Southern California Coastal Ocean Observing System (SCCOOS)

Integrated Ocean Observing System Implementation: Southern California Regional Coastal Ocean Observing System

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I. PROJECT SUMMARY

Project Title: Integrated Ocean Observing System Implementation:
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Scripps Institution of Oceanography (SIO)
University of California, Los Angeles (UCLA)
University of California, Santa Barbara (UCSB)
University of Southern California (USC)

Other Partners:

California Coastal Commission
California Coastal Conservancy
California Cooperative Oceanic Fisheries Investigation (CalCOFI)
California Current Ecosystem Long Term Ecological Reserve (LTER)
California Department of Fish and Game
California Oil Spill Prevention and Response (OSPR)
City of Los Angeles Environmental Monitoring Division
City of Los Angeles Wastewater District
City of San Diego Wastewater District
County Health Agencies (Santa Barbara, Ventura, Los Angeles, Long Beach, Orange and San Diego)
Jet Propulsion Laboratory (JPL)
Los Angeles County Sanitation District
Marine Exchange of Southern California
Naval Air Systems Command (NAVAIR)
NOAA Southwest Fisheries Science Center
NOAA HAZMAT
NOAA National Weather Service (NWS)
The Ocean Institute
Orange County Sanitation District
Sea Grant
Southern California Coastal Water Research Project (SCCWRP)
U.S. Army Corps of Engineers (USACE)
U.S. Coast Guard (USCG)
U.S. Environmental Protection Agency
U.S. Geological Survey (USGS)
U.S. Navy
U.S. Minerals Management Service
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As the regional ocean observing system for Southern California, the principal goal of SCCOOS is to work interactively with a diverse audience to provide observations and products that advance our understanding and management of the coastal environment. The delivery of timely informational products, summarizing relevant observations of the coastal ocean, is needed for effective management of ocean resources. As a sustainable ocean observing system, SCCOOS has developed the capabilities to support short-term decision-making and long-term assessment by leveraging unique, long-term biological and physical observations.

SCCOOS has aligned its organizational priorities and objectives with the four focus areas designated by the National Federation of Regional Associations:

Ecosystems and Climate Trends: To monitor climate trends and effects on the Southern California Bight by collecting physical, chemical and biological time series.

Water Quality Management: To provide tracking and prediction tools for water quality caused by harmful algal blooms, outfall and stormwater plumes and surfzone contaminants.

Marine Operations: To advance integrated, customized products that are critical for safe and efficient navigation, search and rescue and oil spill response.

Coastal Hazards: To promote safe recreational use of beaches and provide warnings of wave and tide-induced coastal inundation.

By addressing issues within these focus areas, SCCOOS also provides a foundation for Marine Spatial Planning in Southern California at many levels of its development. SCCOOS works interactively with local, state and federal agencies, resource managers, industry, policy makers, educators, scientists, non-governmental organizations and the general public. As a result, data and informational products are made available in a variety of formats to ensure that they are easily interpretable and understood by different users, while preserving the necessary depth of detail to support the scientific and educational communities. SCCOOS also works closely with the Central and Northern California Ocean Observing System on statewide collaborations. The recently formed Joint Strategic Advisory Committee (JSAC) includes representatives from across the state to create a unified and coordinated approach to ocean observing in California.

II. INTRODUCTION

In FY2004, SCCOOS initiated the development of a regional ocean observing system in Southern California, a region that is unique and important for several reasons. Southern California has a population of 24 million people, representing 25% of the coastal population of the United States. With 175 million beach users spending more than $1.5 billion annually on tourism in the region, clean beaches and coastal waters are integral to the economy, public health and the environment.

Southern California has 21 Publicly Owned Treatment Works (POTWs) that discharge more than 1.2 billion gallons ($4.6 \cdot 10^6$ m^3/day) of treated sewage every day directly into the coastal ocean. The Southern California Bight is also used heavily for military operations and commercial transportation. The Los Angeles/Long Beach port complex accounts for approximately 45% of all container traffic in the U.S. Southern California's high coastal population density raises concerns about how human activities directly affect the coastal ocean environment already impacted by climate change, and how climate change, in turn, affects the economy and increases the risk of coastal hazards.

SCCOOS is working to meet the challenge of informing effective management of the coastal ocean through accurate and comprehensive observations, and the delivery of that data through useful decision-making tools and products. Heightened interest in Marine Spatial Planning by federal and state governments–including California's unique effort to develop a Marine Protected Area (MPA) network–accentuates the importance of these tools in managing human use of a variable environment. As demonstrated in the following focus areas, SCCOOS observations and products represent multi-disciplinary and collaborative efforts that specifically address the needs of the region, the state and the national Integrated Ocean Observing System (IOOS).

III. ECOSYSTEMS AND CLIMATE TRENDS

A. Goal and Objectives

The overarching goal of the SCCOOS Ecosystems and Climate Trends component is to monitor climate trends and effects on the Southern California Bight (SCB) through the ongoing collection of physical, chemical and biological variables. Specific objectives are to:

- Sustain observations of currents, temperature, salinity, phytoplankton and zooplankton throughout the SCB through ongoing operations of an array of glider transects, the SCCOOS high frequency (HF) radar array and automated pier stations.
- Begin observations of dissolved oxygen on glider transects to quantify trends in upwelling induced hypoxia.
- Continue offshore and nearshore ecosystem observations via the California Cooperative Fisheries Investigation (CalCOFI) and maintenance of data from discharger oceanographic stations and the west-coast wide manual shore station program that began in 1916.
- Work with users to cooperatively develop and refine indices relevant to ecosystem and fisheries management and coastal planning. Conduct re-analysis using regional ocean models to assess suitability for future climate-relevant products.

B. Background

The California Current System (CCS) off Southern California consists of the southward flowing, surface intensified California Current, northward flowing Southern California Counter Current, and the northward flowing, subsurface California Undercurrent. Thus, waters from both the north and the south affect the SCB and the resulting mixture of waters has striking effects. The SCB is profoundly influenced by El Niño (Lynn and Bograd, 2002) with southern influences arriving by advection, coastally trapped waves and atmospheric teleconnection. With a moderate to strong El Niño predicted for 2009-2010, there is a possibility that the SCB will see significant changes. For example, previous studies have shown that the most powerful El Niños are characterized by an advective component which

brings distinctly southern water and species into the SCB (Lynn et al., 1998). The physical features of the SCB make it a remarkably productive area of the world's oceans. The flow structures in the SCB are thought to influence retention of organisms, while the vertical fluxes at meso and submesoscales provide nutrients to the euphotic zone. Seasonal upwelling also causes the intrusion of low-oxygen waters onto the shelf, a phenomenon that is becoming more intense, for example off Oregon (Chan et al., 2008).

Southern California is fortunate to have the 60-year CalCOFI with its unique sustained ship surveys. The National Science Foundation-funded California Current Ecosystem Long Term Ecological Research (LTER) programs and the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) are focused on the regional effects of climate changes. This combination of efforts gives the SCB an established baseline for further changes and makes the region an ideal site for further development of observational systems. Ongoing observations, including gliders and HF radar, are coordinated with Central and Northern Ocean Observing System (CeNCOOS). Discussions are also underway with the Pacific Coast Ocean Observing System (PaCOOS) concerning future collaborative projects.

C. Audience

Managers responsible for long-range planning and members of the general public concerned about climate change are potential users of the data and indices. Specific users include the NOAA National Marine Fisheries Service, NOAA Southwest Fisheries Science Center (SWFSC), U.S. Environmental Protection Agency, U.S. Geological Survey, U.S. Minerals Management Service, California Department of Fish and Game, Multi-Agency Rocky Intertidal Network (MARINe), non-profit organizations, marine mammal stranding networks, commercial fishermen and the general public.

D. Approach

SCCOOS is focused on the sustained collection of data to provide a reliable climate record. Analyses of these data are intended to produce indices as assessments for ocean and ecosystem health. State-of-the-art models will assimilate these data to produce predictions of ocean state. Underwater gliders are to be used in a network in the SCB. Bight-wide monitoring is accomplished on a series of lines, with a

round-trip section completed once every two to three weeks. Data are transmitted by satellite from each glider dive and posted on a public web site within minutes of collection. Further quality control is performed both automatically and by trained operators. Subsequently, plots of archived data are available on the SCCOOS web site. Experience to date suggests that the procedures are sound, with no major obstacles to continued success. The addition of dissolved oxygen sensors will expand the suite of observed variables relevant to ecosystem health.

SCCOOS proposes to continue the operations and maintenance of the HF radar array composed of twenty-five short and medium range systems and six long range systems. The array provides seamless coverage along the SCB and interfaces with the CeNCOOS and Northwest Association of Networked Ocean Observing Systems (NANOOS) array, covering the entire west coast. Data from the network are broadcast to the National Data Buoy Center (NDBC) using the NOAA IOOS sponsored National Network. SCCOOS proposes to begin the synthesis of time records for purposes of generating indices for climate and ecosystem relevance.

The long-term collection of water properties at shore stations document climate change at the focal points of human use along the coast. Nineteen historical shore stations, consisting of daily temperature and salinity measurements, are maintained on the west coast through a partnership with the California Department of Boating and Waterways (CDBW). Historical analysis of the data has also been used by the California State Water Board to assess climate-scale natural variability of coastal salinity values for analyzing potential impacts of brine discharges from planned desalination plants. It is expected that maintenance of these long term time records will provide data to develop future climate change indices for local MPAs.

The combination of observations will be used to generate maps of seasonal and annual trends of eddy statistics, mean flow fields, and to estimate the connectivity between biologically important regions using trajectories. Maps of these fields have been identified as priorities by NOAA SWFSC biologists examining egg and larvae trends that are used for catch analyses. Estimating biological

connectivity will be critical to this and other Marine Spatial Planning efforts, such as MPA management and assessment.

A goal of the coming year is to develop physical indices relevant to the Pacific sardine (*Sardinops sagax*) and market squid (*Loligo opalescens*) fisheries. The sardine fishery is one of the few that uses a physical index in the determination of harvest guidelines. This physical index, the three-year average SIO pier temperature, is a proxy for physical conditions further offshore that profoundly affect sardine health. Market squid embodies the "grow fast and die young" strategy of loliginid cephalopods and is strongly influenced by environmental variability. This is evidenced by the crash observed in the market squid fishery in El Niño years. Therefore, market squid recruitment is quite likely to be amenable to prediction using physical indices.

SCCOOS will continue to expand the utility of CalCOFI by extending the quarterly sampling cruises to add an alongshore transect near the coast. Along the transect, nine conductivity, temperature, depth (CTD) casts and net tows for zooplankton biomass and the collection of fish and invertebrate larvae are conducted and underway measurements of temperature, salinity, irradiance and fluorescence while the vessel is underway. These data records, now in their fourth year of collection, provide an indication of coastal biological productivity as compared to the offshore (CalCOFI samples offshore to 300 nautical miles) and provide a mechanism to understand how coastal waters change.

Long-term changes in marine ecosystems can be indexed by fluctuations in the life history, abundance or demography of top predators, such as marine birds and mammals. In the CCS, changes in seabird and mammal breeding success, diet and foraging behavior, and abundance have all been shown to be sensitive indicators of ecosystem and food web change, with some responses related to climate change (Sydeman et al. 2001, 2006, 2009). In partnership with the Farallon Institute for Advanced Ecosystem Research, SCCOOS will continue a 22-year record of seabird and marine mammal observations conducted in conjunction with the CalCOFI program. Seabird observations will contribute to scientific and public appreciation of the SCCOOS program.

E. Benefits

Reliable ocean data are essential as society grapples with a response to climate change, both natural and anthropogenic, and as regional governments develop frameworks for Marine Spatial Planning. The central role of SCCOOS is to provide these data as well as improved or new informational products derived from ocean observations. For example, reliable physical indices may be used to set harvesting guidelines, and the documented effects of El Niño will be used by planners throughout Southern California. As model predictability improves, enhanced understanding of advective effects on the ecosystem will aid coastal management, including MPA assessments.

IV. WATER QUALITY

A. Goal and Objectives

The SCCOOS Water Quality component addresses three areas affecting water quality in Southern California: harmful algal blooms (HABs), outfall and stormwater plumes, and surfzone contaminant transport. Specific objectives are to:

- Deliver timely data and informational products describing the occurrence and extent of HABs throughout coastal waters of the SCB using gliders, other autonomous underwater vehicles (AUV) and pier-based observations.
- Develop data products and tools to observe and forecast dispersion of outfall and stormwater plumes using observations and modeling.
- Develop a surfzone contaminant trajectory tool, based on an existing IOOS-funded wave observation-driven surfzone model to help locate point sources of unhealthy water and assist in the real-time response to beach contamination events.

B. Background

Maintaining good water quality is essential for the health of the large coastal population and regional economy in Southern California. Year-round coastal water uses include shipping, recreational boating, swimming, surfing, diving, fishing, aquaculture, military activity and wastewater discharge. These increasing and sometimes conflicting human uses have sparked an interest in Marine Spatial Planning

management efforts in state and federal government. A challenge to maintaining water quality in Southern California is the daily discharge over 1.2 billion gallons of treated sewage directly into the ocean along with additional inputs from river systems that carry treated sewage, untreated stormwater, agricultural runoff, and nuisance urban dry-weather runoff. These discharges contribute bacterial and viral contamination and may influence HAB development. Human uses of the ocean also affect marine ecosystem health including fisheries, marine mammals, and aesthetic values. Delivering timely synthetic data products summarizing critical observations of the coastal ocean off Southern California is imperative for effective management of ocean resources, for mitigating effects of human activities, and for assessing management effectiveness.

The SCCOOS HAB effort complements a state-wide HAB alert network system for researchers, decisions makers, and the general public. This effort was initiated by NOAA, the California Ocean Science Trust (CalOST), and SCCWRP. SCCOOS will partner with CeNCOOS to extend the collaborative HAB network state-wide, ideally incorporating additional regional associations as the network develops and matures.

C. Audience

SCCOOS works directly with various agencies and regulators to provide products that are useful for management and policy affecting the coastal ocean. SCCOOS is working with the California State Water Quality Control Board to develop trajectory maps between coastal nonpoint discharges and Areas of Special Biological Significance (ASBS) and to develop new technology and standards for coastal ocean monitoring by POTWs. The SCCOOS HAB component provides early warning of HAB events to the California Department of Public Health, to marine mammal and bird rescue centers, and to regional agencies. SCCOOS is working directly with local POTW monitoring groups (especially the Orange County Sanitation District) to complement their regional monitoring and provide far-field effluent plume mapping. SCCOOS collaborates directly with the Southern California Coastal Water Research Project (SCCWRP) in the planning, design, and execution of their 5-year regional studies. The water quality

component of this effort focused on harmful algal blooms and nutrient fluxes and incorporates both observational and modeling components of SCCOOS.

D. Approach

Harmful Algal Blooms: The SCCOOS HAB monitoring program, initiated in the summer of 2008, consists of five pier-monitoring sites posting real-time temperature, salinity, water level, and chlorophyll fluorescence data. The pier sites provide indications of fresh water input, upwelling and algae blooms. Weekly bottle samples measure chlorophyll, nutrients, domoic acid and harmful algal species. Data are immediately enumerated, posted to the SCCOOS web site and distributed regionally and nationally via the California HAB Monitoring and Alert Program Listserv. When HABs are detected, opportunistic sampling is performed at additional shore sites and from boats to determine their extent and severity.

Gliders will map the offshore and subsurface evolution of HABs based on chlorophyll fluorescence. This approach proved effective during the spring of 2009 when glider mapping detected an offshore chlorophyll maximum and domoic acid-producing *Psuedo-nitzschia* bloom. Barnacles growing on the glider during its deployment proved excellent bio-accumulators of domoic acid and are now routinely bio-assayed.

Outfall and stormwater plumes: The approach to understanding the environmental effects of outfall and stormwater plumes will use gliders, HF radar, automated pier stations, agency moored and shipboard observations, plume models (EPA Roberts, Snyder and Baumgartner [RSB] model) and high resolution Regional Ocean Modeling System (ROMS). The observations and ROMS have sufficient spatial resolution to resolve outfall plume distributions (Cetinic et al., 2009; Petrenko et al., 1997; Todd et al., 2009). Models will be initialized and tested with glider-derived maps of currents, stratification, temperature, salinity, colored dissolved organic matter (CDOM), chlorophyll and turbidity obtained during a major field experiment at Huntington Beach, CA in 2006 (HB06). Ultimately, gliders will provide the real-time data essential for the outfall plume models and ROMS will predict plume transport and dispersion. The POTWs who discharge into Southern California have identified these nowcasts and

forecasts of plume location as important data products. These partners include the Orange County Sanitation District, the City of Los Angeles and the City of San Diego. Toward this end, SCCOOS has gained valuable experience in running a version of ROMS in real time at 2 km resolution to make predictions regularly posted online and publicly accessible. Validation of the ROMS output against non-assimilated observational records (e.g. moored ADCP and temperature data) is underway to provide guidance for developing future products for the water quality community.

SCCOOS will continue to track river and stormwater plumes using near real-time simulated particle trajectories derived from HF radar observations of surface currents. Stormwater trajectories and plume trajectories will be combined with agency bacterial data to test simulations of shoreline contamination. In collaboration with the County of San Diego Department of Environmental Health and the Imperial Beach marine safety office, this approach was successfully employed recently for the Tijuana River and two outfalls by SCCOOS investigators (Kim et al., 2009). The approach will be extended to other river sites in Southern California for evaluation purposes.

Surfzone Contaminant Transport: Bacterial contamination of beaches through surface surfzone transport processes is a great concern for public health, stormwater management, and regulatory agencies in Southern California. A wave-driven surfzone current prediction system developed by the Coastal Data Information Program (CDIP), a SCCOOS partner, provides real-time estimates of the current direction and mean speed at multiple points along the major beaches in Southern California. This system will be incorporated into a real-time surfzone contaminant trajectory tool to estimate the alongshore extent of water discharged into the surfzone from land sources, or entrained into the surfzone from offshore effluent plumes. These surfzone trajectories will be coupled with the HF radar data outside the surfzone for monitoring storm drain and river discharges. The long-term goal is to combine the proposed surfzone trajectory model with surfzone mixing and bacterial sunlight decay models to make quantitative predictions of contaminant concentrations.

E. Benefits

The HAB component will provide several products beneficial to coastal managers, public health officials and regulators to prepare and respond to bloom events: 1) Real-time detection of the presence of potentially toxic HAB species; 2) future development of forecast models to predict the formation and evolution of blooms; and 3) initiation of a HAB climatology to use in future forecasting of toxic HAB events.

The outfall and stormwater component will provide trajectory data products for estimating the transport of surface discharges such as river runoff. It will also produce data products based on sub-surface observations and high resolution modeling to describe sub-surface movement of outfall plumes. The surfzone component produces a contaminant trajectory tool for use with routine beach water quality monitoring data to assist managers and public health agencies in identifying persistent point sources of unhealthy water. This tool will be used in real-time during spill events to predict which up- or downcoast beaches will likely suffer the greatest impact.

V. MARINE OPERATIONS

A. Goal and Objectives

The goal of the SCCOOS Marine Operations component is to continue to advance previously IOOS-funded and newly proposed projects that are critical for safe and efficient navigation, search and rescue (SAR) and oil spill response. Specific objectives are to:

- Develop and expand integrated, customized products that involve multi-layer views of the observations and nowcast and forecast models including winds, waves and currents, sea surface temperature, bathymetry and navigation charts.
- Deliver ocean current data and surface wind analyses to aid oil spill and Search and Rescue (SAR) real-time recovery and post-analysis trajectories. In collaboration with the Oxnard National Weather Service (NWS), continue to expand the on-demand capability to provide risk assessment in a given area/region and impact assessment following an incident.

- In collaboration with the U.S. Navy at Point Mugu, continue to expand the near real-time, customized wave display with additional parameters such as currents and winds.
- Communicate glider data to the Naval Oceanographic Office for assimilation into the Navy Coastal Model (NCOM), which is published for public distribution by NOAA National Centers for Environmental Protection (NCEP).

B. Background

Maritime transportation plays a major role in Southern California's economy and national defense system. Los Angeles and Long Beach combined comprise the largest port in the U.S. and the fifth largest port in the world; the Port of San Diego includes the largest naval fleet in the world. Port Hueneme is the only deep water port between Los Angeles and San Francisco and the only Navy controlled port between San Diego and the Puget Sound. The Santa Barbara Channel and San Pedro shelf are the locations of several active oil fields with sustained reserves, as well as major shipping channels.

The unique challenge for marine operations in Southern California is to assure that the vast amount of maritime traffic is provided with the highest quality ocean observations and models to assure safe and efficient transit as well as effective event response. SCCOOS has addressed this challenge with the development of a customized Ports and Harbors interactive online display and by further expanding the Google-based observation maps for the entire Southern California region. These maps are consistent with the approach of Marine Spatial Planning as they provide integrated, map-based tools for coastal management. Two programs that are leveraged heavily are the California Ocean Current Monitoring Program (COCMP), funded by the California Coastal Conservancy, and CDIP, cooperatively funded by the CDBW and the U.S. Army Corps of Engineers (USACE). COCMP is the State's contribution to the HF radar system and CDIP maintains a network of offshore wave buoys.

SCCOOS works collaboratively with State and federal partners to integrate and distribute data relevant to marine operations. The U.S. Navy provides the Coupled Ocean/Atmosphere Mesocale

Predictions (COAMPS) from the Marine Meteorology Division of the Naval Research Laboratory. SCCOOS wave and currents data are ingested into the NOAA National Weather Service/National Data Buoy Center for dissemination. A memorandum of understanding between NOAA and USACE will allow SCCOOS/CDIP wave data to be displayed on the NOAA PORTS site. This will serve as a template for further IOOS data integration and displays. The National Aeronautics and Space Administration (NASA) provides MODIS (Moderate Resolution Imaging Spectroradiometer) sea surface temperature to SCCOOS.

In collaboration with CeNCOOS, SCCOOS contributes to regional coordination by participating in maritime transportation meetings throughout the State where there is interest in employing the web template from the Los Angeles/Long Beach site. These two regions also work closely on HF radar and wave buoy maintenance. At the national IOOS level, SCCOOS has presented to the Hydrographic Survey Research Panel and NOAA Science Advisory panel on maritime transportation. Both of these events reinforce the visibility and recognition that SCCOOS is receiving for its marine operation products. SCCOOS has also played a key role in writing both the IOOS National Wave Plan and the IOOS National HF Radar Plan.

C. Audience

Representative stakeholders and users include: Catalina Express Ferry (one million passengers from San Pedro to Catalina since year 2000), Commercial Cargo Vessels, Commercial Fishermen, Harbor Pilots (San Diego, Los Angeles, Long Beach and Port Hueneme), Marine Exchange of Southern California, NWS, NOAA HAZMAT, California Office of Oil Spill Prevention Response (OSPR), USCG, U.S. Navy, Passenger Cruise Ships, recreational beachgoers and boaters. All of these stakeholders are interested in both real-time and forecast customized data which complement their decision-support tools. The audience includes users of different levels of sophistication and technical knowledge. Web-training sessions are scheduled for interested stakeholders such as the USCG.

D. Approach

The previously IOOS-funded infrastructure and methodology used to collect, analyze and disseminate observations in near real-time will continue development. Customized, integrated products include expanding the seamless geo-referenced user tools to all regions within Southern California. Discussions with stakeholders throughout Southern California aid in determining the customization of the site. One example is the USCG recent request for on-demand location referencing within the customized Google maps enabling users to enter specific latitude/longitude for tracking small vessel operations.

An ocean current data and surface wind analyses product will be created for estimating trajectories of floating objects in the coastal ocean including people, debris, and drifting boats. In collaboration with the NWS office, the effects of windage on trajectories using surface wind products will be incorporated. This product will complement the Water Quality discharge task. As requested by the Navy, winds and surface currents will be integrated with the existing operational wave observations/models. As glider data are now being delivered to NCOM, this partnership between SCCOOS, the Navy, and NOAA NCEP will allow SCCOOS to generate and distribute model-based products from the operational model for maritime operations.

E. Benefits

SCCOOS will continue to provide unique customized products that will be readily and routinely available to the maritime community and will inform Marine Spatial Planning efforts. NOAA HAZMAT benefits from real-time surface current measurements integrated in General NOAA Operational Modeling Environment (GNOME) for trajectory analysis. Surface Current data are made available to OSPR in a netCDF/shape file format, a capability that has been tested in both drills and in real spills. Automated messages are sent to the Long Beach harbor pilots during energetic, long period wave events (over 1 meter and 12 seconds). The threshold warning for these long period events is critical to the pilots' operations as the deep draft vessels will start pitching and will lack the under keel clearance

necessary for entering the harbor. The cost estimate is between $100,000-$200,000 per day to retain a vessel offshore. The customization and integration of near real-time products aid decision-making capabilities for the Coast Guard, emergency responders and the general public at large.

VI. COASTAL HAZARDS

A. Goal and Objectives

The goal of the Coastal Hazards component is to decrease the loss of property and life associated with nearshore waves and wave-driven currents in the populous coastal communities of Southern California. Building upon previously SCCOOS funded projects, the specific objective is to:

- Develop and expand integrated, customized products that promote *safe recreational use of beaches* and provide warnings of *wave and tide-induced coastal inundation.*

B. Background

Several Southern California beachgoers drown each year and rescues are common. In 2007, Newport Beach recorded 3865 rescues and during the August 20, 2009 weekend south swell event, there were over 90 rescues on San Diego County beaches. Presently, lifeguards have extensive local knowledge, but are not provided with the best available wave and surfzone currents information in a format tailored to their needs.

Coastal inundation on the U.S. west coast is often caused by the co-occurrence of high tides and energetic ocean waves. The large waves cause both a super-elevation of the mean water level above the tide level and large oscillations about that level. The California Coastal Sediment Management Workgroup report indicates that several beaches and structures are vulnerable to dangerous high surf and coastal flooding conditions (California Beach Restoration Survey 2008) during storms where wave uprushes can reach several meters above tide level. Simple inundation models, where the uprush limit depends only on the tide level and wave height, yield qualitative, general information but not the information most valuable for issuing site specific warnings for highway closures and sand-bagging.

Synergies have developed between the U.S. Geological Services Coastal Hazards Project, the

USACE, CDBW, Coastal Sediment Management Working Group and the American/California Shore and Beach Preservation Association. In 2008, SCCOOS also co-authored the San Diego Foundation Regional Focus 2050 Study, sponsored by the California Energy Commission. The inundation infrastructure served as a basis for the sea level rise projections for year 2050. SCCOOS will partner with the San Diego NWS on their Storm Surge Study. SCCOOS will supply wave and current input to their model and collaborate on model validation. In collaboration with CeNCOOS, the inundation dissemination infrastructure currently developed is transmitting warnings to the Monterey NWS for Central California, Carmel Lagoon. SCCOOS also participates in the IOOS funded inundation discussions which address on-going technical issues.

C. Audience

The audience includes lifeguards, NWS and the Emergency Alert Network, recreational beachgoers, USACE, California Department of Transportation and California Coastal Commission as well as regional city and county governments. Partnership has been established with the City of Encinitas and City of San Diego who will contribute observational validation of the inundation notifications. These users require real-time products indicating coastal conditions. Future web training is scheduled with the lifeguards and emergency managers.

D. Approach

Working co-operatively with NWS and local lifeguards, environmental products tailored to lifeguard needs will be developed, including coastal wave height and direction and the strength of alongshore currents. These alongshore currents and wave predictions are being ingested by the San Diego NWS to help develop a rip current warning capability for specific beaches. These evolving products will be included in “lifeguard” themed webpage for tailored access to critical information.

A site-specific model for tide and wave-driven inundation will be calibrated with field observations of shoreline water level acquired during winter storms. Information describing incoming wave conditions and NOAA tide gages will be used to estimate water level, including the astronomical tides,

storm surge, El Niño and other regional factors. The field observations will show the importance of local details, such as ramps and structures, on shoreline run-up and inundation and allow customization of inundation warnings. Model-based inundation nowcasts and forecasts and special warnings, will be disseminated directly to users via the Internet and/or automated phone call. Users (e.g. highway departments) have indicated a willingness to work cooperatively to improve warnings by providing information on when highways flood during storm events.

Beta-stage operational coastal wave nowcast models (MOPS) includes both remotely generated swell and locally generated seas with high temporal (hourly) and spatial (100m) resolution. The CDIP Spectral Refraction Wave model utilizes measurements from a network of wave buoys and co-located point forecast spectra from the NOAA WaveWatch III global wave model (Tolman, 1997, 1999, NOAA 2006) for offshore boundary conditions. Field testing in Southern California has extensively validated the Spectral Refraction Model. This model provides 10m depth boundary conditions (e.g. wave height, direction and period) immediately offshore of the surfzone for wave-driven inundation models for Coast Highway 101 at Torrey Pines, California and the Navy recreational use facility at Point Mugu.

When the modeled inundation tops Highway 101, automated warning messages are sent to the Engineering Departments at the City of Encinitas and City of San Diego. At this time, the inundation thresholds and wave run-up estimates are both very crude. Along selected MOP profiles, the run-up height will be estimated using recently collected beach profiles in empirical run-up formulations (Ruggiero et al., 2004 and Stockdon et al., 2006). Observations are critically needed to improve model accuracy by including site specific effects. However, as validation proceeds, the 'beta site' demonstrates that the dissemination mechanism and users are in place for developing decision-making products.

E. Benefits

The long-term collection of waves, currents and wind observations is critical for building a historical database for coastal managers. As climate trends and changes become increasingly evident, the value of

these databases will increase. With rising sea levels and El Niño winters, it is critical that a West Coast inundation model be developed for future safety and protection of the coastal community.

VII. DATA MANAGEMENT

SCCOOS aims to improve access to high-quality integrated data and support regional user needs while complying with the standards and protocols for sharing and archiving data that are developed nationally. SCCOOS will continue to integrate a broad suite of observations including: surface currents, satellite imagery, wave conditions and forecasts, meteorological conditions and forecasts, water quality, ocean temperature, salinity, chlorophyll, and density in the form of data products and raw data. Product delivery of observations and nowcast and forecast models will continue. These observations are available in a user-friendly display on the SCCOOS web site.

The primary components of SCCOOS data conform to rigorous quality control (QC) standards. SCCOOS has developed standards and guidelines for waves QC and data processing at a national level through QARTOD (Quality Control of Real-Time Data) and international level through the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM). SCCOOS participants play an active role in the ongoing effort to develop QC standards for HF radar derived surface currents. All wave and current data have associated XML and FDGC compliant metadata. SCCOOS will participate in the California Water Quality Monitoring Council which defines water quality standards. SCCOOS recently hosted a workshop to develop compliant sensor observation services (SOS) for IOOS core variables as defined by the Data Integration Framework (DIF) and will be implementing SOS within the near future. The data management effort provides scientists, decision makers, and the public access to products and data services that will facilitate a scientific basis for research and management of the Southern California ocean environment.

VIII. CONCLUSION

As demonstrated, SCCOOS maintains coastal ocean assessments to identify trends in the environment and ecosystem variability, supports the beach water quality management community,

informs operational users for marine safety and delivers information to coastal managers and beachgoers critical to safety while distributing ocean information of public interest. SCCOOS is focused on providing critical observations for effective and integrated Marine Spatial Planning and management of ocean resources and the environment in Southern California, but is also committed to contributing to larger ocean observing efforts at the regional, national and international level.

IX. MILESTONE SCHEDULE

ECOSYSTEMS AND CLIMATE TRENDS	
Monthly	Continue offshore glider transects
Monthly	Continue CalCOFI observations
July 1, 2010-June 30, 2011	Develop indices relevant to ecosystem fisheries management and coastal planning
Ongoing	ROMS reanalysis for climate trends and connectivity assessment
Monthly	Continue time series on the distribution and abundance of marine birds and mammals in the Southern California Bight
July 1, 2010-June 30, 2011	Underway conductivity, temperature, depth (CTD)
WATER QUALITY	
Weekly	Conduct sampling at five HAB monitoring sites
Bi-Monthly	Support glider mapping for the detection of potential HABs
July 1, 2010-June 30, 2011	Develop tools to observe and forecast plume dispersion
May 31, 2011	Surfzone contaminant trajectory tool available online
MARINE OPERATIONS	
Ongoing	High frequency (HF) radar operations and maintenance
Ongoing	Develop and expand integrated, customized products with multi-layer views of observations, nowcasts and forecasts
Oil Spill and SAR events	Deliver ocean current data and surface wind analyses to aid oil spill and SAR real-time recovery and post-analysis trajectories
March 31, 2011	Expand the near real-time, customized wave display for Navy to include surface currents and winds
Ongoing	Deliver glider data for assimilation into Navy Coastal Model
COASTAL HAZARDS	
Storm Events	Monitor storm inundation at selected locations
Post-storm conditions	Validate and refine inundation model
Ongoing	Expand development and integration of inundation web site

SCCOOS Work Plan

		Ecosystems and Climate Trends	Water Quality	Marine Operations	Coastal Hazards
ECOSYSTEMS AND CLIMATE TRENDS					
Offshore Glider Surveys	UCSD - DAVIS/RUDNICK	✓	✓		
Underway conductivity, temperature, depth (CTD)	UCSB - WASHBURN	✓	✓		
Egg, larval Hydrographic Stations nearshore - CalCOFI	UCSD - GOERICKE	✓			
Ocean data synthesis through development of climatology and climate relevant indices; hindcast reanalyses for indices with sardine and squid catch	UCSD - RUDNICK SWFSC - MCCLATCHIE	✓			
Regional Ocean Modeling System (ROMS) reanalysis for climate trends and connectivity assessment	UCLA - MCWILLIAMS	✓	✓		
Time series on the distribution and abundance of marine birds and mammals in the Southern California Bight	FARALLON INSTITUTE - SYDEMAN	✓			
WATER QUALITY					
Harmful Algal Bloom (HAB) Surveillance	CAL POLY - MOLINE UCSB - BRZEZINSKI USC - JONES/CARON UCLA - SHIPE UCSD - MCGOWAN	✓	✓		
Automated Shore Stations at four piers (San Diego, Orange County, Los Angeles, Santa Barbara)	UCSD - TERRILL	✓	✓		
HAB Glider Operations	USC - JONES	✓	✓		
ROMS - model evaluation with Huntington Beach 2006 (HB06) data set ($100K real-time, $50K fine resolution. Model implementation)	UCLA - MCWILLIAMS/CHAO	✓	✓		
Shoreline/surfzone currents toolset	UCSD - OREILLY		✓	✓	✓
MARINE OPERATIONS					
HF Radar Operations and Maintenance	CAL POLY - MOLINE UCSB - WASHBURN USC - JONES UCSD - TERRILL	✓	✓	✓	✓
COASTAL HAZARDS					
Shoreline Inundation Forecast Tool and National Weather Service (NWS) Rip Current Forecast Validation	UCSD - GUZA			✓	✓
DATA MANAGEMENT					
Manage SCCOOS data feeds and outside data integration, data delivery, and online products www.sccoos.org	UCSD - TERRILL	✓	✓	✓	✓

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RESUMES

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Selected Publications

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Selected Publications

Caron, D.A., P.D. Countway, P. Savai, R.J. Gast, A. Schnetzer, S.D. Moorthi, M.R. Dennett, D.M. Moran and A.C. Jones, 2009. Defining DNA-based operational taxonomic units for microbial eukaryote ecology. Applied and Environmental Microbiology 75: 5797-5808.

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Scientist, Research Scientist, Principal Scientist, Jet Propulsion Laboratory (JPL), 1993-present
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Selected Publications

Wang, X., Y. Chao, C. Dong, J. Farrara, Z. Li, J. C. McWilliams, J. D. Paduan, and L. K. Rosenfeld, 2009. Modeling tides in Monterey Bay, California. Deep-Sea Research II, doi:10.1016/j.dsr2.2008.08.012.
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Assistant/Associate Professor, Scripps Institution of Oceanography, 1968-1977
Assistant Research Geophysicist, University of California San Diego, 1967-1968

Awards and Honors
Member, National Academy of Science; Fellow, American Geophysical Union; Fellow, American Academy of Arts and Sciences; Fellow, American Meteorological Society; A.G. Huntsman Award (1997); Henry Stommel Medal, WHOI (2000); David Packard Distinguished Lecturer (2006); Albert I Medal, IAPSO (2007)

Selected Publications
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Appointments
Research Oceanographer, Scripps Institution of Oceanography, 2004-present
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Selected Publications
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Appointments

Professor, Scripps Institution of Oceanography, 1975-present
Center for Coastal Studies/Integrative Oceanography Division, Co-Director, 1994-2009

Selected Professional Activities

Outstanding Journal Paper Award (Amer. Soc. Civil Eng., Ocean Division, 1991); AGU Fellow (l993); California Shore & Beach Preservation Association 2001 award for outstanding contributions to coastal engineering (with Pawka and O'Reilly); AGU Outstanding Student Paper (junior author w/ student Okihiro 1991, Schmidt 2002, Omand 2006 & Apotsos 2006)

Selected Publications

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Selected Publications

Caron, D. A., M.-E. Garneau, E. Seubert, M. D. A. Howard, L. Darjany, A. Schnetzer, I. Cetinic, G. Filteau, P. Lauri, B. Jones, and S. Trussell, 2009. Harmful algae and their potential impacts on desalination operations off southern California. Water Research 43.

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Research Interests

Multiple stable states in the community of the North and South Pacific central water masses; Large scale patterns in space and time and the Californian El Niños; Diversity maintenance; Biogeography; Timeseries in coastal California; Climate and pelagic ecology.

Selected Publications

McGowan, J. A. and M. Williamson. In press. The copepod communities of the North and South Pacific gyres and the form of species abundance distributions. Journal of Plankton Research.
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Ph.D., Applied Mathematics, Harvard University, 1971
Research Fellow in Geophysical Fluid Dynamics, Harvard University, 1971-74

Appointments

Louis B. Slichter Professor of Earth Sciences in the Institute of Geophysics and Planetary Physics and Department of Atmospheric Sciences, UCLA, Los Angeles, CA, 1994-present; Chair, 2007-present
Research Scientist at the National Center for Atmospheric Research, Boulder, CO, 1974-2005

Honors and Committees

Fellow of the American Geophysical Union (2001); Member of the National Academy of Sciences (2002); Jet Propulsion Laboratory Earth Science Advisory Council (1997-present); Visiting Committee for the Division of Geological and Planetary Sciences, California Institute of Technology (1999-present); Scientific Committee for the Département Terre Atmosphère Océan,

École Normale Supérieure (2003-present); Fluid Envelope Sub-Section Head, National Academy of Sciences (2007-present)

Recent Publications

Dong, C., E.Y. Idica, and J.C. McWilliams, 2009. Circulation and multiple-scale variability in the Southern California Bight. Prog. Oceanography, in press.

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Marchesiello, P., J.C. McWilliams, and A. Shchepetkin, 2003. Equilibrium structure and dynamics of the California Current System. J. Phys. Ocean. 33, 753-783.

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Assistant Professor, California Polytechnic State University, 1998-2002
Postdoctoral Associate, Rutgers University, 1996-1997

Recent Awards and Honors

Fellow, California Council on Science and Technology (2008); Distinguished Scholarship Award, Cal Poly State University (2007); Editors' Citation for Excellence in Refereeing, American Geophysical Union (2005); Earth Systems Scholar, NASA (2004); Frontiers Scientist, National Academy of Science (2002); National Research Distinction Award, Cal Poly State University (2002); Presidential Early Career Award for Scientists and Engineers (2002); Young Investigator Award, Office of Naval Research (2000); New Investigator Program Award, NASA

Selected Publications

Moline, M. A., and O. M. Schofield, 2009. Remote real-time video-enabled docking for underwater autonomous platforms. J. Atmos. Oceanic. Technol., doi:10.1175/2009JTECHO666.1.

Benoit-Bird, K. J., M. A. Moline, C. M. Waluk, and I. C. Robbins, 2009. Integrated measurements of acoustical and optical thin layers I: Vertical scales of association. Continental Shelf Research, doi:10.1016/j.csr.2009.08.001.

Moline, M. A., K. J. Benoit-Bird, I. C. Robbins, M. Schroth-Miller, C. M. Waluk, B. Zelenke. 2009. Integrated measurements of acoustical and optical thin layers II: Horizontal length scales. Continental Shelf Research, doi:10.1016/j.csr.2009.08.004.

WILLIAM C. O'REILLY

Senior Development Engineer, Scripps Institution of Oceanography,
University of California, San Diego, CA, 858-534-6258, bor@cdip.ucsd.edu

Education

B.A., University of Michigan, Env. Eng.,1983
B.A., University of Michigan, Civil Eng.,1983
M.S., Ph.D., Scripps Institution of Oceanography, Oceanography, 1985, 1991
Post-Doctoral Researcher, Scripps Institution of Oceanography, 1991-1993

Appointments

Senior Development Engineer, Scripps Institution of Oceanography, 1993-present
Research Assistant Professor (25% time), US Naval Postgraduate School, 1996-2001
Visiting Scholar, College of Engineering, U.C. Berkeley, 1999-2001

Selected Publications

Ardhuin, F, W.C. O'Reilly, T.H.C. Herbers, and P.F. Jessen, 2003. Swell transformation across the continental shelf. Part I. Attenuation and diretional broadening. J. Phys. Oceanogr., 33, 1921-1939.

Elgar, S., R. T. Guza, W. C. O'Reilly, B. Raubenheimer, and T.H.C. Herbers, 2001. Wave energy and direction observed near a pier, J. Waterway, Port, Coastal, and Ocean Engineering, 127, 2-6.

Ardhuin, F, Herbers, T.H.C., and W.C. O'Reilly, 2001. A hybrid Eulerian-Lagrangian model for wave spectra evolution with application to bottom dissipation on the continental shelf, J. Phys. Oceanogr., 106.

Herbers, T.H.C., Hendrickson, E.J., and W.C. O'Reilly, 2000. Propagation of swell across a wide continental shelf, J. Geophys. Res. 105, 19729–19737.

DANIEL L. RUDNICK

Professor, Scripps Institution of Oceanography,
University of California, San Diego, CA, 858-534-7669, drudnick@ucsd.edu

Education

B.A. Cum Laude, University of California, San Diego, Physics, 1981
Ph.D., Scripps Institution of Oceanography, UCSD, Oceanography, 1987
Postdoc, Woods Hole Oceanographic Institution, 1987-1989

Appointments

Professor, Scripps Institution of Oceanography, UCSD, 2001-present
Deputy Director of Education, Scripps Institution of Oceanography, UCSD, 2005-2008
Associate Professor, Scripps Institution of Oceanography, UCSD, 1997-2001
Assistant Professor, Scripps Institution of Oceanography, UCSD, 1993-1997
Assistant Professor, School of Oceanography, University of Washington, 1989-1993

Selected Publications

Todd, R. E., D. L. Rudnick, and R. E. Davis, 2009. Monitoring the greater San Pedro Bay region using autonomous underwater gliders during fall of 2006. Journal of Geophysical Research, 114, doi:10.1029/2008JC005086.

Davis, R. E., M. D. Ohman, D. L. Rudnick, J. T. Sherman, and B. Hodges, 2008. Glider surveillance of physics and biology in the southern California Current system. Limnology and Oceanography, 53, 2151-2168.

Rudnick, D. L., R. E. Davis, C. C. Eriksen, D. M. Fratantoni, and M. J. Perry, 2004. Underwater gliders for ocean research. Marine Technology Society Journal, 38, 73-84.

REBECCA SHIPE

Assistant Professor, Institute of the Environment and Department of Ecology and Evolutionary Biology, University of California, Los Angeles, CA, 310-794-4903, rshipe@ucla.edu

Education

B.S., The Pennsylvania State University, 1995 (Biology)
Ph.D., University of California, Santa Barbara, 2000 (Marine Science)

Appointments

Assistant Professor, Institute of the Environment and Department of Ecology and Evolutionary Biology, UCLA, 2003-present
Postdoctoral Researcher, Biological Sciences Department, USC, Los Angeles, 2001-2002

Selected Publications

Shipe, R.F., A. Leinweber, and N. Gruber, 2008. Abiotic controls of potentially harmful algal blooms in Santa Monica Bay, California. Continental Shelf Research, 28, 2584-2593.

Shipe R.F., Carpenter E.J., Govil S., Capone D.G, 2007. Limitation of phytoplankton production by Si and N in the western Atlantic Ocean. Marine Ecology Progress Series. 338:33-45.

Shipe, R. F., Curtaz, J.,Capone, D. G. and Carpenter, E. J, 2006. Diatom biomass and productivity in oceanic and plume-influenced waters of the western tropical Atlantic Ocean, Deep Sea Research I. 53,1320-1334.

Shipe, R. F., and M. A. Brzezinski, 2003. Siliceous plankton dominate primary and new productivity during onset of El Nino conditions in the Santa Barbara Basin, California. Journal of Marine Systems. 42, 127-143.

Shipe, R. F., Passow, U., Brzezinski, M.A., Graham, M. A., Pak, D. K. Siegel, D. A. Alldredge, A. L, 2002. Effects of the 1997-98 El Niño on seasonal variations in suspended and sinking particles in the Santa Barbara Basin. Progress in Oceanography. 54, 105-127.

WILLIAM J. SYDEMAN

President/Senior Scientist, Farallon Institute for Advanced Ecosystem Research, Petaluma, CA, 707-478-1381, wsydeman@faralloninstitute.org

Education

Ph.D., Ecology, University of California, Davis, CA, 1999
M.Sc., Biology, Northern Arizona University, Flagstaff, AZ, 1985
B.S., Biology, Lewis and Clark College, Portland, OR, 1979

Appointments

Research Associate, Bodega Marine Laboratory, UC Davis, 2008-present
President/Senior Scientist, Farallon Institute, Petaluma, CA, 2007-present
Research Associate, Integrative Oceanography, UCSD, La Jolla, CA, 2000-present
Director of Marine Ecology, PRBO Conservation Science, Petaluma, CA, 1992-2007

Professional Activities

NCEAS working group, Marine Climate Impacts (June 2009-present); Science Advisory Team, California Ocean Protection Council (2008-present); Co-Chair, Advisory Panel for Marine Birds and Mammals, PICES (2003-present)

Selected Publications

Sydeman, W.J. and S.A. Thompson. The California Current integrated ecosystem assessment: trends and variability in system state. Progress in Oceanography (in prep.)

Sydeman, W.J., J.F. Piatt, and H. Browman (Editors), 2007. Seabirds as indicators of marine ecosystems. Special Volume. Marine Ecology Progress Series 352.

Thayer, J.A. and W.J. Sydeman, 2007. Spatio-temporal variability in prey harvest and

reproductive ecology piscivorous seabird, Cerorhinca monocerata, in an upwelling system. Marine Ecology Progress Series 329:253-265.
Sydeman, W.J., M. M. Hester, J. A. Thayer, F. Gress, P. Martin, and J. Buffa, 2001. Climate change, reproductive performance, and diet composition of marine birds of the southern California Current, Progress in Oceanography 49:209-329.

ERIC J. TERRILL

Technical Director, Southern California Coastal Ocean Observing System
Director, Coastal Observing Research and Development Center, Scripps Institution of Oceanography, University of California, San Diego, CA 858-822-3101, eterrill@ucsd.edu

Education

Ph.D., Physical Oceanography - Applied Ocean Sciences, Scripps Institution of Oceanography, University of California, San Diego, 1998
B.S., Applied Mechanics and Engineering Science (*magna cum laude*), University of California, San Diego, 1993

Research Interests

Applied ocean sciences and technology development: ocean measurement systems, naval hydrodynamics, sensor development, EM (radar) and EO (lidar, imaging) sensing of the air-sea interface, ocean measurement platforms (HF radar, moorings, buoys, autonomous and towed vehicles, fixed platforms), coastal and ocean engineering.

Project Experience

Technical Director of the Southern California Coastal Ocean Observing System (SCCOOS) and founder and director of the Coastal Observing R&D Center (CORDC) at Marine Physical Laboratory, Scripps Institution of Oceanography

Selected Publications

Kim, S. Y., B. D. Cornuelle, and E. J. Terrill, 2009. Assessing coastal plumes in a region of multiple discharges: the U.S.-Mexico border. Environmental Science & Technology. Accepted.
Kim, S., E.J. Terrill. A statistical model for water quality predictions from a river discharge using coastal observations. Eos Trans. AGU, 88(52), Fall Meeting, Supplement.
Kim, S. Y., E. J. Terrill, and B. D. Cornuelle, 2008. Mapping surface currents from HF radar radial velocity measurements using optimal interpolation, J. Geophys. Res., 113, C10023, doi:10.1029/2007JC004244.

JULIANNA O. THOMAS

Executive Director, Southern California Coastal Ocean Observing System
Program Manager, Coastal Data Information Program, Scripps Institution of Oceanography, University of California, San Diego, 858-534-3034, jot@cdip.ucsd.edu

Research Interests

As Program Manager of CDIP, priority is to maintain standards for collecting and disseminating high resolution wave data throughout the marine community. As Executive Director of SCCOOS, priority is the development of the Ocean Observing Systems at regional, state and national levels, promoting inter-agency collaboration, data interoperability and data standards.

Appointments

Executive Director, Southern California Coastal Ocean Observing System, 2008-present
Program Manager, Coastal Data Information Program (CDIP) and Southern California Beach Processes Study (SCBPS), 2001-present
Data Manager, CDIP, 1984-2001

Selected Publications

Swail, V., J. Thomas, S. Gulev, J. Turton, M. P. Etala de Aso, B. Lee, R. Jensen, D. Meldrum, and V. Cardone, Enhanced Global Wave Observation Network, OceanObs 09, in print.

Thomas, J., E. Terrill, R. Guza, and W. O'Reilly, Long Beach/Los Angeles Harbor IOOS Demonstration Project, Regional Integrated Ocean Observing System, CFDA 11.473 Coastal Services Center, NOAA, 2007.

LIBE WASHBURN

Professor, Department of Geography and Institute for Computational Earth Systems Science, University of California, Santa Barbara, CA, 805-893-7367, washburn@icess.ucsb.edu

Education

Ph.D. Engineering Science, University of California, San Diego, 1982
M.S. Engineering Science, University of California, San Diego, 1978
B.S. Mechanical Engineering, University of Arizona, 1974

Appointments

Professor, Department of Geography, UCSB, 1998-present
Associate Professor, Department of Geography, UCSB, 1993-1998
Assistant Professor, Department of Geography, UCSB, 1991-1993
Research Assistant Professor of Physical Oceanography, Center for Earth Sciences, USC, Los Angeles, 1985-1990
Postgraduate Research Oceanographer, Scripps Institution of Oceanography, 1982-1985
Research Assistant and Teaching Assistant, Dept. of Applied Mechanics and Engineering Sciences, UCSD, 1977-1982
Aeroballistics Engineer, General Dynamics, Convair Division, San Diego, CA, 1975-1977

Selected Publications

Melton, C., L. Washburn, and C. Gotschalk, 2009, Wind relaxations and poleward flow events in a coastal upwelling system on the central California coast, in press, J. Geophys. Oceans.

Ohlmann, C., P. White, L. Washburn, E. Terrill, B.M. Emery, and M. Otero, 2007, Interpretation of coastal HF radar derived surface currents with high resolution drifter data, J. of Atmospheric and Oceanic Tech., 24, 4, 666–680.

Cudaback, C., L. Washburn, and E.P. Dever, 2005, Inner-shelf circulation near Pt. Conception California, 110, C10007, doi:10.1029/2004JC002608.

Bassin, C.J., L. Washburn, M.A. Brzezinski, and E.E. McPhee-Shaw, 2005, Sub-mesoscale coastal eddies observed by high frequency radar: A new mechanism for delivering nutrients to kelp forests in the Southern California Bight, Geophys. Res. Let., 32, L12604, doi:10.1029/2005GL023017.

Beckenbach, E.H., and L. Washburn 2004, "Low frequency waves in the Santa Barbara Channel observed by high frequency radar", J. Geophys. Res., 109, doi:10.1029/2003JC00199.

FY 2010 Integrated Ocean Observing System Implementation
Southern California Coastal Ocean Observing System (SCCOOS)

Responses to National Environmental Policy Act (NEPA) Questions

Question C1. Is the proposed activity going to be conducted in partnership with NOAA or would the proposed activity require NOAA's direct involvement, activity, or oversight? If yes, describe NOAA's involvement, activity, or oversight, including the name of the office or program that is involved.

NOAA representatives from the offices of the Coastal Services Center, National Marine Sanctuaries, National Weather Service, Sea Grant, Southwest Fisheries Science Center, and Tijuana River National Estuarine Research Reserve participate in the SCCOOS and CeNCOOS Joint Strategic Advisory Committee.

Question C2. Would the proposed activity involve any other federal agency(ies) partnership, direct involvement, activity, or oversight? If yes, provide the name(s) of the agency(ies) and describe its involvement, activity, or oversight.

The proposed activity would involve the participation of federal agencies on the SCCOOS and CeNCOOS Joint Strategic Advisory Committee including U.S. Army Corps of Engineers, U.S. Coast Guard, U.S. Geological Survey and U.S. Minerals Management Service.

Question D1. Provide a brief description of the location of the proposed activity.

The proposed activity is located in the Southern California Coastal Ocean region. The Categorical Exclusion for the Southern California Coastal Ocean Observing System (SCCOOS) Project is available upon request.

Question E1. List any federal, state, or local permits, authorizations, or waivers that would be required to complete the proposed activity. Provide the date the permit, authorization, or waiver was obtained or will be obtained. Provide copies of the permit, authorization, or waiver as appropriate. Was a NEPA analysis prepared for the permit, authorization, or waiver? If yes, state the title of the NEPA analysis and provide copies of the NEPA analysis. NO.

Question F1. Is there the potential for the proposed activity to cause changes that would be different from normal ambient conditions (e.g., temperature, light, turbidity, noise, other human activity levels, etc.)? If yes, describe the changes and the circumstances that would cause these changes. NO.

UCSD 20100696

SCCOOS OBSERVATIONS MAP