Measurement of winter swell transformation and breaking over a narrow, steep shelf reef system.

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Description and motivation

A field experiment was conducted from January 11,2013 to February 25, 2013 at the Tres Palmas Marine Reserve in Rincon, Puerto Rico

Two pressure sensors, an AWAC, and a Sentinel ADCP were deployed in the reef area to measure the transformation and breaking of winter swell waves

A moored Waverider buoy was used to get the deep water wave conditions

Data collected to be used for validation of wave transformation and breaking on non-phase and phase resolving models under natural swell / high coastal wave conditions

- SWAN
- FUNWAVE

Extend findings to other coastal hazards such as hurricane generated swells, run up, coastal inundation

Get better understanding of coastal dynamics on deep reef and island environments

Experiment location

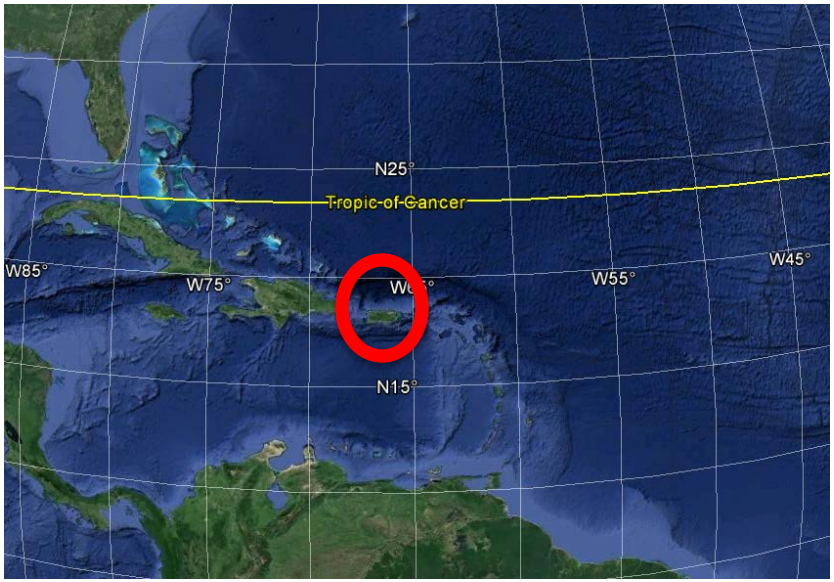
Puerto Rico is exposed to swells generated At the North Atlantic during October-March

Due to its location, the town of Rincon is affected by most swells that range in direction from NorthWest to NorthEast

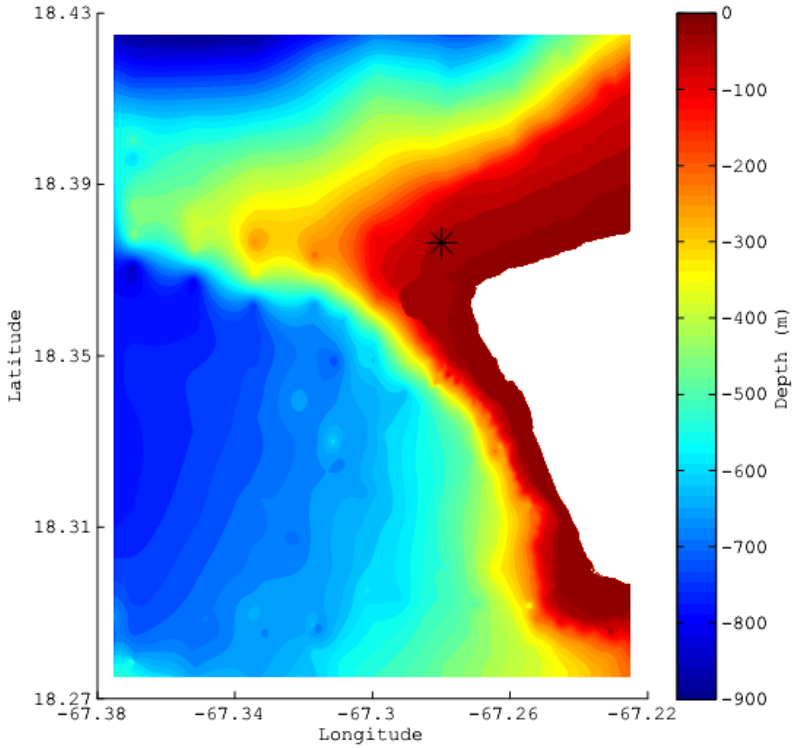
As a consequence of the local bathymetry of Rincon, the wave field refracts (almost 90◦) and is focused towards the coast

The Tres Palmas Marine Reserve has an extensive coverage of Elkhorn corals reef, and depths go from more than 100 m to 20 m directly into the reef area

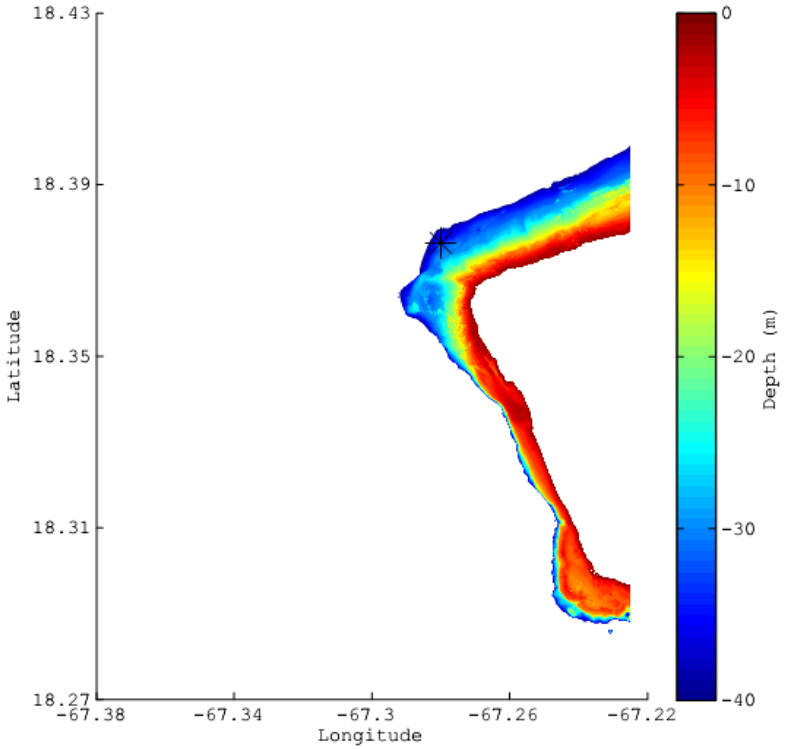
The refracted wave field comes close to perpendicular to the reef area



Full bathymetry



40 m depth



Bathymetry: NGDC Tsunami DEM, 10 m resolution

Instrument setup

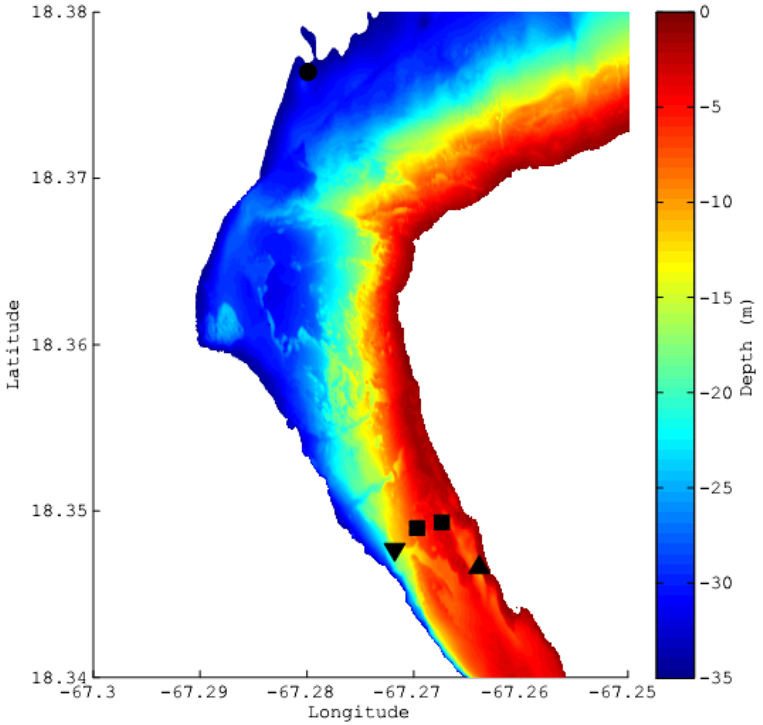
(1) Datawell Waverider
(1) Nortek AWAC
(2) Ocean Sensor Systems Pressure Sensor
(1) Teledyne Sentinel ADCP

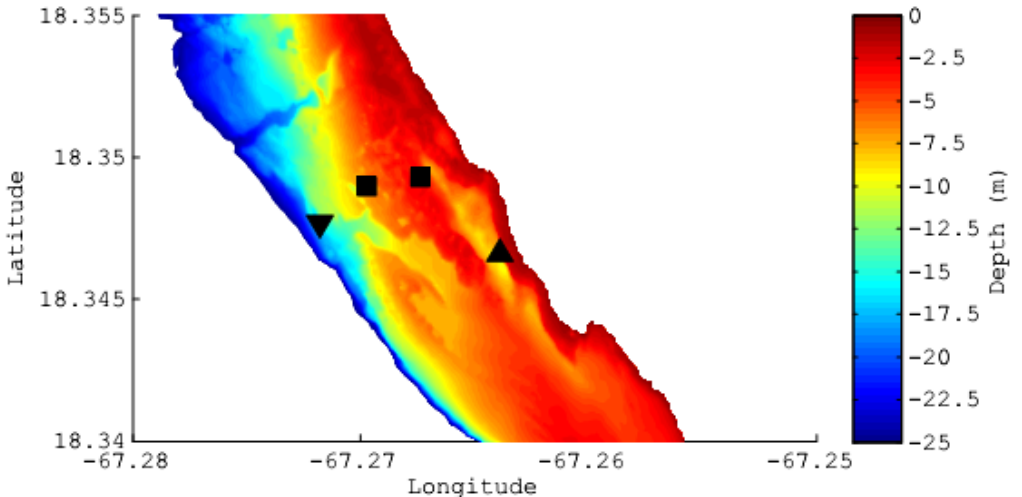
Waverider (2D spectrum):
33 m, 30 min interval sampling

AWAC (2D spectrum):
18 m, 30 min interval sampling (waves)
ADCP had comm. problem

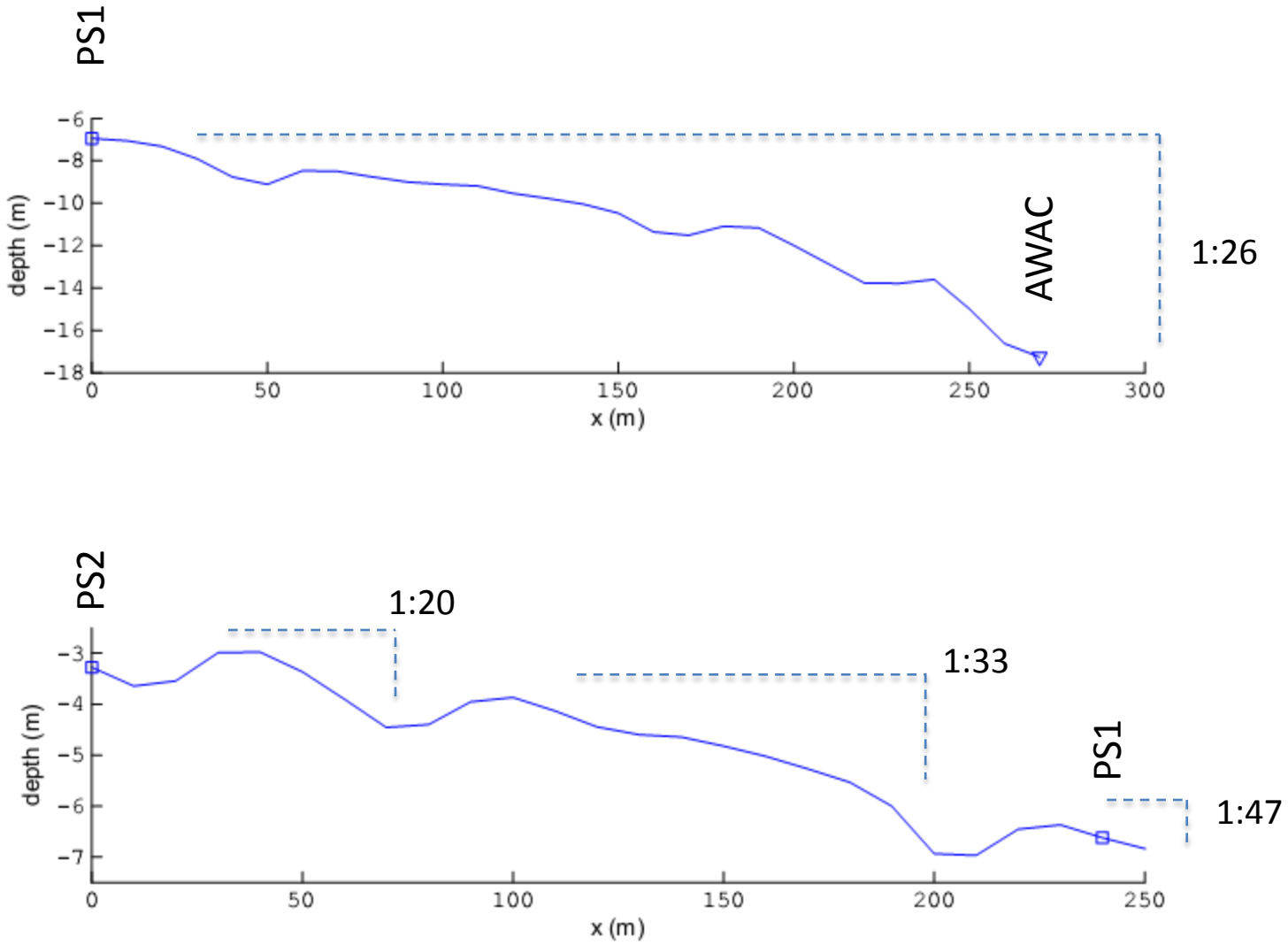
Pressure Sensors:
6.54m, 3.33 m
Continuous, 10 Hz sampling rate

Sentinel ADCP:
10 m channel, 30 min interval sampling
0.5 m bin size





Transect Profiles



Pressure sensor processing

Divide into 30 min intervals (18000 sample points)

Detrend with quadratic fit (pressure offset increased with time)
- Verified this was appropriate by comparing mean sea level to closest tide gauge

When instrument moved due to wave events, use new mean water depth
- Minimize effect when calculating wavenumber k

Low-pass filter 30 min pressure record
- Matlab FIR filter, Hamming window, cutoff frequency = 0.5 Hz (0.1*Nyquist)

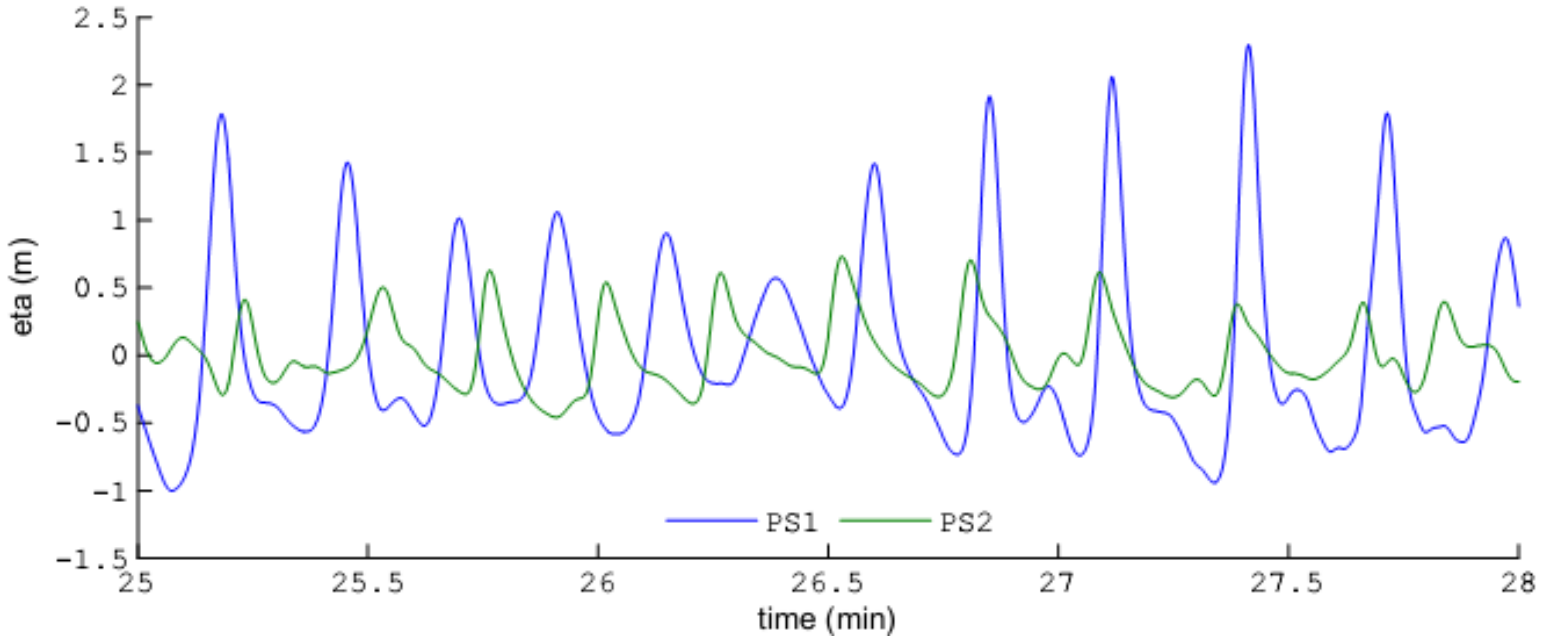
Do FFT on filtered series, solve for k iteratively
Apply inverse FFT to k after attenuation

After inverse FFT, the first and last 60 seconds of the 30 min series is eliminated to avoid contamination when calculating wave spectrum and zero down-crossing

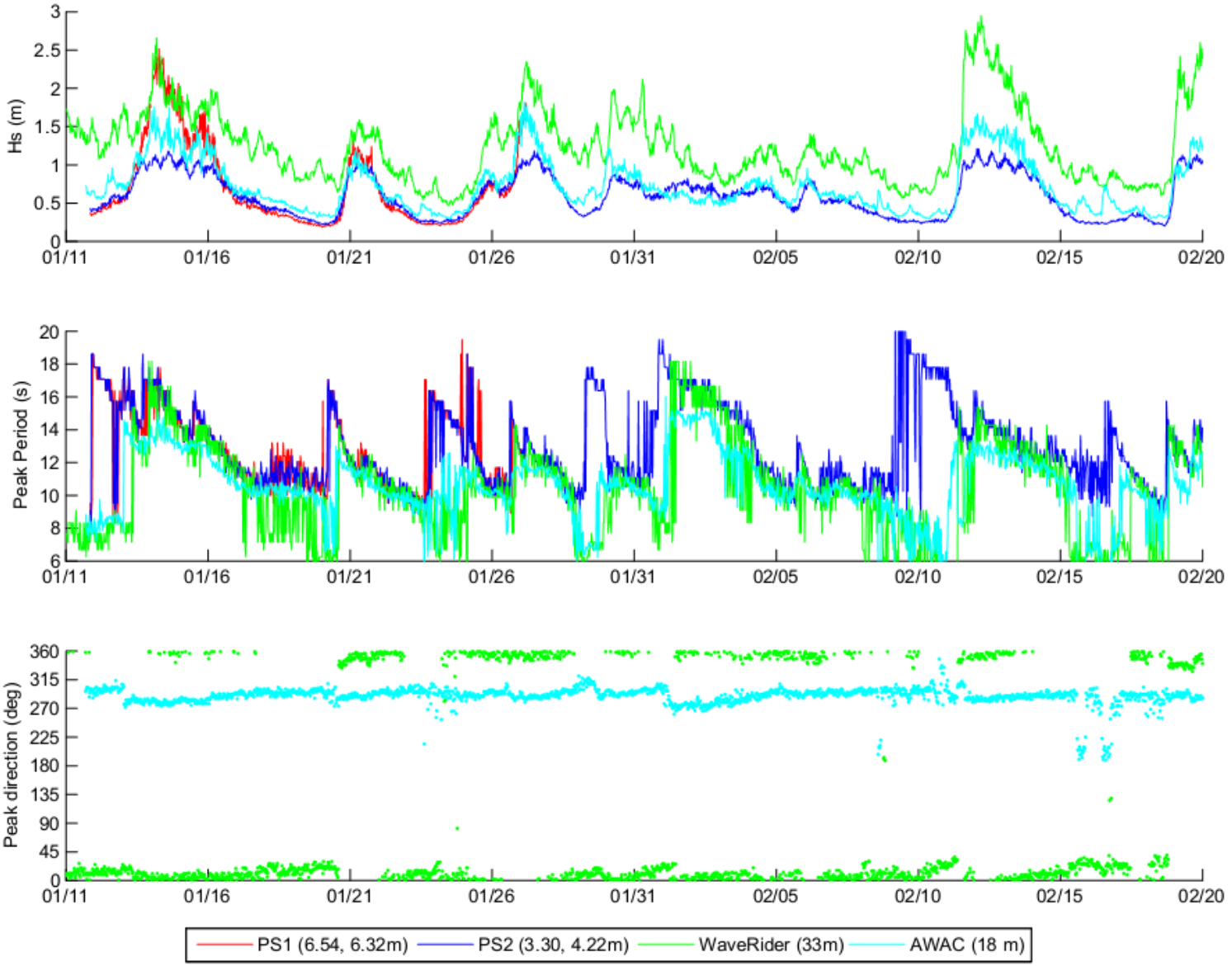
January 14, 2013

Instruments right under the waves!
ADCP on alongshore channel after waves break (to the left)

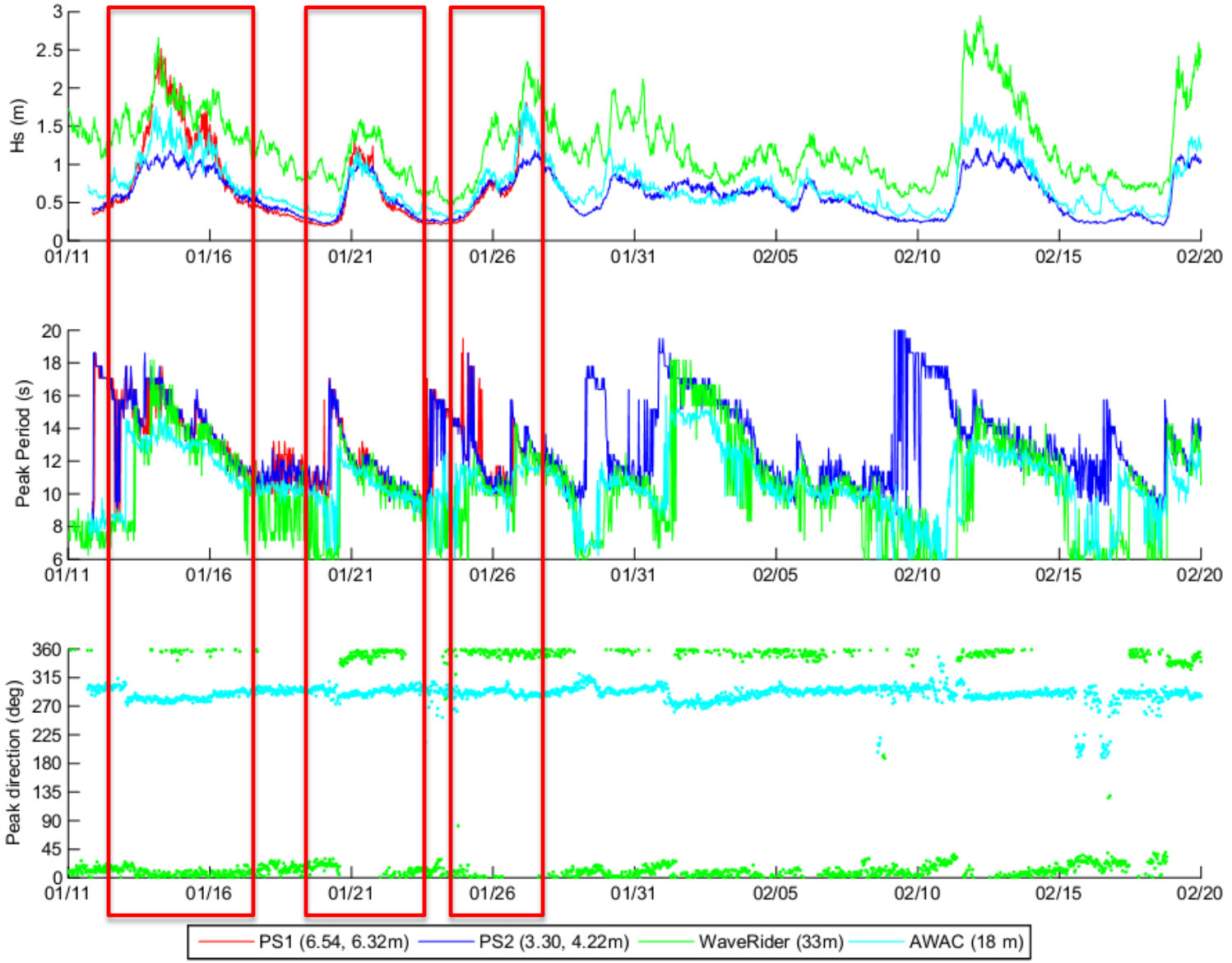
January 14, 02:00 – 02:30 Z



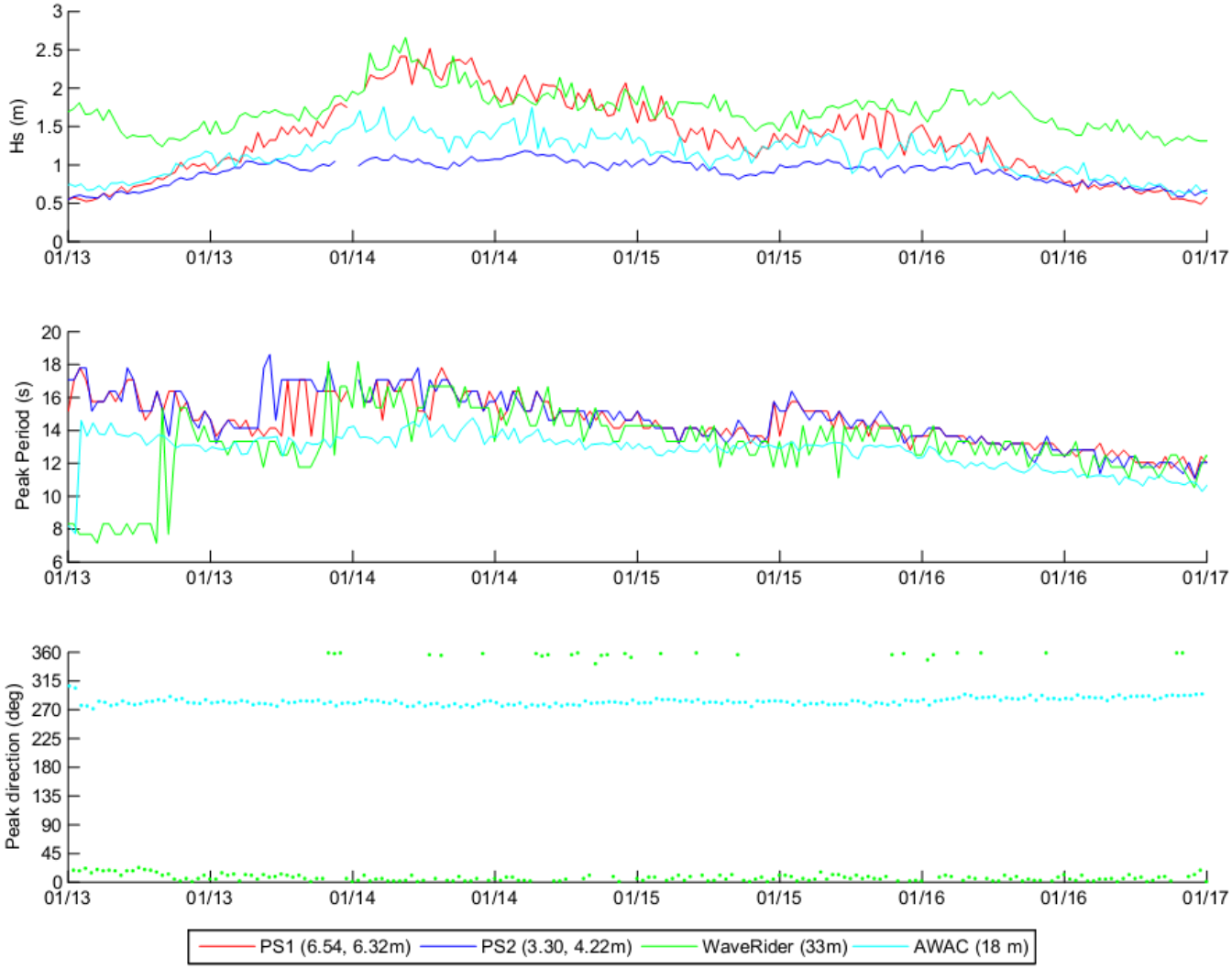
January 11 – Feb 20, 2013

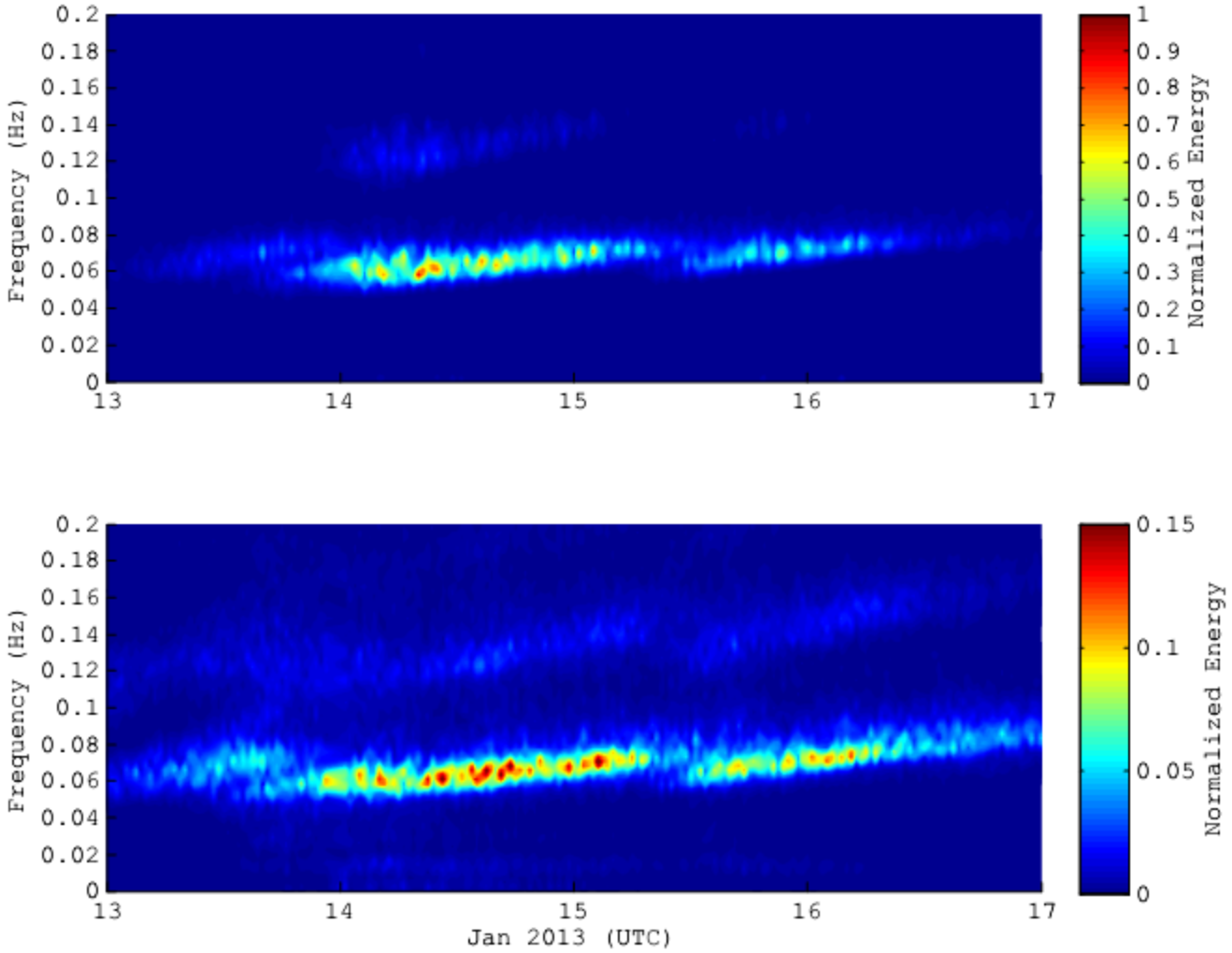


January 11 – Feb 20, 2013



January 13 – 17, 2013

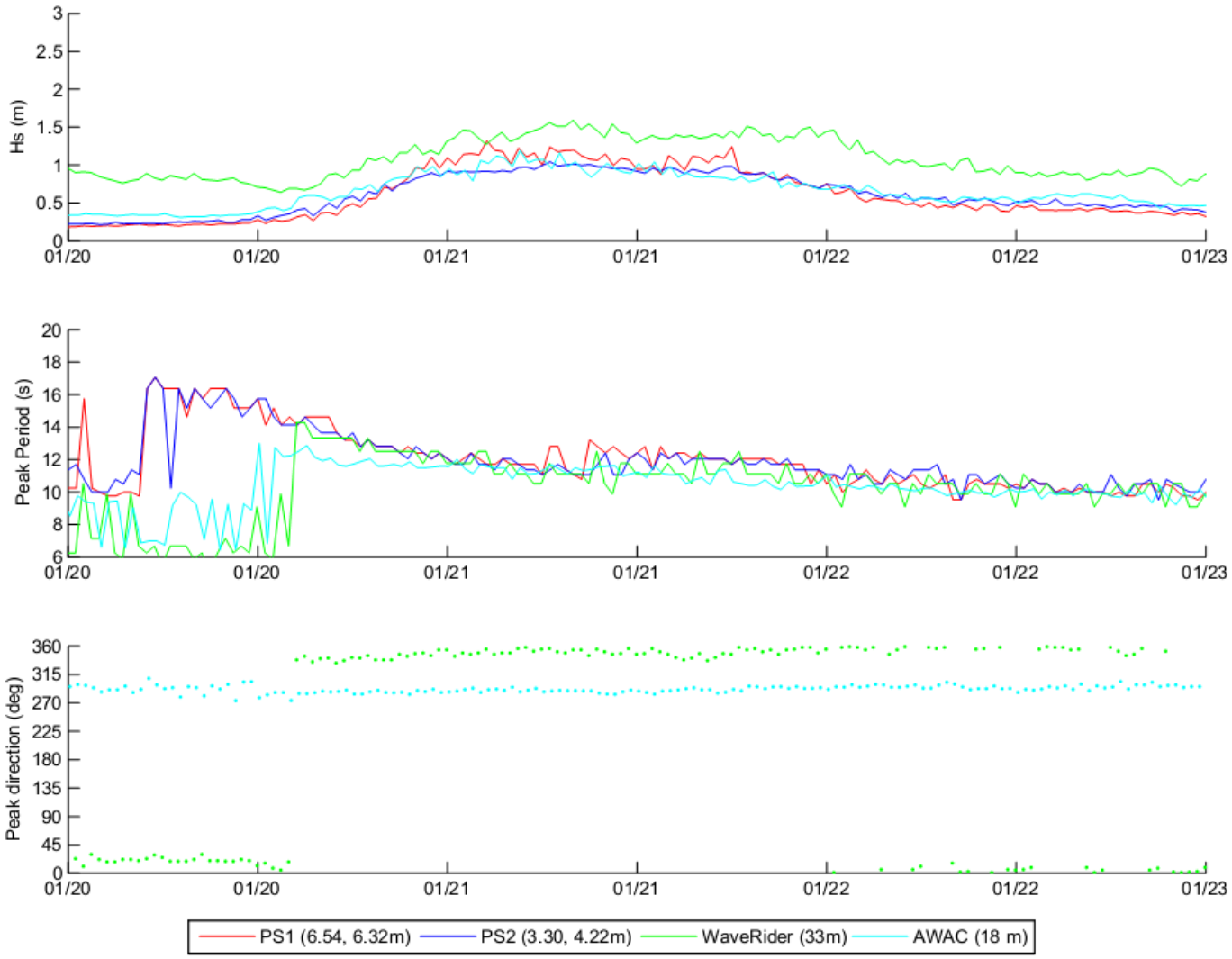


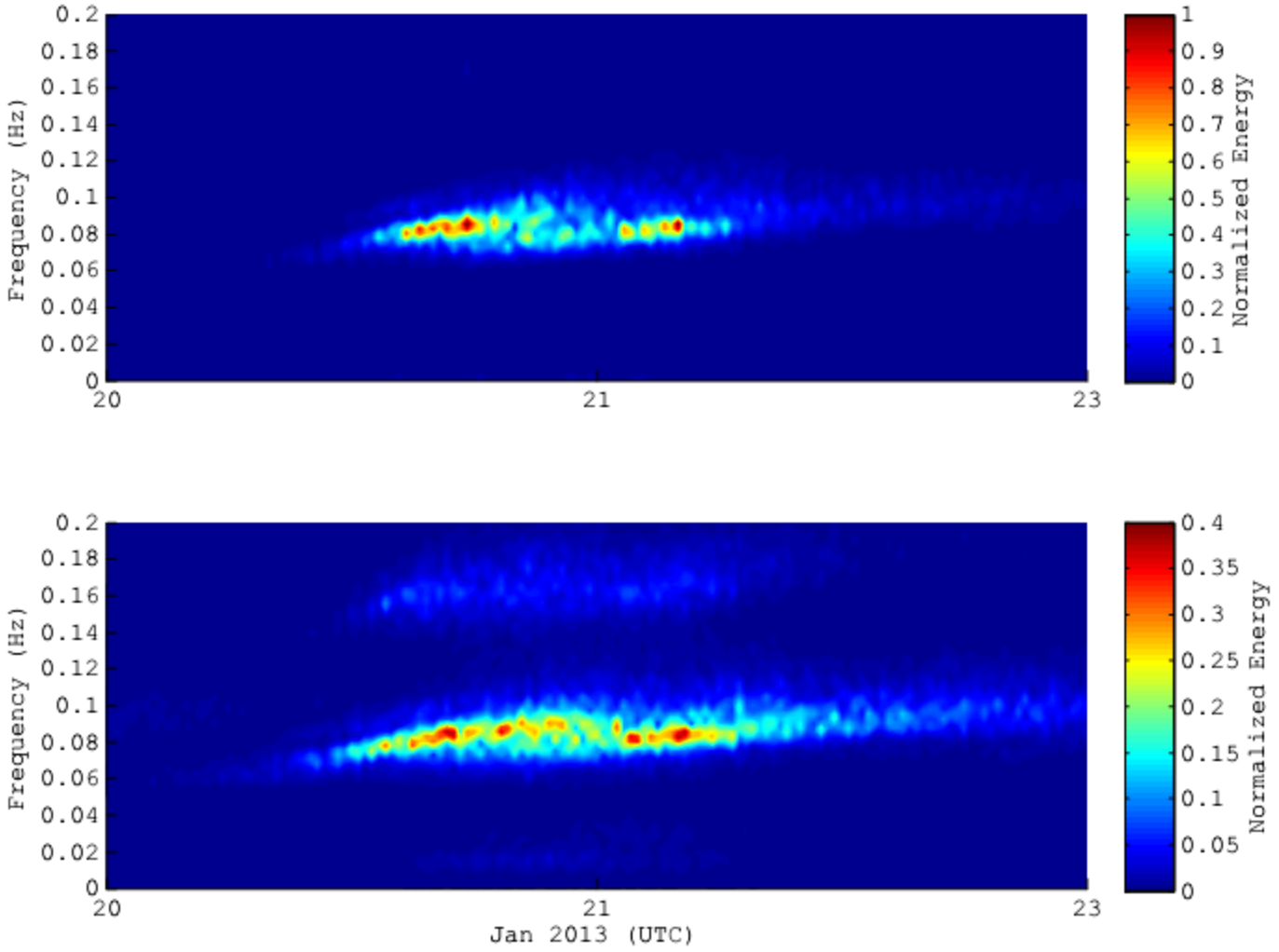


About 85% energy dissipation/redistribution over 200 m distance

Max Hs (Waverider) 2.5 m, Highest wave zero-crossing 3.2 m

January 20 – 23, 2013

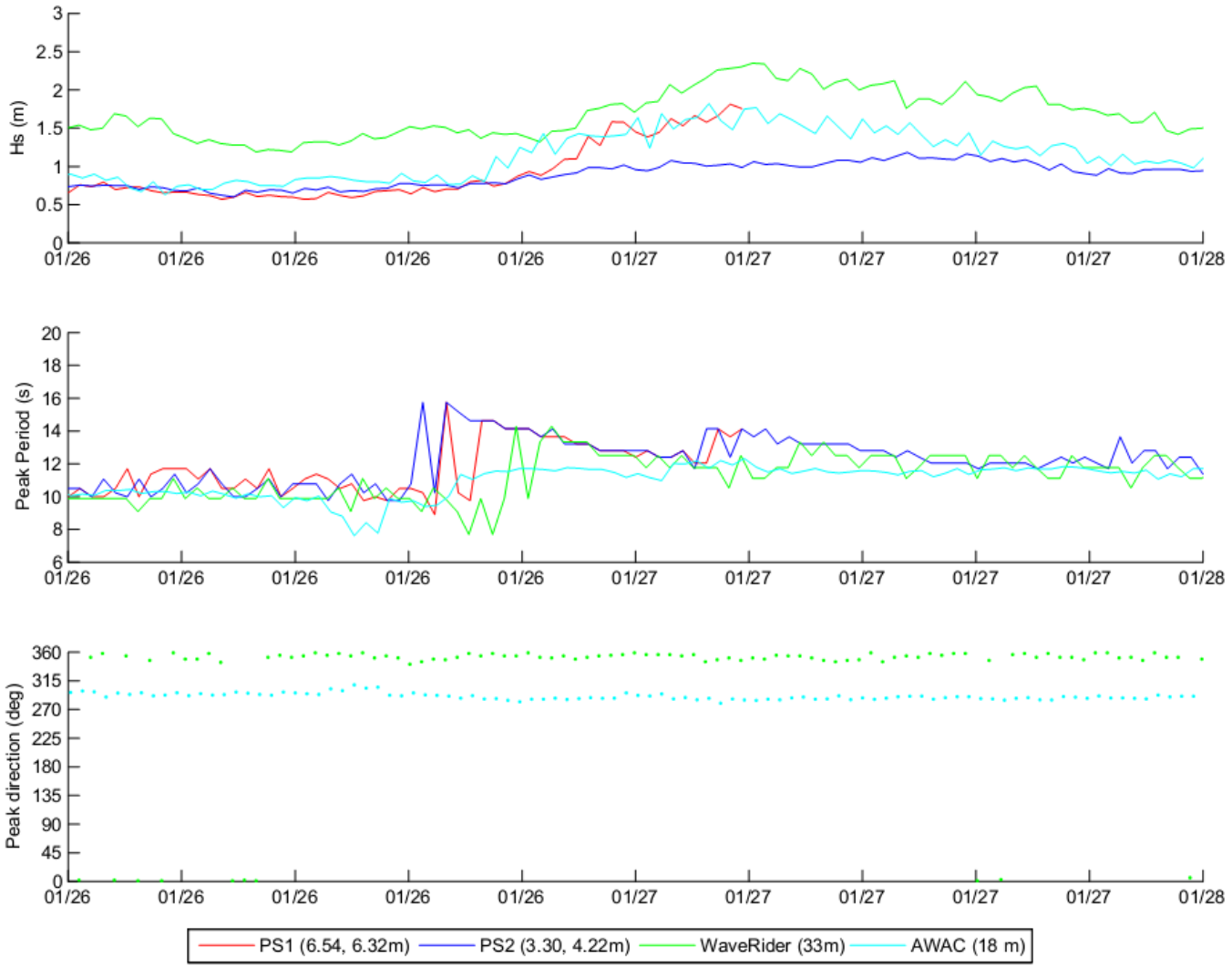


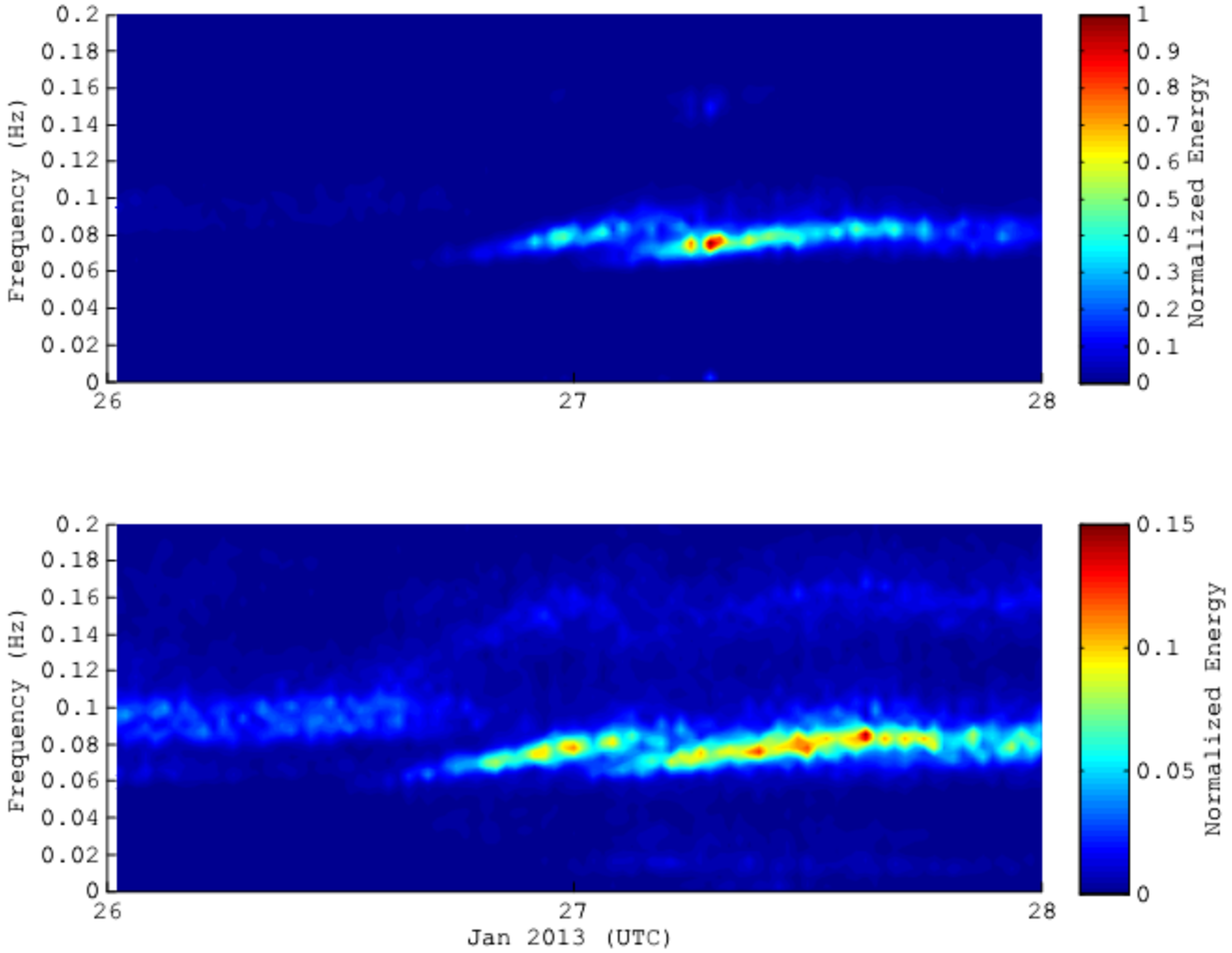


About 40% energy dissipation/redistribution over 200 m distance

Max Hs (Waverider) 1.5 m

January 26 – 28, 2013





About 85% energy dissipation/redistribution over 200 m distance

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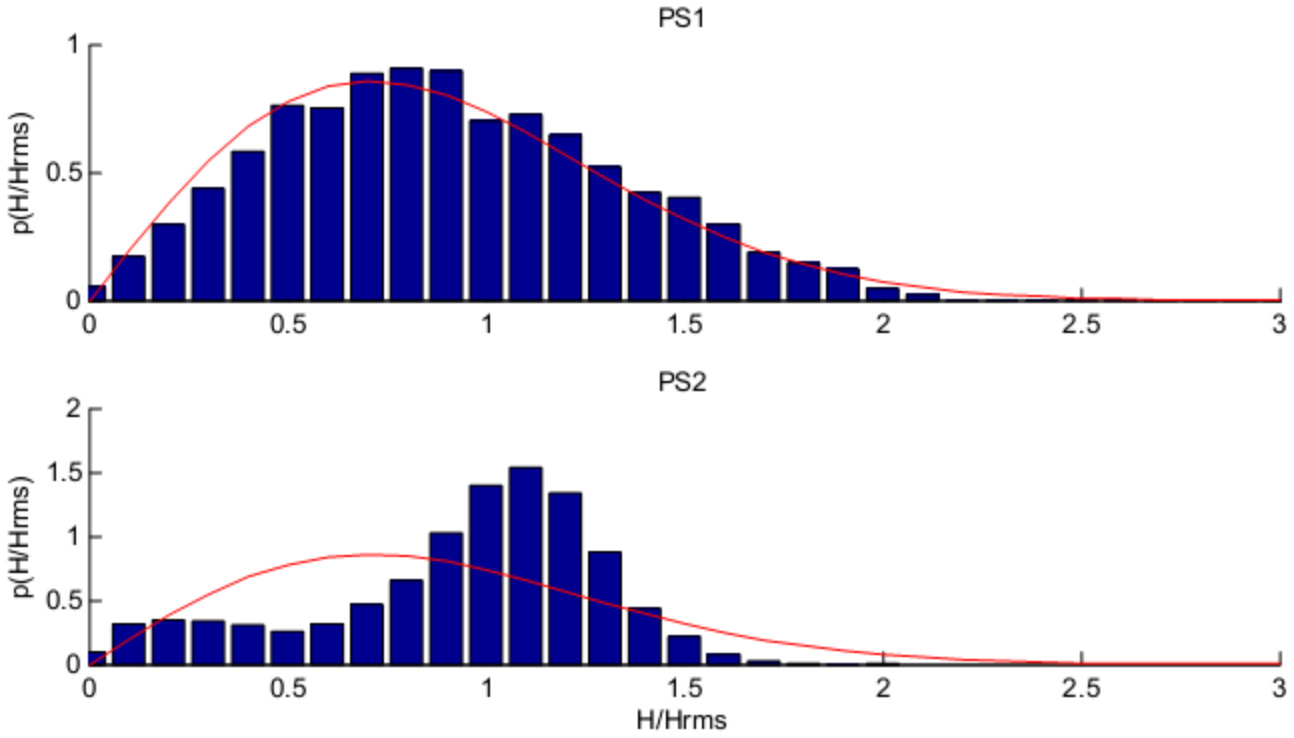
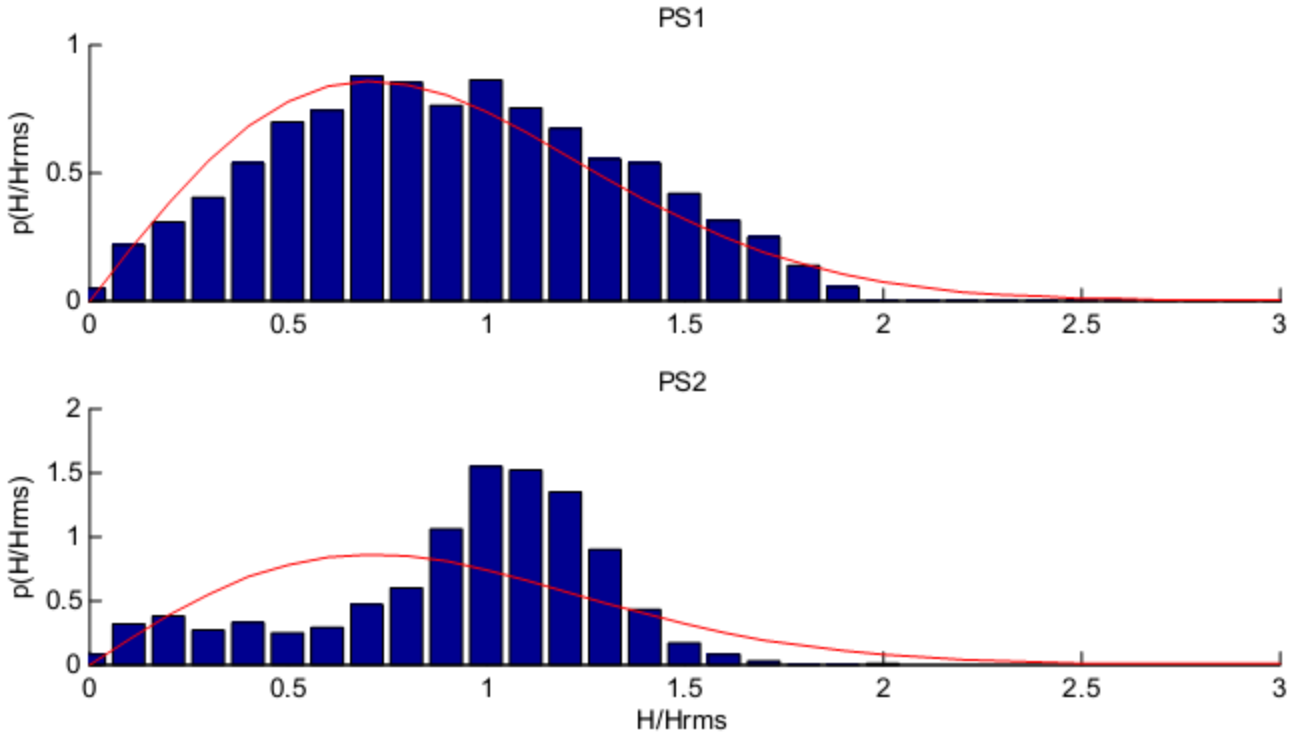
Probability density functions over 24 hour record



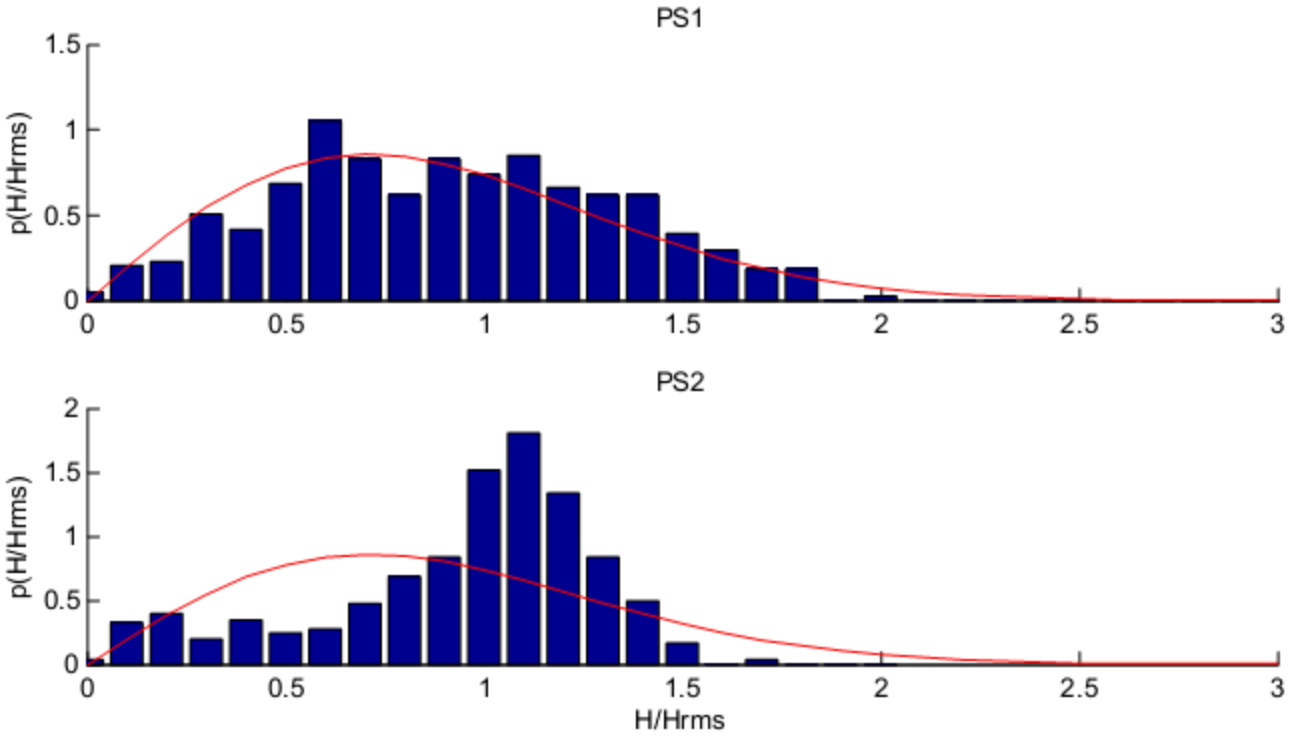
Red: Rayleigh PDF

Probability density functions over 12 hour record



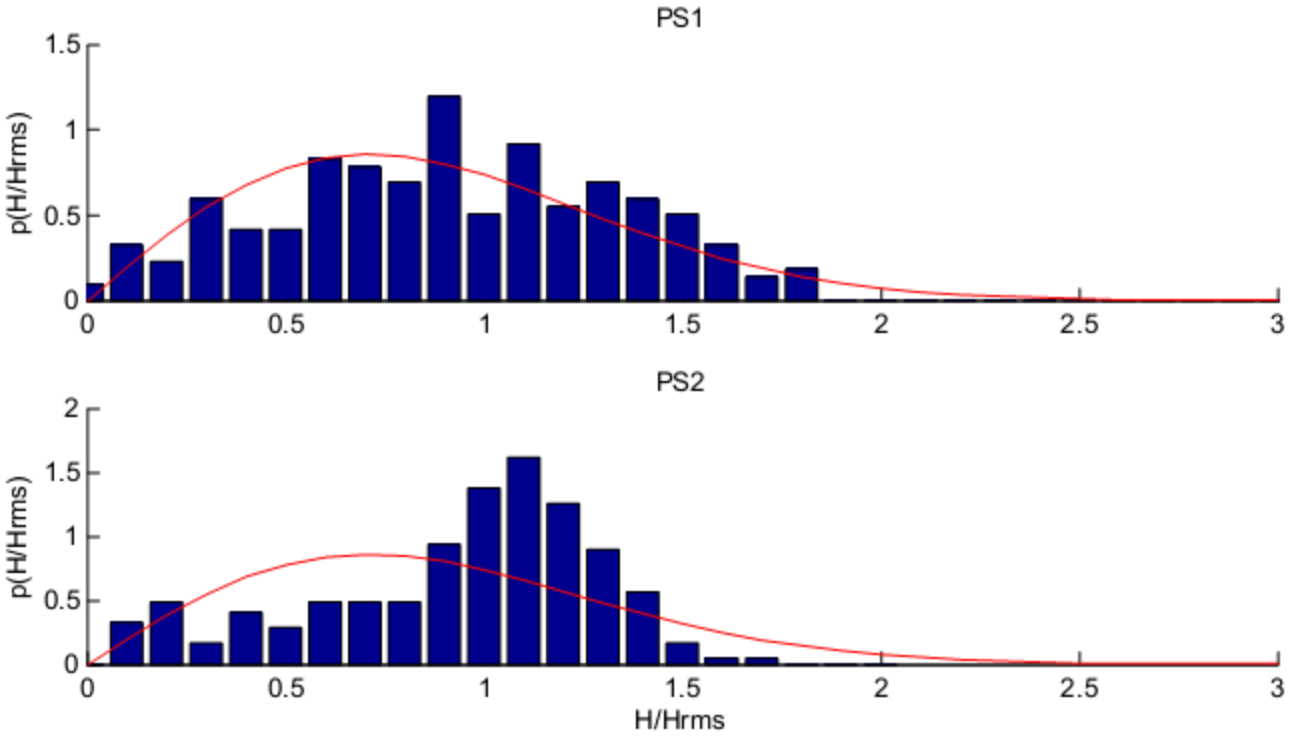
Red: Rayleigh PDF

Probability density functions over 3 hour record



Red: Rayleigh PDF

Probability density functions over 1 hour record



Red: Rayleigh PDF