

Coastal Data Information Program: Wave Observations and Nowcast



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PI & Program Manager

5 March 2024

NOAA HSRP Public Meeting



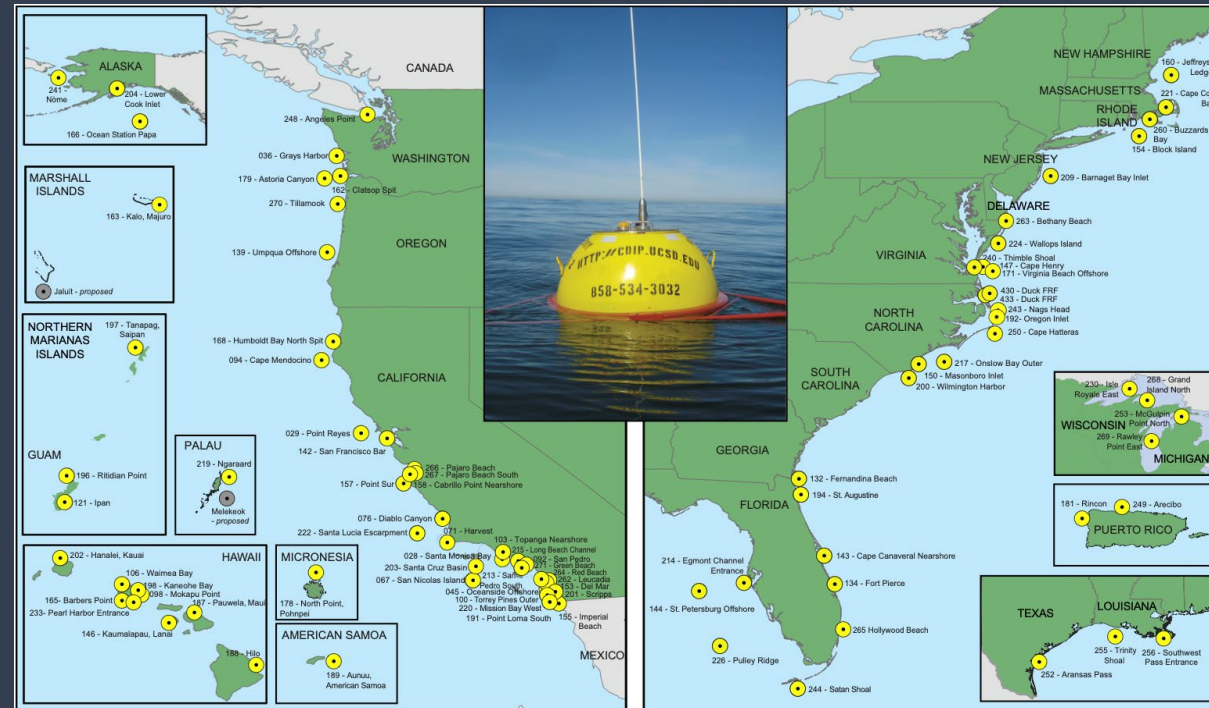


US Army Corps of Engineers



COASTAL DATA INFORMATION PROGRAM

- Established 1975
- ~ 90 wave buoy stations worldwide, ~25 in California
- 15-person CDIP Waves operations team
- Major Funding from:
 - US Army Corps of Engineers
 - California State Parks
 - Navy
- Partners:
 - *NOAA IOOS Regional Associations*
 - *Ports and Industry: Marine Exchange, Marathon, Chevron, Columbia River Bar Pilots*
 - DOE National Renewable Energy Laboratory



Coastal Data Information Program

- Precision wave monitoring nationwide
- California wave model
- *Coastal Engineering, Inundation, Erosion*
- *Real Time Conditions*
- *Maritime Safety*
- *National Security*
- *Climate Record*

Ports, Harbors
and Waterways



Recreational
Safety



Beach nourishment



Infrastructure Impacts



San Diego beaches being battered by big waves and king tides

Posted: Jan 18, 2019 8:33 AM PST
Updated: Jan 19, 2019 5:06 PM PST

By CBS News 8 Team [Connect](#)

Severe coastal erosion, Ocean Beach at Sloat, San Francisco, California. Photo source: © Shields



Nuclear Deterrent



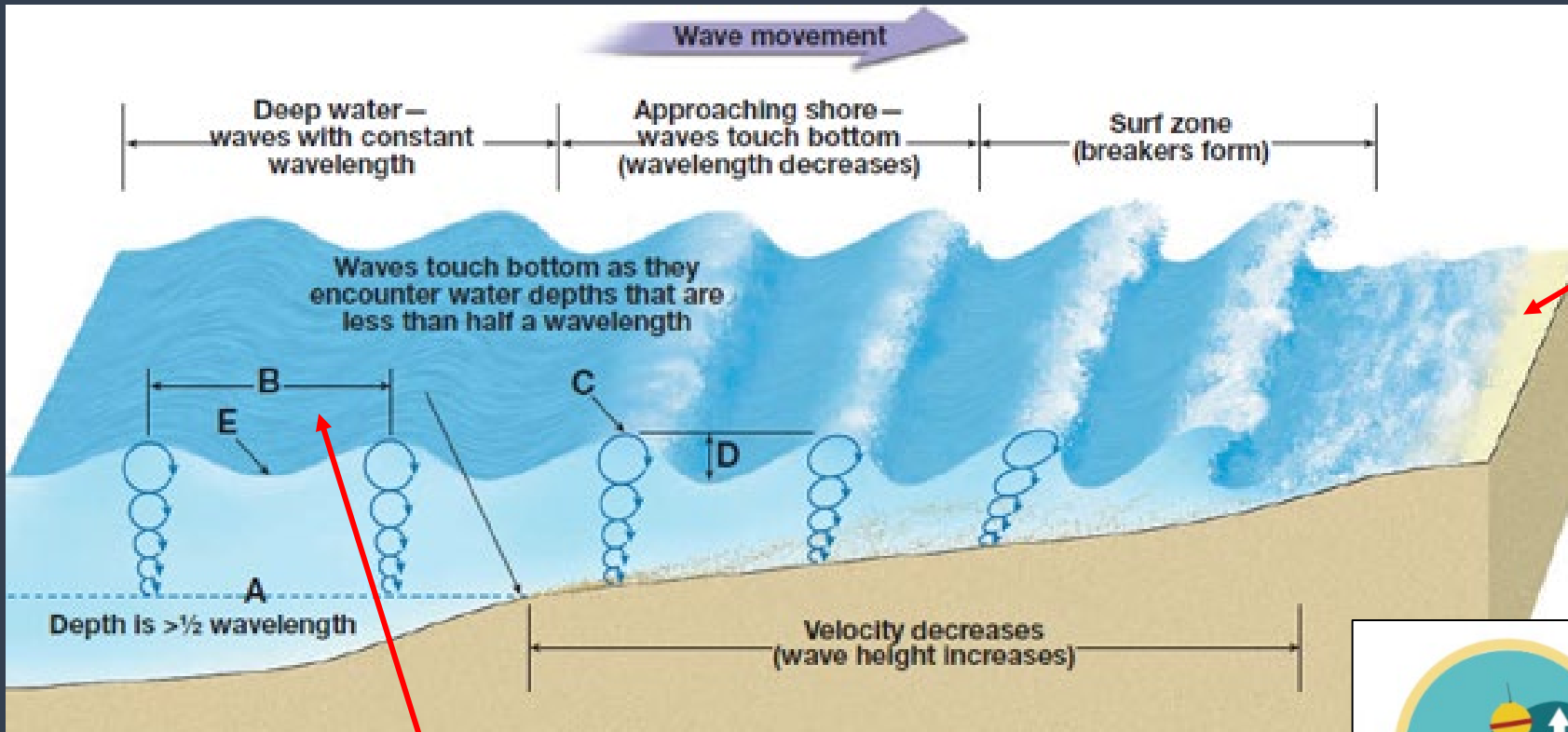
Dredging

Waverider buoys

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

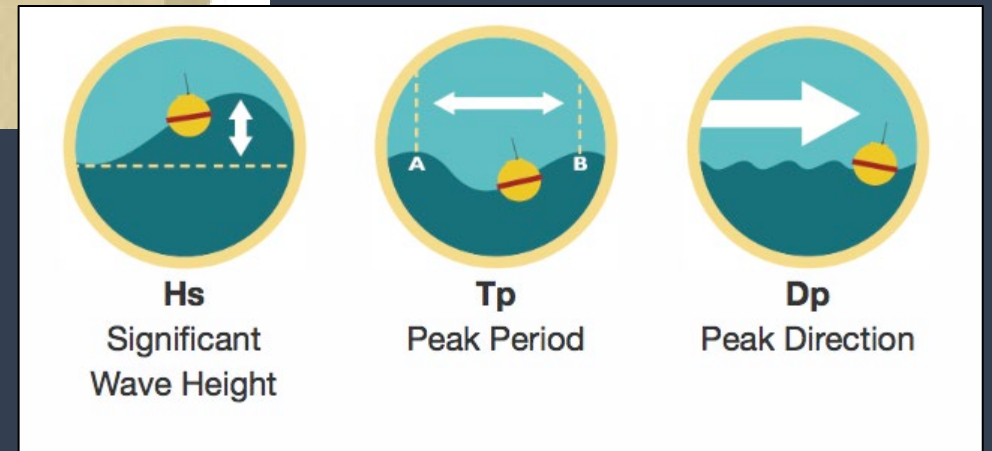


Wave motion

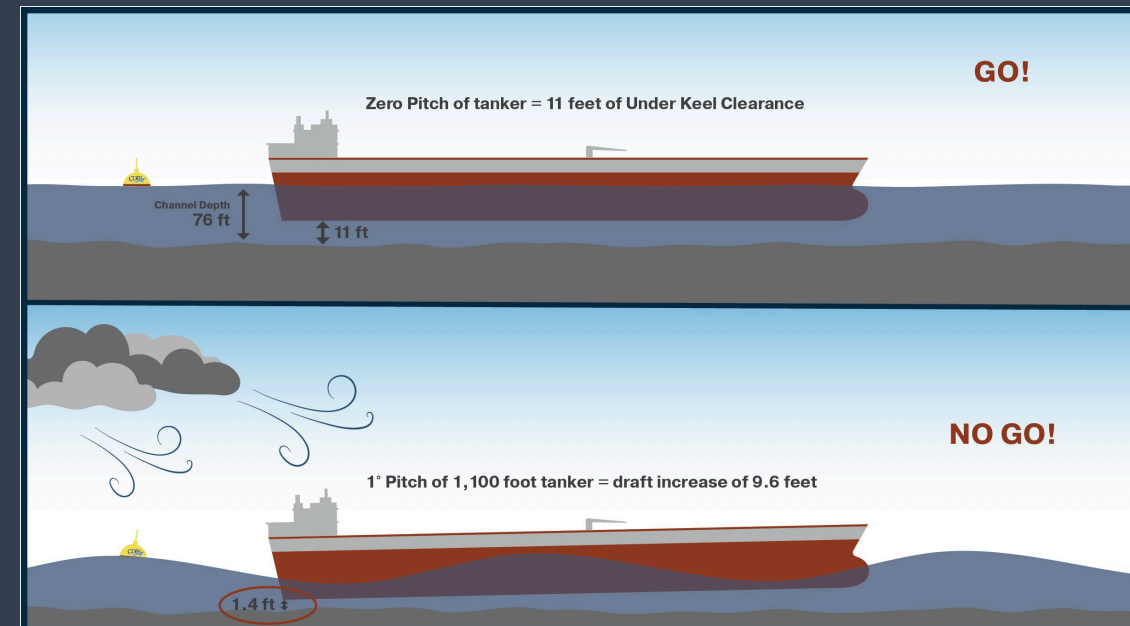
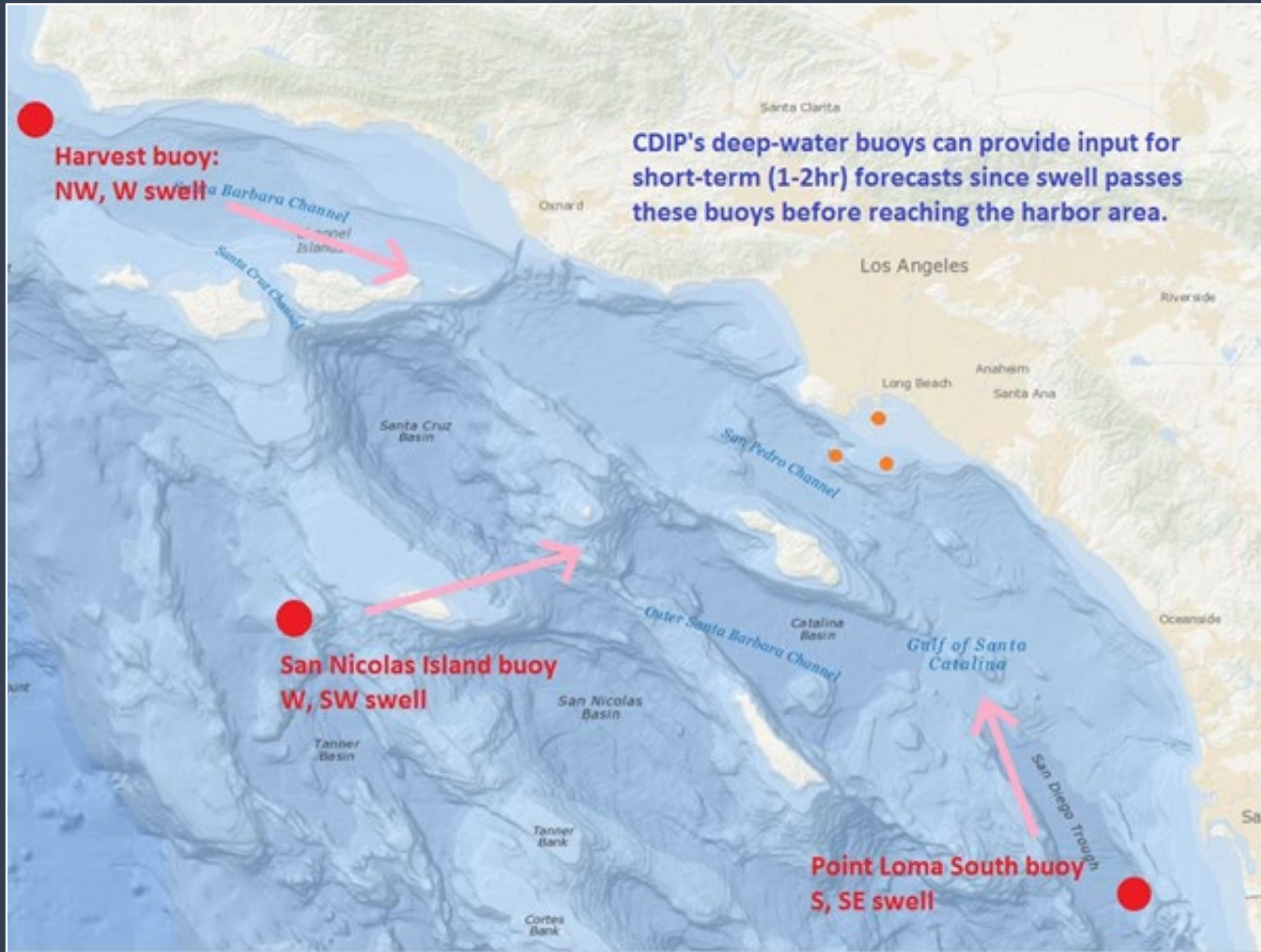


**Wave runup,
Erosion,
Infrastructure risk**

Maritime conditions



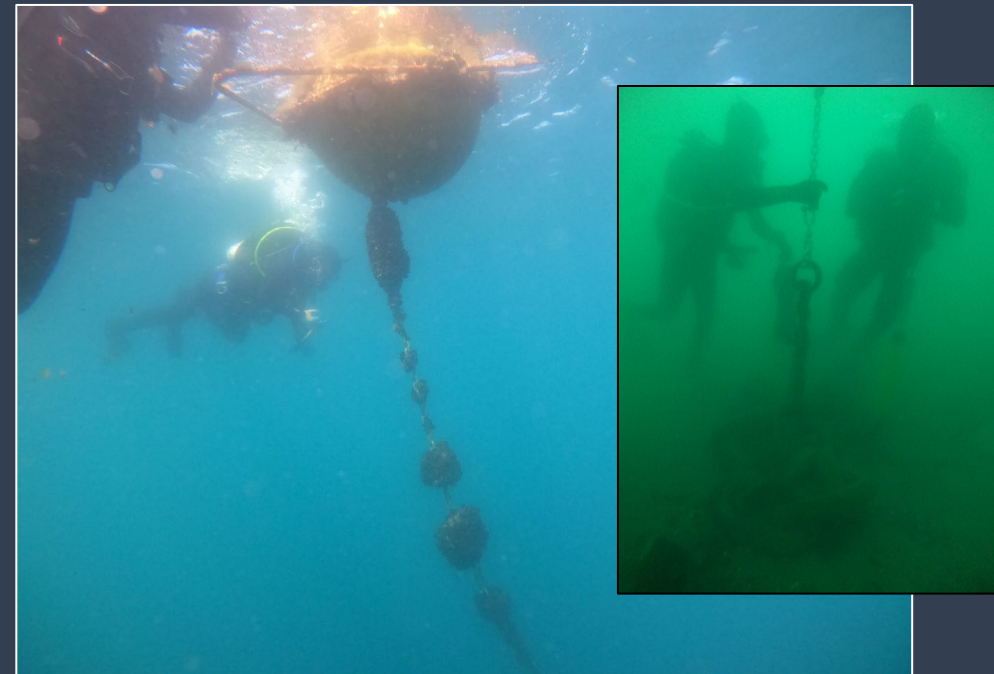
Under-Keel Clearance: Port of Long Beach



- In collaboration with Marathon and Marine Exchange of Southern California VTS.
- CDIP buoy-driven 1-3 hour forecast is used to make final "go / no-go" decision on VLCC transits.
- ~2 vessels per month now transit with 65'-69' draft

Operations & Maintenance

- Batteries
- Moorings
- Anchors
- Acoustic Releases
- Service & Repairs
- Paint
- **Calibration**
- Travel
- Vessels
- Vehicles



CDIP About Observations Wave Models More... ⚙️

Waves and Sea Surface Temperatures

Parameter Summary

Hs
Significant Wave Height

Tp
Peak Period

Dp
Peak Direction

SST
Sea Surface Temperature

Classic table

Recent Buoy Observations		Jan 29, 17:39				
Stations	All	Hs ft	Tp s	Dp °	SST °F	
+	KALO, MAJURO, MARSHALL ISLANDS - 163	24 min ago	4.43 ft	11.1 s	4 °	83.7 °F
←	IPAN, GUAM - 121	9 min ago	6.04 ft	7.1 s	83 °	82.0 °F
↓	RITIDIAN POINT, GUAM - 196	9 min ago	9.78 ft	13.3 s	354 °	81.7 °F
+	AUNUU, AMERICAN SAMOA - 189	9 min ago	5.25 ft	13.3 s	346 °	86.0 °F
+	KAIMALAPA SOUTHWEST LANAI HI - 220	9 min ago	3.21 ft	12.5 s	320 °	75.6 °F

Data Dissemination

- Updates every 30 minutes (> 99% reliable)
- CDIP Website (~17,000 unique visitors per day)
- National Data Buoy Center / NOAA (NWS)
- National Centers for Environmental Information
- Physical Oceanographic Real-Time System (PORTS®): Humboldt Bay, San Francisco, LA/LB

Quality Control

- Instrument Calibration
- Automated messaging
- Sensor and Mooring Status

National Oceanic and Atmospheric Administration's
National Data Buoy Center
Center of Excellence in Marine Technology

Home About Us Contact Us

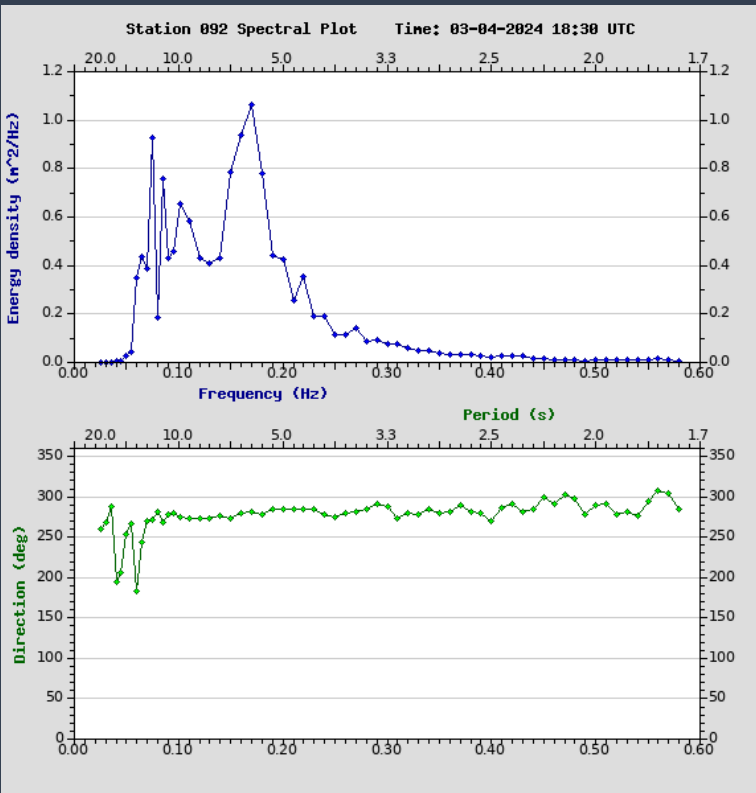
Station 46258 - Mission Bay West, CA (220)

Information submitted by Scripps Institution of Oceanography
Waverider Buoy
32.752 N 117.501 W (32°45'6" N 117°30'3" W)

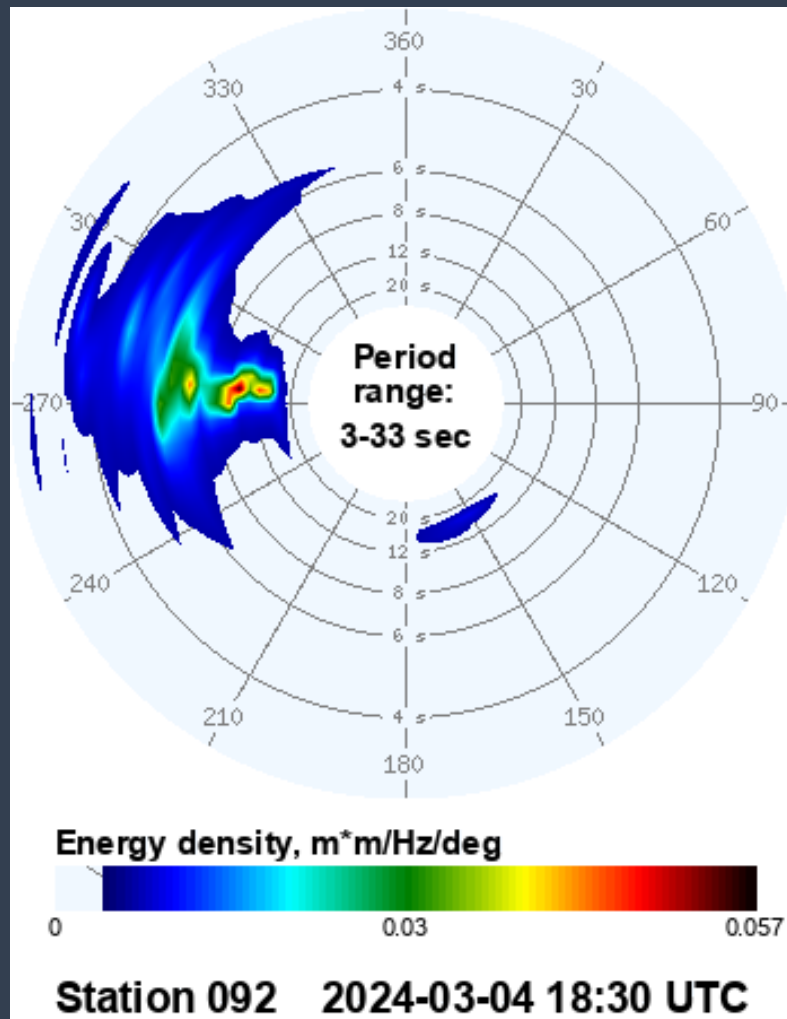
Site elevation: sea level
Sea temp depth: 0.46 m below water line
Water depth: 588.6 m

Latest NWS Marine Forecast
Search And Rescue (SAR) Data
Meteorological Observations from Nearby Stations and Ships
Regional HF Radar Surface Current Observations

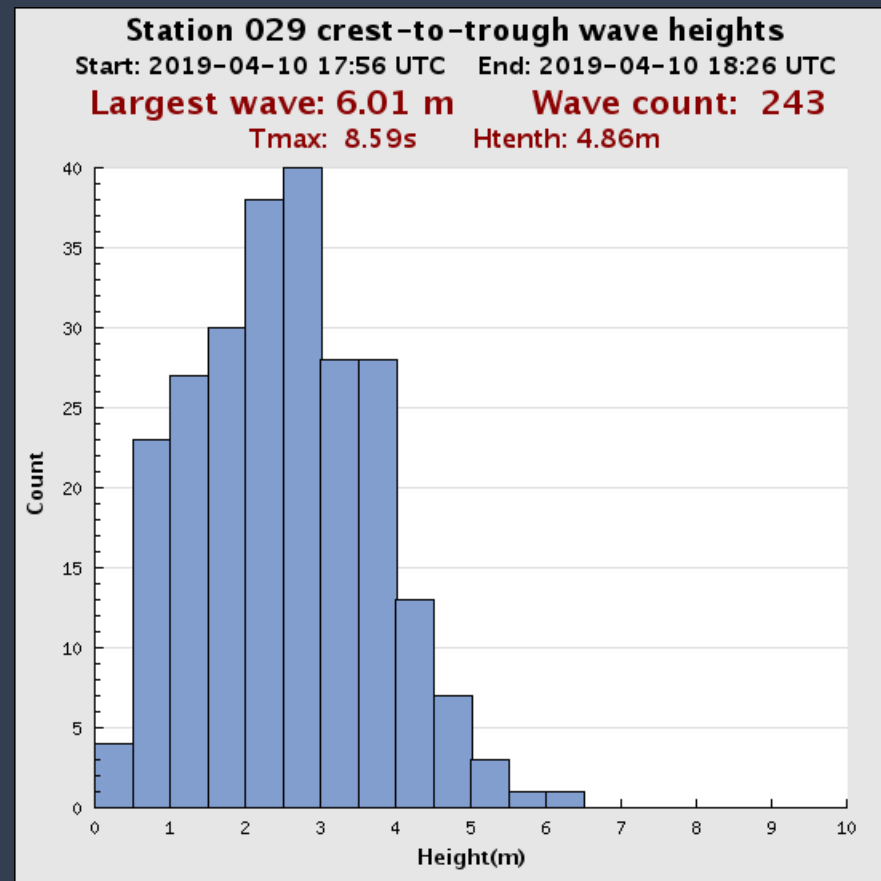
Large icon indicates selected station.
 ◊ Stations with recent data
 ◊ Stations with no data in last 8 hours
 ◊ (24 hours for tsunami stations)



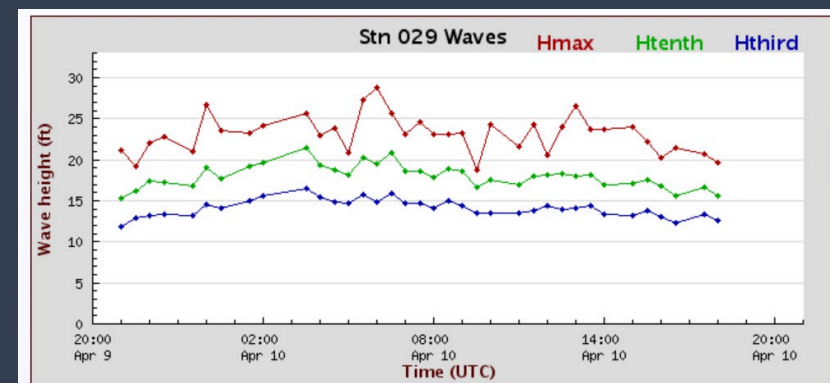
Wave Energy Spectra
(1 - 30 sec)



Directional Spectra



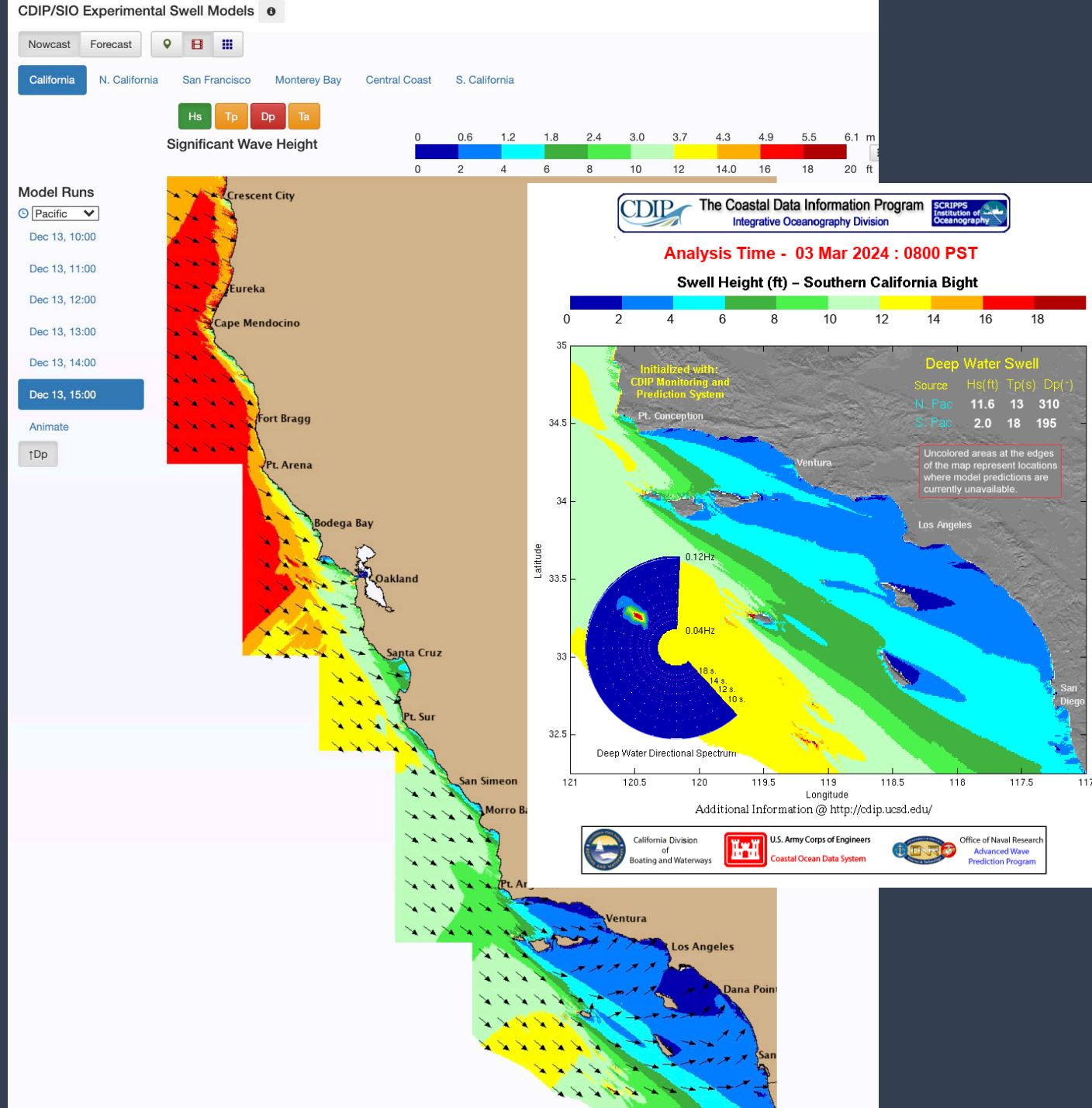
Individual Waves

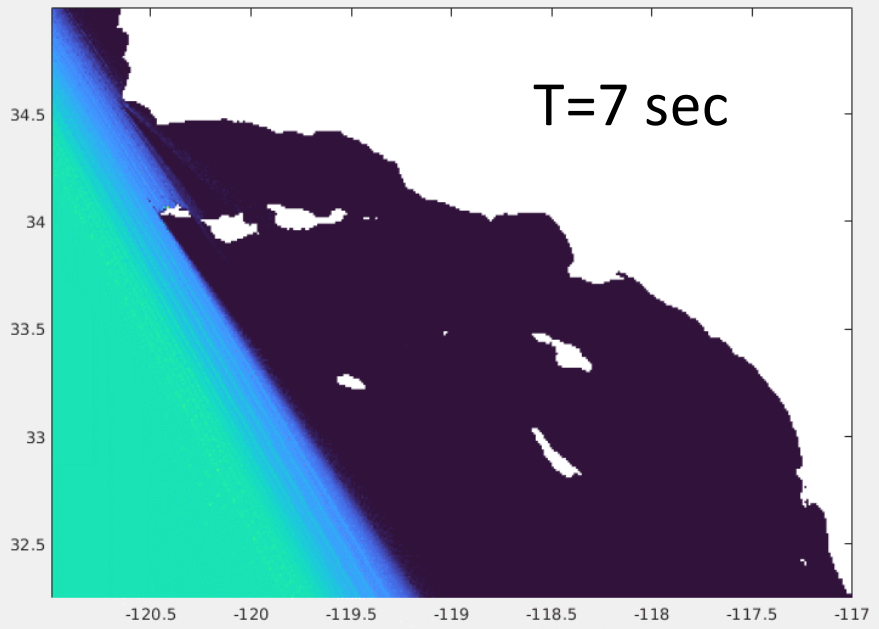


CDIP California Wave Model

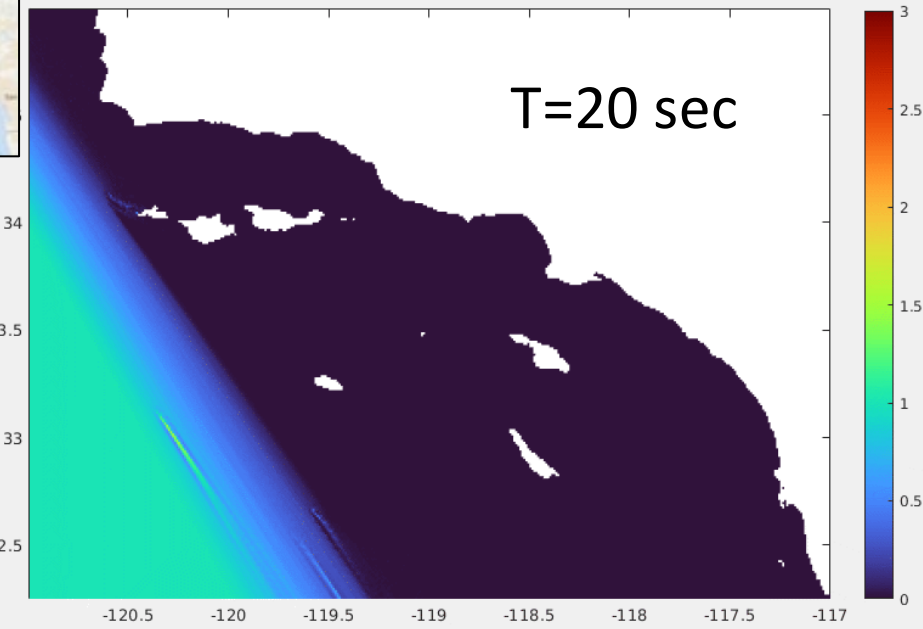
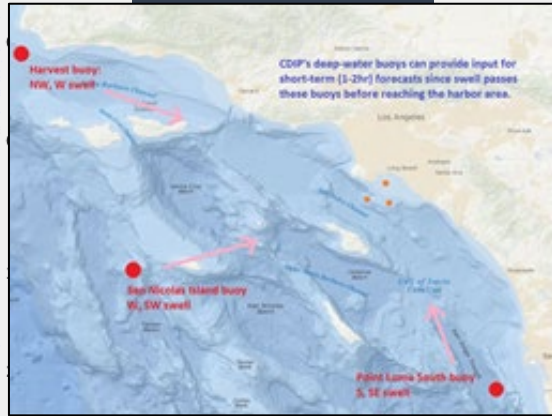
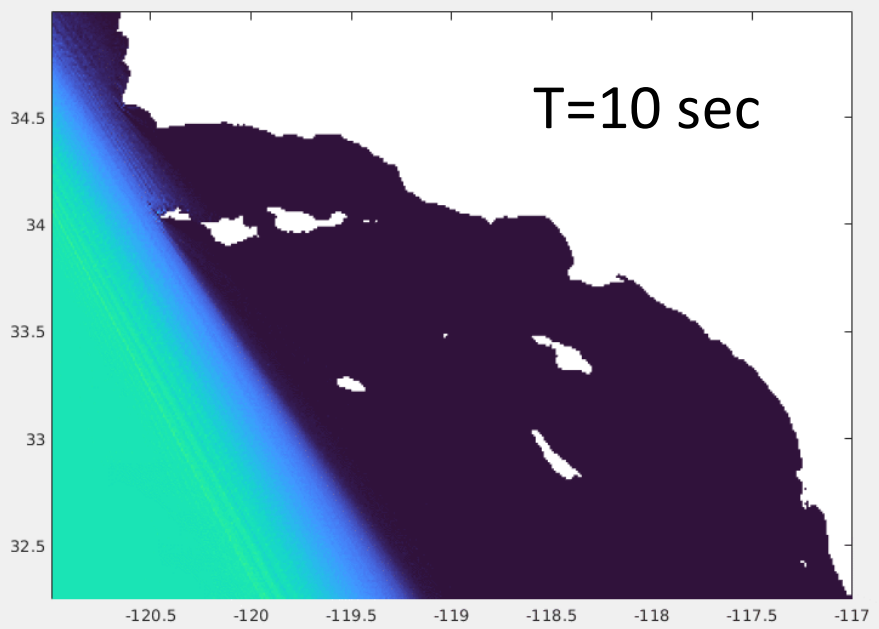
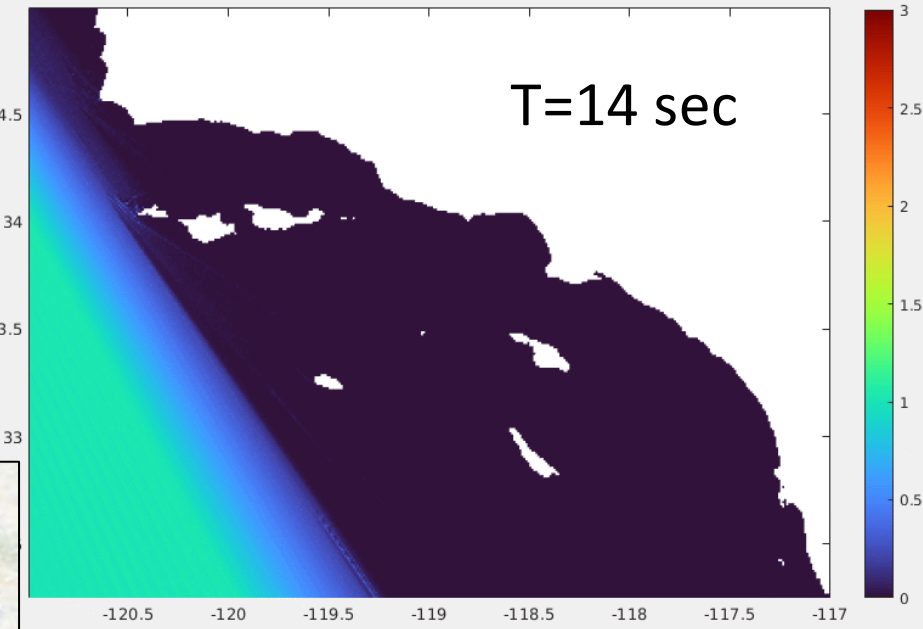
“Nowcast” and hindcast
(back to 2000) model driven
by **buoy data** + bathymetry +
physics

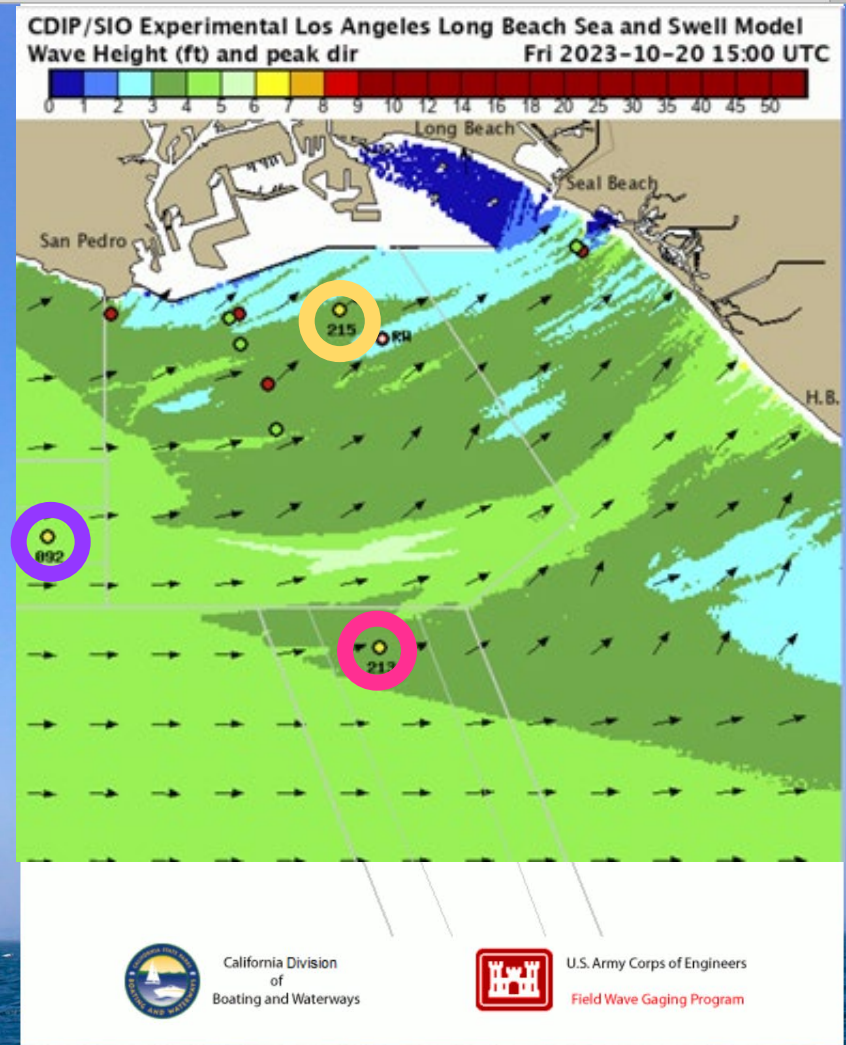
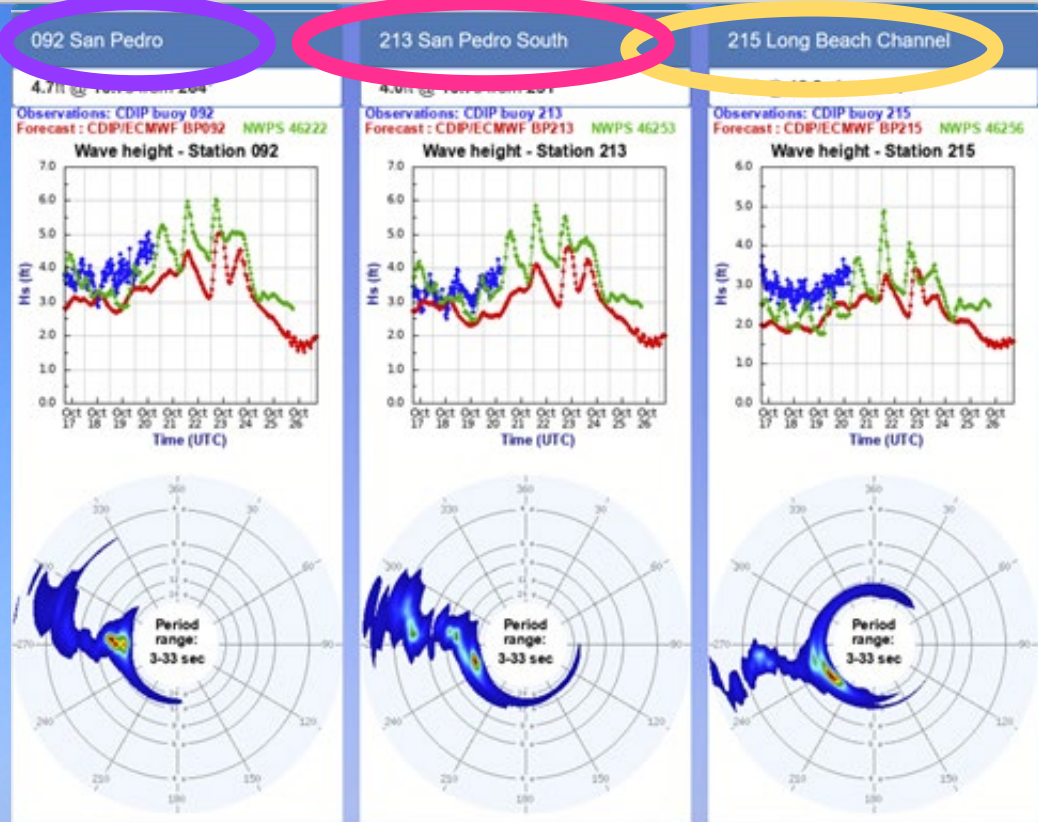
Output points every 100 -
200 m along the coast





Wave shadowing and refraction





Display at Marine Exchange
Buoys update every 30 minutes

Dataset comparison: 092 and BP092

Parameter:

Frequency range:

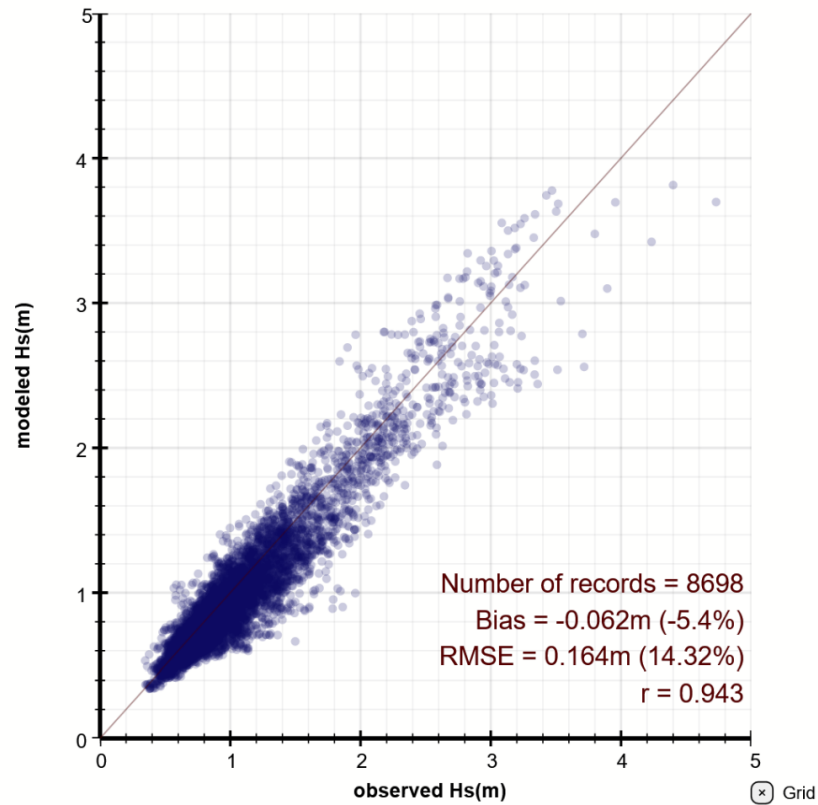
-
-
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Year:

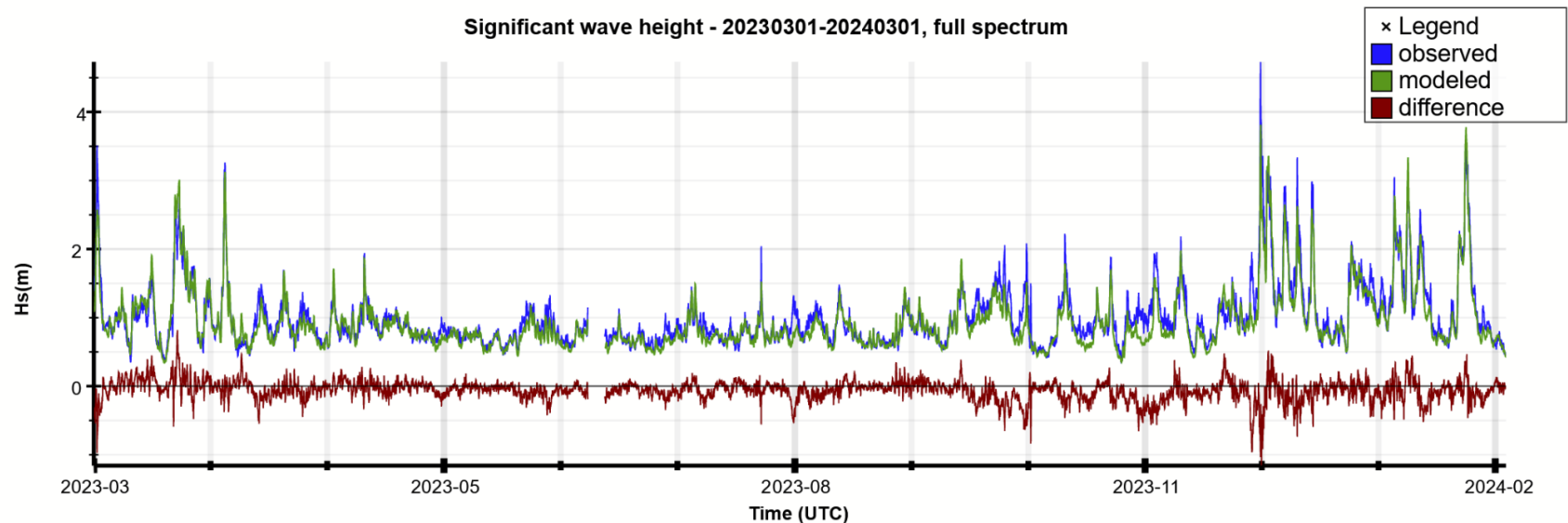
Month:

Click and drag horizontally to zoom in the plot below.

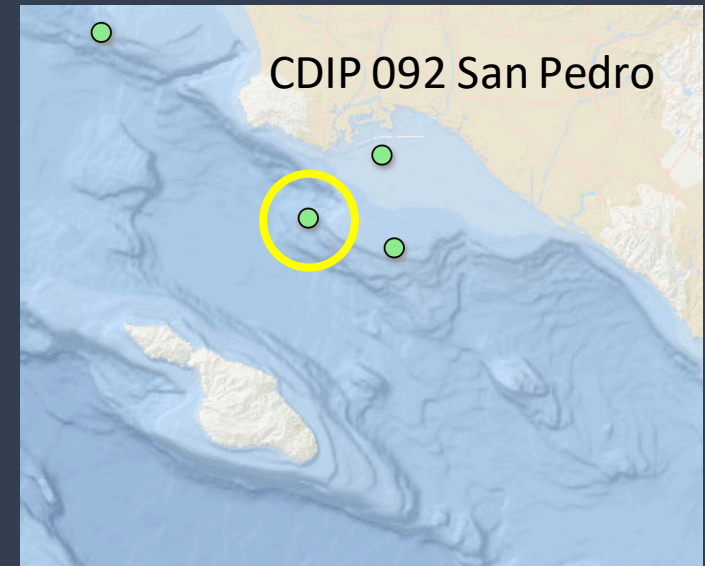
Significant wave height - 20230301-20240301, full spectrum



Significant wave height - 20230301-20240301, full spectrum

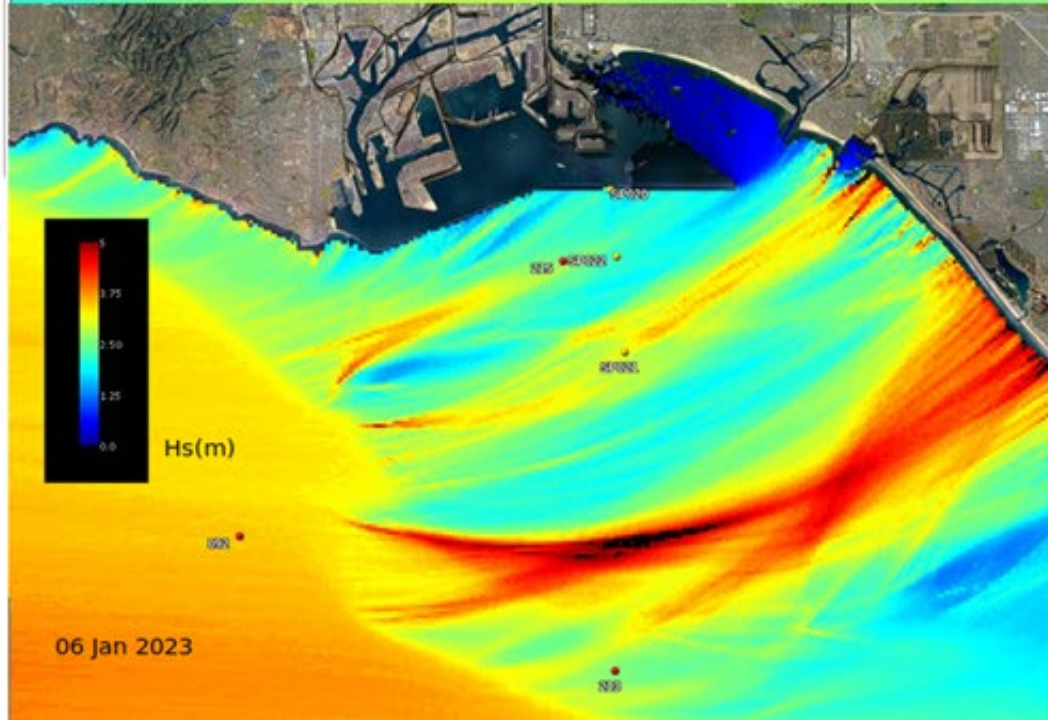
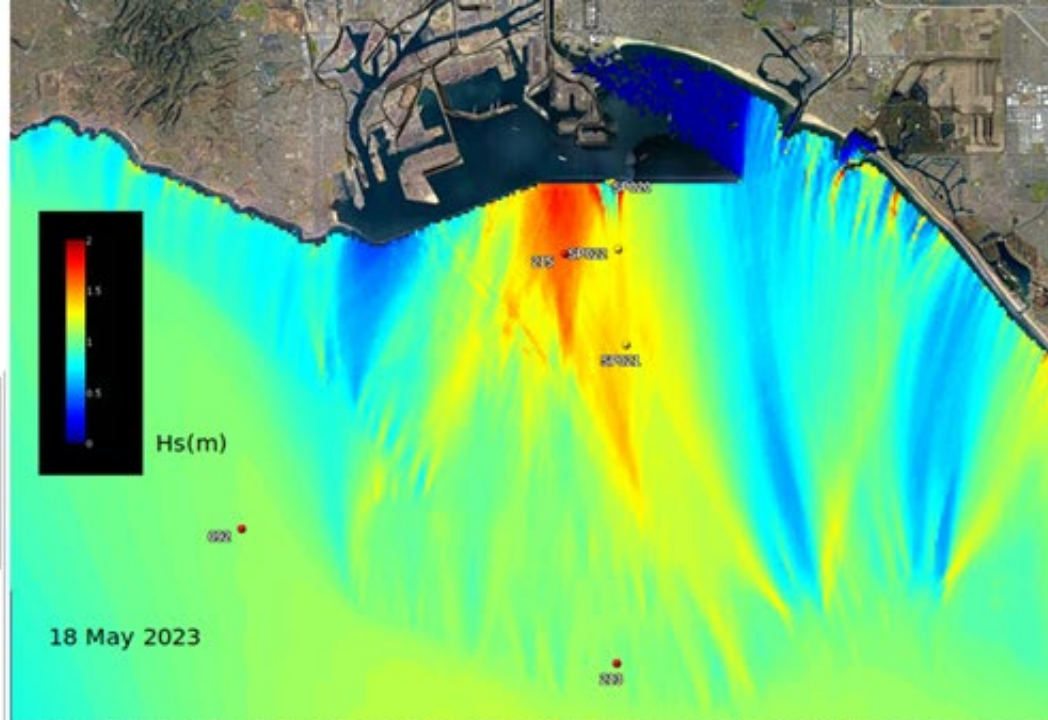
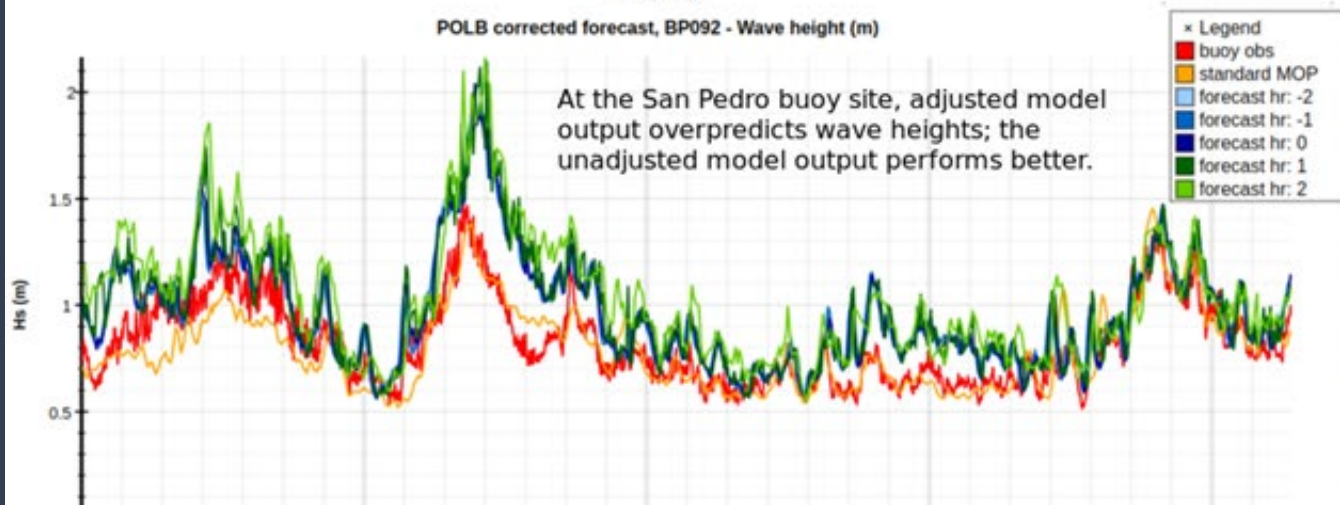
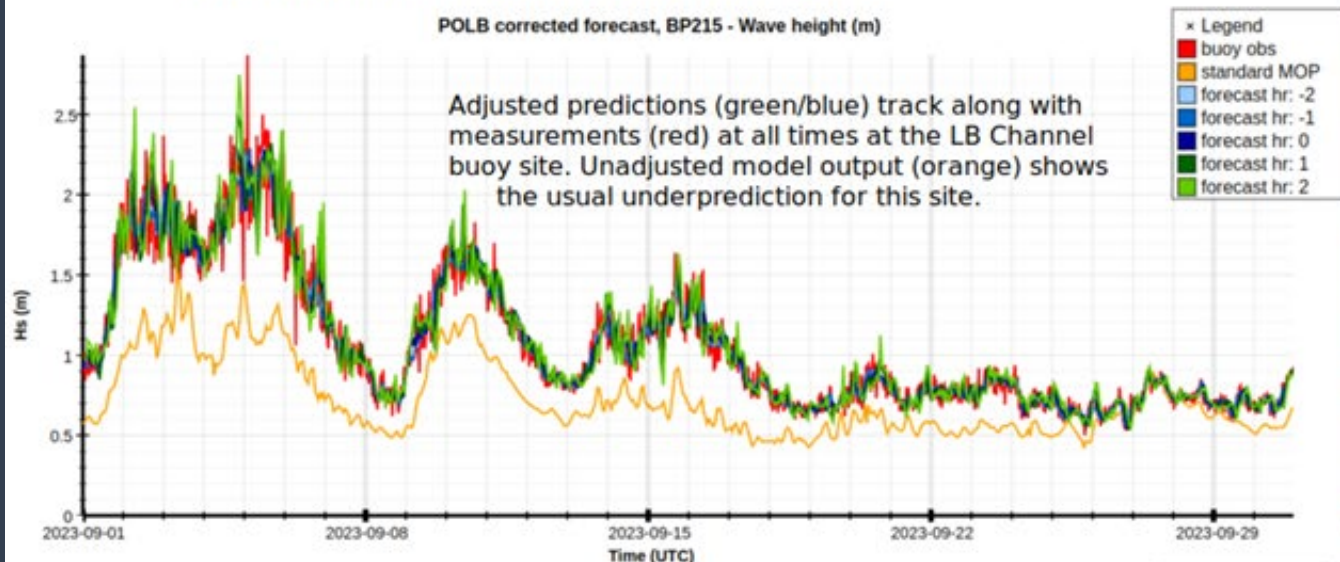


Validation of CDIP wave model using CDIP buoy data

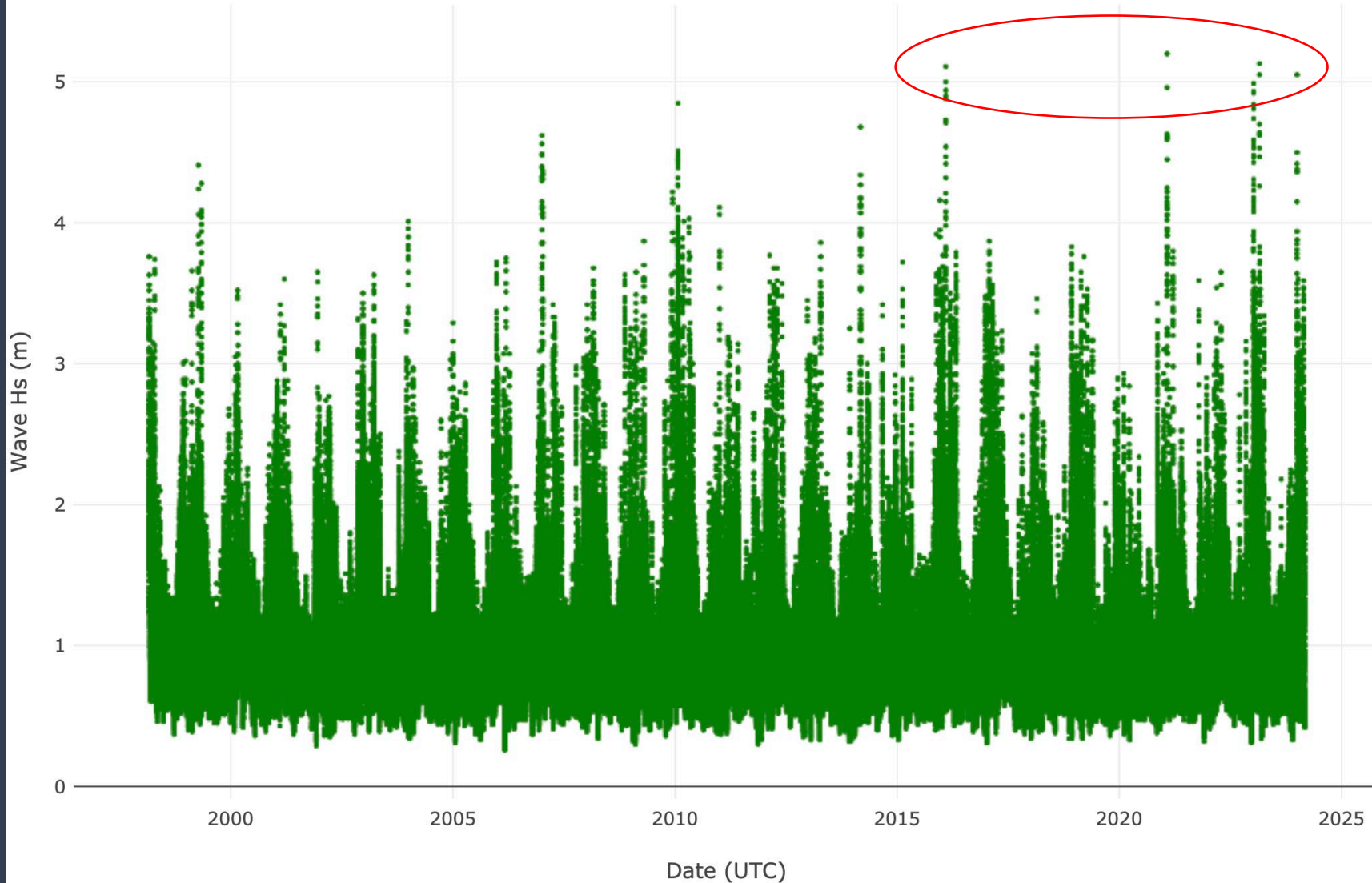


Using LB Channel buoy data to adjust model predictions

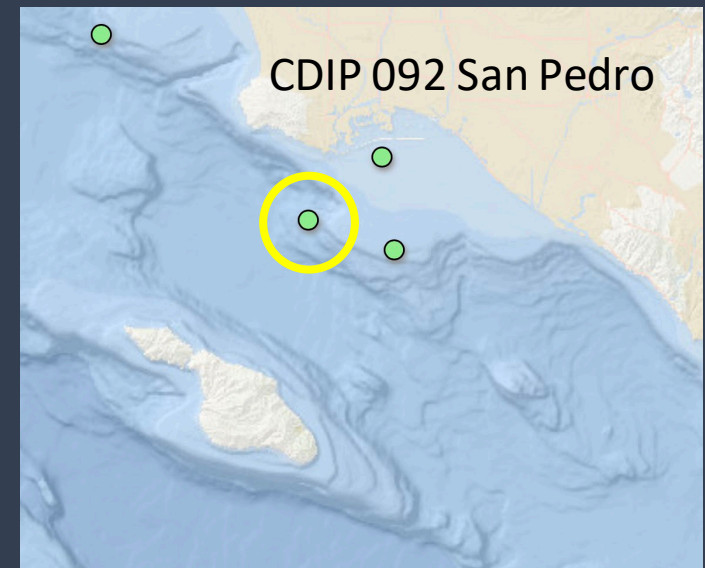
- Adjusted values are likely to be an improvement in close proximity to the buoy used, where depths are similar and variability in the wave field is limited.
- Adjusted values based on buoy 215 do not improve predictions at the 092 and 213 buoy sites. The extent to which predictions may be improved for SP020 and SP021 is unknown.



Wave Hs Chronological



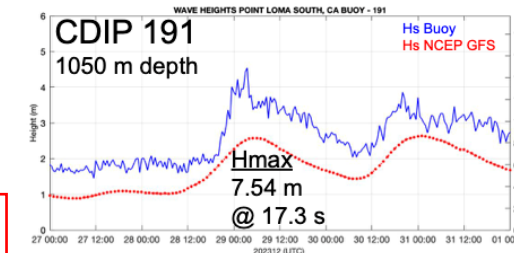
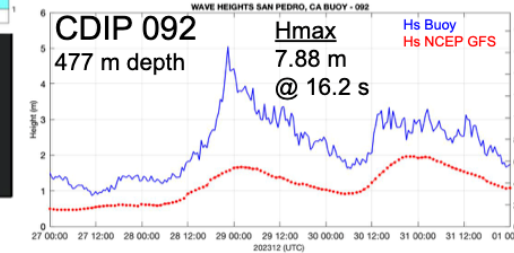
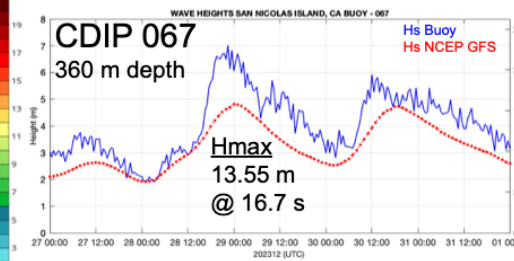
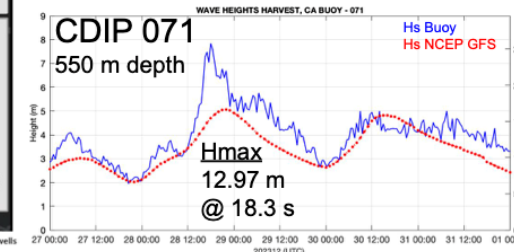
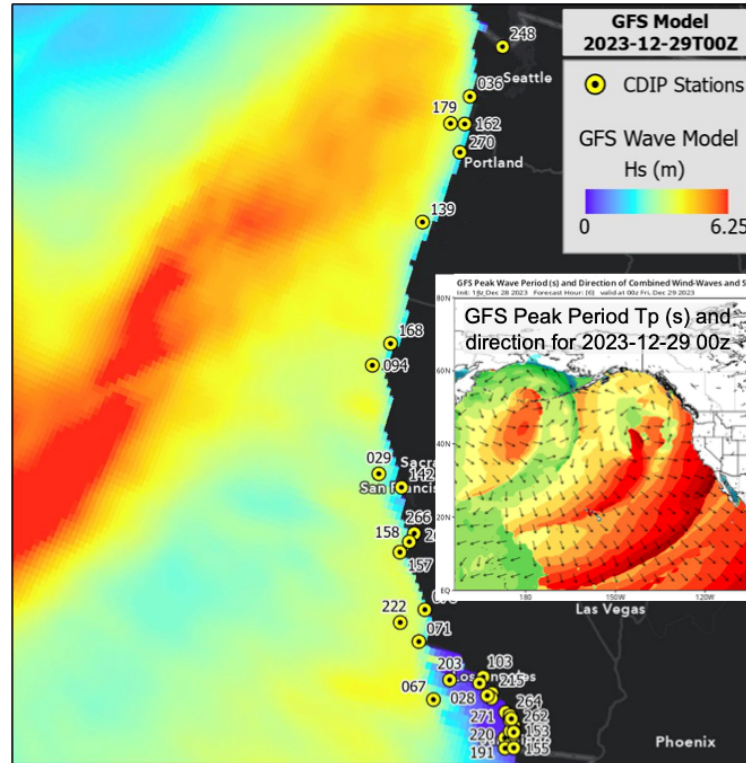
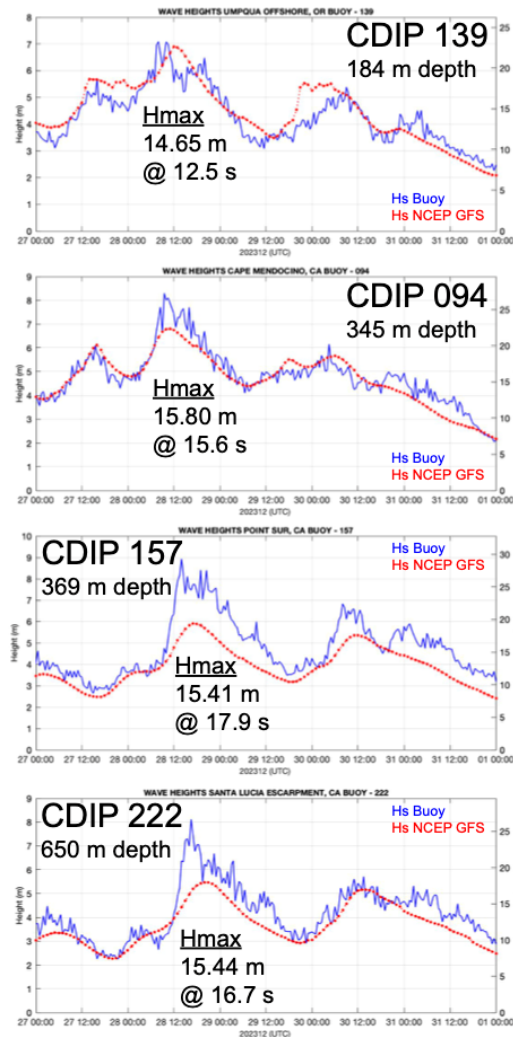
Historic extreme wave events have been occurring in recent years at the Port of Long Beach



CDIP Wave Observations: West Coast Storms December 28 - 31, 2023



US Army Corps
of Engineers®



- Extratropical low pressure systems in the North Pacific Ocean generated a series of swells impacting the West Coast late December into the new year. Large waves over high tides caused inundation flooding and significant coastal erosion.
- Wave heights during the swell that arrived 28 Dec exceeded 8 m Hs at some CDIP stations, up to 3 m greater than the NOAA GFS wave model for the California coastline in particular, with exceptionally long average period $T_a > 15$ seconds.
- Peak Hs values were near historic records at CDIP stations 092 San Pedro (established 1998), 157 Point Sur (est. 2008) and 222 Santa Lucia (est. 2016).
- Elevated storm activity in the Pacific Ocean is consistent with El Niño conditions which are forecast to continue through the winter.



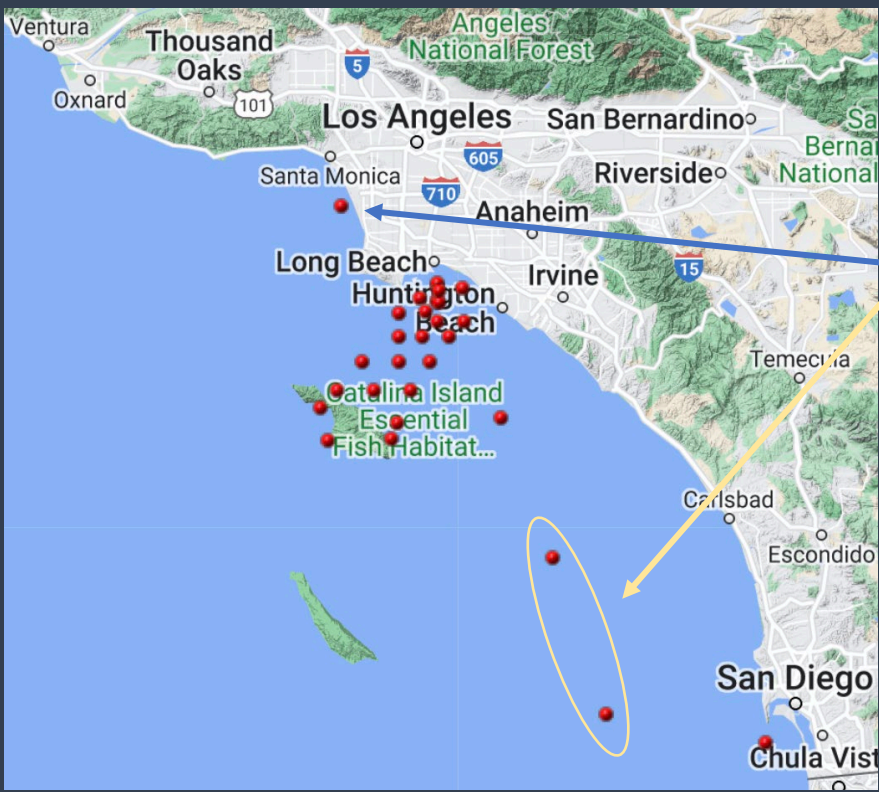
Left: Waves crash into the Ventura Pier (Eric Boldt -Ventura County Star)
Right: Flooded Streets in Capitola, California (Nic Coury/AP)

Hmax = largest individual wave
Hs = significant wave height

CDIP wave bulletins:
cdip.ucsd.edu/themes/cdip?d2=p12




cdip.ucsd.edu



Automated Forecast Threshold Messaging:

- Echo-PAL Offshore Lightering Zone
- El Segundo Marine Terminal




uprocc@model-e.cdip.ucsd.edu
 Echo-PAL wave forecast warning
 To: cdip-cdipsw, cscwwl@chevron.com

Prediction site: SP401 - Echo-PAL North
 Total wave height threshold (8ft) exceeded
 Date (PST) 14+ Hs 14+ Tp 14+ Dp Tot Hs Tot Tp Tot Dp
 (ft) (secs) (deg T) (ft) (secs) (deg T)
 2023-03-30 02:00 pm 2.40 14.29 275 8.04 11.11 282

Link:
https://cdip.ucsd.edu/mops/?moplist=San_Pedro_Harbor&mop=SP401&xitem=forecast&xperiod=14&tz=PST&units=english

Prediction site: SP402 - Echo-PAL South
 Total wave height threshold (8ft) exceeded
 Date (PST) 14+ Hs 14+ Tp 14+ Dp Tot Hs Tot Tp Tot Dp
 (ft) (secs) (deg T) (ft) (secs) (deg T)
 2023-03-30 11:00 am 2.69 14.29 281 8.79 7.69 268
 2023-03-30 02:00 pm 3.12 14.29 281 9.88 11.11 283
 2023-03-30 05:00 pm 2.85 14.29 281 9.19 11.11 282
 2023-03-30 08:00 pm 2.36 14.29 280 8.07 11.11 284

Link:
https://cdip.ucsd.edu/mops/?moplist=San_Pedro_Harbor&mop=SP402&xitem=forecast&xperiod=14&tz=PST&units=english

Recent observations

Extreme wave events

cdip.ucsd.edu

CDIP coastal data information program

Monitoring and Prediction of Waves and Shoreline Change

CDIP About Observations Wave Models More...

Welcome to CDIP

Recent Observations

California Wave Model

Station Map

Extreme Wave Events

Additional Projects

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

Selected region of interest **All**

West Coast Swells

Swells impacted the west coast in December.

Read more ...

East Coast Storm

An extratropical storm impacted the east coast.

Read more ...

Hawaii Swell

CDIP waves bulletin for Pacific extratropical storm.

Read more ...

Extreme wave events

Station Max/Min

Bulletins Recent Wave Observations Recent SST Observations

Global Pacific Islands Pacific Coast Atlantic Coast

Ten largest CDIP buoy measured significant wave heights over the past 7 days.

Station id	Station Name	Time (UTC)	Significant Wave Height (m)
270	TILLAMOOK BAY SOUTH JETTY, OR BUOY - 270p1	2024-01-09T23:30:00Z	9.69
036	GRAYS HARBOR, WA BUOY - 036p1	2024-01-09T23:30:00Z	9.28
154	BLOCK ISLAND, RI BUOY - 154p1	2024-01-10T10:30:00Z	7.79
139	UMPQUA OFFSHORE, OR BUOY - 139p1	2024-01-09T22:00:00Z	7.68
162	CLATSOP SPIT, OR BUOY - 162p1	2024-01-10T00:00:00Z	7.66
171	VIRGINIA BEACH OFFSHORE, VA BUOY - 171p1	2024-01-10T03:00:00Z	7.16
250	CAPE HATTERAS EAST, NC BUOY - 250p1	2024-01-10T02:30:00Z	6.98
160	JEFFREYS LEDGE, NH BUOY - 160p1	2024-01-10T09:00:00Z	6.84
222	SANTA LUCIA ESCARPMENT, CA BUOY - 222p1	2024-01-06T12:00:00Z	6.46
029	POINT REYES, CA BUOY - 029p1	2024-01-06T05:30:00Z	6.36