



## **FY 2013 Implementation of the U.S. Integrated Ocean Observing System (IOOS)**

Southern California Coastal Ocean Observing System (SCCOOS)

National Oceanographic Partnership Program Report:

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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](mailto: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](mailto: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)

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[www.sccoos.org](http://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<sup>®</sup>). 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<sup>®</sup>), 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 WORKPLAN**

### **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. SCCOOS is progressing towards a standards-based foundation for DMAC capabilities by converting HF radar and shore station formats into NetCDF and THREDDS. SCCOOS has released ncSOS service for its automated and manual shore stations. SCCOOS has leveraged CDIP wave data that are decimated to the NDBC for ingestion into WMO GTS. Wave and current data have associated XML and FDGC compliant metadata.

### **2.) Partners**

#### **California Polytechnic State University, San Luis Obispo**

Dean Wendt and Ian Robbins manage 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, Remote Sensing Solutions, 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)**

Roberta Marinelli manage the HF radar systems and coastal glider operations for discharge plume tracking; David Caron collaborate to lead the HAB monitoring program in San Pedro Bay, specifically the collection of water samples at the Newport Beach Pier.

### **3.) Workplan**

In FY 2013, SCCOOS received an increase of \$119,544 over FY 2012. A portion of this additional funding (\$30k) was directed by U.S. IOOS to go toward the development and deployment of ocean acidification marine sensor technology in collaboration with Carlsbad Aquafarm, a local shellfish grower. The SCCOOS Executive Steering Committee (ESC) chose to have the additional funds augment several ongoing SCCOOS programs: the time series on the distribution and abundance of marine birds and mammals in the Southern California Bight (+\$10K); the harmful algal bloom (HABs) monitoring program (+\$50K); the automated shore stations (+\$27K); and the regional association organization & outreach/education (+\$17K). The remainder of SCCOOS projects received level funding from FY 2012.

In FY 2013, 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:**

- Operate, support, and maintain network of underwater glider surveys to collect measurements of temperature, salinity, chlorophyll, current velocity, and acoustic backscatter; deliver data to SCCOOS website and push to modeling centers.
- Dissolved oxygen sensors have been added to gliders to monitor hypoxia and ocean acidification and are reporting that data to the SCCOOS website in near-real time. The integration of dissolved oxygen sensors on the gliders is proceeding for the purpose of monitoring hypoxia in coastal waters. The dissolved oxygen data also allow an estimate of parameters relevant to ocean acidification through proxy relationships. Using relationships developed by scientists at Scripps Institution of Oceanography, NOAA Pacific Marine Environmental Laboratory, Universidad Autonoma de Baja California, and University of Washington, the glider data have been used to estimate pH and aragonite saturation. Aragonite is important to organisms that form shells, as saturation levels below one may lead to dissolution of the shells.
- As part of CalCOFI-LTER program, operating and maintaining long-term nearshore 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. Under the auspices of SCCOOS, the California Current Ecosystem Long Term Ecological Research (CCE\_LTER) program, and in conjunction with the California Cooperative Ocean Fisheries Investigation (CalCOFI), SCCOOS conducts shipboard observations three times yearly to count seabirds and marine mammals in

conjunction with CalCOFI-LTER surveys. Data, products, and modeling page display results on SCCOOS website. Publish survey reports and maps of species' distribution and abundance on SCCOOS web site.

- Conduct automated sampling at four shore stations of temperature, salinity, chlorophyll, turbidity, and water level.
- 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.
- HABs monitoring program has been expanded to include Central and Northern California.
- Continue automated sampling at four shore stations to measure temperature, salinity, chlorophyll, turbidity, and water level.
- The 3-km California statewide ROMS ocean forecasting system for real-time operations has been integrated into the SCCOOS website and systematic validation of the model are being conducted.
- 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 the network of short, medium, and long range HF radar systems and deliver data streams to the National HFR Network.
- 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.
- Ocean conditions, surface currents measurements, and surface wind analyses can be used to aid in spill response as well as generate trajectories to inform search and rescue (SAR) operations.
- Customized, interactive map displays of ocean conditions with multilayer views of observations, nowcasts, and forecasts 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.

#### **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 still ongoing.

### **IMPACT AND APPLICATIONS**

#### **National Security**

- Operate and maintain the network of short, medium, and long range HF radar systems and deliver data streams to the National HFR Network.
- 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.
- Ocean conditions, surface currents measurements, and surface wind analyses can be used to aid in spill response as well as generate trajectories to inform search and rescue (SAR) operations.
- Customized, interactive map displays of ocean conditions with multilayer views of observations, nowcasts, and forecasts 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, measurements, and reports of water quality, 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.
- Use surveys of sand levels on beaches and monitor storm inundations at selected locations to validate and refine 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).
- Analyze pollution dispersal in finescale, nearshore, and shelf ROMS for the San Pedro and Santa Monica bays.
- Operate and maintain 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. Under the auspices of SCCOOS, the California Current Ecosystem Long Term Ecological Research (CCE\_LTER) program, and in conjunction with the California Cooperative Ocean Fisheries Investigation (CalCOFI), the distribution and abundance of seabirds during 3 seasonal surveys were studied.

## **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**

- 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 are now available on the national HFR network for oil and hazardous spill response in the Environmental Response Management Application<sup>®</sup> (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 and surface wind analyses are integrated into the General NOAA Operational Modeling Environment (GNOME) for oil spill trajectory analysis.
- Customized and expanded interactive map displays of wave and surface currents with multi-layered views of observations, nowcasts, and forecasts were developed for Naval Air Systems Command (NAVAIR), Point Mugu.
- Annually provide training to first responders of maritime incidences in the use of SCCOOS products.

## **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.

- Use surveys of sand levels on beaches and monitor storm inundations at selected locations to validate and refine 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**

- 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). The HAB program generates a baseline time-series of ocean properties to monitor ocean conditions in the very near shore zone of the Southern California Bight. These measurements are used to develop forecast models for short term warnings. They also increase our knowledge of the sign, frequency, and magnitude of variation of temperature, salinity, density, nutrients, and pollutants.
- In conjunction with autonomous glider and boat sampling *Pseudo-nitzscha* blooms that produce domoic acid are being monitored. The Caron lab is responsible for the analysis of domoic acid from the 5 SCCOOS HAB monitoring sites.
- Fine-scale simulations with ROMS are being analyzed at UCLA to examine two phenomena. First, pollution effluent dispersal from the Orange County and Hyperion discharge outfalls we examined. This includes alternative near shore outfalls planned in the coming years. The second examined area was a storm river plume dispersal near Santa Barbara. In both situations the material stays mainly on the continental shelf and slope, and the near shore outfall materials stay very near the coast.
- Weekly reports are derived from a year long time series of sampling for HAB species and related water quality measurements and are provided to the California HAB Monitoring and Alert Program Group.
- 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 ocean data can inform classroom curriculum and informal education programs.
- Conducted by the Ocean Institute, the 5<sup>th</sup> grade "Weather and Water" school program is based on SCCOOS meteorological data and meets Earth Science Standards on the water cycle and weather.
- 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.
- SCCOOS regularly participates in tours, workshops, and meetings within Southern California in order to further collaboration and provide data and information when requested.
- Lisa Hazard, a SCCOOS Ex-Officio Advisor testified to the House Subcommittee on the U.S. Coast Guard and Maritime Transportation. Her testimony provided insight on how to improve efficiency, safety, and security of maritime transportation: better use and integration of maritime domain awareness data.
- SCCOOS, CeNCOOS and NANOOS will be hosting a one-year fellowship with the West Coast Governors Alliance (WCGA) West Coast Ocean Data Portal that began this fall. This West Coast Oceanographic Data Integration Fellow, Laura Lilly, is located at the SCCOOS program office at Scripps Institution of Oceanography in La Jolla, CA. The fellow will focus on the identification of priority regional management questions and information needs to be informed by West Coast oceanographic data products and the development and distribution of those products. The fellowship is administered by California Sea Grant.

## RELATED PROJECTS

- The marine mammal health map has been added to [SCCOOS's project page](#). The goal of this project is to develop a national marine mammal health tracking program that is web-based and readily accessible to scientists, managers, and to the general public. The map will allow detections of spatial and temporal changes in marine mammal health that will enable early prioritization of management and conservation.
- The [Cardiff Beach Erosion and Inundation Project](#), part the SCCOOS Coastal Hazards Program, is developing a field-validated, site-specific model for use in providing real-time warnings of wave and tide-induced inundation. After a reliable model is developed, inundation warnings will be disseminated to users via the Internet and/or automated phone calls. Ongoing monitoring is building a database of sand level changes and waves at local beaches, including an El Nino and the recent 2012 nourishment at Solana-Cardiff beaches, and are updated on the SCCOOS website
- SCCOOS and CeNCOOS are in the final stages of reviewing summary report and a lessons learned report for the [2012 Orange County Sanitation District \(OCSD\) Diversion](#). The project as a whole will be evaluated throughout the various stages of planning, data collection, modeling, product development, reporting, and conclusions in order to identify the most useful and cost-effective methods to predict and mitigate environmental issues related to the diversion. SCCOOS and CeNCOOS representatives will present the reports at OCSD offices. The report will provide the foundation for further determining best practices in ocean modeling and monitoring in support of future diversions to the 78-inch outfall.
- The Southern California Bight (SCB) Regional Ocean Modeling System (ROMS) Model Output has been replaced by a single 3 km resolution California state-wide ROMS. The 3km model is being supported by CeNCOOS and SCCOOS, providing long-term continuity and direct connection to management and operations groups in California. This allows us to apply our results across the State. Also, the 3km version of the model better captures mesoscale and large scale variability, reducing issues with boundary conditions that were occurring in the nested models. Lastly, the partnership with SCCOOS/CeNCOOS provides a new feature, including 72 hour forecasts for the entire State.
- The State of California Areas of Special Biological Significance (ASBS) system: <http://www.sccoos.org/data/asbs/?p=20>
- California Cooperative Oceanic Fisheries Investigations (CalCOFI): SCCOOS added a cruises section to their data, products, and modeling page with the intention of making it easier for the user of this information to access the most current data. There is an overview of CalCOFI cruises and SCCOOS involvement as well as a link to the most current cruise data on bird and mammal distribution. <http://coastwatch.pfeg.noaa.gov/erddap/info/index.html?page=1&itemsPerPage=1000>
- 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>
- El Nino Project Page: The Spray glider lab, headed by Dan Rudnick, has calculated a "SoCal Niño Index" For comparison the "Oceanic Niño Index" published by NOAA and the indices are remarkably correlated [http://www.sccoos.org/data/el\\_nino/](http://www.sccoos.org/data/el_nino/)
- Farallon Institute for Advanced Ecosystem Research: <http://www.faralloninstitute.org>
- Meteorological Assimilation Data Ingest System (MADIS): <https://madis-data.noaa.gov>
- Orange County Sanitation Department (OCSD <http://www.ocsd.com/>) diverted flow from their 120 inch outfall pipe just 4.5 miles offshore to a 78 inch outfall pipe 1 mile offshore from September 11, 2012 to October 1, 2012. SCCOOS developed a project page (<http://www.sccoos.org/projects/ocsd-diversion/>) to update the public on the overview and history of the project as well as environmental support data for the OCSD diversion. Orange County Sanitation Department (OCSD) diverted flow from their 120 inch outfall pipe just 4.5 miles offshore to a 78 inch outfall pipe 1 mile offshore from September 11, 2012 to October 1, 2012. SCCOOS provided a real-time mooring and data for high frequency radar (HFR) trajectories. SCCOOS and Central and Northern California Coastal Ocean Observing System (CeNCOOS) will synthesize the results of the diversion's modeling and monitoring for a technical review of those activities as well as the results highlighting successes, failures, and lessons learned. The synthesis report will provide the foundation for further technical review as to the effectiveness and efficiency of the overall plan.

- SCCOOS Ocean Acidification Page: SCCOOS developed an ocean acidification (OA) page to help inform any user about what OA is, what the potential impacts are, what SCCOOS is doing, who the partners are, what their technology are, and what their data are. This project page is updated as progress occurs. <http://www.sccoos.org/projects/2012OA/>
- State Water Resource Control Board (SWRCB): <http://www.swrcb.ca.gov/>

## OUTREACH MATERIALS

- **Figure 1:** Laura Lilly is the new Sea Grant fellow for SCCOOS, CeNCOOS and NANOOS with the West Coast Governors Alliance (WCGA) Regional Data Framework (RDF). This one-year West Coast Oceanographic Data Integration Fellowship began November 2013. Ms. Lilly will sit at the SCCOOS program office at Scripps Institution of Oceanography in La Jolla, CA. She will focus on the identification of priority regional management questions and information needs to be informed by West Coast oceanographic data products and the development and distribution of those products. The fellowship was administered by California Sea Grant.
- **Figure 2 & 3:** Red to brownish red waters were observed at Scripps Pier September 3-9, 2013. Once tested it was found that *Lingulodinium polyedrum*, a dinoflagellate, was the cause of the discolored water. Aerial surveys by Eddie Kisfaludy indicated that the bloom spanned from La Jolla to Carlsbad within 1-3 miles offshore. SCCOOS HAB monitoring program not only provides data (much like the data displayed to the right), but also is a resource for news, weekly updates, and programmatic information. SCCOOS works alongside CeNCOOS (Central and Northern Coastal Ocean Observing System) to monitor for HABs at 8 piers along the California coastline.
- **Figure 4:** SCCOOS received \$30K for the FY13 ocean acidification marine sensor program. SCCOOS/SIO will operate a “Burkalator” pCO<sub>2</sub> analyzer at Carlsbad Aquafarm, to track ocean acidification impacts on shellfish aquaculture. Lessons learned from these operations will be applied to future coastal measurements of ocean acidification.
- **Figure 5:** Wide beaches protect shoreline infrastructure and support recreation and tourism. Southern California beaches have been occasionally replenished with sand. In 2012, 1.5M cu yd of sand from offshore were placed on San Diego beaches at an estimated cost of 28M\$. A 50-yr, 200+M\$ plan to nourish San Diego area beaches has been proposed. Potential impacts of beach nourishments (or a lack of beach nourishments) include effects on lobster and other biota, surfing, cliffs, tourism, Hwy 101, and the Amtrak rails. Our understanding of nearshore sand transport, and ability to estimate future waves and water levels, is so limited that the probability of negative environmental impacts from cannot be estimated reliably. How high on the beach does wave uprush reach, where does the nourishment sand go, and why does it go there? Our research objective is to understand the physics at work, and to thereby help answer relevant management questions.  
Ongoing monitoring is building a database of sand level changes and waves at local beaches, including an El Nino and the recent 2012 nourishment at Solana-Cardiff beaches. Beach widths were minimum in the recent El Nino at all sites, and maximum at the recently nourished sites. Monitoring is ongoing and beach widths are posted on SCCOOS project page.
- **Figure 6:** SCCOOS published in June subscription of Sidelights Magazine. The magazine Sidelights is published by the Council of American Master Mariners and is dedicated to supporting and strengthening the U.S. Merchant Marine and the position of the Master by fostering the exchange of maritime information. SCCOOS’s article focuses on leveraged products in Southern California that are made available for and have been of use to the Maritime Community.