MISSION

J-2 IGDR-C vs GDR-C – relative bias



Results: OSTM/JASON-2 MISSION

J-2 IGDR-C vs GDR-C – relative bias



Conclusions

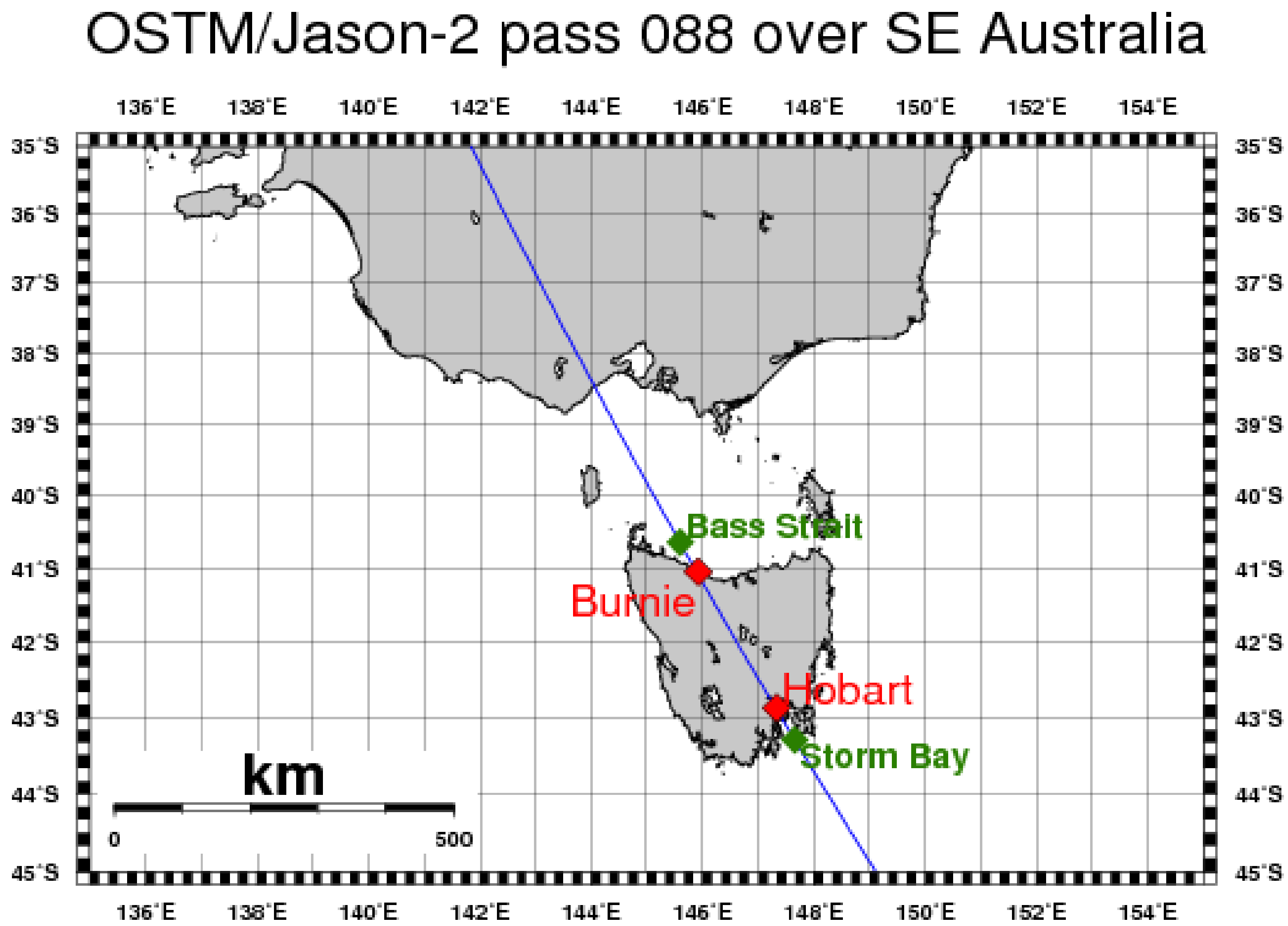
Data	Cycles	N	Mean Bias	Std Error
Jason-1 GDR-C	001-259	212	+98.9	2.8 mm
Jason-1 GDR-C	239-259	20	+107.4	5.0 mm
Jason-2 GDR-C	000-020	15	+159.5	8.5 mm
J-2 GDR-C – J-1 GDR-C	*as above*	*14*	*+45.5*	*8.5 mm*
Jason-1 GDR-C (std JMR)	228-259	30	+104.6	4.8 mm
Jason-1 GDR-C (updated JMR)	228-259	30	+102.8	4.8 mm
Jason-2 GDR-C (std AMR)	000-026	16	+158.0	8.1 mm
Jason-2 GDR-C (updated AMR)	000-026	15	+164.5	9.1 mm

Future Tasks:

1. **Investigate other ways to improvement our ability to transform the tide gauge SSH to the comparison point (i.e meteorological forcing etc).**
2. **Further investigate altimeter bias with and without Burnie FTLRS data used to determine orbits. Do we see geographically correlated effects?**
3. **SSB effects – results from Storm Bay.**

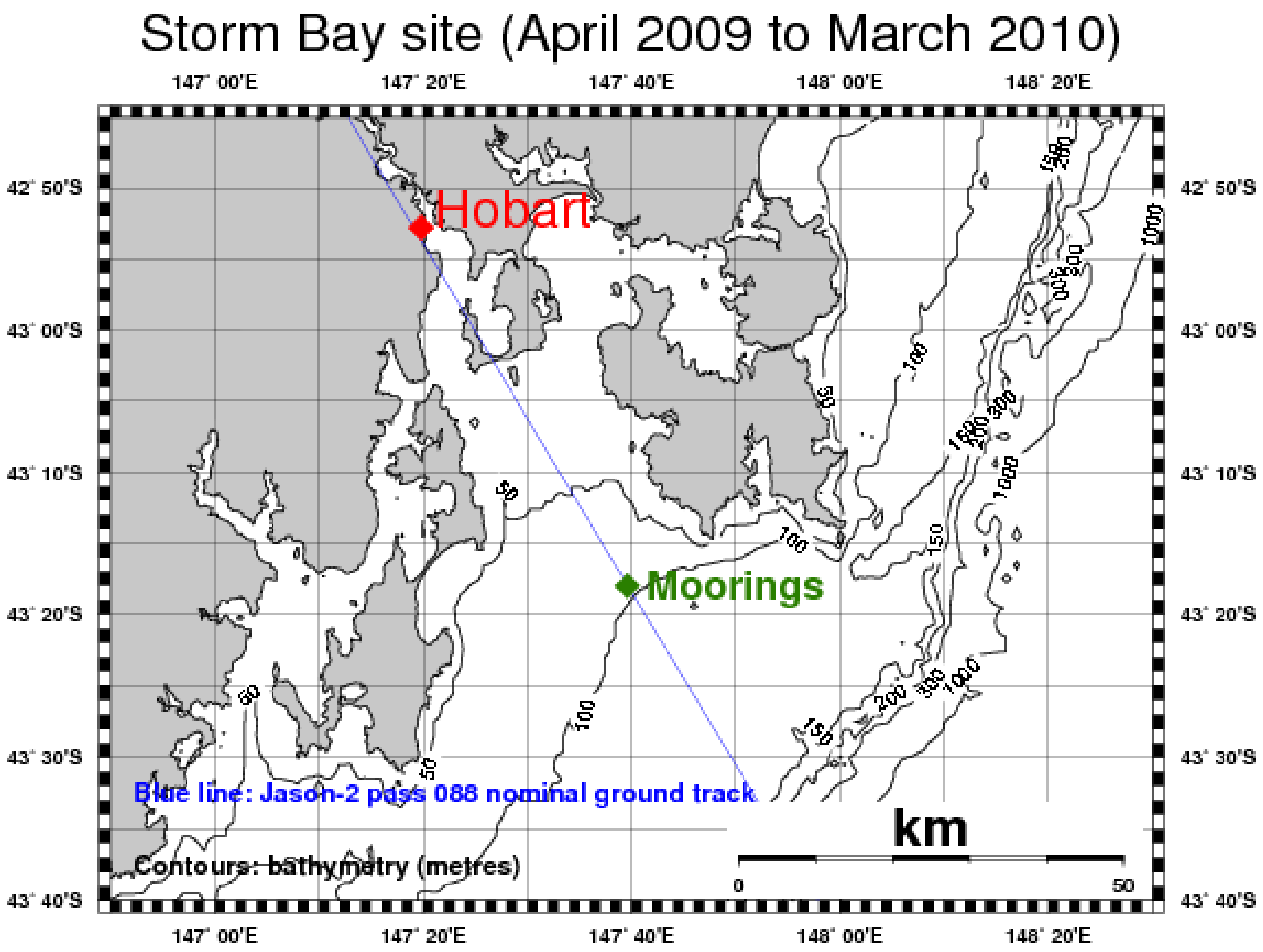
Future Plans

Storm Bay



Future Plans

Storm Bay



Questions?

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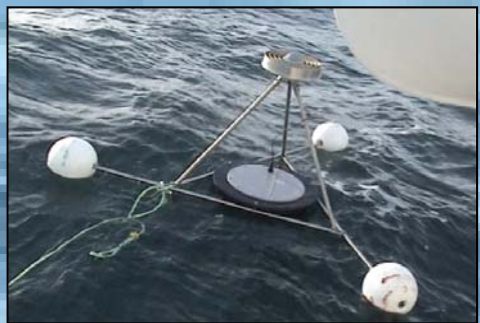


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