

An Introduction to Southern California's Ocean Observing System

How to use ocean observing system data related to water quality assessment

Lisa Hazard
SCCOOS
Data & Information
Advisor

Danielle Williams
SCCOOS
Program Coordinator

Darren Wright
SCCOOS
Data & Information
Manager



December 12, 2012

Introduction Outline

- What is U.S. IOOS[®]?
- What is SCCOOS?
- How are we funded?
- What do we do?
- How does it apply to water quality in California?
- What's in store for the future?

What is U.S. IOOS?

- US contribution to **G**lobal **O**cean **O**bserving **S**ystem
- Program Office in D.C. within NOS / NOAA
- Includes global (satellites, drifters, etc.) and coastal components
- Coastal component includes 17 Federal agencies, 11 regional associations and 2 other consortia
 - Federal backbone of coastal component includes tide gauges, NDBC buoys, USGS river gauges, ect.



Purpose of U.S. IOOS

To enable the nation to track, predict, manage and adapt to changes in our ocean, coastal and Great Lakes environment for the purposes of:



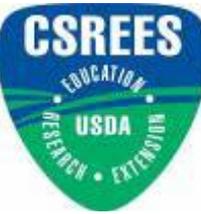
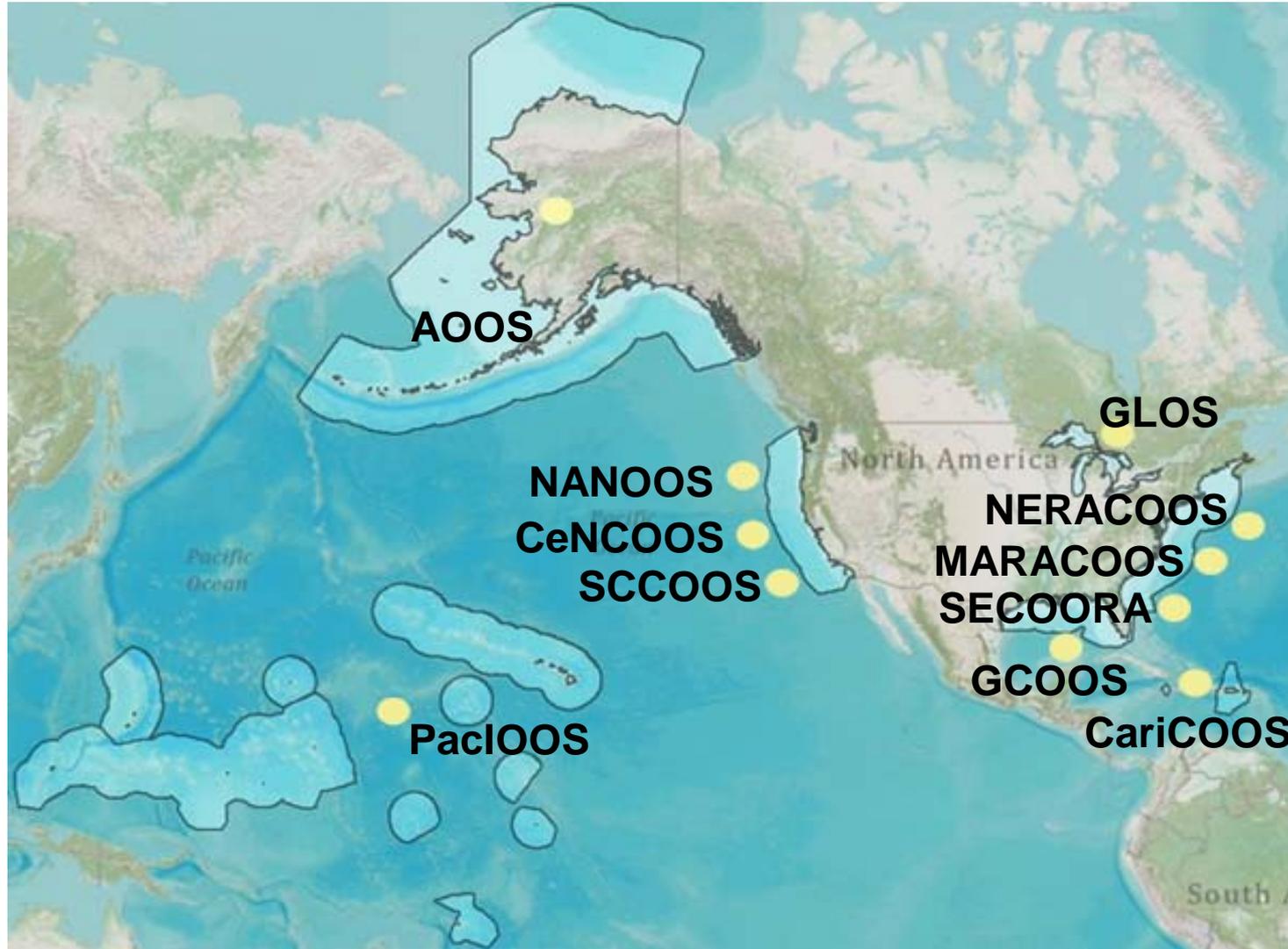
**Improving
Safety**

**Enhancing
our Economy**

**Protecting
our Environment**

IOOS Coastal Component

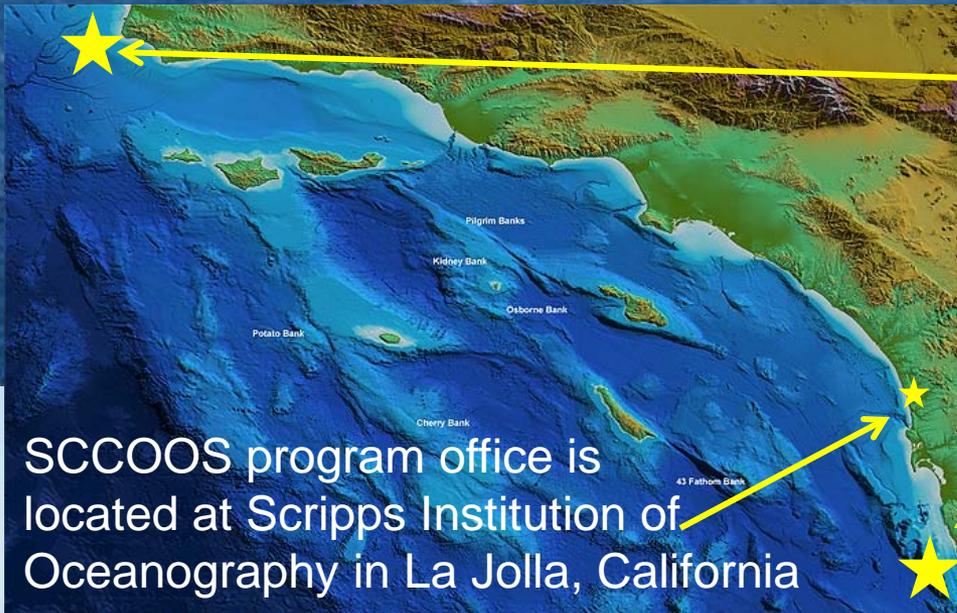
11 Regional Associations; 17 Federal Agencies



What is SCCOOS?

- Southern California Coastal Ocean Observing System
- SCCOOS is one of 11 regional ocean observing systems that contribute to the US Integrated Ocean Observing System (IOOS)
- A collaborative network of scientists and research teams from universities, institutions, and industry in Southern California that collect and aggregate coastal ocean data and provide a single online portal for its distribution

Where is SCCOOS?



The Southern California Bight extends from Point Conception to the US/Mexico Border

SCCOOS program office is located at Scripps Institution of Oceanography in La Jolla, California

www.SCCOOS.org

How is SCCOOS funded?

- Primary funding is via 5-year grant from NOAA/IOOS (Federal)
 - Year 1 (6/11-5/12): ~\$1.75M to SCCOOS
 - Year 2 (6/12-5/13): ~\$2.1M to SCCOOS
 - Year 3 (6/13-7/14): ??????????
- Other smaller current and anticipated funding sources include:
 - NOAA HABs (SCCOOS)
 - OCSD (SCCOOS and CeNCOOS)
 - ASBS (SCCOOS)
 - CA Dept. of Boating & Waterways (SCCOOS Manual Shore Program)
 - US Army Corp of Engineers (SCCOOS Wave Data)
- In the past, significant funding came from:
 - California State Coastal Conservancy



US Army Corps
of Engineers®



SCCOOS Program Office Staff

Executive Director: Julie Thomas (15%, 1/08)

Technical Director: Eric Terrill (10%, 2/05)

Data & Information Advisor: Lisa Hazard

Data & Information Manager: Darren Wright (50%, 10/12)

Public & Government Relations Coordinator: Chris Cohen
(40%, 2/10)

Program Coordinator: Danielle Williams (100%, 5/12)

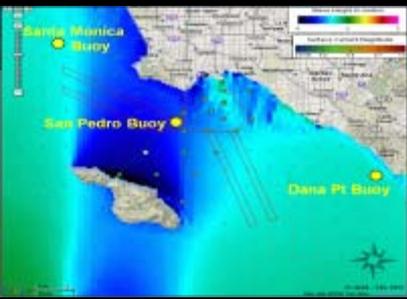
What does SCCOOS do?

Manage an “end-to-end” coastal ocean observing system ...

- Data collection
- Data management
- Data dissemination
- Numerical model simulations and forecasts
- Product development
- User outreach and facilitation

... to benefit USERS in four broad focus areas:

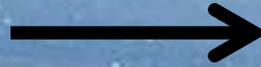
- Water quality
- Ecosystems and climate
- Marine operations
- Coastal hazards



What else does SCCOOS do?

The foundation is a network of ocean observing assets that measure:

- Physical and chemical properties (e.g. temperature, salinity, dissolved oxygen)
- Biological properties (e.g. Harmful Algal Blooms, chlorophyll fluorescence)
- Waves
- Meteorological conditions
- Surface currents



Observational assets include:

- Shore stations
- Gliders
- Land-based high frequency radar stations
- Ship-based surveys



Gliders



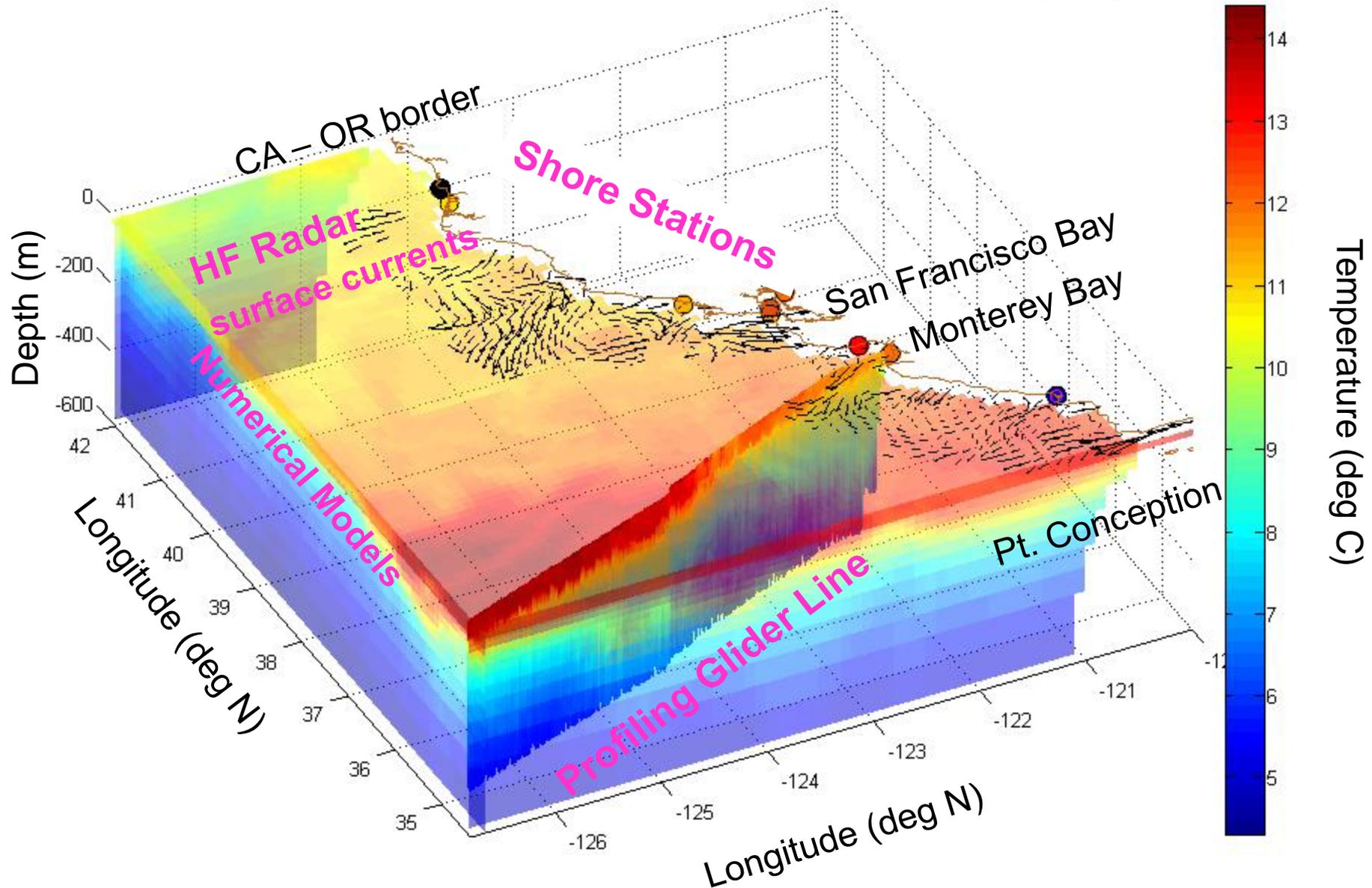
Cruises



HFR



The result is an integrated picture of the ocean environment that is useful for a multitude of purposes

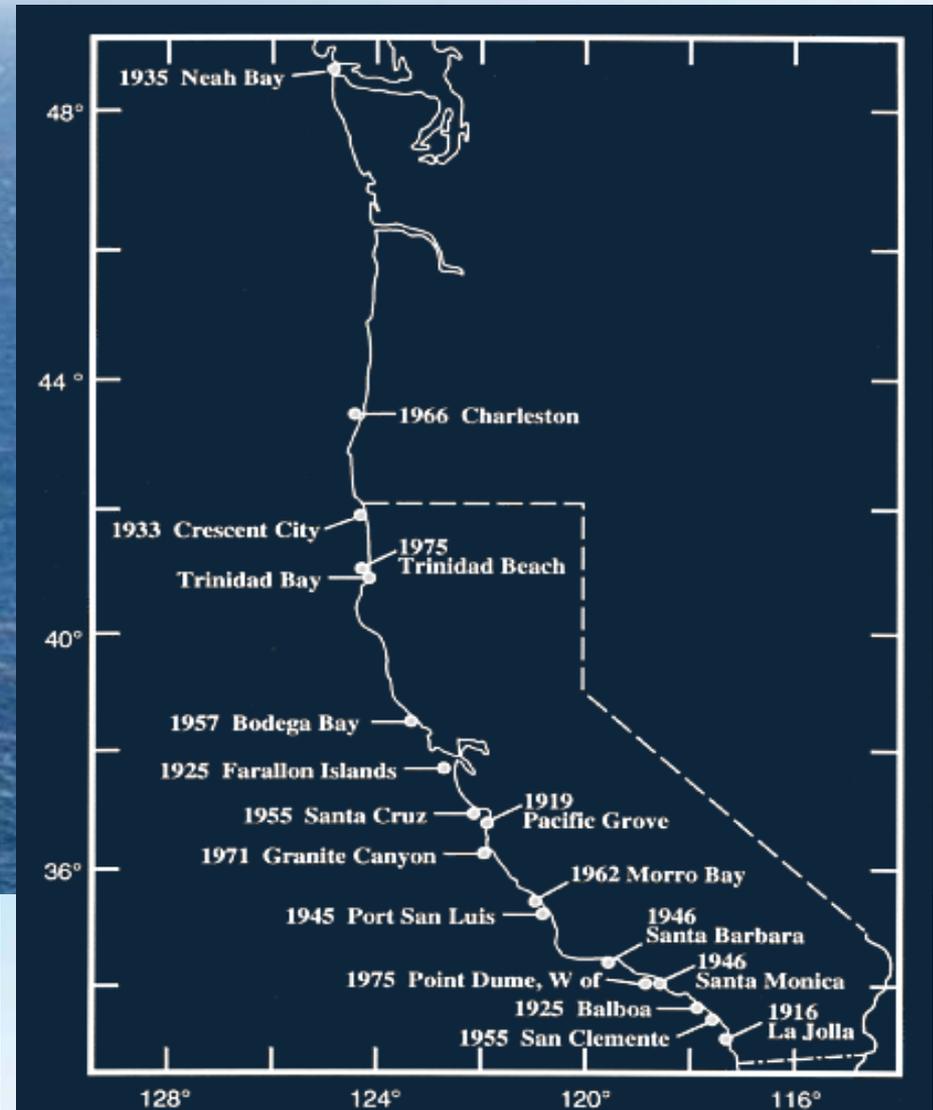


Data are from the Jan-Feb 2012 timeframe

Nearshore measurements from automated and manual shore stations

Data collected include:

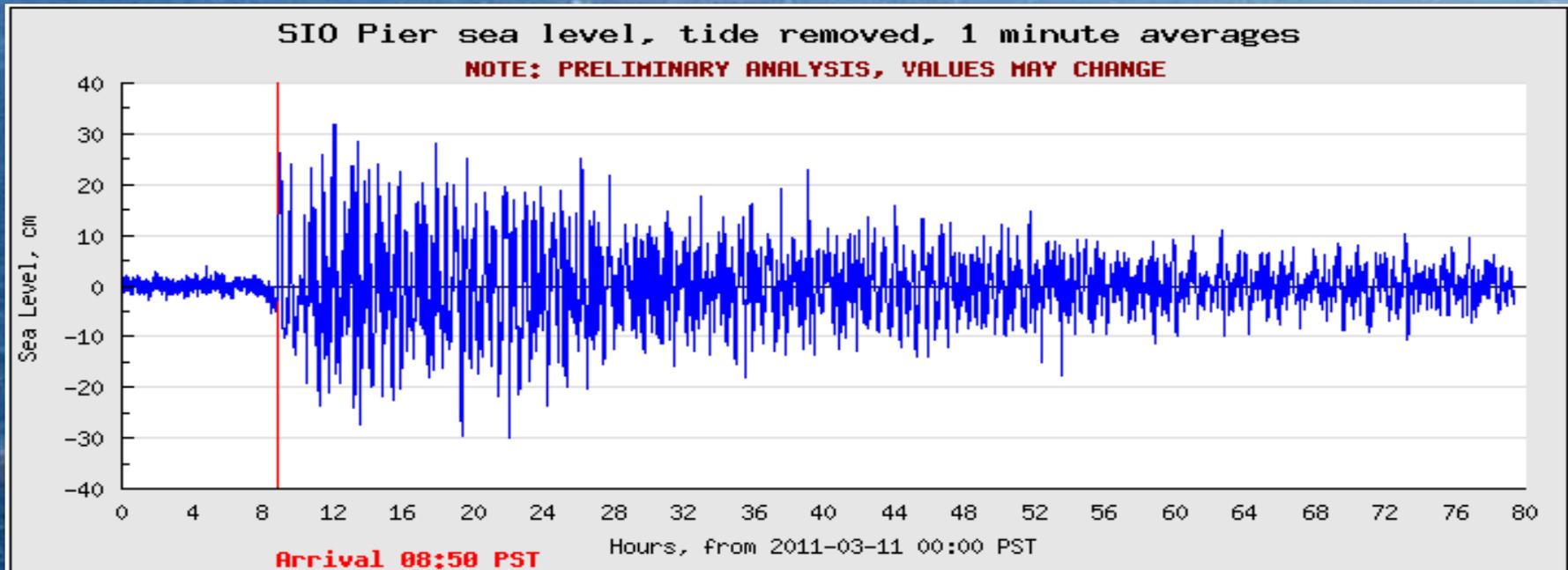
- Temperature & salinity
- Chlorophyll fluorescence & turbidity or transmissivity
- Dissolved oxygen, pH, & water level
- Meteorological variables
- Phytoplankton & algal toxins to detect Harmful Algal Blooms



Nearshore Measurements

Short-term event detection; e.g. tsunamis

http://www.sccoos.org/projects/2011_tsunami/



Long-term climate records

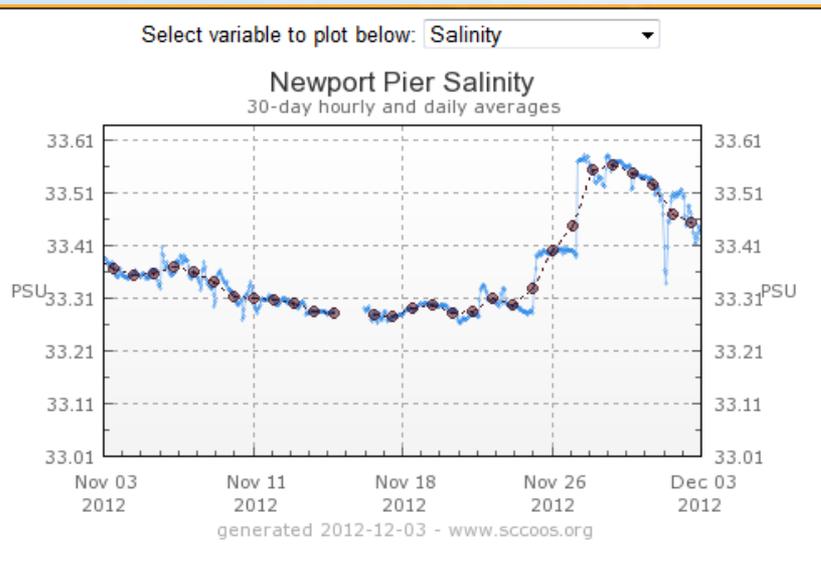
Sea Level since 1855 • Sea Surface Temperature since 1880

Ocean pH and pCO₂ trends since 1993 • Salinity since 1916

Wave Height Trends since 1950

Coastal Upwelling trends since 1960

Automated Shore Station Page



Legend Map Satellite Terrain

NEWPORT PIER
 33° 36.37' N, 117° 55.87' W
Last Updated: 9 minutes ago
Last Update Time: 2012-12-04 18:59:29 UTC
Provider: UCI

Measurement	Value
Chlorophyll	1.8090 ug/L
Pressure	3.4710 dbar
Salinity	33.3950 PSU
Water Temperature	17.3741 °C 63.2734 °F

Previous Observations

Map data ©2012 Google

LEGEND

- Operational
- More than 3 hours old
- More than 1 day old
- More than 1 week old
- Status unknown

SITES

Stearns Wharf
 Santa Monica Pier
> Newport Pier <
 Scripps Pier

Manual Shore Station Page

<http://www.sccoos.org/data/manualshorestations/>

Please note:
Manual shore station data are updated periodically not continuously. As a result, the data repository may lag behind the actual data collection.

Manual Shore Stations

UTC Time: 2012-12-04 19:25:16

Local Time: 2012-12-04 11:25:16

Balboa / Newport Beach Shore Station

Latitude: 33° 36.00' N

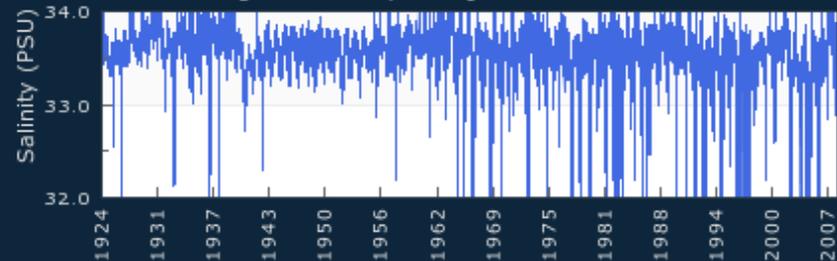
Longitude: 117° 54.00' W

Measurements Taken

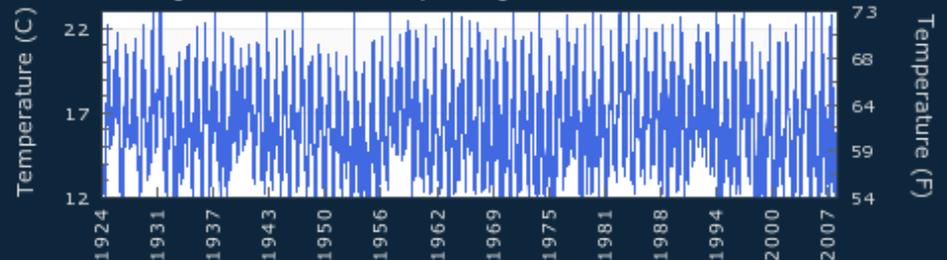
Salinity

Temperature

Salinity at Balboa / Newport Beach Shore Station



Temperature at Balboa / Newport Beach Shore Station



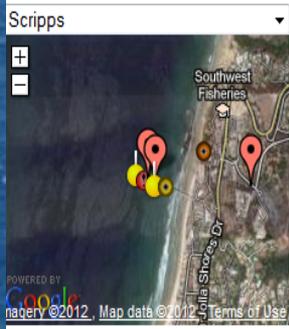
Integrated Pier Pages

<http://www.sccoos.org/data/piers>

PIER DATA

PIER LOCATION

Scripps Pier
 Lat: 32° 52.0188 N
 Lon: 117° 15.4350 W



PIER WEB CAM



DATA FEEDS

WATER CONDITIONS

OCEAN

WATER CONDITIONS

<p>TEMPERATURE 16.60° C / 61.88° F</p> <p>WATER PRESSURE 5.38 dbar</p> <p>OBSERVED WAVE HEIGHT 0.76 meters / 2.49 feet</p> <p>HABS</p> <p>TEMPERATURE PROFILE PLOT</p>	<p>SALINITY 32.65 PSU</p> <p>CHLOROPHYLL 1.56 ug/L</p> <p>OBSERVED PEAK PERIOD 11.64 secs</p> <p>SST TEMPERATURE 16.90° C / 62.42° F</p> <p>TEMPERATURE CONTOUR PLOT</p>
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Last updated: 2012-12-04 11:26 Local

WAVE CONDITIONS

<p>MODELED WAVE HEIGHT 0.71 meters / 2.33 feet</p> <p>MODELED PEAK DIRECTION 297.00°</p>	<p>MODELED PEAK PERIOD 9.87 secs</p>
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Last updated: 2012-12-04 09:00 Local

WEATHER

AIR CONDITIONS

<p>WIND SPEED 4.00 m/s</p> <p>AIR TEMPERATURE 16.60° C / 61.88° F</p> <p>BAROMETRIC PRESSURE 1022.90 dbar</p>	<p>WIND DIRECTION 338.00°</p> <p>RELATIVE HUMIDITY 89.40%</p> <p>RAINFALL 0.00</p>
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WATER CONDITIONS

Observed at: 32.8667, -117.257
 Updated: 2012-12-04 11:26 Local
 2012-12-04 19:26 UTC
 Provided by: [SCCOOS Auto Shore Stations](#)

Observed at: 32.8667, -117.2567
 Updated: 2012-12-04 10:45 Local
 2012-12-04 18:59 UTC
 Provided by: [SCCOOS Temperature Chain](#)

Observed at: 32.867033, -117.25735
 Updated: 2012-12-04 10:59 Local
 2012-12-04 18:59 UTC
 Provided by: [SCCOOS Temperature Chain](#)

WAVE CONDITIONS
 Observed at: 32.8672, -117.2580
 Updated: 2012-12-04 09:00 Local
 2012-12-04 17:00 UTC
 Provided by: [CDIP Modeled Point](#)

AIR CONDITIONS
 Observed at: 32.866667, -117.25
 Updated: 2012-12-04 11:18 Local
 2012-12-04 19:18 UTC
 Provided by: [NOAA](#)

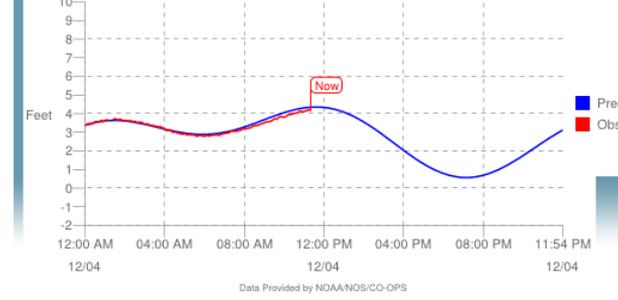
Observed at: 32.8667, -117.2560
 Updated: 2012-12-04 10:00 Local
 2012-12-04 18:00 UTC
 Provided by: [Scripps Hydroclimate Weather Program](#)

Observed at: 32.86833, -117.25330
 Updated: 2012-12-04 09:45 Local
 2012-12-04 17:45 UTC
 Provided by: [MADIS](#)

Last updated: 2012-12-04 11:18 Local

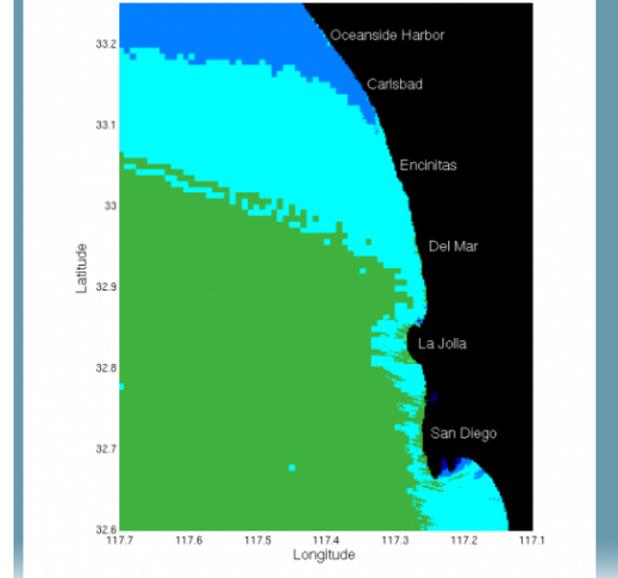
TIDES

Observed Water Level vs. Predicted Tide for 12/04
 La Jolla, CA



SWELL MODELS

Coastal Data Information Program – Scripps Institution of Oceanography
 4 DEC 2012 : 743 PST
 California Dept. of Boating and Waterways – Army Corps of Engineer



SCCOOS support ocean acidification efforts by collecting oxygen & pH levels in coastal waters

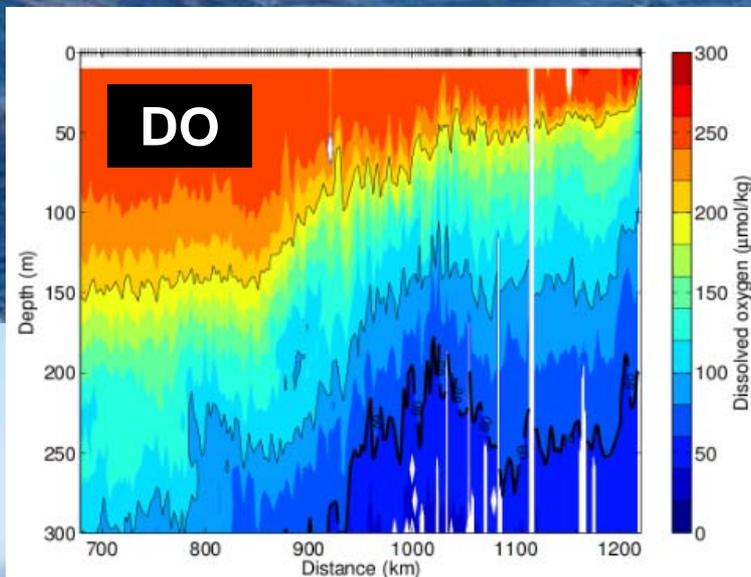
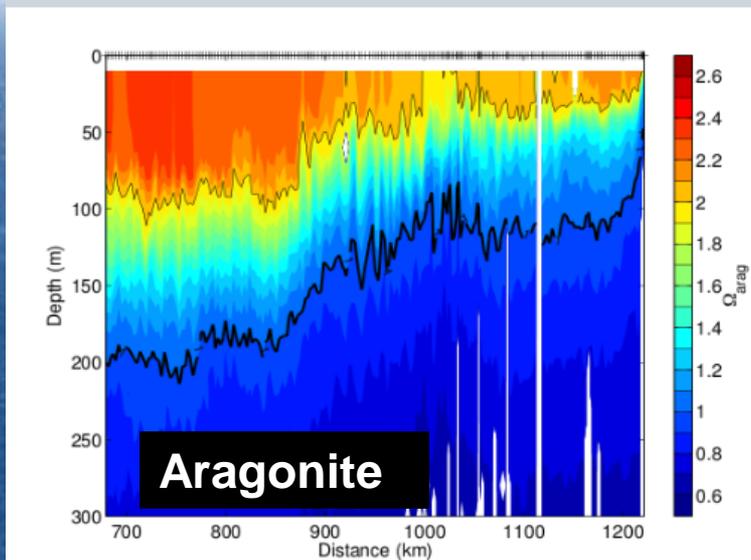
<http://www.sccoos.org/projects/2012OA/>

What is SCCOOS doing?

SCCOOS plans to add ocean acidification monitoring to its ongoing observations of the coastal ocean.

Sensors that monitor pH, $p\text{CO}_2$, and dissolved oxygen can be added to pier stations and gliders.

These observations will support continuous measurements of acidification in the Southern California Bight and will allow for improvements to be made to the models that forecast climate change.



SWRCB Pilot Program on Ocean Acidification

- Durafet pH sensors have been installed at 3 CeNCOOS and 2 SCCOOS shore stations and 1 LOBO estuarine mooring
- Water samples are being collected weekly for analyses at Scripps
- Help establish pH variability in coastal ocean and determine best methods to measure it

Profiling Gliders

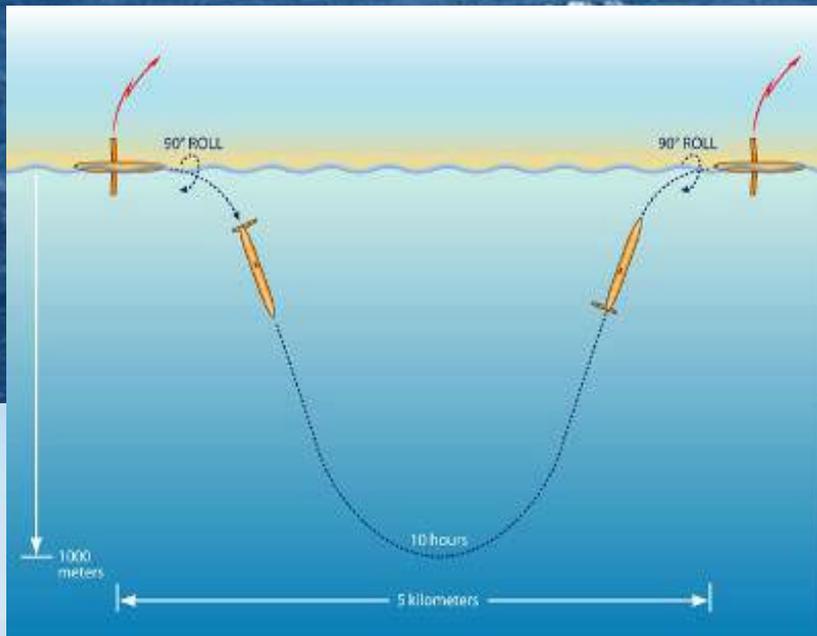
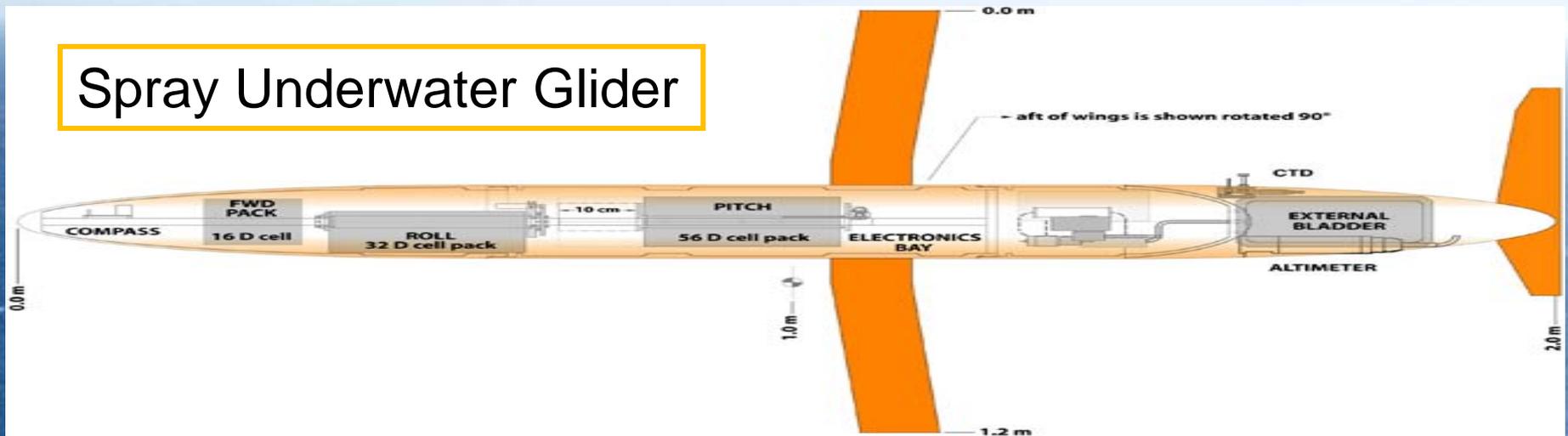
- Gliders are controlled remotely via satellite, and autonomously collect data in the water column along a transect
- Measure temperature, salinity, chlorophyll fluorescence, current velocity, dissolved oxygen (and pH and aragonite saturation via proxy relationships for **acidification monitoring**)
- Data is assimilated into numerical models, and used in studies of climate change and its impacts on California's coast



Glider operations on the US coast

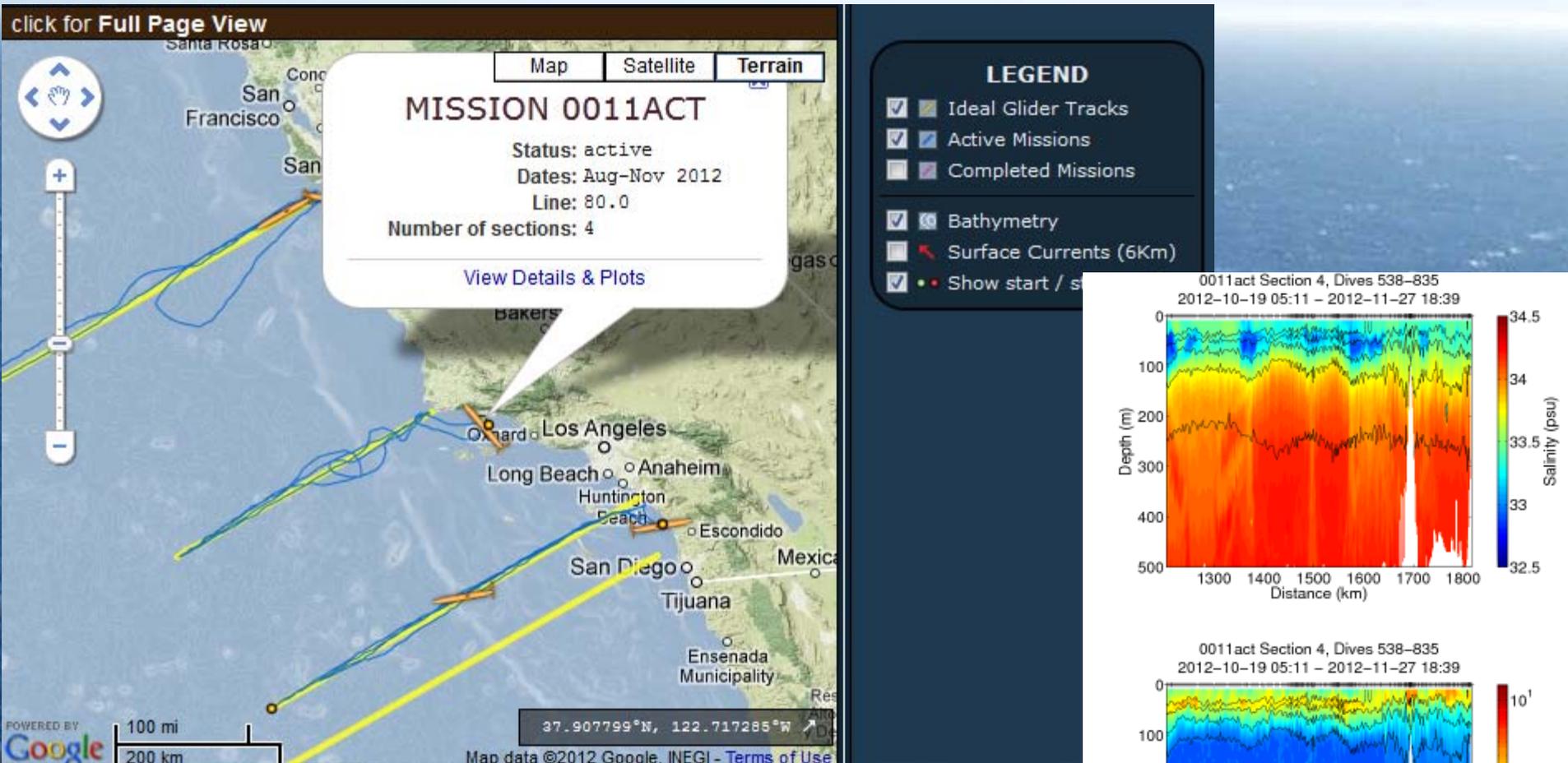
How Gliders Work...

Spray Underwater Glider



- Weight: 50 kg, Length: 2 m, wingspan: 1 m
- Profiles by changing buoyancy
- Steers by changing center of mass
- 2-way Iridium communication
- GPS navigation
- Pressure, temperature, salinity, velocity, chlorophyll, fluorescence, acoustic backscatter, nitrate, optical backscatter, ...

SCCOOS Glider info



These are the current active gliders in California

<http://www.sccoos.org/data/spray/?r=0>

Possible Future Capabilities

http://cencoos.org/sections/news/Pacific_glider_crossing.shtml

- Surface wave gliders

4 wave gliders were launched on Nov. 7, 2011 out of San Francisco. During their 33,000 nautical mile journey, they will travel across some of the world's most challenging environments.

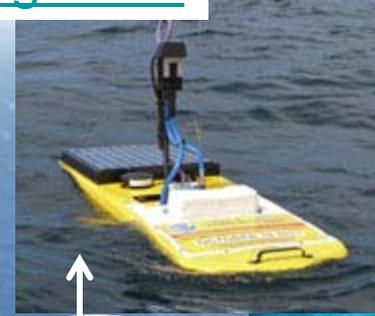
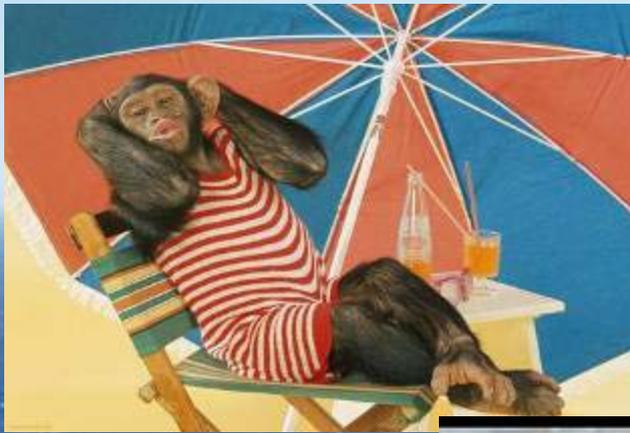


Photo from above and below

- Ambient noise and acoustic tag monitoring

Acoustic tags, small sound emitting devices, have been mounted on various pelagic fish. Receivers on moorings and wave gliders detect tagged fish that are within 400 - 800 m, and the information is relayed to shore via satellite. Other types of receivers detect ambient noise. Other types of animal tags measure oceanographic properties as well as animal's position.





BREAK!!



Meet Back in This Room in 15 Minutes, Thank you!

Coastal Data Information Program

Wave Buoys

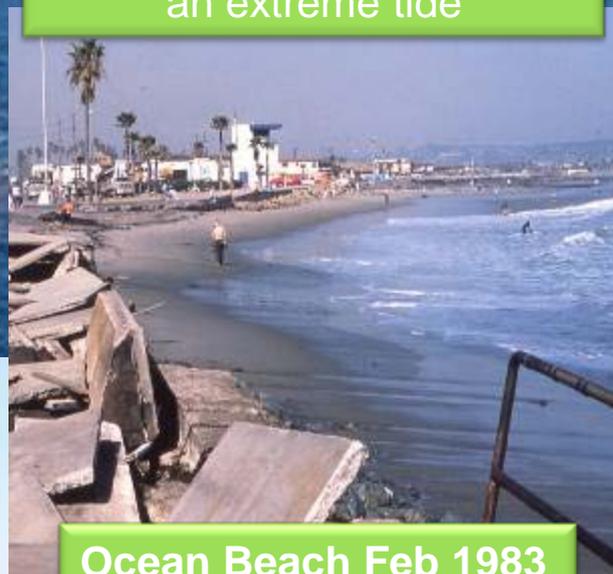
Mission: Monitor and predict near shore waves and shoreline change.



- Based at SIO since 1975
- 35 Wave Stations
LIDAR & In-Situ Beach Surveys
- \$3.5M+ / year budget
- Funded by:
USACE
CDBW (SCCOOS
NOAA, CCC, ONR...)

Investigators:
Richard Seymour
Robert Guza
Bill O'Reilly

Storm and El Niño enhanced sea levels during an extreme tide



Ocean Beach Feb 1983

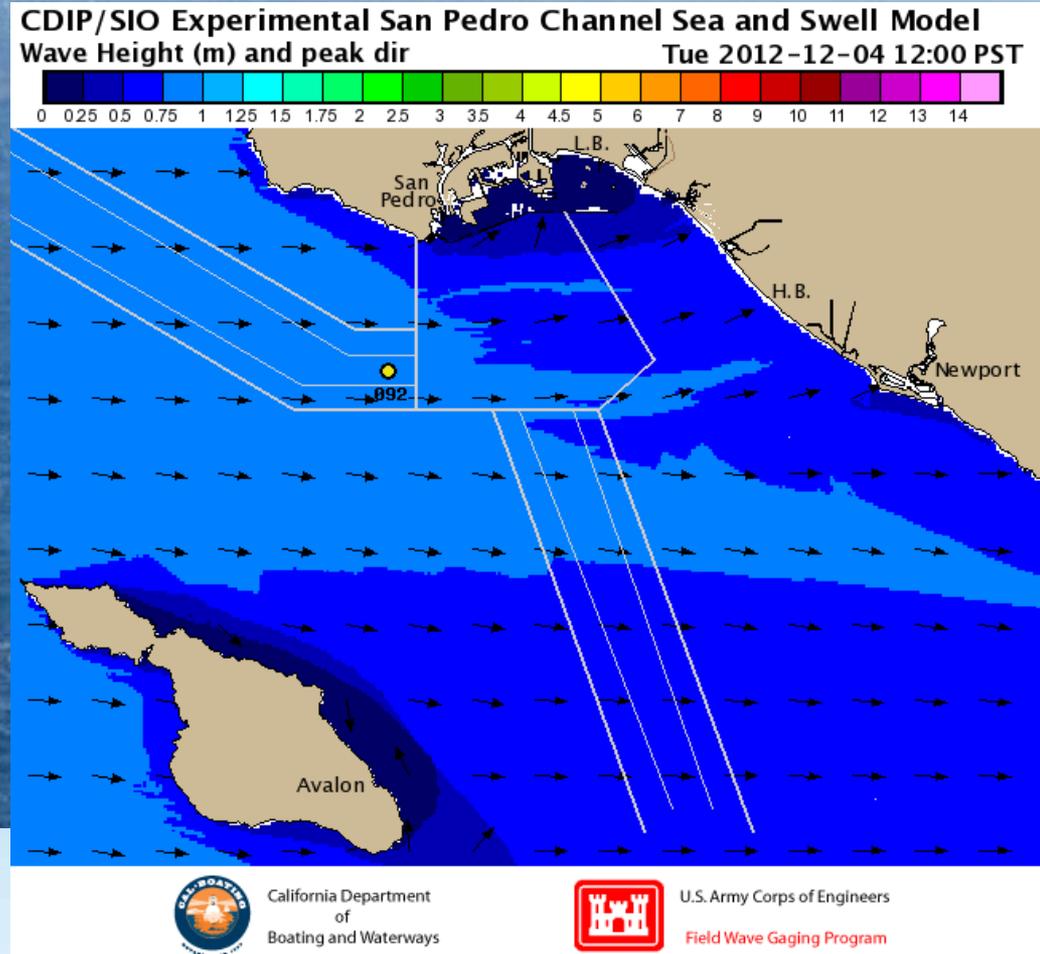
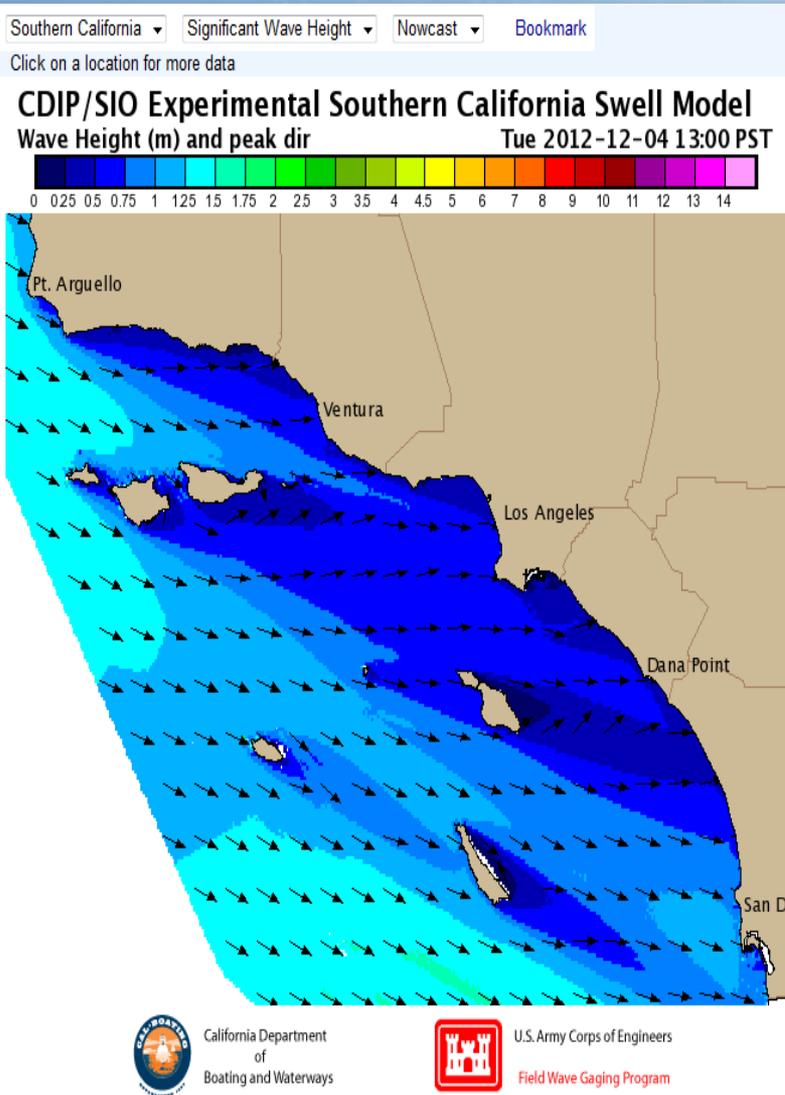
**Current CDIP
Measurements
Contribute To Baseline
& Sustaining Data**



CDIP wave buoys in California

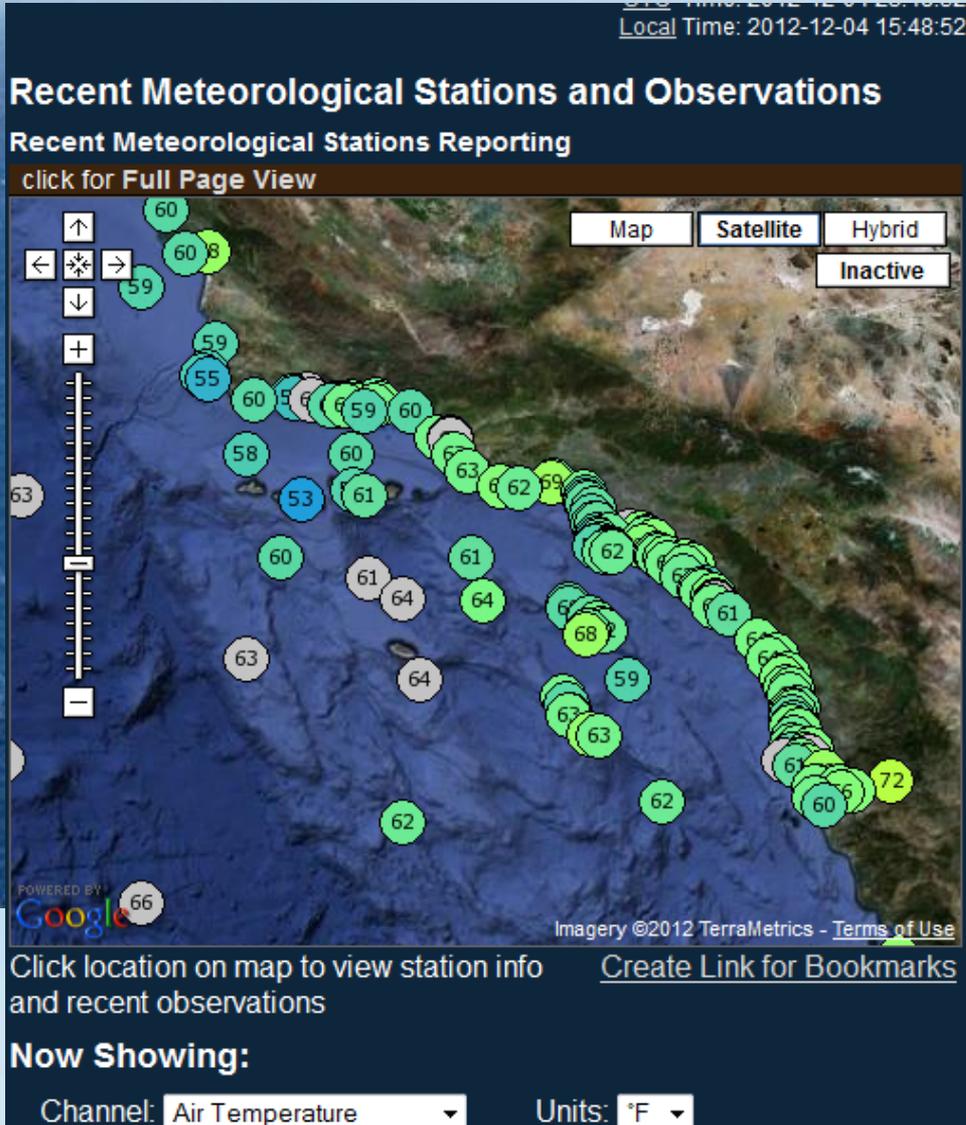
Swell Model

<http://www.sccoos.org/data/waves/?r=0>



Meteorological Observations

<http://www.sccoos.org/data/mets/>



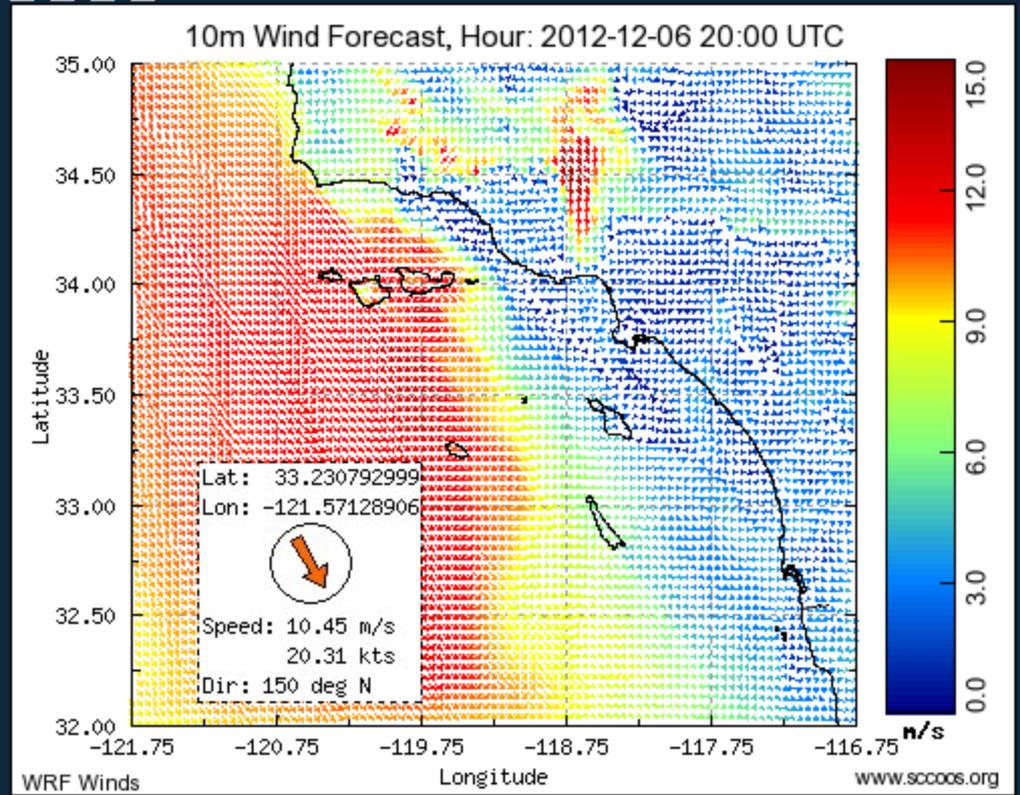
Weather Research & Forecasting 12.5 km Model

<http://www.sccoos.org/data/winds/>

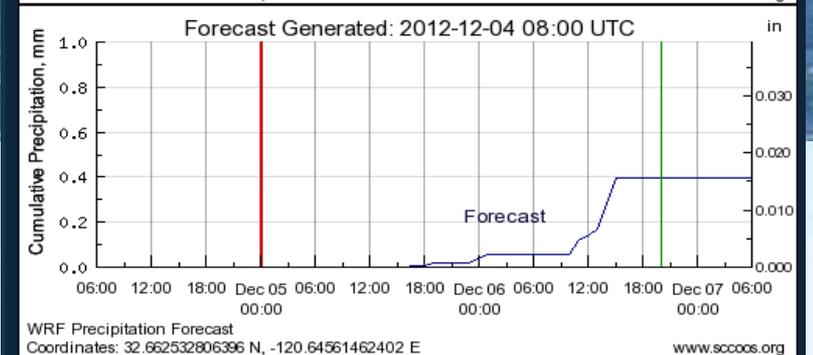
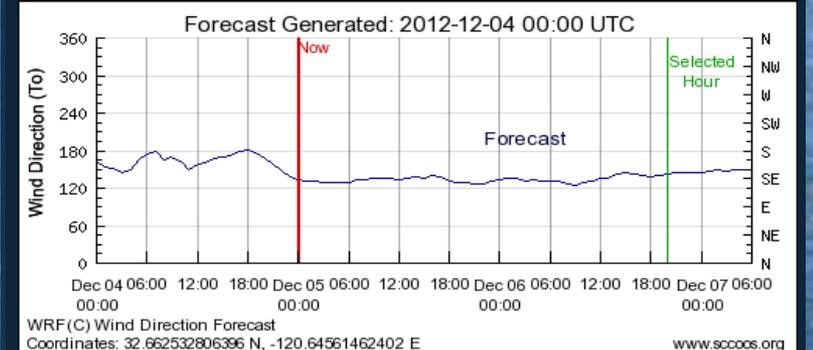
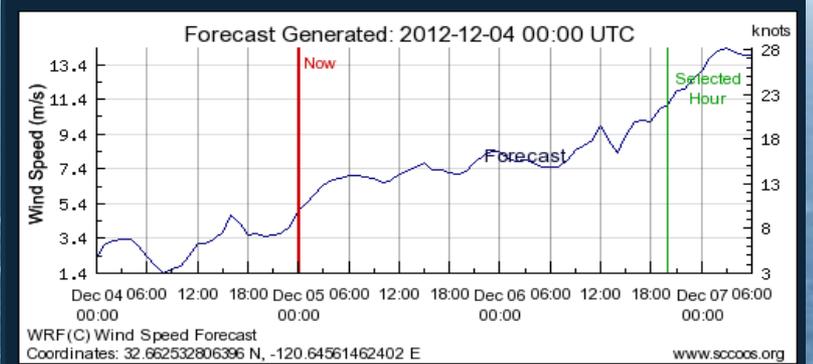
WRF 12.5km Modelled 10m Wind Fields - Southern California
 UTC Time: 2012-12-04 23:58:29
 Local Time: 2012-12-04 15:58:29

Hourly Forecasts
 Time Sample: 2012-12-06 20:00:00 UTC

-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54																					



WRF Timeseries Plots at 32.662532806396, -120.64561462402
 UTC Time: 2012-12-05 00:00:12
 Local Time: 2012-12-04 16:00:12



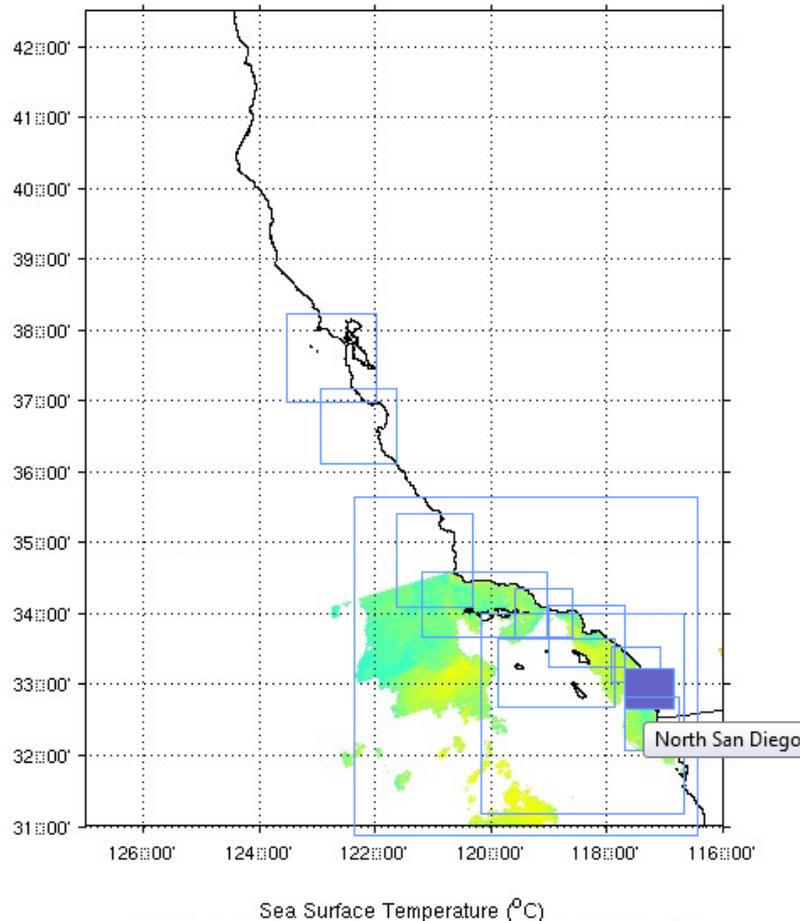
Remote Sensing Sea Surface Temperature and Chlorophyll

http://www.sccoos.org/data/modis/modis_california.php

MODIS California Overview

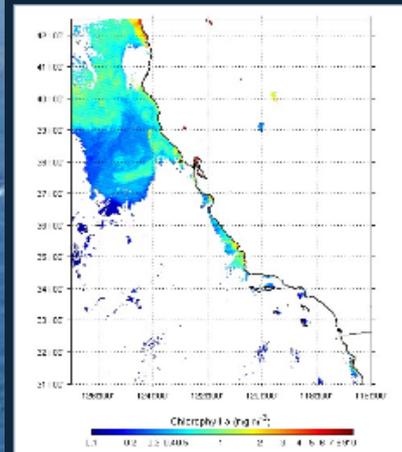
Time of pass: Nov 24 2012 20:30:00 UTC

[Nov 29] [Nov 26] [Nov 25] [Nov 25] [Nov 24] [Nov 24] [Nov 24] [Nov 19]

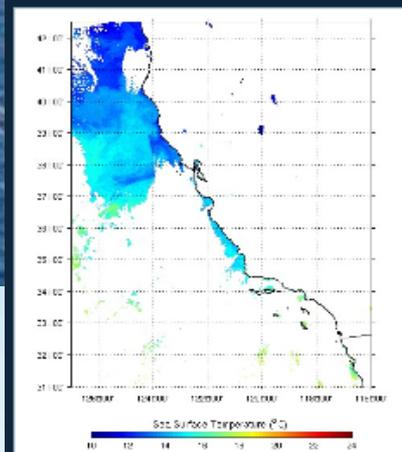


MODIS » California

Time of pass: Nov 25 2012 21:15 UTC



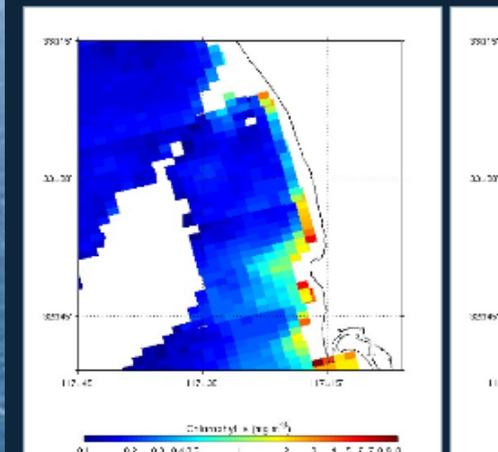
Chlorophyll



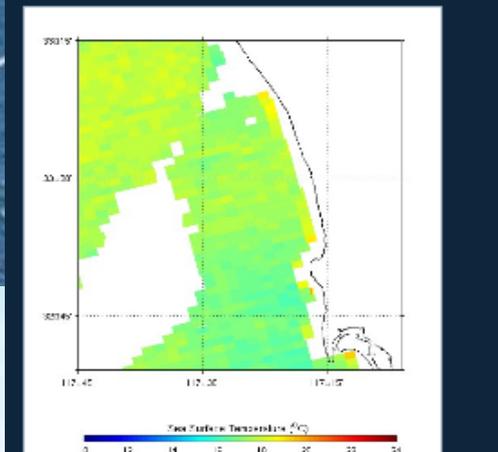
SST (Sea Surface Temperature)

MODIS » North San Diego

Time of pass: Nov 24 2012 20:30 UTC



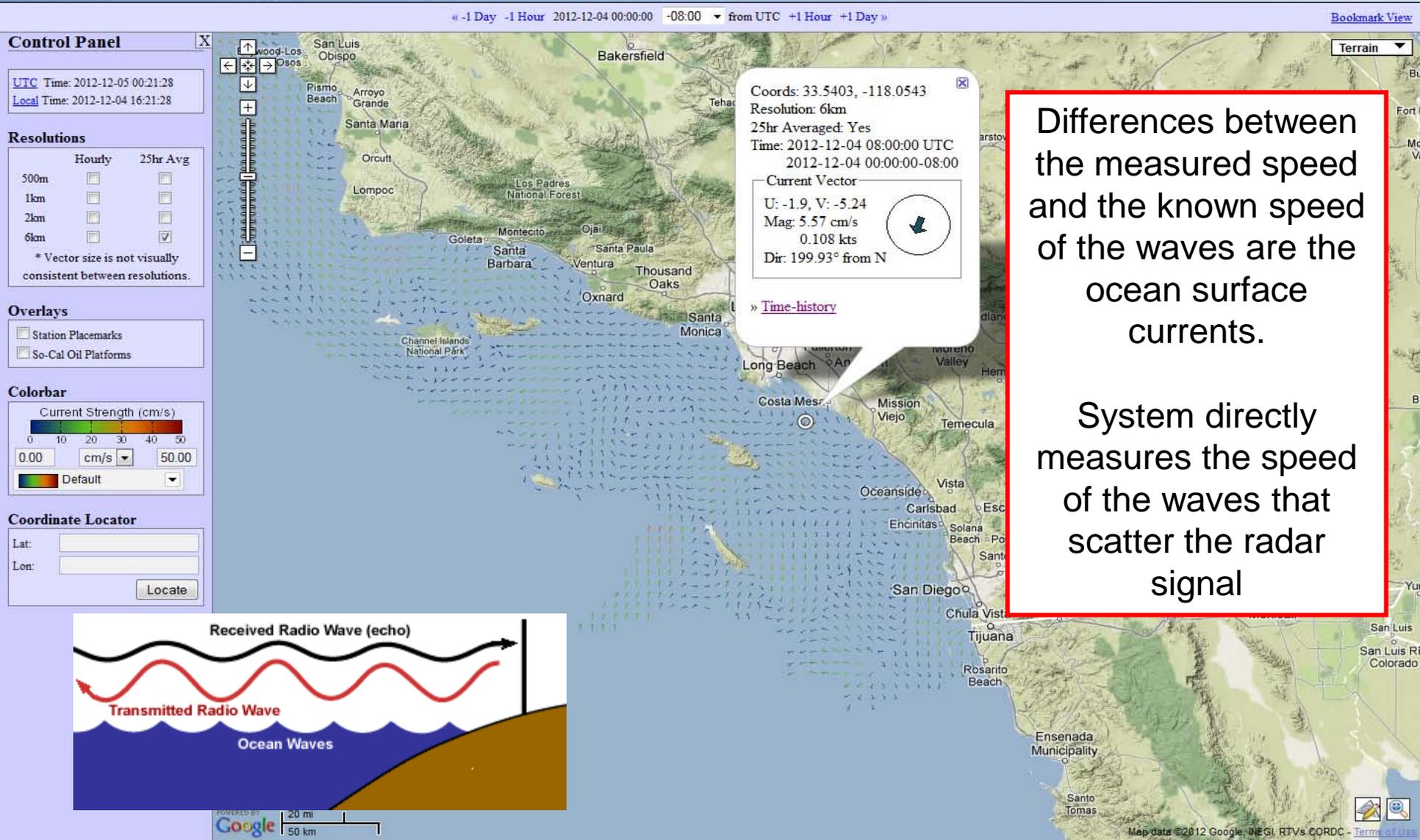
Chlorophyll



SST (Sea Surface Temperature)

HF Radar Surface Current Maps

<http://www.sccoos.org/data/hfrnet/>



Differences between the measured speed and the known speed of the waves are the ocean surface currents.

System directly measures the speed of the waves that scatter the radar signal

Real Time Processing of HF Radar-Derived Surface Current Mapping Data

- ✦ Retrieve radial current fields from each site each hour
- ✦ Form vector maps
- ✦ Fill spatial gaps
- ✦ Compute surface particle trajectories
- ✦ Estimate tomorrow's velocity fields based on recent mean current and tidal fluctuations
- ✦ Produce netCDF file for GNOME model with 48 hr observations and 24 hr forecast



COCMP

Coastal Ocean Currents Monitoring Program

Why is surface current mapping with high frequency radar (HFR) important?

Local, state, and federal agencies, educators, scientists, and the general public can use web based products to:

- ⊖ Tracking oil and other pollutants to improve water quality and reduce exposure
- ⊖ Manage marine fisheries – larval transport maps , MPA management, help design conservation areas
- ⊖ Increase efficiency & safety of maritime shipping
- ⊖ Aid USCG search and rescue operations
- ⊖ Track planned and unplanned coastal discharges
- ⊖ Aid recreational boaters – sailing races, boat deliveries, ect

As a long term time series of surface currents are established, HF radar derived surface currents have the ability to:

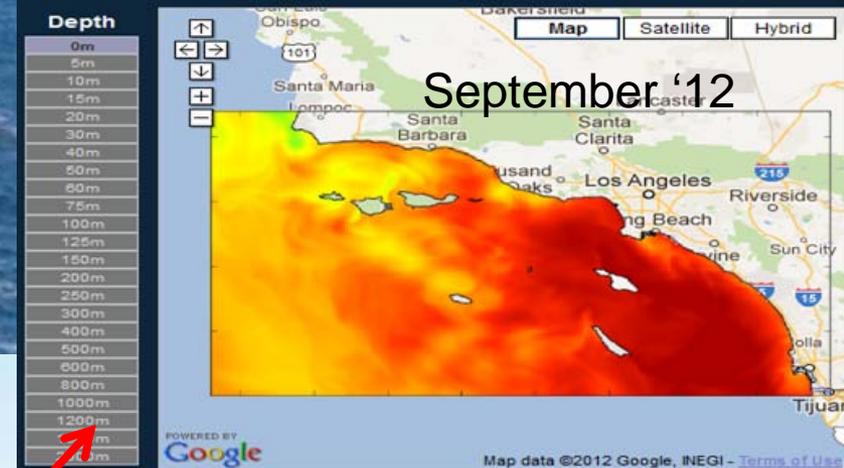
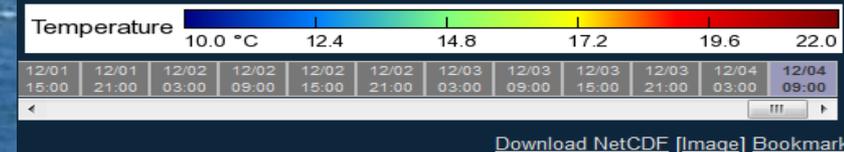
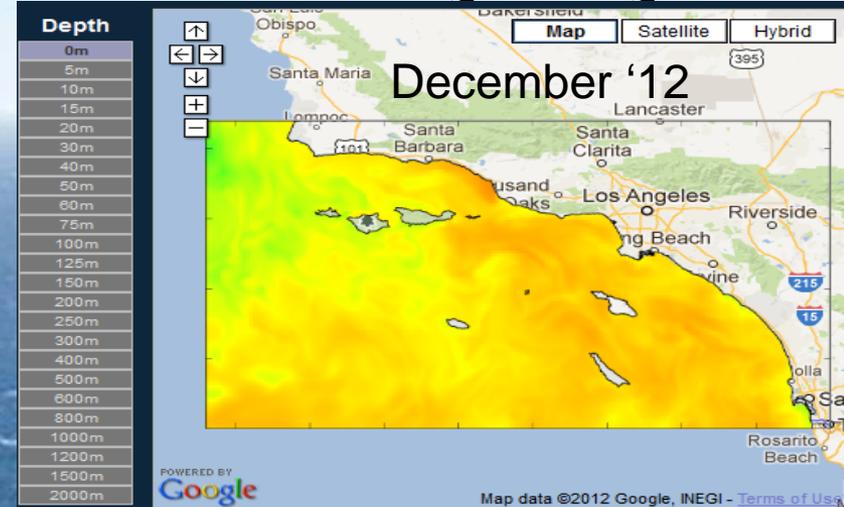
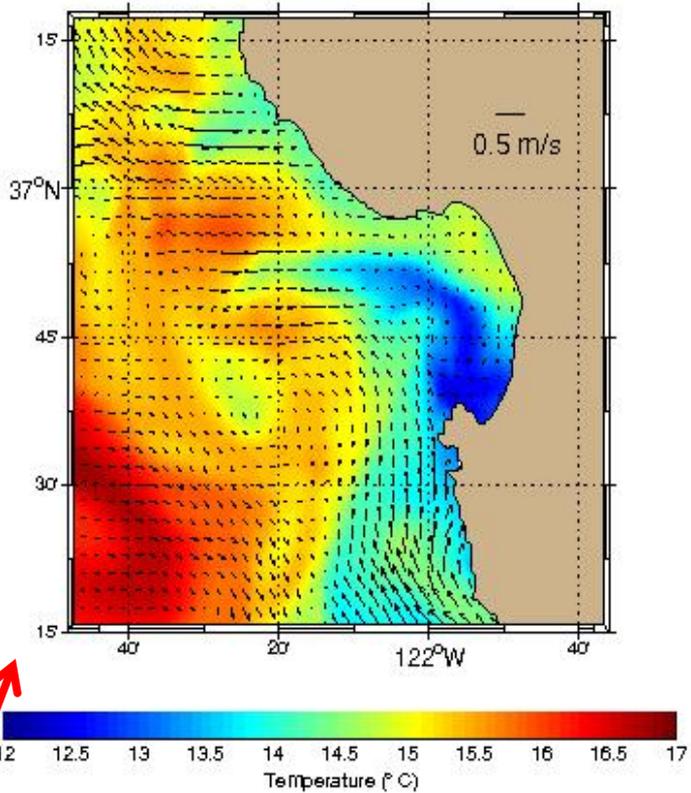
- ⊖ Monitor climate change
- ⊖ Assess the impacts of climate change on coastal habitats
- ⊖ Increase precision in weather and climate forecasts
- ⊖ Predict storm surge
- ⊖ Mitigate coastal erosion

Numerical Ocean Models

- 1-2 km resolution models in Monterey Bay & SCB
- California 3 km resolution model
- 12 km resolution model running on the US West Coast
- Drop-a-drifter tool
- Virtual moorings
- Coupled physical-ecosystem models under development

1-2 km resolution models in Monterey Bay and Southern CA Bight

Temp (°C, color), Current (m/s, arrows) at 0m for 11/06/2010 at 3GMT



<http://www.cencoos.org/sections/models/ROMS.shtml>

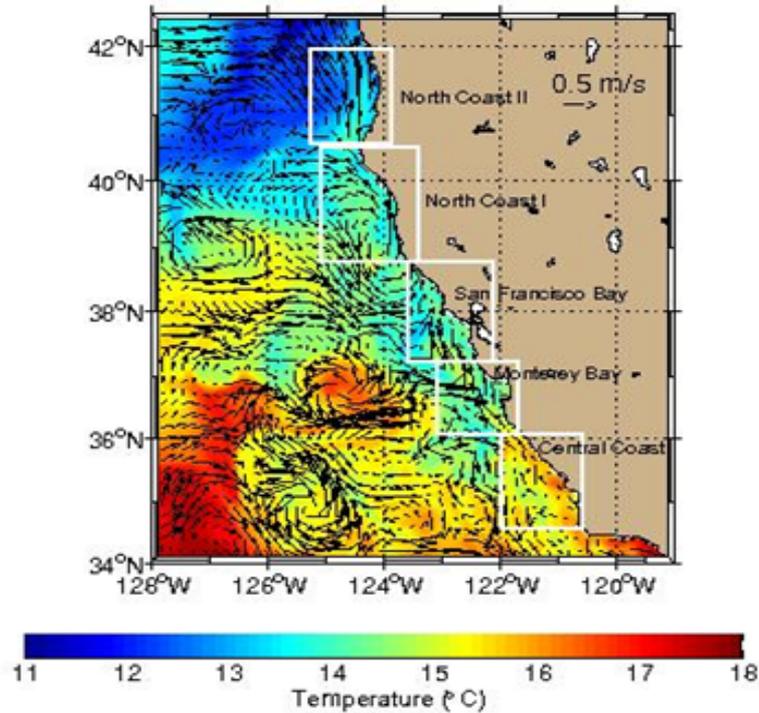
<http://www.sccoos.org/data/roms/>

Download NetCDF [Image] Bookmark

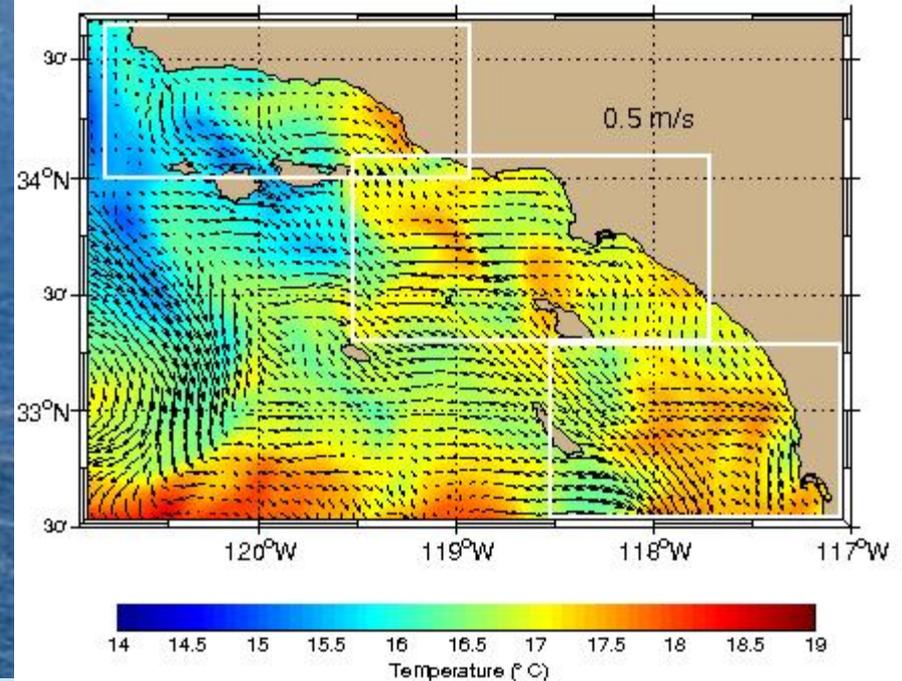
3 km resolution model covering ocean off California Coast

<http://ourocean.jpl.nasa.gov/CA/>

Temp (°C, color), Current (m/s, arrows) at 0m for 12/05/2012 at 3GMT

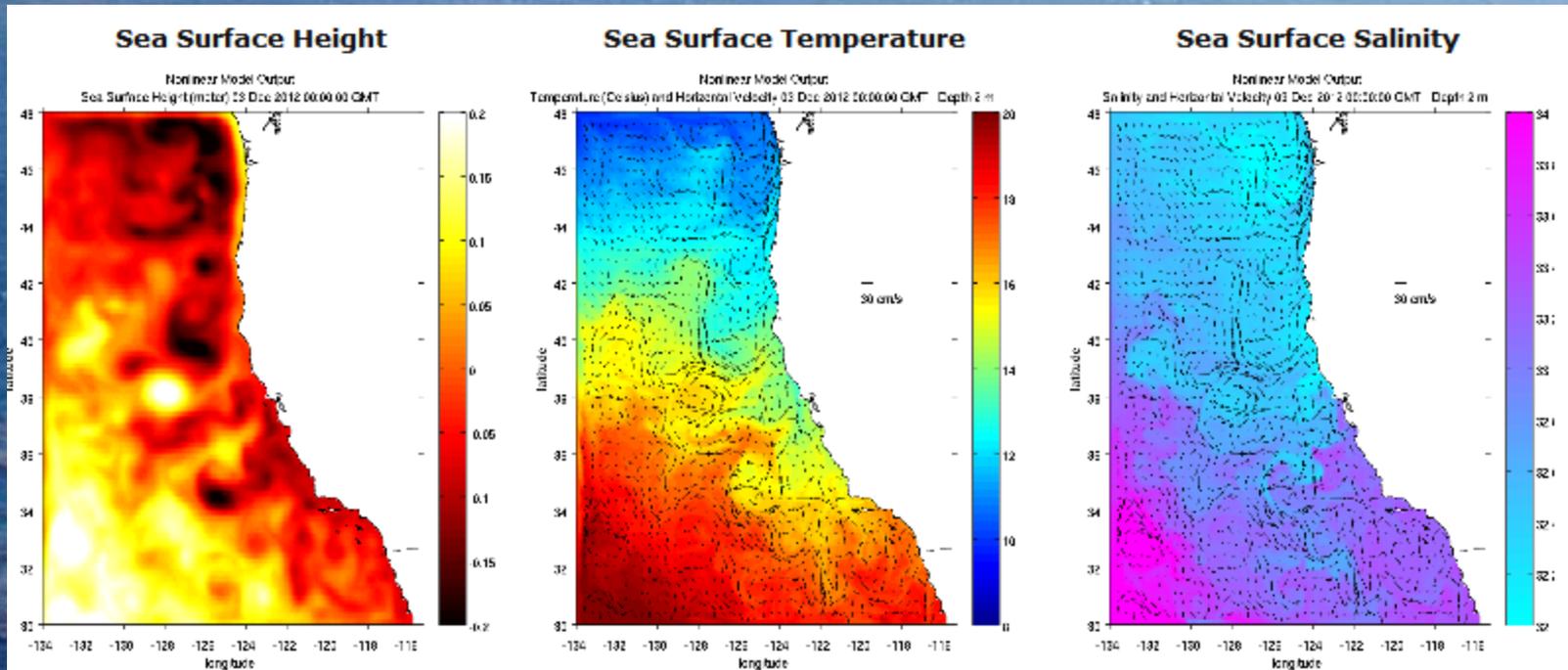


Temp (°C, color), Current (m/s, arrows) at 0m for 12/05/2012 at 3GMT



ROMS Nowcast - Temperature

12 km resolution model within the California Current System



http://www.cencoos.org/sections/models/UCSC_ROMS.shtml

"Drop-a-Drifter" Surface Water Trajectories

http://www.cencoos.org/sections/products/drop_a_drifter.shtml

<http://ourocean.jpl.nasa.gov/SCB/scbmangen.jsp>

If you wish to determine the origin of something found floating or on the beach, please use the multiple drop mode and: select an end time of whenever it was found and a start time previous to the end time, then drop multiple drifters over a large area to see the most likely origin.



SCCOOS 3 day est.
Trajectory in single drop
mode



SCCOOS 3 day est.
Trajectory in multiple drop
mode

SCCOOS Virtual Moorings

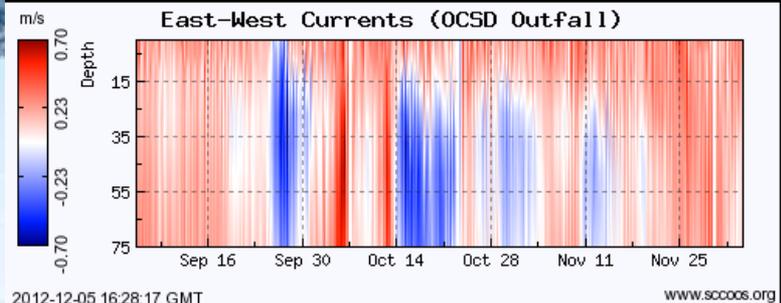
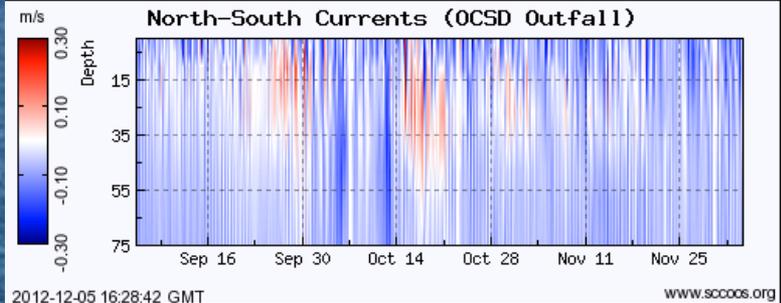
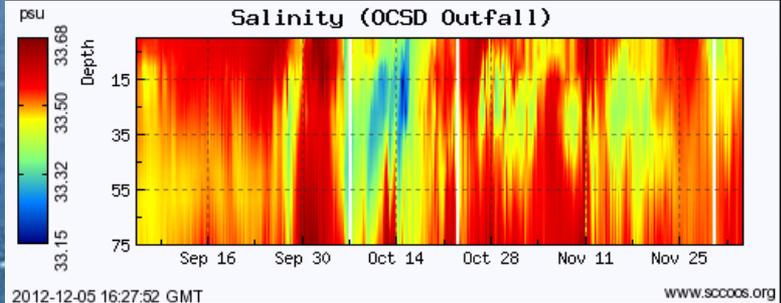
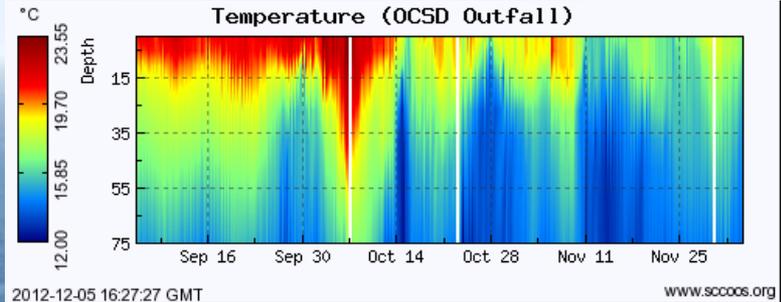
Virtual Moorings

ROMS Model Output



Site Name	Location
CalCOFI Line 55, Station 33	33.7500 -120.4100
Hyperion Outfall	33.9120 -118.5215
Near LACSD Outfall	33.7000 -118.3400
OCSD Outfall	33.5747 -118.0108
Point Loma Outfall	32.6657 -117.3248
South Bay Ocean Outfall	32.5367 -117.1850
Santa Monica SMBO Mooring	33.9333 -118.7167

Recent Profiles:
[2 Week](#) [1 Month](#) [3 Month](#) [6 Month](#) [1 Year](#)



<http://www.sccoos.org/data/roms/virtual/>

Biological and Geochemical Forecast Models Under Development or Consideration

- Statistical models relating ocean conditions to HABs
- Linked hydrologic, ocean, atmosphere models to forecast salmon populations
- Coupled physical/NPZD (nitrogen, phytoplankton, zooplankton, detritus) models for ecosystem forecasts
- Geochemical modeling to identify natural and outfall-based sources of nutrients



Lunch...Yum!

**We will resume 1 hour,
Thank you!**