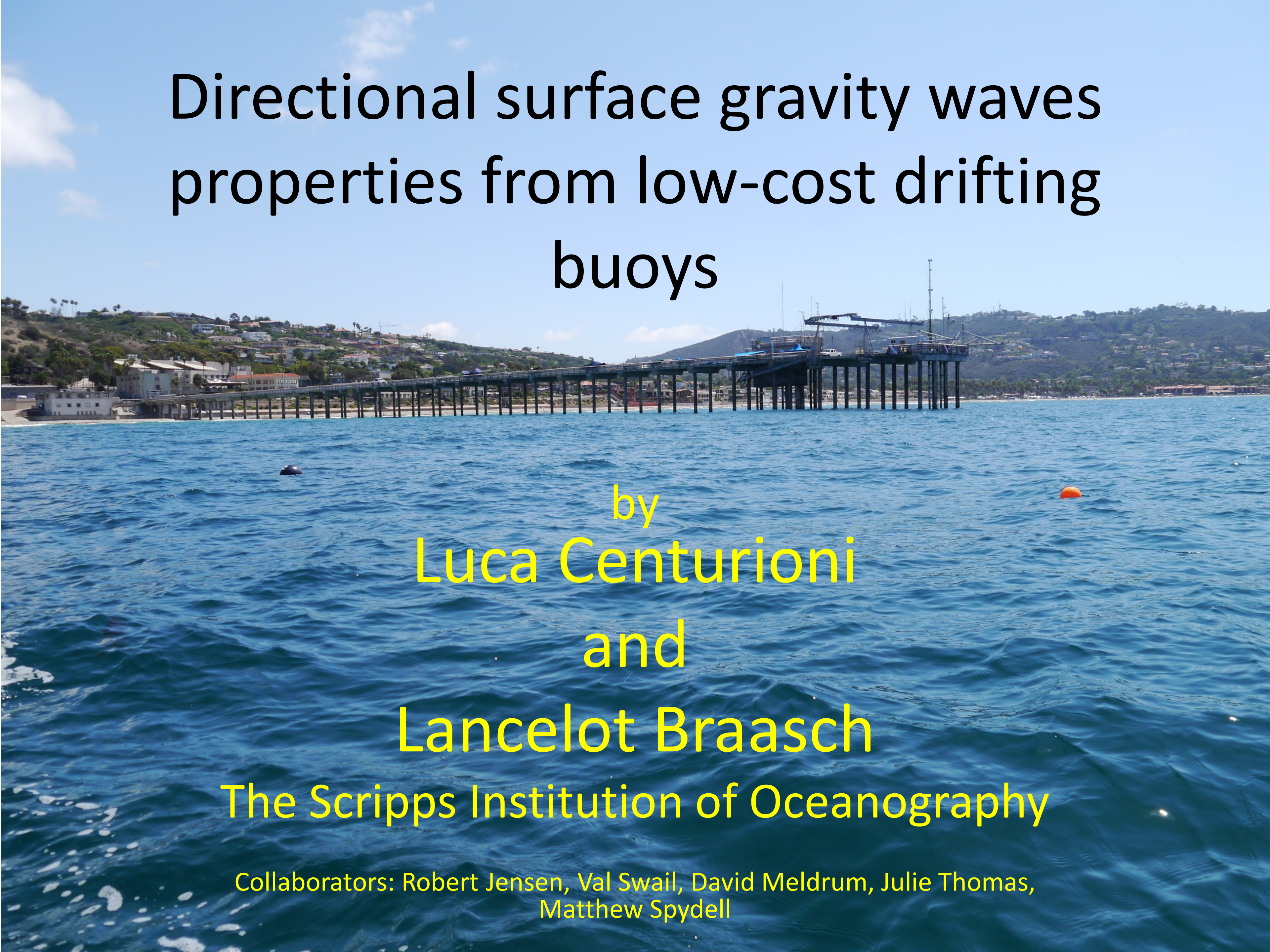

Directional surface gravity waves properties from low-cost drifting buoys

by
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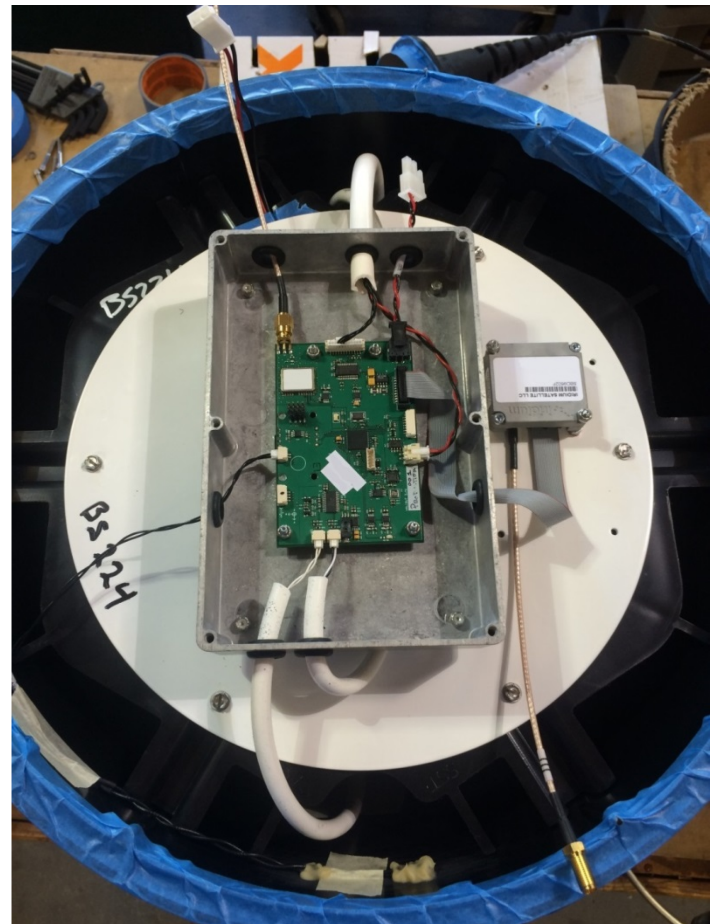
Collaborators: Robert Jensen, Val Swail, David Meldrum, Julie Thomas, Matthew Spydell

Background

- GPS base wave sensors, measuring x,y,z and u,v and w have been around for a long time (e.g. Krogstad et al. 1999, Herbers et al. 2012). Datawell has a commercial version of the GPS wave rider.
- From published data, a 40 cm diameter sphere with a damping element, such as a piece of tether hanging below, can measure waves w/out resonance contaminations for frequency lower than 1Hz.
- Differential GPS is not really needed as the low frequency modulation and steps can be filtered out.
- Short distances between wave sensors (short compared to the wavelength, ~100m) can lead to significant differences in measured wave parameters

The Technology: Hardware
SVP Drifter Hull

– 15” Diameter
– 40lbs
– 56 Ah Ruggedized Battery Pack
    • 1 month continuous with raw logging
– 20 lbs reserve buoyancy



The Technology: Sampling, Duty Cycle and On-Board Processing

- ~17 min long sampling of u, v, and w divided in ~4 min segments. 2 Hz sampling.
- High pass filter, cutoff at 0.035 Hz, but can be pushed lower, probably to 0.01 Hz.
- Optional: de-mean and/or de-trend (effectiveness tbd).
- Power Spectral Density and Co-Spectra are Computed with FFT -Hamming window (tapered).
- Shallow water correction (linear dispersion relation) for u and v.
- Both u,v and w are used to compute the first 5 directional spectrum parameters;
- The four computations of the five parameters are averaged and transmitted: these are a_0, a_1,b_1,$a_2$and b_2 (note: a_2 and b_2 are independent of w)

Wave parameters

Zero Moment: $m_0 = \pi \Delta f \sum_{i=1}^{n} a_{0,i}$
First Moment: $m_1 = \pi \Delta f \sum_{i=1}^{n} f_i \cdot a_{0,i}$
Second Moment: $m_2 = \pi \Delta f \sum_{i=1}^{n} f_i^2 \cdot a_{0,i}$

- Significant Wave Height

$$H_{mo} = 4\sqrt{m_0}$$

- Average Period

$$T_{av} = \frac{m_0}{m_1}$$

- Peak Period (estimated at max a_0)

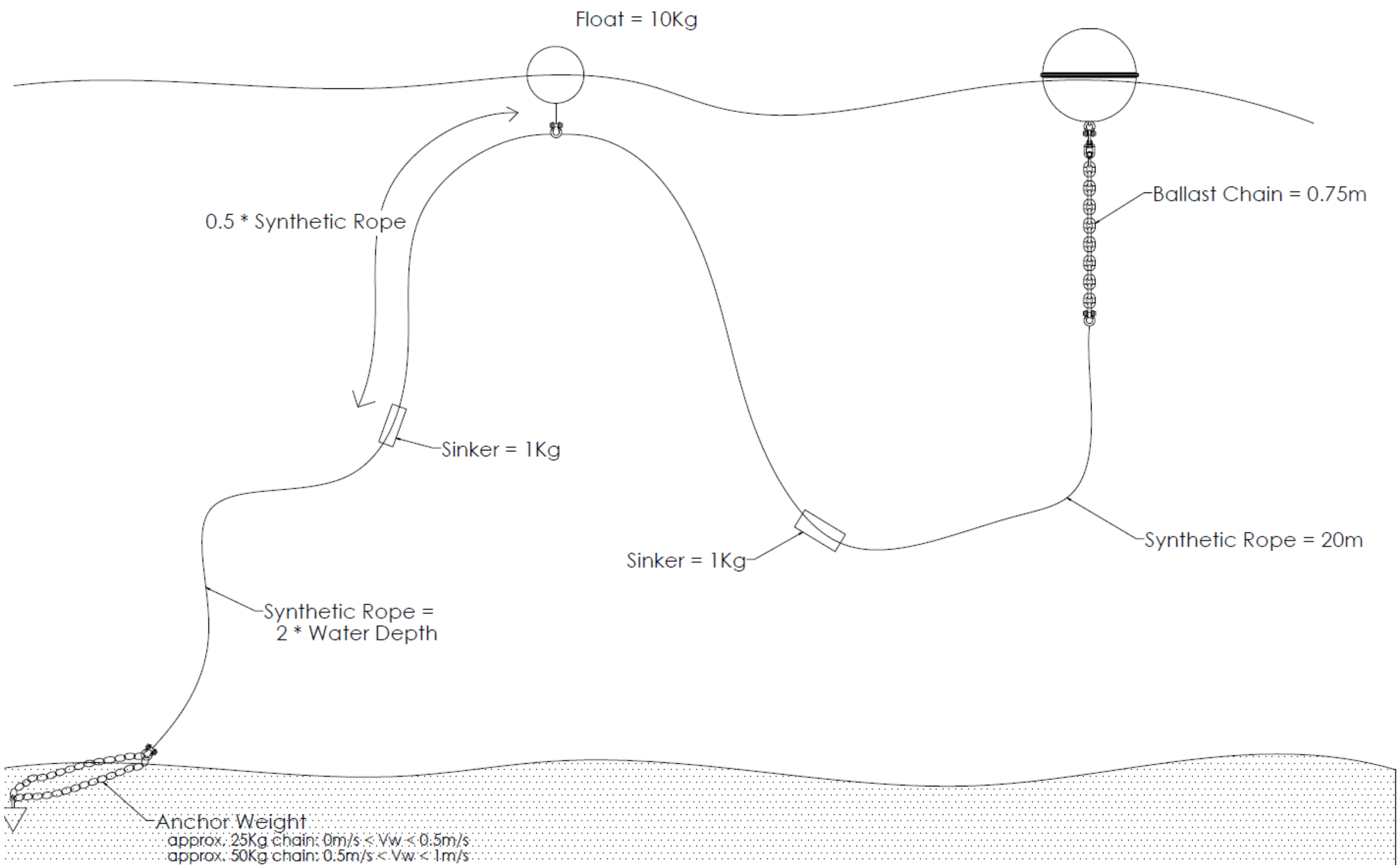
$$T_p = \frac{1}{f_{peak}}$$

Directional Spreads

$$\theta_1 = \arctan\left(\frac{b_1}{a_1}\right)$$

$$\theta_2 = \frac{1}{2}\arctan\left(\frac{b_2}{a_2}\right)$$

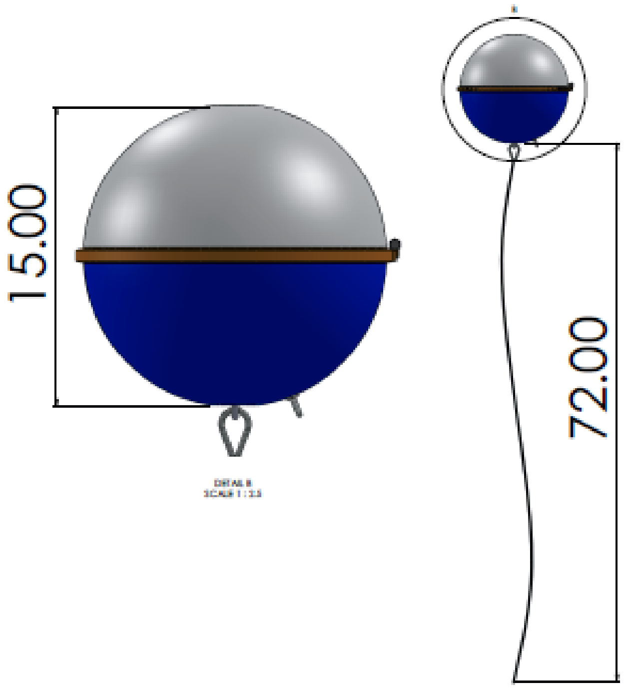
Sea Trials : SIO Mooring Configuration



Location of the SIO mooring and of the Other Reference Sensors

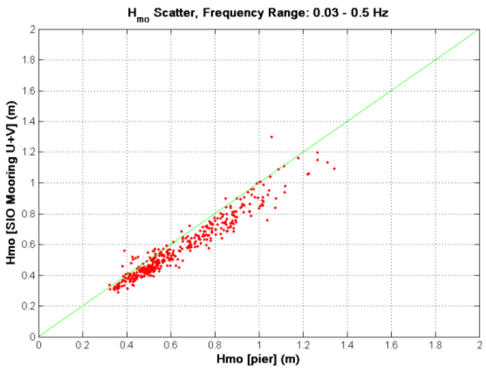
http://gdp.ucsd.edu/projects_portal/dbcp_waves/tracker.php

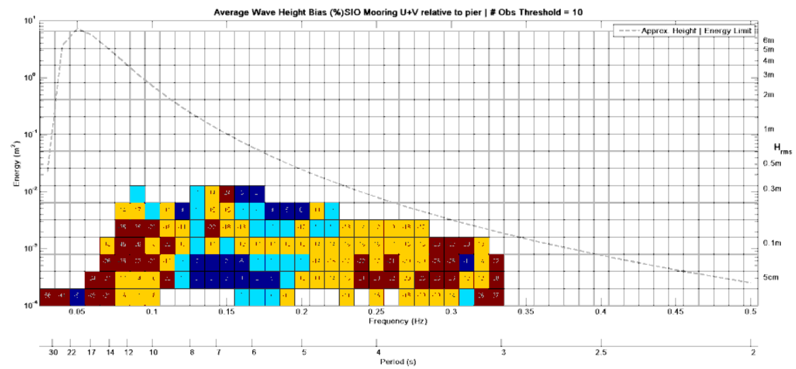
Sea Trials: Drifting Configuration



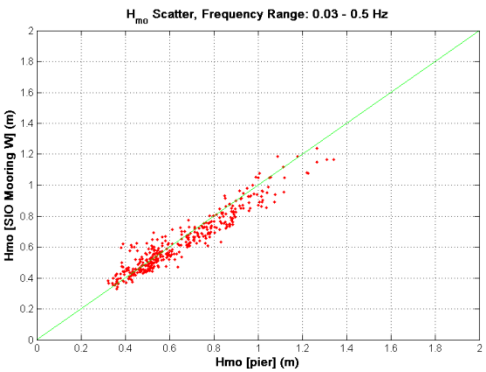
- http://gdp.ucsd.edu/projects_portal/dbcp_waves/tracker.php

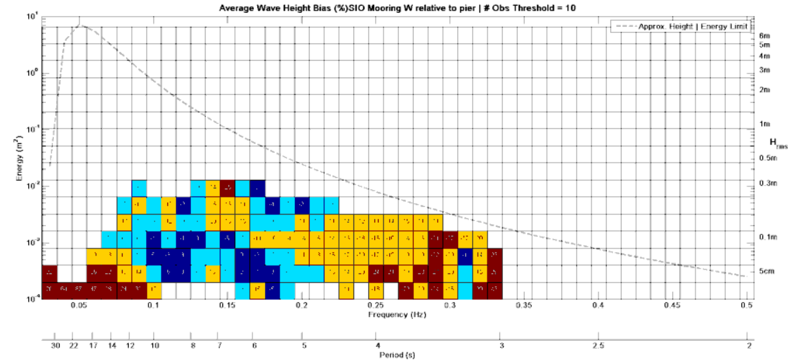
Validation: SIO drifter vs SIO pier (pressure sensors) with Waveval Tools. ~1month long



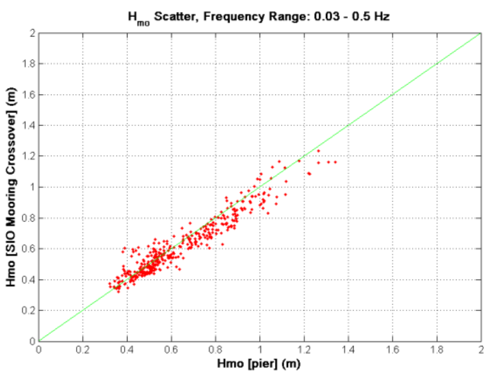


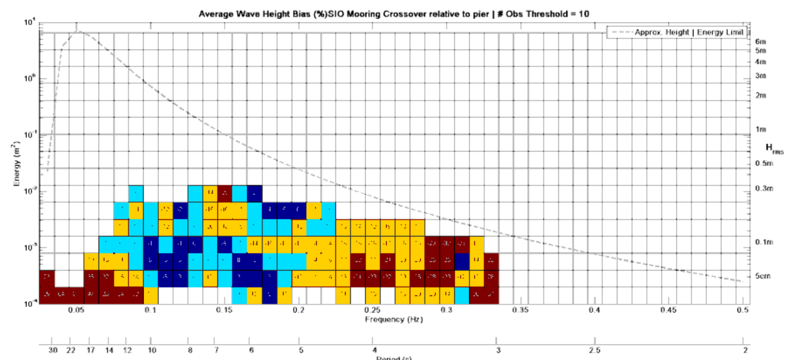
u,v, 2s-30s





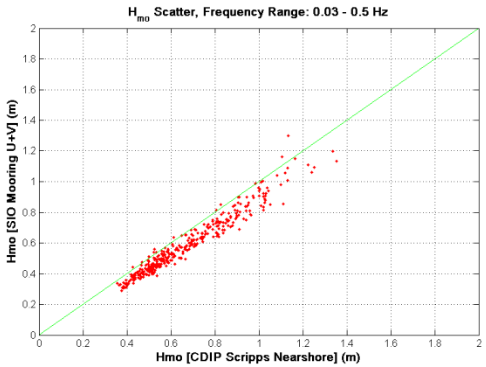
w, 2s-30s

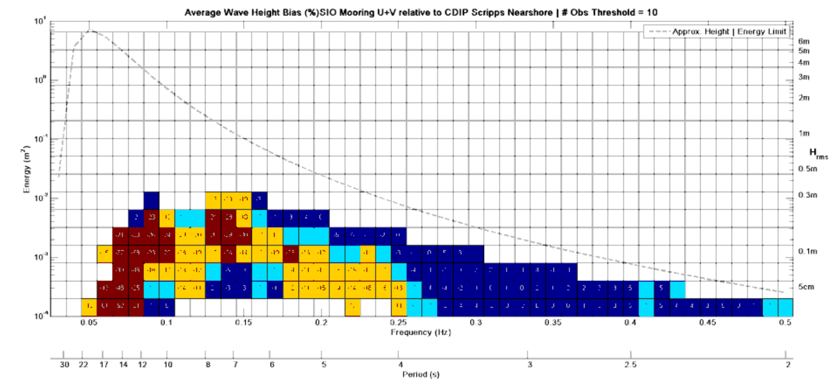




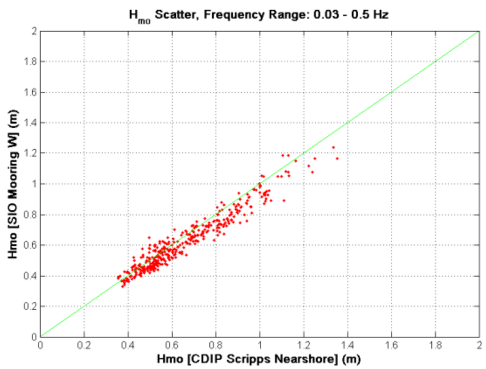
u,v, 2s-6s
w,6s-30s

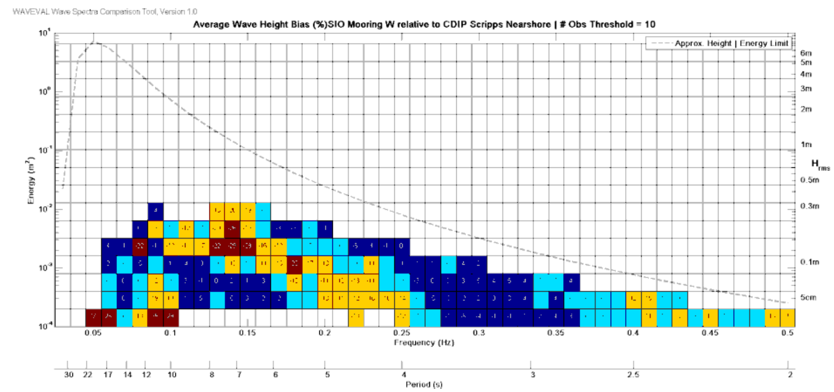
Validation: SIO drifter vs CDIP Datawell (pressure sensors) with Waveval Tools. ~1month long



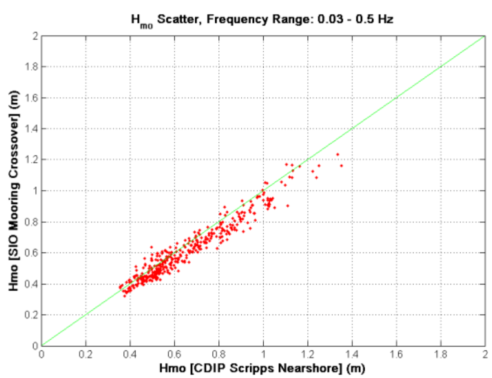


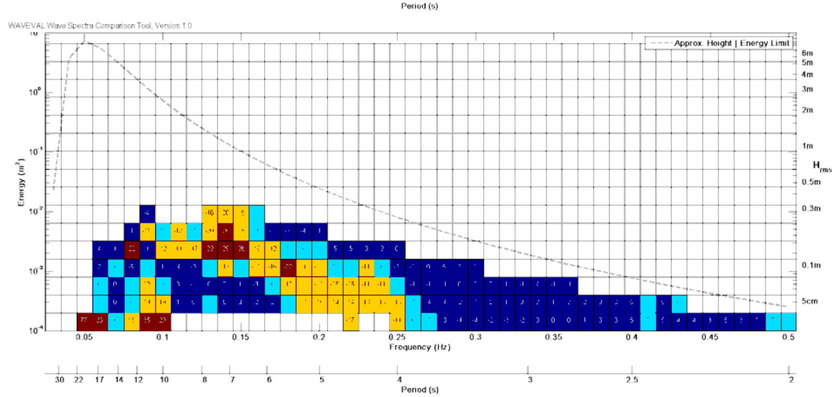
u,v, 2s-30s





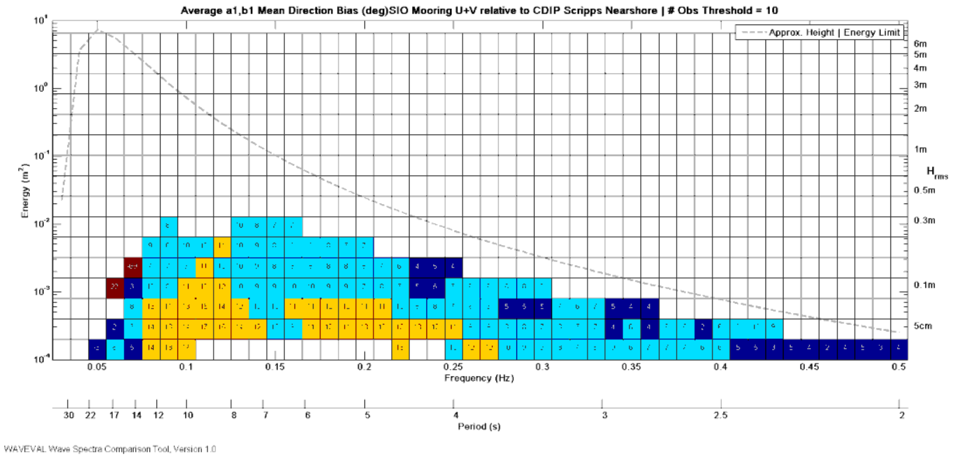
w, 2s-30s



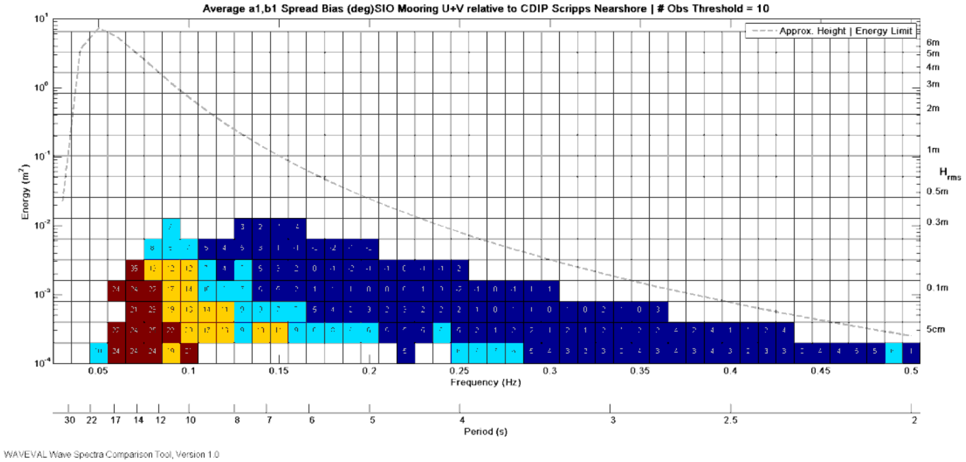


u,v, 2s-6s
w,6s-30s

Validation: SIO drifter vs CDIP Datawell (pressure sensors) with Waveval Tools. ~1month long

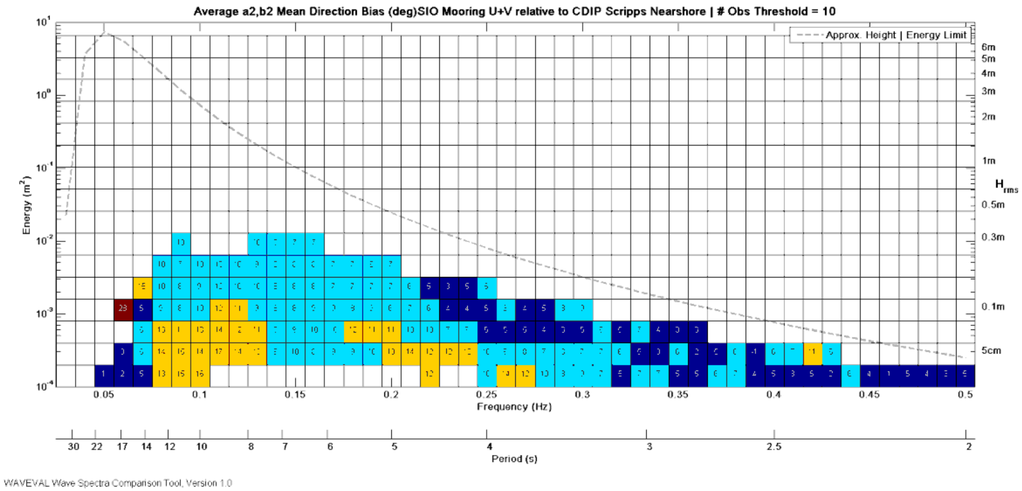


Mean Wave Direction Bias,
a_1 and b_1

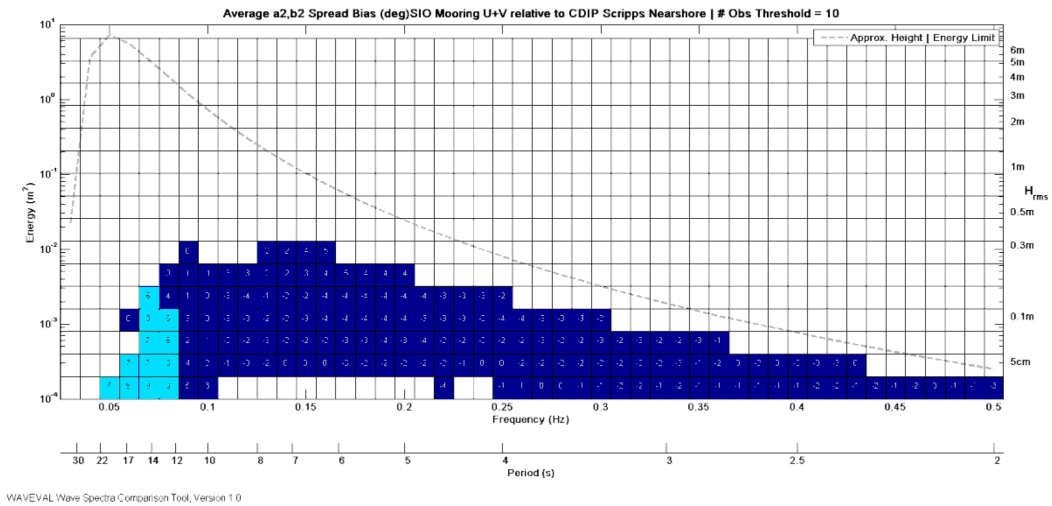


Directional Spread Bias,
a_1 and b_1

Validation: SIO drifter vs CDIP Datawell (pressure sensors) with Waveval Tools. ~1month long



Mean Wave Direction Bias, a_2 and b_2



Directional Spread Bias, a_2 and b_2

Roadmap for the next fiscal year

- Co-locate with Datawell (top hat). Very Important
- Bay of Biscay deployment and recovery
  - Log raw U,V,W, optimize sampling segment size
  - Eliminate mooring line effects on small hull
- Power budget analysis
- Pilot for transition of undrogued drifter array to wave sensor array with remote switch
- Evaluate potential for GPS+IMU or IMU based engine

Vision for the future

- Global fleet of wave drifters
  - Drogued and undrogued
- Evaluation of in-situ wave observations on numerical wave forecasts