

CDIP: Measuring and Modeling California's Waves

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Pacific Ocean Energy Trust

California Offshore Wind Industry Summit

Panel: Research and Development to Advance Offshore Wind

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Primary Sponsor:



US Army Corps of Engineers

Partners:

USGS science for a changing world

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

IOOS Integrated Ocean Observing System

NASA

NREL

Chevron

COLOMBIA RIVER BAR PILOTS ESTABLISHED 1845

JACOBSON PILOT SERVICE LONG BEACH PILOTS SINCE 1924

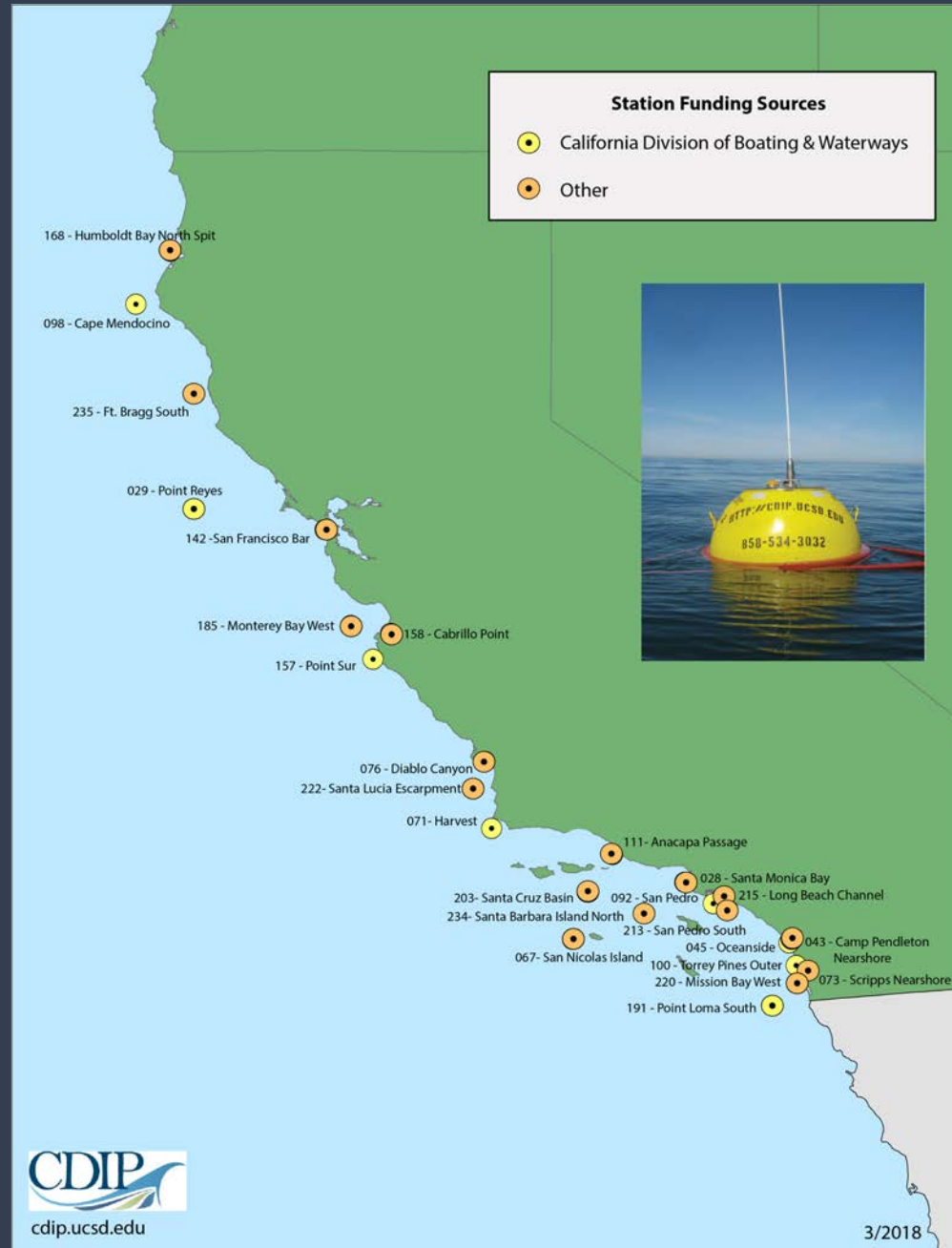
SPACEX

andavor

PG&E



CA state funding for
CDIP since 1975!



Waves and offshore renewable energy

- Resource
- Design criteria
 - Typical conditions
 - Maximum conditions
 - Platforms and moorings
 - Wave-driven currents
- Maintenance & Mitigation

CDIP generates long timeseries of wave data.

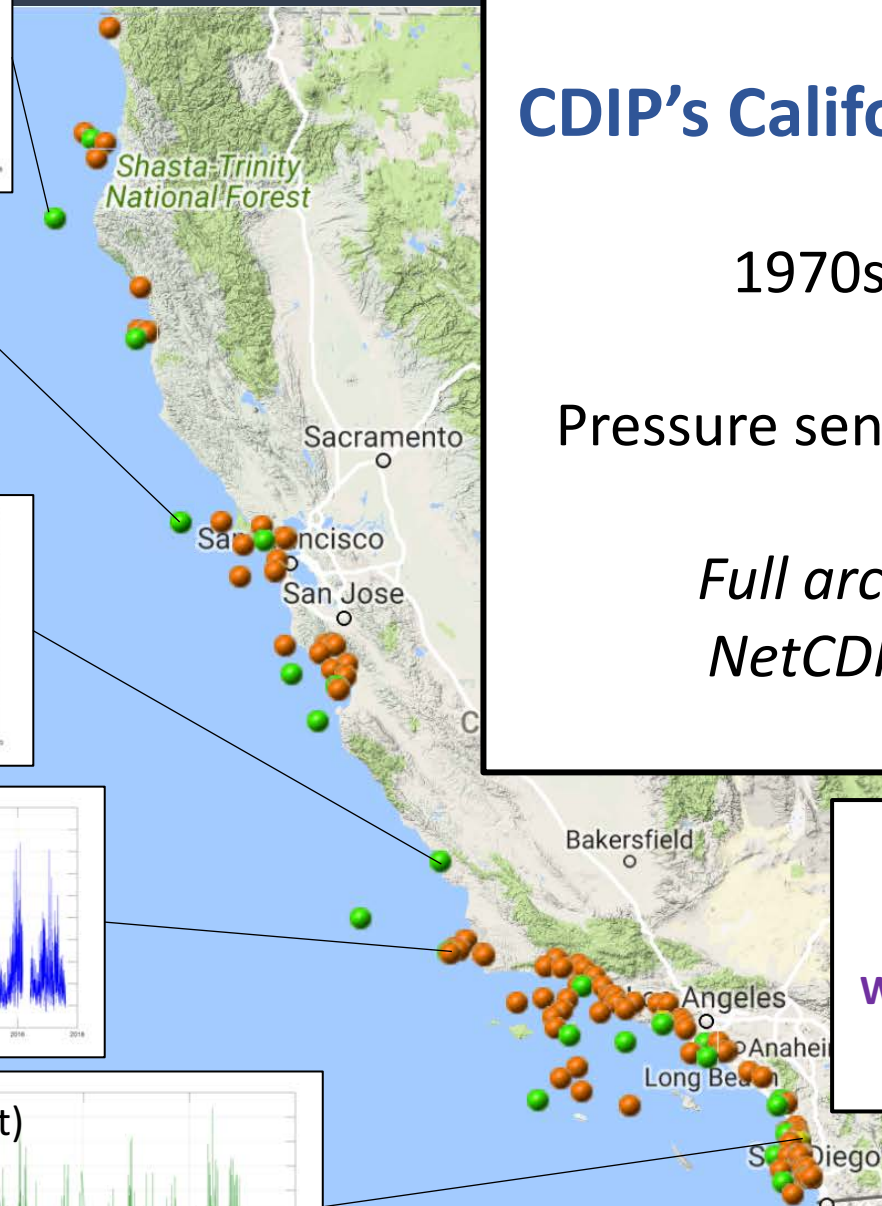
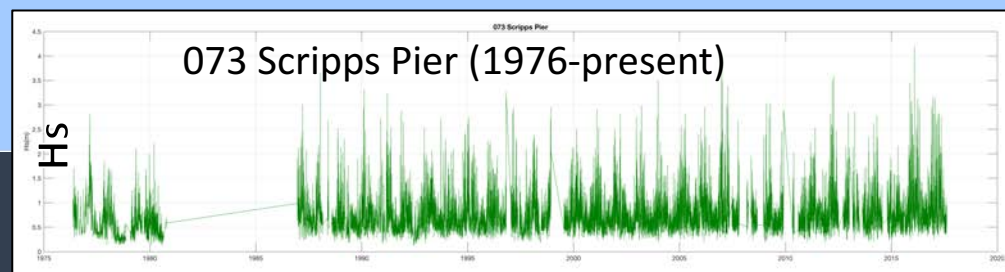
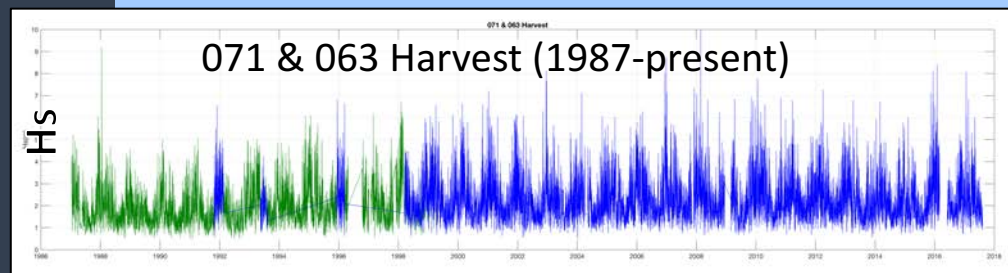
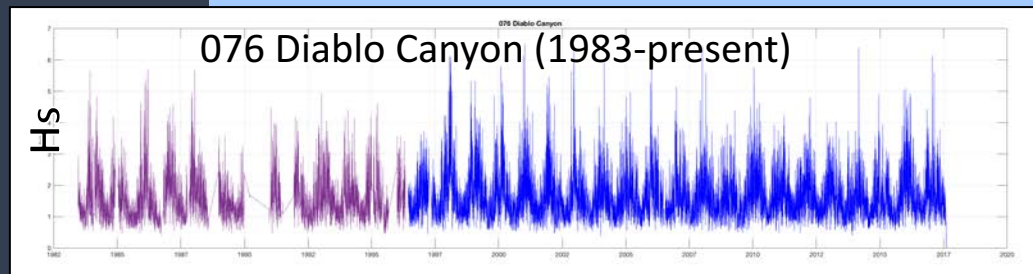
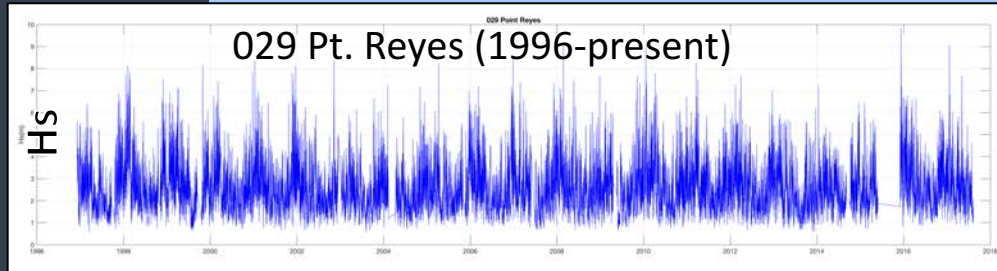
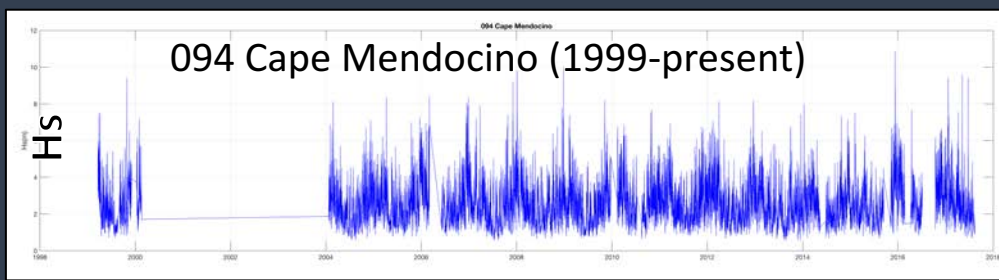
CDIP program manager Julie Thomas is on NREL steering committee for for wave and current energy hotspot identification and resource characterization.

CDIP participation in California offshore renewable energy research and assessment for many years, including the recent Wave Energy Test Center (CalWave) DOE-funded program.

Waverider buoys

- Wave Energy Spectrum
- Directional Spectrum
- XYZ (E,N,V) Displacements
- Sea Surface Temperature
- *Sea Surface Currents*
- *Air Temperature*





CDIP's California wave data

1970s – present

Pressure sensors, wave buoys

*Full archive online:
NetCDF, THREDDS*


Data Type

Wave Buoy (directional)


Wave Buoy (non-directional)

Pressure Sensor


cdip.ucsd.edu




The Coastal Data Information Program
Integrative Oceanography Division



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Welcome to CDIP

The Coastal Data Information Program (CDIP) measures, analyzes, archives, and disseminates coastal environment data for use by coastal engineers, planners, and managers, as well as scientists and mariners.


Site Divisions:

- Recent** - the latest coastal conditions, wave models, and forecasts
- Historic** - archived wind, wave and temperature data
- Documents** - wave measurement and CDIP operations explained
- SCBPS** - the Southern California Beach Processes Study



CDIP contributes to the Ocean Observing Systems.  IOOS

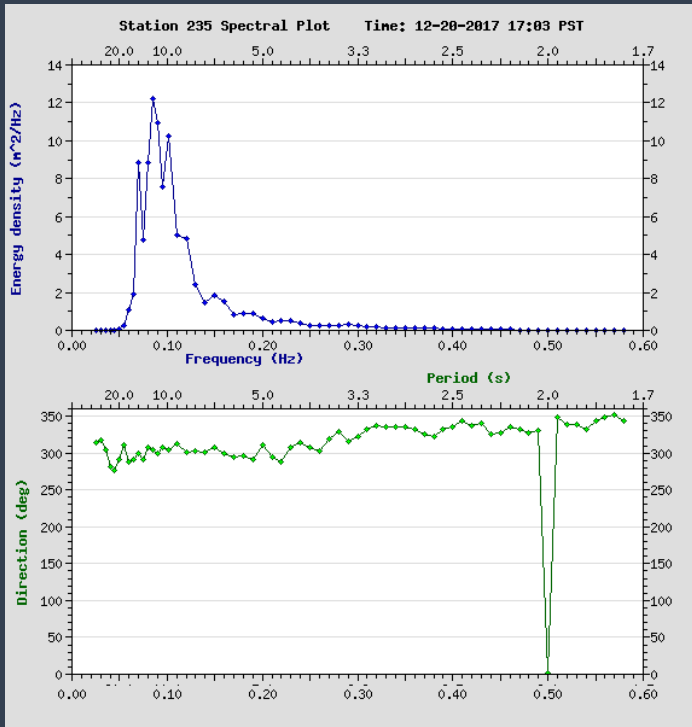


Official Web Page of the University of California, San Diego

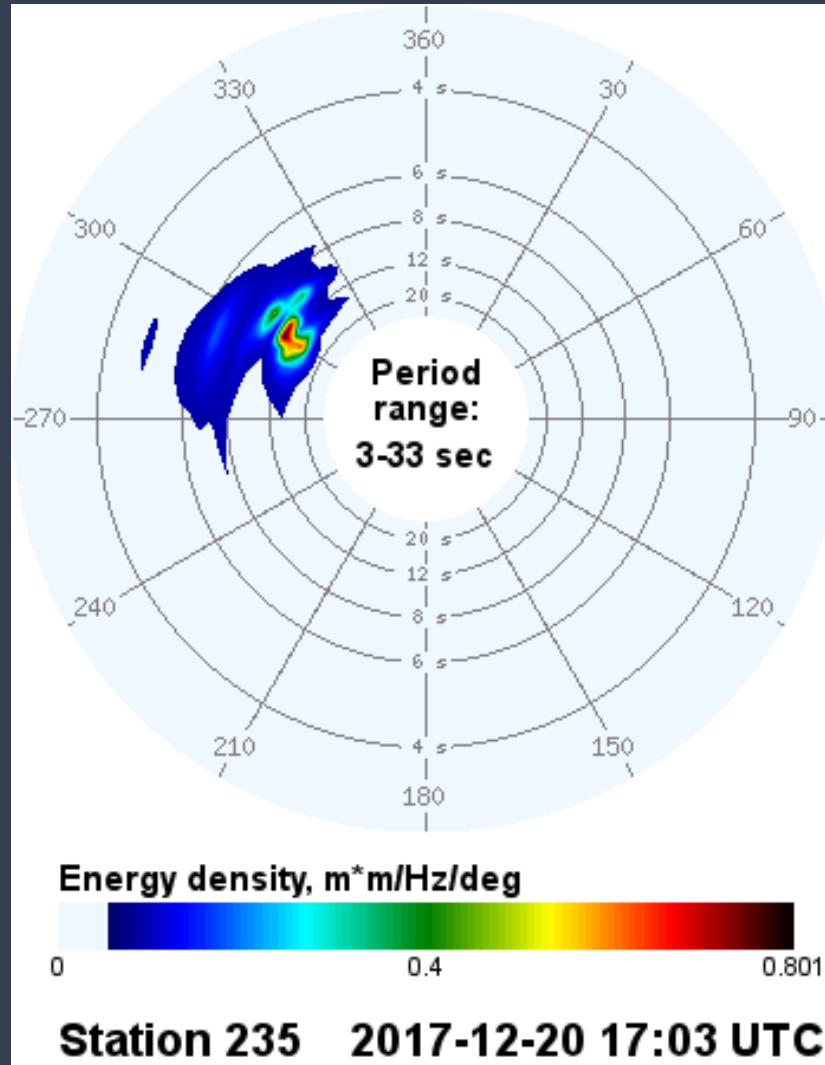


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WRN
WEATHER-READY NATION

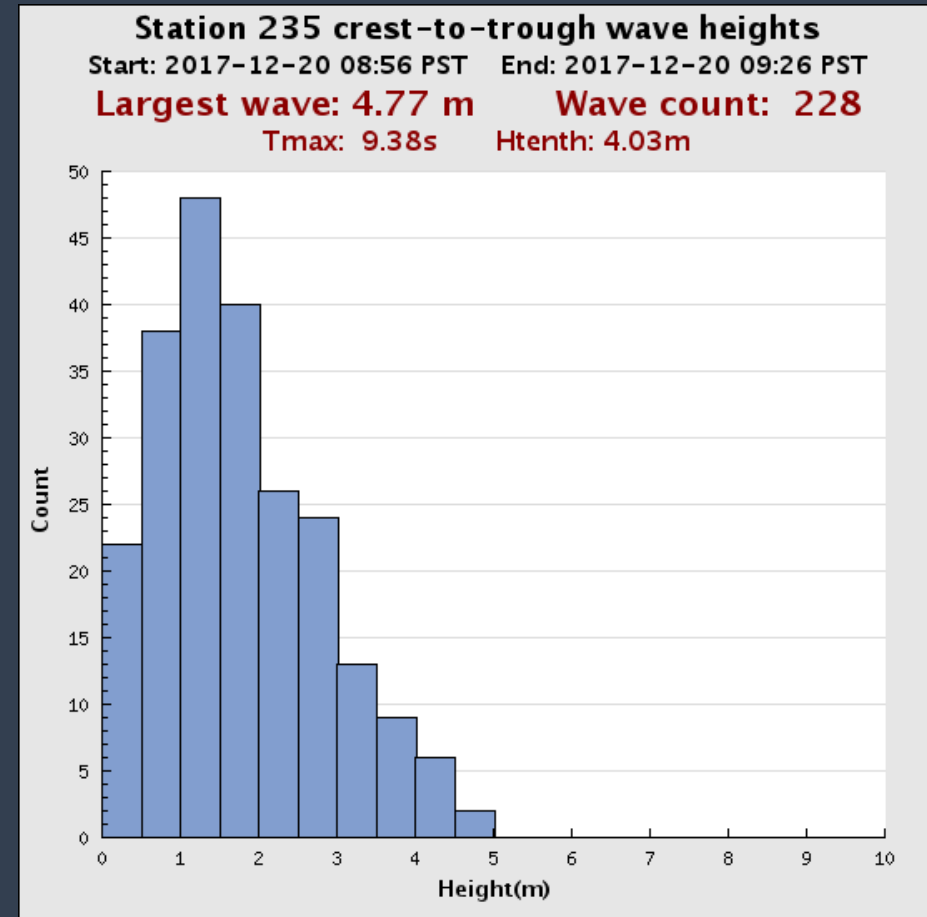




Energy Spectra
(1 - 30 sec)



Directional Spectra



Individual Waves



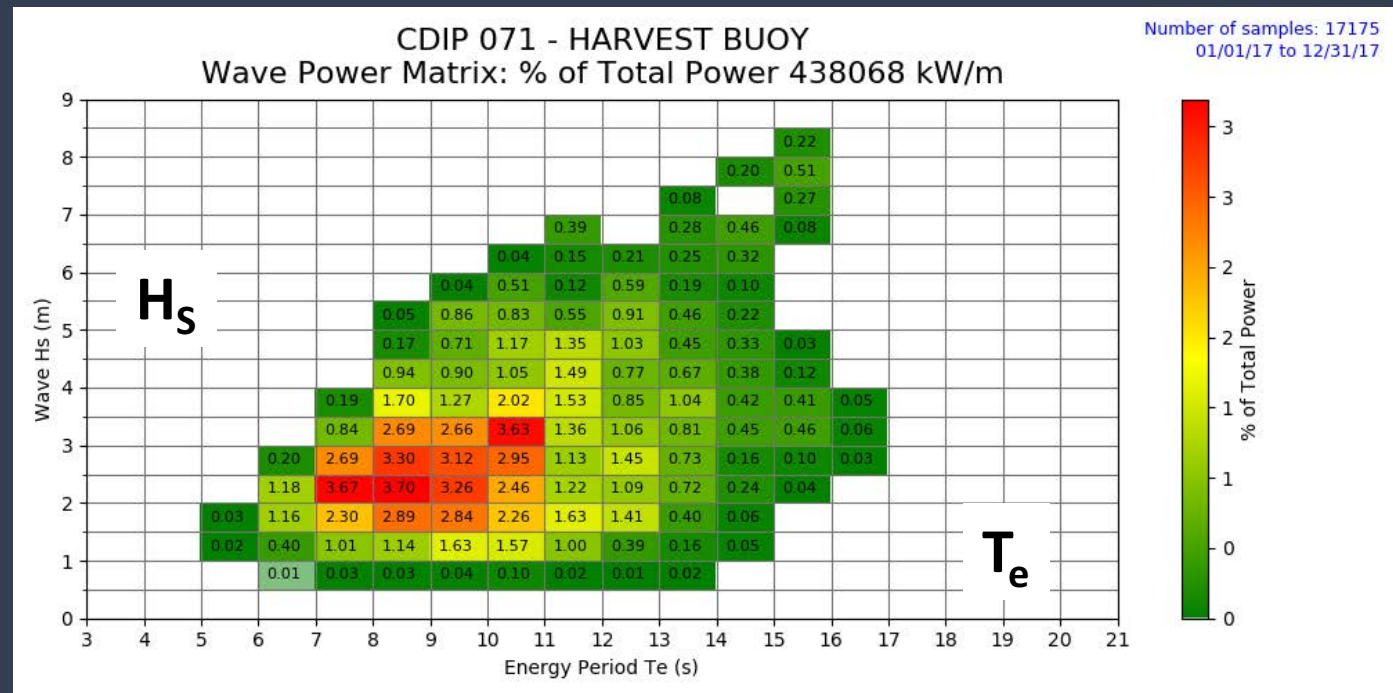
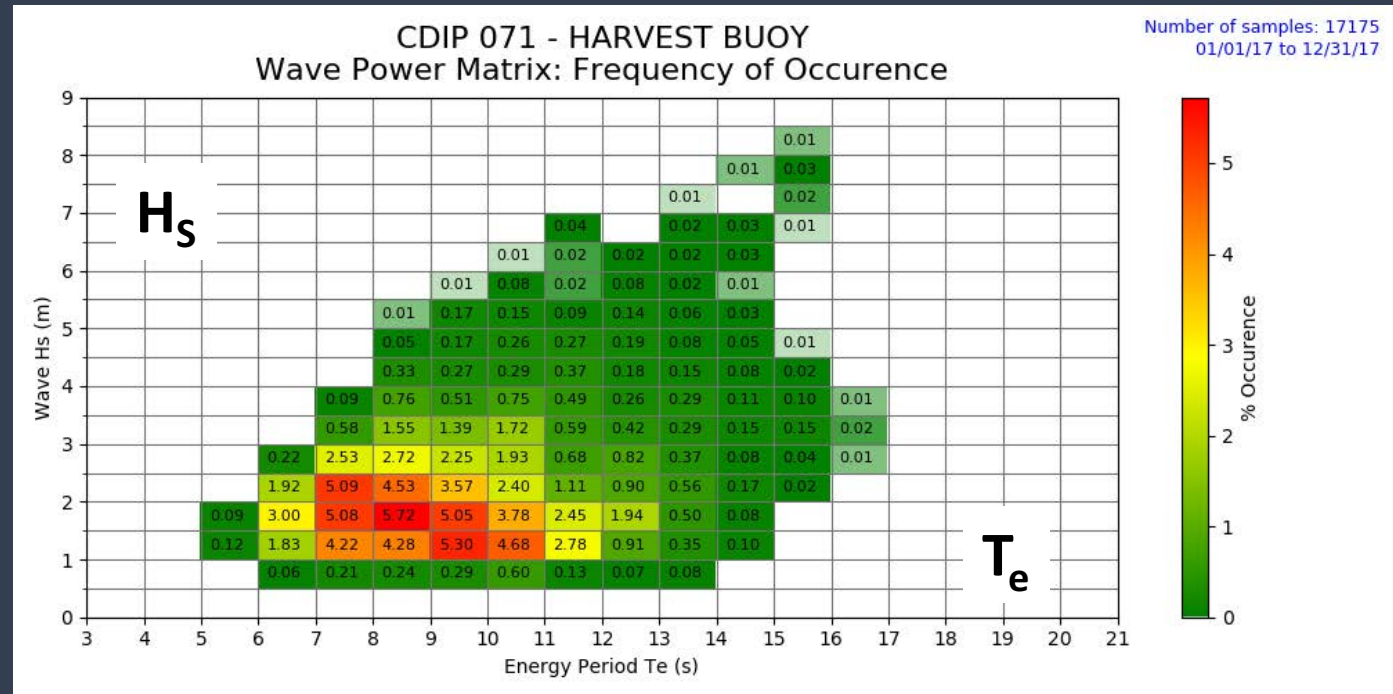
"Wave Power Density"

$$P \text{ (W/m)} \propto T_e \cdot (H_s)^2$$

T_e : "Energy Period", $T_e < T_p$

H_s : "Significant Wave Height"
(avg of largest 1/3 of waves)

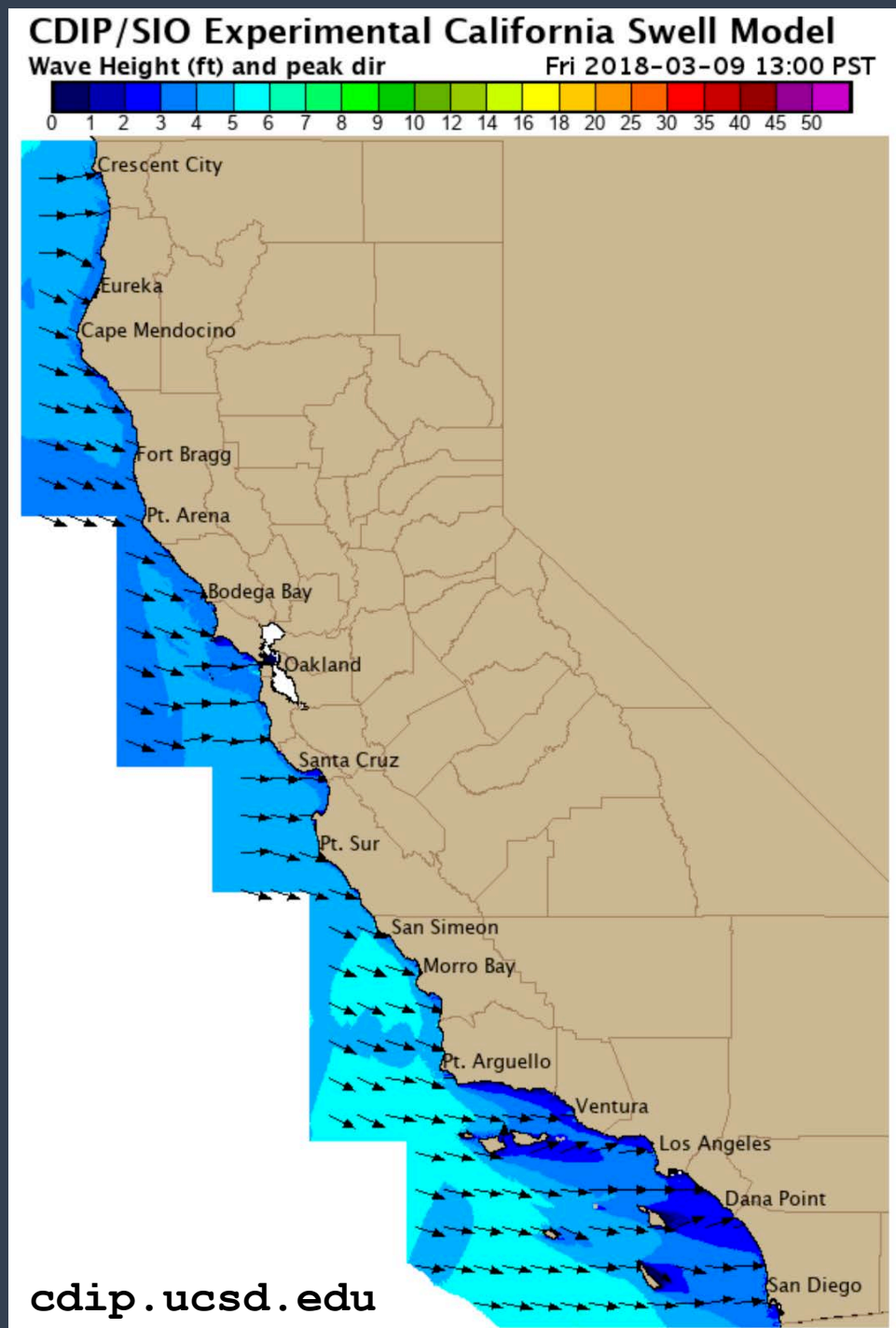
CDIP 071 HARVEST (Pt. Conception)
(after Hagerman / CalWave)



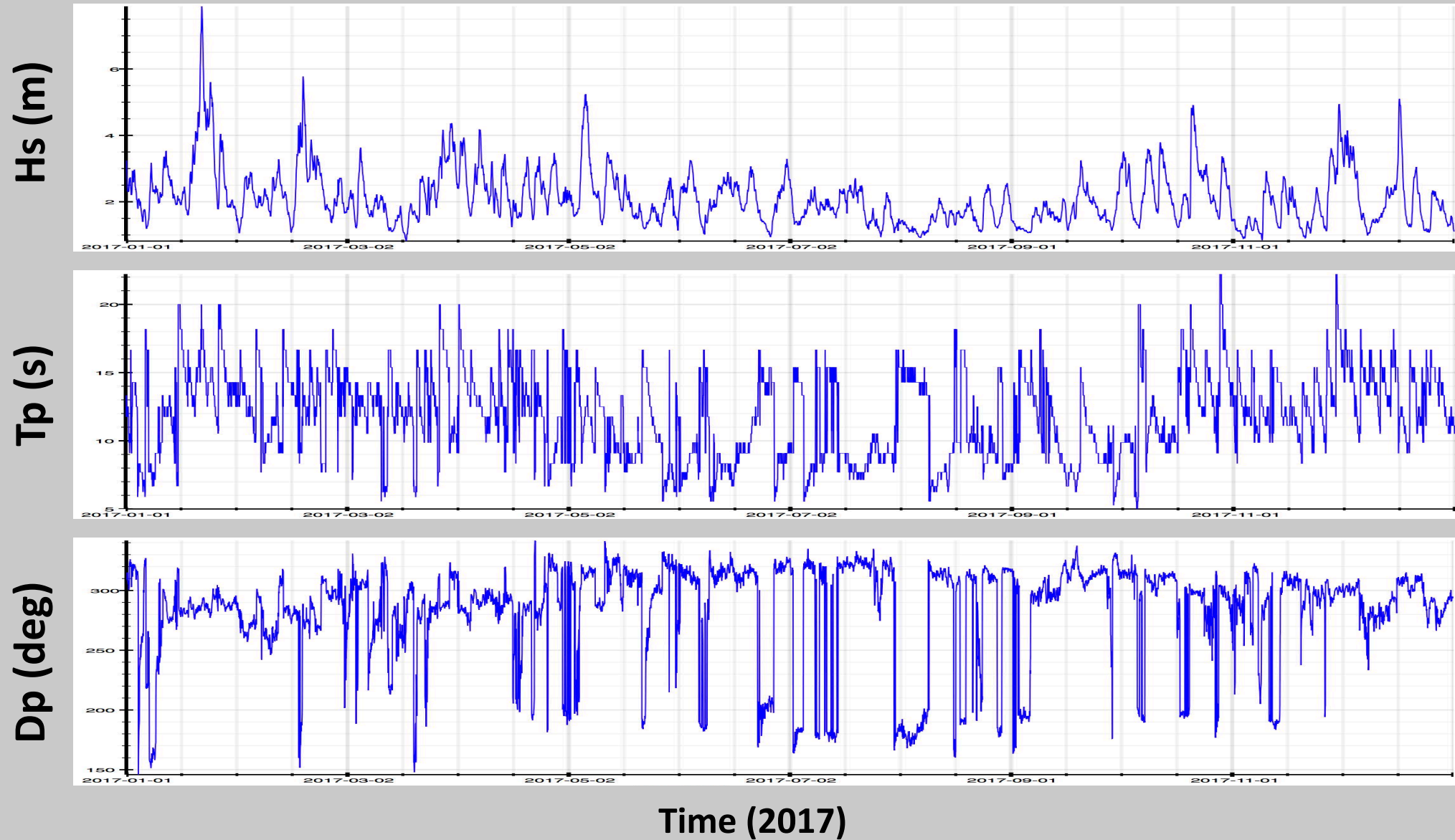
CDIP California Wave Model

“Nowcast” and hindcast
(back to 2000) model driven
by **buoy data** + bathymetry +
physics

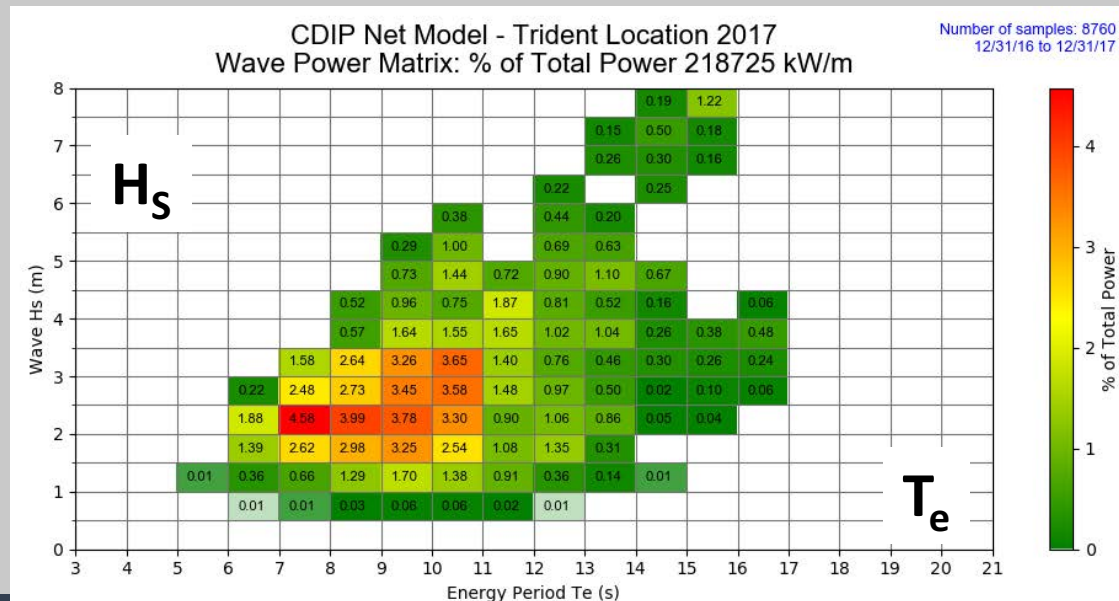
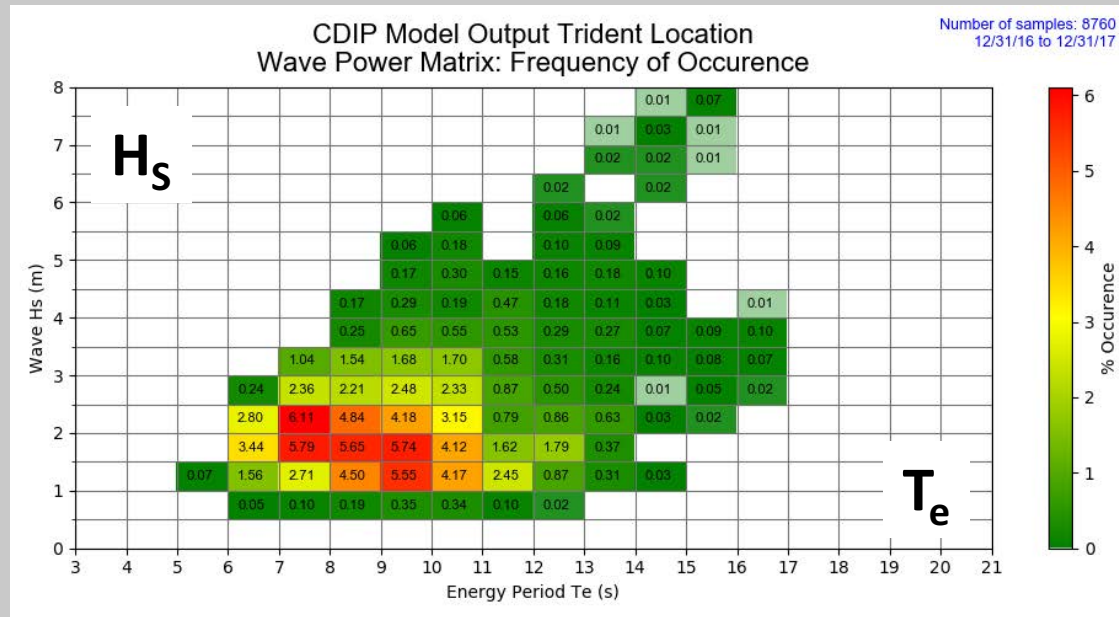
Output points every 100 -
200 m along the coast



CDIP buoy-driven wave model: Wave conditions at Trident Winds location



CDIP buoy-driven wave model: Wave conditions at Trident Winds location



`www.cdip.ucsd.edu`

Facebook.com/CDIPbuoys

THE COASTAL DATA INFORMATION PROGRAM

The Coastal Data Information Program (CDIP) specializes in wave measurements and wave models. CDIP's network of buoys provides real-time wave data, which serves both commercial users (harbor masters, lifeguards, mariners) and recreational users (boaters, surfers and beach-goers.)

WHAT BUOYS CAN TELL US

CDIP's buoys look simple but, are actually complex instruments capable of providing a wide range of important information such as:



SEA SURFACE TEMPERATURE



WAVE PERIODS



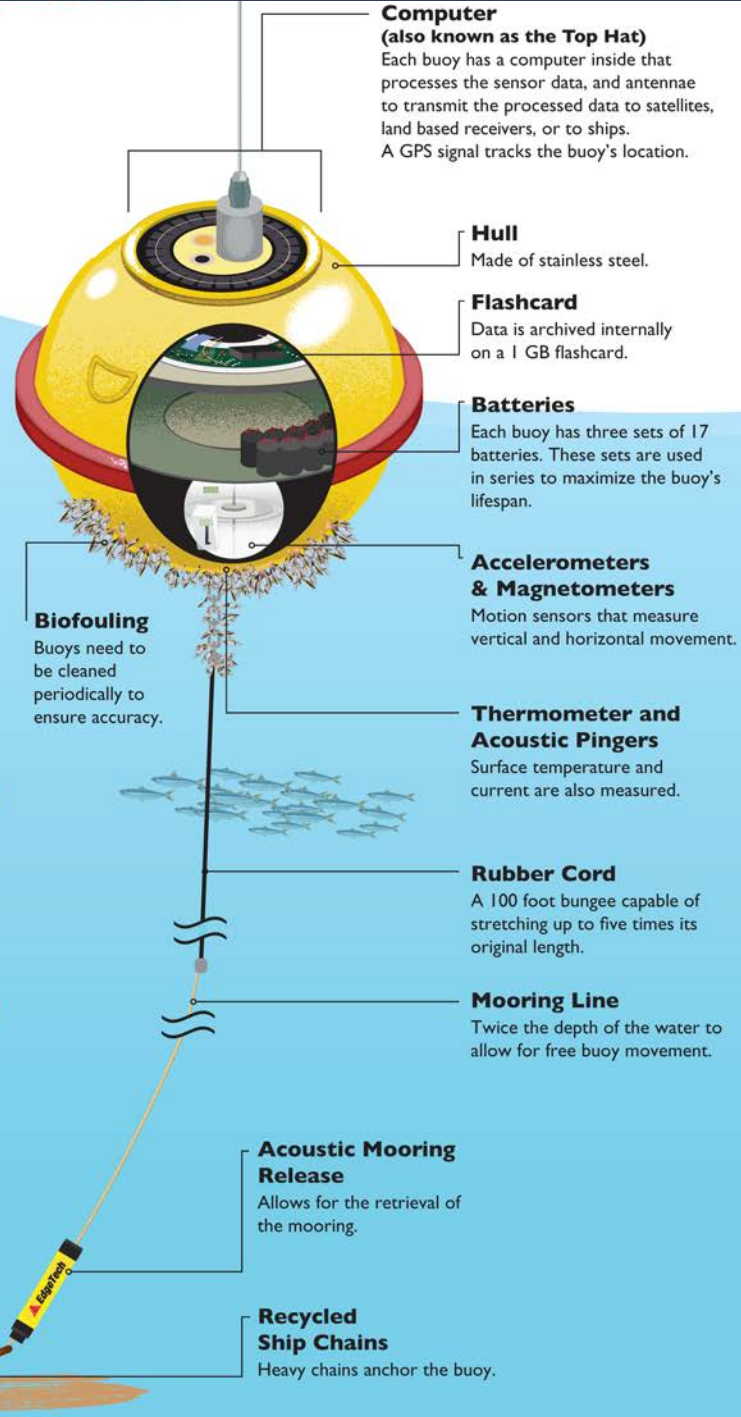
WAVE HEIGHT



WAVE DIRECTION



SURFACE CURRENTS



Computer (also known as the Top Hat)

Each buoy has a computer inside that processes the sensor data, and antennae to transmit the processed data to satellites, land based receivers, or to ships. A GPS signal tracks the buoy's location.

Hull

Made of stainless steel.

Flashcard

Data is archived internally on a 1 GB flashcard.

Batteries

Each buoy has three sets of 17 batteries. These sets are used in series to maximize the buoy's lifespan.

Accelerometers & Magnetometers

Motion sensors that measure vertical and horizontal movement.

Thermometer and Acoustic Pingers

Surface temperature and current are also measured.

Rubber Cord

A 100 foot bungee capable of stretching up to five times its original length.

Mooring Line

Twice the depth of the water to allow for free buoy movement.

Acoustic Mooring Release

Allows for the retrieval of the mooring.

Recycled Ship Chains

Heavy chains anchor the buoy.

