In-Situ Calibration Activities in Bass Strait, Australia

Christopher Watson[1], Richard Coleman[1,2,3], Neil White[2,3], John Church[2,3], Ramesh Govind[4]

[1] *University of Tasmania*
Centre for Spatial Information Science
GPO Box 252-76, Hobart, Australia 7001

[2] *CSIRO Marine Research*
GPO Box 1538, Hobart, Australia 7001

[3] *Antarctic CRC*
GPO Box 252-80, Hobart, Australia 7001

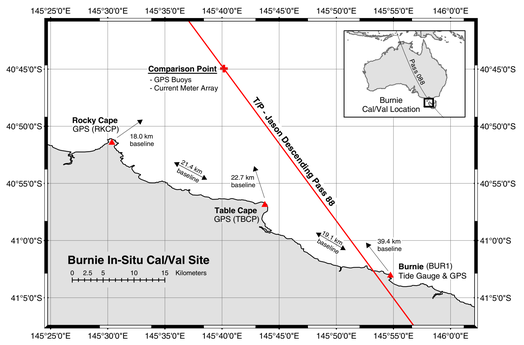
[4] *Geoscience Australia*
Space Geodesy Analysis Centre
PO Box 2, Belconnen, ACT, Australia 2616

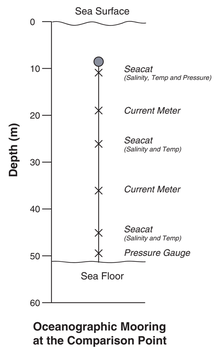
Introduction

The Burnie calibration site is located in northern Tasmania, Australia (41° 03' S, 145° 55' E) under TOPEX/Poseidon, Jason-1 descending pass 088.

The focus of the calibration activities is the regular deployment of two GPS buoys at our chosen comparison point, approximately 40km from Burnie.

Data from the episodic GPS buoy deployments, combined with the Burnie tide gauge and collocated GPS time series and supplementary oceanographic instrumentation allows the estimation of both the TOPEX/Poseidon and Jason-1 absolute bias. The project also aims to monitor any long-term drift in the bias of both altimeters.





Oceanographic Mooring at the Comparison Point

Calibration Methodology

The comparison point along the altimeter ground track was selected as a compromise between GPS network geometry (minimising baseline lengths for GPS buoy processing) and maximising the distance from land to avoid interference to the satellite data.

Three oceanographic moorings were deployed under the altimeter ground track between the 17th December, 2001 and 11th September, 2002. These data are being used to independently estimate the sea surface height at the comparison point and aid in the determination of the geoid slope along the altimeter ground track.

Two wave rider GPS buoys are deployed at the comparison point for a four hour duration centered at the time of overflight. Both buoys are tethered within ~50m to an anchored boat.

GPS Buoy

Burnie Tide Gauge & GPS

The GPS buoy development has included a range of investigations:

- Independent measurements of the height of the antenna above mean water level.
- Determining the effect of the antenna radome on phase centre offset and variation.
- Measuring the buoy dynamics using a scale model and wave tank to ensure the buoy follows the mean sea surface whilst tethered to a fixed point.

Three static GPS reference sites are used. The Burnie site is continuously operating and is co-located with a Sutron Aquatrak tide gauge. The sites at Table Cape and Rocky Cape record over a 24 hour period for each deployment. Baseline distances to the comparison point are 18.0 km, 22.7 km and 39.4 km respectively.

GPS Processing Methodology

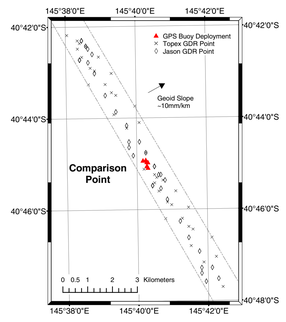
The static sites in the analysis are processed using the GAMIT/GLOBK suite in a regional network solution together with other sites contributing to the Australian Regional GPS Network (ARGN). Global IGS solutions are used in the final GLOBK processing to enable the estimation of site coordinates in ITRF2000.

The BUR1, TBCP and RKCP sites are then used as fixed reference sites in the kinematic processing of the the two GPS buoys using TRACK software developed at MIT. The emphasis in kinematic processing development remains the successful determination of the differential tropospheric delay parameter on a moving platform. The development of improved kinematic processing strategies for the GPS buoys form a major component of the research undertaken by the group.

Deployments Completed

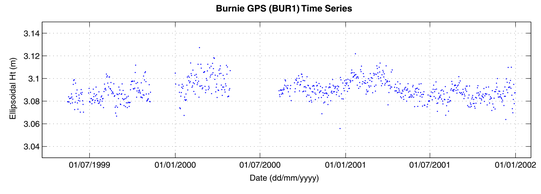
A total of seven (7) buoy deployments have been completed to date.

1: 21/09/2001. T/P Cycle 332
2: 17/02/2002. T/P Cycle 347, J1 Cycle 04
3: 09/03/2002. T/P Cycle 349, J1 Cycle 06
4: 07/04/2002. T/P Cycle 352, J1 Cycle 09
5: 27/04/2002. T/P Cycle 354, J1 Cycle 11
6: 07/05/2002. T/P Cycle 355, J1 Cycle 12
7: 27/05/2002. T/P Cycle 357, J1 Cycle 14



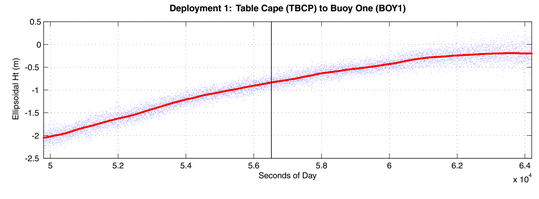
Burnie GPS Time Series

The continuous GPS at Burnie is processed by Geoscience Australia and additionally by the University of Canberra. The time series shows a small annual cycle of amplitude 6mm peaking during the austral summer. The time series is however still too short to allow any meaningful estimates of vertical motion.



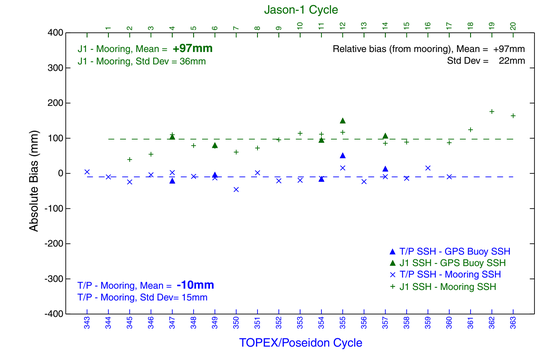
Example GPS Buoy Results

An example of the GPS buoy time series from the first deployment shows the 1Hz height time series for the 4 hour deployment. The red line shows the low pass filtered signal, highlighting the tidal displacement over the duration of the deployment. The vertical bar indicates the time of overflight. SWH for this deployment was 0.8m.



Results

Data from the bottom-mounted pressure gauge and dynamic height data from the three CTD instruments (all moored at the comparison point) have been used to calculate a SSH time series relative to an arbitrary level. Absolute heights from the GPS buoy deployments are then used as an absolute datum for the mooring SSH time series.
The GPS constrained mooring SSH time series allows a continuous comparison to the T/P and Jason-1 SSH during the cal/val period.



TOPEX/Poseidon Data Used:
T/P MGDR data with path length corrections made (wet & dry tropo, iono and e.m. bias)
- GCP wet tropo
- GCP e.m. bias
- GCP ionosphere
- Iono correction smoothed (including GCP iono)

Jason-1 Data Used:
Jason-1 IGDR with path length corrections made (wet & dry tropo, iono and e.m. bias)
- Iono correction smoothed
- There are problems with the JMR flagging and correction which adds approximately 1cm to the uncertainty on the Jason-1 calibration.

Absolute Bias Determination

Data from the GPS Buoy SSH has been used to calculate both T/P and J1 absolute bias at the comparison point. Data from deployment 4 has been excluded due to rough conditions preventing a satisfactory GPS solution. Data from T/P cycle 355 has been excluded due to Alt_Bad_2 flags being set.

Deployment	T/P Cycle	Jason-1 Cycle	T/P Bias	Jason-1 Bias
1	332	-	-21 mm	-
2	347	004	-04 mm	+104 mm
3	349	006	-16 mm	+80 mm
5	354	011	-27 mm	+95 mm
6	355	012	-	+150 mm
7	357	014	+13 mm	+107 mm
		MEAN:	***-11 ± 20 mm***	***+107 ± 30 mm***

Notes:
The error budget incorporates both systematic and random terms. Preliminary estimates include GPS reference position (10mm), GPS buoy SSH (22mm), altimeter SSH (30mm), cross track SST (5mm) and model differences (15mm). Jason-1 has an additional term (10mm) caused by the problems with the JMR flagging and correction. These values are still under review.

Issues to be Addressed

Further Investigation of Error Sources
- Further investigation of error sources such as atmospheric loading and differences observed in solid Earth tide models is required.

Oceanographic Mooring Data
- Data from all current meters (inshore and offshore moorings) and the ADCP (centre mooring) is yet to be processed following the recent retrieval. These data will allow the determination of geoid slope along the ground track from the tide gauge site to the comparison point.

GPS Buoy Processing
- Further development of integrated multi reference, multi rover solutions
- Improved resolution of tropospheric delay parameters

Acknowledgements

CSIRO Earth Observation Centre
Australian National Tidal Facility
Burnie Port Authority
GPS Group, MIT
AVISO
PODAAC