Coastal Ocean Currents Monitoring Program (COCMP)
in Southern California
Grant # 04-078

2nd Quarter Report 2008
Period of Performance: 1 April 2008 – 31 June 2008

Submitted to the State Coastal Conservancy by the
Southern California Coastal Ocean Observing System (SCCOOS)

INTRODUCTION

The Southern California Coastal Ocean Observing System (SCCOOS) continues the implementation of the Coastal Ocean Currents Monitoring Program (COCMP) for Southern California.

COCMP is a significant component of SCCOOS's efforts to build ocean observing and monitoring capacity for the region. This effort is augmented with federal funding to serve user needs and contribute to the evolution of a comprehensive ocean observational system for both the region and state. SCCOOS continues to coordinate with the Central and Northern California Ocean Observing System (CeNCOOS) to ensure a unified statewide system.

Program tasks include:

A. Surface Current Mapping (SCM) Array
B. Nearshore and Surf zone Observations
C. Subsurface Observations
D. Regional Ocean Modeling
E. Data Distribution and Management

This report describes second quarter activities and progress that took place in these task areas.

SCCOOS MEETINGS

The SCCOOS Senior Advisory Committee (SAC) met on 27 May 2008 at the SCCWRP offices in Costa Mesa. COCMP updates were given by Eric Terrill and Sheila Semans, and included operational updates and discussions on development of operational funding for the program. The SCCOOS Board of Governors (BOG) met on 9 June 2008, again at the SCCWRP offices. Eric Terrill presented an update on COCMP status. Both the SAC and the BOG
agreed to work on raising awareness of ocean observing, and expressed the desire to develop unified statewide products. SCCOOS and CeNCOOS are exploring the possibility of a statewide, shared Senior Advisory Committee.

PROGRESS REPORT BY TASK

Task A. ESTABLISH SCM ARRAY FOR MAPPING OCEAN CURRENTS

Task A.1 SCM Site Assessment

CalPoly, UCSB, USC and SIO continued efforts on HF radar site assessments and permissions throughout the second quarter of 2008. The HF radar site at Nicholas Canyon was re-assessed in May 2008 in preparation for re-installation of hardware. The County of Los Angeles has made a number of changes to the site since the initial installation, and the HF radar configuration required changes. SCCOOS personnel also had to re-evaluate the site at Point Arguello after the U.S. Coast Guard could not allow installation. The Coast Guard also had to locate operational antennas offsite from Point Arguello. Negotiations are underway with Vandenberg Air Force Base (VAFB) for both a long range and standard range HF radar and are in the final stages.

Site assessments are nearing completion and SCCOOS partners are looking at gap areas following full COCMP build-out. The Southern California HF Radar Consortium has evaluated HF Radar locations, and has targeted gap areas requiring additional radars. Most gaps include offshore areas within the Southern California Bight. A coastal gap exists offshore the city of Ventura and the area seaward of the mouth of the Santa Clara River. Coverage offshore the Santa Clara river is important because it drains a very large agricultural watershed, and is a major source of nutrient and sediment input to coastal waters.

Task A.2 Site Permissions

Permission to install a system at Gaviota has been granted by Union Pacific following completion of a land lease agreement. UCSB plans to deploy the system this upcoming quarter. Although this is not a designated COCMP site, it will significantly improve coverage of existing COCMP sites. An agreement for a system at Point Mugu has also been finalized with the U.S. Navy. Following this quarter, SCCOOS personnel will have three more permissions agreements to complete. Staff are working with the U.S. Coast Guard for permission to deploy a system at Point Conception, and with the City of Newport Beach to deploy a system at the Newport Pier. The system at Point Vicente is presently nearing the end of the assessment phase.

Task A.3 Frequency Allocation

There are no new updates for task A.3. SCCOOS submitted an FCC license renewal on 18 May 2007. NOAA is pursuing approval and transition of HF radar for mapping surface currents into the permanent frequency band. NOAA has requested several center frequencies with bands in the 25MHz, 13MHz, and 5MHz frequency range. We anticipate that this process will take 4-5 years for approval. SCCOOS will continue to operate under the existing experimental licenses. If the May 2007 renewal is denied, SCCOOS surface current mapping systems will be altered to operate under existing NOAA experimental licenses.

Task A.4 Site Preparation and Equipment Order

SCCOOS has entered the final quarter for HF radar delivery. SCCOOS has received all HF radars ordered for this project. SCCOOS personnel continue to purchase supporting equipment as the final sites are installed.

UCSB has developed a water-cooled system for HF radar electronics. Several other HF radar groups have contacted UCSB to inquire about the newly developed water cooling system. A principal advantage of the system is its much lower power use compared with conventional air conditioners. This is important for sites with solar power. The system was developed over the past year by Edward Reams, an undergraduate mechanical engineering student, with advice from Cyril Johnson. The system will first be deployed at our Santa Cruz Island site, and will be documented and available for other interested HF radar groups.

Task A.5 Standard Operating Practices

SCCOOS participants at UCSB have been working to understand how measured antenna patterns can best be routinely incorporated into algorithms for computing divergence and rotation (vorticity) of regional circulation. Specifically, Brian Emery has been analyzing artifacts resulting from the Multiple Signal Classification (MUSIC). This work is based on a previous study by de Paolo and Terrill on the interpretation of results from the MUSIC algorithm. Cyril Johnson has been experimenting with various hardware configurations (i.e. setup of modems, uninterruptible power supplies, and site computers) to improve site reliability.

Several updates have been made to the working document: *Deployment & Setup of a High-Frequency Radar for Ocean Surface Current Mapping: Best Practices*. SCCOOS members plan to iterate on this document with input from the HF Radar community. The ROWG site continues to provide a central location for HF radar recommendations, operating procedures, documents, and agreements. The membership grows steadily and has many international members. The SCCOOS home institution, SIO, maintains the site administration for the HF radar community.

TASK B. ESTABLISH NEARSHORE AND SURFZONE OBSERVATIONS (HB06)

Task B.1 Wave and Current Observations

Data are continuing to be qa/qc'd by the performers involved in the HB06 demonstration program.

Task B.2 Transition Zone Observations – AUV, Drifter and Mooring Deployment

Surf zone measurements from AUVs, drifters, and moorings were collected during the Huntington Beach 2006 experiment. No further updates at this time.

Task B3 : Modeling wave evolution & currents to nowcast surfzone currents (Santa Monica and Huntington Beach regions)

Real-time nowcasts of surfzone waves and alongshore currents for LA and Orange counties (including Huntington Beach and Santa Monica Bay) are now available online*. These nowcasts use CDIP's newly developed MOnitoring & Prediction (MOP) system that includes both remotely generated ocean swell and locally generated seas, and bathymetry representative of each local region. The alongshore currents can be used to estimate the transport of pollution spilled into the surfzone.

* http://cdip.ucsd.edu/?moplist=Overview&pub=public&xitem=overmap Click on the desired County, and then select the desired variable from the listed "alongshore plots."

Deliverable for December 2008: The temporary URL (above) will be integrated into the main CDIP "theme-based" website (to be released September, 2008). Time permitting, local bathymetry for San Diego County will also be incorporated, providing alongshore current nowcasts from the Mexican Border to the Santa Barbara/Ventura County border.

Task B.4 Northern and Central Nearshore Data

Realtime nowcasts of surfzone waves for San Luis Obispo, Monterey, Santa Cruz, San Mateo and San Francisco counties are now available online*. These nowcasts use CDIP's newly developed MOnitoring & Prediction (MOP) system that includes both remotely generated ocean swell and locally generated seas, and bathymetry representative of each local region. The predictions have been expanded to include wave-driven alongshore (Sxy) and cross-shore (Sxx) radiation stress estimates, which can be used to estimate the transport of sediment in the surfzone.

* http://cdip.ucsd.edu/?moplist=Overview&pub=public&xitem=overmap Click on the desired County, and then select the desired variable from the listed "Alongshore plots".

Deliverable for December 2008: The temporary URL (above) will be integrated into the main CDIP "theme-based" website (to be released September, 2008).

TASK C. ESTABLISH SUBSURFACE OBSERVATIONS

Task C.1 Underway CTD

The underway CTD (uCTD) transects across the San Pedro Channel continue to be suspended due to lack of availability of the *R/V Sea Watch*, the vessel used for data collection earlier in the program. Apparently a number of research vessels, including the *Sea World* of UCLA, have been constrained in their operations due to legal action by a private boat operator in the Los Angeles area. We are in communication with marine operations personnel at UCLA and USC about this problem. This situation continues to be extremely frustrating, given all of the effort put into initiating the uCTD program. The program has been very successful, thanks to capable work of Troy Gunderson of USC, Jochen Klinke of Ocean Sciences (the manufacturer of the uCTD), and Kirk Ireson of UCSB. We are very anxious to resume routine operations with the new system that we obtained at the end of 1997. A database of all data collected to date is available at: http://www.icess.ucsb.edu/iog/uCTD/index.php

While waiting to resume our long-term monitoring with the uCTD, we have begun planning operations for the Bight '08 sampling program currently scheduled for winter 2008-2009. A major goal of the SCCOOS Bight '08 effort will be to determine the nutrient budget for San Pedro Bay, an ocean area strongly affected by Los Angeles and surrounding coastal cities. The uCTD will be operated along two transects crossing the bay, with the goal of resolving water properties with higher spatial resolution compared with conventional hydrographic sampling. The sections will be important for estimating fluxes of various materials, including nutrients, into the bay. Planning is at an early stage, but it is likely the uCTD will be an important instrument for the overall Bight '08 effort.

Task C.2 Bight-Scale Monitoring

Glider Operations: We have maintained continuous cross-shelf sampling on CalCOFI Line 90, which runs south southwest from Dana Point. We have also completed, under COCMP funding, three-months of measurements along the cross-shelf CalCOFI Line 67, which runs south

southwest from Monterey Bay. Having put another glider in service on this line, sampling is now continuous, like on Line 90, with a new glider replacing every one that is recovered (roughly every quarter). Under non-COCMP funding, we have maintained continuous cross-shelf sampling on CalCOFI Line 80, which runs south southwest from Point Conception.

All records provide sections to 500 m depth of temperature, salinity, chlorophyll a fluorescence, acoustic backscatter strength at 750 kHz, and absolute velocity sections as measures of variations in physical conditions and the abundance and distribution of phytoplankton and zooplankton. All data is available in real time through the web site spray.ucsd.edu and the SCCOOS web site.

Our first analysis of that data is reported in the paper, "Glider surveillance of physics and biology in the southern California Current System" by Russ Davis, Mark Ohman, Dan Rudnick, Ben Hodges, and Jeff Sherman, which is now in press for *Limnology and Oceanography*.

Planning is underway to use COCMP gliders in the Bight 08 project to assess the impact that sewer outfalls have on the nutrient budget of the San Pedro Channel and, by inference, determine if outfall nutrient loading is a significant factor in harmful algal blooms.

TASK D. ESTABLISH REGIONAL OCEAN MODELING

Task D.1and D.3.2 Model Research and Development and Synthesis of SCCOOS Data and Prediction of Fields

A multi-year reanalysis data assessment of the non-assimilated solutions for the operational Southern California Bight ROMS model configuration is nearly ready for journal submission. The measurements include hydrographic temperature and salinity, tide-gauge and altimeteric sea level, and moored and HF radar currents.

Further investigations of subsurface biases in the operational assimilation of HF radar continue.

Tides have been fully implemented into the 1-km ROMS over the SCCOOS domain. The tidal resolving ROMS can now be run and directly assimilated with the HF radar data without filtering out the tides.

The SCCOOS ROMS web site continues to be upgraded. It was recently tested during the deployment of a new glider by USC. The web site captured the new data in near real-time, and the assimilated output included the glider data.

Task D.2 Wind Product for use by ROM

Tasks under D.2 are ongoing.

Task D.3.1 Covariance and Objective Mapping using COCMP observations

We have transitioned our operational mapping from two stages to one—objective mapping

directly from the radial velocities observed by the radar. This can either use observed covariances or simplified covariances for compatibility with the mapping methods that had been in use by the HF radar community, which is now adopting our methods.

Terrill and Kim have implemented these methods for the integrated radar analysis covering most of the west coast of the US, with higher resolution in the Southern California Bight. In addition to mapping velocity, we also map directly to streamfunction and velocity potential for robust identification and tracking of eddies.

The estimated currents are also in use for estimating particle trajectories and making a statistical model for water quality predictions from Tijuana River discharge using the integrated coastal observing system. A paper is in preparation describing this work.

The paper submitted on the observed response of the currents to wind has been reviewed favorably, and is now under revision for final approval for publication in the *Journal of Physical Oceanography.*

The refinement of the covariance matrices for the velocity continues, both through direct estimation from radial covariances and decomposition of the fields into wind-driven, tidal, and band-passed components, each of which has a different covariance structure. A paper is in preparation on decomposition of the velocity fields. We have successfully implemented a research version of mapping horizontal velocity covariance directly from radials, and are preparing a publication describing the method and results.

Another paper is in preparation on the signatures of coastally trapped waves propagating northward along the west coast. The statistical estimates of surface current response to wind have been extended to the entire west coast. so that wind-driven effects can be separated from other features for better resolution of coastally trapped propagation.

This work has highlighted the variable quality of wind estimates available along the coast, and Kim has been examining surface wind variability in the San Diego region using output from the COAMPS model. The ability of the wind to account for surface velocity variability is apparently a measure of its quality, and we are hoping for improved wind products as part of SCCOOS.

The paper on MITgcm 4DVAR (adjoint) assimilation of radials for the San Diego region on a 1 km grid has been submitted, and the work will continue.

ROMS runs on a 1km grid with observed winds continue for estimating larval dispersion, and a paper is in revision on the physical results from those runs, and another is in preparation on the biological implications of the results and comparison to observations made for mussel larvae.

TASK E. DATA DISTRIBUTION AND MANAGEMENT

Task E.1 Information Technology Development

SCCOOS programmers continued HF Radar network development throughout the second quarter of 2008. This quarter programmers focused on continued implementation of system upgrades and data system optimization. Several of the memory upgrades that shipped had incompatibility issues with the motherboards, even though system specifications showed compatible hardware. This has delayed the memory upgrades within the HF radar network. Presently, new code is being tested that will optimize the backend database through effective indexing techniques. The code will be deployed next quarter following an intensive test period.

SCCOOS programmer Mark Otero visited UCSC this quarter to conduct system training on the HF radar network (HFRNet). Training consisted of system overview, data interaction, scripting, and file manipulation. Participants were encouraged to review the system architecture and request further information on the technology and structural design. Code development and maintenance is ongoing and will be supported not only through COCMP, but also through NOAA national network efforts. Continued system and hardware maintenance are required on the remotely deployed portal and node systems.

In May, the NOAA IOOS Program Office data management team held a WSDE (Web Services & Data Encoding) Working Group conference call in which SCCOOS programmers participated. Several topics were discussed, including an international standard of XML called Climate Science Modeling Language, CSML, which is currently being reviewed by NOAA. IOOS efforts on the Observation Registry continue and may transform into the CSML markup language. Programmers continue to discuss limitations of RDBMS (Relational Database Management Systems), particularly that high-volume/high density data is unsupported, leading to database limitations and lagging queries. This system works well for point observations with succinct time limits, but not for gridded or ongoing real-time data. SCCOOS programmers are developing a new backend architecture to account for these types of data.

Task E.2 Product Development

SCCOOS participants received positive feedback from the newly launched ports page, a theme-oriented section targeting harbor-directed activities:
http://www.sccoos.org/data/harbors/lalb/index.php. The site can be expanded to full view, and is presently being evaluated by the Harbor maritime community. This work has also been presented to NOAA's Hydrographic Services Review Panel again, receiving enthusiastic responses. This project is heavily leveraged from the COCMP work and would not be possible without the State's investment in surface current mapping and data management systems.

SCCOOS participated in a California Department of Fish and Game MLPA Initiative meeting on 18 June 2008 in Los Alamitos, California. The meeting was held to discuss data needs and to identify potentially available data sets or opportunities for collaboration in data collection. SCCOOS plans to participate in a September workshop that will bring together physical and biological oceanographers to discuss synthesizing data sets applicable to the MPA planning process.

SCCOOS supported an oil spill response exercise conducted in accordance with the National Preparedness for Response Exercise Program Guidelines (NPREP), June 9-10. Participants included US Coast Guard (USCG), Office of Spill Prevention and Response (OSPR), NOAA HAZMAT, Office of Emergency Services (OES), Navy Region Southwest, and Chevron. The exercise focused on effective communications and response in the event of a marine oil spill. SCCOOS provided near real-time surface current measurements to feed into the NOAA HAZMAT operational models as well as provided particle tracking based on optimally interpolated currents. The particle-tracking model indicated the speed and direction of surface waters off the San Diego coast, and was found to be consistent with a dye release conducted offshore as a surrogate for spilled oil. SCCOOS effectively displayed transport and fate of the simulated spilled oil. Shape files were also created on an automated basis for California OSPR GIS specialist and his team so that they could include maps of ocean currents with their integrated on-scene GIS products. As a result of the success of the exercise, NOAA HAZMAT has invited SCCOOS to participate in future California training exercises to help raise awareness of surface current mapping technology for oil spill response