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

2nd Quarterly Report 2006
Period of Performance:  1 April 2006 – 30 June 2006

Submitted to the State Coastal Conservancy by the
Southern California Coastal Ocean Observing System (SCCOOS)
October 2006
INTRODUCTION

The Southern California Coastal Ocean Observing System (SCCOOS) continues the implementation of the Coastal Ocean Currents Monitoring Program (COCMP) for Southern California. As described in this report, Principal Investigators (PIs) and project scientists have made progress in each of the task areas identified in the COCMP 2006 Annual Work Plan.

COCMP is a significant component of SCCOOS’s efforts to build ocean observing and monitoring capacity for the region. This effort is being augmented with federal funding to serve user needs and contribute to the development 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 Surfzone Observations
C. Subsurface Observations
D. Regional Ocean Modeling
E. Data Distribution and Management

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 2006.

Site assessments have been made for the Central California node between Big Sur and Pt. Conception, and Cal Poly is in the process of finalizing permissions. The standard range systems will extend to the Pt. Estero area with long range systems provided by CeNCOOS overlapping with the SCCOOS systems in this transition area. Sites that have been identified for placement of HFR from north to south in this region are; Ragged Point, Estero Point, Diablo Canyon, Pt. San Luis, Guadalupe Dunes, Pt. Sal, Pt. Arguello, and Pt. Conception. Pts. Sal, Arguello and Conception are being jointly pursued through USCG permissions process.

On 17 July 2006, potential sites on Santa Rosa Island and Santa Cruz Island were surveyed by small boat. Two of these appear to be suitable. The sites are on National Park Service property near Valley Anchorage, on the south side of Santa Cruz Island, and near Cluster Point, on the south side of Santa Rosa Island.

Task A.2 Site Permissions

The permissions process proves variable for each location, depending particularly on site owner and land situation. The Abalone Farm in Cayucos, California granted access to Cal Poly for the installation and operation of a standard-range CODAR SeaSonde on their property. Additional permission was sought to operate a long-range HFR site at a property near Ragged Point, California. Following a presentation of the COCMP project to the landowner, permission
was granted for use of the Ragged Point property on May 8, 2006. Installation of that site is planned to begin next quarter.

The UCSB group has submitted a proposal to the Los Angeles County Department of Beaches and Harbors to obtain access to a site at Zuma Beach. Equipment would be located near an equipment storage yard and near a restroom facility. Zuma Beach is located west of Point Dume. Discussions with USC personnel indicated that sites on either side of Point Dume should be pursued, since locating a site at Point Dume would not be practical, due to negative feedback from local community and agencies. Reliant Energy postponed a site approval at the Ormond Electrical Generating Station due to a newly proposed natural gas project on location.

UCSB continued efforts to obtain permission at an oil processing facility near Gaviota, CA. This is a valuable site because it would greatly extend HF radar coverage in the western Santa Barbara Channel. The application process has been complicated by the number of agencies and companies involved. For example, one company involved in this process, Arguello PXP Inc., recently determined that it is not the landowner of the site; Gaviota Terminal Company (GTC) is the owner. GTC is a consortium of oil companies. UCSB personnel have submitted a site proposal to GTC. A copy was also sent to the Santa Barbara County Energy Division (SBCED), which may have some influence over use of the property. SBCED personnel have indicated support of our proposal. A further complication is that ownership of this site may be transferred from the GTC to the California Department of Parks & Recreation.

USC began discussions with Newport City officials for permissions at the very end of the Newport Pier. City officials were open to the idea of a system based at the end of the pier; however, they do require Professional Engineer (PE) signatures on hardware mounting. SIO engineers are able to provide technical drawings for signoff from USC licensed PEs. In anticipation of the focused Huntington Beach effort, SCCOOS secured temporary authority from the USCG for deployment at Point Fermin. This site proved invaluable for the coverage it provides within the Huntington Beach Region.

On April 11, 2006, State Coastal Conservancy, State Parks, and COCMP representatives participated in a conference call to discuss permissions on State Parks property. State Parks representatives encouraged COCMP members to find alternative site locations to State Parks property due to the sensitive nature of antenna requests on Parks property. All individuals, however, supported the Coastal Ocean Currents Monitoring Program and agreed to review requests for locations where either alternates could not be found or where minimal impact to State Parks property would be incurred. SIO entered a testing phase at San Elijo State Park while continuing to pursue a larger effort application and permitting process for within the State Parks through a Memorandum of Understanding. The antenna is mounted on an existing light post, and does not impede views, as the park area is located along the Coastal Route 101. SCCOOS anticipates a successful future for this location.

Task A.3 Frequency Allocation

SIO SCCOOS personnel submitted an FCC experimental site request for 18 additional locations spanning several frequencies on April 27, 2005, which, coincidentally, was the largest request the department had ever received. Most locations now have FCC approval. Because this request was submitted very early in the project, a few locations have been changed and certain additional frequencies are necessary.
Measurements of the frequency space present at The Abalone Farm between 12-14 MHz showed radio station interference from 13.41-13.57 MHz in the WFM band, impeding operation using the intended frequency of 13.5 MHz. Federal Communications Commission (FCC) permission was sought to operate at a lower band and a Special Temporary Authority (STA) was granted for operation at 12.165 MHz.

An application for an additional frequency license for San Nicholas Island was submitted to the FCC by UCSB, in support of the request to place a HF radar site on San Nicholas Island.

Task A.4 Site Preparation and Equipment Order

Standard hardware at HF radar locations consists of a CODAR SeaSonde with optional global positioning system, air-conditioned weatherproof electronics enclosure, uninterruptible power supply (UPS), antenna tuner, Apple Macintosh laptop computer, router, and network communications. This hardware configuration has been developed throughout the past year in an effort to optimize and standardize sites. Specific site locations, however, can vary and SCCOOS personnel adapt based on location details. For example, although wireless communications to a land connection can normally be established, Point Estero required a satellite modem due to the remote area.

WildBlue high-speed satellite Internet service was installed at ESTR to provide broadband data access to the HFR site without the need for a wireless relay with a second Internet connection or the installation of a wired connection. This solution for data transmission allows sharing in near real-time of the ocean surface current measurements with both regional and national networks for the development of data products.

Task A.5 Standard Operating Practices

In order to further collaboration with the larger SCCOOS community, SCCOOS members attended the Southern California Marine Monitoring Conference (IV) in April 2006 sponsored by SCCOOS, Aquarium of the Pacific, Wrigley Institute for Environmental Studies, and the Catalina Conservancy Divers at the Aquarium of the Pacific, in Long Beach. Relationships between marine monitoring efforts within Southern California were reviewed to identify opportunities for collaboration.

UCSB hired an engineer (Mr. Cyril Johnson) to fill the second HF radar technician position (50% time through 31 December 2006), and an undergraduate assistant Mr. Gordon Yu. Both positions are partially funded by COCMP. The UCSB technical personnel now include one full time technician (Mr. Brian Emery), two half-time technicians (Mr. Kirk Ireson and Mr. Cyril Johnson) and two undergraduate engineering students (Mr. Joshua Kleiner and Mr. Gordon Yu).

TASK B. ESTABLISH NEARSHORE AND SURFZONE OBSERVATIONS

Task B.1 Wave and Current Observations

Plans continued for the Huntington Beach field experiment (HB06), to calibrate and test SCOOS model predictions of shallow-water weaves and surfzone currents, on schedule for Fall
The HB06 PIs conducted another planning meeting in early May 2006. Construction of the nearshore current measuring system (cables, surfzone drifters, current/pressure sensors and instrument mounting frames) is completed, and field testing is underway.

The surfzone component will take place approximately 5 September - 25 October 2006. Huntington Beach is heavily used for recreation. The Coastal Conservancy has provided additional funds for supplementary lifeguard services required to maintain public safety (the fixed frames we deploy in the surfzone are hazardous to swimmers/surfers, as are the jet skis we use for surveying and dye-tracking.) Issues concerning approximately $6,000 of overhead remain to be resolved.

Dr. Robert Guza made a presentation on HB06 to the Orange County Coastal Coalition at its meeting in May 2006. The Coalition is interested in having Bob return with a presentation following implementation of the field demonstration.

USGS and the Orange County Sanitation District in June deployed moorings that expand the observations beyond those supported by SCCOOS. Additionally, some of the SCCOOS PIs have obtained ONR, Sea Grant and other funds to build out HB06. HB06 now extends much further offshore than originally planned, and contains several new components (e.g. sampling biota and FIBS, dye tracking, and studies of nearshore mixing.).

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

Cal Poly is currently finalizing the logistics for the HB06 experiment. The REMUS AUV has been run repeatedly in the past month to mimic the likely missions during the experiment. The data systems are automated to provide data approximately one hour after access to the vehicle each day. Investigation of the area has also revealed an access ramp near the study site that would significant improve the efficiency of deployment and recovery. The REMUS vehicle has also been modified through SCCOOS to have iridium communications and a GPS transmitter to improve recovery operations. Other improvements include an integrated rhodamine dye fluorometer to assess currents nearshore during the dye deployments and current tracking missions. Recently this was tested in the field and operated to specifications. The Cal Poly team will spend approximately 30 days at the study site.

The drifters purchased from Pacific Gyre Corporation (Oceanside, CA) will be used in the Huntington Beach demonstration.

The UCSB group has coded a web-based real-time display system. The system accepts the drifter GPS position data and displays it in real-time on a map that is accessible from a web browser. The display can be found on the “realtime” tab at www.drifterdata.com. The raw data (drifter tracks) are displayed on the “realtime” page during the day they are collected. They are displayed as processed data following the day of collection. The processed data include GPS tracks with 10 minute (nominally) positions, north-south and east-west velocity components, along-shore and across-shore velocity components, total velocity, water depth at the location of each position, and the change in water depth between position records.

Additional meetings with other transition group investigators and additional players have been held in effort to develop a coordinated and comprehensive near-shore monitoring program for Huntington Beach and provide information desired by a variety of local agencies and municipalities.

Administratively, the budget was transferred to PI Uwe Send, and a fabrication account
was set up to reflect a design change for the 2 moorings to be constructed. Some technical salaries were spent on the design of the new moorings and to initiate fabrication. The actual purchase of hardware and consumables will take place in July and August 2006.

The new design now carries, on each of the 2 moorings, one ADCP and 3 microcats delivering temperature and salinity, all in real-time via a novel cellphone-internet modem. Additional stand-alone (no telemetry) sensors are four temperature and one bottom pressure logger per mooring. 4 Solar cells will be used to charge gel cell batteries, and an ARGOS beacon independently reports position and battery voltage for system monitoring. Deployment is now scheduled for 30 August, for a period of two months.

**Task B.3 Modeling wave evolution & currents to nowcast surfzone currents**

Near real-time predictions of breaking wave height and surfzone averaged alongshore currents are now available for a 5km alongshore reach at Huntington Beach at http://cdip.ucsd.edu/hb06. Predictions of wave conditions with high along-shore spatial resolution (100m) are obtained using a "network" wave model that concurrently uses wave measurements from multiple buoys in the surrounding CDIP and NOAA wave observation networks. The wave model output is then used to drive a simple 1-D model for surfzone alongshore currents. Observations collected in the Fall 2006 during the HB06 field experiment will be used to validate the model predictions. This site also includes historical bathymetric surveys in shallow water.

**Task B.4 Northern and Central Nearshore Data**

The new network wave model for coastal waves is being implemented at 1,249 longshore wave model output locations, approximately 200m apart, for Monterey and Santa Cruz Counties. For each location, the SIO team is deriving the spectral refraction transformation coefficients needed to produce nearshore wave predictions using the surrounding CDIP buoy network. The network model uses concurrent data from the CDIP Harvest, NOAA Monterey Bay, and CDIP Pt Reyes directional wave buoys. The model is being validated with recently collected nearshore measurements from Ocean Beach, San Francisco, in coordination with USGS.

C. ESTABLISH SUBSURFACE OBSERVATIONS

**Task C.1 Underway CTD**

The main goal of this project is to establish a transect across the San Pedro Channel for measuring time series of sub-surface water properties. The project uses a new oceanographic instrument developed in Dr. Daniel Rudnick’s laboratory at SIO/UCSD by Dr. Jochen Klinke. Time series obtained using the instrument will be used to monitor the evolving structure of water masses in the area. Data will be incorporated in water quality studies and assimilated into regional numerical ocean circulation models. Specific goals of the project are to:

1. Equip a ship of opportunity for routine deployment of an underway conductivity-temperature-depth (uCTD) instrument;
2. Establish procedures for acquiring uCTD data on a regular schedule; conduct routine operations to obtain time series of uCTD transects.
3. Establish procedures for processing the uCTD profiles and transferring processed data to databases. (Moline)

During the reporting period, routine operation continued of the underway conductivity, temperature, depth (uCTD) instrument. Observations are conducted from the R/V Sea Watch during its weekly trips to the Wrigley Marine Institute on Catalina Island. Observations are conducted about twice each month, although trips are somewhat less regular due to occasional mechanical problems with the vessel.

A new uCTD instrument is being developed by Sea Bird Electronics and another private company for commercial sale. The new instrument will use standard Sea Bird temperature, conductivity, and pressure sensors which will simplify calibration procedures.

Technicians from USC (Mr. Troy Gunderson) and SIO (Dr. Jochen Klinke) continued their improvements on the uCTD. In particular, a new level winding system developed by Klinke was used successfully on a recent trip. This should simplify future deployments. Mr. Kirk Ireson, the UCSB programmer working on the uCTD project, participated in a recent cruise to observe the field procedures. uCTD data have been collected on 10 dates so far. Processed data along with plots of transects and various property sections are available at: http://www.icess.ucsb.edu/iog/uCTD/index.php

Contracts and grants personnel at UCSB and USC have been working to transfer funds to cover costs of technician salaries, supplies, and other expenses incurred at UCS during the project.

Task C.2 Bight-Scale Monitoring

The COCMP glider project will build three Spray gliders and put them in service monitoring physical variability of subsurface coastal waters within 40 km of the coast between the Mexican border and Pt Dume.

One glider has been completed and will put it into service near Huntington Beach in mid-September as part of the HB06 field experiment. A second glider will be completed in time to be deployed in that experiment. This will allow for operation observing regularly while completing the third glider, observing and feeding data both for web distribution and as input into the ROMS data assimilation model that will assemble much of the SCCOOS observations into a dynamically consistent field.

Data from such Sprays is available within a few minutes on the website Spray.UCSD.edu in pictorial and tabular form and is ready for linking from any COCMP distribution to be developed.

D. ESTABLISH REGIONAL OCEAN MODELING

Task D.1 Model Research and Development

The UCLA group successfully designed, ordered, and installed a Linux cluster from Aspen Systems. Given the experience in successfully operating the system, the group is now planning for its expansion, probably to occur in the fall 2006.
Next steps include:

- Extend the new, fine-resolution Bight model to the year 2006, forced by both wind forcing and tides. We will focus our analysis on eddies and the alongshore pressure gradient to guide the planning and interpretation of the Huntington Beach experiment in the Fall 2006.
- Incorporate surface wave influences on sediment transport using CDIP and SWAN wave analyses and work with JPL to implement the ROMS Data Assimilation scheme in the new, fine-resolution Bight model.
- Configure a very high-resolution nested grid (with grid size about 100 m) in the San Pedro Bay and Huntington Beach region in support of the nearshore and shelf experiment this coming fall.
- Conduct a special study of the diurnal variation of the surface stratification and currents due to combined tidal, inertial, solar, and sea-breeze influences.
- Work with JPL and SIO to implement CODAR data assimilation in ROMS.
- Implement a general wave-current interaction theory in ROMS and use the SWAN model to calculate the surface wave field.

UCLA made retrospective ROMS simulations of the circulation in the Southern California Bight (SCB) in two configurations that are embedded within a larger regional configuration for the U. S. West Coast forced by regional wind reanlyzes and lateral boundary conditions based on the global Simple Ocean Data Assimilation (SODA) product. A coarse-grid configuration (with a horizontal grid size of 6 km) is integrated for 1996-2003, and a fine-grid configuration (a size of 1 km) is integrated for 2002.

Forcing of eleven tidal constituents is included in the latter configuration, based on both Oregon global and ADCIRC regional data sets. The group’s purpose is to understand the climatological circulation and its natural variability as background for the SCCOOS operational current analyses to come. Figure 1 shows the simulated mean seasonal variability of the surface circulation, and Fig. 2 shows various aspects of the dynamic pressure field along the coastline (known to be an important influence on the nearshore and shelf circulations).

The UCLA group configured the SWAN model (Simulating WAves Nearshore) for the SCB to simulate local surface gravity wave generation, refraction, and nearshore breaking, both for wave-current interactions on the Bight scale (with a horizontal grid size of 1 km) as well as for nearshore currents on the scale of the Huntington Beach. SWAN is a well-validated wave model based on a spectral action balance equation that computes random, short-crested gravity waves in coastal regions, accounting for wave propagation in time and space, shoaling, refraction and frequency shifting due to currents and bathymetry; wave generation by wind; three- and four-wave nonlinear interactions; whitecapping, bottom friction, and depth-induced breaking, etc. An MM5-predicted ocean surface wind field and an in-situ frequency spectral data modified with the ECMWF’s wave directional hindcast are utilized for the surface and open boundary conditions in SWAN. A snapshot of the simulated waves (Fig. 3) shows that the model is capable of realistically reproducing amplitude attenuation and refraction towards the shoreline, shedding due to islands and headlands, and wave growth due to local wind. The model results are also compared with the buoy measurements in the SCB. Whereas the wave height shows a good agreement with the observation, the period tends to be slightly shorter than that measured by the buoys, and the UCLA researchers believe this may be due to the wave growth parameterization that should be further examined.
The group made a study of island current wakes and the submesoscale eddies they spawn and a study of sediment transport in the SCB during a sequence of winter storms in 2002 using the CDIP surface gravity wave analysis.

The researchers have shown the importance of fine-grid wind patterns near the shoreline and behind islands in the SCB. Two papers were written on the data assimilation scheme (ROMS-DAS) being deployed in the SCB, and the system was implemented within the new fine-grid SCB configuration in anticipation of the operational current analyses.

Task D.2 Wind Product for use by ROMS

The forecasts have been scaled back by the UCLA group to 24 levels since the 38-level version was taking too long to run. They are working on getting a new machine to run another version of the forecast that will be parallelized and 38 levels. The replacement version will not contain the enhanced boundary layer parameterization (which is not coded for parallelization), but will have a better SST initialization. This better SST initialization shows some improvement in the marine stratocumulus cloud forecast. The improvement of simulation of the stratocumulus clouds is a continuing objective.

The Weather Research and Forecast (WRF) atmospheric model from the National center for Atmospheric Research is still planned as an eventual successor to the present model (MM5) we use to produce surface wind analyses for Southern California. The WRF forecasts are currently operational at 16 km resolution. Next step is to implement the wind stress calculations into WRF and automate a nested version.

The 4km MM5 forecasts are up and running and are being downloaded from the UCLA website. We translate the MM5 output into netCDF format and only save the variables requested, make the downloaded file 43 Mb, much more manageable than the default 535 Mb. Also per request, the group has added surface wind stress as an output variable. Two wind stress variables are calculated; the first is calculated directly from the boundary layer parameterization, using ustar directly (which includes stability information from the parameterization), and the second is a standard approximation of surface wind stress from the 10-m winds.

Task D.3.1 Covariance and Objective Mapping using COCMP observations

Work up of data covariances of key observations of currents and their forcing continued, using the new techniques which objectively map directly from radials to vector currents. This eliminates most of the spurious values that plagued the older efforts, especially along baselines between CODAR installations. The CODAR data have been processed with the measured antenna patterns, which also increases the quality of the products.

Maps and movies have been improved as the estimates are optimized, and a model of particle trajectories from the Tijuana River has been implemented using the observed velocities. We have yet to investigate the covariances between the inner radar bins and the surfzone currents have not yet been investigated, as they were not yet available to the group.

Regional Ocean Modeling System (ROMS) runs on fine grids using observed winds and tides are in progress. Linda Rasmussen has been using both NWP wind products and observed winds from shore stations to force a nested high-resolution ROMS grid for the San Diego area. Experiments with several wind products have been carried out on both grids, as well as
experiments with open and closed boundaries on the inner grid. Better NWP forcing products (wind stress, etc) have become available, but are still being evaluated in comparison to the coastal wind observations.

The statistical model produced by Sung Yong Kim is being upgraded from the two shore station winds to COAMPS winds currently under evaluation as mentioned above. In the future, the MM5 outputs will be evaluated that should become available from JPL and UCLA. Validation techniques and comparisons of assimilated data versus observed data will be provided (ongoing activity distributed over 12 months).

Task D.3.2 Synthesis of SCCOOS Data and Prediction of Fields

The main accomplishment during the last quarter is the transition from the original 4-level nested model to a single-level high-resolution model for the entire Southern California Bight (SCB) domain. The original 4-level ROMS was developed using the shared-memory OpenMP programming model and the highest resolution (0.75-km) ROMS domain only covers the Santa Monica and San Pedro Bays. In order to study the SCB-wide processes from San Diego to Santa Barbara, one has to rely on the 6.6-km ROMS domain. With the changing computing landscape moving from centralized shared-memory OpenMP to distributed MPI programming model, we have developed a single-level ROMS configuration that covers the entire SCB region at 1-km resolutions. The new MPI ROMS can be run on either shared-memory or distributed cluster computers.

A 1-year integration of this 1-km SCB ROMS has been made during 2002 forced with the MM5 daily wind. Preliminary analysis of this 1-year ROMS output has been made and the results are very encouraging. Currently, we are in the process of setting up this SCB ROMS for the HB06 experiment. It is expected that the SCB ROMS will be run in near real-time forced with the real-time MM5 wind. It should be pointed out that the SCB ROMS to be run during the HB06 experiment does not assimilate oceanographic measurements. We are implementing the 3-dimensional variational (3DVAR) data assimilation scheme to this SCB ROMS, hopefully we can establish a real-time data assimilation ROMS in the Year 3 of the COCMP project. The assimilation technique of HF radar data is also being developed.
Figure 1. Snapshots of sea surface temperature, salinity and current on 15 January 2002 simulated by the single level SCB ROMS at 1-km resolution.

E. DATA DISTRIBUTION AND MANAGEMENT

Task E.1 Information Technology Development

SCCOOS programmers have developed detailed system diagnostic utilities from the available metadata allowing for a quick look at data transfer latencies, system health, data reliability, and error estimates. Programmers continually interact with vendor representatives in an effort to expand and improve diagnostic, and have made numerous recommendations, which in turn have been implemented in subsequent software releases. Diagnostic measurements allow system managers take a quick look at overall performance of the full system array.

SCCOOS programmers continued efforts on full West Coast integrated HF radar surface currents. High-resolution maps have been generated with 1 km spacing for mapping totals as they are ingested into the network. Programmers plan to develop 2km and 6km grid spacing for long-range systems providing coverage approximately 150 km offshore.

JPL continued efforts on Map Server development to integrate with PO.DAAC data and NOAA funded SCCOOS project, so as to be a fully functional web-mapping portal for near real-time observation for west coastal ocean. JPL programmers rearranged the main page display to be consistent with SCCOOS pages and provide animated images for specific time intervals to give user more interactive information about the ocean condition. The Interactive Map Server consists of three related subcomponents:

- Web Mapping portal for near real-time costal observation
- Data communication and management
Application element

Task E.2 Product Development

SCCOOS members attended the Southern California Marine Monitoring Conference (IV) in April 2006 sponsored by SCCOOS, Aquarium of the Pacific, Wrigley Institute for Environmental Studies, and Catalina Conservancy Divers at the Aquarium of the Pacific, in Long Beach. A focused effort was made to identify potential opportunities for collaboration and specific user needs for data products, and develop a better understanding of potential applications. Follow-up is being conducted with individuals and groups, such as the Rocky Intertidal monitoring community, to explore data exchange and development of products.

SCCOOS programmers at SIO continued their development of real-time data displays on the web site of surface current maps and of real-time data access and information transfer.