Ongoing monitoring of absolute bias from the Australian In-Situ Calibration Sites: Bass Strait and Storm Bay

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Review

- Primary site located in Bass Strait (40° 39′S, 145° 36′E) on decending pass 088. Contributed to the SWT/OSTST since launch of TOPEX/Poseidon.
- Geometric approach – In situ SSH determined at a comparison point through combination of GPS buoys, ocean moorings and TG observations.
- We present updated absolute bias results and briefly draw attention to our bias drift work (poster).
**Instrumentation: TG and CGPS**

- **Bass Strait site:**
  - Burnie TG (part of the ABSLMP)
  - BUR1/2 and RHPT CGPS sites
  - An additional 2 GPS sites are used episodically to further support GPS buoy processing.

- **Storm Bay site:**
  - Spring Bay TG (part of the ABSLMP)
  - Hobart TG (local port operated)
  - HOB2 CGPS
  - An additional 2 GPS sites as per Bass Strait.
Instrumentation: GPS

- BUR1/2 record suggesting marginal subsidence in latest GPS solution.
- RMS of each GPS height time series ~6-7 mm.

Looking NW towards Hobart from the TSP2 GPS site on the Tasman Peninsula
Instrumentation: Ocean Moorings

Bass Strait  40°39'S, 145°36'E

Storm Bay  43°18'S, 147°40'E

SBE26 pressure gauge: PT    SBE37 CTD: TS(P)    Current meters: uv(TP)
GPS Buoy Deployments (UTAS Mk IV)

- Deployment duration ~50 hrs
- Design intended to limit excessive tilt and unwanted dynamic effects.
- Tethered horizontally to a surface float, in turn anchored to sea floor.
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\[ H_{ARP} = 0.527 \text{ m} \]
GPS+INS Buoy Solutions

- Buoy deployments have included a trial of a combined GPS / INS unit (Novatel SPAN CPT).
- Orientation data during a rougher than average deployment shows the buoy remains within ±5° in pitch and roll.
In Situ SSH Determination

Datum comparable with altimeter

Buoy A

Mooring 1

Buoy B

Mooring 2

Buoy C

Tide gauge
In Situ SSH Determination

1) Determine mooring to TG offsets using a harmonic analysis of time series differences (dominated by M2, Amp = 0.126 m). RMS of the non-tidal residual, (mooring – tide gauge) is 22 mm (reduces to 20 mm when differential effect of air pressure is considered).
1) Determine mooring to TG offsets using a harmonic analysis of time series differences (dominated by M2, Amp = 0.126 m). RMS of the non-tidal residual, (mooring – tide gauge) is 22 mm (reduces to 20 mm when differential effect of air pressure is considered).

2) Define the datum using multiple GPS deployments (min of 2 per 6 month mooring deployment).
Results: Buoys v Mooring

- Typically < 5 mm agreement between differences observed with Buoy 3 and Buoy 4.
- Residual time series (filtered buoy SSH – mooring SSH) shows RMS of 23 mm.
- Larger excursions are likely GPS artefacts given they typically correlate well with times of poorest GPS constellation coverage.
Results: Absolute Bias

- Jason-1 GDR-C + GSFC1204 orbits, Jason-2 GDR-D + GSFC1204 orbits.
- Pole tide issue resolved (now using crust only component, scaled from GDR value).
- The large negative trend in Jason-2 is slowing, unlikely to be TG/VLM related.
Results: Bias Spectra

TOPEX A&B

Jason-1

Jason-2
Results: Jason-2 Orbit Comparisons

Jason-2 Absolute Bias: Orbit Comparison (GDR / GSFC1201 / GSFC1204)

- Marginal increases in bias when using GSFC1201 or GSFC1204 orbits.
- (Note slightly different data durations).
- Anomalous trend seems to cease towards end of 2010.
Results: Jason-2 Orbit Comparisons

Jason-2 Absolute Bias: Orbit Comparison (GDR / GSFC1201 / GSFC1204)

- Jason-2 GDR-D GDR Orbit: Mean Bias: -0.6mm Median Bias: 1.5mm
  N: 92, Std Dev: 22.8mm Std Error: 2.4mm
- Jason-2 GDR-D GSFC1201 Orbit: Mean Bias: 7.7mm Median Bias: 9.3mm
  N: 63, Std Dev: 26.5mm Std Error: 3.3mm
- Jason-2 GDR-D GSFC1204 Orbit: Mean Bias: 7.7mm Median Bias: 9.9mm
  N: 84, Std Dev: 24.7mm Std Error: 2.7mm

(MOORING ONLY)

- Marginal increases in bias when using GSFC1201 or GSFC1204 orbits.
- (Note slightly different data durations).
- Anomalous trend seems to cease towards end of 2010.
Results: **Bass Strait v Storm Bay (GDR-D)**

- **Bass Strait Rate:** $-5.9 \pm 1.7 \text{ mm/yr}$

- **Storm Bay Rate:** $-6.2 \pm 2.4 \text{ mm/yr}$

- Comparable rate observed at Storm Bay using the transformed Spring Bay TG time series.
- Increased noise at Storm Bay attributed primarily to TG location.
- Absolute bias at Storm Bay marginally higher – needs further work.
Results: **Bass Strait v Storm Bay** (GDR-D)

- **Bass Strait Rate:** $-4.4 \pm 1.5 \text{ mm/yr}$
- **Storm Bay Rate:** $-6.0 \pm 2.3 \text{ mm/yr}$

**Jason-2 Absolute Bias: Bass Strait vs Storm Bay (Spring Bay TG)**

- **Bass Strait:** Mean Bias: -0.6mm Median Bias: 1.5mm
  - N: 92, Std Dev: 22.8mm Std Error: 2.4mm
- **Storm Bay:** Mean Bias: 12.9mm Median Bias: 9.8mm
  - N: 90, Std Dev: 27.3mm Std Error: 2.9mm

- Mooring only rates comparable despite different data periods.
- Storm Bay mooring time series marginally more noisy c.f. Bass Strait, in part driven by water depth ($\sim 52 \text{ m vs } \sim 96 \text{ m respectively}$), and sparser instrumentation.
Bias Drift at nearby TGs

- As part of our global bias drift work, we compute bias drift for a series of comparison points (CPs) along passes close to TGs, CPs separated by 20 km.
- TGs *Lorne* and *Spring Bay* are also on Pass 088 and show similarly anomalous drift rates for Jason-2 (likewise for pass 149 for *Lorne*, and 225 for *Burnie*).
Bias Drift Poster

- Aims to refine estimates of time variable bias in the climate record.
- Assess sensitivity to various altimeter data treatments, and to the method itself.
- Multiple altimeter passes per TG, and multiple comparison points per pass.

![Bias Drift Poster](image)
Bias Drift Poster

- Results show significant dependence of bias drift estimates on VLM, with the largest effect for TOPEX A and B.
- Application of the drift estimates to the GMSL record produces a marginally more linear time series, and suggests a downward revision in the rate (from +3.2 to +2.5 mm/yr, GIA+IB corrected).
- Come and see the poster!
Conclusions...

<table>
<thead>
<tr>
<th>Data</th>
<th>Cycles</th>
<th>N</th>
<th>Mean Bias ± Std Error</th>
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</thead>
<tbody>
<tr>
<td>Jason-1 GDR-C</td>
<td></td>
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<td></td>
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<tr>
<td>GDR Orbits, enc JMR</td>
<td>001-259</td>
<td>234</td>
<td>+115.6 ± 2.1 mm</td>
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<td>GSFC0905 Orbits, enc JMR</td>
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<td>+112.9 ± 2.2 mm</td>
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<tr>
<td>GDR Orbits</td>
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<td>GSFC1201 Orbits</td>
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<tr>
<td>GSFC1204 Orbits</td>
<td>001-173</td>
<td>156</td>
<td>+6.0 ± 2.9 mm</td>
</tr>
</tbody>
</table>

- Jason-2 GDR-D absolute bias not significantly different from zero.
- However —regional coherence in anomalous drift remains puzzling.
- Storm Bay biases (and drift) consistent with those from Bass Strait.
- Recall that non-time averaging systematic error contributions likely dictate that the “absolute” error is 10-15 mm for these estimates.
Questions?

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