U.S. Integrated Ocean Observing System (IOOS) Implementation
Southern California Coastal Ocean Observing System (SCCOOS)
FY16-21 National Oceanographic Partnership Program Report:
1 June 2018 to 30 November 2018

Clarissa Anderson, Co-Principal Investigator
SCCOOS Executive Director
Scripps Institution of Oceanography, University of California, San Diego
9500 Gilman Drive, Mail Code 0206, La Jolla, CA 92093

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: jothomas@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: NA16NOS0120022
www.sccoos.org

I. PERFORMANCE PROGRESS REPORTS

1) PROJECT SUMMARY

The Southern California Coastal Ocean Observing System (SCCOOS) is one of eleven regions that contributes 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 principal goal of SCCOOS is to provide observations and products to a diverse stakeholder community of managers and planners, operational decision makers, scientists, and the general public. As the regional observing system for Southern California, SCCOOS, has developed the capabilities to support short-term decision-making and long-term assessment by implementing and leveraging biological, chemical, and physical observations and models, many of which are available in near real-time. SCCOOS priorities and objectives are aligned with the seven societal goals as outlined in the IOOS Summit Report. The focus themes, as designated by IOOS, highlight these priorities and are designed to improve safety, enhance the economy, and protect our environment.

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

2) PROGRESS AND ACCOMPLISHMENTS

SCCOOS continues to achieve its milestones by providing access to high-quality integrated data and supporting 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 use of the UCAR community program Thematic Real-Time Environmental Distributed Data Services (THREDDS) and the Environmental Research Division's Data Access Program (ERDDAP). By leveraging the Coastal Data Information Program (CDIP) and the HF Radar National Network programs, SCCOOS targets THREDDS and ERDDAP distribution for most of our datasets, including automated shore stations and ocean acidification measurements. SCCOOS also continues to implement QARTOD data quality control standards for all parameters for which QARTOD exists, including the recent chlorophyll fluorometry QARTOD manual. All data have associated ISO 19115 compliant metadata.

As a result of SCCOOS listservs and social media streams (e.g., Facebook, Twitter, YouTube), more ocean observing news items are now widely distributed throughout the Regional Associations, the IOOS program office, as well as the SCCOOS user community.

Climate Variability and Change

1. Operate and maintain a network of gliders to collect measurements of temperature, salinity, chlorophyll, current velocity, dissolved oxygen, and acoustic backscatter; deliver data to the SCCOOS website and push to modeling centers.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: The principal investigator has added an oxygen sensor (SBE63) to the glider fleet. New procedures for *in situ* and lab calibration have been implemented. Real-time

data are delivered to the ERDDAP, then to the national glider DAC, and then onto GTS. Delayed mode, quality controlled data including temperature, salinity, depth-averaged velocity, time, latitude, longitude, where/depth and profile ID are available for download at spraydata.ucsd.edu.

There are three Spray underwater gliders off the coast of California at all times sending back data on temperature, salinity and ocean currents. These missions are funded through IOOS and the NOAA Climate Program Office/Ocean Observing and Monitoring Division. The data are assimilated into regional circulation forecasts. These models are used by a variety of end-users and are crucial to predicting circulation patterns relevant to fisheries and oil spill response. An alongshore glider line has been occupied intermittently over the past year. The Fill the Gaps funding will allow this line to be sustained for the year starting in January 2019.

2. Continue to develop, integrate, and enhance long-term time series products for distribution.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: Lead Co-PI C. Anderson spearheaded the California HAB Bulletin that is hosted on the SCCOOS website (sccoos.org/california-hab-bulletin/). The CA HAB Bulletin synthesizes model output, near real-time observations, and public health alerts to provide a more complete picture of the regional variability in harmful algal blooms (HABs) to help managers and the public interpret the HAB seascape on a monthly basis. The bulletin is a nice example of a federal-state-academic-private collaboration in that many groups are actively engaged in contributing data or model output: SCCOOS and CeNCOOS California Harmful Algal Bloom Monitoring and Alert Program (HABMAP) monitoring data, monthly means of California Harmful Algae Risk Mapping (C-HARM) predictions, California Department of Public Health (CDPH) Marine biotoxin Quarantines and Health Advisories, and The Marine Mammal Center (TMMC) and the Pacific Marine Mammal Center (PMMC) sea lion strandings due to domoic acid. The team hopes to soon incorporate HABMAP nutrient data, BeachCOMBERS sea bird strandings, and NOAA Marine Mammal Stranding Network cetacean strandings to the CA HAB Bulletin.

Coastal Hazards

1. Shoreline inundation forecast, validation, and dissemination of warnings to select city managers.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: Emails are sent to the City of Encinitas when the Cardiff flood index shows potential flooding events three days in advance.

2. Expand development and integration of inundation website.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: Surveys of sand levels on beaches and storm inundation monitoring at select locations are posted on the SCCOOS website. The data are used to validate and refine coastal data and forecast models of erosion and flooding, and inundation levels can be used to protect and improve beaches, real estate, and highways. These endeavors have led to the development of a statewide 'flooding index' in accordance with the CDIP research on wave run-up. The new flood forecasts are based on the tide and wave height, as well as wave

period. The resulting water level predictions are generally lower than those from the old model, but they should be significantly more representative of the actual water levels observed at the coast. The Cardiff CDIP water level page has been updated to include mild and moderate flood thresholds.

As part of its Resilient Futures project, the SIO Center for Climate Change Impacts and Adaption (CCCIA) has teamed with the Imperial Beach community with support from the David C. Copley Foundation and SCCOOS to upgrade the city's flood alert capabilities and to develop tools to better prepare stakeholders for sea-level rise. The dedicated observing network and modeling system will provide the information needed for accurate, early flood warnings for vulnerable locations throughout the city, as well as the baseline information needed to develop and evaluate future sea-level rise adaptation strategies. A prototype Imperial Beach website has been developed (http://resilientib.ucsd.edu/home.html) for presentation of historical, current, and forecast conditions.

Work to develop the Cardiff coastal hazard website analogous to the Imperial Beach website is in progress.

3. Develop model for Huntington and Imperial Beach inundation sites
    a. Completion date: TBD – ongoing milestone
    b. Status: On-Track
    c. Successes: In order to provide the public and beach managers with an assessment of how various processes combine to cause coastal flooding, total water level for extreme historic events at Imperial Beach have been deconstructed to quantify relative contributions from tides, nontidal residual sea level, and wave runup. Examples of these extreme water level products are available at the Imperial Beach CCCIA Resilient Futures website (http://resilientib.ucsd.edu/pastevents.html). The website continues to be populated with products and updated based on city managers feedback on website content.

Ecosystems, Fisheries, and Water Quality

1. Monitor Harmful Algal Blooms (HABs) at five pier stations by collecting weekly measurements of temperature, salinity, chlorophyll, nutrients and potentially harmful phytoplankton species. Provide data online and distribute via the California HABMAP listserv.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    Successes: SCCOOS HABs webpage includes Central and Northern California (CeNCOOS) stations. Weekly reports of HAB species and related water quality measurements are provided to the California HAB Monitoring and Alert Program (HABMAP) and the California Department of Public Health (CDPH). *Pseudo-nitzschia* blooms that produce domoic acid are being monitored as part of ongoing observations. The Caron lab at the University of Southern California (USC) is responsible for the analysis of domoic acid from the five SCCOOS HAB monitoring sites, and the Brzezinski lab at the University of California, Santa Barbara is responsible for organizing the macronutrient

analysis (NO_3, NO2, PO4, $Si(OH)_4$)) with the UCSB Marine Science Institute Analytical Laboratory.

The SCCOOS HAB program contributes to the statewide HABMAP program initiated by NOAA, the California Ocean Science Trust, and the Southern California Coastal Water Research Project (SCCWRP). The HABMAP program generates a baseline time series of HABs, nutrients, and water quality to monitor ocean conditions in the very near shore zone of the Southern California Bight. These measurements are used to validate the California-Harmful Algae Risk Mapping (C-HARM) forecast model system for short-term warnings. They also increase our knowledge of the sign, frequency, and magnitude of variation of temperature, salinity, density, nutrients and pollutants. Data manger, Vicky Rowley, and HABMAP PIs are working to standardize the reporting format to make the datasets Darwin Core-compliant for ingestion to ERDDAP and the OBIS database.

2. Continue to collect California Cooperative Oceanic Fisheries Investigations (CalCOFI) observations and measurements.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: SCCOOS links to data that are measured in the nearshore region of Southern California as part of CalCOFI - CCE-LTER program. These parameters include temperature, salinity, zooplankton, phytoplankton, fish eggs and invertebrate larvae. CalCOFI data, resources, and reports are posted online.

3. Conduct shipboard observations with CalCOFI and NMFS Juvenile Rockfish Ecosystem surveys; count seabirds; post data online.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: Physical and ecological ocean patterns and processes constitute valuable information for Coastal and Marine Spatial Planning and Marine Protected Area monitoring. Under the auspices of SCCOOS, the California Current Ecosystem Long Term Ecological Research (CCE-LTER) program, and in conjunction with the CalCOFI and NMFS Juvenile Rockfish Ecosystem Survey, the distribution and abundance of seabirds and marine mammals during three seasons were studied. Survey reports including time series plots of species density are published on the SCCOOS website (sccoos.org/seabirds/). The main findings in 2017-2018 were: (1) continuing northward range expansion of Elegant Terns from Isla Rasa in the Gulf of California to the Southern California Bight, (2) continuing recovery of large cetaceans in the ecosystem including humpback and fin whales, (3) a general decrease in seabird species with warm-water affinities following the end of the 2016-2017 ENSO event.

4. Publish survey reports and maps of seabird species' distribution and abundance on SCCOOS web site.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: Survey reports and maps of species distribution and abundance are published on SCCOOS website (sccoos.org/seabirds/).

5. Display the 3-km ROMS ocean forecasting system for real-time operations statewide.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track

c. Successes: 3-km California ROMS model with data assimilation and real-time forecasting capabilities has been running continuously. This state-wide ROMS model is assimilating both the HF radar surface current data and the vertical profiles of temperature and salinity from four Spray gliders as well as other available observational data sets including satellite sea surface temperature and vertical profiles of temperature and salinity from moorings, ships and floats. In addition to the display at the SCCOOS web site, we are also displaying some static ROMS images (e.g., nowcasts, forecasts and validations) on a group website.

6. Validate the 3-km CA ROMS output against non-assimilated observations.
   a. Completion date: TBD - ongoing milestone
   b. Status: On-Track
   c. Successes: On a daily basis, we are making on the order of 20 ensemble model forecasts in order to quantify errors. Six hourly nowcasts and 72-hour forecast files are available via OPeNDAP/THREDDS. Three validation products have been developed and are being tested on the PI's web site. On a daily basis, there are on the order of 100,000 satellite SST pixels that are assimilated into ROMS. The RMS difference between the ROMS nowcast and the original satellite SST data is slightly less than 1ºC comparable to the 0.5ºC - 1ºC errors specified for the satellite retrieved SST data. In addition to the assimilated data sets, the ROMS nowcast has been validating against a number of non-assimilated data sets. The results are summarized in a manuscript that was published in April 2017.

7. Develop a coupled ROMS/biogeochemical model to aid the evaluation of the effects of nutrient inputs on bloom formation and nutrient cycles.
   a. Completion date: TBD - ongoing milestone
   b. Status: On-Track
   c. Successes: Fine-scale simulations with a research-level, high-resolution ROMS are being analyzed in hindcast mode at UC Los Angeles to examine two phenomena in particular. First, pollution effluent dispersal throughout the Southern California Bight is being assessed for augmentation of net primary productivity in the surrounding shelf regions. Second, shelf submesoscale currents and surf-zone turbulence under various surface gravity wave and coastline shape influences are being assessed to determine their roles in along- and across-shore transports of material concentrations, biological and otherwise. This is being done using the surface wave-current interaction theory and grid-nesting capabilities of ROMS to examine cross-shore exchange of materials in the shelf and surf zone. Sites near Pt. Conception, the northern Channel Islands, Santa Monica Bay, and the Newport region are the primary locales of interest. In parallel, we are developing a coupled ROMS/biogeochemistry/ecosystem model to aid the evaluation of the effects of nutrient inputs on bloom formation and nutrient cycles, as well as variability and trends in hypoxia and acidification. The progress is both published and periodically published online. Funding for much of this work is provided by various extramural grants form the Ocean Acifidication Program and the California Ocean Protection Council to SCCWRP and UCLA. SCCOOS funds contribute to general model development and system maintenance.

8. Continue automated sampling at four shore stations to measure temperature, salinity, chlorophyll, turbidity and water level.
   a. Completion date: TBD - ongoing milestone
   b. Status: On-Track
   c. Successes: Thanks to funding from the City of LA/Hyperion Water Reclamation Plant, The Bay Foundation, and The Los Angeles Waterkeeper, the decommissioned Santa Monica

Pier shore station came back online on the 16th of October (sccoos.org/data/autoss/). This site is now being serviced by The Bay Foundation and the Los Angeles Waterkeeper. The automated shore stations program operates and maintains four stations (Scripps Pier, Newport Pier, Santa Monica Pier, and Stearns Wharf) and provides real-time, continuous data at 1-4-minute intervals with limited interruptions. Automated shore station data are one of the most requested data sets provided through SCCOOS. These data are used by both the public and local state and research agencies to assess local conditions related to water quality, nearshore processes, population dynamics of coastal species and HABs.

9. Burkeolator and ACDC field deployment at Carlsbad Aquarium and Catalina Sea Ranch
    a. Completion date: TBD – ongoing milestone
    b. Status: On-Track
    c. Successes: In the summer of 2018, the team deployed the Gen1 ACDC in the Agua Hedionda Lagoon, located near the Carlsbad Aquafarm. The ACDC was operated alongside two SeapHOx units measuring pH, Temperature and Salinity and the on-going Burkeolator (BoL). The calibrated SeapHOx pH data were then combined with the salinity-derived alkalinity to generate a continuous pCO_2 value for comparison with the ACDC system. The SeapHOx units, functioning in real time, provided more accurate pH data in comparison to the ACDC.

       The Gen1 and Gen2 sensors will be tested alongside the SeapHOx unit in the CSRF test tank at Scripps Institution of Oceanography for three weeks in December 2018. The Gen1 will be transferred in Spring 2019 to Catalina Sea Ranch to be deployed on the NOMAD buoy. The Gen2 ACDC will be deployed at the Carlsbad Aquafarm in Spring 2019 alongside the SeapHOx and BoL units for comparison. Carlsbad Aquafarm is actively engaged in helping to maintain the BoL and use data for their daily operations; these data are routed in real-time to the IPACOA web portal and displayed on both the SCCOOS and GOA-ON websites.

Marine Operations

1. Annually provide training to first responders of maritime incidents in the use of SCCOOS products.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: SCCOOS participates in training and science education to a broad range of stakeholders either by request or as opportunity arises.

2. Operate and maintain a network of short, medium, and long-range HF radar systems and deliver data streams to the National HFR Network.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: The live feed of HF radar data is available on the national HFR network for oil and hazardous spill response in the Environmental Response Management Application® (ERMA) map viewer for the southwest region.

       At Port San Luis (LUIS) the existing electrical connection was lost so the team worked with local stakeholders (Port San Luis Harbor District; Port San Luis Lighthouse Keepers) to move the site to a new location, including pouring a new concrete foundation and the design of a public-friendly sign to accompany the instrument (sign to be installed in 2019). At Point Arguello (ARG1 and AGL1) the team fixed existing electrical issues mainly due to corrosion and got both sites back up and running (e.g., rewired junction boxes, rewired

ground rods, reinstalled satellite service, fixed transmission antennas, etc., depending on the site).

Some of the oldest HF radar systems are located in California. SCCOOS and CeNCOOS operate 62 radars, which currently equates to 40% of the overall IOOS network. California RAs evaluated the HF radar network to determine needs for maintaining the existing network within operational requirements of NOAA, USCG, the Bureau of Ocean Management, State Agencies, County Sanitation Districts and Public Works, private companies and non-governmental organizations. The study showed a growing need to recapitalize aging hardware infrastructure of the network with 10% of the network having reached the normal service life of equipment over 20 years, and 65% of the network over 10 years in service. At this time, the network requires hardening of the existing infrastructure, repairs, and technology updates. The operators have assessed that $7.5 million is needed to fully recapitalize and bring the network back to its original specifications.

3. Maintain and expand integrated, customized products with multi-layer views of observations, nowcasts, and forecasts. Collaborate with the Port of Long Beach to maximize the benefit of SCCOOS observations.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: 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.

4. Deliver surface current data and surface wind analyses to aid spill response, SAR real-time recovery, and post analysis trajectories.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: 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), at Point Mugu. 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.

5. Provide HF Radar Quality Control Development.
    a. Completion date: TBD - ongoing milestone
    b. Status: On-Track
    c. Successes: Over the past six months work has continued to implement the QA/QC procedures over the entire IOOS network of about 145 radars. An important ongoing step is to identify all HFR-site pairs for comparing radial currents along over-water baselines. Another important step is to identify all groups of three HFR sites for computing synthetical radials. This work is almost complete for the over-water baselines and is continuing for the synthetic radials for which there are many HFR-site combinations. A user interface has been developed so that comparison results can be obtained from the over-water baselines and synthetic radials. The QA/QC software code is being tested over the entire network. Problems have been found for some over-water baseline site combinations and synthetic radial site combinations. Work is underway to correct these. Overall the scaling up of the QA/QC procedures to the IOOS HFR network is proceeding satisfactorily.

3) SCOPE OF WORK

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.

4) PERSONNEL AND ORGANIZATION STRUCTURE

Megan Hepner joined the SCCOOS team as the new Program Coordinator on June 20th, 2018. Megan joins us from the Marine Biodiversity Observation Network (MBON) where she obtained her masters in Marine Science at the University of South Florida under the guidance of Dr. Frank Muller-Karger. Prior to graduate school Megan worked with NOAA at the Office of National Marine Sanctuaries where she witnessed firsthand the interactions and relationships among federal, state, and local governments. Megan has experience in communicating complex science and policy concepts to a diverse audience, including government officials, stakeholders, and the public and has strong writing and data analysis skills.

Megan Rawls, an undergraduate at Palomar College, joined us this summer as a student volunteer intern. Megan, under the guidance of M. Hepner and C. Anderson, helped us design and develop content for our new website. She is now a transfer student at UC Davis majoring in Environmental Science.

5) BUDGET ANALYSIS

FY 2018, SCCOOS received an increased allocation of directed funding ($175,422) and an increase in base funds ($4,542) from FY17. Directed Fill the Gaps Observations went towards gliders ($150,000) and HF radar operations and maintenance ($150,000). To streamline access to ocean observations we received an additional $75,000 in directed funds that we put toward improving HAB monitoring and developing the CA HAB Bulletin. The Matt Howard Memorial one-time fund was directed to advance biological observations by creating new data management schemes for applying "Darwin Core" standards to SCCOOS (and CeNCOOS) HABMAP data, and serving them on the ERDDAP for eventual ingestion by the global Ocean Biogeographic Information System (OBIS) database.

FY18 funding has provided a valuable investment in important assets and will strengthen regional partnerships and national program planning. SCCOOS will continue providing 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.

Expenditures are progressing as expected, with no major discrepancies between actuals and budgeted on both the main award and the subawards.

II. PERFORMANCE PROGRESS REPORT ADDENDUM

1) Education and Outreach
   a. SCCOOS has updated the Education and Outreach Inventory.

2) Data Management, Products, and Services
   a. Open Data Sharing

SCCOOS continues to have the ability to achieve its milestones by providing 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 targets THREDDS and ERDDAP distribution for wave, surface currents and shore station data. SCCOOS also continues to implement QARTOD data quality control standards. Wave and surface current data have associated XML and FDGC compliant metadata. SCCOOS has completed a standards-based foundation for DMAC capabilities by converting HF radar and shore station formats into NetCDF, THREDDS and ERDDAP.

SCCOOS has released ncSOS service for its automated and manual shore stations.

- SCCOOS has released ERDDAP service for its existing data sets, including adding the ability to select temporal or geographic subsets of data.
- SCCOOS has leveraged CDIP wave data that are decimated to the NDBC for ingestion into WMO GTS
- SCCOOS has developed a Data Management Plan describing the current status of SCCOOS data streams and future goals for data quality assurance, quality control, dissemination, distribution, and archiving.
- In addition to the Data Management Plan, SCCOOS has developed more detailed descriptions of various data streams and products in the form of Sensor Plans.
- Sensor Plans follow a NOAA Data Sharing Template.
- Sensor Plans have been developed for Gliders, Automated Shore Stations, CalCOFI Cruises, CDIP, HFR, HABs, Manual Shore Stations, Satellite Imagery, AIS and the Burkeolator.
- Observations are collected from a variety of platforms in a variety of ways, each of which has its own level of data processing maturity. SCCOOS accepts data from both automated and manual systems via SFTP, HTTP, serial over internet, Webforms, email and Google Drive. Observations are stored in flat files, databases and NetCDF files, all of which are available on the SCCOOS website.

b. Data Management Planning and Coordination

Ongoing program-level participation in data management planning and coordination activities are:

- Anderson and Rowley attended the IOOS Biological Data Training Workshop in Seattle, WA on February 8 - 9, 2018.
- Anderson and Rowley organized and attended the SCCOOS and CeNCOOS Shore Station HABMAP Meeting in Costa Mesa, CA on April 4, 2018.
- Rowley attended the IOOS DMAC meeting in Silver Spring, MD on May 21 – 23, 2018.
- Anderson and Rowley led and attended SCCOOS Board of Governors meeting in Playa Del Rey, CA on November 28, 2018.
- Rowley collaborates with the West Coast RA Data Managers to ensure that our west coast wide ocean observing efforts are coordinated.

- Vicky Rowley and Sarah Heim collaborate regularly with our project scientists on data management tasks that provide high quality data and products while sustaining existing infrastructure, improving data quality control and coordinating efforts with our partners.
- J. Thomas and Rowley participate in ongoing program-level data management and J. Thomas is on the committee for IOOS DM standards.
- Anderson and Thomas participate in the Joint Planning DMAC work groups.
- Thomas is a QARTOD steering team member, and Anderson contributed to the chlorophyll QARTOD manual.

c. Provision of Data to the Global Telecommunication System (GTS)'

	WMO GTS	THREDDS	ERDDAP	SOS	IOOS Catalog (DAC)	Web Page	Primary Funder	Operated	Maintained (QC, Archive)
Automated Shore Stations		x	X	x	x	x	SCCOOS	SCCOOS	SCCOOS
Burkolator		x	x	x		x	SCCOOS	SCCOOS	SCCOOS
Gliders	x	x	x		x	x	NOAA/SCCOOS	NOAA/SCCOO	NOAA/SCCOOS
Harmful Algae Blooms						x	SCCOOS	SCCOOS	SCCOOS
High Frequency Radar	x	x		x	x	x	SCCOOS	SCCOOS	SCCOOS
State & Federally Leveraged									
Automated Information System						x	USCG	USCG	USCG
CalCOFI			x			x	NOAA/State of CA/NSF	NOAA/State of CA/NSF	NOAA/State of CA/NSF
CDIP Wave Data	x	x		x	x	x	USACE	CDIP	CDIP
Satellite Data						x	NASA/JPL	NASA/JPL	NASA/JPL

Table 1: Table indicates which communication; web services and access options are available for SCCOOS distributed data.

- SCCOOS has leveraged CDIP wave data that are disseminated to the NDBC for ingestion into WMO GTS (See Table 1).
- The HFR, glider, and CDIP wave observations are all transmitted to the National Data Buoy Center for inclusion on the World Meteorological Service Global Telecommunication Service.

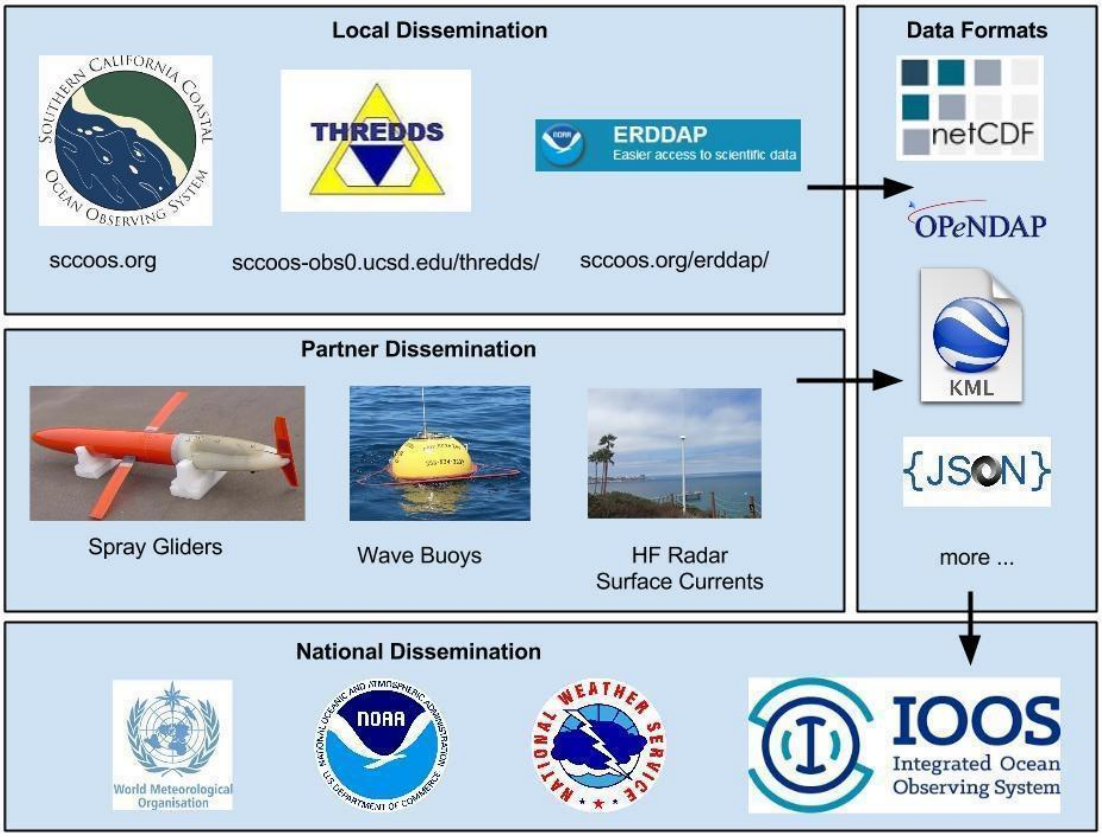
d. Data Access Services

See Table 1 above for a breakdown of how SCCOOS data can be accessed. SCCOOS adheres to the NOAA Data Sharing Procedural Directive. All real-time and near real-time data managed by SCCOOS are freely available through open services, without delay or restriction. Avenues for accessing the data include the SCCOOS website: sccoos.org. SCCOOS does not restrict access to any data it collects or serves.

- SCCOOS targets THREDDS and ERDDAP distribution for wave, surface currents, shore station data and most recently the Burkeolator. This will soon include ACDC data, although without a real-time capacity.
- SCCOOS has completed a standards-based foundation for DMAC capabilities by converting glider, HF radar, shore station, Burkeolator, and (soon) HAB/nutrient data formats into NetCDF, THREDDS and ERDDAP.
- All SCCOOS data are publicly available through the SCCOOS website. SCCOOS actively participates in on-going efforts to standardize data distribution through the use of web

services such as the Sensor Observation Service and the Open-Source Project for a Network Data Access Protocol (OPeNDAP)/THREDDS.

- As an operational Data Assembly Center, SCCOOS aggregates and manages the integration and distribution of ocean data and products. Serving as a federal repository for physical and bio-chemical datasets, the Data Assembly Center provides data ingest, analysis, quality control, discovery, access services, visualization and archive. Observational information is made available in a variety of data formats to ensure that products are useful and easy to access, while preserving the necessary detail to support the scientific and educational communities.



Picture 1. Real-time and near real-time data managed by SCCOOS are freely available through open services, without delay or restriction.

e. Catalog Registration

HFR, gliders, Automated Shore Station and CDIP wave buoys are registered in the IOOS Service Registry. Registration of datasets and services with IOOS provides basic monitoring of service availability and response time.

f. Common Data Formats

- All SCCOOS data are publicly available through the SCCOOS website. The HFR, glider, and CDIP wave observations are all transmitted to the National Data Buoy Center for inclusion on the World Meteorological Service Global Telecommunication Service. SCCOOS actively participates in on-going efforts to standardize data distribution through the use of web services such as the Sensor Observation Service and the Open-Source Project for a Network Data Access Protocol (OPeNDAP)/THREDDS.

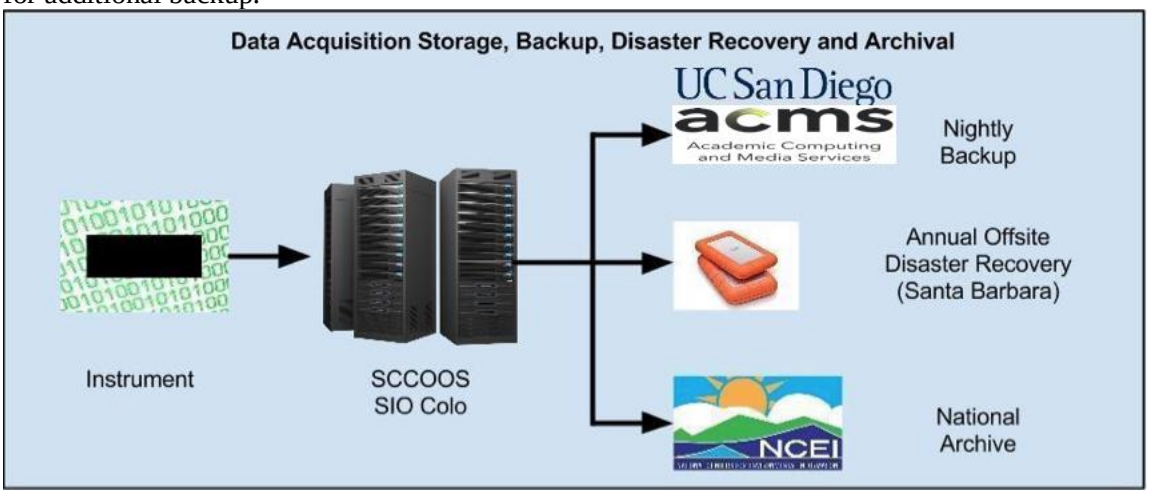
- SCCOOS participates with IOOS partners in a highly distributed system of interoperable components.
- Collaboration with international programs such as OceanSITES and the Joint Commission of Oceans and Meteorology (JCOMM) are on-going instructive for CF compliancy and data handling issues.

g. Metadata Standards

SCCOOS is regularly in accordance with manufacturer guidance or industry best practice for calibrating, validating, operating, and maintaining equipment owned and/or operated by SCCOOS. Publicly available data are quality controlled at minimum with the following QARTOD required tests: 1) timing, 2) syntax, 3) location, 4) range, 5) climatology. SCCOOS maintains an active role in the ongoing effort to develop and apply QC standards throughout the IOOS Regions. Highly leveraged programs such as CDIP wave data, HFR network, CalCOFI cruise data, and glider programs manage their own quality control which are compliant with the federal repository data management standards.

h. Storage and Archiving

SCCOOS stores observational data on servers located at Scripp's CoLo data center. SCCOOS operates two enterprise servers running Redhat Operating Service. Each server has dual 18 core Xeon Processors, 128 GB of RAM and a JBOD with 24 Terabyte of storage. Servers are backed-up nightly and copies stored offsite at the University of California San Diego Academic Computing and Media Services. The SCCOOS website is backed up nightly, and in the event of a catastrophic failure of the website hardware, it could be restored from backup within hours. Annual disaster and recovery hard drives are sent to the University of California Santa Barbara for additional backup.



Picture 2. Data acquisition, storage, disaster recovery and archival.

There are only two existing datasets that are not archived at NCEI at this time:

- HABs, will be archived by June 2019 at NCEI,
- Burkeolator Ocean Acidification Data - SCCOOS is in discussion at NCEI and preparing to submit a request or archive by April 2018.

Presently, Automated Shore Station data, CDIP's wave data, HFR data, HAB/nutrient, Burkeolator and glider data are all archived at NCEI. Certain datasets that are registered with the IOOS Service Registry contain FGDC and ISO 19115-2 metadata are available through ERDDAP and THREDDS.

i. Ontologies, Vocabularies, Common Identifiers

Observations are collected from a variety of platforms in a variety of ways, each of which has its own level of data processing maturity. SCCOOS accepts data from both automated and manual systems via SFTP, HTTP, serial over internet, Webforms, email and Google Drive. Observations are stored in flat files, databases and NetCDF files, all of which are available via the SCCOOS website.

j. Consideration for Long-Term Operations

SCCOOS Data Management and Communications goals are to develop and maintain the following capabilities:

- Deploy the information system components (including infrastructure and relevant personnel) for full life-cycle management of observations including product creation, public delivery, system documentation, and curation.
- Deliver accurate and timely ocean observations and model outputs to a range of consumers including government, academic, private sector users, and the general public utilizing standardization and specifications common across all providers.
- Establish a robust data exchange that is responsive to a wide breadth of customer requirements and user feedback, assuring the data handling flexibility to accommodate decision-support requirements.

SCCOOS will continue to provide timely access to high-quality integrated data and support regional user needs while complying with the national standards and protocols for sharing and archiving data following the "Guidance for Implementation of the Integrated Ocean Observing System (IOOS) Data Management and Communications Subsystem." SCCOOS will also continue to integrate a broad suite of observations in the form of raw data and products. Collaboration with partner RAs to advance stakeholder access to cross-regional data services as defined by commonalities in specified user requirements, is on-going through IOOS Data Management and Communications including workshops and webinars. SCCOOS is well poised to improve ingestion with a level of quality control based on Quality Assurance of Real Time Oceanographic Data (QARTOD) parameters, standardize the web services for all parameters, submit to National Centers for Environmental Information (NCEI) for archive, and enhance data visualization. Additional desired outcomes are described on pages 18-30 of the Strategic Operational Plan.

3) Observing Assets

a. RA Asset Inventory

The RA asset inventory can be found on the SCCOOS website under Documents.

b. HF Radar Asset Inventory

c. HF Radar Staffing Inventory

d. Glider Days Inventory

III ENVIRONMENTAL COMPLIANCE

1) First Responder Training

IOOS/NOAA determined this project has a categorical exclusion, and their statement is as follows:
The aforementioned project will not result in any changes to the human environment. As defined in Section 6.03c3(d), Administrative r Routine Program Functions, of NAO 216-6, this project involves conference room and/or classroom training activities that hold no potential for significant environmental impacts. As such, they should be categorically excluded from the need to prepare an Environmental Assessment or an Environmental Impact Statement.

2) Gliders

IOOS/NOAA determined this project has No Significant Impact, and their state is as follows:
It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

3) Shore Stations

IOOS/NOAA determined this project has No Significant Impact, and their state is as follows:
It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

4) Vessel Sampling – CalCOFI

IOOS/NOAA determined this project has No Significant Impact, and their state is as follows:
It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

5) Mooring

IOOS/NOAA determined this project has No Significant Impact, and their state is as follows:
It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

The project and its potential impact may be limited through the following terms or conditions placed on receipt of NOAA funds:

- A permit is in place to allow the mooring to reside in its location: 1) Aid to navigation application; 2) Aid to navigation addendum; and 3) FCC Experiment License valid until 2017. The applicant must provide copies of these permits to the I OOS Office for the EC File of Record prior to undertaking the Del Mar Mooring Activities under the subject award.
- SCCOOS has implemented the Essential Fish Habitat Conservation Recommendations provided by NMFS on July 7, 2014 to avoid, minimize, or offset effects of this activity.

David Gassier, 9500 Gilman Drive, 0230, La Jolla, CA 92093-0230

United States of America
FEDERAL COMMUNICATIONS COMMISSION
EXPERIMENTAL
RADIO STATION CONSTRUCTION PERMIT
AND LICENSE

EXPERIMENTAL	**WI2XAA**
(Nature of Service)	(Call Sign)
XR FX	0539-EX-PL-2015
(Class of Station)	(File Number)

NAME Scripps Institution Of Oceanography

Subject to the provisions of the Communications Act of 1934, subsequent acts, and treaties, and all regulations heretofore or hereafter made by this Commission, and further subject to the conditions and requirements set forth in this license, the licensee hereof is hereby authorized to use and operate the radio transmitting facilities hereinafter described for radio communications in accordance with the program of experimentation described by the licensee in its application for license.

Operation: In accordance with Sec. 5.3(d) of the Commission's Rules

Station Locations

(1) Santa Barbara Channel, within 32 km, PC - NL 34-18-31; WL 120-48-15
(2) Pacific Ocean,, within 32 km, PC - NL 33-31-41; WL 122-30-15
(3) Pacific Ocean, within 32 km, PC - NL 32-55-48; WL 117-18-57

Frequency Information

Santa Barbara Channel, within 32 km, PC - NL 34-18-31; WL 120-48-15

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
161.975-162.025 MHz	FX	25K0F1D	12.5 W (ERP)	0.00015 %

Pacific Ocean,, within 32 km, PC - NL 33-31-41; WL 122-30-15

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
161.975-162.025 MHz	FX	25K0F1D	12.5 W (ERP)	0.00015 %

This authorization effective **November 09, 2017** and
will expire 3:00 A.M. EST November 01, 2019

FEDERAL COMMUNICATIONS COMMISSION

Frequency Information

Pacific Ocean, within 32 km, PC - NL 32-55-48; WL 117-18-57

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
161.975-162.025 MHz	FX	25K0F1D	12.5 W (ERP)	0.00015 %

Special Conditions:

(1) The occupied bandwidth of the emission shall not extend beyond the band limits set forth above.