



SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

U.S. Integrated Ocean Observing System (IOOS) Implementation

Southern California Coastal Ocean Observing System (SCCOOS)

FY16-21 National Oceanographic Partnership Program Report:

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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.

1. **Climate Variability and Change:** to 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, and to continue to develop, integrate, and enhance long-term time series products for distribution.
2. **Coastal Hazards:** to provide accurate, validated inundation models and information about wave observations and run-up, total water levels, coastal erosion, and storm surge, with the long-term goal of improving coastal safety.
3. **Ecosystems, Fisheries, and Water Quality:** to monitor ocean climate trends and environmental changes in the Southern California Bight by collecting physical, chemical, and biological data and to provide monitoring, tracking, and prediction tools for harmful algal blooms, outfall and storm water plumes, and surf zone contaminants.
4. **Marine Operations:** to advance integrated, customized coastal products that are critical for safe and efficient navigation into ports and harbors, search and rescue missions, and oil spill response.
5. **Science Education and Communication:** to maintain a public, accessible website for data discovery and a portal that provides visualizations and resources for the public to learn, educate, and promote scientific research with SCCOOS data. A spreadsheet of SCCOOS education and outreach efforts can be found [here](#), as well as a spreadsheet of stakeholders can be found [here](#).

2) PROGRESS AND ACCOMPLISHMENTS

With advances in public health safety information to prevent the spread of COVID-19, many operations are now back online.

SCCOOS continues to achieve its milestones by providing access to high-quality integrated data and supporting regional user needs while complying with national standards and protocols for sharing and archiving data. SCCOOS leverages the [Coastal Data Information Program](#) (CDIP), the [HF Radar Network](#) (HFRnet), and the [California Underwater Glider Network \(CUGN\)](#). SCCOOS actively participates in IOOS DMAC efforts, such as the use of the UCAR community program Thematic Real-Time Environmental Distributed Data Services (THREDDS) and the NOAA NMFS Environmental Research Division's Data Access Program (ERDDAP) to facilitate distribution of most of our datasets ([SCCOOS Data Access and Services webpage](#)). SCCOOS also continues to implement QARTOD data quality control standards for all parameters for which QARTOD exists, including the chlorophyll fluorometry manual. All data have associated ISO 19115 compliant metadata and are well catalogued in our [RICE certification documentation](#). As a result of SCCOOS listservs (e.g., sccoos@sio.ucsd.edu, CA.HAB.Bulletin@sccoos.org) and social media streams (e.g., [Facebook](#), [Twitter](#)), more ocean observing news items are now widely distributed throughout the Regional Associations, the IOOS program office and 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 and data archive centers.

a. Principal Investigator: Rudnick (UCSD); b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: Real-time data are delivered to the NOAA Southwest Fisheries ERDDAP then to the national glider DAC, and then onto the GTS. Delayed mode, quality controlled data are available for download at spraydata.ucsd.edu. The major recent advance has been the creation of a calibrated chlorophyll fluorescence data set, adjusted to agree with satellite color data, available at spraydata.ucsd.edu. The goal is 5 sustained lines using Spray underwater gliders off the coast of California. The lines follow the CalCOFI geometry, from south to north: line 90.0 (funded by NOAA GOMO), alongshore at station 60 (SCCOOS), line 80.0 (SCCOOS), line 66.7 (NOAA GOMO), and line 56.7 (CeNCOOS). The COVID-19 pandemic interrupted the observations, with all lines except for line 90.0 having a break. All lines are now back up and functioning normally. More information on the California glider network can be found on the [SCCOOS website](#).

2. Continue to develop, integrate, and enhance long-term time series products for distribution.

a. Principal Investigator: Anderson (UCSD); b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes: Lead PI C. Anderson, Program Coordinator, Megan Medina, and Data Analyst, Ross Timmerman, published six [CA HAB Bulletins](#) during the performance period. The CA HAB Bulletin is posted on the SCCOOS website, shared on our media platforms and goes out to 313 people registered to our [CA HAB Bulletin listserv](#). The listserv comprises academic (90), government (102), nonprofit (53), industry (21), and public (47) stakeholders. Additionally, in response to the recent prolonged [Red Tide Event](#), SCCOOS solicited a questionnaire to collect community anecdotal information/data for inclusion in future publications and bulletins on potential respiratory symptoms experienced after being exposed to the dinoflagellate bloom. The questionnaire was publicly available from June to July 2020 and made available in both English and Spanish. With the help of Surfrider Foundation, Surfline and CICESE, we received 872 responses, of which 25% reported symptoms and nearly all indicated seeing evidence of the algal bloom. We are in communication with OEHHA, CDPH and Surfrider to analyze the data and discuss how to conduct more surveys in the future and notify the public of potential health impacts.

COASTAL HAZARDS

1. Shoreline inundation forecast, validation, and dissemination of warnings to select city managers.

a. Principal Investigator: Merrifield/Fedderson (UCSD); b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: Cardiff and Imperial Beach flooding forecasts integrated on the [SCCOOS website](#) for city officials and the public. We have developed a detailed error analysis and a probabilistic assessment to be included with the website forecasts, as described in a manuscript to be submitted in December 2020 to Natural Hazards. Advanced flood models have been developed for Coronado and Huntington Beach, with additional flood reports needed to finalize flood thresholds. COVID has posed a challenge for collecting data of flood occurrence, particularly at Huntington Beach.

2. Expand development and integration of inundation website.

a. Principal Investigator: Merrifield/Fedderson, UCSD; b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: A website for Imperial Beach is now live at [CCCCIA](#) and on the [SCCOOS website](#) and includes products showcasing historic trends, latest observations, and the flood forecast. Historic products include a compilation of past events, a record of historic beach width, and a beach profiles viewer for identified flooding sites. Latest observations include wave height predictions for Imperial Beach and an elevation map of the beach based on the latest LiDAR survey. Beach products, including the beach width plot, beach profiles viewer, and LiDAR elevation map, are in the process of being improved to automatically update with the latest sand level surveys. The Imperial Beach site will serve as a template to expand to other coastal sites. A website for Cardiff Beach is also on the

[SCCOOS website](#) and includes historic products as well as a flood forecast. The forecast has been specifically developed for Cardiff Beach and is in the process of being evaluated and improved. Other products are in development, although not live yet, and include a beach profiles viewer and record of past flooding events. Prototype websites for Huntington Beach and Coronado are currently in development with a profiles viewer and a flood forecast based on the improved runup parameterization developed at Imperial Beach. We will continue to develop these sites as well as evaluate and improve the forecasts with observations.

3. Develop model for Huntington and Imperial Beach inundation sites

a. Principal Investigator: Merrifield/Fedderson (UCSD); b. Completion date: TBD – ongoing milestone; c. Status: On-Track

d. Successes and Challenges: We have completed a study that demonstrates how to improve Imperial Beach flood forecasts based on remote sensing of the nearshore to estimate surf zone width. The information is used to account for otherwise unresolved offshore bathymetry. We will evaluate the effectiveness of using live stream videos for this purpose at Imperial Beach, and will start to scout similar options for Huntington Beach. We are continuing to document flood events, or the lack thereof, at Imperial Beach and Huntington Beach to improve flood threshold estimates. This information feeds into our new probabilistic assessment of minor and moderate flood risk.

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. Principal Investigators: Washburn/Brzezinski (UCSB), Caron (USC), Walter/Pasulka (Cal Poly), Shipe (UCLA), Carter/Anderson/McGowan (UCSD); b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: Weekly measurements of temperature, salinity, chlorophyll, particulate domoic acid, macronutrients, and potentially harmful phytoplankton species are distributed via the California HABMAP listserv and are discoverable online via the [SCCOOS ERDDAP server](#). Interruptions in sample collection and processing occurred between March 23-Nov 30, 2020, with the closing of several piers, university laboratories, and shelter-in-place orders throughout California, associated with the COVID-19 pandemic. Details for each station follow:

- Cal Poly Pier/Cal Poly: Cal Poly obtained an exemption to continue weekly sampling at the Cal Poly Pier during COVID-19. PIs Walter and Pasulka, along with former undergraduate student Alex Barth and Senior Research Scientist Ian Robbins, published a paper in *Marine Ecology Progress Series* ([Barth et al., 2020](#)) describing seasonal and interannual phytoplankton variability from a decade of HAB measurements made at this site.
- Stearns Wharf/UCSB: UCSB shutdown all non-essential research on March 20, 2020. Routine weekly sampling, including new efforts to implement SPATT bag deployments for dissolved phycotoxins ceased at that time. Data processing continues from remote (home) locations.
- Santa Monica Pier/UCLA: Santa Monica Pier access was closed during two weeks in April, 2020, with restricted lab access and delays in processing samples April - July 2020. Samples have been partially processed and full analyses will be completed once university laboratories are reopened.
- Newport Beach Pier sampling (USC): As with other pier sampling efforts, sampling at Newport Beach was shutdown beginning in mid-March. The pier itself was closed to the public for some time, and University policy curtailed all sampling at the pier and sample processing in the lab through June 15th. On-campus research activities were restarted at USC the week of June 15th, and sampling at the Newport Beach pier restarted on June 22nd. Two manuscripts were published recently that were in part or whole a result of samples and data collected at Newport Beach pier: [Busch et al., 2019](#) and [Smith et al., 2019](#).
- Scripps Pier/SIO: SIO obtained an exception to continue weekly sampling throughout the UCSD campus closure. Efforts to minimize time on campus from March 18th through November 30th included freezing chlorophyll samples for later analysis and deferring cell counts. Since the campus closure, Scripps Pier data has not been uploaded to ERDDAP due to limited time on campus and deferred analysis of chlorophyll samples and cell counts. These will be uploaded as soon as feasible. Deployment of SPATT was planned for March 2020 and

was delayed due to campus restrictions. The SPATT rig was deployed 6/18/20 and weekly samples are currently being collected. Collaborations with Jules Jaffe, Peter Franks, Andrew Barton and staff scientist, Kasia Kenitz, utilizing the Scripps Pier Plankton Camera and weekly cell counts led to the following paper by [Kenitz et al., 2020](#) published in *Limnology and Oceanography*. Collaboration with Carl Carrano at San Diego State University and graduate student Kuyoko Yarimizu investigated the role of bacteria producing iron and bloom dynamics. This research utilized weekly chlorophyll and cell counts and led to the publication by [Yarimizu et al., 2019](#) published in *BioMetals*.

Data Manager, Vicky Rowley, has upgraded, standardized and automated the weekly acquisition and distribution of HAB data from seven collection sites with the data being made available via the [SCCOOS ERDDAP server](#). HABMAP information, products and data are available on the SCCOOS [HABMAP page](#) and UCSC- and SCCOOS-operated [HABMAP site](#). In addition, a Darwin-Core compliant version of these data is being developed to facilitate their submission to global biological data repositories such as MBON and OBIS thanks to Matt Howard Memorial supplemental funding from IOOS.

2. Continue to collect California Cooperative Oceanic Fisheries Investigations (CalCOFI) observations and measurements.

a. Principal Investigator: Goericke (UCSD); b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: Since 2004, SCCOOS has funded nine nearshore stations in addition to CalCOFI's standard 66 stations. SCCOOS links to data that are measured in the nearshore region of Southern California as part of CalCOFI - California Current Ecosystem Long Term Ecological Research (CCE-LTER) program. These parameters include temperature, salinity, zooplankton, phytoplankton, fish eggs and invertebrate larvae. CalCOFI data, resources, and reports are posted on the [CalCOFI website](#). More information on SCCOOS-CalCOFI background, observations, data access and publications can be found on the [SCCOOS website](#). Due to COVID-19, the CalCOFI Spring 2020 cruise was canceled. We were able to go out to sea for the Summer and Fall CalCOFI cruises and covered all SCCOOS stations.

3. Conduct shipboard observations with CalCOFI and NMFS Rockfish Recruitment and Ecosystem Assessment Survey (RREAS); count seabirds; post data reports and data online.

a. Principal Investigator: Sydeman (Farallon Institute); b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: The spring (April) CalCOFI and spring-summer (May-June) RREAS were cancelled due to COVID concerns. Instead, we have emphasized DMAC, and in particular have been working to implement new statistically derived data products to be shared with the IOOS community in the near future. These new derived products will include a dataset of time series of 20 species' densities by season for the period May 1987-present. We are working with NOAA's Environmental Research Division and SCCOOS to post the seabird dataset on the ERDDAP for the benefit of the marine science community and other data users including NMFS, USGS, HT Harvey and Associates and others. Finally, we are working with collaborators on a manuscript investigating the effect of climate change and fisheries on range shifts of seabirds from the subtropics into the California Current. This investigation is focusing on several species that have shifted their distributions from the Gulf of California into the Southern California Bight.

4. Publish survey reports and maps of seabird and marine mammal species distribution and abundance on the SCCOOS website.

a. Principal Investigator: Sydeman (Farallon Institute); b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: Survey reports and maps of species distribution and abundance are published on [SCCOOS website - Seabird and Marine Mammal page](#). As we look at adding biological data to our digital offerings, looking at a way to provide these data in a digital format is an upcoming challenge. One possible avenue is to assist the CCE LTER in assimilating the information and then SCCOOS could pull the data from there

- 5. Display the 3-km ROMS ocean forecasting system for real-time operations statewide.**
 a. Principal Investigator: Chao (UCLA); b. Completion date: TBD - ongoing milestone; c. Status: On-Track
 d. Successes and Challenges: 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. The ROMS model is displayed in near-real time on the [SCCOOS website - ROMS page](#). In July 2020, we replaced the aging computers used to run this quasi-operational model. With assistance from essential on-site personnel we were able to install the new ROMS hardware at Scripps Institution of Oceanography. The model is now running on enterprise level server hardware at SIO and the data is now available on the SCCOOS ERDDAP and THREDDS servers.
- 6. Validate the 3-km CA ROMS output against non-assimilated observations.**
 a. Principal Investigator: Chao (UCLA); b. Completion date: TBD - ongoing milestone; c. Status: On-Track
 d. Successes and Challenges: Six hourly nowcasts and 72-hour forecast files are available on SCCOOS THREDDS and ERDDAP servers. The validation results have been published in [Chao et al., 2018](#). Over the years, we have developed a number of validation products. On a daily basis, we are comparing the ROMS nowcast against satellite SST, glider measured profiles of temperature and salinity and HF radar derived surface current. As the new SCCOOS 3-km ROMS is developed, we plan to display these real-time model validation results on that web page. Operational impacts due to COVID-19: Minimum to none. Most of our work is being performed remotely, so there has been little impact on our 3-km ROMS modeling effort.
- 7. ROMS High-Resolution Shelf and Nearshore model developed to aid the evaluation of the effects of nutrient inputs on bloom formation and nutrient cycles.**
 a. Principal Investigator: McWilliams (UCLA); b. Completion date: TBD - ongoing milestone; c. Status: On-Track
 d. Successes and Challenges: Fine-scale simulations with a research-level, high-resolution ROMS are being analyzed in hindcast mode at UC Los Angeles to examine two circulation 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 with ancillary consequences for subsurface oxygen and carbon. 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 (ROMS-BEC) that we hope to use in the future 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 from the California Ocean Protection Council, NOAA, and UCLA. SCCOOS funds contribute to general model development and system maintenance but do not currently support additional product dissemination or development.
- 8. Continue automated shore sampling at four stations to measure temperature, pressure, salinity, chlorophyll, as well as DO and pH at Newport Beach Pier and pH at Scripps Pier.**
 a. Principal Investigators: Carter/Giddings/Anderson/Terrill (UCSD); b. Completion date: TBD - ongoing milestone; c. Status: On-Track
 d. Successes and Challenges: 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 4-minute intervals with limited interruptions. Automated shore station data is one of the most requested data sets provided by 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, and provides long-term time series data critical for assessing ecosystem health and climate trends. SIO obtained an exception to

work during the ongoing COVID-19 campus closure to maintain the Automated Shore Station (SASS) at Scripps Pier, Newport Pier, and Santa Monica Pier. Data were collected at all sites throughout the closure and captured the recent *L. polyedra* bloom (March 19-May 18, 2020). However, COVID-19 restrictions and shelter-in-place orders kept the UCSB team from servicing the Stearns Wharf Station from February through June 2020. Due to the long break in cleaning and maintenance at this site, the sensors (CTD and fluorometer) and cables were damaged due to excessive biofouling and will need to be replaced at significant expense. The Stearns Wharf station was back online July 1, 2020. The Stearns Wharf Pier station has been supplemented by funds through the University of California, Santa Barbara to support maintenance and cleaning dives in collaboration with the Santa Barbara Long-Term Ecological Research Project. This is an important and leveraged partnership.

Supplemental funding for the Newport Pier SASS has been renewed by the Orange County Sanitation District for the July 2020- June 2021 period with the option for renewal up to 4 years through 2024. This funding supports the collection of oxygen and pH measurements alongside the standard automated shore station observations. New pH sensors, SeaBird SeaFET, were purchased by OCSB and will be deployed in the next performance period. Challenges for this station include outages due to old infrastructure and power related issues which are currently being evaluated and temporarily resolved though additional investment in infrastructure will be required for long-term observations at this site.

The Santa Monica Pier shore station was decommissioned in years past and then reinstated with City of LA funding. However, funding from the City of LA Sanitation/Hyperion Water Reclamation Plant, The Bay Foundation, and The Los Angeles Waterkeeper for the Santa Monica Pier shore station ended on July 31, 2019 and has not been renewed at this time. Due to COVID-19 and possible city and state budgetary challenges, this funding may not be renewed in the future. Since December 2019, SIO has maintained this station and PIs are working to keep this site online.

All stations are now equipped with engineering controls to improve real-time measurements from underwater sensors. Date and stations when air-blasters were installed SB 2/26/18, SIO 1/25/2019, SM 6/27/2019 and NB 2/13/2020. The SASS program also continues to provide “hands-on” training and learning for graduates and undergraduates at UCSD by providing tours to learn about the ocean observations and climate change, use of SASS data in classes, and complementary data set for student projects. SIO and UCSD classes include SIO221, SIO210, SIO101, SIO87, and MAE3.

9. SeapHOx mini-mooring operations at Carlsbad Aquafarm (CAF)

a. Principal Investigator: Martz (UCSD); b. Completion date: TBD – ongoing milestone; c. Status: On-track

d. Successes and Challenges: Since 2019 the Martz lab has operated a real-time mini-mooring with SeapHOx in the Agua Hedionda Lagoon (AHL), within 10m of the CAF growing area. During 2020 the mooring operated successfully, sending real-time data to SCCOOS. Data are currently available through [ERDDAP](#) and time series plots of the real-time data are available on the [SCCOOS website](#). The SeapHOx successfully delivered data for four months (Jan - Apr), at which time the cellular modem battery died on April 7th. A battery replacement was scheduled, but, due to COVID-19 shutdown, maintenance was delayed. On June 15th, the system was recovered and redeployed in July. The data downloaded captured the low dissolved oxygen and pH levels in AHL during the recent Red Tide event, specifically anoxic levels for 9 days in May in the lagoon which likely contributed to the 80% die off of Carlsbad Aquafarm crop. The current deployment is ongoing, with a recent modem battery replacement and mooring overhaul planned for early 2021. [Bresnahan et al., 2020](#) was published in *Results in Engineering* on Equipping smart coasts with marine water quality IoT sensors, and the 2020 low oxygen data are currently contributing to two student-led manuscripts.

10. Drivers of Primary Productivity of the Shelf and Nearshore Region

a. Principal Investigators: Davis (UCI), Lucas/ Send (UCSD); b. Completion date: TBD; c. Status: On-Track

d. Successes and Challenges: This is a one-year project to demonstrate an observing approach for nutrient flux triggers of phytoplankton blooms in shelf and nearshore waters in Southern California. Progress made over the performance period includes: (1) integration of a SUNA V2 optical nitrate sensor onto the Wire Walker profiler platform and (2) deployment and maintenance of the Wire Walker mooring near Uwe Send's Del Mar mooring (100 m isobath) for 22 days in late April and May 2020. Work on the initial integration of the SUNA V2 was delayed by a month because PI Davis was unable to recover a SUNA V2 from a field experiment in Panama due to COVID-19

related travel restrictions. As a work-around solution, a SUNA V2 was borrowed from a colleague (Dr. Erika McPhee-Shaw) allowing work to continue. Key outcomes of the research during the performance period include: (1) successful demonstration of the SUNA V2 integration on the Wire Walker, (2) the collection of high-frequency profiles (approximately every 11 min) of physical data and nitrate concentrations during the harmful algal bloom (*L. polyedra*) event, and (3) collection of supporting data from Del Mar mooring, including images from the Imaging Flow Cytobot (IFCB). Preliminary analyses of these novel observations indicate that optical attenuation by strongly swimming dinoflagellates (*L. polyedra*) can significantly influence the upper ocean heat budget, suggesting that biological feedbacks can be of first-order importance to the physical structure of the upper ocean. A second, prolonged deployment is underway being on 13-Nov 2020. This 3-5 month deployment includes 1) the installation of a SUNA sensor of the Del Mar Mooring, 2) the deployment of a “mini-mooring” at the 20 m isobath inshore of the Del Mar mooring, with velocity, temperature/salinity, and SUNA sensor, and the deployment of the SUNA-equipped Wirewalker on the 50 m isobath, between the Del Mar mooring and the Mini-mooring. These assets will be serviced monthly until Feb-March 2021.

MARINE OPERATIONS

1. Annually provide training to first responders of maritime incidents in the use of SCCOOS products.
 - a. Principal Investigators: Walter (Cal Poly), Washburn (UCSB), Heidelberg (USC), and Terrill (UCSD)
 - b. Completion date: TBD - ongoing milestone;
 - c. Status: On-Track
 - d. Successes and Challenges: SCCOOS participates in training and science education to a broad range of stakeholders either by request or as opportunity arises. Dr. Angelica Rodriguez presented on behalf of SCCOOS, CDIP and CCCIA on June 3rd at the Port of Long Beach/Los Angeles Harbor Safety Committee Meeting. Angelica spoke on issues surrounding ports and sea level rise, inundation and data/model products that support maritime transport. The new Captain of the Port, Captain Ore, was impressed by the presentation and sea level rise research in the region. SCCOOS and CORDC staff also attend and present at the routine US Coast Guard Area Committee Meetings, informing teams of USCG and CA OSPR staff about the HFR data products and their use in SAROPS and GNOME model systems. The spring meeting was cancelled due to COVID, but a virtual meeting was held in July 2020.

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. Principal Investigators: Walter (Cal Poly), Washburn (UCSB), Heidelberg (USC), and Terrill (UCSD);
 - b. Completion date: TBD - ongoing milestone;
 - c. Status: On-Track
 - d. Successes and Challenges:
 - Cal Poly: Cal Poly obtained an exemption to continue accessing sites during Covid-19, although some on-campus work has been limited. Cal Poly’s nine HF radar sites were calibrated on their yearly schedule. All sites were updated to version 8, update 5 of SeaSonde software and updated to High Sierra or Mojave operating systems when possible. Diablo Canyon’s solar batteries were all recharged and maintained to maximize their lifespan. The computer at the Diablo Canyon SR site was replaced after the hard drive failed. The Point San Luis site (LUI5) received a new GPS share module. External antennas at ESTR were installed for the cellular modem to compensate for the end of life 3G signal. The computer at Fallback 22, on Vandenberg Air Force base, was replaced. An ethernet power controller was replaced at PTC1. Antennas and hardware were reinstalled and restarted at ARG1 after hardware and electrical failures. A new computer and front panel board was installed in the TX unit at Ragged Point (RAGG). Hardware at the site was temporarily removed due to the Dolan fire in August 2020. All other Cal Poly sites were maintained in a manner that maximizes their uptime and lifespan. Ongoing student research using HF-Radar data has been looking at circulation patterns and upwelling jet formation near San Luis Obispo Bay under various wind-driven upwelling regimes. One of these students will be submitting their senior thesis in December 2020. Moreover, several students have been contributing to a public information display that will be installed at the Point San Luis site.
 - UCSB: A continuing challenge over the past six months has been the ramp-down of research at UCSB due to the pandemic that began in mid-March 2020. The research ramp down for the UCSB radar group has been

eased somewhat based on modifications to our research plan that was originally submitted in April. We have since received Phase 3 approval at UCSB based on these modifications which allows us more occupancy time in our lab. This has helped us maintain radars at all sites subject to safety restrictions such as one person per vehicle for field work, mask use, and social distancing in the lab. During the previous reporting period we had hoped to conduct drone-based antenna pattern measurements (APMs) at the Point Mugu site (PTM1), but have been unable to do so. The reason is that our contacts for the site, which is located on a Navy base, have been unresponsive to our requests to conduct APMs. This may be due to pandemic restrictions. For PTM1 we have been using the Automated Identification System (AIS) and ships of opportunity to make APMs. Earlier loss of a transformer at our site in Oxnard, CA has required us to power the Mandalay Generating Station site (MGS1) with an aging solar trailer. We are in the process of acquiring new batteries for the trailer so we can operate MGS1 at full transmit power. Rather than pay for a new grid-based power installation, we have chosen to buy batteries so we can move the radar equipment if a new property owner requires us to leave the site. Salazar and Romero continue to perform maintenance procedures on the aging trailer to protect it from the local marine environment and extend its life. Romero constructed a new batch of circuit boards for signal sources used to make drone-based APMs. We have continued our collaboration with the Channel Islands National Marine Sanctuary, National Park Service, and the Anthropocene Institute to establish a new radar site on Anacapa Island. Challenges: As reported previously, many of UCSB's radar systems and ancillary equipment are old and require frequent maintenance procedures and repairs. Romero and Salazar frequently perform these maintenance procedures to minimize downtime. Another continuing challenge is acquiring new sites and upgrading existing sites to fill gaps in radar coverage. For example, assuming we can get permission, we are considering replacing the 13 MHz medium-range SeaSonde on Santa Cruz Island (SCI1) with a 5 MHz long-range system. This would expand total vector coverage since it would overlap extensively with the new site on San Clemente Island (SDSN).

- USC: A new GPS antenna, mount and cable were installed at Newport Beach (SCNB) as well as a modifying the enclosure for added structural integrity. Communications at Point Fermin (SCPF) were upgraded by adding a second cell phone antenna mounted in a location with a clearer line of sight. Permission to reinstall the radar at Torrance Beach (SCTB) has finally been given and will be completed in the next couple of weeks. While the original antenna and electronic chassis will be used, there will be a new cell antenna, GPS antenna and new cables. New communications equipment was installed at Catalina Island (SCCI) to improve remote connectivity, however we are still waiting to receive the new antenna and upgraded electronics from CODAR so the site can be reinstalled. Electronic cabinet reinforcement was done for sights at SCNB, SCTB and SCCI.
- UCSD/SIO: HF sites maintained by SIO continue to be in a good operational state but as the network ages some major repairs were required to extend their lifespan and, in some cases, restore operation. Following COVID-19 response protocol and research ramp up initiative after the ramp down initial effort, UCSD identified the High Frequency Radar (HFRNet) sensor network as an essential and critical activity in support of national and domestic operations. Applications include U.S. Coast Guard response to search and rescue and domestic oil spill response. Safety protocols were established with personal protective equipment (PPE), enhanced cleaning, and appropriate social distancing allowing the University to respond to site maintenance in most areas. A new long range HFR site was installed along the north coast of San Clemente Island. This site has been in planning for at least 8 years and operators have overcome many logistical hurdles to finally commission the site in late November 2020. This site has already increased total current coverage in the western portion of the SoCal Bight and will allow for even greater increase of coverage if other existing sites are modified to a long range frequency. This site was the original location where NOAA representatives researched and tested HF radar in the use of mapping surface currents, so it is notable to have an operational site established as part of HFRNet. Another new site along the Camp Pendleton coast is close to completion. Camp Pendleton personnel in conjunction with operators, have completed ecological studies and signed a license with UCSD Real Estate, and are now awaiting a formalized agreement with the US Department of Defense. Existing sites are still being maintained, albeit not at the same pace as previous years due to COVID-19 restrictions. Some highlights include: 1) Replacement of the solar power system at the San Mateo Point HFR site. Previous components, including batteries and solar panels were over 15 years old and reaching their end of life. We have also formalized our license agreement between UCSD Real Estate and Lincoln Properties, who

manage the site for Camp Pendleton. 2) The existing HFR antenna at Border Park, which was over 18 years old was replaced in early 2020 with a new dome-style antenna. Additionally, the antenna mount was replaced and modified to alleviate and slow the response of general degradation of the park facilities which support the mount. 3) The HFR antenna at the Point Loma Wastewater Treatment plant was replaced with a modern dome-style antenna. The existing antenna mount was removed and replaced with an improved mount that includes a tilt plate to facilitate access for antenna maintenance. One COVID-19 related impact is the lack of maintenance at the Coronado Island site. The site is in need of battery replacement. While a preliminary plan was being worked out between UABC and SIO to transport new batteries to the island, travel restrictions between US and Mexico have complicated the situation and the battery transport is on hold for the time being. We hope to be able to complete this replacement as soon as possible in the upcoming year.

Challenges: SCCOOS operators continue to identify possibilities for funding recapitalization of network hardware. Many of the oldest HFR systems in the IOOS network are located in California. SCCOOS and CeNCOOS jointly operate about 60 radars at any given time and these comprise about 40% of the overall IOOS HFR network. SCCOOS and CeNCOOS operators estimate that \$7.5 million is needed to fully recapitalize and bring the network back to its original specifications. This funding could be spread over multiple years. Operators are identifying high priority repairs using IOOS "fill the gaps" funding which will keep the network operating in the near term.

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. Principal Investigators: Anderson (UCSD) Behrens (UCSD/CDIP); b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: SCCOOS received \$10K in pass through funding to CDIP to help maintain the LA/LB wave buoy. 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. SCCOOS and CDIP staff participate and present at monthly to quarterly LA/LB Harbor Safety Committee Meetings.

4. Deliver surface current data to aid spill response, SAR real-time recovery, and post analysis trajectories.

a. Principal Investigators: Walter (Cal Poly), Washburn (UCSB), Heidelberg (USC), and Terrill (UCSD); b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: SCCOOS and CeNCOOS HF radar participants have hosted collaborative outreach discussions to foster informative exchanges with users/stakeholders of the HF radar derived surface currents and radial vectors. Recent meetings included topics such as: forecasting and modeling availability in the U.S. Coast Guard SAROPS application with Dr. Cristina Forbes; initiatives in coastal modeling assimilation with Dr. Chris Edwards and marine protected area research with CeNCOOS and SCCOOS support fellows; and data availability, limitations, and opportunities for the U.S. Olympic sailing team as they plan for 2028 Olympics in Long Beach, CA. Near real-time surface current measurements continue to be available for integration into common operating systems via [NOAA National Data Buoy Center](#) (NDBC) and the [Coastal Observing Research and Development Center](#) (CORDC) at Scripps. These data allow for harvesting, redistribution, and visualization. NOAA CoastWatch has integrated the data sets into their ERDDAP server allowing alternate access for data downloads and visualization in multiple formats - example of the west coast 6km data [here](#). Data are also archived with NDBC's National Centers for Environmental Information (NCEI).

5. Provide HF Radar Quality Control Development.

a. Principal Investigator: Washburn (UCSB); b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: A primary goal of this project is to allow HF radar operators to quickly evaluate the consistency of radial currents measured by different radars. Work during the most recent reporting period was focused on improving the core software toolbox on which the QA/QC comparison website is built. The code calculates two types of radials for QA/QC evaluation: (1) over-water baseline radials from two radars and (2) synthetic radials formed by two radars for comparison with radial currents from a third radar. This approach provides

critical tests on the consistency of radial currents measured by different radars. Toolbox improvements will also enable us to more easily operate and maintain the code base while simplifying the incorporation of new sites for the QA/QC website comparisons.

During the reporting period we faced a significant challenge that prevented the website from operating in real time. The server on which the website and data management code was running reached the end of its life, and building a replacement took a significant amount of time due to staff limitations and COVID restrictions. However, the new server is operational and the website and processing code is running on it operationally. During this period we also paid a computer science student with web developing expertise to develop enhancements to the web site code base. The enhancements, developed based on suggestions by users, include the ability for users to select a wide range of times for the comparisons, and to interactively choose which particular location within the radial coverage to visualize the comparisons. The javascript-based web design now dynamically generates the plots and statistics, while the MATLAB code generates and maintains the comparison data that feeds into the javascript. We are in the process of testing the improved code base along with the enhanced website and plan for it to be live in the next couple of weeks.

3) SCOPE OF WORK

SCCOOS operates as a system of partnerships and projects that are facilitated by technical and programmatic staff. Organized by the five 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 (now served via the JPL PODACC), high frequency (HF) radar surface current mapping, and data-assimilative ocean modeling. The projects described in this report represent the highly leveraged, multi-disciplinary, and collaborative efforts of the research teams that contribute data and information to SCCOOS.

4) PERSONNEL AND ORGANIZATION STRUCTURE

SCCOOS governance organization chart can be found on the [SCCOOS website - People page](#) as well as a list of governing members and Principal Investigators. Program Coordinator, Megan Medina, was on maternity leave from August 21 to October 6, 2020. During that time, Data Analyst, Ross Timmerman, worked full-time with SCCOOS Program Office to help with education and outreach efforts, curate monthly CA HAB Bulletin, participate on conference calls, and help develop the FY21-26 proposal.

5) BUDGET ANALYSIS

Directed Fill the Gaps Observations went towards gliders (\$150,000), HF radar operations and maintenance (\$150,000), Harmful Algal Bloom (HAB) and toxin monitoring (\$75,000) and SCCOOS data management (\$166,000). The Matt Howard Memorial funding (\$16,500) 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; an important development is that HABMAP data are now being ingested by the global Ocean Biogeographic Information System (OBIS) database, increasing the reach and discoverability of IOOS data. An additional \$125K directed from IOOS went toward operations and maintenance of the new CA IFCB Network. SCCOOS was also received a pass-through (\$10K) from IOOS to GlobalHAB for conference support of the GlobalHAB Modeling and Prediction Workshop in Glasgow, Scotland that Anderson is co-leading, but due to COVID-19 travel restrictions, the Workshop has been postponed until in-person travel is allowed, with virtual components planned in the interim. FY20 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 expanded data products when possible within budget constraints. SCCOOS is committed to and actively involved in regional, national, and international initiatives, such as the NAS Ocean Shots and UN Decade of the Oceans upcoming submissions for actions.

II. PERFORMANCE PROGRESS REPORT ADDENDUM

1) Education and Outreach

a. SCCOOS has updated the [Education and Outreach Inventory](#). SCCOOS has also updated our internal [Education and Outreach Spreadsheet](#) of all meetings, workshops, conferences, and webinars attended by SCCOOS staff.

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 to 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 DMAC efforts, including supporting new efforts to develop and utilize open-source software applicable across IOOS regions, participating in workgroups designed to develop and enhance representation and dissemination of ocean biological data, improving quality and expanding the amount and types of data made available, primarily via ERDDAP, but also using a SOS-enabled Thematic Real- Time Environmental Distributed Data Services (THREDDS). In order to maximize sharing of data, SCCOOS adheres to FAIR principles and endeavours to make its datasets (F)indable, (A)ccessible, (I)nteroperable and (R)eusable through extensive leveraging of metadata, use of standard protocols and tools to provide access and participation in larger national and international data catalogs and repositories, including NCEI, NDBC, IPACOA, GBIF, and OBIS

- SCCOOS continues to implement QARTOD data quality control standards on Automated Shore Station data, with plans to extend those checks to newly added pH and O2 data streams.
- In early 2020, we overhauled the data pipeline for CA HABs data to better adhere to FAIR data principles. These data are now available programmatically as well as manually in a wide variety of formats and with associated metadata via our ERDDAP server.
- Availability of the SCCOOS HABs data via ERDDAP has since been leveraged to create a Darwin-Core compliant version that is being submitted to global biological data repositories GBIF/OBIS thanks to Matt Howard Memorial supplemental funding from IOOS.
- As part of a continuing effort to keep our cyberinfrastructure maintainable and our data accessible, display of information for Tijuana River Plume Tracking, ROMS data and Automation Shore Station information was migrated to the recently re-architected SCCOOS website.
- SCCOOS worked with Dr. Yi Chao's team at UCLA to rehost the ROMS simulations on new server hardware located at SCCOOS, including making the resulting fore/nowcasts available on the SCCOOS ERDDAP and THREDDS servers.
- Data on UCSD outfall into the La Jolla MPA were made available via ERDDAP and a new webpage was developed to provide this information in a format more in tune with the needs of our stakeholders.
- SCCOOS is updating its Data Management Plan describing the current status of SCCOOS data streams and future goals for data quality assurance, quality control, dissemination, distribution, and archiving.
- Sensor Plans follow a NOAA Data Sharing Template.
- Sensor Plans are being updated for Gliders, Automated Shore Stations, CalCOFI Cruises, CDIP, HFR, and HABs,
- 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 FTP, 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:

- Rowley attended SCCOOS BOG in Los Angeles, CA on January 29, 2020
- Rowley attended a virtual ESC meeting on May 28, 2020.
- Rowley attended the SCCOOS ESC and BOG meeting in Los Angeles, CA on June 4, 2020.
- Rowley attended monthly CCE/PAL LTER meetings.
- Rowley attended monthly IOOS DMAC webinars.

- Rowley attended monthly ESIP Biological Data Standards Cluster meetings.
- Rowley supported an IOOS sponsored cross-regional effort to develop a new state-wide portal providing access to data related to biodiversity and ecology of Marine Protected Areas.
- Rowley collaborated with stakeholders on the development of a new webpage for Automated Shore Station data.
- Rowley attended the IOOS sponsored ESIP Biological Data Standards Workshop on July 13
- With Abby Benson from USGS, Rowley presented at the Monthly DMAC tech webinar on August 27, 2020.
- Rowley coordinated an intra-regional meeting to review and revise the protocol document(s) related to acquisition of HABS data, which was held on September 22, 2020.
- Rowley virtually attended the IOOS DMAC meeting held online October 13-15, 2020, including participation as a panelist in a breakout session to discuss insights and experiences with the Darwin Core (DwC) standard as well as submission of data to OBIS..
- Rowley began discussions with our NAVAIR stakeholders on feasibility of new display.
- Vicky Rowley collaborates 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. Most recently, this has involved making observations of pH, O2 and HABS data available via our ERDDAP server. We have also begun making automatically updated, interactive visualization of select data available on our SCCOOS website using R Shiny.
- Rowley participated in the “Standardizing Marine Biological Data Working Group.”
- Anderson participates in the Joint Planning DMAC work groups.
- Thomas is a QARTOD steering team member, and Anderson contributed to the chlorophyll QARTOD manual.
- Rowley collaborates with the West Coast RA Data Managers to ensure that our west coast wide ocean observing efforts are coordinated.

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 Organization Global Telecommunication Service.

d. Data Access Services

SCCOOS data access services meet the core data requirements as defined in IOOS Data Standards and Requirements, as well as the RICE Certification Requirements Guidance. In addition to making data available for interactive display and download via its website, <https://sccoos.org>, SCCOOS operates both ERDDAP and THREDDS servers, with plans to operate an additional, private ERDDAP server for use by our NAVAIR stakeholders in early 2021. SCCOOS continues to make data available over SOS via an installed THREDDS extension. Both ERDDAP and THREDDS allow data to be downloaded programmatically and both supply metadata that allow the data to be further shared and distributed accordingly. In addition, the SCCOOS ERDDAP server allows data to be downloaded in numerous formats, allows sensitive datasets to be password protected, provides basic plotting and graphing functionality, allows federation of independent ERDDAP data collections, and facilitates searching for data across multiple ERDDAP data repositories. 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 distributes automated shore station data through its website, ERDDAP and THREDDS.
- SCCOOS has completed making its HABS data more available and accessible by adding it to the ERDDAP server, as well as reformatting it in Darwin Core format and submitting it to GBIF/OBIS.
- All SCCOOS data are publicly available through the SCCOOS website, which provides interactive display of the associated information.
- As an operational, RICE certified Data Assembly Center (DAC), 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 DAC provides data ingestion, 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.

e. Catalog Registration

HFR, gliders, Automated Shore Station (SASS) and CDIP wave buoys are registered in the IOOS Service Registry. In addition, NDBC harvests SASS data, currently via FTP, but by mid 2021 SASS metadata will be compliant with IOOS Metadata Profile 1.2 and NDBC will switch to pulling this data from our ERDDAP server. 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 Organization Global Telecommunication Service. SCCOOS actively participates in on-going efforts to standardize data distribution through the use of web services, including making it available programmatically as well as manually in a wide variety of formats and with associated metadata via our ERDDAP server.
- SCCOOS participates with IOOS partners in a highly distributed system of interoperable components.
- SCCOOS is participating in the Standardizing Marine Biological Data Working Group to help develop standards for representing biological data collected from the marine environment.
- Collaboration with international programs such as OceanSITES and the Joint Commission of Oceans and Meteorology (JCOMM) are on-going instructive for CF compliance and data handling issues.
- SCCOOS has made its HABS data available Darwin Core format via ERDDAP

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. Metadata are regularly updated, extended, improved and adjusted to better align with standards such as ISO 19115-2, IOOS Metadata Profile Version 1.2, Climate and Forecast metadata (CF), Attribute Convention for Data Discovery (ACDD) and Darwin Core. 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, including working to apply newly developed QC standards for pH. 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.

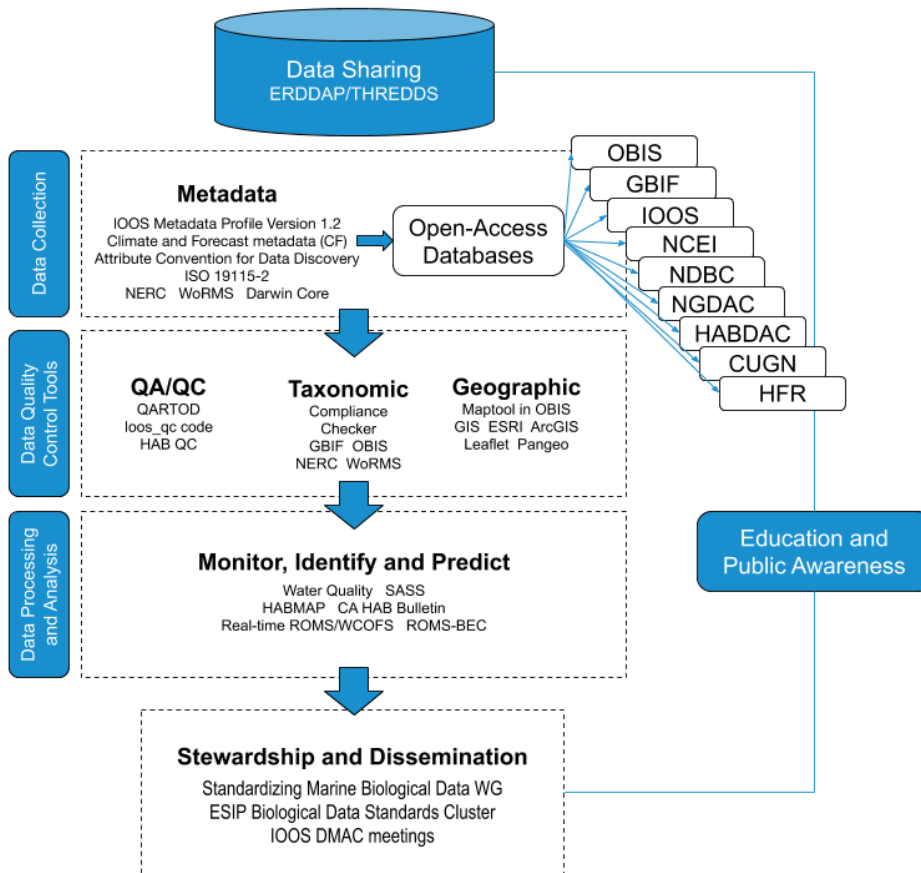


Figure 1. DMAC Overview - SCCOOS Data Management and Cyberinfrastructure (DMAC) handles southern California ocean and coastal information including gathering initial observations of raw data and ingesting them in the cyberinfrastructure, applying quality control measures, providing long-term and archival storage, engaging in product development to aid stakeholders and enabling public dissemination. These efforts combine to facilitate public discovery of, access to, and understanding of this important environmental information. Figure based on Saeedi et al., 2019.

h. Storage and Archiving

SCCOOS data are stored both on-site in the enterprise-level SIO data center and in private cloud storage located at UCSD's San Diego Supercomputer Center (SDSC). SDSC provides off-site backup storage for SCCOOS data. Additionally, SCCOOS datasets are archived in additional national and international data repositories, including NCEI, NDBC, IOOS and GBIF/OBIS. Most notably the glider data is archived at the NGDAC, the HFR data is archived at NDBC and within the HFRNet, the HABMAP data from manual water sampling is being archived at GBIF/OBIS and SASS data is being archived at IOOS and NDBC.

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. Before making these data publicly available, every possible effort is

made to convert the information provided into standard ontologies such as Darwin Core, and to use standardized vocabularies, including CF, NERC, etc.

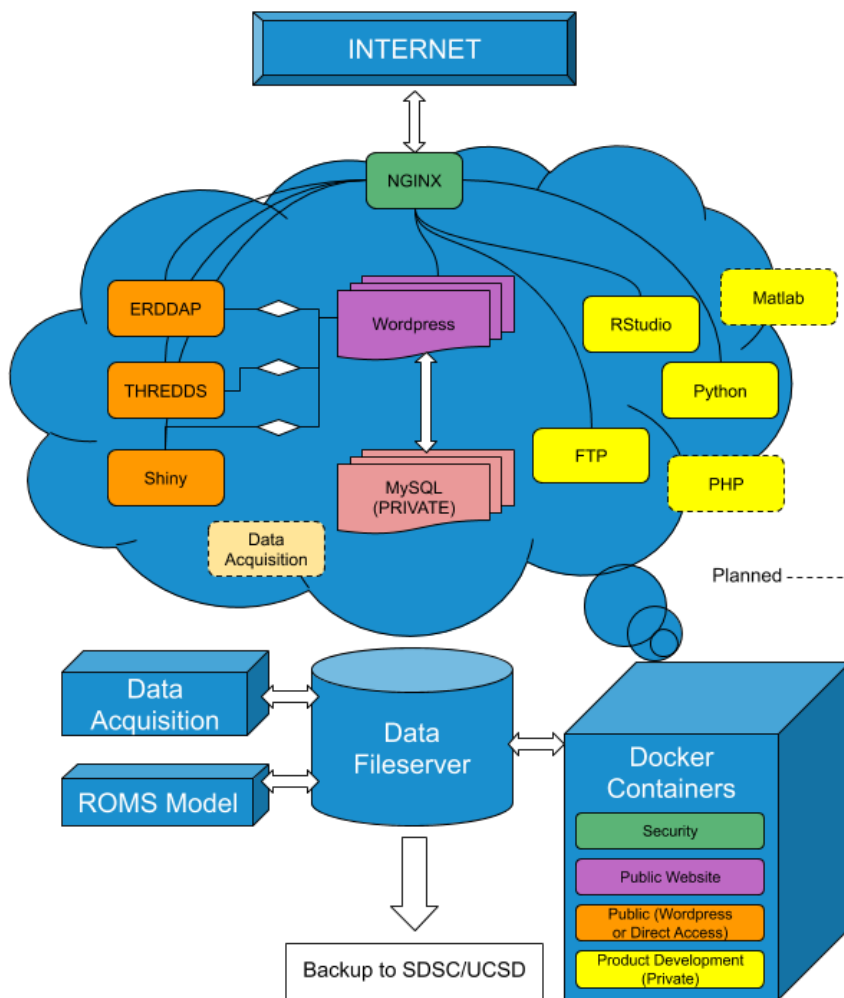


Figure 2. DMAC Infrastructure - The hardware, software, and policy framework needed to ingest and manage ocean observations and other derived information from multiple sources, to support environmental modeling, to allow development of data analysis and display products, to provide end-user displays, and to enable discovery of and access to Southern California ocean and coastal information.

j. Consideration for Long-Term Operations

SCCOOS recently invested heavily in modernizing and future-proofing its underlying cyberinfrastructure (see Figure 2.) The new architecture allows more data to be ingested, processed, archived and disseminated with less human intervention. This flexible, scalable system facilitates continual growth, improvement of services offered, and integration of emerging technologies related to cloud computing, artificial intelligence, and distributed computing platforms and allows us to pursue the goals we have 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.

Our entire software infrastructure has been rebuilt in order to take advantage of new technologies and techniques that represent best practices for building, maintaining and growing technical infrastructure for both managing data and providing services to stakeholders. Automation, modularity, and repeatability are the cornerstones of the new architecture. Technologies that SCCOOS is now able to leverage because of this new approach include infrastructure as code (IaC), containerization (i.e. Docker), collaborative development (i.e. use of open source software and organized code sprints) and reuse of software products by designing for modularity, generality and reuse. Our containerized infrastructure allows SCCOOS data products to be developed in multiple languages (e.g. R, Python, MatLab, Bash, etc.), come from multiple sources (e.g. open source, DMAC community, SCCOOS researchers, etc.), leverage the most appropriate framework or technology (e.g. RStudio, Shiny, MySQL, Leaflet, PHP, NetCDF, GIS libraries) and integrate seamlessly into our Wordpress-based website, which can be quickly and easily modified and updated by anyone on the SCCOOS team. Wherever possible, system design and automated tools are created to be generally applicable so that efforts to standardize, upgrade or automate one component results in system wide improvements. Our physical hardware infrastructure is also undergoing modernization.

To help ensure continuity of operations, on-site equipment is housed in the SIO data center, which provides enterprise level power, cooling, fire suppression, security and 24/7 monitoring of SCCOOS equipment, including 2 enterprise level servers for VMWare virtual machine and Docker hosting, a server dedicated to ROMS modeling and a 40TB data/file server. Off-site/private cloud storage of SCCOOS backups is hosted on equipment located at SDSC in their 19,000 sq. ft. climate-controlled and secure datacenter that is fully equipped with 13 megawatts of power, 10-gigabit network connectivity, and a 24/7 operations staff. SCCOOS websites and data are backed up nightly. Critical SCCOOS software is under distributed source control.

SCCOOS will continue to provide timely access to high-quality integrated data and support regional user needs while complying with national guidelines, standards and protocols for sharing and archiving data such as those given in IOOS' Data Standards & Requirements and NOAA's EDM Framework. 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 DMAC, including workshops and webinars.

The SCCOOS cyberinfrastructure makes it possible for SCCOOS 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

[SCCOOS Asset Inventory](#) can be found on the [SCCOOS website](#) under Documents.

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 statement 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 statement 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 statement 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 statement 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 IOOS 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.

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

<u>EXPERIMENTAL</u> (Nature of Service)	<u>WI2XAA</u> (Call Sign)
<u>XR FX</u> (Class of Station)	<u>0539-EX-PL-2015</u> (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



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.