A new inverted echo sounder for satellite altimetry calibration and validation.

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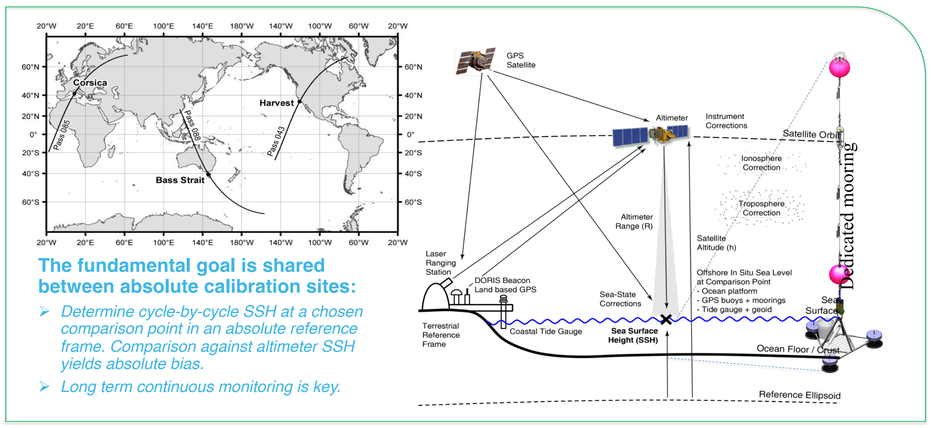
Introduction: The Bass Strait site is one of the main cal/val sites around the globe and the only site in the southern hemisphere that has contributed to absolute calibration of all sea level reference missions TOPEX/Poseidon, Jason-1 and Jason-2 and Jason-3, commencing in late 1992. Sentinel-3A (S3A) was launched in Feb. 2016 and Sentinel-3B (S3B) is planned for 2018, Jason-CS for 2020 and SWOT for 2021.

With the growing number of missions to calibrate and sites to instrument, we are developing novel and independent ways to estimate the SSH which can assist the absolute calibration.

Here we show the recent development we have made using a wave-ADCP as a Pressure Inverted Echo Sounder at the Sentinel-3B comparison point in Bass Strait. This site boasts a 28m water depth. This is quite shallow and allowed us to confidently install a 5 Beam 500 KHz ADCP which allows to range the surface accurately in addition to measure currents and waves.

Over the period from April to August 2018 we had both the ADCP system, and a more classic Pressure, Temperature and Salinity moorings. On top of this we had a 70h GPS buoy session at the end of July. This allows us to do a 3 way comparison of 3 different ways to estimate SSH.

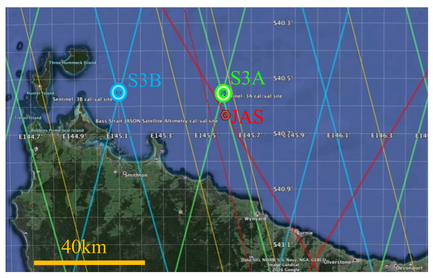


The fundamental goal is shared between absolute calibration sites:

- *Determine cycle-by-cycle SSH at a chosen comparison point in an absolute reference frame. Comparison against altimeter SSH yields absolute bias.*
- *Long term continuous monitoring is key.*

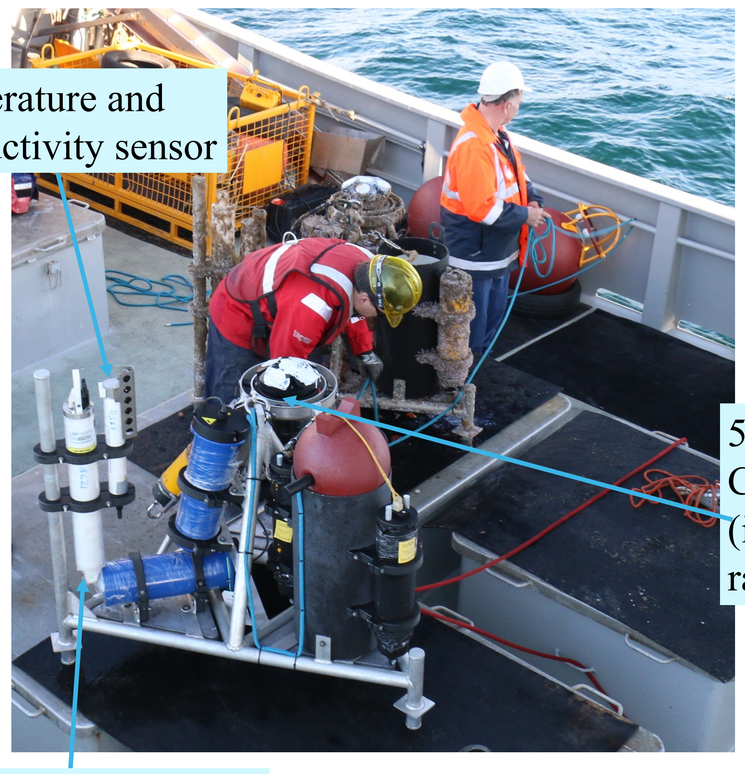
Bass Strait historical and long term absolute calibration Jason site is 8-9 km away from the Sentinel-3A crossover monitored since they are both in 50m deep waters.
The Sentinel-3B reference crossover is ~ 40km West of the Jason and Sentinel-3A calibration sites and is in 28m deep waters.
A full set of instrumentation is installed in preparation for Sentinel-3B :

- One mooring with bottom Pressure, Temperature and Salinity measurements.
- One mooring with bottom P,T,S and a 5 beam ADCP.

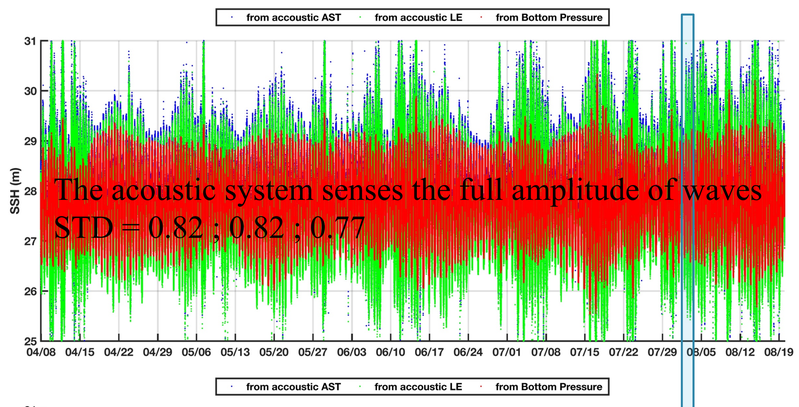


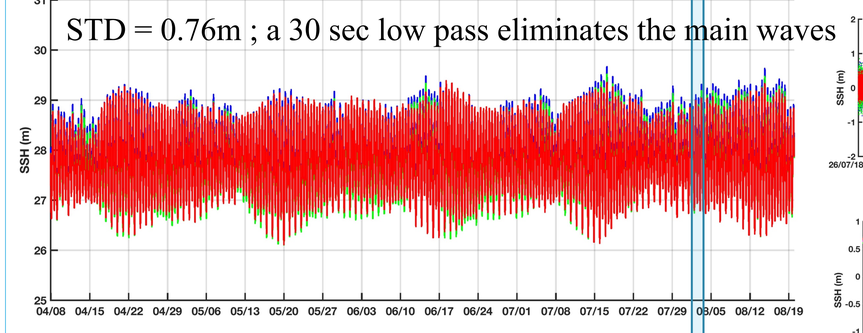
The ADCP operates over 2 parallel programs :
- one operates the 5 beams to measure currents, wave spectra and Sea Surface Height during 20min every hour
- one operates the vertical beam only for the 40 other minutes of every hour.

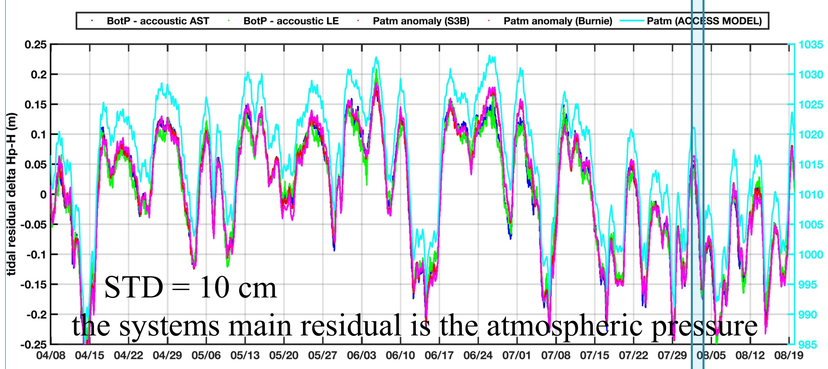
This configuration allows us to record the SSH continuously while fitting energy and data storage for over 6 month long deployments. 2 SSH detection modes are available with the ADCP : leading edge detection (LE) and acoustic surface tracking (AST). We obtain a continuous SSH record at ~ 3Hz.

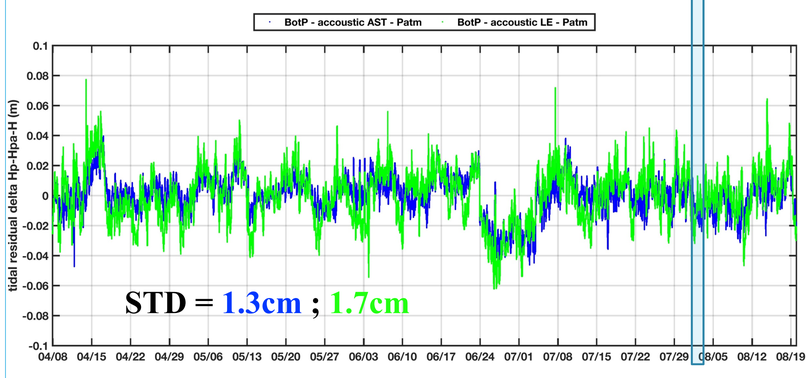


Acoustic and bottom P

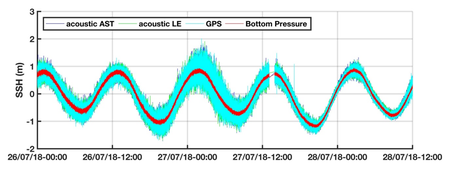


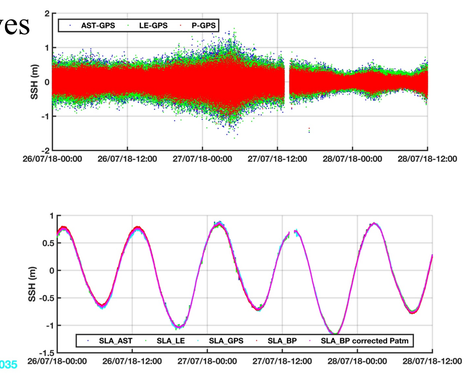


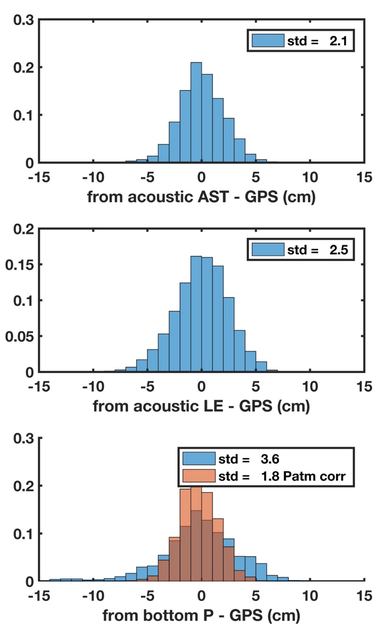




Acoustic, GPS and bottom P







This system is valid to do altimetry cal/val.
The collocation of Pressure, Temperature and Salinity as well as 2 acoustic ranging helps to detect outliers (<1%) inherent to acoustic ranging. The acoustic system measures accurately the waves and we can observe the damping when comparing to the pressure sensor at depth. The system SSH compares very well to the bottom pressure estimates. The comparison to the GPS buoy data is at the cm level when the waves are filtered (low pass 30 seconds).
The system main signal in acoustic minus bottom pressure is the atmospheric pressure and here it correspond very nicely to the Australian ACCESS model. This is an indirect validation which gives us confidence to use this model in our cal/val and on the IBE validity.
Improvements are ongoing on the data QC, in this first experiment we didn't get a good Salinity record which should improve with the recovery of the secondary mooring, one important aspect of the mooring design relate to the necessity for a vertical and stable pointing of the ADCP as a previous experiment showed a quick degradation of the measurements when the pointing was affected by large swell.
Unlike the bottom pressure systems the Acoustic and GPS systems do not show significant time drifts. This new kind of mooring as well as other ongoing longer term deployable GPS buoys help with the increase in the number sea level capable altimetry missions.

FOR FURTHER INFORMATION
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REFERENCES

1. Watson, C.S., White, N., Church, J., Burgette, R., Tregoning, P., and Coleman, R. (2011) Absolute Calibration in Bass Strait, Australia: TOPEX, Jason-1 and OSTM/Jason-2. Marine Geodesy, 34:3-4, pp242-260.
2. King, M. A., M. Keshin, P. L. Whitehouse, I. D. Thomas, G. Milne and R. E. M. Riva (2012), Regional biases in absolute sea-level estimates from tide gauge data due to residual unmodeled vertical land movement. Geophys. Res. Lett., 39(14), L14604, doi:10.1029/2012GL052348.
3. Watson, C.W., N.J. White, J.A. Church, M.A. King, R.J. Burgette and B. Legresy. (2015). Unabated global mean sea-level rise over the satellite altimeter era. Nature Climate Change. http://dx.doi.org/10.1038/nclimate2635
4. Herzfeld, M. (2006) An alternative coordinate system for solving finite difference ocean models. Ocean Modelling, 14, 174 – 196.
5. Chen, X., X. Zhang, J.A. Church, C.S. Watson, M.A. King, D. Monselesan, B. Legresy and C. Harig (2017), The increasing rate of global mean sea-level rise during 1993-2014. Nature Climate Change 7, 492-495, doi:10.1038/nclimate3325

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http://www.cmar.csiro.au/sealevel/sl_hist_last_decades.html

http://imos.org.au/facilities/srs/srscalval/