
Ocean Observing System Systems
Ocean at your fingertips
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Outline

- Overview
  - *Ocean observing systems - general*
  - *The example of a regional system: SCCOOS*
  - *SCCOOS today – who how where*
  - *Primary Elements of SCCOOS*
- Our part in SCCOOS
  - *HF radars*
  - *Boat operations*
  - *Manual sampling*
  - *Gliders*
- Classroom applications
  - *Ideas for classroom*

Ocean observatory systems

From Monterey Bay 2006 field experiment
http://www.mbari.org

- networks that monitor conditions in critical coastal and remote open-ocean locations
- provide a continuous flow of data in near-real time to scientists and marine resource managers onshore
- provide critical information for research on climate change, biogeochemical cycles, ecosystem assessment, and environmental hazards
- enhances presence in the ocean—follow the changes in the ocean over longer period of time

Discrete vs. Continuous data – household example

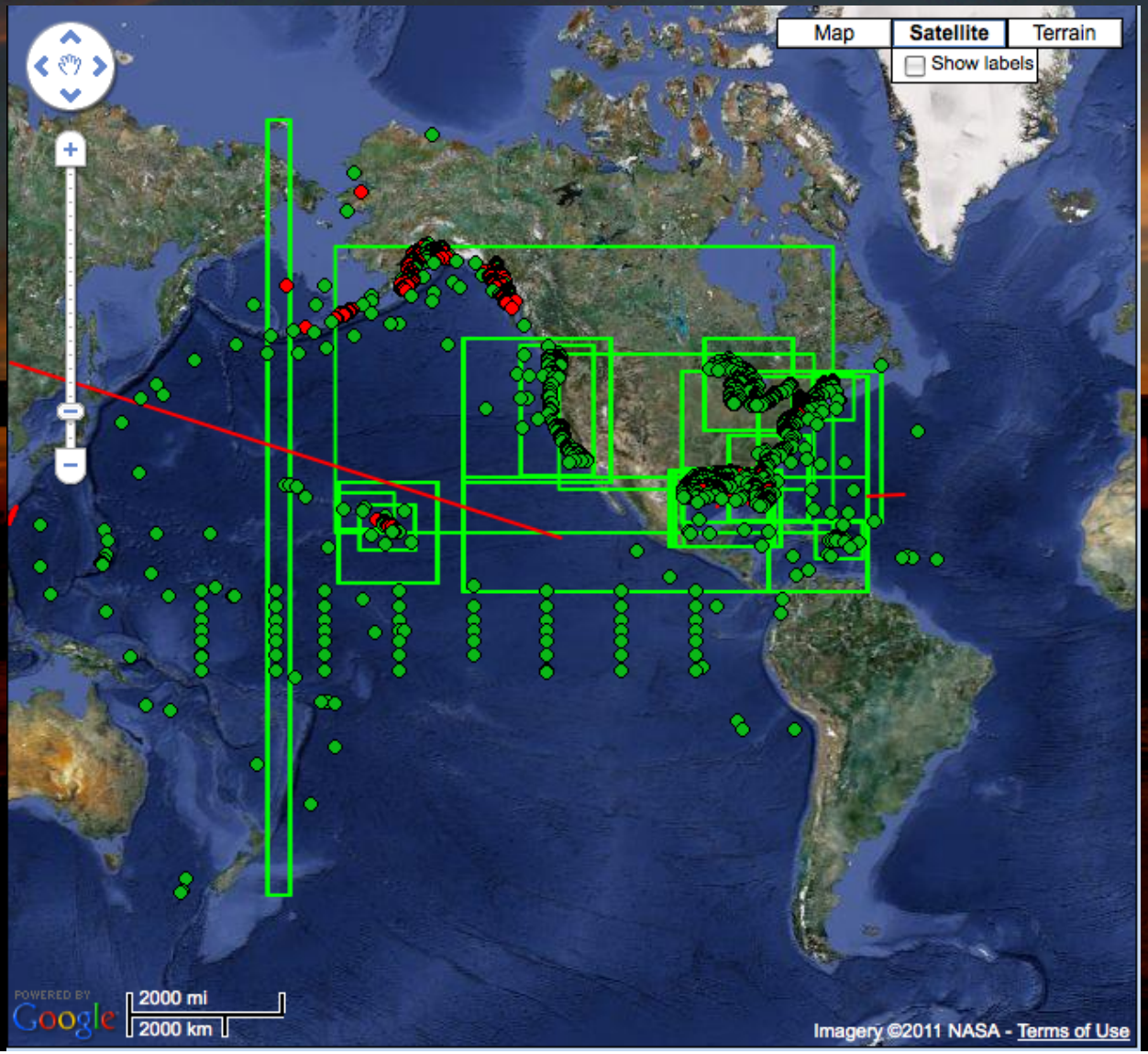
allows us to better

cean

Hierarchy of Ocean Observing

- Global Ocean Observing System (GOOS)
  - *single, contiguous, body of water encircles the globe. From the Arctic ice through the warm equatorial waters to the Antarctic Circumpolar Current all the Earth's oceans, seas, bays and inlets are connected. They form one body of water, the one Global Ocean.* ***GOOS*** *is designed and being implemented to embrace the oceans as a single entity, to provide a global view of the ocean system.*
- GOOS is comprised of a set of national and regional OOSes around the world.
  - *Includes the U.S. Integrated Ocean Observing System (IOOS)*
  - *IOOS is comprised of 11 Regional Associations (RAs).*
    - Regional OOSes
      - *Example of the Southern California Coastal Ocean Observing System*

NOAA IOOS


Map
Satellite
Terrain
Show labels
POWERED BY
Google
2000 mi
2000 km
Imagery ©2011 NASA - Terms of Use

Development of Collaborative Observational Efforts - Southern California

- Historical observing systems
- Evolution of NPDES efforts
- Specialized observation efforts
- Integrated ocean observing system

Historical Ocean Observing Systems in Southern California

- CalCOFI (California Cooperative Fisheries Investigations)
  - *>50 years (Started in 1949)*
- NOAA Buoys
- CDIP – Coastal Wave Prediction (1975)
- NPDES Permittee Monitoring (Clean Water Act 1972)
  - *Local Monitoring*
  - *Regional Monitoring / Assessment beginning 1994*
- NEOCO – Pier monitoring (Univ. of Calif.)
  - *Network for Environmental Observations of the Coastal Ocean*
  - *Began 1994*

Evolution of NPDES Regional Monitoring

Bight 94 (EMAP affiliation)

- *Goal: State of the Bight*
- *Municipal monitoring agencies only*
- *Agency transition from independent local sampling to regionally coordinated sampling*

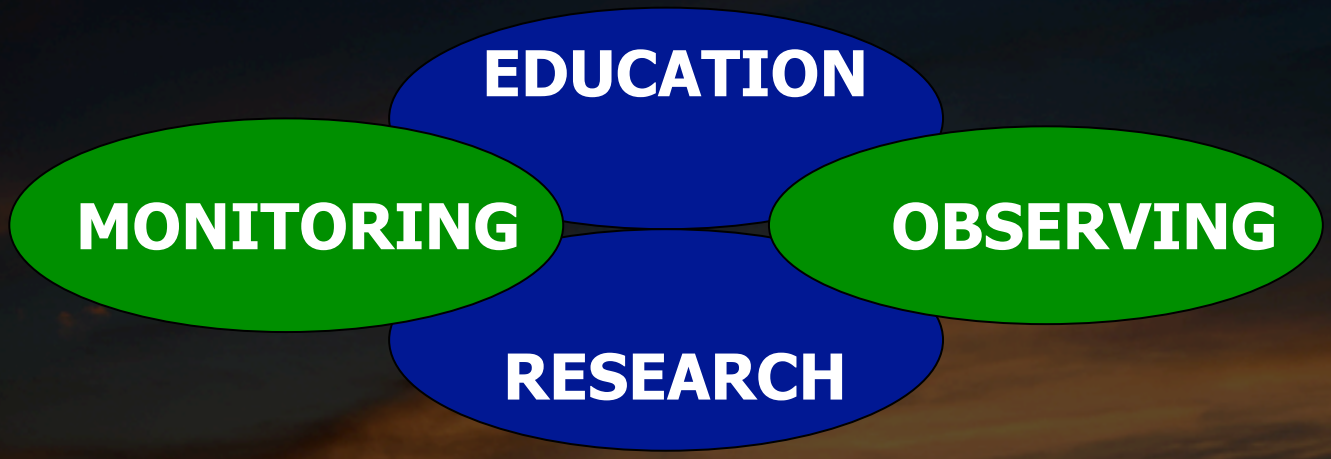
- Bight 98
  - *Beginning of academic collaboration with monitoring agencies*
  - *Water Quality focus on Stormwater Runoff*
- Bight 03
  - *Larger role of academic involvement*
  - *Collaboration of SCCOOS Components to provide complementary observational tools*
    - Remote sensing
    - Drifters
    - HF Radar surface current mapping
- Bight 08
  - *Collaboration of monitoring (agencies), observations (SCCOOS), and modeling (physics and biogeochemistry)*
  - *Focus on Harmful Algal Blooms and Nutrient Sources*

Focused Observational Programs: Specific Problem Areas

SCCOOS established by MOU in 2003

SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM


Cal Poly, SLO
University of California, Santa Barbara
University of Southern California
University of California, Los Angeles
Jet Propulsion Laboratories
Southern California Coastal Water Research Project
Scripps Institution of Oceanography
CALIT2
Raytheon Corporation
CODAR Ocean Sensors
NOAA
USGS
ACOE
ONR
OCSD
Los Angeles Regional Board
Southern California Coastal Ocean Observing System



Monitoring: *systematic collection of mission driven environmental data to determine current conditions, trends, variation*

Observing: *collection of real-time environmental data for a host of uses*

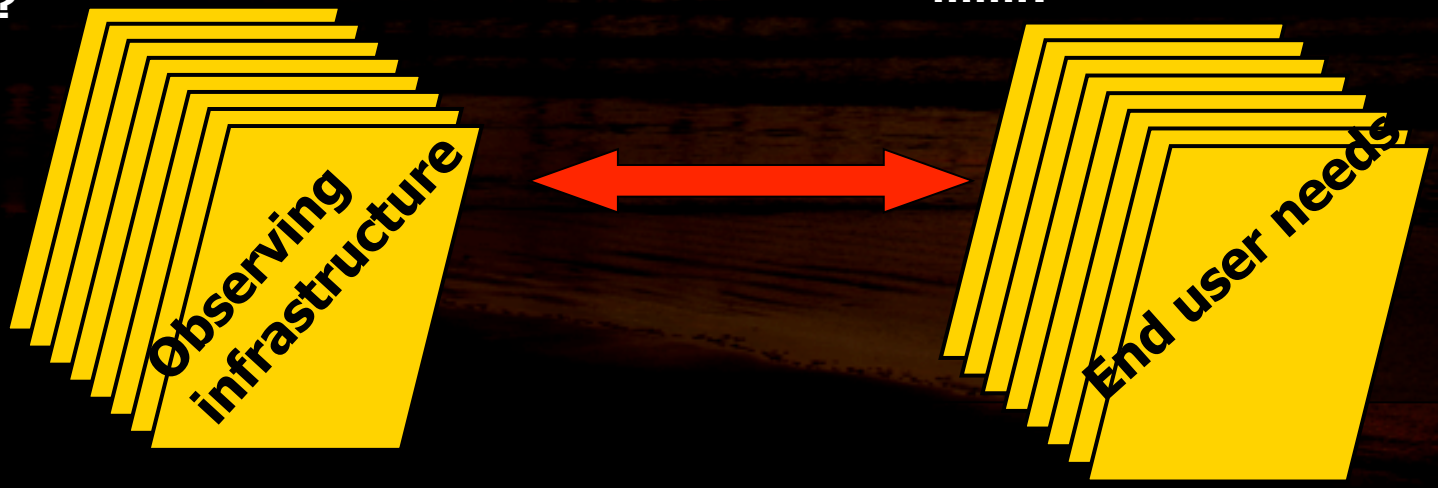
Research: *scientific investigation and scholarly pursuit of knowledge*

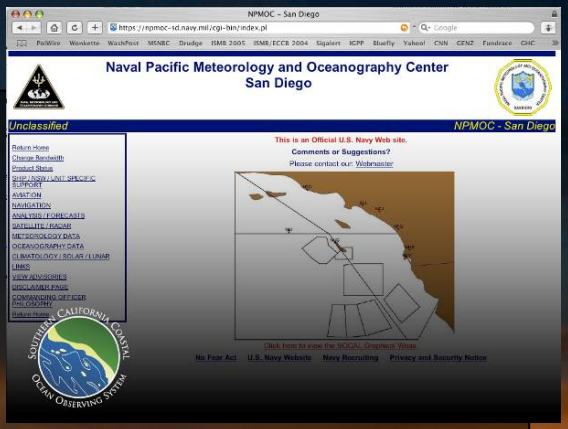
Education: *presentation of information in a manner that people can take action*

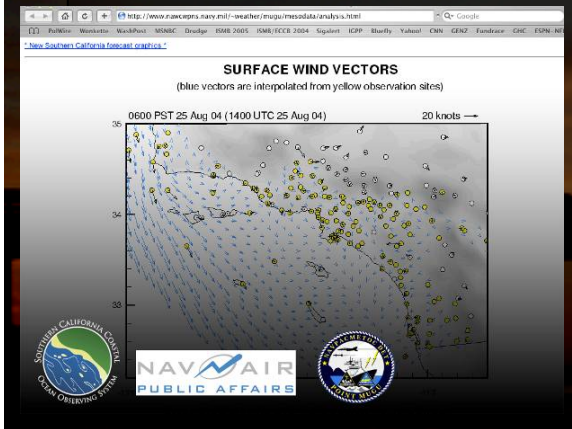
….the many layers of an integrated coastal observing system

- Existing agency monitoring
- surface current measurements
- satellite and aircraft remote sensing
- physical,bio-optical moorings
- autonomous vehicles
- meteorological measurements
- modeling
- distributed databases
- ……. ?

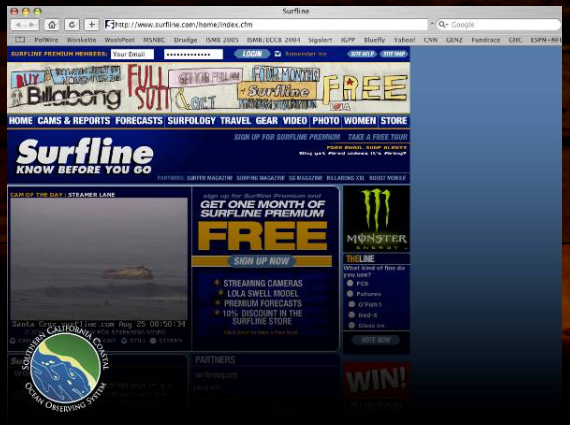
- water quality
- marine life resources
- coastal hazards
- educators
- search and rescue
- spill response
- security
- regional marine science
- …….?





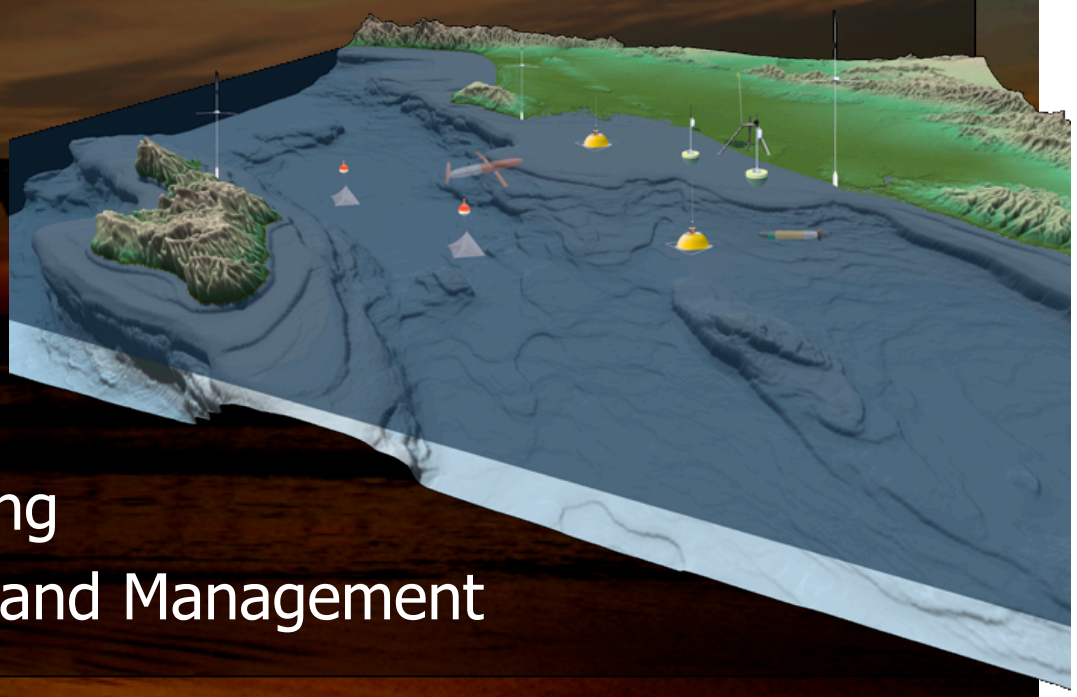


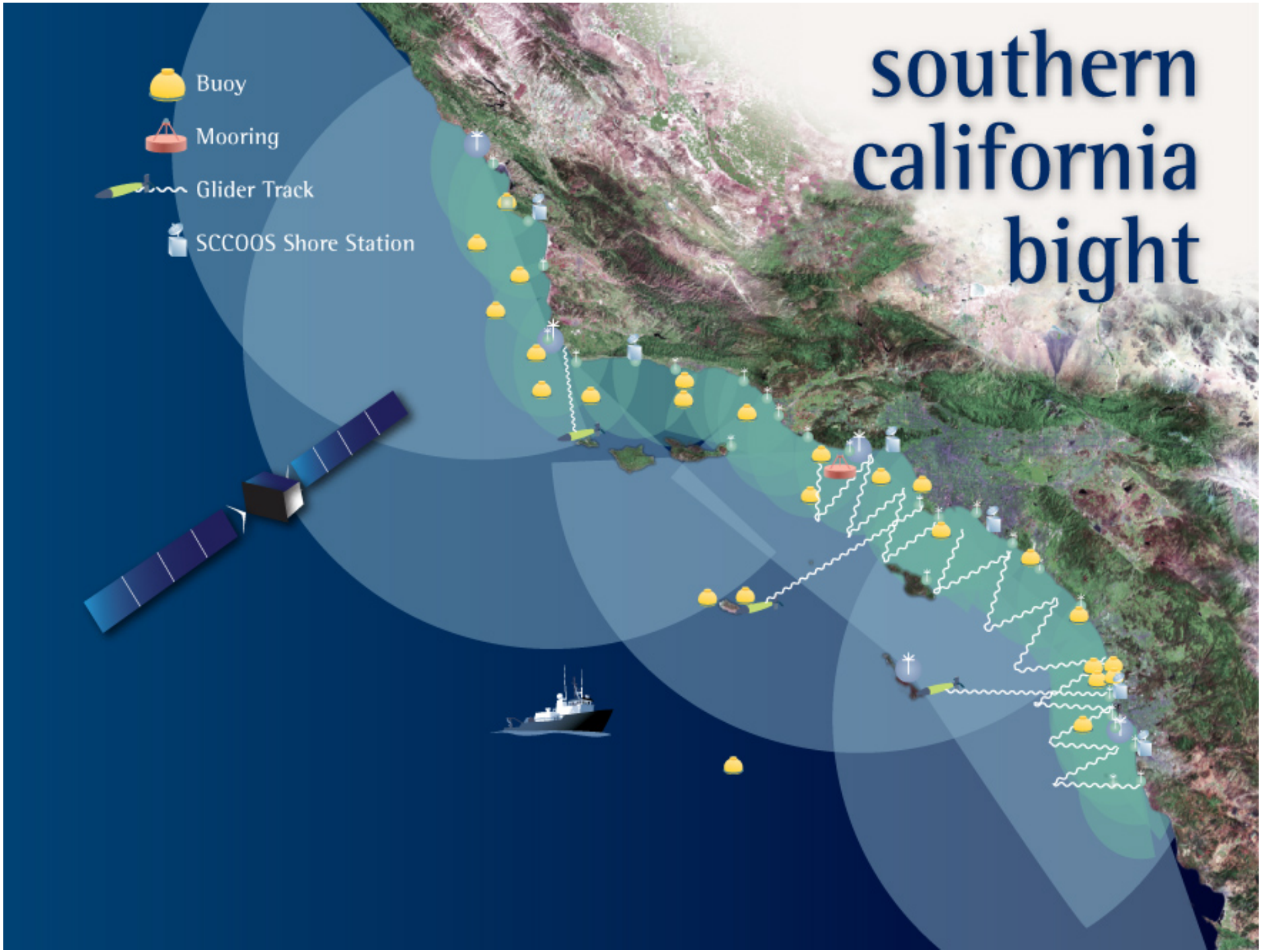
Partnerships with Agencies, Private companies, NGO community.



Primary Elements of SCCOOS

- Coastal Ocean Current Mapping (HF Radar Network)
- Meteorological stations
- Automated shore stations
- Manual shore station
- Boat based programs
- Moorings + buoys
- Gliders
- Remote Sensing
- Data Assimilation Modeling
- Data Base Development and Management




Buoy
Mooring
Glider Track
SCCOOS Shore Station
southern
california
bight

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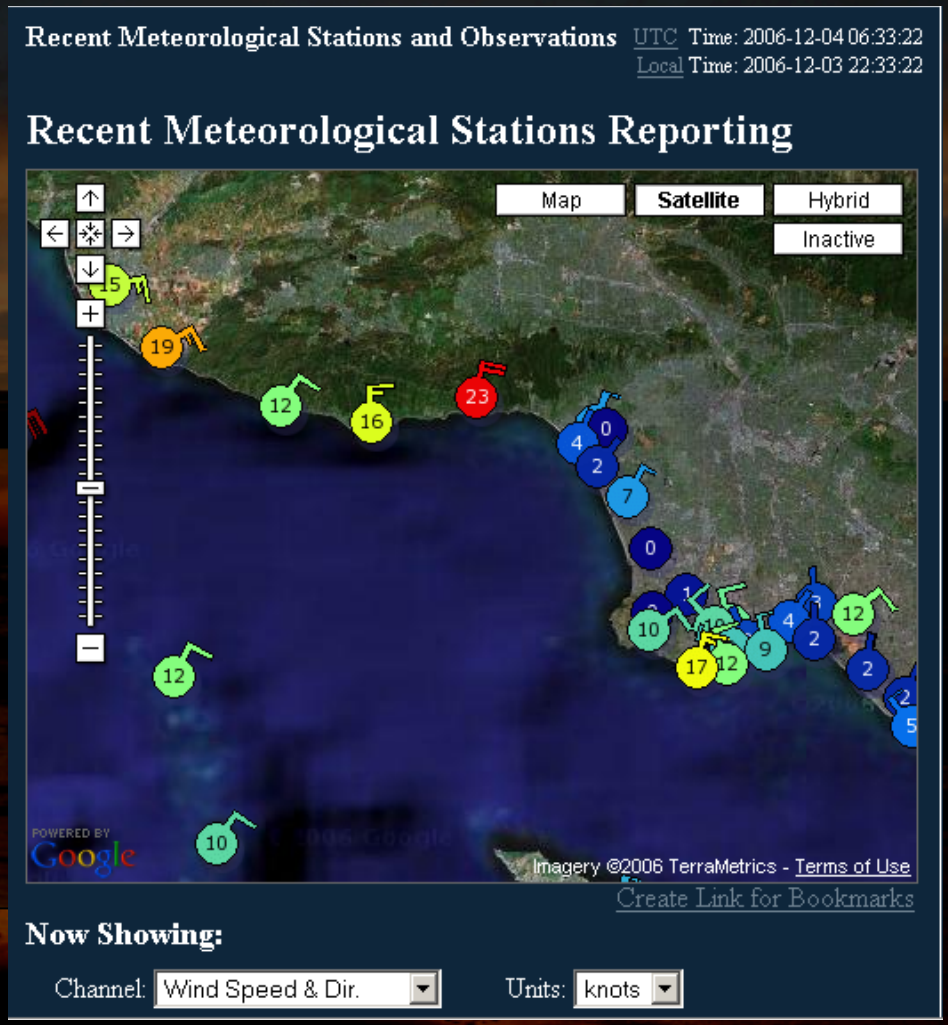
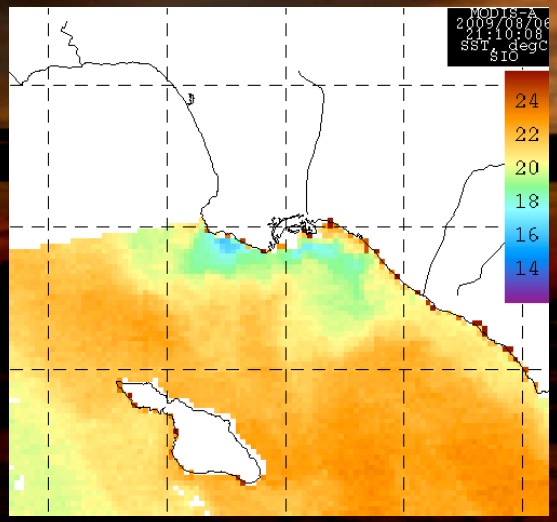
Meteorological stations

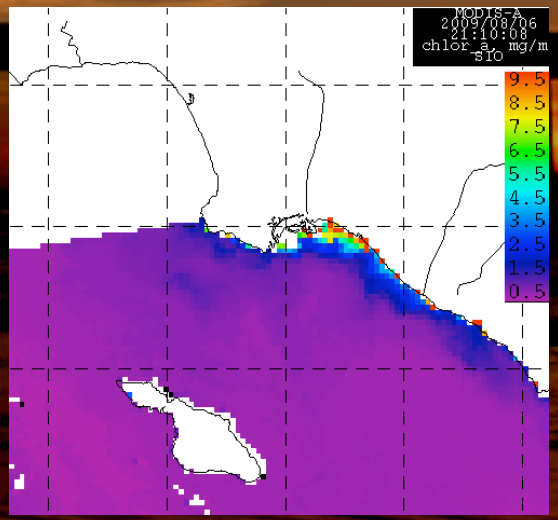
- along the coast
- provide wind speed, wind direction, air temperature, relative humidity, barometric pressure, solar radiation, rainfall and water temperature data
- coastal circulation, upwelling and changes to the weather and climate

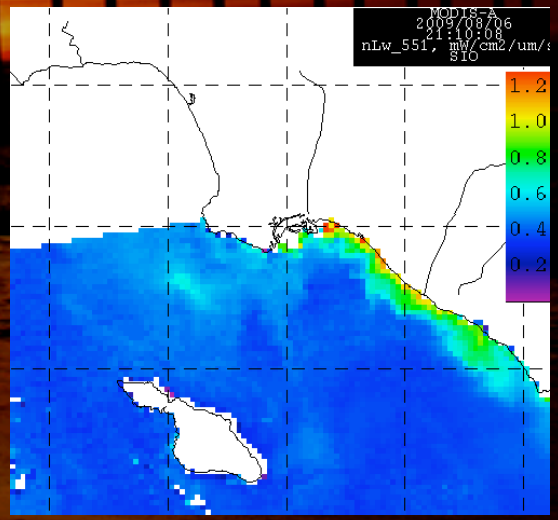


Remote Sensing

- OCM, MODIS, and GOES satellites for ocean color products
- chlorophyll and turbidity, sea surface temperature, and atmospheric conditions

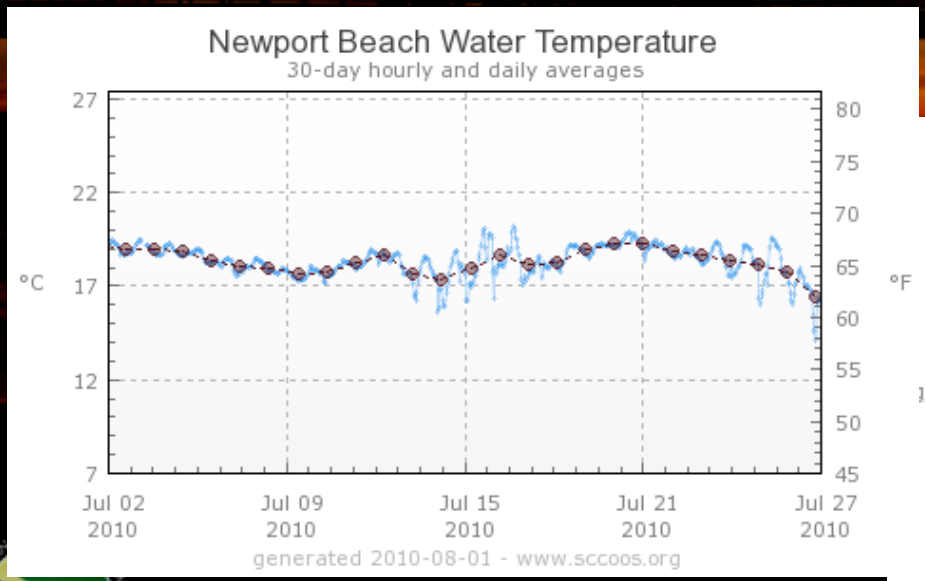


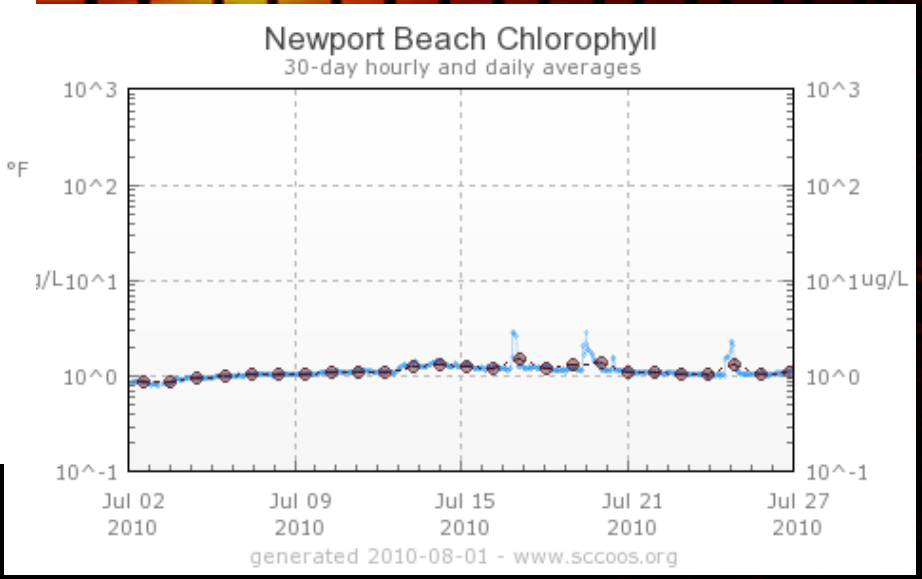




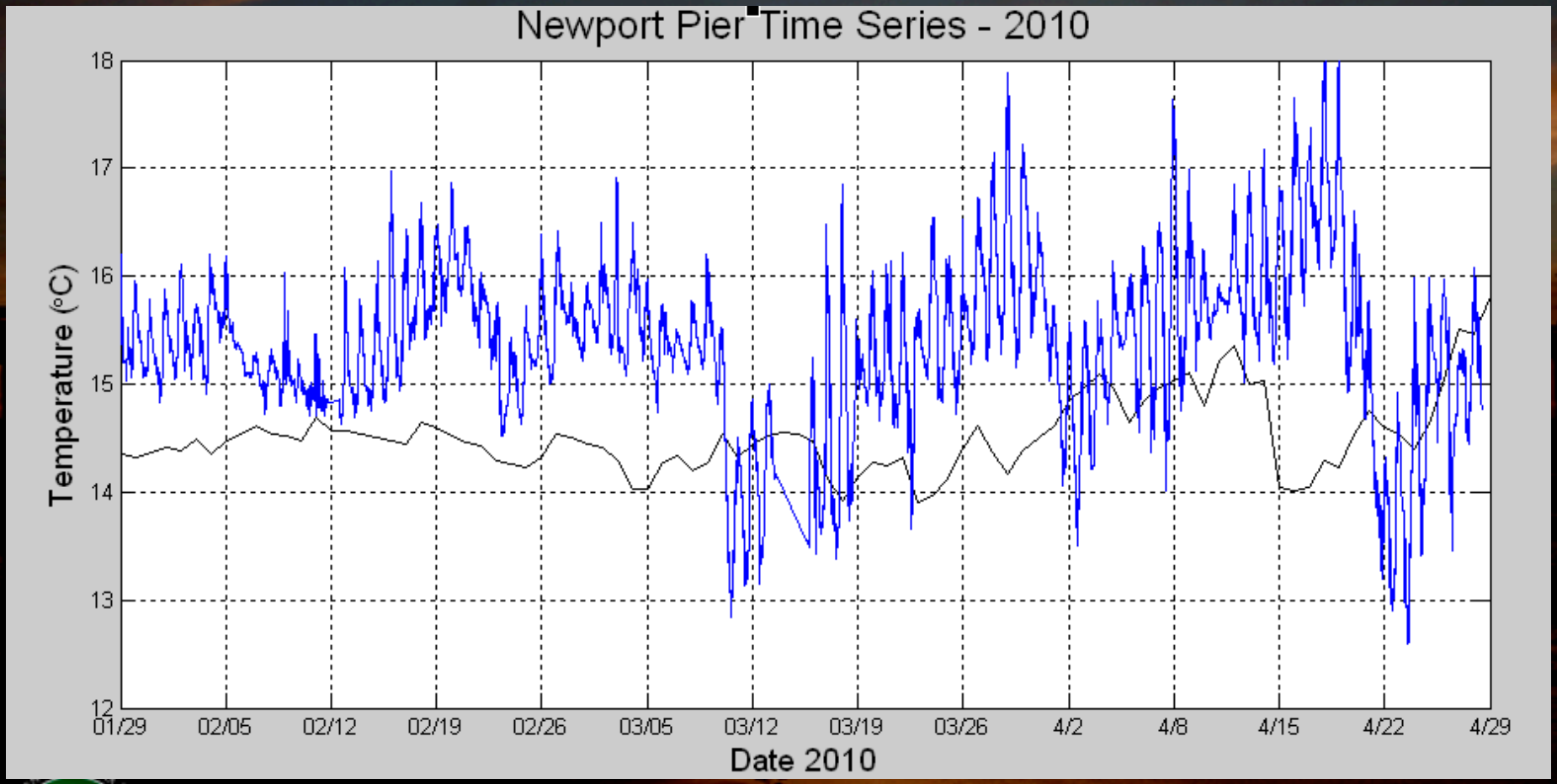
Automated shore stations

- suite of sensors at piers along the California coast
- automated sensors measure temperature, salinity, chlorophyll, turbidity and water level
- local and regional information on mixing and upwelling, land run-off, and algal blooms.



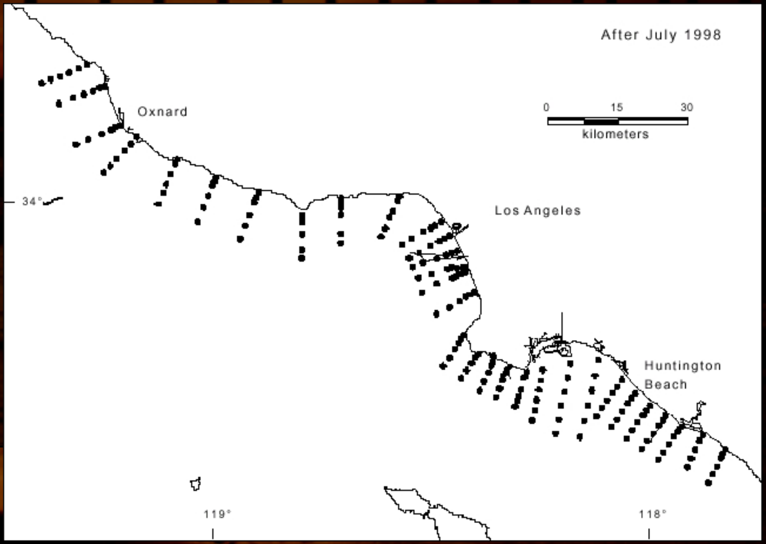


Long-term data sets - Pier Stations



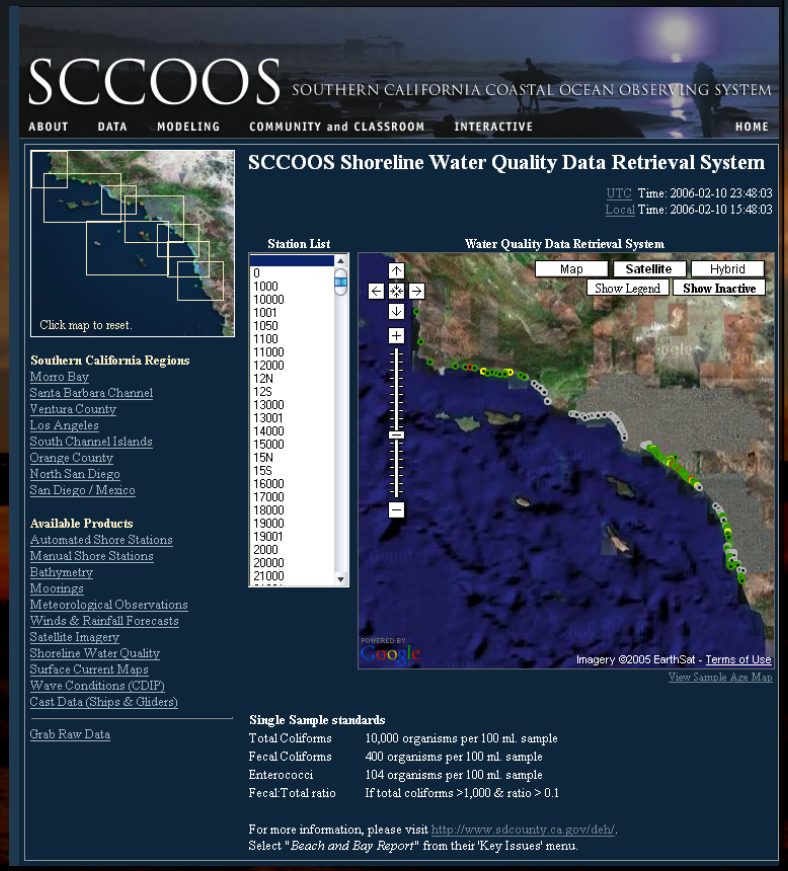
Cast data integration program

- snapshots of regional conditions at the time data are collected
- boat based programs sample physical, chemical and biological properties of the ocean
- using instruments that are generally attached to the ship and deployed overboard at specific stations
- discrete samples provide fine scale data
- ongoing series of cruises (**CalCOFI**) are invaluable for analysis of seasonal, interannual or long term changes in the ocean ecosystem.



Manual shore station - SCCOOS Water Quality

- Project involves 6 Health Agencies
- Encompasses 525 shoreline stations
- Regular monthly and/or weekly updates
- Ingests AB411 state mandated shoreline monitoring



Moorings + Buoys

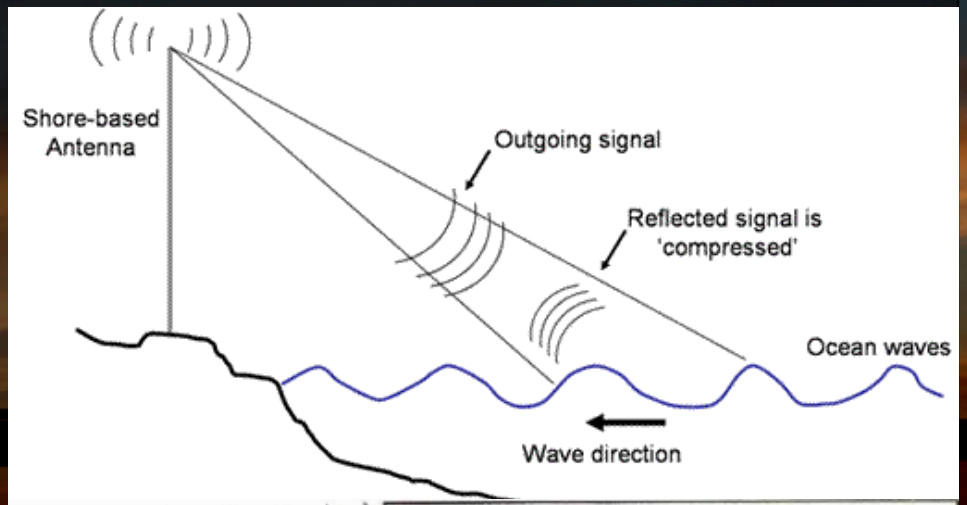
- several packages of automated sensors which are spaced throughout the water column
- Measure water temperature, salinity, turbidity, chlorophyll, nutrients, speed and direction of currents
- data is used in model forecasts, as well as in analysis of long term ocean trends.

Coastal Ocean Current Mapping (HF Radar Network)

- Specific length radio waves reflect off of the ocean surface
- Measure the speed and direction of ocean surface currents (to 1 meter's depth)
- Transmit antenna – ocean surface - receive antenna

Coastal Ocean Current Mapping (HF Radar Network)

- Surface Waves: half of the radar wavelength to be reflected back to the radar system
- Doppler shift: toward or away from the radar
- For true direction and velocity of surface waves, at least 2 radars needed



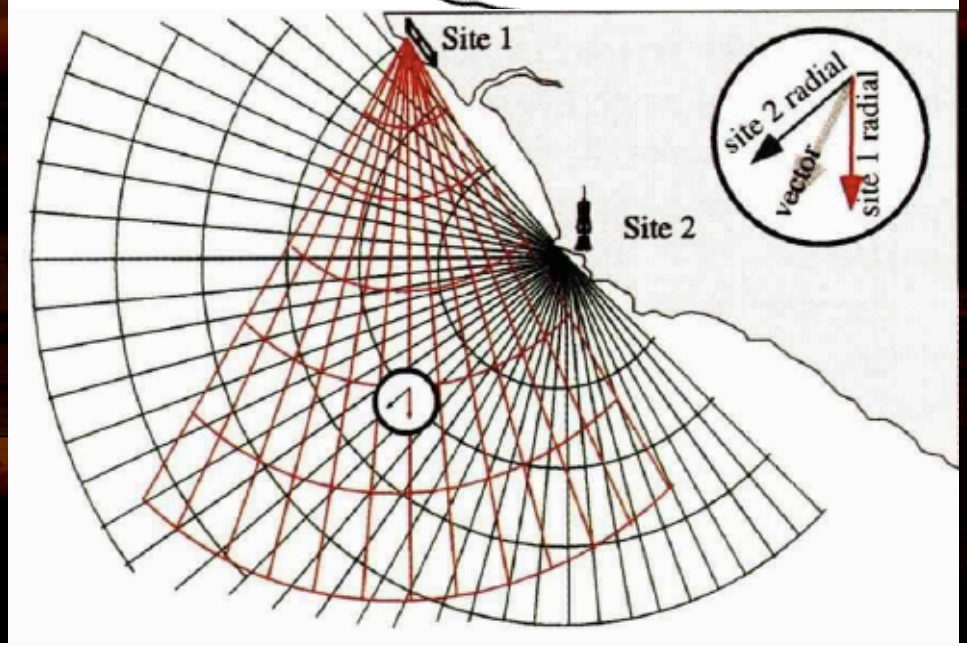
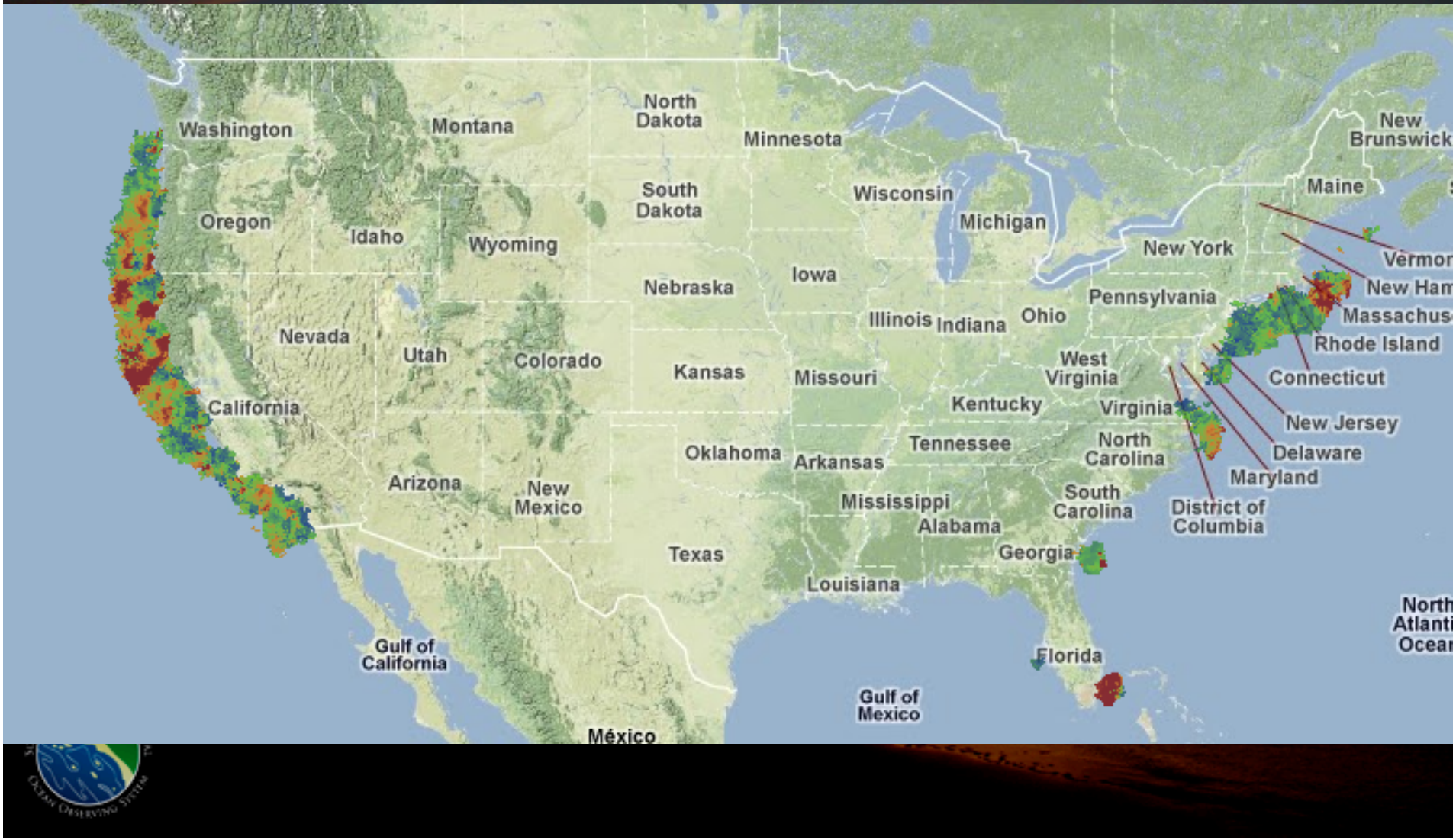
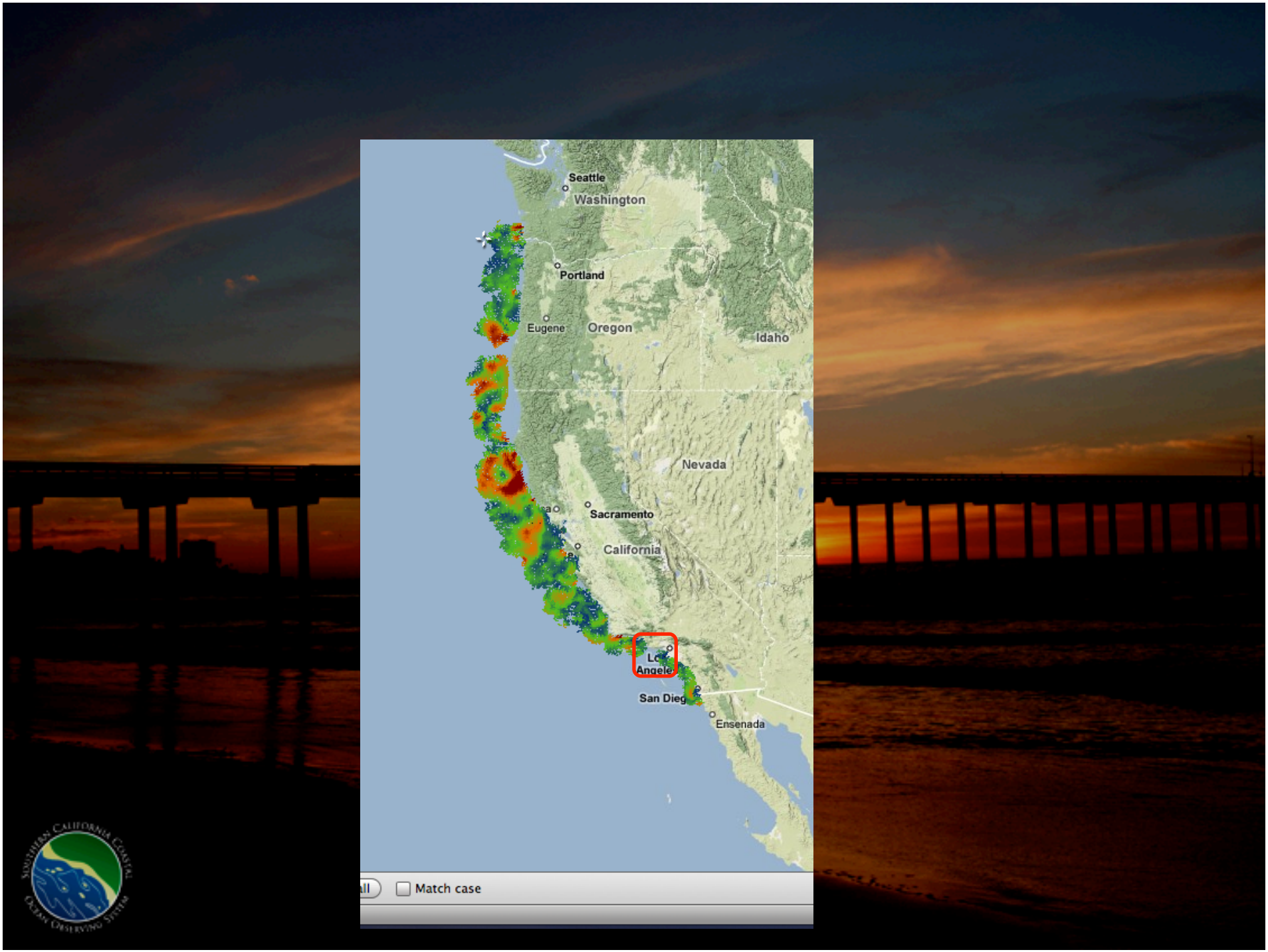


Fig. 4: Sample radial current coverage for a phased-array radar (site 1) covering a 60° swath and a direc-

U. S. Network


Washington
Montana
North Dakota
Minnesota
New Brunswick
Maine
Oregon
Idaho
Wyoming
South Dakota
Wisconsin
Michigan
New York
Vermont
New Hampshire
Massachusetts
Rhode Island
Connecticut
New Jersey
Delaware
Maryland
District of Columbia
Virginia
West Virginia
Pennsylvania
Ohio
Indiana
Illinois
Iowa
Nebraska
Kansas
Missouri
Kentucky
Tennessee
North Carolina
South Carolina
Georgia
Florida
Alabama
Mississippi
Louisiana
Arkansas
Oklahoma
Texas
New Mexico
Arizona
Colorado
Utah
Nevada
California
Gulf of California
Gulf of Mexico
México
North Atlantic Ocean

California Surface Current Mapping Network


Seattle
Washington
Portland
Eugene
Oregon
Idaho
Nevada
Sacramento
California
San Dieg
Ensenada
Match case

Local Maps of Surface Currents (hourly)

« -1 Day -1 Hour 2010-07-23 15:00:00 UTC +1 Hour +1 Day » Bookmark View

Control Panel X

UTC Time: 2010-08-02 05:25:05
Local Time: 2010-08-01 22:25:05

Resolutions

	Hourly	25hr Avg
500m	☐	☐
1km	☐	☐
2km	☐	☑
6km	☐	☐

* Vector size is not visually consistent between resolutions.

Overlays

- ☐ Station Placemarks
- ☐ So-Cal Oil Platforms

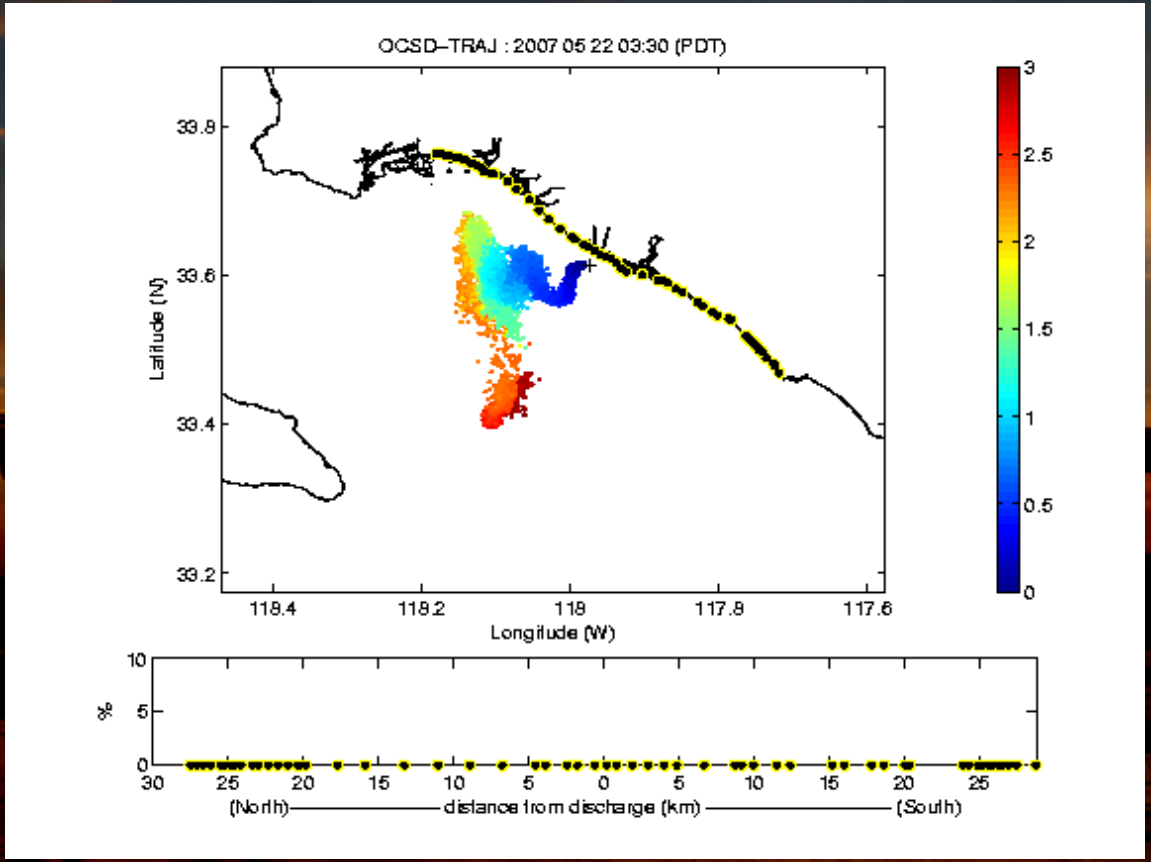
Colorbar

Current Strength (cm/s)

0 10 20 30 40 50

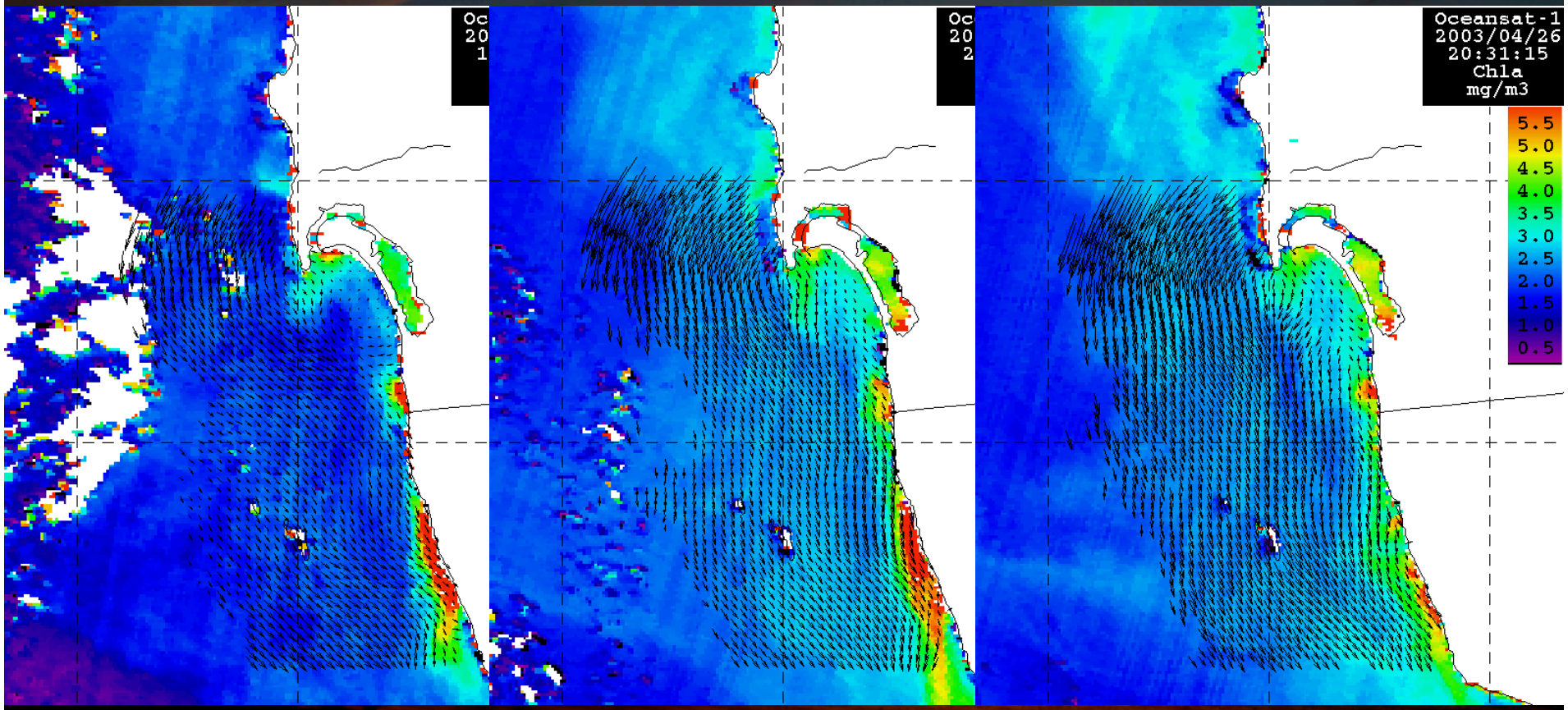
Find: vision Next Previous Highlight all Match case

Tracking plumes in time



HF Radar and Modeling

Tracking plumes in time



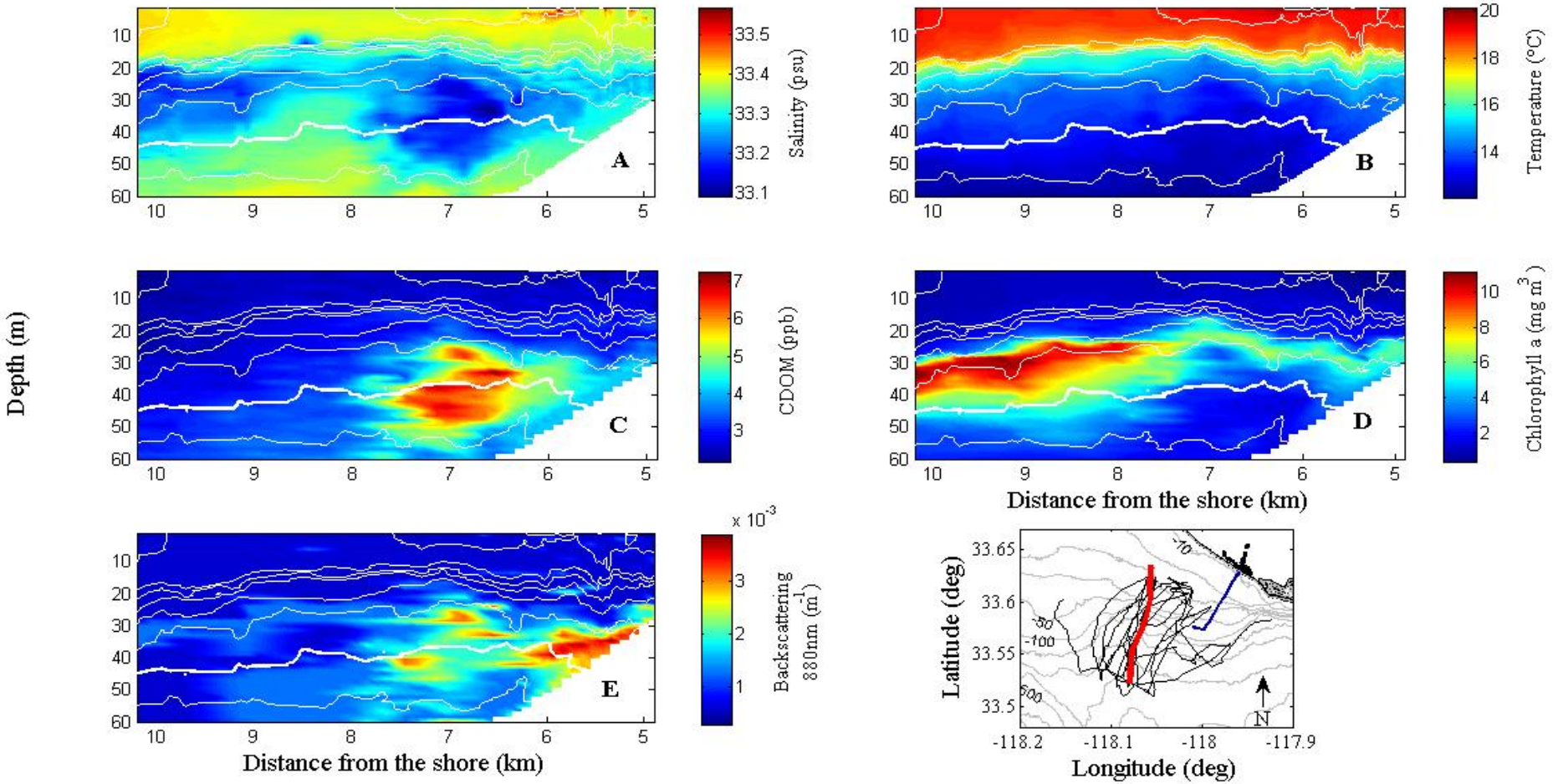
HF Radar and
Satellite Remote Sensing

Gliders

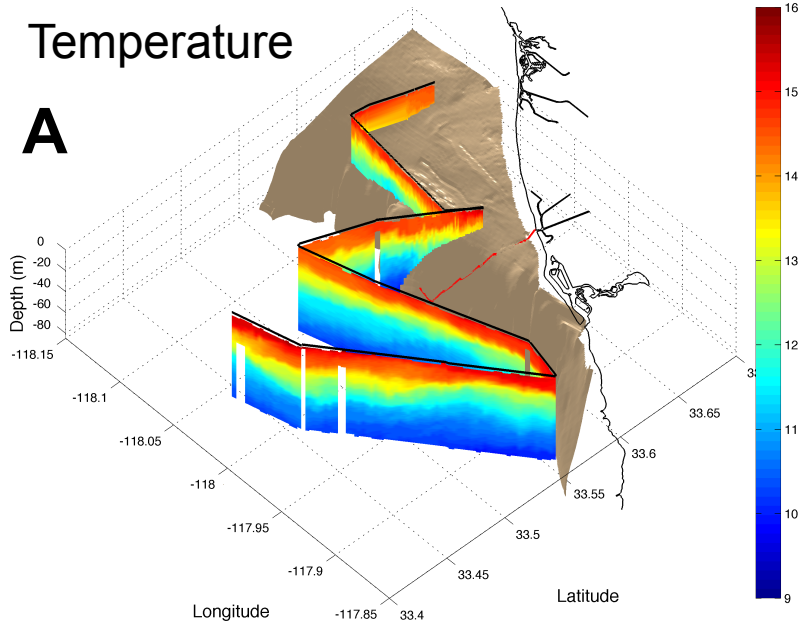
- Vertical movement – fish bladder concept
- Horizontal movement - wings
- Control - Rudder or changing the center of the mass
- Two way communication (real time)
- Movement – pre-setup coordinates
- Low speed
- low energy cost – long deployment
- Seaglider (UW), Spray (Scripps) & Slocum (Webb)

Gliders

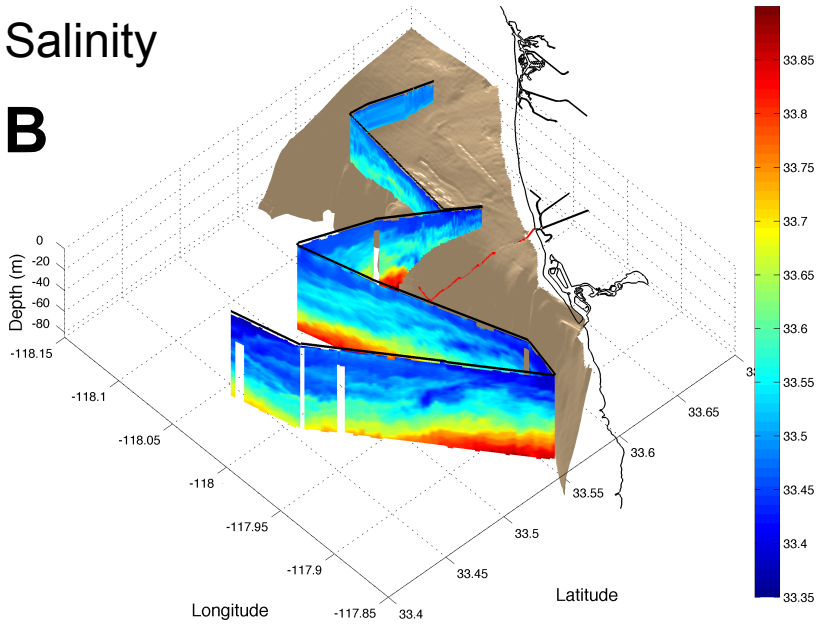
- Measurements:
  - Scattering
    - Particle abundance and size
  - Fluorescence channels
    - Chlorophyll (~ primary production, algae)
    - Colored Dissolved Organic Matter (important for runoff and effluent plumes)
    - Phycoerythrin / Rhodamine WT
  - Temperature, Salinity and Depth (CTD)


Depth (m)
A
B
C
D
E
Salinity (psu)
Temperature (°C)
CDOM (ppb)
Chlorophyll a (mg m^{-3})
x 10^{-3}
Backscattering 880nm (m^{-1})
Distance from the shore (km)
Latitude (deg)
Longitude (deg)
N

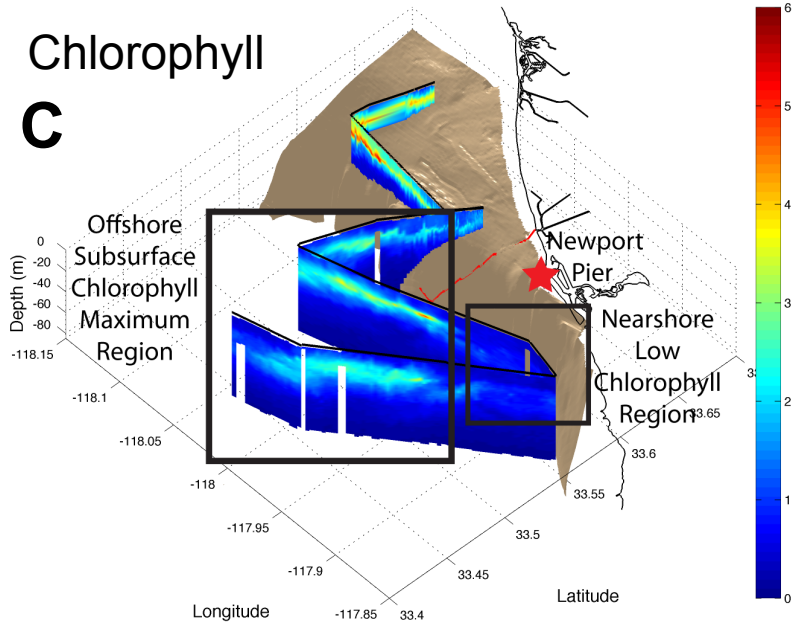
Glider Rusalka - Temperature (°C) - Apr 04 2009 1839 - Apr 07 2009 0442 UT



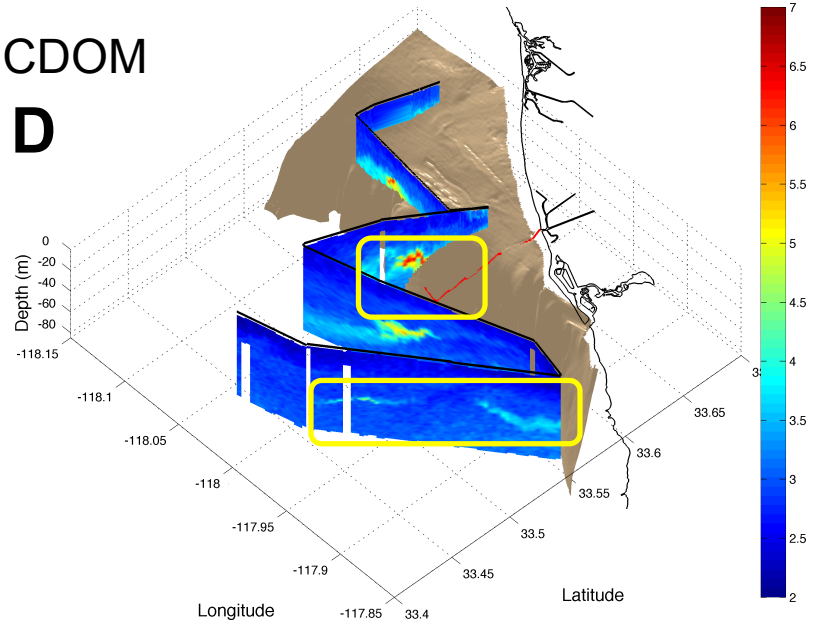
Glider Rusalka - Salinity - Apr 04 2009 1839 - Apr 07 2009 0442 UT



Glider Rusalka - Chlor. Fluor. (µg· l¯¹) - Apr 04 2009 1839 - Apr 07 2009 0442 UT



Glider Rusalka - CDOM Fluor. (µg-QSE· l¯¹) - Apr 04 2009 1839 - Apr 07 2009 0442 UT

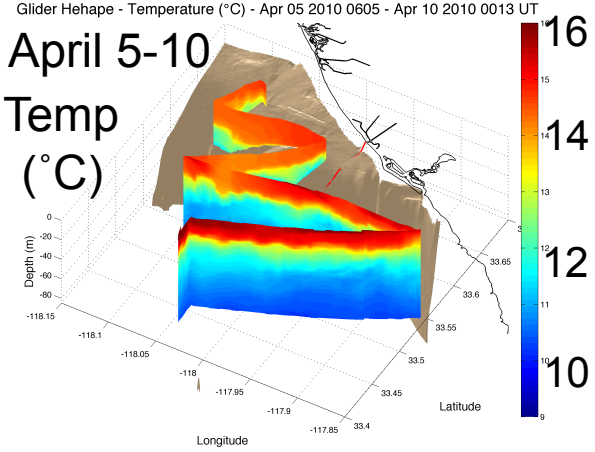


Short Time Series – Spring 2010

Glider Hehape - Temperature (°C) - Apr 05 2010 0605 - Apr 10 2010 0013 UT

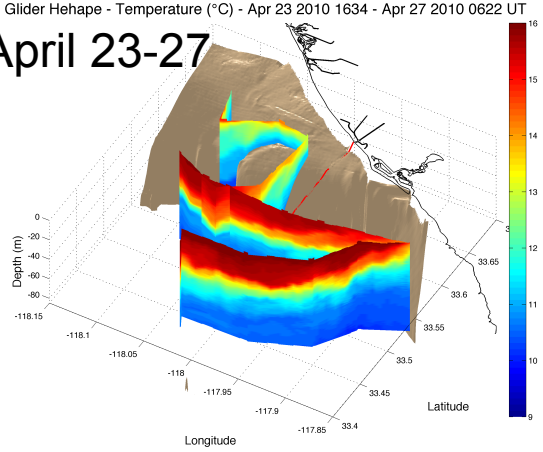
April 5-10

Temp (˚C)



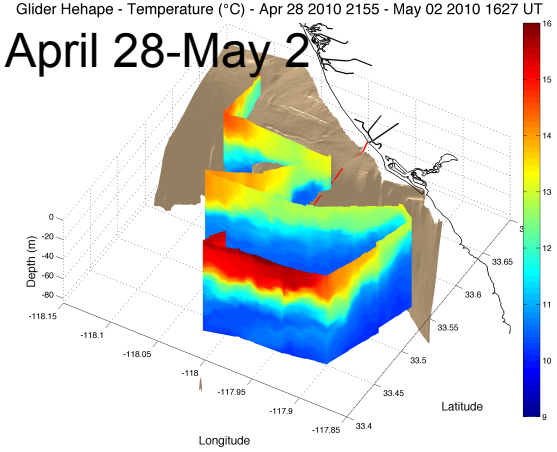
Glider Hehape - Temperature (°C) - Apr 23 2010 1634 - Apr 27 2010 0622 UT

April 23-27



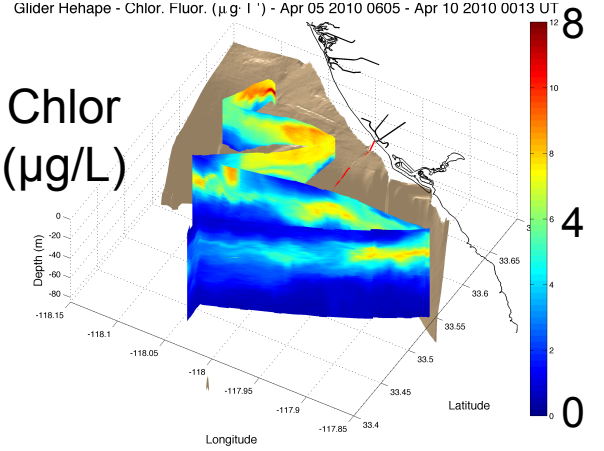
Glider Hehape - Temperature (°C) - Apr 28 2010 2155 - May 02 2010 1627 UT

April 28-May 2

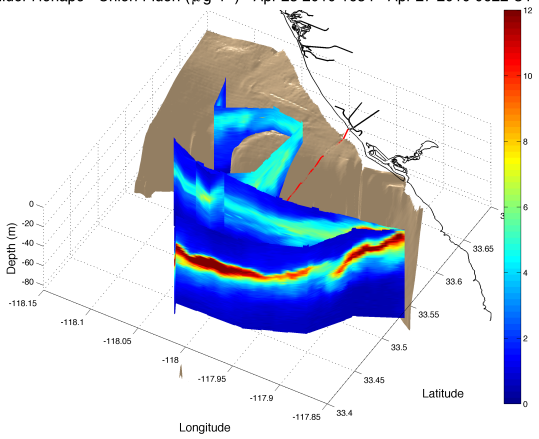


Glider Hehape - Chlor. Fluor. (µg· l ˉ¹) - Apr 05 2010 0605 - Apr 10 2010 0013 UT

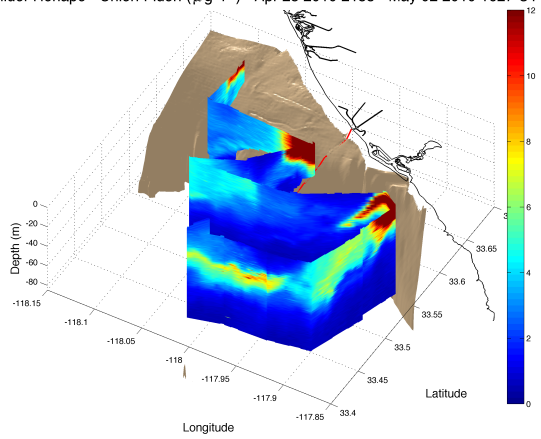
Chlor (µg/L)



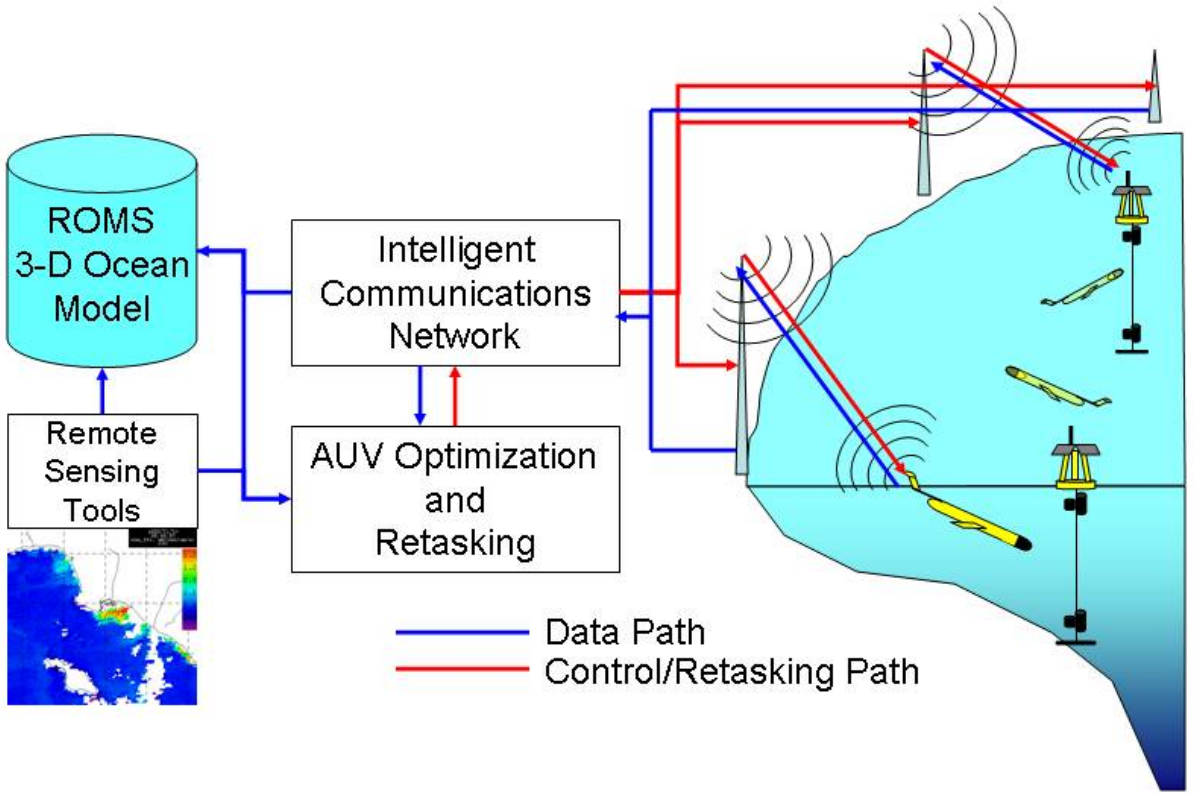
Glider Hehape - Chlor. Fluor. (µg· l^{-1}) - Apr 23 2010 1634 - Apr 27 2010 0622 UT



Glider Hehape - Chlor. Fluor. (µg· l^{-1}) - Apr 28 2010 2155 - May 02 2010 1627 UT



Integrated Modeling and Observations



Center for Integrated Networked Aquatic Platforms (CINAPS)
http://cinaps.usc.edu

SCCOOS HAB COASTAL SURVEILLANCE PROGRAM

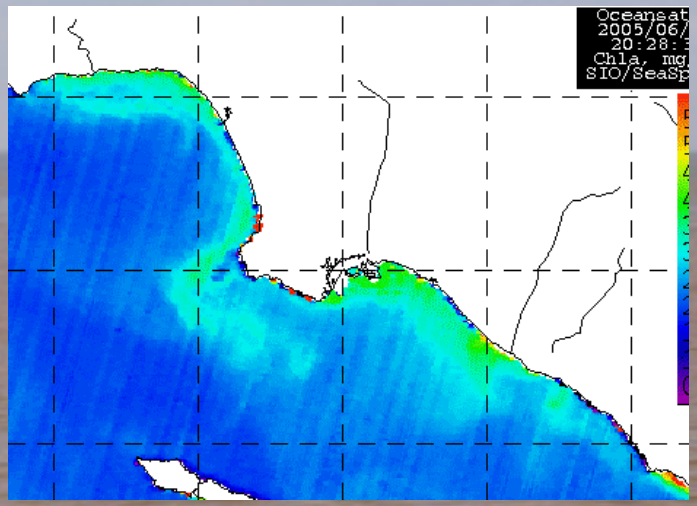
Automated Pier Stations
- T, S, Chl. Fluor.

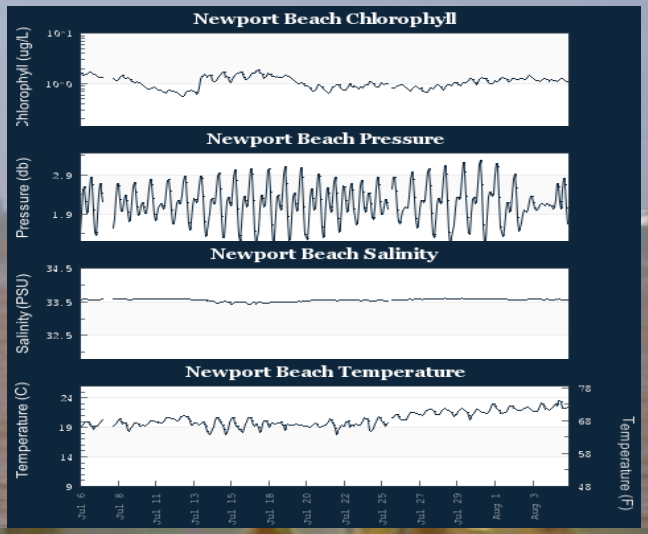
Group time series (weekly)
- Nutrients, Chlorophyll,
- HAB Species, DA analysis

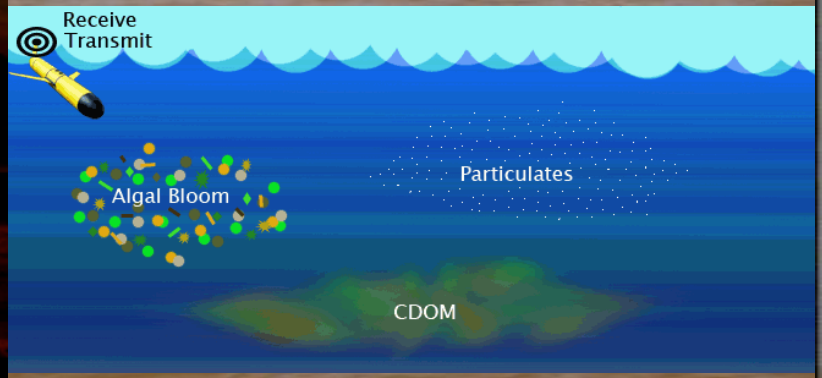
Glider monitoring
- San Pedro Bay

Remote sensing imager of ocean color

HAB's monitoring







Caron lab, USC

Huntington Beach Study – Sept-Oct 2006 (HB06)

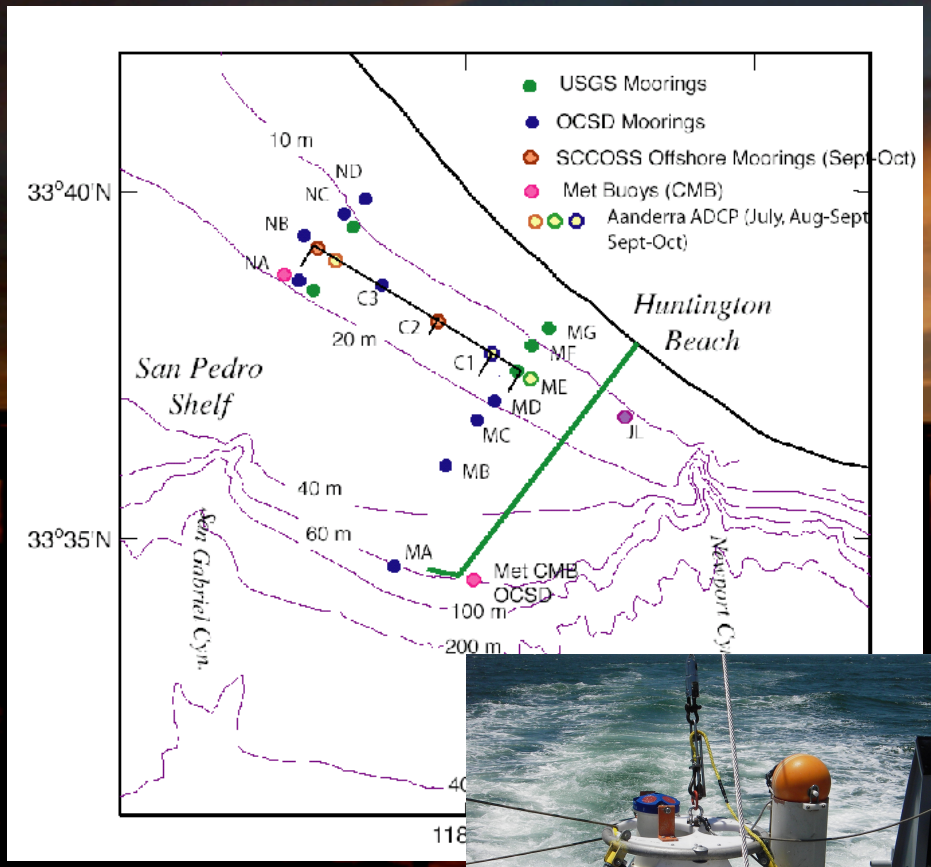
Collaborative, interdisciplinary, multiscale effort to:

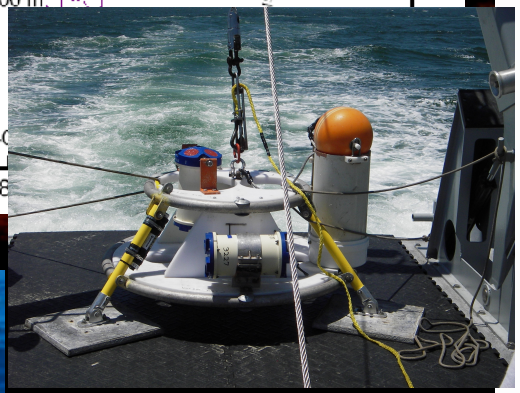
- Monitor
- Predict
- Understand
- Provide real-time availability of nearshore coastal observations relevant to managerial decision making

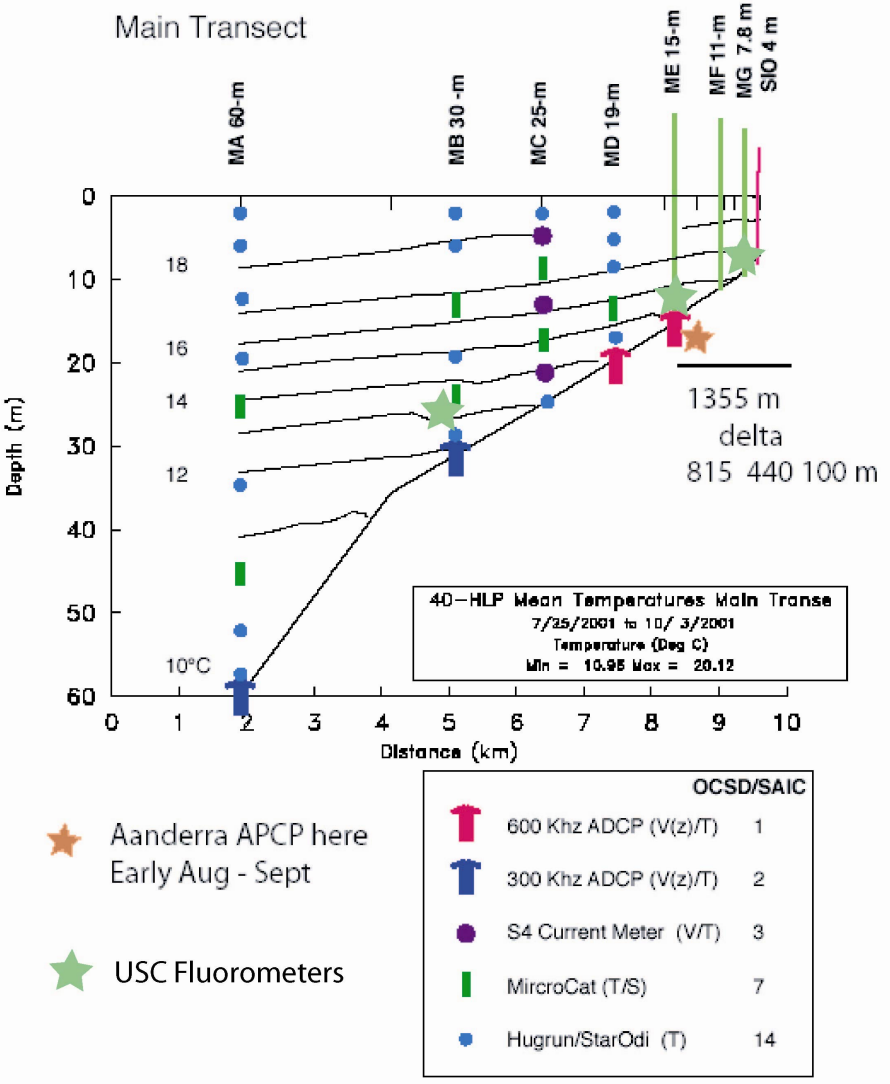
Components

- Surf Zone (UCSD)
- Moorings (USGS, OCSD, UCSD)
- Drifters (UCSB)
- AUVs – REMUS (CPSLO)
- AUVs – Gliders (CPSLO, UCSD)
- HF Radar (USC, UCSD)
- Numerical Models (UCLA, JPL)
- Meteorology (JPL)
- Dye Studies (UCSD, USC, OCSD)
- Microbiology (OCSD)
- Biology (USC, UCSD, CPSLO)

Transition Zone Moorings

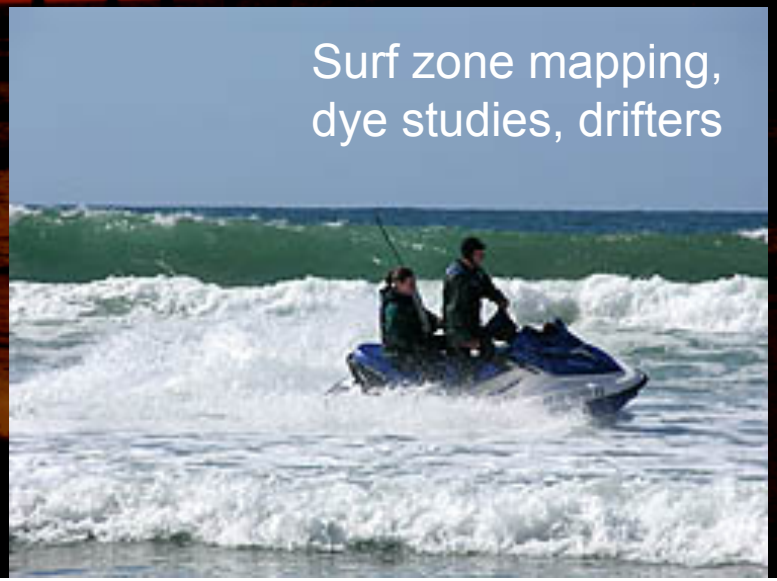






Surf Zone Array

Surf Zone
T, S,
currents



The Global Ocean

So what are the advantages of using real-time data in the classroom?

- National Assessment of Educational Progress (NAEP) Science
  - *statistically significant increase in scores of those students who downloaded and analyzed data*
  - *compelling evidence that this approach to science instruction improves standardized test scores (National Center for Education Statistics, 2001)*
  - *good problem solvers work harder than poor problem solvers*

Source: http://marine.rutgers.edu/outreach/...

Classroom ocean observatory station

Currents

•HF radar, meteorological stations, winds

Coastal pollution

•HF radar, models, rainfall, satellite imagery

Food webs, fishy!!

•Satellite imagery, automatic stations

Online Resources

- www.sccoos.org
  - *Southern California Coastal Ocean Observing System*
- cinaps.usc.edu
  - *USC Center for Integrated Networked Aquatic Platforms*
- usclab.usc.edu
  - *Jones Lab at USC*


Thank you