TITLE PAGE (PROPOSAL COVER SHEET)

Proposal submitted to the Integrated Ocean Observing System Program, National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA), Department of Commerce, through the National Oceanographic Partnership Program (NOPP)

Pursuant to FY2011 Implementation of the U.S. Integrated Ocean Observing System (IOOS)

Topic Area 1: Coordinated Development of Regional Coastal Ocean Observing Systems

Developing the Pacific Islands Ocean Observing System (PacIOOS)

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Funding Request: $20,000,000

2. Project Summary

a. Project Name/Title

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Mr. Davis Yogi, Administrator, Hawaii Department of Transportation—Harbors Division
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e. Brief Project Summary including objectives and intended benefits

The School of Ocean and Earth Science and Technology at the University of Hawaii at Manoa, in collaboration with the Pacific Islands Ocean Observing System (PacIOOS) Governing Council and partners at non-governmental organizations, and local, state, territorial, and federal agencies, proposes to continue development of the Pacific Islands Ocean Observing System (PacIOOS). PacIOOS is the Pacific Islands regional partner in the 11-region U.S. IOOS Program and is engaged in observing system development as called for in the President's National Policy for the Stewardship of the Oceans, Coasts, and Great Lakes. Observing system planning and development was initiated in 2007 through the Hawaii Ocean Observing System (HiOOS) as a pilot program for the PacIOOS region. The goal of the proposed work is to maintain the existing capacity developed in Hawaii and elsewhere in the U.S. Insular Pacific through the initial stage of PacIOOS implementation and to continue to enhance the operational ocean monitoring and forecasting system to provide integrated, customized, and timely ocean information, data products, and marine spatial planning tools that meet defined user needs. Initial development of PacIOOS, through the HiOOS pilot project, has focused on four thematic areas: *Coastal Ocean-State and Forecasting, Coastal Hazards and Resiliency, Water Quality Sensing, and Marine Ecosystem Information and Monitoring.* PacIOOS presently serves data, information, and products through a dynamic web interface to stakeholders in each of these thematic areas (www.pacioos.org and www.hioos.org) and has developed a novel spatial-data viewer to visualize information for marine spatial planning (http://www.soest.hawaii.edu/hioos/map/). Integration of the two existing web portals has begun and will be finalized under www.pacioos.org late in 2010. The work proposed herein will continue to strengthen and integrate Federal and non-Federal observing assets within the PacIOOS region with other regional associations into the national system. An iterative, participatory process of engagement, outreach, and extension of PacIOOS capacity and data products has led to clearly defined stakeholder needs for additional customized and integrated data and information products in both Hawaii and the Insular Pacific region. To that end, PacIOOS proposes to continue to develop the observational, modeling, data management, and outreach components of the observing system to generate products that help ensure a safe, clean, and productive ocean and resilient coastal zone for the U.S. Pacific Islands.

f. Partners

Partners of PacIOOS listed below have been instrumental in the initial development of ocean observing capacity in the Pacific Islands region and have provided resources and funds for component systems, contributed data and/or products, maintained and managed observing instrumentation, assisted in planning or served on the PacIOOS Governing Council (whose Members and Delegates are shown in bold).

Federal: NOAA (**Pacific Islands Fisheries Science Center—Coral Reef Ecosystem Division**, IDEA Center, National Data Buoy Center, National Weather Service, Pacific Marine Environmental Lab, CO-OPS, Pacific Services Center, National Marine Sanctuary Program, Pacific Islands Benthic Habitat Mapping Center, Coastal Storms Program), **US Army Corps of Engineers**, US Coast Guard, US Navy (Oceanographic Office, Joint Typhoon Warning Center, Naval Maritime Forecast Center, Office of Naval Research), US Geological Survey, Environmental Protection Agency 9th District, Department of Homeland Security (National Center for Island, Maritime, and Extreme Environment Security (CIMES), Federal Emergency Management Agency), **Western Pacific Regional Fishery Management Council,** National Park Service, National Science Foundation, US Department of Agriculture

State: Department of Land and Natural Resources, Department of Health, Ocean Resources Management Plan (Office of Planning), **Department of Transportation – Harbors**, Hawaii Community Development Authority, Hawai'i State Civil Defense, Pacific Disaster Center, **Marine and Coastal Zone Advocacy Council, State Office of Planning—Coastal Zone Management Program**, University of

Hawai'i (**SOEST**, Hawai'i Institute of Marine Biology, Joint Institute for Marine and Atmospheric Research, Infrasound Laboratory, UH Sea Level Center, International Pacific Research Center, EPSCoR, Hawaii Mapping Research Group, UH Sea Grant College Program, Pacific Aquaculture and Coastal Resources Center, Waikiki Aquarium),

Territorial: **American Samoa Environmental Protection Agency**, American Samoa Community College, American Samoa Department of Marine and Wildlife Resources, American Samoa Department of Commerce, American Samoa Coral Reef Task Force, University of Guam, Guam Bureau of Planning and Statistics**, Office of the Governor of the Commonwealth of the Northern Mariana Islands**, CNMI Coastal Resources Management Office, CNMI Department of Environmental Quality

International: **College of the Marshall Islands**, Marshall Islands Department of Justice, Marshall Islands Sea Patrol, Marshall Islands Coastal Management Advisory Council, **College of Micronesia**, **Palau International Coral Reef Center,** Palau Automated Land and Resource Information System

Local: County of Hawai'i (Office of Planning), County of Maui (Office of Planning, Office of the Mayor), City and County of Honolulu (Board of Water Supply, Department of Environmental Services, Ocean Safety Division), County of Kauai (Office of Planning, Ocean Safety Division)

NGO: Alliance for Coastal Technologies, Conservation Society of Pohnpei, **Hawaii Harbor's User's Group**, Marine and Environmental Research Institute of Pohnpei, Mariana Islands Nature Alliance (MINA), Pacific Marine Resources Institute (PMRI), Yap Community Development Program

Private: Atlantis Adventures, Guam Fisherman's Cooperative, Hilton Hawaiian Village, Honolulu Yacht Club, **Liquid Robotics Inc., Outrigger Hotels and Resorts,** Sea Engineering, Sheraton Waikiki Hotel, Waikiki Yacht Club

3. Project Description

a. Background

The distinctive beauty of the Pacific Islands reflects the unique setting of our land, ocean, tropical climate, and biological diversity. The Pacific Islands region covers a vast area of the globe—spanning six time zones across the Pacific Ocean; the region is bisected by the International Date Line, straddles all four hemispheres, is distributed over a surface area of nearly 35 million km^2 and includes 2,500 km of coastlines and over 2,300 individual islands. The Exclusive Economic Zone (EEZ) of the Pacific Island jurisdictions covers an area larger than the other ten regions of U.S. IOOS combined and Hawaii alone constitutes nearly $1/5^{th}$ of the total U.S. EEZ. The Pacific Islands are uniquely an ocean region; over 99% of the surface area is ocean. The vast majority of the land lies within 10 km of the shoreline and all the land in the region is within the coastal zone.

Each of the island constituents of the PacIOOS region is distinct in terms of their respective governments, languages, legal systems, geography, cultural norms, societal structure, economies, and infrastructural development needs. The extreme geographic extent and remoteness of most island locations, coupled with a variety of local and federal governance and economic realities, present both significant opportunities and challenges for the growth of regional programs. Human activity is tightly coupled to the marine ecosystem—we are the top predators, introduce nutrients and pollutants, redistribute sediments, alter environmental links between land and sea, impinge upon the natural biological order of the ecosystem and, in the process, increasingly expose ourselves, our visitors and our endemic biota to natural and anthropogenic hazards, ecological depletion, and environmental stress.

The Federal government has played a significant role in the Pacific since the end of World War II. As the islands and their economies are each considerably more isolated than continental cities of comparable size and population, Federal resources have been needed to create and sustain infrastructure that, in other regions, might be supported by state, county, or city governments. The Federal government also plays an important role in region-wide coordination in large part associated with military facilities and activities, weather services, fisheries and coastal zone management. As we continue to integrate coastal ocean information with ocean observing capabilities into a system that serves end users, we confront resource limitations that face other regions, as well as the special dependence on Federal resources uniquely endemic to the Pacific Islands.

Present situation

Regional Coastal Ocean Observing System

Coastal ocean observing system development within the PacIOOS region was *initiated* in 2007 with a cooperative agreement between SOEST and NOAA to establish the Hawaii Ocean Observing System (HiOOS). Given the prohibitive cost associated with developing an observing system over *an area four times larger than the continental United States*, HiOOS was instead designed as a demonstration project within the larger PacIOOS region that could be jump-started by leveraging substantial SOEST capacity and partner assets/funding. Its development as part of the national IOOS network of regional coastal ocean observing systems was undertaken with the intent, following the initial demonstration phase, of transferring technology, expertise, and best practices, with adequate Federal support, to other archipelagos in the PacIOOS region.

The initial focus of the Hawaiian effort, similar to the current focus of the national IOOS program, has been on the provision of operational products to the public, private sector, and agencies to ensure for a safe, clean, productive ocean and resilient coastal zone for all. Early scoping meetings with multiple agency personnel, followed by sustained, iterative, participatory stakeholder engagement, led PacIOOS to implement regional modeling, sensor deployment, and data integration in four key product areas: *Coastal Ocean-State and Forecasting, Coastal Hazards and Resiliency, Water Quality Sensing, and Marine Ecosystem Information and Monitoring.* New sensors were deployed primarily along the south shore of Oahu, the regional center of population, commerce and tourism, with additional water quality sensors being deployed in each of the PacIOOS insular jurisdictions outside Hawaii (Appendix 1, Table 1).

The initial observing efforts of PacIOOS were possible due to significant leveraging of existing (non-IOOS) ocean observing assets within the Pacific Islands Region (Appendix 1, Figure 1) including: the cabled Kilo Nalu Observatory (NSF/ONR), the CRIMP-CO2 system in Kaneohe Bay (NOAA/Sea Grant and PMEL), the Hawai'i Ocean Time Series (NSF), Coral Reef Ecosystem Integrated Observing System — CREIOS (NOAA-PIFSC), NOAA CO-OPS, the UH Sea Level Center (NOAA-JIMAR), CDIP, NOAA-NWS, the Ocean Tracking Network, and various county and state agencies (especially for water quality and fish tag monitoring at aggregation devices).

Annual funding at a level 40% less than the amount proposed limited the development of the PacIOOS pilot project as initially designed. However, substantial fiscal contributions by the University of Hawaii, the State of Hawaii, SOEST, the City and County of Honolulu, the DHS Center for Island, Maritime, and Extreme Environment Security (CIMES), the Joint Institute for Marine and Atmospheric Research (JIMAR), the UH Sea Grant College Program, and in-kind contributions by numerous PacIOOS partners have allowed for the successful demonstration of an end-to-end observing system pilot project that has achieved initial success in each of the aforementioned four key product areas. Work proposed herein builds upon these initial successes and leveraged systems towards a vision of a comprehensive end-to-end ocean observing system for the whole of the Pacific Islands region.

Regional Association

Planning for PacIOOS Regional Association (RA) development began in 2005 with funding from NOAA's Coastal Services Center to the East-West Center (EWC). Upon the initialization of observing infrastructure development by SOEST in 2007, program staff and management at the EWC requested that SOEST take the lead for the PacIOOS RA cooperative agreement. The EWC-to-SOEST transition for PacIOOS planning and management was completed in Q4 of 2007. SOEST entered into a cooperative agreement with NOAA in 2008 to formalize a framework for collaborative governance and establish the PacIOOS Regional Association. The establishment of collaborative governance over the whole of the PacIOOS region, given the geographic expanse, diversity of cultures, modes of government, distribution of populations, and disparities in economic development is a daunting challenge unequaled in existing regional governance systems within U.S. IOOS. PacIOOS program partners, regional stakeholders, existing regional organizations, international collaborative bodies, the NOAA regional collaboration team, and PacIOOS regional liaisons were engaged to propose and review prospective governance modes for the PacIOOS RA. After a thorough review of existing regional and international governance mechanisms, SOEST proposed a PacIOOS governing framework in 2009. This was formalized in a Memorandum of Agreement that was executed by partners in the regional stakeholder community in 2010. Execution of the MOA by partners created a PacIOOS Governing Council charged with oversight, guidance, and support of the Regional Association, formalized the organization of the system under a PacIOOS Council Chair (Dr. Brian Taylor) and Director (Mr. Chris E. Ostrander), and provided a framework for continued collaboration on the execution, management, and design of the PacIOOS RA and RCOOS.

Stakeholder engagement

Broad, consistent interaction through an iterative, participatory process involving scientists, educators, recreational and commercial communities (tourists, divers, fisherman, mariners), resource managers, government officials, and other decision makers in the public and private sector has been a key focus of PacIOOS stakeholder and partner engagement during the initial phase of system development. The purpose of this engagement has centered on five key focus areas: (1) evaluation of potential modes of system governance, (2) discovery of existing observations and data to include in the PacIOOS data management and product development system, (3) assessment and documentation of local and regional ocean observing information, product and service requirements, (4) evaluation of observations, data, and products produced by the system and (5) prioritization of effort and analysis of options for future PacIOOS development activities. Liaisons hired through partner institutions in each of the jurisdictions that comprise the Pacific Islands region facilitate this end-to-end linkage of stakeholders to the program planning process and work consistently to identify new partners and stakeholders and bring them into the engagement process. Due to the geographic breadth of the region, remoteness of some island locations, and the diversity of stakeholder groups, multiple means of engagement have been employed to ensure consistent input from stakeholders including: multiple focused workshops in each of the jurisdictions, face-to-face meetings, written assessments, engagement of existing regional collaborative groups, review of existing regional reports, online surveys and, where appropriate, the establishment of local PacIOOS stakeholder councils. Input received and reviewed through this iterative, multi-year process has been used to formalize and establish the aforementioned Governing Council as well as prioritize the deployment (location, timing, and focus) of observing assets, the development of products, the engagement of users through education, outreach, and extension, and the system development proposed herein.

Prioritization of Effort

Observing system development through Hawaii and the Insular Pacific has been limited by an annual lack of sufficient financial resources within the U.S. IOOS Program to sustain and expand operations over the whole of the PacIOOS geographic domain. In light of this persistent financial constraint on system development, the U.S. IOOS Program Office recommended in 2010 a two-tiered prioritization of effort for future IOOS- funded activities (Appendix 2). As requested by U.S. IOOS, the principal focus of this proposal is on the State of Hawaii, the Commonwealth of the Northern Mariana Islands, and the Territories of Guam and American Samoa, following the established prioritization. Also, as encouraged by the IOOS Program Office, we have included in this proposal continued support for personnel, existing observing system assets, and data development efforts presently engaged in the Freely Associated States in the Pacific (the Republic of Palau, the Republic of the Marshall Islands, Federated States of Micronesia) and the U.S. Minor Outlying Islands (Howland, Baker, Johnston, Kingman, Jarvis, Wake, Palmyra, Midway) that comprise the second priority area.

b. Goals and Objectives

The primary goal of the proposed work is to continue the development of an operational ocean monitoring and forecasting system that provides integrated, customized, and timely products that enable an ocean-literate and well-informed public and policy makers. PacIOOS has focused initial development on water quality sensing, ocean-state and forecasting, the provision of marine ecosystem information, prediction of coastal hazards, and the development of integrated data visualization capabilities to inform marine spatial planning, operations, commerce, and recreation. Through this proposed effort, PacIOOS will enhance development of observing and product suites in each of the aforementioned focus areas and will continue to engage users, stakeholders, and system partners in the use, extension, education, and outreach of technical capacity, data visualization, and ocean information.

Specific objectives towards this goal are detailed in the Work Plan (Section 3.d.) with further detail, including objectives to be completed in each year of the proposed work, included in the Milestones (Appendix 3) and the detailed budget narrative (Appendix 5).

c. Audience and Benefits

With initial PacIOOS funding, a wide-range of user groups have been identified and actively engaged to help define, and refine, PacIOOS. This engagement has been wide-reaching, both geographically as well as programmatically, including many levels of Federal, State and local/regional government, the ocean recreation and commerce (fisheries, transportation, offshore energy) sectors, the hotel and tourism industry, nongovernmental organizations, the media, as well as residents and visitors to the State of Hawaii, Territories, Nations, and unincorporated possessions that comprise the domain of the PacIOOS RA. Despite the inherent diversity among these groups and their wide range of interests, our interactions with them indicate some commonalities for ocean-related data products. This audience is asking for increasingly focused, innovative, and accurate products upon which to base decision-making, policy, safety, and future cultural and community planning.

Focus groups established to evaluate existing PacIOOS products and data distribution mechanisms have identified delivery of information via web-based, dynamic and frequently updated map-oriented products as the principle means of providing ocean users with an improved basis for decision-making and planning. The work proposed herein will continue to distribute information and services via the PacIOOS web portal (www.pacioos.org) guided by iterative, regular engagement with focus groups to evaluate and recommend improvements to web tools, services, and visualizations. While the majority of users request that data be processed and included in map-oriented product displays, access to raw data sets and providing the audience with the ability to manipulate data for customized user needs is, and will continue to be, an important part of the PacIOOS data management and distribution system. PacIOOS currently operates a variety of tools for data discovery (LAS, Dchart, ERDDAP) and access (OPeNDAP, SOS, WMS/FS/CS) that benefit from existing knowledge or targeted training to use to their full capacity. PacIOOS has initiated training workshops for data users covering the full range of data services and will continue to provide training on product and data discovery, access, and visualization (GIS and web) in concert with annual stakeholder meetings convened in each PacIOOS jurisdiction.

Given the strong presence of the ocean in all aspects of life in the Pacific Islands, the need for a better understanding of the ocean environment is pervasive. Lifeguards and safety officials identify drowning as the #1 preventable cause of death among visitors and residents of our islands. Working with those safety officials we have developed and operate the first beach safety forecasting website in the country (and indeed, the world) and propose to continue serving real- and near real-time coastal ocean conditions for beaches and shorelines region-wide.

The U.S. Coast Guard, territorial emergency responders, and maritime rescue agencies in Hawaii, the Territories, and the U.S.-affiliated nations of the Pacific request real-time, accurate, and highly resolved information on coastal currents, waves, and offshore conditions for effective search-and-rescue (SAR) operations. We have developed operational models, deployed HF radars, wave buoys, gliders, and drifters in the Hawaiian Islands and propose to expand that development to meet ever-growing user demand for real-time ocean information and forecasts in other areas of the PacIOOS region.

Developers, planners, and coastal zone management departments cite coastal erosion, sea-level rise, and the lack of data to define appropriate setbacks and planning benchmarks as major challenges. We presently operate coastal cameras and conduct T-LIDAR surveys at two locations and propose to expand that capacity to eight additional locations. That additional capacity, coupled with our existing high water level forecasting system, will allow for inundation forecasting, accurate sea-level rise projections, and increased information on the effect of coastal erosion region-wide.

National Marine Sanctuary, National Monument, and Marine Protected Area managers, water quality personnel and environmental groups identify sewage spills, sediment plumes, reef dredging, upland deforestation, and industrial pollution as major threats to coastal ecosystems. They ask for real-time monitoring of water quality parameters and knowledge of the fate of spills, plumes, and discharge in the coastal waters. We have developed map-based visualizations of water quality parameters for coastal Waikiki and propose to expand that capability region-wide in concert with the deployment of new sensor platforms through focused partnerships with local community groups. This enhanced spatial network of water quality sensors, coupled with expanded numerical modeling capability, will allow for near real-time predictions of plume dispersal, particle trajectory, and water quality in priority coastal areas.

Island communities, industry, and transportation officials point to maritime commerce as providing a critical lifeline for food, material goods, and transportation within the Pacific Islands and to North America, Australia, and East Asia. The seaways are our interstate highways and railways. Harbormasters, recreational and commercial boat owners, and government maritime agencies desire accurate measurements and predictions of the state of the coastal and open ocean and of seiche amplitude in their harbors forced by wind, high swell, storm surge, and tsunamis. The PacIOOS website presently serves model and observational data on open and coastal ocean conditions from around the Pacific region. Expanded observations and model domains proposed herein will grow existing web-based visualization capacity in both resolution and spatial area. Harbor monitoring systems currently in place in Barber's Point Harbor will be expanded through this proposal to three other priority harbors in Hawaii (Haleiwa, Hilo, and Kahului) to provide needed information to mariners, harbormasters, and contractors currently engaged in the $618 million Hawaii Harbor Modernization Program.

As the regional population grows so too does the inevitable conflict and competition for limited ocean resources. Planners, resource managers, policy makers, and the public are increasingly asking for centralized data portals that provide integrated visualization of marine and coastal information from which to base commercial, planning, policy and conservation decisions. We have been approached by a variety of state and local agencies who request help in making their data more easily available and accessible and have worked with them to integrate their data into our information management system. We have developed and deployed a data viewer for the Hawaiian Islands and are in the process of finalizing an integrated data viewer for the rest of the Pacific Islands region. Through the work proposed herein we will continue to populate those viewers with real-time, archived, and spatial data sets that inform industry, managers, policy makers, and the public and improve access to marine data for integrated planning, management, commerce, and conservation.

d. Work Plan

Work proposed for the 2011-2016 phase of PacIOOS development is presented below and organized by PacIOOS thematic areas of effort. Numerical modeling, data management (and MSP visualization), education/outreach, and project management—components which are tied to each of the PacIOOS thematic areas, are presented individually. Costs and details associated with equipment, supplies, travel, personnel, contractual commitments, fringe benefits, and partner responsibilities are presented in the detailed budget narrative (Appendix 5)

Water Quality

Automated sensing of coastal water quality parameters has been identified as a high-priority focus within each of the PacIOOS jurisdictions. In order to assess accurately water quality we have deployed an observational network of cabled platforms, autonomous underwater vehicles, and coastal moorings in the nearshore waters of Hawaii and nearshore sensors in each of the jurisdictions within PacIOOS. Our top priority in the coming funding cycle is to maintain the existing water quality network and to merge PacIOOS data streams and those coming from leveraged sources with modeling output and HF radio observations in order to generate a suite of real-time map-based visualizations showing water quality indices related to water clarity, salinity, temperature, and biological activity. An initial map-based visualization (http://www.soest.hawaii.edu/hioos/data_product/WQ/) for Waikiki will be used as a template for regional expansion.

The Kilo Nalu Observatory is a cabled coastal ocean observatory situated within the Waikiki geographic focus area that has been in operation since 2004. Kilo Nalu serves as both a power and communications hub for some of the PacIOOS water quality, coastal hazards, and ocean-state and forecast platforms and, at a minimum, support is requested to maintain this essential capacity.

PacIOOS currently operates an array of eleven nearshore sensor packages—nine measure light attenuation (turbidity), temperature, salinity, and fluorescence, while two monitor only salinity and temperature. These nearshore sensor packages are a core component of both our water quality network as well as our extension effort to build technical capacity in the region (Figure 1). Working with our PacIOOS liaisons and local partners we have installed one of these sensor packages in each of the PacIOOS jurisdictions. In addition to this nearshore sensor network PacIOOS operates two CO_2 and water quality buoys in cooperation with NOAA's Pacific Marine Environmental Lab (PMEL). These systems are core components of the global CO_2 monitoring network and provide a coastal, shallow-water signal of climate variability. In addition to the variables measured by the nearshore sensor packages, these buoys measure barometric pressure, relative humidity, dissolved oxygen and CO_2 in both the atmosphere and ocean surface water and dissolved nitrate, an important nutrient element and frequent land and human derived contaminant. At a minimum, we request funds to maintain these existing nearshore and CO_2 climate buoy arrays—additional funds requested will be used to upgrade two existing nearshore sensor packages to also measure light attenuation and fluorescence.

The University of Hawaii at Hilo currently operates a real-time buoy in Hilo Bay (YSI EMM 68 buoy) and funds are requested to provide for annual operation and maintenance of this system. The buoy provides Hilo Bay users with measurements of biological activity, light attenuation, dissolved oxygen, phycoerythrin, salinity, temperature, pH, PAR, and nitrate. Hilo Bay is heavily influenced by surface runoff and ground water discharge and is a major center of commercial and recreational maritime activity. In addition to the Hilo Bay buoy, co-PI Adolf will install, through EPSCoR funding, two real-time Satlantic water quality buoys off the Kona coast of Hawaii Islands in 2011. Funds to maintain these systems will be provided at no cost to this effort; however, data from those instruments will be processed by the PacIOOS data management system and served via the PacIOOS website.

Should funding be available, we request additional resources to expand our water quality monitoring effort through: 1) regular and event response-driven autonomous underwater vehicle surveys (AUV) and, 2) the deployment of additional water quality sensors in each PacIOOS jurisdiction. Monthly, 1-day AUV surveys along the south shore of Oahu will allow for a better understanding of the spatial dynamics of water properties in the Waikiki area and allow for increased resolution of map-based spatial data products related to coastal water quality. Additional response-driven surveys will allow PacIOOS to better characterize water quality variability following extreme events (sewage spill, storm discharge).

In consultation with the Alliance for Coastal Technologies (ACT), PacIOOS has identified a variety of options for affordable sensor platforms that provide for basic measurement and telemetry of temperature, pressure, salinity, and turbidity data. We propose to expand significantly the geographic domain of the PacIOOS water quality network through the purchase and deployment of 35 ACT-PacIOOS identified sensor packages. We request funds for the purchase, deployment, telemetry, and annual calibration of these new sensors. In order to ensure deployment of these new sensors in priority locations and to maximize user involvement in their deployment, operation, and maintenance we propose to partner with established community conservation groups (such as: Malama Maunalua, Surfrider Foundation, Pacific Marine Resources Institute of Saipan) to identify sites, deploy sensors, and perform regular maintenance of the systems. We request funds to support a technician within the PacIOOS water quality group to work with ACT personnel to train community group members and volunteers on the proper operation and maintenance of these sensors as well as travel funds to deploy and service sensor systems annually. We view this community-based observational network as a novel means to generate local ownership and interest in PacIOOS observations, ensure the successful extension of technology and capacity region-wide, and provide affordable, end-to-end development of observations and public information products in priority areas of the PacIOOS jurisdictions.

Coastal Hazards and Resiliency

The coastal margins of the Pacific Islands are vulnerable to both long-term and episodic changes in coastal water levels and accurate forecasting of these changes has been identified as a common priority among all PacIOOS jurisdictions. Observing systems are in place to assess sea-level rise and interannual to decadal sea level variations for the region; however, the immediate local need is for predictions of short-term, high water level events. The combination of spring tides with seasonal swell events leads to the regular over-topping of coastal roads, flooding of storm drains, and inundation of low-lying beaches and coastal margins. The addition of positive water level anomalies associated with mesoscale eddies and other ocean circulation features can exacerbate the impacts of these events, and the frequency and severity of inundation will only increase with rising sea levels.

During the initial development of the PacIOOS project, we have focused on developing the data streams (water level, swell, wave set-up, atmospheric pressure) needed to specify all components of high water level events. Using these data sources, we have developed an empirical model for high water level based on incident wave and water level conditions. Our observational and model data streams have been combined into a nowcast and up to 6-day forecast product of extreme swash/water level events at eight locations (see the "High Sea Level – Inundation Hazards" topic on the HiOOS Coastal Hazards page: www.soest.hawaii.edu/hioos/hazards.php). At a minimum, we request funding to maintain the observational components (wave buoys, tide gauges, pressure sensors) and modeling components (forecast wave heights) that go into the high-water level product and to use existing personnel to continue to refine the water level prediction tool. The present network of PacIOOS near-shore sea-state instrumentation and wave buoys (in partnership with CDIP) requires ongoing maintenance to remain in operation.

To improve the accuracy of high water level forecasts by providing estimates of horizontal run-up, we have deployed an observational network of digital cameras and tripod scanning LIDAR (T-LIDAR) at two focus sites on Oahu (Waikiki, Waimea). The camera and T-LIDAR datasets can be combined to map the elevation of the run-up line along the beach during a range of wave and water level conditions. Previous limitations in program funding have prevented our development of such an inundation forecast and we request funds to develop that inundation-forecasting capability at the two sites listed above. At a minimum, personnel are needed to continue the camera datasets, which provide real-time run-up observations that are posted on the PacIOOS website, as well as the time series needed to validate and improve the inundation nowcast/forecast product.

To build capacity for inundation prediction outside of Hawaii, we plan to extend the camera (2012-2014) and T-LIDAR (2011-2016) survey locations to provide estimates of variable beach state (erosion/accretion phases) as a function of incident wave forcing and water level conditions at eight locations in both the Hawaiian Islands and the Insular Pacific. Funding is also sought for personnel to quality assess the components that go into the inundation product, and to quantify the empirical inundation model skill versus prediction time, which will be added to the on-line inundation product. In addition to providing necessary measurement of wave run-up, the existing and proposed network of PacIOOS coastal cameras provides real-time visualization of the coastal zone and has been identified as a valuable tool by emergency responders, disaster and resource managers.

Finally, our extremely successful Hawaii Beach Safety site has been transitioned to the PacIOOS server, is being integrated into the PacIOOS webpage, and is being maintained with partner funding (http://oceansafety.soest.hawaii.edu/).

Coastal Ocean-State and Forecasting

Commonly identified as a region with a small terrestrial area, the Pacific Islands most accurately are depicted as a large-ocean region. The ocean is the primary pathway for the transport of fuel, food, manufactured goods and raw materials to, from and between the islands and provides the backbone for the commercial and recreational maritime economy. The ocean is the regional inter- and intra-state highway and railway system with every shipping route to and between the islands using one of 6 primary ports on Oahu (Honolulu Harbor, Barber's Point Harbor, Pearl Harbor), Guam (Apra Harbor), American Samoa (Pago Pago Harbor) and Saipan (Saipan Harbor).

Essential to the efficiency, safety, and timeliness of transit in the marine environment is reliable information on the state of the ocean as well as timely and accurate forecasts on future conditions. Generally, stakeholders have identified this ocean-state information as the highest priority for observing system development and, along with modeling, is the principle thematic focus of our proposed system expansion. PacIOOS currently operates the initial components of an observational network of high-frequency radios (HFRs), ocean gliders, wave buoys, coastal ocean and harbor moorings, and numerical models in order to produce the most accurate information possible. This information is served in real- and near-real time via the PacIOOS website. Funds requested herein are dedicated to maintaining existing regional capacity for ocean-state observations and forecasting and expanding PacIOOS capacity to additional geographic priority areas.

PacIOOS presently operates three high-frequency Doppler radio systems along the southern shore of Oahu with a fourth to be installed along the western shore of Oahu in early 2011. HFR allows for real-time imaging of coastal currents and wave spectra over a large spatial area extending 100km from shore. The data derived from HFR observations are processed in real-time, yielding derived data products (currents, wind direction, wave spectra) made available on the PacIOOS website and are assimilated into the numerical models. At a minimum, PacIOOS requests funds to maintain the four existing HFR systems and add one new location at Barber's Point on the southwest corner of Oahu in FY11. Barber's Point is a major commercial harbor for the state and offshore resides the only oil lightering facility in Hawaii. With large vessel and tanker groundings occurring on average every 18 months, accurate imaging of currents and waves is essential to ensure safe transfer of oil to shore stations and improve the safety of operations of large vessels in the coastal environment. Deployment of this new HFR at Barber's Point will be done in concert with the Hawaii Department of Transportation—Harbors Division, a PacIOOS partner and landowner of the deployment site. PacIOOS requests additional funds in each additional year to deploy one WERA type HFR per year at locations designated in the U.S. National Surface Current Mapping Plan. Surface current mapping through the use of HFR, while a high priority for search-and-rescue, pollution tracking, and interisland shipping in the Hawaiian Islands, has not been expressed as a high priority in the Insular Pacific. That prioritization, coupled with the significant cost of system expansion over a large geographic area has led to the proposed use of these additional HFR systems to augment the existing Hawaii-based array and allow for real-time spatial coverage of the island of Oahu as well as coastal areas of Molokai, Lanai, and Maui.

Collaborating with PacIOOS, the U.S. Army Corps of Engineers, and local partners, the Coastal Data Information Program (CDIP) has deployed a fleet of 5 Datawell directional wave buoys in the waters surrounding Hawaii (Waimea Bay, Mokapu, and Lanai), Guam, and the Marshall Islands (Majuro). These buoys provide critical wave information for recreational and commercial mariners in coastal waters and are essential validation points for existing and proposed regional wave models. PacIOOS, through support from partners in the region, has purchased three additional Datawell buoys and plans to deploy them offshore important harbors in the State of Hawaii (Barber's Point, Kahului, Hilo) in the coming year. While the capital costs to establish the observational network in the region were borne by PacIOOS and partners, annual support for operation and maintenance no longer exists for the buoys. We request support, at a minimum, for annual maintenance of the six buoys that will reside in the Hawaiian Islands beginning in 2011. These funds will allow for routine service and maintenance, recovery in the event of a buoy/mooring separation, and processing (telemetry, QA/QC, archiving) of the data by CDIP. These buoys are key systems in the National Operational Wave Observation Plan, a core component of PacIOOS operations and are essential for the development of coastal inundation, harbor condition, and nearshore safety products. We request additional support in each program year to maintain the two existing CDIP buoys in Majuro and Guam as they are the only real-time wave measurement stations in coastal waters of the western and central Pacific.

In the present funding cycle we have begun to address the needs of the maritime industry through a focus on shipping activities related to Barber's Point Harbor, the second most active commercial harbor in Hawaii. In consultation with harbor users and the State Department of Transportation we identified waves, water level, and currents as priority variables to measure and have deployed current meters, wave buoys, and water level stations in the harbor and entrance channel to produce an integrated picture of real-time conditions in the immediate vicinity of the harbor. At a minimum we request funds to maintain these existing systems for Barber's Point Harbor and, should funding be available, propose to expand this capability to three other harbors on Oahu, Hawaii, and Maui (Haleiwa, Hilo, Kahului) through the addition of new equipment.

With the development of an operational modeling system and, through the integration of existing data streams (PacIOOS and leveraged assets), it is now possible to expand our ocean information services beyond real-time measurements and begin providing ocean state forecast products. To accomplish this new forecasting role we request support to maintain two deep-water multi-purpose moorings off the coast of Oahu and to purchase one Liquid Robotics Wave Glider. The Wave Glider is a customizable autonomous oceanographic vehicle capable of extended open and coastal ocean deployments that supports a variety of sensor payloads measuring oceanographic and atmospheric variability. The system is powered by wave energy and uses solar panels to power integrated payloads and satellite communications. We propose to outfit the Wave Glider with CO_2 sensors for integration into our coastal CO_2 monitoring array, an acoustic doppler current profiler (ADCP) for current measurements, and subsurface sensors of temperature, salinity, dissolved oxygen, and chlorophyll. Long-term deployments of the Wave Glider will provide data over a broad spatial area for inclusion in map-based products and serve to validate and assimilate into our regional numerical models.

The two deep-water moorings, capitalized through collaboration within SOEST and manufactured by McClane Labs, consist of fixed sensors and a profiling package that traverses the full water column. Measurements include the full range of properties (T, S, DO, turbidity, chlorophyll, PAR) as well as waves and currents at multiple levels. As a primary data source, these profilers will also provide essential validation and assimilation points for the circulation models and have been sited to maximize that assimilated value to the models. As the moored profilers do not have a surface expression (for security in heavily trafficked coastal waters), we propose to integrate acoustic modems into each profiler to enable the real-time transfer of subsurface data to the WaveGlider as it passes by the mooring locations.

To build observing system and technical capacity in the Insular Pacific jurisdictions we request resources to begin the assemblage of an instrument pool consisting of current meters, wave sensors, stream flow gages, and water quality sensors that can be used by partners in each PacIOOS sub-region to conduct short-term process studies and evaluate baseline marine ecosystem properties. Understanding the coastal marine environment is essential in the development of long-term monitoring plans and the site selection of future instrument deployments. Establishing observational capacity to measure and define variability in Insular Pacific marine ecosystems by using common, shared instrumentation has been requested by a multitude of users. Personnel central to PacIOOS will manage the instrument pool and train users on deployment, maintenance, and data processing and work with users to integrate data into the PacIOOS data management system as well as produce data products for local management needs.

While the bulk of the proposed PacIOOS work in the upcoming funding cycle is focused on pre-defined user priorities and the development of customized public information products, we also request funding for annual rapid event response. These additional resources will allow for component specific (e.g. HFR, AUV, T-LIDAR) observing system response (information, products, observations) to critical events that occur in the region including tsunamis (such as Samoa/Tonga 2009), severe runoff events, oil tanker spills, typhoons/cyclones (storm surge, flooding) and search-and-rescue. The Governing Council will direct the expenditure of rapid response funds in consultation with the U.S. IOOS Program Office, PacIOOS researchers, public emergency responders, and stakeholder groups.

Marine Ecosystem Monitoring and Information

SOEST is a major partner in the Ocean Tracking Network (www.oceantrackingnetwork.org) and currently supports an array of automated acoustic receivers that span the whole of the Hawaiian archipelago, from Midway Atoll to the Island of Hawai'i. These receivers monitor the presence of fish tagged with acoustic transmitters that broadcast a unique identification code and other information (depth, water properties). This array monitors movements of ecologically important top predators, and the data collected from this system are used to estimate transfer rates between areas, describe patterns of residency and associative behavior of groups of fish, to improve estimates of the population size, and to better inform local agencies regarding public safety issues with respect to sharks. Additionally, development of 'smart-tag' technology within this array allows for the transfer of data between tagged animals away from the receivers located near the Hawaiian Islands. This technology has the potential to revolutionize the collection of subsurface water property data essential to model validation and assimilation. We request funds to maintain this novel array, to continue technology development, and to expand the integration and distribution of ecologically important data to stakeholders.

The aggregation of existing biological data from previous studies and the development of standards by which that data can be served through the data management subsystem has been a priority area of development through the initial PacIOOS funding cycle. The continuation and expansion of data integration and distribution, an essential component of our marine ecosystem monitoring and information focus area, is described in the data management and education and outreach sections.

Modeling

At present, three modeling systems (atmospheric, waves and ocean circulation) produce a comprehensive package for ocean state prediction in the main Hawaiian Islands. The atmospheric Weather Research and Forecasting (WRF) model with assimilation is used to generate daily nowcast and forecasts for the main Hawaiian Islands region as well as higher resolution runs for each island. These are provided directly to the local NWS office and are used by the wave and ocean models for forcing. Using Wave Watch III and the Simulating Waves Nearshore (SWAN) models, daily nowcast and forecasts of ocean wave conditions are produced for each of the main Hawaiian Islands as well as for the entire Pacific basin. These forecasts provide estimates of wave run-up and allow estimates of inundation for use by state and federal agencies during storm mitigation efforts. Estimates of general ocean circulation are produced using the Regional Ocean Modeling System (ROMS) in a nested configuration. Each day, nowcast and forecasts of the ocean state are generated using advanced 4D-Var data assimilation to combine the observations and the models in a dynamically consistent way such that the result should be more accurate than either component alone. The ocean circulation fields are used to generate a number of products for stakeholders including: circulation estimates and forecasts, particle (drifter, plume) trajectories, probable locations of advection for search-and-rescue, and are currently being included in the development of an optimal ship routing tool for inter-island transportation. Each modeling group also uses numerical output to produce regular climatologies of key marine and atmospheric parameters.

We propose to maintain this baseline capacity for modeling and analysis and to expand each modeling suite to cover the whole of the jurisdictions within the first PacIOOS priority geographic area (Hawaii, Guam, American Samoa, CNMI). Implementation of new modeling domains will require 1 year of development per sub-region and will be executed by personnel hired through the funding proposed herein. Upon completion of model development, existing personnel responsible for maintaining each numerical model will assume operation of each new domain. Operational modeling for PacIOOS is run on a dedicated machine at SOEST, with model development occurring through the Hawaii Open System Computing facility at the University of Hawaii. Annual user fees are requested to support model development proposed herein.

Atmospheric: We propose to expand the WRF domain with assimilation to cover the Northwest Hawaiian Islands (NWHI), Guam, American Samoa, and the CNMI and to provide daily nowcast and forecasts of atmospheric conditions. These outputs will be fed directly to the regional NWS office and sub-regional Weather Forecast Offices (WFOs). Boundary conditions for the WRF sub-regional models will be drawn from existing NCEP 30km basin-scale model output.

Waves: PacIOOS presently runs Wave Watch III for the entire Pacific Basin at 100km resolution and at 10km resolution for the main Hawaiian Islands. We propose to expand this 10km spatial resolution to the NWHI and to the Commonwealth and Territories in the western and south Pacific. For islands containing population centers in our insular jurisdictions (Guam, Tutuila, Saipan, Tinian, Rota), we propose to use the SWAN model to generate nowcast and forecasts for each island at 1km resolutions.

Ocean: ROMS is presently run for the main Hawaiian Islands at 4km resolution with a nested grid covering the southern shore of Oahu at 1km resolution. We propose to expand this 1km grid to cover the whole of the main Hawaiian Islands and propose to expand the 4km grid to cover the NWHI, Guam, CNMI, and American Samoa. Essential to the expansion of the 4km grid is a basin-scale ROMS model from which nested grids can be generated. Development of this basin-scale grid will be completed in the first year of effort. Validation of output and the provision of data for assimilation to the ocean model is an essential element of our modeling capacity in the Hawaiian Islands. For this purpose, PacIOOS presently operates an iRobot SeaGlider within the 1km Oahu ROMS grid and proposes to continue glider operations through use of capacity within the SOEST SeaGlider Operations Group. At a minimum we request 2 three-month missions per year with the ideal scenario allowing for four in the first year of proposed work, six in each of years 2 and 3, five in year 4, and four in year 5.

Data Management and Product Development

Central to the PacIOOS effort, and critical to its success, is the link between data (instruments) and information (data-synthesis products) in the data management system. The initial focus of the PacIOOS data management system has been to provide the architecture through which data from the observing network could be archived, evaluated, integrated, and transmitted to users in the form of raw data and refined products, including the development and maintenance of the PacIOOS web pages. The data management system, following the 2005 Data Management and Communication Plan for IOOS, and the 2009 PacIOOS Regional Data Management Plan provides five essential functions: 1) data archive, 2) metadata management, 3) data discovery tools, 4) data transport servers, and 5) on-line browse capabilities. More recently, IOOS has developed a guideline for implementation of DMAC subsystems within the regions. This specifies the additional task of sensor-to-database data acquisition. In this proposal, we combine this into the more broadly defined "data archive" activity. Data management activities are a critical component of the PacIOOS development effort. Maintenance of core capacity within the data management system is essential in any funding scenario and is presented first in this section. Additional support for system administration, server upgrade and replacement, and integrated biological product development is presented as a desirable add-on to existing data management core capacity.

***Data archive**:* The PacIOOS data archiving activities encompass initial data collection (at the individual sensor), to entry into a database or file system, to final archiving at NDBC. There are two main types of data steams within PacIOOS, data from active sensors (funded primarily through IOOS) and data from external sources. The first category includes near-shore sensors, gliders, HFR, water quality buoys, acoustic devices, and numerical models. The second category includes a huge variety of maps, single point measurements, databases, etc., both one-time and repeat observations, and are in various stages of maturity (e.g., ranging from hard-copy plots to complete databases with standard metadata). PacIOOS initially divided these into two distinct efforts and we propose to continue doing so. One part of the data management team is focused on maintaining the IOOS-funded data streams while another part of the team is focused on acquiring existing data in the region, including legacy data sets and continuous measurements made by PacIOOS partners. These include, for example, State Department of Health water quality measurements, NOAA and NWHI National Monument ecosystem data, USGS stream flow data, and an extensive list of data from providers region-wide. Finally, PacIOOS will continue to rely on NDBC for long-term archive, as well as providing data via the GTS, for all locally collected data (although at present PacIOOS has not identified any users who subscribe to GTS).

***Metadata management**:* PacIOOS is actively engaged in providing the most accurate metadata for all data and data services. This has allowed PacIOOS to become one of the first regional programs integrating assets into the National Data Catalog (http://ioos.gov/catalog/). Both FGDC and ISO metadata standards are used at present, and we will continue to rely on existing standards for metadata.

***Data discovery tools**:* Through the PacIOOS pilot project for Hawaii, and funds for the initial development of the PacIOOS RA, two different data discovery tools have been developed. Both are web-browser based; one (focused on the Hawaii domain) is based on GoogleMaps and allows users to geographically search for existing assets and data (www.soest.hawaii.edu/hioos/map/), while the other is

Insular Pacific focused and based on map services (GeoServer; http://128.171.104.45:8080/geoserver/www/styler/index.html). These two services were constructed as complementary, but separate services, based on input received through several meetings with stakeholders and data providers. Given the successful development of the PacIOOS RCOOS and RA, we have begun the integration of these two systems into a single system served through the PacIOOS web-portal.

***Data transport**:* PacIOOS is presently running three complimentary data servers that allow for direct, binary access to the data archive. Two are based on Data Access Protocol (DAPPER and OPeNDAP), while the third is based on the Open Geospatial Consortium (OGC) Sensor Observation Service (SOS). OPeNDAP services are handled with Thematic Real-time Environmental Distributed Data Services (THREDDS). Our implementation of THREDDS (http://oos.soest.hawaii.edu/thredds/catalog.html) provides both Web Coverage Services (WCS) and a simple Web Map Service (WMS). The SOS implementation that we have employed is based on the IOOS standard developed by the OOSTETHYS group (http://oos.soest.hawaii.edu/oostethys/). Initially PacIOOS used TDS for the gridded data (e.g., model output) and SOS for point measurements. However, we now serve both point measurements and gridded data via TDS and propose further development of a more sophisticated map server for the wider Pacific region.

***Data browse**:* The 2005 DMAC Plan specifies this component as providing users with a way to query data via web-based browsers. We interpret this more broadly to additionally include web page development and data product development (to provide users with information based on IOOS data). Web pages for PacIOOS will continue to be developed and maintained by the data management group. PacIOOS has employed three web-browsing tools: DChart (http://oos.soest.hawaii.edu/dchart/), Live Access Server (LAS; http://oos.soest.hawaii.edu/las/getUI.do) and the Environmental Research Division's Data Access Program (ERDDAP; http://oos.soest.hawaii.edu/erddap/info/index.html). All three allow for web-based data queries, sub-setting, plotting and data download. These servers access data both directly and through the PacIOOS TDS and we propose to expand the data holdings in these servers in concert with our regional liaisons and PacIOOS partners.

In addition to these five tenets of data management, product development has and will continue to be a primary focus of the data management as well as the education and outreach group. PacIOOS has recently hired a dedicated product developer within the data management system and proposes to hire an additional developer through this proposal. These product developers will work with existing focus groups, partners, regional liaisons, PacIOOS researchers, stakeholder groups, and the education and outreach staff to develop, refine, and display user-defined public information products for each of the PacIOOS observation and modeling components.

The PacIOOS effort continues to expand, and now includes several machines for data acquisition and archival. To date, the University of Hawaii/SOEST has led the effort, and all machines are owned and operated by the School. As PacIOOS continues to grow, we request additional support to upgrade and replace the existing SOEST machines and for a full-time system administrator to maintain the computing and data archive system hardware. Additionally, the system administrator will work to ensure PacIOOS standardization of data services, monitoring of server response and availability, tracking of data viewing and download, capture of web usage statistics, and will develop a service for registering data distributed through the PacIOOS data management system.

The Pacific Islands have long been a focus of research, science, and process studies by institutions around the world. The biological diversity (1/4 of all endangered species are found only in the PacIOOS region), abundance of marine and estuarine resources, temperate climate, and relative isolation have drawn incredible interest that has led to the collection of large amounts of biological and ecological data. Through this proposal, we request additional support for our outreach and data management groups to work with regional partners (Papahanaumokuakea Marine National Monument, NOAA PIFSC, U.S. OBIS, NOAA Humpback Whale National Marine Sanctuary) on the identification of past, current, and proposed biological and ecological studies within the jurisdictions that comprise PacIOOS for the purposes of not only accessing available data sets (acoustic recordings, benthic surveys, fish population surveys, habitat mapping, bathymetric mapping, time series data) but also for collaboration on studies and/or sharing of resources and funding for projects. Data and information from this effort will inform the creation of an online database that allows for area-based or project-topic searches.

PacIOOS is currently engaged with the U.S. IOOS Program Office and regional partners on the development of data standards for the integration of biological data into the IOOS data management system. This PacIOOS data standards effort will continue through FY11 and all possible data sets identified through the proposed PacIOOS discovery and aggregation initiative will be integrated into PacIOOS web-based servers using standards identified through this ongoing project.

PacIOOS will actively collaborate with the other IOOS regional associations along with Pacific Ocean coastlines (AOOS, NANOOS, CENCOOS, and SCCOOOS) over the course of the funding cycle to advance stakeholder access to cross-regional data services as defined by commonalities in specified user requirements. At a minimum and initially, PacIOOS and the other Pacific RAs propose to improve access to existing data services (products, map-based visualizations, information) through collaborative effort to establish common website linkages. Future effort will focus on the development of shared visualization services (common Application Programming Interface (APIs) and Web-Map Services (WMS)) that focus on data and products common to all regions (i.e. glider data, model nowcasts and forecasts, key climate variables and high frequency radar). These common data services will be established and maintained as a core component of our DMAC effort.

Data management lead and PacIOOS co-PI Jim Potemra has been representing PacIOOS data management activities on the IOOS Data Integration Framework (DIF) team, and will continue to participate as the DIF evolves. He is also involved in numerous other national and international data management efforts including PI-GOOS, Argo, and the Asia-Pacific Data Research Center (APDRC).

Education and Outreach

The education and outreach team (E/O Coordinator Marcie Grabowski and a part-time individual to be hired through this proposal) will continue to work with PacIOOS investigators, liaisons, and technical staff to interpret and communicate effectively complex scientific information and data to natural resource managers, researchers, educators, and the public in a clear, understandable manner. They will focus on two main areas: (1) working with the data management group, regional liaisons, and existing stakeholder focus groups to maintain and update effective data products, web-based information, and web services and, (2) increasing the impact of ongoing outreach efforts through effective PacIOOS and IOOS branding, distribution of public outreach materials (flyers, PSAs, flat panel displays, commercials, press releases, articles, web features), generation of a regular newsletter detailing PacIOOS success stories, and collaboration with existing regional and national ocean outreach initiatives.

The education and outreach team, in cooperation with the web and product developers within the data management group, have worked with focus groups to refine web content and product design and will continue that regular engagement throughout the course of the proposed project period. The feedback received in these regular meetings, coupled with annual feedback from the larger stakeholder community at regional meetings, is a critical component that will allow PacIOOS to modify and fine-tune their products in response to user input.

Interpretation of real-time data and ocean observing products is an important part of the education and outreach mission. One area of successful development during the Hawaii pilot project has focused on placing real-time data in a larger temporal and spatial context through the development of a Hawaii Ocean

Atlas (www.soest.hawaii.edu/hioos/oceanatlas/index.htm). We propose to continue the development of this Ocean Atlas for each of the jurisdictions within the Pacific Islands region, populating the Atlas through the use of existing real-time observations and data derived from historical studies and observing programs.

Many efforts have been initiated to increase awareness for PacIOOS products and activities during the initial phase of system development. Public presentations and lectures showcasing PacIOOS developed products have been a consistent part of our outreach effort to date and will continue through his proposal. We have generated a PacIOOS Newsletter and will continue that publication as part of our regular outreach effort. Partners have provided 10 high-definition flat panel machines on which to display ocean observing public information products and community-specific data visualizations and we are in the process of developing content for and negotiating the deployment of those systems in high traffic areas (Waikiki Aquarium, College of the Marshall Islands, Palau International Coral Reef Center, American Samoa Public Library, Outrigger Hotels, Waikiki and Hawaii Yacht Clubs, Pacific Marine Resources Institute of Saipan). We are collaborating with local agencies and the regional NOAA team to populate those machines with additional content complementary to PacIOOS efforts and request funds through this proposal to augment, upgrade and replace our existing machines.

As concerned residents of the Pacific Islands region, we are dedicated to the "K through Gray" education of our public so that present and successive generations may make informed choices to enhance the use and preservation of the life-sustaining resource that is our ocean. As educators at various universities throughout the region, we are also dedicated to the preparation of our primary and secondary students and education of undergraduate and graduate students. PacIOOS has been involved in the collaborative generation of primary school curriculum through the NOAA-funded Navigating Change Program and, through the part-time education and outreach specialist to be hired through this proposal, will continue to work with the NFRA E/O Committee, Navigating Change, the Hawaii Ocean Resources Management Plan advisory body, as well as the UH Sea Grant College Program on the generation of marine science and oceanography modules for use in public schools. PacIOOS provides a foundation for research experiences for both undergraduate students at the University of Guam, the 10-campus University of Hawaii system, the College of Micronesia, the College of the Marshall Islands, and the American Samoa Community College. Work proposed herein will continue to develop that research foundation as well as provide support for graduate students through the M.S. and Ph.D. degree programs at the University of Guam and the University of Hawaii.

Project Management

In order to ensure that direct project goals are achieved effectively, appropriate partnerships for system growth are pursued, and that the system continues to generate public products that are valuable and relevant to the user community, a governance framework has been created for PacIOOS through the execution of a Memorandum of Agreement with partner agencies and organizations. The Governing Council of PacIOOS (Section 2.f) provides strategic and policy guidance to the system Director (Mr. Chris Ostrander) and is involved in the management of the observing system through an Executive Committee that meets between full Council meetings. Members of the Governing Council are elected by their peers to serve two-year terms and select from their membership a Chairperson to serve as the presiding officer of the Council (currently Dr. Brian Taylor, Dean of SOEST).

To ensure broad engagement of the diverse community of stakeholders in the Insular Pacific, PacIOOS has contracted regional liaisons at partner institutions in each jurisdiction to assist with the solicitation of local information, product, and service requirements, dissemination and evaluation of ocean information and products, and coordination of local stakeholder councils. These liaisons are the local face of the PacIOOS program and work to update and refine user requirements and priorities in the time between annual stakeholder workshops and training sessions in each jurisdiction. The network of regional liaisons dedicated to the development of PacIOOS are the essential linkage between stakeholder expressed requirements and the observations, data, products, and services proposed, produced, and delivered by the PacIOOS.

The synergy realized from effective collaboration with existing regional and national ocean partnerships is a critical focus of the PacIOOS leadership. Director Ostrander serves as a member of NOAA's Pacific Islands Regional Collaboration Team, is a member of the Leadership Team for NOAA's Coastal Storms Program and works with both programs to ensure consideration and fulfillment of PacIOOS priorities within regional NOAA initiatives. Dean Taylor and Director Ostrander are both involved in Hawaii's Ocean Resource Management Plan implementation and oversight (Taylor at the executive level, Ostrander at the working group level) and both serve as the PacIOOS representatives to the National Federation of Regional Associations. Taylor also serves on the Board Executive of the Consortium for Ocean Leadership that has the NSF contract for implementing the Ocean Observing Initiative. PacIOOS is closely involved with the IOC regional ocean observing system for the Pacific, Data Management Lead (Dr. Jim Potemra) sits on the Advisory Board of the Pacific Islands Global Ocean Observing System (PI-GOOS). PacIOOS has and will continue to work closely with the Pacific Risk Management Ohana (PRiMO), the NOAA Integrated Data and Environmental Applications (IDEA) Center, the Pacific Climate Information System (PaCIS), the Pacific Islands Coastal Storms Program and the Pacific Regional Integrated Data Enterprise (PRIDE) to document stakeholder requirements, chronicle existing capacity, and ensure collaborative development of observing platforms, data servers, and public information products.

e. Milestone Schedule

A timeline for major tasks, target milestones for product development, and key project outcomes are shown in Appendix 3. Lines in blue represent observations; lines in red represent products; and lines in black represent modeling efforts.

f. Cost Proposal

See Appendix 4 (Cost Proposal) and Appendix 5 (detailed budget information)

g. References

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