FY 2011 Implementation of the U.S. Integrated Ocean Observing System (IOOS)
Southern California Coastal Ocean Observing System (SCCOOS)
National Oceanographic Partnership Program Report:
1 October 2010 to 30 September 2011

Eric Terrill, Principal Investigator
SCCOOS Technical Director
Scripps Institution of Oceanography, University of California, San Diego
9500 Gilman Drive, Mail Code 0214, La Jolla, CA 92093
Phone: 858-822-3101 E-mail: eterrill@ucsd.edu

Julie Thomas, Co-Investigator
SCCOOS Executive Director
Scripps Institution of Oceanography, University of California, San Diego
9500 Gilman Drive, Mail Code 0214, La Jolla, CA 92093
Phone: 858-534-3034 E-mail: jot@cdip.ucsd.edu

Proposal Partners:
California Polytechnic State University, San Luis Obispo
Farallon Institute for Advanced Ecosystem Research
University of California, Los Angeles (UCLA)
University of California, Santa Barbara (UCSB)
University of Southern California (USC)

Grant Number: NA11NOS0120029
www.sccoos.org

LONG-TERM GOALS

The Southern California Coastal Ocean Observing System (SCCOOS) is one of eleven regions that contribute to the national U.S. Integrated Ocean Observing System (IOOS®). The regional observing systems work to collect, integrate, and deliver coastal and ocean observations in order to improve safety, enhance the economy, and protect the environment. The primary goal of SCCOOS is to provide the scientific data and information needed to inform decision-making and better understand the changing conditions of the coastal ocean in Southern California.

OBJECTIVES

SCCOOS has aligned its priorities and objectives with the focus areas designated by U.S. Integrated Ocean Observing System (IOOS®), as identified by users and stakeholders throughout the nation.

- **Ecosystems and Climate:** to monitor ocean climate trends and environmental changes in the Southern California Bight by collecting physical, chemical, and biological variables.
- **Water Quality:** to provide monitoring, tracking, and prediction tools for harmful algal blooms, outfall and storm water plumes, and surf zone contaminants.
- **Marine Operations:** to advance integrated, customized products that are critical for safe and efficient navigation, search and rescue, and oil spill response.
- **Coastal Hazards:** to provide accurate, validated inundation models and information with the long-term goal of improving coastal safety.

APPROACH AND WORK PLAN

1.) Scientific/Technical Approach

SCCOOS operates as a system of partnerships and projects that are facilitated by technical and programmatic staff. Organized by the four focus areas, the SCCOOS scientific and technical approach is based on a system of core ocean observing technologies and the delivery of useful data products and tools. System components include sub-surface ocean observations from underwater gliders, nearshore and coastal measurements, wave measurements and models, pier-based monitoring, satellite imagery, high frequency (HF) radar surface current mapping, and data assimilative ocean modeling. The projects described in this report represent the multi-disciplinary and collaborative efforts of the research teams that contribute data and information to SCCOOS.

Data Quality Requirements

SCCOOS will continue to provide access to high-quality integrated data and support regional user needs while complying with the standards and protocols for sharing and archiving data that are developed nationally. SCCOOS actively participates in IOOS Data Management efforts such as the Thematic Real-Time Environmental Distributed Data Services (THREDDS). By leveraging the Coastal Data Information Program (CDIP) and the HF Radar National Network programs, SCCOOS will target THREDDS distribution for both wave and surface current data. SCCOOS participants also contribute to ongoing efforts to develop quality control standards for waves and HF radar-derived surface currents. Wave and current data have associated XML and FDGC compliant metadata.

2.) Partners

California Polytechnic State University, San Luis Obispo

Mark Moline manages the array of six HF radar sites for the central California coast and oversees the HAB water sampling program off the Cal Poly Pier in San Luis Obispo Bay.

Farallon Institute for Advanced Ecosystem Research

William Sydeman oversees shipboard observations of the distribution and abundance of marine birds and mammals, conducted three times yearly in conjunction with the California Cooperative

Oceanic Fisheries Investigations (CalCOFI) Long-Term Ecological Research (LTER) ship surveys.

Scripps Institution of Oceanography (SIO), University of California, San Diego
Spray underwater glider operations are conducted by Daniel Rudnick and Russ Davis of the Instrument Development Group. Ralf Goericke manages the nine stations that comprise the nearshore component of the CalCOFI Program. John McGowan and Melissa Carter collect and analyze water samples to monitor HABs at the Scripps Pier. Robert Guza and William O'Reilly conduct coastal hazards projects in order to develop validated, customized warnings of wave and tide-induced coastal inundation. Eric Terrill serves as Technical Director, with his team at the Coastal Observing Research and Development Center, operates and maintains the HF radar systems and automated shore stations as well as the data management component. Julie Thomas serves as SCCOOS Executive Director and provides wave data and models from the CDIP buoys in Southern California.

University of California, Los Angeles (UCLA)
Rebecca Shipe conducts the HAB monitoring program at Santa Monica Pier. Jim McWilliams, Oceanic Research Group, and Yi Chao, Jet Propulsion Laboratory, develop the Regional Oceanic Modeling System (ROMS).

University of California, Santa Barbara (UCSB)
Libe Washburn manages the operation of HF radar systems in the Santa Barbara region, and along with Mark Brzezinski, oversees the HAB monitoring program at Goleta Pier and Stearns Wharf.

University of Southern California (USC)
Burt Jones manages the HF radar systems and coastal glider operations for discharge plume tracking and HAB detection; he collaborates with David Caron to lead the HAB monitoring program in San Pedro Bay, specifically the collection of water samples at the Newport Beach Pier.

3.) Workplan
In FY2011, SCCOOS will continue its core observations and expand data products when possible within budget constraints. SCCOOS is also committed to contributing to larger ocean observing efforts regionally, nationally, and internationally.

Ecosystems and Climate:
- Underwater glider surveys collect offshore measurements of temperature, salinity, chlorophyll, and current velocity.
- As part of CalCOFI-LTER program, measure variables in nearshore region including temperature, salinity, zooplankton, phytoplankton, fish eggs and invertebrate larvae.
- Conduct shipboard observations three times yearly to count seabirds and marine mammals in conjunction with CalCOFI-LTER surveys.
- Meteorological stations provide wind speed and direction, air temperature, sea surface temperature, barometric pressure, humidity, and rainfall levels.

Water Quality:

- Monitor HABs at six pier stations by collecting weekly measurements of temperature, salinity, chlorophyll, nutrients, and toxic species; distribute data.
- Expand HABs website to include Central and Northern California.
- Continue automated sampling at four shore stations to measure temperature, salinity, chlorophyll, turbidity, and water level.
- Implement the 3-km California statewide ROMS ocean forecasting system for real-time operations and conduct a systematic validation of the model.
- Analyze pollution dispersal in finescale, nearshore, and shelf ROMS for the San Pedro and Santa Monica Bays.
- Provide HF radar-based trajectory tracking tool for Tijuana River Plume.

Marine Operations:

- Operate and maintain HF radar systems; display surface current maps and tools online.
- Provide Weather Research & Forecasting Model (WRF) wind and precipitation forecasts online from the UCLA Department of Atmospheric and Oceanic Sciences, Climate Sensitivity Research Lounge.
- Maintain integrated map displays for ports and harbors with multi-layered views of near real-time surface currents, wave nowcasts and forecasts, and nautical charts.
- Deliver ocean current data and surface wind analyses to aid oil spill and Search and Rescue (SAR) real-time recovery and post-analysis trajectories.

Coastal Hazards:

- Validate and refine inundation models based on surveys of beach sand and water levels.
- Expand online development and integration of inundation information.

WORK COMPLETED & RESULTS

U.S. IOOS regional awards were finalized by the National Oceanic and Atmospheric Administration (NOAA) in late August 2011, so work on this award is just beginning.

IMPACT AND APPLICATIONS

National Security

- Ocean conditions and surface currents measurements can be used to generate trajectories and inform search and rescue (SAR) operations and hazardous/oil spill response.
- Customized, interactive map displays of ocean conditions can improve navigation and safety for military regions and testing ranges.
- Ocean observing data can be used to inform and validate ocean models used by the military and federal agencies.

Economic Development

- Customized, interactive map displays of ocean conditions can improve navigation, safety, and efficiency for commercial vessels, harbor pilots, and port operations.
- Accurate forecasts and measurements of water quality, such as for coastal pollutants and harmful algal blooms, inform beach closures and warnings which can affect tourism revenue and the local economy.
- Coastal data and forecast models of erosion, flooding, and inundation levels can be used to protect and improve beaches, real estate, and highways.

Quality of Life

- Tracking impacted or polluted sources such as rivers and sewage outfalls can influence public health and ecosystem health (Areas of Special Biological Significance and marine protected areas).
- Long-term time series of physical, biological, and chemical ocean data are critical in monitoring climate trends and determining ecosystem health.
- Physical and ecological ocean patterns and processes constitute valuable information for Coastal and Marine Spatial Planning and marine protected areas monitoring. For example, surveys of marine birds are being used by California Audubon and Birdlife International to delineate marine Important Bird Areas (mIBA) in the sea.

Science Education and Communication

- SCCOOS ocean data can inform classroom curriculum and informal education programs.
- SCCOOS data visualizations can provide a larger, environmental context for aquariums, science centers, and coastal tourist locations.

TRANSITIONS

National Security

- Initial implementation of surface currents measured by the SCCOOS HF radar network are now accessible by U.S. Coast Guard for search and rescue (SAR) applications using their Environmental Data Server.
- The live feed of HF radar data is now available for oil and hazardous spill response in the Environmental Response Management Application® (ERMA) map viewer for the southwest region. Near real-time and archived surface current measurements have been used in the National Preparedness for Response Exercise Program (NPREP) drill scenarios led by the U.S. Coast Guard in San Diego, Los Angeles, and Ventura.
- Surface current measurements are integrated into the General NOAA Operational Modeling Environment (GNOME) for oil spill trajectory analysis.
- Customized, interactive map displays of wave and surface currents were developed for Naval Air Systems Command (NAVAIR), Point Mugu.
- Glider data is provided to the Naval Oceanographic Office (NAVO) for assimilation into operational models.

Economic Development

- The customized, interactive map display of ocean conditions and forecasts for the Port of Los Angeles and Long Beach Harbor is used to improve navigation, safety, and efficiency for commercial vessels, harbor pilots, and port operations.
- CalCOFI incorporates measurements from the nine nearshore stations, supported by SCCOOS, into the long-term CalCOFI time series used to inform fisheries management.
- SCCOOS recently signed a Memorandum of Understanding with CeNCOOS and NANOOS to expand and strengthen coordination at the West Coast scale, which will enhance efforts to contribute ocean observing information to regional management efforts including coastal and marine spatial planning and the West Coast Governors' Agreement on Ocean Health.

Quality of Life

- The SCCOOS HAB program contributes to the statewide HAB Monitoring and Alert Program (HABMAP) initiated by NOAA, the California Ocean Science Trust, and the Southern California Coastal Water Research Project (SCCWRP).
- HAB data and samples (plankton net tow and monthly mussel samples) are sent to the California Department Public Health Plankton Monitoring Program.
- The County of San Diego's Department of Environmental Health uses the SCCOOS Tijuana River Plume Tracker to inform water quality warnings and beach closures.
- The YMCA Camp Surf in Imperial Beach uses the SCCOOS Tijuana River Plume tracker, HABs data, and CDIP swell model to help make decisions about the campers' health and safety.
- SCCOOS is working closely with staff from the California Ocean Science Trust's Marine Protected Area Monitoring Enterprise on the development and successful execution of a monitoring program for Southern California's newly established network of marine protected areas.

Science Education and Communication

- SCCOOS surface currents are featured on an interactive touch-screen kiosk at the Birch Aquarium as part of "Boundless Energy," an exhibit on sources of renewable ocean energy.
- In partnership with SCCOOS PIs and staff members, the Centers for Ocean Sciences Education Excellence (COSEE)-West and University of Southern California Sea Grant educators conduct an education program for HABs, Ocean Observing Systems Institute for teachers, and multiple online workshops.
- Conducted by the Ocean Institute, the 5th grade "Weather and Water" school program is based on SCCOOS meteorological data and meets Earth Science Standards on the water cycle and weather.
- SCCOOS data is included in the Channel Islands National Marine Sanctuaries Interactive Touch Screen Kiosk Program.

RELATED PROJECTS

California Cooperative Oceanic Fisheries Investigations (CalCOFI): http://calcofi.org
Centers for Ocean Sciences Education Excellence (COSEE): http://www.cosee.net
Coastal Data Information Program (CDIP): http://cdip.ucsd.edu
Coastal Observing Research and Development Center (CORDC): http://cordc.ucsd.edu
Farallon Institute for Advanced Ecosystem Research: http://www.faralloninstitute.org
Meteorological Assimilation Data Ingest System (MADIS): https://madis-data.noaa.gov

OUTREACH MATERIALS

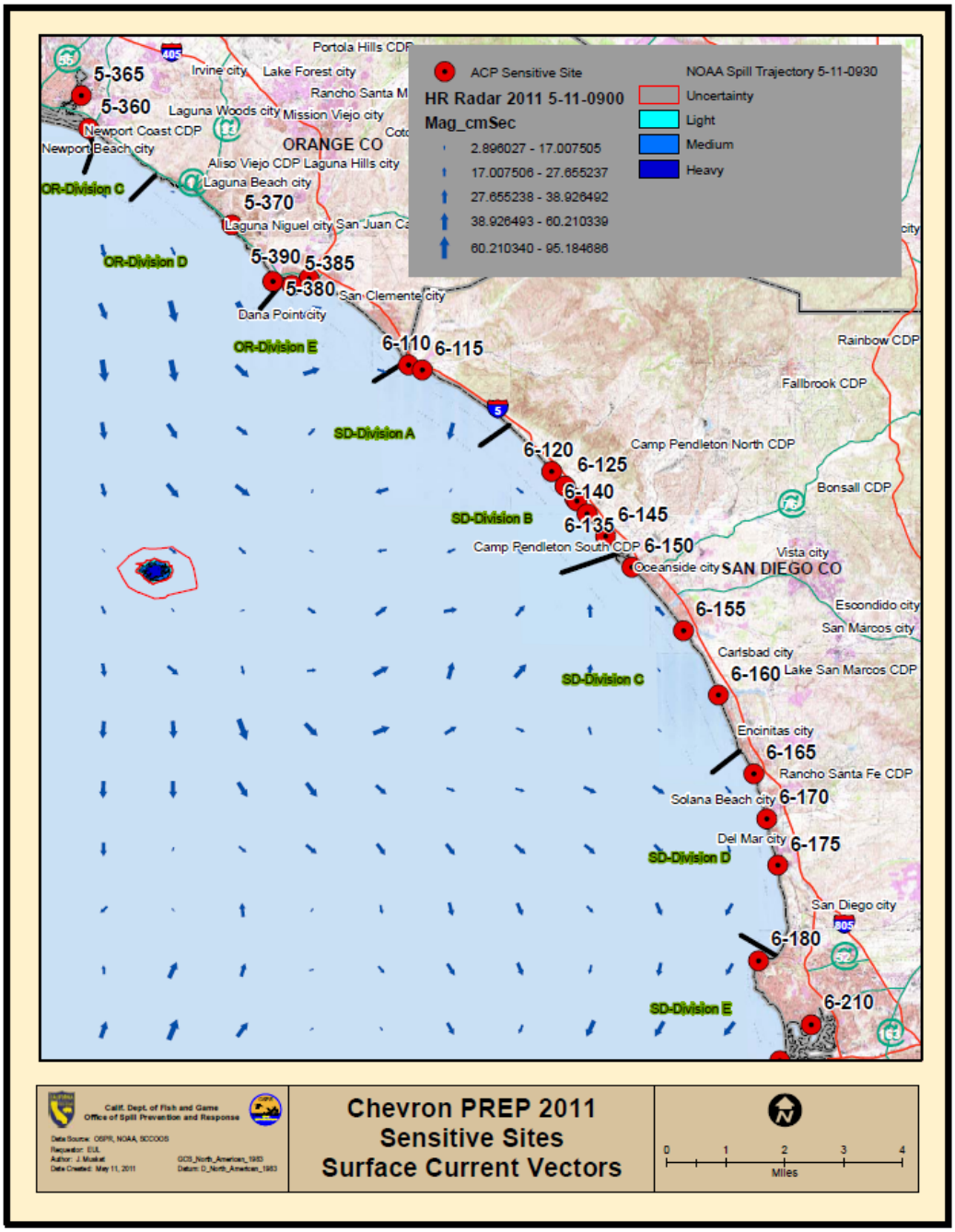

Figure 1. SCCOOS surface current measurements were included in the map for the National Preparedness for Response Exercise Program (NPREP) in San Diego, May 2011.

Figure 2. SCCOOS surface currents are featured on an interactive touch-screen kiosk at the Birch Aquarium as part of "Boundless Energy," an exhibit on sources of renewable ocean energy.

Figure 3. SCCOOS monitors harmful algal blooms (HABs) at six pier stations in Southern California. At the Scripps Pier, a “red tide” algal bloom of Lingulodinium polyedrum showed bright bioluminescence at night (Photo Credit: Christopher Wills, University of California, San Diego, September 2011).

IOOS® INTEGRATED OCEAN OBSERVING SYSTEM

IOOS® in Action: California

Improving Lives and Livelihoods in California

Overview:
Thousands of tools – from satellites above Earth to sensors below the water – continuously collect ocean and coastal data. The Integrated Ocean Observing System (IOOS) is expanding this network of data and making it easier to access and use.

Two IOOS regions address California's ocean and coastal data needs – the Central and Northern California Ocean Observing System (CeNCOOS) and the Southern California Coastal Ocean Observing System (SCCOOS).

As uses of our nation's oceans and coastal waters increase and become more diverse, the need for accurate and timely ocean information intensifies. With 850 miles of coastline, California's beaches are integral to the economy, environment, and public health. Ocean observing systems provide the scientific data and information needed to better understand the changing conditions of the ocean and coast. With physical, chemical, and biological data, California's ocean observing systems inform both rapid decision-making and long-term assessment of the coastal ocean.

CeNCOOS spans the coastal ocean from the California/Oregon border south to Point Conception, while SCCOOS provides coverage from Point Conception to Mexico's border.

Oil Spills and Coastal Pollution:
Tracking hazardous spills and pollution are essential to managing and protecting coastal waters. California's ocean observing systems operate a statewide network of high-frequency radar stations that record the speed and direction of surface currents in near real time to inform emergency responders, water quality, and human health concerns.

Scientists incorporate surface currents into NOAA's official model for spill response and enable responders to predict the path of a spill. After rainfall, contaminated runoff from the Tijuana River can flow along the coast to nearby beaches. Water quality managers, lifeguards, and surfers use trajectory maps generated hourly by high-frequency radar, to predict when and where outflow from the Tijuana River will affect local beaches.

"The ocean observing system is a great tool to estimate where exactly the Tijuana River plume is impacting beach water quality," Benjamin McCue, WiLDCOAST.

Harmful Algal Blooms:
Have you ever wondered where Alfred Hitchcock got his inspiration for "The Birds"? Domoic acid poisoning from a harmful algal bloom may have caused hundreds of birds to get sick and die in Northern California, only a few miles from Hitchcock's home, in the summer of 1961. Harmful algal

blooms can impact shellfish, seabirds, marine mammals, and human health. CeNCOOS and SCCOOS monitor harmful blooms at pier sites along the coastline. Weekly water samples measure domoic acid, water temperature, salinity, chlorophyll and abundance of algal species. Abalone farmers use this information on ocean conditions and algal blooms to protect their shellfish stocks. The ocean observing systems are, "a very important component of the security for our business operations," stated Art Seavey of the Monterey Abalone Company.

Safe, Better Marine Operations: Timely and accurate information about ocean conditions is critical to the safe passage of ships and efficient harbor navigation.

U.S. Coast Guard workers can now access surface currents measured by California's high frequency radar network and use data for search and rescue applications through the agency's Environmental Data Server. San Francisco Bar Pilots also need real-time information such as waves, winds and currents, to safely navigate large vessels through the bay and into port.

The San Francisco Bar buoy, "allows for safer transits, safer pilot boat operations, and efficiency for the shippers that call at San Francisco Bay," Captain Bill Greig.

Tsunami Detection: After Japan's March, 2011 tsunami, IOOS data supported the issuance of warnings to safeguard lives and property. CeNCOOS and SCCOOS experienced web traffic hikes as they captured the tsunami passage in real time from the deep ocean and near shore, displayed inflows and outflows via video cameras mounted on piers, and informed media and stakeholders.

LEFT: Both CeNCOOS and SCCOOS monitor water quality and other data—such as currents, waves, and weather—and issue information and warnings to decision makers, media, and the public. The information supports maritime safety and security, prevents business losses, and aids port operations.

Ocean observing data are used in models to improve search and rescue operations, spill response, and severe weather and event predictions, as well as to optimize shipping routes and plan civil defense response.

RIGHT: Abalone farmers rely on data provided by California's ocean observing systems—including domoic acid, water temperature, salinity, chlorophyll and abundance of algal species—to protect shellfish stocks from harmful algal blooms.

Beach Erosion and Inundation: Coastal erosion and inundation can damage homes, cause highway closures and disrupt transportation.

With rising sea levels, storm surge, and El Niño winters, it is crucial that scientists develop a West Coast inundation model for future safety and protection of coastal communities.

The goal of the SCCOOS Coastal Hazards Project at Cardiff State Beach is to develop a field-validated, site-specific model for inundation and flooding.

The project included installation of ten buried pressure sensors to measure water levels along with surveys of beach sand levels.

Data will inform model validation and feed into real-time displays of wave and tidal inundation for the safety and protection of coastal communities.

For More Information:

NOAA IOOS:
1100 Wayne Ave.,
Suite 1225
Silver Spring, MD 20910
(301) 427-2420
www.ioos.gov

The National Federation of Regional Associations
205 Oakledge Rd.
Harpswell, ME 04079
(207) 725-8143
http://usnfra.org

Central and Northern California Ocean Observing System
Monterey Bay Aquarium Research Institute
7700 Sandholdt Road
Moss Landing, CA 95039

Southern California Coastal Ocean Observing System
Scripps Institution of Oceanography
9500 Gilman Drive
La Jolla, CA 92093

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
Integrated Ocean Observing System (IOOS®) Program

www.ioos.gov

November 2011

Figure 4. "IOOS In Action: California" flyer