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

3rd Quarter Report 2007
Period of Performance: 1 July 2007 – 30 September 2007

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 Surfzone Observations
C. Subsurface Observations
D. Regional Ocean Modeling
E. Data Distribution and Management

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

COCMP EXTERNAL REVIEW

SCCOOS executive committee members Eric Terrill, Burt Jones, Mark Moline, and Yi Chao participated in a meeting with the State Coastal Conservancy this quarter. Topics covered included a summary of the 2nd year review comments and operation and maintenance costs of various components of COCMP.

The MPL business office received approval from the State Coastal Conservancy for the year three work plan, which authorizes allocation of the balance of year three funds. This brings the end-date (based on our award document) to 15 November 2007. Allocation of the funds for the balance of year three is underway.

Eric Terrill is working with the State Coastal Conservancy and the MPL business office at Scripps to arrange for a no-cost extension for the work to continue.

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 surface current mapping site permissions and installations throughout the third quarter of 2007.

Southern California site assessments have reached near completion, although a few site locations have required modification. SCCOOS representatives are continuing to work with the US Coast Guard (USCG) on several sites along the coast. Those sites include Point San Luis, Point Arguello, Point Conception, Point Fermin, and Point Loma. SCCOOS received temporary approval for Point Fermin, and installed the site in July 2006. Personnel are currently working with the USCG on approval for the remaining site requests. In August 2007, a representative informed SCCOOS staff that unfortunately Point Arguello will likely never receive approval for a Surface Current Mapping system. The site at Point Arguello does not support transmitting antennas. The USCG tried to install a system that required transmission, but was required to work with Vandenberg Air Force Base. SCCOOS personnel are currently pursuing a site assessment of the Vandenberg Air Force Base property.

SCCOOS staff submitted a request letter to the Range Control Officer at Camp Pendleton in November, 2006 and began discussions on an appropriate site location. On 8 June, four SCCOOS personnel attended a Range Safety Officer (RSO) class required for conducting fieldwork on United States Marine Corps (USMC) property. Following completion of the class, field engineers conducted a feasibility test on 19 June at a mutually agreed upon location which provided much needed coverage bridging Los Angeles and San Diego counties. The test proved successful; however SCCOOS personnel recently received a new point of contact and will be required to conduct a new site assessment and approval process.

The Camp Pendleton system will complement the high-resolution systems at Newport Pier and Dana Point, Ocean Institute, the mid-range system at Catalina Island, as well as the long-range system on Navy property at San Clemente Island. This site may be co-located with a proposed Automated Surface Observation Stations (ASOS) weather station essential for weather advisory conditions provided to military pilots during operations by the coast. SCCOOS has already fostered a partnership with the USMC weather office by directly collecting weather data from a MetData1 station further inland. SCCOOS aggregates this weather information with existing data sets online for near real-time access. The SIO/USMC mutually beneficial partnership illustrates the value of collaboration between the military and academic communities.

Task A.2 Site Permissions

On 20 August, the USCG submitted final paper work for approval of a site at Point San Luis, which includes land under the jurisdiction of both the Port San Luis Harbor and the USCG. The Port gave approval for this site in October 2006, but delays have occurred with the Coast Guard. The USCG NEPA document has now been approved, and this site is in the final process for approval. SCCOOS anticipates Point San Luis will be fully approved by fourth quarter 2007.

The Diablo Canyon long range and mid range HF Radar were installed this quarter. Pacific Gas and Electric Company (PG&E) granted CalPoly permission to enter certain portions of PG&E's real property, a portion of the San Miguelito Rancho and the Rancho Pecho y Islay situated in the County of San Luis Obispo in January 2007. Although PG&E is a power company, SCCOOS representatives were unable to obtain power close to the site locations. To extend the electrical grid at these sites would require getting the necessary permits to trench through hundreds of yards of archeologically sensitive soil in the coastal zone, increasing the installation time by

several years. Instead, CalPoly sought a solar power solution. The solar power systems were installed early this quarter and the sites became operational late September 2007.

SCCOOS personnel expect to receive approval for Point San Luis, Newport Beach Pier, Camp Pendleton, and the La Jolla Wastewater Treatment Plant in the coming quarter.

Task A.3 Frequency Allocation

SCCOOS has 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 field engineers conducted several HF radar calibration surveys throughout the third quarter. Long and mid range systems installed on bluffs or cliff edges are unable to receive the return signal from a standard transponder. The standard transponder echoes the transmit signal back to the instrument, and if echoed back at a constant distance, any deviation in the receive pattern can be calculated. Calibrations are conducted from a small boat and performed at a range of approximate 1.5km and a speed of 5 knots. Engineers had difficulty calibrating the mid range system at Santa Cruz Island, and the long range systems at Scripps Institution of Oceanography and San Clemente Islands. Engineers were able to work with Codar Ocean Sensors and conduct those calibrations with a transmitting system nicknamed the “super transponder”. This “super transponder” is actually not a transponder; instead, the system is a signal source providing the installed HF Radar system with a much more powerful signal for calibration. SCCOOS engineers were able to successfully calibrate the Santa Cruz Island and Scripps sites and have scheduled a San Clemente trip in early October.

Task A.5 Standard Operating Practices

A workshop conducted 10-13 September 2007 at Scripps Institution of Oceanography brought together representatives of the HF radar technical community from around the nation. The workshop included representatives from the Radiowave Operators Working Group (ROWG). The main goal of the workshop was to garner input from participants into a "Best Practices" document highlighting the many aspects of HF radar operation, including siting requirements, communications, supporting equipment, software settings, data management, and quality assurance/quality control. The workshop was supported through IOOS funding as part of an effort to bring the HF Radar technical community together for discussions on field installations, radar operation, software programming, and site integration.

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. A post-effort organization meeting was held at the Orange County Sanitation District, and included participants from the USGS, OCSD, SAIC, SCCWRP, USC, UCLA, JPL and SIO. Goals of the meeting were to establish a timeline for coordinated data analysis that may be of use for future (unfunded) product development. The present goal of COCMP funded participants is to document scientific results through peer-review publications. Data have been shared by participants on the interactive page of the SCCOOS website.

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

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

Task B.3 Modeling Wave Evolution & Currents to Nowcast Surfzone Currents

By mid-2008, the following products will be available online: high spatial resolution (100 or 200m alongshore spacing model, on the 10 or 15m depth contour); and nowcasts of waves for all of Santa Monica Bay and San Pedro Bay, the reach between Pt Conception and Pt Arena, and selected areas of Northern California. Nowcasts for selected locations in Southern California, and in Monterey, Santa Cruz, San Mateo and San Francisco Counties are online (http://cdip.ucsd.edu/? Moplist=Overview).

The surfzone current model is restricted to straight or gently curving shorelines (e.g. Huntington Beach and Hyperion sites). Transport past headlands, jetties, bay mouths and similar features are largely unstudied and are poorly understood. For example, the reduction of the alongshore flux of waterborne debris past a jetty relative to the open coast is completely unknown/unmeasured.

Task B.4 Northern and Central Nearshore Data

The HB06 group provided model output and wave data to validate and confirm information on the Monterey Bay wave website developed by Thornton and colleagues at the Naval Postgraduate School (NPS). Surfzone alongshore currents for Santa Monica Bay and San Pedro Bay (including the Huntington Beach Website) are online at Http://cdip.ucsd.edu/hb06/). To assist NPS in their alongshore current modeling, we are passing to NPS a file hourly of predicted spectra for the section of coast from Pacific Grove to Moss Landing (the area most heavily studied and monitored by the NPS group).

TASK C. ESTABLISH SUBSURFACE OBSERVATIONS

Task C.1 Underway CTD

Routine operation of the underway conductivity, temperature, depth (uCTD) instrument continued throughout 2006. Observations were conducted from the R/V Sea Watch during its weekly trips to the Wrigley Marine Institute on Catalina Island. Observations can be found at http://www.icess.ucsb.edu/iog/uCTD/index.php. A new underway CTD was purchased in 2007; it was received this quarter. The goal of the new instrument is to improve field logistics and enhance data quality. COCMP technical personnel and the PI (Washburn) have been working closely with Ocean Sciences, the underway CTD manufacturer in this effort.

Task C.2 Bight-Scale Monitoring

Technical staff at the Scripps Institution of Oceanography continues to maintain glider lines in California and provide qa/qc to these data. Data are available through http://spray.ucsd.edu. Links to these data are provided by the www.sccoos.org website.

TASK D. ESTABLISH REGIONAL OCEAN MODELING

Task D.1 Model Research and Development

Using the Regional Ocean Modeling System (ROMS) configuration over the SCCOOS domain developed by the UCLA ROMS group (led by Prof. Jim McWilliams), the JPL/Raytheon ROMS group (led by Yi Chao) has implemented the 3-dimenstional variational (3DVAR) data assimilation system that can assimilate both in situ and remote sensing data including both satellite data and land-based HF radar data.

The SCCOOS ROMS configuration used consists of a single domain covering the southern California coastal ocean from Santa Barbara to San Diego at a resolution of 1 km. Boundary conditions for this domain are provided from a separate ROMS domain, run as part of the Monterey Bay forecast system, that covers the U.S. West Coast at a resolution of 15 km. In-situ and satellite measurements that are available in near real-time are assimilated into ROMS using the 3DVAR data assimilation scheme. An incremental 3DVAR scheme is used with an assimilation window of six hours. The ROMS nowcast (also known as analysis) is issued every six hours at 03, 09, 15, and 21 GMT hours.

ROMS uses a sigma-type vertical coordinate in which coordinate surfaces follow the bottom topography. There are 40 unevenly-spaced sigma surfaces used with the majority of these clustered near the surface to better resolve processes in the mixed layer. For visualization purposes, model data are interpolated to constant depth surfaces using a cubic-spline based interpolation method.

Task D.2 Wind Product for use by ROM

The UCLA group (Alex Hall) has developed a mesoscale atmospheric model over the SCCOOS domain at 4-km spatial resolution based on the mesocale atmospheric model known as MM5. It

is run operationally in near real-time at UCLA. MM5 uses resolved convection and a specialized boundary layer parameterization. The 48-hour forecasts are initialized daily with 06Z national forecasts from NCEP. Figure 1 shows the most recent snapshot of surface winds from the innermost domain, which has a 4-km horizontal resolution. The MM5 model is going to be replaced by the community-based WRF (Weather Research Forecasting) model in the near future.

Task D.3.1 Covariance and Objective Mapping using COCMP observations

Upgrades of the mapping methods for the HF coastal radars are underway, as well as continued refinement of estimates of the covariances of velocity from observations. For compatibility with the JPL 3DVAR effort, covariances can be computed in terms of the Helmholtz decomposition (velocity potential and streamfunction) (phi and psi) in addition to u and v. The observed currents are being separated into components with distinct physical sources: wind-driven, tidal, and low-frequency, for example. Each component is expected to have independent statistics, and estimates of covariances for each from observations are underway. Mapping methods used for the Southern California bight radars to OI from unweighted least-squares are now upgraded, and Terrill and Kim have implemented real-time mapping of the long-range radar network, including estimates of streamfunction and velocity potential.

With Kim, Terrill and Cornuelle are working on statistical-dynamical wind-driven current models for inferring the wind-driven component of current as added information for the mapping.

Implementation of 4DVAR ROMS assimilation (using initial conditions as the only control) in the Southern California region continues, as well as the ROMS tracer dispersion modeling, using downscaled winds from the California reanalysis and the Regional Spectral Model (RSM). It is clear from these experiments and from the comparisons of the reanalysis winds with observations that better wind forcing products are needed. A possible solution would be to acquire wind data from the MM5 SCCOOS runs, which JPL has been using; this is under consideration.

As a complement to the ROMS assimilation, MITgcm 4DVAR (adjoint) assimilation of radials for the San Diego region on a 1 km grid have been implemented. The MITgcm 4DVAR assimilation has initial conditions, boundary conditions, and forcing as controls, and produces dynamically consistent evolving fields. The comparison of the more stringent 4DVAR assimilation with the JPL 3DVAR should provide insights into the resolving power of our observing network, and the adjoint sensitivity can be used to evaluate observation strategies.

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

ROMS nowcast data can be downloaded from the JPL ROMS web site, http://ourocean.jpl.nasa.gov/SCB/index.jsp, and also from the link on the main SCCOOS web site. Through the 'Image' button, the user can display fields of temperature, salinity and current at the ocean surface. Through the Live Access Server (LAS), the user can also conduct interactive visualizations of the time evolution of the 3-dimensional ROMS nowcast.

The SCCOOS ROMS nowcast/forecast will fill in the data gaps where HF radar signal cannot reach. In those areas where there are HF radar data, there is a good agreement between the measurement and ROMS analysis, suggesting the power and consistency of the data assimilation methodology. Further, the model analysis suggests that the meanders within the Santa Barbara channel are actually part of the broader-scale anti-cyclonic circulation originated south of the channel.

Working with the data providers, we have dramatically reduced the ROMS nowcast latency from 32 hours when we started the real-time operation in April 2007 to 12 hours today. There is a possibility that this latency can be further reduced, although significant efforts are required. One possibility is to transfer the UCLA MM5 atmospheric model from the UCLA workstations to the JPL cluster computer. This will speed up the MM5 code somewhat, and also reduces the potential delay associated with the data transfer between UCLA and JPL.

TASK E. DATA DISTRIBUTION AND MANAGEMENT

Task E.1 Information Technology Development

Throughout the third quarter, the SCCOOS data management team focused primarily on configuring an interactive Federal Geographic Data Committee (FGDC) compliant metadata engine. Programming this system required a significant amount of research into various metadata standards and cataloging software. Many of the available tools were either not fully compliant or relied on vendor supported databases. Although the SCCOOS programmers used existing community accepted standards, new code was needed for the backend system. Future work will include populating the database for a full FGDC compliant metadata catalog of SCCOOS data. Programmers also began work on implementing the common application programming interface (api) for ease of access to existing metadata, as well as contributing to NOAA's Regional Observations Registry.

Task E.2 Product Development

Product development continued to advance throughout the third quarter as SCCOOS programmers were able to improve the data management administrative interface to databases by adding a summary page for collections of measurements displaying some statistics, a plot of surface data, and a small map. This interactive administrative interface allows for quick data looks and statistical summaries. Optimization of the data system for fast retrieval continues to require time and constant updating as the near real-time system grows.

SCCOOS will soon release an interactive display of JPL's Regional Ocean Modeling System (ROMS) output of temperature, currents, and salinity overlaid on bathymetry. Users will be able to not only select a depth profile, but also choose any cross-sectional area of the Southern California Bight and produce a gradient along that path. This display will enhance online data usability. SCCOOS programmers are also working toward integrating glider data, consisting of several different file formats, into the system. The interface will include the flexibility to interactively plot glider tracks using polylines versus images for Google Maps glider track displays.