

**Performance Progress Report**  
**Developing the Pacific Islands Ocean Observing System (PacIOOS)**  
**Cooperative Agreement # NA16NOS0120024**  
**Performance Period: June 1, 2018 through November 30, 2018**

**Submitted December 2018 by:**  
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This report covers activities conducted during the fifth six 6-month performance period of this award. PacIOOS' estimated operating budget for the fiscal year is \$2,659,836.

## **1.0 Progress and Accomplishments**

### **REGIONAL GOVERNANCE AND MANAGEMENT SYSTEM**

#### **Finalize Subaward for Filling the Gaps; Original completion date: November 2018**

*Status: In progress. PacIOOS did not receive NOAA approval for Subaward to MERIP for a part of our FY18 filling the gaps effort until early November 2018. PacIOOS, JIMAR, and UH ORS are completing the paperwork to set up the fiscal account for this subaward. Anticipated completion date for this is now during the spring of 2019.*

#### **Conduct 2018 Governing Council Elections; Original completion date: November 2018**

*Status: Complete. See more details below in Section 3.0.*

#### **Convene Governing Council meeting; Original completion date: November 2018**

*Status: Complete. November 2018. Members of the PacIOOS Governing Council (GC) gathered on the University of Hawai'i Mānoa campus for the annual meeting in Honolulu, HI. The U.S. Integrated Ocean Observing System Office and the IOOS Association provided overviews, and PacIOOS shared programmatic updates with meeting participants. The council also engaged in valuable discussions during breakout sessions to provide input on regional capacity building workshops, biological observations, and PacIOOS' short- and long-term priorities. While on campus, council members toured PacIOOS' labs and facilities and met co-investigators and staff. GC members from across the region represent various sectors and provide valuable feedback to help guide the future of the program.*

#### **Internal performance metrics report; Original completion date: August 2018**

*Status: Complete. October 2018. The revised performance metrics (adopted by the Governing Council Executive Committee last performance period) was utilized for this reporting period. Operational uptime was slightly below the 90% targeted metric due to various issues, including the closure and cut of power to a city facility for several months, lack of spare instruments, and challenges with maintenance in remote areas of our region. Some of this was unavoidable, but other aspects highlight a need for capacity development in parts of our region. Operational uptime and spatial coverage of PacIOOS numerical models was well above the 90% target. The*

*operational uptime of the PacIOOS website and data services was above the 99% target. The number of website sessions increased by 26% from the previous year (more details on numbers for this below). PacIOOS improved overall system effectiveness, annually, across all components, and exceeded the target to increase the number of ocean and coastal data sets available via PacIOOS. New performance measures to optimize five partner/user relationships and to secure supplemental investment in PacIOOS at 50% of the core IOOS funds were both achieved as well.*

**Additional activities for regional governance and management** that highlight regional observing system successes and occurred during this reporting period include the following:

- *PacIOOS secured funding from DOI Office of Insular Affairs to enhance public safety through improved atmospheric and wave forecasts for the Pacific Island territories. During this three-year project, PacIOOS will improve and validate the existing suite of atmospheric forecasts for the three territories, and also develop new high-resolution wave forecasts for Saipan, Tinian, and Rota in the CNMI and for the Manu'a Islands in American Samoa.*
- *PacIOOS participated in IOOS Fall Meeting in Annapolis, MD (September 2018).*

## **OUTREACH, STAKEHOLDER ENGAGEMENT, AND EDUCATION SUBSYSTEM**

**Lead OceanObs'19 community white paper efforts; Submit papers; Original completion date: November 2018**

*Status: Complete. PacIOOS management led or collaborated on three different community white papers for OceanObs '19, which have all been submitted and are currently under review. PacIOOS co-investigators were involved in additional community white papers as well.*

**Ongoing outreach and engagement with stakeholders and partners to ensure meeting ocean data needs; Original completion date: Ongoing**

*Status: Ongoing. Outreach and stakeholder engagement with partners is ongoing via e-mail, phone calls, and meetings; stakeholder and community outreach and education efforts are conducted as appropriate. Specific activities during this reporting period are listed below.*

### **Outreach Efforts**

- *PacIOOS continues to publish and distribute monthly e-newsletters; more than 130 new contacts were added to the newsletter mailing list, the majority of which signed up through the subscription form on the PacIOOS website. Bouncing contacts were taken out of the database; a total of 1,887 recipients receive monthly updates.*
- *Increased public awareness and interest throughout PacIOOS with targeted press release to announce receipt of grant to expand and enhance wave and atmospheric modeling capacity in the insular Pacific. Participation in "Island Focus" television show focusing on ocean topics. Continued media coverage as part of Sea Grant's and State of Hawai'i's Sea Level Rise Adaptation Report and PacIOOS' companion sea level rise interactive map viewer.*
- *Increased the number of web stories that are easy to share on social media, to provide PacIOOS updates, announce new tools and data sets. Coverage included typhoon and storm updates from the region; new citizen scientists water quality data set in Voyager; deployment*

*of a (short-term) water quality sensor; deployment of the Lana‘i wave buoy; and data collection in West Maui.*

- *During this reporting period, the PacIOOS website was visited by over 63K users and had more than 173K sessions.*
- *Combined page views of the PacIOOS wave buoy pages from NDBC, and CDIP and the PacIOOS website total over 1.18 million. PacIOOS wave buoys accounted for over 2.2 million data requests and over 1.6 million RSS requests through NDBC during this reporting period.*
- *PacIOOS continues its presence on social media, in particular on Facebook and Twitter.*
- *PacIOOS’ Facebook page has more than 1,430 likes; Twitter following increased to over 420 followers.*
- *Popular posts included new tiger shark tracks on the PacIOOS website; posting of the PacIOOS Operations Coordinator position, deployment of the Lāna‘i wave buoy, availability of new Maui water quality citizen scientist data.*

### **Stakeholder Engagement**

- *Presentations at: O‘ahu Geospatial Expo; Estuarine and Coastal Modeling Conference; 3<sup>rd</sup> Pacific Islands Training Workshop on Ocean Observations and Data Applications; Pacific Risk Management ‘Ohana Conference; International Conference on Coastal Engineering.*
- *Participation in annual Hawai‘i Conservation Conference.*
- *Participated in NOAA Habitat Blueprint meetings, NOAA Pacific Regional Outreach Group (PROG), one NOAA American Samoa, and State of Hawai‘i Ocean Resources Management Plan (ORMP) Working Group.*
- *Continued collaboration with the Hawai‘i Office for Coastal and Conservation Lands and the UH Coastal Geology Group to address needs of what is now called the Hawai‘i Climate Commission.*
- *Participated in the 3<sup>rd</sup> Pacific Islands training workshop on Ocean Observations and Data Applications as a trainer. JCOMM’s Data Buoy Cooperation Panel convened the workshop in conjunction with the fifth JCOMM Marine Instrument Workshop for the Asia-Pacific region (RMIC/AP-5). The joint workshop took place in Hai Kou, China, where more than 55 workshop participants discussed global ocean observing systems, data utilization, quality control, best practices and many other topics.*

### **Educational Efforts**

- *Participated in outreach and educational events, including Marine Educators’ Night, Friends of Kewalos annual Park Clean up; provided tiger shark lecture at Hawaiian Islands Humpback Whale National Marine Sanctuary; and modeling lecture to American Samoa Community College students.*
- *Continue to run PacIOOS kiosks at University of Guam, College of Marshall Islands, Kailua Sailboards & Kayaks, Maui Ocean Center, Dolphin Quest (Kohala Coast, Big Island), Mokuapāpapa Discovery Center (Hilo), and Kaua‘i Community College.*
- *Continue collaboration with UH Maui College to use PacIOOS Voyager lesson plan as classroom activity for oceanography lab; focusing on data relevant to students and real-world decision-making.*
- *Water quality team continues to mentor undergraduate college students and high school students to support sensor program.*

## OBSERVING SUBSYSTEM

### **Waverider buoy operating in HI, Mariana Islands, American Samoa, and the Marshall Islands; Original completion date: Ongoing**

*Status: Ongoing. Keeping all the wave buoys managed by PacIOOS operational continued to be challenging this reporting period. Additional staff and supplies-on-hand have enabled the team to shorten turn-around times when certain buoys break free, but a lack of spares still comes into play. We continue to work with partners to identify funding sources to support spare wave buoys.*

*This year's hurricane season was one of the most active on record in our region. After recording a maximum wave height of 36 feet, the Ritidian (Guam) buoy broke free from its mooring during Typhoon Mangkhut in September 2018. It was retrieved and redeployed in November.*

*Super Typhoon Yutu broke the Tanapag mooring off Saipan in October 2018. Due to dangerous ocean conditions, we were unable to retrieve the buoy immediately, and it drifted 800 nm—halfway to Taiwan. Thankfully, our US Coast Guard partners were able to retrieve the buoy (December). It will be redeployed as soon as resources and weather permit. Of note, the largest individual wave measured by the Saipan wave buoy during this storm was 14.66m (48 ft) peak-to-trough, 10.2 wave period, on October 25, 2018.*

*Also unplanned this performance period was a retrieval of the Hilo buoy. Data collection within this buoy continued, but the buoy was unable to transmit data for 8-10 hour intervals due to partial submergence. Acting proactively, the team recovered the buoy to find that the mooring line was heavily weighted with biofouling that was increasing the drag and was pulling the buoy underwater. It will be redeployed as soon as resources and weather permit.*

### **Deploy new wave buoy off Lana'i; Original completion date: August 2018**

*Status: Complete. Deployed in June 2018. This was a newly permitted site slightly south of the previous location in order to move it away from ship traffic.*

### **Redeploy Kaua'i wave buoy; Original completion date: November 2018**

*Status: Complete. Deployed in September 2018.*

### **Swap Pearl Harbor wave buoy; Original completion date: August 2018**

*Status: Complete. Successful wave buoy swap accomplished in July 2018.*

### **Swap Mokapu wave buoy and mooring and conduct Waimea mooring work; Original completion date: November 2018**

*Status: Complete. Mokapu was swapped in September 2018.*

*A modified mooring line composition (without the rubber cord) was tested at the Waimea buoy through October 2018, in order to test if CDIP's 'check factor' analysis would flag these data. If so, this would let us know that the rubber cord was broken and the safety line was in use. For the duration of the test, there was no change in the check factor values (i.e., no flags on data); buoy data were not compromised. The mooring set-up is now back to normal.*

**Real-time wave data and associated products online; Original completion date: Ongoing**  
*Status: Ongoing.* <http://www.pacioos.hawaii.edu/waves-category/buoy/>

**Nearshore sensors operating and data online; Original completion date: Ongoing**  
*Status: Ongoing.* PacIOOS currently has 5 near shore sensors operational in Hawai'i (4 on O'ahu and 1 on Maui), and 4 operational in the Insular Pacific (American Samoa, the Federated States of Micronesia, the Republic of the Marshall Islands, and Guam). Partners on the islands other than O'ahu are key to keeping these sensors operational, and data flowing.

**Expand Water Quality Sensor Partnership Program; Original completion date: Ongoing**  
*The PacIOOS Water Quality Sensor Partnership Program (WQSPP) continues to be popular with partners and the PacIOOS Governing Council. The program currently has three sensors deployed, with another one on order with FY18 Fill the Gaps funding. The WQSPP project in Palmyra with U.S. Fish and Wildlife's coral rehabilitation study recently completed in October 2018, and the data will soon be available on PacIOOS data services.*

*A WQSPP project sensor was deployed in September 2018 in Maunalua Bay with non-governmental partners to support their ongoing water quality monitoring efforts for one year.*

*Another WQSPP sensor is deployed in Kewalo Basin, O'ahu, HI to help another local non-profit organization monitor water quality conditions before and during a construction project in Kewalo Basin Harbor. This project was recently extended for another 6 months (until May 2019).*

*A third WQSPP sensor was deployed in Pohnpei (FSM) in November as part of a sedimentation-monitoring project in collaboration with the Conservation Society of Pohnpei.*

**Pelekane Bay water quality buoy operational & data online; Original completion date: Ongoing**  
*Status: Ongoing.* The buoy is in the water, reporting, and data are online.  
<http://www.pacioos.hawaii.edu/water/wqbuoy-pelekane/>

**Outreach with Stakeholders on Hawai'i Island about location for former Kiholo WQ Buoy; Original completion date: May 2019**  
*Status: In progress.* Co-Investigator Colbert conducted a survey of locations to determine optimal oceanographic locations where the buoy is suitable. The next step is to connect with various stakeholders to discuss opportunities and potential challenges with regard to community support for the buoy in their coastal waters.

**Real-time and Logged water quality data and products online; Original completion date: Ongoing**  
*Status: Ongoing.* Dynamic graphs and map viewers on the PacIOOS website provide a quick way to check the latest observations. <http://www.pacioos.hawaii.edu/water-category/sensor/>,  
<http://www.pacioos.hawaii.edu/water/wqbuoy-pelekane/>

**Real-time surface currents available online for west and south shores of O‘ahu and Hilo Bay; Original completion date: Ongoing**

*Status: Ongoing. Focus continues to be on operations and maintenance of 7 HFR stations on O‘ahu and Hawai‘i Island. Cables at the Kalaeloa station were damaged by mongoose; the team has requested assistance from the SOEST Facilities to pull new cables, in the mean time the radar operates at reduced range.*

*Ka‘ena radar, off-grid and operating on wind/solar, saw its storage changed from second-hand lead acid batteries, to state-of-the-art Lithium-Ferro-Phosphate cells, for a total of 20 kWh of capacity, sufficient to operate uninterrupted over the darkest days in December-January.*

*Many of the other outdoor equipment (cables, antennas) at the HFR sites are aging and will soon require repairs/recapitalization. The UH-designed radar electronics, however, has proven to be rock-solid, with not a single electronics failure since they were installed to replace the failing WERAs in 2012.*

**Repair PacIOOS SeaGlider; Original completion date: November 2018**

*Status: In progress. Because the funding for other equipment costs were tied up with the same internal budget for the SeaGlider, we could not proceed with the purchase order for the repairs until November. The PacIOOS SeaGlider has now been sent to Kongsberg for servicing and repair. We anticipate receiving the repaired glider during the spring of 2019.*

**Validation samples for NOAA-ON Ocean Acidification effort; submit data to NCEI every 6 months; Original completion date: Ongoing**

*Status: Ongoing. Eric DeCarlo continues efforts to support the OAP at our Class III station. The recent reclassification of the CRIMP-2 buoy as the Class III station and reclassification of the Kāne‘ohe buoy as a Class II station means that they have largely shifted efforts to the new location over the most recent project period. Thus, they continue to collect and analyze validation samples for DIC and TA at a frequency of every two weeks at CRIMP-2. They do, however, continue to also collect such samples at the Kāne‘ohe buoy, weather permitting, under the auspices of our NOAA/Sea Grant College Program funding.*

*During this performance period, they also submitted their most recent data set for archiving to NCEI and the data have now been published by this organization. They have also modified and updated a data set from a previous submission that was missing metadata. The latter has now also been published by NCEI. Both data sets have been issued accession numbers, which allow for their easy retrieval by interested parties.*

*The earlier (now modified) data set was assigned NCEI Accession Number 0177741. The newer submission was assigned NCEI Accession Number 0176671. Information about the data sets can be found at: <https://www.nodc.noaa.gov/oceanacidification/data/0177741.xml> and <https://www.nodc.noaa.gov/oceanacidification/data/0176671.xml>*

*One of the mooring cables on the CRIMP-2 buoy broke this summer, and a complete new set of mooring lines (cables, bungees, and fittings) was installed in November 2018. The buoy is scheduled for annual instrument swap-out and refurbishment at the end of this year.*

**Deploy benthic instruments from PMEL on OA buoy(s); validation samples; submit data to NCEI every 6 months; Original completion date: Ongoing**

*Status: Delayed. No activities to report at this time. DeCarlo and Chris Sabine are awaiting receipt of instruments from PMEL for a new deployment.*

#### DATA MANAGEMENT SUBSYSTEM

The data management milestones that directly relate to specific observing, modeling, or other subsystem components are listed and described with those components.

**Additional activities for the data management subsystem** that are not mentioned within the other subsystems but that highlight regional observing system success and occurred during this reporting period include the following:

- *During this performance period, over 38,280 unique visitors (via direct external access to our servers) accessed more than 11.2 million pages in our servers (TDS, ERDDAP, and LAS) and transferred over 2.8 TB of data.*
- *Updated versions of NOAA's Coral Reef Watch's coral bleaching monitoring products are now available on PacIOOS data services and PacIOOS Voyager. The products cover 33 years of data, from 1985 to present and include daily average night-time sea surface temperature (SST), SST anomaly, coral bleaching hot spots, and degree heating weeks. A new addition is the 7-day maximum coral bleaching alert area.*
- *Coastal water quality measurements from the island of Maui, sampled by the citizen science effort Hui O Ka Wai Ola (Association of the Living Waters) are now available on PacIOOS data services and PacIOOS voyager. The data are from 25 locations, spanning from 2016 to present. Measurements include water temperature, salinity, turbidity, pH, dissolved oxygen, and nutrients (nitrogen, phosphorus, ammonia, and others). Samples are collected and analyzed roughly every 2-3 weeks, and results are disseminated quarterly.*
- *Supported with partner funding, components of a data collection platform for the Hawai'i Sea Grant King Tides effort was completed, including an interface that functions as a mobile app, and a map interface to view all photos collected in a user-friendly fashion.*  
<https://www.pacioos.hawaii.edu/kt>

#### MODELING, ANALYSIS, AND PRODUCT DEVELOPMENT SUBSYSTEM

**High-water level forecasts upgraded based on feedback/new inputs, forecasts available online; Original completion date: Ongoing**

*Status: Ongoing. Continuously refining forecasts with user feedback and collaborating with partners to obtain on-the-ground validation during predicted events.*

<http://www.pacioos.hawaii.edu/shoreline-category/highsea/>

**Harbor surge forecast upgraded based on feedback/new inputs, forecast available online; Original completion date: Ongoing**

*Status: Ongoing. Work ongoing to refine harbor surge forecast and obtain non-IOOS funding to expand locations.* <http://www.pacioos.hawaii.edu/shoreline-category/harborsurge/>



*PacIOOS team members gave a conference talk that included information gained and lessons learned through comparisons of three phase-resolved numerical models, which is also part of PacIOOS' efforts to develop a high-resolution wave run-up forecast for West Maui, with the support of NOAA's Regional Coastal Resilience Grant (Azouri, A., Roeber, V., and D. S. Luther, 2018: The Response of Harbor Environments Protected by Irregular Fringing Reef Systems to Strong Gravity Wave Forcing – A Case Study, Abstract #1181 presented at 36th International Conference on Coastal Engineering 2018, Baltimore, MD, 30 July – 3 August.).*

*During the previous reporting period another related talk was given: Azouri, A. and D.S. Luther, 2018: Existence and forcing of resonant infragravity oscillations on harbor to island scales, Abstract #CD23A-02 presented at 2018 Ocean Sciences Meeting, AGU, Portland, OR, 12-16 Feb.*

**Wave run-up forecasts upgraded based on feedback/new input, forecasts available online; Original completion date: Ongoing**

***Status:** Ongoing. PacIOOS continues to refine forecasts with user feedback and collaborating with partners to obtain on-the-ground validation during predicted events. The work being conducted for the PacIOOS Coastal Resilience Grant project for West Maui will also provide a significant addition and upgrade to our published PacIOOS run-up forecasts.*

*<http://www.pacioos.hawaii.edu/shoreline-category/runup/>*

*Related to PacIOOS' wave run-up efforts, the following seminars/presentations were given to provide information about our efforts and to disseminate the results of the research that led to the production of our various forecasts:*

*Roeber, V., Azouri, A., Guiles, M., and D. Luther, 2018: Assessment of Numerical Models for Forecasting of Wave-driven Run-up and Currents, Abstract #IG04-A021 presented at Asia Oceania Geosciences Society (AOGS) 15th Annual Meeting, Honolulu, HI, 03-08 June.*

*Iwamoto, M., Luther, D. Owens, T., Langenberger, F., Guiles, M., Roeber, V., Azouri, A., and C. Tognacchini, 2018: Enhancing Coastal Community Resilience with Real-Time Notifications, and Long-Term Projections, of Hazardous Wave-driven Flooding and Erosion Events in West Maui, Abstract #24 presented at the Pacific Risk Management 'Ohana (PRiMO) 16<sup>th</sup> Conference in Honolulu, HI, 07-09 August.*

*A team of researchers from PacIOOS and the Department of Oceanography at the School of Ocean and Earth Science and Technology, UH, deployed 24 instruments along the West Maui shoreline. Data from pressure sensors, current and wave meters will provide valuable insights into wave dynamics along West Maui and serve as validation for the high-resolution wave run-up forecast that is currently in development for this stretch of shoreline. Measurements will be obtained for a 6-month winter and 6-month summer period to capture seasonal differences. The wave run-up forecast is being developed as part of a 3-year NOAA Regional Coastal Resilience Grant. Funding for the extensive data collection was provided by the UH Sea Grant College Program, the Joint Institute for Marine and Atmospheric Research, and PacIOOS. Numerous local partners on the Maui also made this effort possible.*



**Continuously upgrade ROMS circulation model in operation for Hawai‘i, Mariana Islands, and Samoan Islands; Original completion date: Ongoing**

*Status: Ongoing. All data can be accessed online on the PacIOOS website and on PacIOOS Voyager. PacIOOS ROMS is available for various areas and grid sizes in Hawai‘i, the Mariana Islands, and Samoa.*

*In the last reporting period, the team fully upgraded the PacIOOS software to be based on free software: python and ROMS. The automated, operational system that downloads, processes, and archives near real-time data; processes global HYCOM; converts atmospheric and wave-forcing output; etc. are all now entirely written in python. The latest version of ROMS is now used for all models. In addition, as part of the OTT effort to examine the impact of observations on the operational system, we have extended the effort to the Philippine Sea, Mariana Islands, and Guam. Each day, every observation used in Hawaii, Marianas, and Guam are quantified as to how they improved our estimate of various features in each region (e.g., the depth of given isopycnals, the transport of water in the region, the eddy kinetic energy, etc.).*

*During this reporting period, we worked to develop the coupled ROMS/COBALT model to begin the capability of real-time biogeochemical forecasts. This work is ongoing, but we have now successfully integrated the coupled physical and biogeochemical models for nearly 1 year without issue. Further development, validation, and configuration are required, but we are moving toward the PacIOOS goal of producing biogeochemical forecasts.*

*PacIOOS co-investigator, Brian Powell, gave a plenary talk at the 15th Estuarine and Coastal Modeling Conference in Seattle, WA, on PacIOOS modeling systems with a focus on how near real-time observations are integrated to make predictions from the regional to estuary scale for the Hawai‘i region. Professor Powell also described how observational data are being assessed and how the data can be used to inform the forecasts (as part of the OTT project).*

**Model data and products (including Ala Wai Plume Forecast) online; Original completion date: Ongoing**

*Status: Ongoing. All forecasts and data output are available via the PacIOOS website. <http://www.pacioos.hawaii.edu/currents-category/model/>, <http://www.pacioos.hawaii.edu/water/model-plume-alawai/>*

**RESEARCH AND DEVELOPMENT SUBSYSTEM**

**Transmitting tags deployed on pelagics (sharks) throughout the year; Original completion date: Ongoing**

*Status: Ongoing. During the reporting period, four new tiger sharks were equipped with satellite tags of Kāne‘ohe Bay by researchers from the Hawai‘i Institute of Marine Biology. So far, two of the sharks tend to frequent waters off O‘ahu's windward coast and North Shore, one of the sharks went to Penguin Banks off Moloka‘i, and one is covering all those areas. The recent tracks, along with tracks from previous tagging efforts, can be viewed on PacIOOS' shark tracking pages and PacIOOS Voyager. <http://www.pacioos.hawaii.edu/projects/sharks/>*

**Service land-based receivers for shark tags throughout the year; Original completion date: Ongoing**

*Status: Ongoing. Currently 3 land-based receivers are deployed on O‘ahu, and 2 are deployed on Maui.*

## **2.0 Scope of Work**

No changes to the project scope of work are anticipated.

## **3.0 Personnel and Organizational Structure**

PacIOOS held 2018 elections in July-October 2018 to fill 6 seats on the PacIOOS Governing Council. Newly elected PacIOOS Governing Council Members include representatives from the Commonwealth of the Northern Mariana Islands’ Bureau of Environmental and Coastal Quality, National Park of American Samoa, U.S. Coast Guard District 14, U.S. Navy, United States Pacific Fleet, Micronesia Conservation Trust, and the Government of Guam.

PacIOOS added one MOA partners during this reporting period: The Hawai‘i Pilots Association (HPA). HPA provides safe, reliable, and efficient pilotage services for all commercial ports throughout the Hawaiian Islands. HPA’s pool of nine pilots are responsible for safely navigating ships in and out of Hawai‘i’s seven commercial deep draft harbors, 24/7. With an increase in ship sizes, availability of environmental data is becoming more crucial to navigate through the narrow harbor entrances. PacIOOS is looking forward to partnering with HPA on observational and forecasting data that enhances maritime safety. The total number of MOA Signatories is now 59.

## **4.0 Budget Analysis**

Spending for this award is on track with projected program expenditures. The University of Hawai‘i Office of Research Services submitted a semi-annual financial report for the period ending September 30, 2018, through Grants Online. That report showed total receipts of \$4,745,743.69.

As of November 30, 2018, internal budget tracking shows expenditures of \$5,244,552.13 representing a draw down of 67.7% of the Federal funding for this award.

## **Performance Progress Report Addendum (covering December 2017 – November 2018, unless otherwise stated)**

### **Education and Outreach Inventory**

The Education and Outreach Inventory has been updated with PacIOOS activities. Please see the Google Doc for responses.

[https://docs.google.com/a/noaa.gov/spreadsheets/d/1gjQiCa\\_cf1IGUNZPSoS4OG5CAKSXW\\_ejCFEVjLEOZHE/edit?usp=sharing](https://docs.google.com/a/noaa.gov/spreadsheets/d/1gjQiCa_cf1IGUNZPSoS4OG5CAKSXW_ejCFEVjLEOZHE/edit?usp=sharing)

### **Data Management, Products, and Services**

The PacIOOS data management group (DMG) ensures the data collected by PacIOOS are stored and accessible to users via standard services. Progress and challenges toward addressing each data management requirement are described below. See PacIOOS Data Management System (DMS) Plan (2016) for details.

#### **1. Open Data Sharing**

PacIOOS adheres to the NOAA Data Sharing Procedural Directive. All real-time and near real-time data managed by PacIOOS are freely available through open services, without delay or restriction. Avenues for accessing the data are available through the PacIOOS website: <http://www.pacioos.hawaii.edu/data-access/servers/>. Geospatial data are served via GeoServer and OpenLayers. PacIOOS does not restrict access to any data it collects or serves. Metadata are provided for all data, and data are machine-readable.

#### **2. Data management planning and coordination**

PacIOOS ensures local data storage and is working with NCEI for permanent archiving of data. PacIOOS routinely updates our data management plan, which was also part of our successful certification package. The PacIOOS DMG enables activities within PacIOOS modeling groups. PacIOOS continuously strives to make improvements to the system to ensure that regional DAC maintenance is stable, reliable, and efficient. Funding is always a challenge when planning for long-term operations and maintenance, including of a DMAC system. Additional funding sources outside of IOOS are continuously being pursued in order to ensure continuity and stability of the DAC.

PacIOOS supports data management coordination by participating in the operations, maintenance, and evolution of the national DMAC subsystem, including attending annual meetings and joining webinars and conference calls throughout the year. PacIOOS actively participates in cross-regional data management policy and implementation plan development, when invited to do so. PacIOOS is willing to participate in national data management committees and forums.

#### **3. Provision of data to the Global Telecommunication System (GTS)**

PacIOOS does not actively send data to the GTS. However, data that go through the functional DACs (e.g., data from the PacIOOS wave buoys) are sent by the DAC to the GTS when appropriate. WMO numbers will be sought for the remaining observing

platforms (near shore sensors (NSS) and water quality buoys (WQB)). A request has been made for our example WQB data set, and we are awaiting word from NOAA.

#### **4. Data access services**

All PacIOOS data are made available via data access services, and all are registered in the IOOS Catalog. Direct, binary access is provided through standard open-source protocols. Our main service is OPeNDAP (Open-source Project for a Network Data Access Protocol), and the system is built around the Thematic Real-time Environmental Distributed Data Services (THREDDS) DODS Server (TDS). In accordance with IOOS requirements, PacIOOS has also employed Sensor Observation Services (SOS) for providing data from point measurements via the latest version of THREDDS ncSOS service. PacIOOS maintains several web-based data browsing and display tools for gridded, point, and geospatial data, including a Live Access Server (LAS) for gridded data. In addition, the Environmental Research Division's Data Access Program (ERDDAP) is used for a variety of services, including display and browse, and a Web Map Server (WMS) based on GeoServer, is used to serve geospatial data.

#### **5. Catalog registration**

All PacIOOS data have complete and accurate metadata. These metadata are provided in a web accessible folder (WAF) that is read by various catalog services, including the IOOS catalog service.

#### **6. Common data formats**

PacIOOS offers data in IOOS-approved common data formats, including but not limited to, NetCDF, flat IEEE binary, ASCII, CSV, HDF, GRIB, and GIS formats. Our format is consistent with the NCEI netCDF templates.

#### **7. Metadata standards**

PacIOOS data sets conform to the Federal Geographic Data Committee (FGDC) and/or ISO 19115. A python-based PacIOOS web catalog service (pyCSW) provides access to all metadata with query capabilities. All our metadata are in a WAF and catalog service.

#### **8. Storage and archiving**

Local storage for data streams is on a Redundant Array of Independent Disks (RAID) system, which is essentially a single unit with multiple hard drives with data stored redundantly across the disks, so in the event of a hardware failure on a single disk data are preserved on another. In addition, all PacIOOS data are replicated across mirrored RAID systems. PacIOOS is currently working with NCEI to ensure archiving of PacIOOS data. We have set up a process to provide data to NCEI via a WAF. ERDDAP is used to aggregate the daily files into archive files. An initial test has been successful, and we are now waiting for all metadata vocabularies (particularly for QC flags) and for WMO numbers (see 3 above) before proceeding with the other WQB and NSS data. Storage and archiving of data that go through a functional DAC from PacIOOS are handled by each respective functional DAC.

## **9. Ontologies, vocabularies, common identifiers**

The PacIOOS DM sub-system employs a service-oriented architecture (SOA), built on controlled ontologies, vocabularies and identifiers, that enables six essential functions: 1) data storage, 2) metadata management, 3) data discovery tools, 4) data transport servers, 5) on-line browse capabilities, and 6) data quality assurance/quality control (QA/QC). The vocabularies used for geophysical data adhere to the netCDF Climate and Forecast (CF) conventions. Biological data use the IOOS Biology Standard that is based on Darwin Core.

## **10. Consideration for Long-term Operations**

PacIOOS aims to maintain and enhance a system that will persist long-term. Changes to the IOOS DMAC policies and procedures, such as QARTOD updates, will be incorporated as necessary. While PacIOOS has implemented, and will continue to implement automation in the system (through programming, etc.) as much as possible, there will also be a need for experienced, knowledgeable personnel. Federal requirements, software, stakeholder needs, etc. are always changing, and automation cannot always appropriately accommodate such evolutions. Funding, therefore, is always a key consideration when planning for short- or long-term activities. PacIOOS' strategic goals moving forward, therefore, include the need to diversify and expand funding and leveraged resources to create a resilient and robust financial foundation. Additional funding sources outside of IOOS are continuously being pursued in order to ensure continuity and stability of the DAC. This is an ongoing challenge.

## **Observing Assets**

### **1. RA Observing Asset Inventory**

Please see the attached Observing Asset Inventory spreadsheet for PacIOOS.

### **2. HFR Operations and Maintenance progress**

Please see the attached spreadsheet for an annual update on HFR expenditures. Also, please see the attached annual update on HFR assets and staffing.

### **3. Annual Glider Days Inventory**

Please see the attached Annual Glider Days Inventory spreadsheet.