

Performance Progress Report
Developing the Pacific Islands Ocean Observing System (PacIOOS)
Cooperative Agreement # NA16NOS0120024
Performance Period: December 1, 2017 through May 31, 2018

Submitted June 2018 by:
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This report covers activities conducted during the fourth six 6-month performance period of this five-year cooperative agreement. PacIOOS’ estimated operating budget for the fiscal year is \$2,321,620.

1.0 Progress and Accomplishments

Waverider buoys 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 causes delay in some locations.

Additional unplanned operations this reporting period included the redeployment of the Maui wave buoy and rescues of the Waimea, Hanalei, and Aunu‘u, (American Samoa) wave buoys. Waimea and Aunu‘u have already been redeployed.

Submit permit applications for new locations (S. Shore O‘ahu and Lāna‘i); Original completion date: November 2017

Status: Complete. Each new wave buoy location required permits from USACE, State of Hawai‘i Department of Health, NOAA (NEPA), and the USCG. All four permits were approved during this reporting period. The State required a fee of \$1,000 for each buoy.

Deploy new wave buoy off Kalaeloa Barbers Point, O‘ahu, HI

Status: Complete. Deployed in May 2018. See web story and UH-produced video at <http://www.pacioos.hawaii.edu/pacioos-updates/kalaeloa-barbers-point-wave-buoy/>.

Swap Maui and Majuro wave buoys and moorings; Original completion date: Feb 2018

Status: Complete. Successful Maui wave buoy swap accomplished in January 2018. Successful Majuro wave buoy swap accomplished in March 2018. Majuro’s mooring set a ‘deployment length’ record of 1.5 years for Majuro (the old record was 1.4 years).

Re-deploy Kāne‘ohe Bay wave buoy; Original completion date: Nov. 2017

Status: Complete. Kāne‘ohe Bay wave buoy was re-deployed in April 2018. The team was able to retrieve an entangled acoustic release with an ROV and SCUBA divers. Deployment was

delayed due to the need for the acoustic release for this mooring as well as to avoid additional entanglement with the new mooring.

Swap Saipan and Pearl Harbor wave buoys; Original completion date: May 2018

Status: Complete. Successful inspection dives of the Pearl Harbor wave buoy and mooring accomplished in January 2018. Mooring looks good, so it was determined to push mooring and buoy swap forward to summer 2018. Successful Saipan wave buoy swap was accomplished in May 2018.

Real-time wave data and associated products online; Original completion date: Ongoing

Status: Ongoing. New pages for Kalaeloa Barbers Point wave buoy added. See <http://www.pacioos.hawaii.edu/waves/buoy-kalaeloa/>.

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. An undergraduate student continues to help PacIOOS staff maintain the sensors on O'ahu.

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 for this program. One sensor is in Palmyra Atoll to support a U.S. Fish and Wildlife coral rehabilitation study, and the team has just agreed to extend this deployment for another 6 months. The second sensor is deployed in Kewalo Basin, O'ahu, HI to help The Friends of Kewalos, a local non-profit organization, to monitor water quality conditions before and during a construction project in Kewalo Basin Harbor. The third sensor is planned to be deployed in Maunalua Bay, O'ahu with PacIOOS MOA partner, Mālama Maunalua to enhance water quality monitoring efforts in the bay to inform ongoing work at Pāiko Restoration Area, which is adversely impacted by invasive algae. The partner is currently working with PacIOOS to identify an appropriate site.

Hilo Bay water quality buoy operational & data online; Original completion date: Ongoing

Status: Ongoing. The Hilo Bay WQB is operational. Students supervised by Dr. Colbert are assisting with ongoing maintenance. The chlorophyll sensor has to be replaced once a new part is received from the manufacturer.

Permit application for Pelekane water quality buoy; Original completion date: Nov. 2017

Status: Complete. Dr. Colbert met with community members to address questions from the USCG about the visual impact of the buoy, and received the USCG permit. PacIOOS also submitted a NEPA Environmental Compliance questionnaire to IOOS and received permission to proceed. The new buoy was highlighted at the West Hawai'i Integrated Ecosystem Assessment (IEA) Symposium hosted by NOAA in December 2017.

Deploy the Pelekane water quality buoy; Original completion date: May 2018

Status: Complete. Dr. Colbert and his team successfully deployed the Pelekane water quality buoy in March 2018. The new buoy collects salinity, temperature, turbidity, dissolved oxygen,

and chlorophyll measurements in 15-min intervals. See data from the PacIOOS website at: <http://www.pacioos.hawaii.edu/water/wqbuoy-pelekane/>. Outreach to the community included presentations to the South Kohala Coastal Partnership and to the community at Spencer's Beach Park.

Pelekane Bay, home to Pu'ukoholā Heiau National Historic Site, experiences high turbidity levels due to overgrazing within the watershed and reduced wave activity after the construction of Kawaihae Harbor. Automated, real-time water quality measurements will enhance monitoring efforts and provide baseline data. The water quality buoy will support efforts from the South Kohala Coastal Partnership and other initiatives that are aiming to reduce sediment runoff in the South Kohala watersheds to protect nearby coral reef ecosystems. Pelakane Bay also lies within NOAA's West Hawai'i Habitat Blueprint Focus Area and NOAA's Hawaiian Islands Sentinel Site Cooperative.

Real-time & logged water quality data/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.

Real-time surface currents available online for west and south shores of O'ahu and Hilo Bay; Original completion date: Ongoing
Status: Ongoing. Focus has been on operations and maintenance of 7 HFR stations on O'ahu and Hawai'i Island. Changes in management at three of our HFR stations where we have long range WiFi communication relays have resulted in intermittent data uploads. Mongoose damaged cables at the Kalaeloa station; the team has requested assistance from the SOEST Facilities to pull new cables, in the meantime the radar operates at reduced range. Kaka'ako HFR is based within the State-managed park that was recently (October 2017) closed to the public and all power shut down in order to conduct major repairs to 30 light posts throughout the park that were damaged by the houseless community utilizing the grounds. This impacted the power to the HFR on the grounds as well, and as a result, our uptime for the site, and overall across the region, was greatly impacted. Power was finally restored to the park in March 2018. The Kaka'ako HFR was back up and running soon after.

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

Ocean condition products online; Original completion date: Ongoing
Status: Ongoing. Dynamic graphs and map viewers on PacIOOS' new website provide a quick way to check PacIOOS' latest observations and forecasts.

High-water level forecasts upgraded based on feedback/new inputs; 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. A graduate student went through all the Hawai'i Sea Grant King Tide Program's photographs and extracted ones that

provide good documentation of flooding when the forecast was at, or over, the threshold. The student has compiled the best images into figures to be added to the web pages under "Examples." The next step is to write appropriate text for each figure and then include them on the PacIOOS website.

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

Status: Ongoing. Work ongoing to refine harbor surge forecast and obtain non-IOOS funding to expand locations.

Collect data necessary for developing a Harbor Surge forecast for Kahului Harbor, Maui.

Original completion date: May 2018

Status: Delayed. In order to minimize costs, the plan is to collect data at the same time as other data on Maui are collected for similar projects funded by other sources. Expected completion is now Spring 2019.

Wave run-up forecasts upgraded based on feedback/new input; 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.

Coastal hazard data and products online; Original completion date: Ongoing

Status: Ongoing. See <http://www.pacioos.hawaii.edu/shoreline-category/runup/>, <http://www.pacioos.hawaii.edu/shoreline-category/highsea/>, and <http://www.pacioos.hawaii.edu/shoreline-category/harborsurge/>.

Implement chosen backend database and develop interface to sign up for notifications of high sea level and wave run-up events; Original completion date: Feb 2018

Status: In progress. Backend MySQL database has been implemented on Linux. A user interface was developed in Flask and html, resulting in a beta version for testing purposes. Design and usability feature adjustments have been discussed to optimize user-friendly and intuitive uses of the interface. Adjustments will be implemented in the near future. The team also explored Email delivery options to provide visuals graphics in Email notifications.

Programming on backend to identify specific thresholds for notifications; Original completion date: Feb 2018

Status: Complete. Code for thresholds is available. Once the database and interface are moved to the PacIOOS server, the code will be implemented.

Stakeholder engagement to ensure project meets community needs; Original completion date: Ongoing

Status: Ongoing. Engagement to date has focused on key partners that work directly with some of the more impacted communities.

Transfer HSL and Wave Run-up Forecasts into PacIOOS DMAC data services to support access to previous forecast images; Original completion date: February 2018

Status: Complete. See more details below.

Implement dynamic archive plotting function; Original completion date: August 2018

Status: Complete. In addition to the most recent PacIOOS wave run-up, six day high sea level, and harbor surge forecasts, website users can now also view historical plots of the forecasts. The web pages feature a new "Archive" tab, which provides access to all available historical forecast plots, reaching back to the initial implementation of each forecast. Users have the option to choose a date from the calendar, use the slider tool, or the animation buttons to quickly navigate through the images. Two plots are provided for each day, generated at 6:00am and 6:00pm of the local time zone. The archive was created in response to user requests to allow for enhanced comparison and validation of the forecasts with the observed coastal impacts. Implementation was supported by the U.S. Integrated Ocean Observing System OTT Program.

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

Status: Ongoing. PacIOOS' Regional Ocean Modeling System (ROMS) now provides a new high-resolution grid for Kāne'ōhe (approximately 100-m resolution) and the surrounding area along O'ahu's windward shore (1.5-km resolution). The model generates 3-day forecasts for ocean currents (e.g., <http://www.pacioos.hawaii.edu/currents/model-kaneohe/>) water temperature, and salinity. This daily forecast with hourly output allows users to explore values throughout the entire water column, from the surface to the ocean floor. 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.

Extensive development of the operational software to update and improve reliability to deal with new and varying data sources (we collect data from dozens of sources each day for satellites, Argo, HF radar, etc.). These software updates have been rolled into the PacIOOS operational system. A few minor issues were addressed during this reporting period. In addition, the team developed an improved model for the Hawaiian region. They performed a 10+ year reanalysis using over 100M observations. These improvements and the reanalysis are now in the PacIOOS data stores and operational system. A manuscript is currently in draft form.

The team also developed and tested a pathogenic microbe model for Ala Wai. Working with other programs at UH, they deployed several sensors in the Ala Wai canal. These came out of the water in June, and in a pilot cooperation program with Iolani school, students are processing those data to compare with the model to perform validation. The PacIOOS team will conduct other validation tests as well. As part of these efforts, Dr. Grieg Steward, a UH researcher, collected water samples and is processing them via qPCR to identify pathogenic bacteria. The team will use these data as a baseline for model parameterization to capture how well we can simulate and predict blooms.

As part of an OTT project, the team is producing estimates of how the observations used operationally improve our forecasts for a number of metrics.

Model data and products online; Original completion date: Ongoing

Status: Ongoing. All forecasts and data output are available via the PacIOOS website.

Ala Wai plume model online; Original completion date: Ongoing

Status: Ongoing. The Turbidity Plume Model simulates the possibility of a plume developing at the Ala Wai Canal for the upcoming two days, and also includes a hindcast for the previous three days. Turbidity (water clarity) is impacted by various factors, including rainfall, waves, wind, and tidal movement. Very high turbidity levels are normally caused by large amounts of storm water runoff that can severely impact the nearshore water quality.

Transmitting tags deployed on pelagics (sharks); Original completion date: Ongoing

Status: Ongoing. During the reporting period, a 10-foot female tiger shark (#132069) was tagged off Maui with a satellite tag. Multiple detections have been transmitted since the shark was tagged in February 2018 and can be viewed PacIOOS' Shark Tracking Pages.

<http://www.pacioos.hawaii.edu/projects/sharks/>

Shark researchers from the Hawai'i Institute of Marine Biology (HIMB) recently published in Nature Scientific Reports "Habitat geography around Hawaii's oceanic islands influences tiger shark (Galeocerdo cuvier) spatial behaviour and shark bite risk at ocean recreation sites." To better understand tiger shark movement and habitat use patterns, the team of researchers used satellite and acoustic tags to track 41 tiger sharks off Maui and O'ahu. Study findings revealed that tiger sharks prefer insular shelf habitat, which extends from the shoreline up to a depth of 600ft. The Hawai'i Department of Land and Natural Resources and PacIOOS provided funding for the study. The publication is freely available online, and all shark tracks related to this study can be accessed on the PacIOOS website along with more recent tracks.

Service land-based receivers for shark tags; Original completion date: Ongoing

Status: Ongoing. Currently 3 land-based receivers are deployed on O'ahu, and 2 are deployed on Maui. With permission secured to deploy another one on Lāna'i, plans are in place to deploy one more receiver, which will provide increased coverage of Penguin Banks.

Integration of biological data into PacIOOS data management system. Original completion date: May 2018/ongoing.

Status: Delayed. A joint position description was developed with JIMAR (for NOAA PIFSC) and PacIOOS, posted, and applicants reviewed. Unfortunately, due to funding constraints, we were not able to successfully recruit for this position. We are currently assessing next steps and whether or not to continue pursuing this effort together.

Plan and prepare for ATN workshop with IOOS Program Office and partners; Original completion date: February 2018

Status: Complete. PacIOOS Communications and Program Coordinator Fiona Langenberger, PacIOOS Director Melissa Iwamoto, UH researcher Dr. Kim Holland, and ATN Coordinator Bill Woodward served as the planning committee for the ATN workshop and worked with partners to develop the agenda. F. Langenberger coordinated all logistics.

Hold ATN workshop; Original completion date: May 2018

Status: Complete. April 2018. More than 55 researchers, resources managers, and ocean enthusiasts came together for the two-day PacIOOS Animal Telemetry Network Workshop in Honolulu. Organized by the U.S. Integrated Ocean Observing System (IOOS), PacIOOS, and the Hawai'i Institute of Marine Biology (HIMB), the workshop's goal was to explore regional needs and priorities for animal telemetry observations of aquatic species and to identify existing telemetry assets and capabilities. Over 20 speakers from various sectors presented, and workshop attendees discussed ongoing telemetry efforts, needs, opportunities, and challenges in break-out groups. Partners from NOAA Pacific Islands Regional Office (PIRO) and Mālama Maunaloa served as facilitators for the break-out sessions. The workshop is one in a series of regional workshops convened by the U.S. Animal Telemetry Network Program. Bill Woodward is working on the workshop final report, which will be made available online.

Collaborate with the IOOS Program Office to provide on-the-ground support for OceanObs'19 and determine next steps; Original completion date: May 2018

Status: Ongoing. Several abstracts submitted by PacIOOS staff and co-investigators were accepted for full community white papers or mini-reviews. One abstract in particular was submitted on behalf of all the IOOS RA's, as well as IOOS, and the IOOS Association. PacIOOS director, Melissa Iwamoto, is the lead of this community white paper effort, which is focusing on the value and approach of being stakeholder-driven.

Convene PacIOOS Executive Committee meeting; Original completion date: May 2018

Status: Complete. April 2018. Members of the PacIOOS Governing Council (GC) Executive Committee (ExCom) gathered in Maui for two days. Following highly detailed program updates, discussions focused on the PacIOOS internal evaluation, plans for the upcoming fiscal year, updating the PacIOOS performance measures, developing a document articulating GC member responsibilities and expectations, and measuring the impact of PacIOOS. Partners from Maui Ocean Center and the Pacific Disaster Center, as well as the IOOS Program Office, provided additional presentations with content for discussion and PacIOOS awareness. GC ExCom members from across the region represent various sectors and provide valuable feedback to help guide the future direction of the program.

Outreach with stakeholders on Hawai'i Island about location for former Kiholo Water Quality Buoy; Original completion date: May 2018

Status: In progress. The former Kiholo Water Quality Buoy is designed for protected coastal waters. An initial survey of wave conditions around Hawai'i Island was completed to determine what bays are potential sites for the buoy in order to identify appropriate stakeholders. Outreach to stakeholders will be conducted during the next reporting period. Initial assessment of the instruments on the former Kiholo Water Quality Buoy was conducted. Testing and calibration of individual instruments remains to be done.

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

Status: Ongoing. Communication with partners is ongoing via e-mail, phone calls, and meetings. Specific activities during this reporting period are listed below.

Communications

- *PacIOOS continues to publish and distribute monthly e-newsletters; 150 new contacts were added to the newsletter mailing list, the majority of which signed up through the subscription form on the PacIOOS website; a total of 2,024 active contacts receive monthly updates.*
- *Increased public awareness through a joint news release with the State of Hawai‘i and UH Sea Grant to announce the Hawai‘i Sea Level Rise Viewer as a companion to the Hawai‘i Sea Level Rise Vulnerability and Adaptation Report.*
- *Engaging video and news release to document the deployment of and share the news about the redeployment of the new Kalaeloa Barbers Point wave buoy.*
- *Strengthen PacIOOS branding and name recognition through relevant outreach, management, conference, and workshop materials and collateral.*
- *Post web stories to share PacIOOS updates with website users; highlight new and existing tools as “featured item” on the website to draw users’ attention.*
- *During this reporting period, the PacIOOS website was visited by over 51K users and had more than 136K sessions.*
- *A website survey was conducted to solicit input, feedback, and information about specific use cases. More than 150 users participated in the survey.*

Social Media

- *PacIOOS continues its presence on social media, in particular on Facebook and Twitter, with PacIOOS specific posts or shared stories/events from partner organizations.*
- *PacIOOS’ Facebook page has more than 1,359 likes; Twitter following increased by 25% from the last reporting period to 380 followers.*
- *Popular posts included the PacIOOS wave buoy deployment off Kalaeloa Barbers Point, redeployment of the Waimea wave buoy, announcement of the Ocean Tipping Points project pages, Voyager updates, and deployment of the water quality buoy off Pelekane, Hawai‘i Island.*

Collaborative Efforts/Events

- *Participate in outreach and educational events, including Fall in Love with Science at the Bishop Museum, Maunaloa Bay Heritage Festival, and multiple career days.*
- *Program overview presentation and water quality buoy presentation at Symposium on West Hawai‘i Marine Ecosystem in Kona, Hawai‘i Island.*
- *PacIOOS posters and presentations at Ocean Sciences Meeting in Portland.*
- *Continue to run PacIOOS kiosks at University of Guam, College of Marshall Islands, Windward Community College, Kailua Sailboards & Kayaks, Maui Ocean Center, Dolphin Quest (Kohala Coast, Big Island), Mokupāpapa Discovery Center (Hilo), and Kaua‘i Community College.*
- *Water quality team mentors undergraduate college students and high school students to support sensor program.*
- *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.*
- *Meet with stakeholders from various sectors, including industry partners (e.g., Atlantis Submarine, Surfline, Surf News Network, Outrigger Hotels) and agency partners (e.g.,*

Department of Transportation, Department of Health Clean Water Branch, Hawai‘i Coastal Zone Management Program)

- *Participate on the NOAA Pacific Regional Outreach Group (PROG), one NOAA American Samoa, NOAA Habitat Blueprint Program, and State of Hawai‘i Ocean Resources Management Plan (ORMP) Working Group.*

Internal PacIOOS evaluation; Original completion date: Feb 2018

Status: *Complete. March 2018. The internal PacIOOS evaluation is used to provide an objective review of what is going well and what needs more attention within the program. The results were presented to the PacIOOS GC ExCom in April 2018, and were one of the drivers of the FY18 budget discussion with the committee.*

Additional activities not mentioned above that highlight regional observing system successes and occurred during this reporting period include the following:

- *Combined page views of the PacIOOS website and PacIOOS wave buoy pages from NDBC, and CDIP total over 1.3 million. PacIOOS wave buoys accounted for over 4.0 million data requests and over 1.6 million RSS requests through NDBC during this reporting period.*
- *Over 25,300 unique visitors (via direct external access to our servers) accessed more than 10.48 million pages in our servers and transferred over 1.8 TB of data.*
- *Finalized the updated 5-year PacIOOS Strategic Framework with the PacIOOS GC. The document provides PacIOOS staff, researchers, existing partners, potential collaborators, and funders with insight into PacIOOS' desired future, and the strategic direction for the next five years (2018-2022). Over the past two years, PacIOOS leadership collected input from Governing Council members, PacIOOS researchers and staff, and MOA partners to develop this guiding document. The framework includes PacIOOS' core vision and mission, guiding principles, thematic areas, as well as the 5-year strategic outlook, strategic topics, goals, and objectives. Available online at http://www.pacioos.hawaii.edu/wp-content/uploads/2017/11/PacIOOS_Strategic_Framework_2018-2022.pdf.*
- *PacIOOS secured funding from multiple sources, including HNEI, ONR, and DOI Office of Insular Affairs.*
- *PacIOOS developed the Hawai‘i Sea Level Rise Viewer (<http://www.pacioos.hawaii.edu/shoreline/slr-hawaii/>) as a companion to support the State of Hawai‘i Sea Level Rise Vulnerability and Adaptation Report. The viewer provides easy access to coastal hazard exposure areas and vulnerability layers. Homeowners, planners, and other users can explore flooding and coastal erosion for a variety of sea level rise scenarios. Potential economic loss and flooded highways are also displayed in the viewer. Funding was provided by NOAA's 2016 Regional Coastal Resilience Grants Program.*
- *PacIOOS participated in the IOOS Spring Meeting in Washington, DC (March 2018).*

2.0 Scope of Work

No changes to the project scope of work are anticipated.

3.0 Personnel and Organizational Structure

The PacIOOS ExCom is currently comprised of the chair of the Governing Council, Dr. Brian Taylor (School of Ocean and Earth Science and Technology at the University of Hawai‘i at Mānoa), Tony San Jose (Liquid Robotics), Carlos Villacis (Pacific Disaster Center), Moriana Phillip (RMI EPA), and Jason Biggs (U. of Guam).

PacIOOS added two new MOA partners during this reporting period: Trilogy Excursions and Suflin/Wavetrak, Inc. The total number of MOA Signatories is now 58.

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 March 31, 2018, through Grants Online. That report showed total receipts of \$3,767,373.45.

As of May 31, 2018, internal budget tracking shows expenditures of \$4,148,285.74 representing a draw down of 81.5% of the Federal funding for this award.