

Progress Report
Developing the Pacific Islands Ocean Observing System (PacIOOS)
Cooperative Agreement # NA11NOS0120039
Performance Period: June 1, 2015 through November 30, 2015

Submitted December 2015 by:
Chris Ostrander
School of Ocean and Earth Science and Technology, University of Hawai‘i at Manoa

1.0 Project Summary

The Pacific Islands Ocean Observing System (PacIOOS) is the Regional Association (RA) for Hawai‘i and the Insular Pacific region being developed and maintained as part of the national Integrated Ocean Observing System (IOOS). The primary goal of the work proposed under this award 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 in the Pacific Islands. PacIOOS is being planned and implemented through the collective efforts of a consortium of users, signatories to the Memorandum of Agreement, and 17-member Governing Council. PacIOOS has focused initial development on ocean-state and forecasting, prediction of coastal hazards, water quality sensing, the provision of marine ecosystem information, and the development of integrated data visualization capabilities to inform marine spatial planning, operations, commerce, and recreation. Through the efforts proposed under this award, PacIOOS has enhanced development of observing and product suites in each of the aforementioned focus areas and continues to engage users, stakeholders, and system partners in the use, extension, education, and outreach of technical capacity, data visualization, and ocean information.

This report covers activities conducted during the first six 6-month performance period of Year 5 of a 5-year award. PacIOOS’ operating budget for Year 5 is \$2,791,086.00.

2.0 Progress and Accomplishments

2.1 User Needs, Stakeholder Input and Partnerships

User Needs/Stakeholder Input

- Ongoing engagement with stakeholders throughout the PacIOOS region via regional liaisons based in the FSM, Guam, RMI, and American Samoa. Feedback informs continued strategic planning and decision-making.
- Stakeholder engagement to determine the location for a new wave buoy off Majuro. Discussion includes researchers and locals from UH SOEST, NOAA NWS, RMI Ports Authority, Marshall Islands Marine Resources Authority (MIMRA), UH Sea Grant, College of Marshall Islands, Mico Beach Yacht Club, and local watermen.
- Working with Young Brothers, Ltd. to determine how to best address their boat captains’ needs regarding information inside the Lanai boat harbor.
- Recent discussions with U.S. Navy command offices on their data needs with regard to navigation at Pearl Harbor channel.

Partnerships

- PacIOOS has determined that while MOA partners are essential and important to our continued ability to meet stakeholder needs, moving forward, we are focusing more on the quality of such partnerships, rather than the quantity of them.
- New MOA partner: National Park of American Samoa.
- Increased engagement with PacIOOS MOA partners.
- Formal partnership with the Young Brothers Community Support Program to assist PacIOOS in vessel transport for wave buoy operations and maintenance.
- Participated on the NOAA Pacific Island Regional Team (PIRT), NOAA Sentinel Site Program, NOAA Pacific Regional Outreach Group (PROG), NOAA Offshore Aquaculture Group, one NOAA American Samoa, NOAA Habitat Blueprint Program, 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 the Hawai‘i Interagency Climate Adaptation Committee.
- Partnering with NOAA Habitat Blueprint team for West Hawai‘i to develop project page to inform the public on the efforts in the priority area and to enable access to related data.
- Continued discussions with Pacific Islands Regional Planning Body on potential partnership with PacIOOS providing the data management backbone for the RPB.
- Collaborated with partners on several proposals, including the NOAA resiliency FFO. Partners submitting proposals including PacIOOS elements include The Nature Conservancy Hawai‘i, UH Sea Grant/Hawai‘i Department of Land and Natural Resources, and Forever Oceans, Ltd.

2.2 Governance and Administrative Structure

- Conducted elections for the following six seats on the PacIOOS Governing Council: CNMI, Guam, FSM, American Samoa, one Hawai‘i seat, and one Regional seat.
- Hosted a Governing Council meeting in October in Honolulu to: 1) discuss updates and budgets; 2) strategize specific aspects of the future direction of PacIOOS; and 3) foster continued partnerships and collaboration to advance ocean observing in the region.
- PacIOOS Governing Council elected a new Executive Committee from their membership, which will meet in the spring of 2016.
- Continued engagement with Co-PIs and all recipients of IOOS funding through the PacIOOS cooperative agreement.
- Participated in IOOS activities that provide direction on the development of PacIOOS.
- Increased engagement with PacIOOS Governing Council outside of annual meetings.

2.3 Business/Operations Plan

- Became first certified RICE; signed MOA with NOAA.
- Submitted 5-year proposal to IOOS to maintain and enhance PacIOOS.
- PacIOOS 5-year Strategic Operational Plan continues to inform program efforts.
- Successfully secured \$45K additional funding to supplement the \$40K provided by IOOS to purchase a Majuro wave buoy to replace the one lost due to a ship encounter in January-- \$30K from NOAA NWS Pacific Islands Regional Headquarters; \$10K from

the Australian Bureau of Meteorology (COSSPac Program); and \$5K from an anonymous donor via the College of the Marshall Islands.

- Secured funding from the Hawai‘i Natural Energy Institute (HNEI) to purchase another wave buoy for deployment outside Pearl Harbor, O‘ahu and two spare buoys to increase our asset uptime.
- Collaborating with University of Guam (UOG) EPSCoR to deploy water quality sensors in Pago Bay to characterize the system and achieve EPSCoR goals and objectives.
- Tracked PacIOOS Performance Metrics for overview of progress and effectiveness.
- Identified and strengthened partnerships on neighbor islands to assist with operations and maintenance of nearshore water quality stations and offshore wave buoys.
- Continued to leverage funding and partnership opportunities with NOAA CSC, NOAA Coastal Storms Program (CSP), City and County of Honolulu, State of Hawai‘i, US Army Corps of Engineers, EPSCoR, US Navy, UH Sea Grant, and NOAA PMEL.
- Continued services contract with UOG Sea Grant for sensor maintenance and outreach.
- No-cost extension of services contract with Hibiscus for website redesign/development.
- Continued implementing consultant suggestions for improved communications.

2.4 Observing System Implementation

Ocean-State

- Combined page views of PacIOOS wave buoy pages from NDBC, CDIP, and PacIOOS websites total over 1.4 million during this reporting period. PacIOOS wave buoys accounted for over 2.4 million data requests and over 6 million RSS requests from NDBC during this reporting period.
- Continued to maintain an array of 13 wave buoys across the system. Recovered, redeployed, or swapped the following wave buoys: Tanapag (CNMI), Barber’s Point (HI), Ritidian Point (Guam), Hilo (HI), Mokapu (HI), and Kāne‘ohe Bay (HI).
- Open position posted for PacIOOS Oceanographic Research Instrument Associate.
- Examined options to strengthen moorings throughout region to minimize runaway buoys; now implementing a new back-up line with all new wave buoy moorings deployed.
- Speed and direction of ocean surface currents are now being mapped in a new data set for Hilo Bay. Hourly updates are available on PacIOOS Voyager via CORDC.
- Chevron HFR now operational, and in new frequency (13.5 MHz). Range is 110-120 km. Currently 8 antennae are up. Data served on PacIOOS Voyager via CORDC.
- Improved data stream from Ka‘ena, Kalaeloa, Kaka‘ako, and Kokohead stations.
- Transferred Ka‘ena HFR station to the new frequency. Currently preparing to transfer remaining HFR stations to the new frequency.
- Continue to operate and maintain 7 HFR stations.
- Upgrade all HFR sites with system upgrade, new PC, latest software, reconfiguration.
- On behalf of PacIOOS, Dr. Pierre Flament participated in the Radiowave Oceanography Workshop in Woods Hole Oceanographic Institution. A PacIOOS-supported graduate student also gave a presentation at the workshop.

Forecasting

- Ongoing maintenance and operation of PacIOOS WRF, ROMS, and wave models.

- Attempted to run one PacIOOS glider mission for data assimilation into ROMS model. Unable to complete run due to vehicle limitations with the UH glider facility.
- Upgraded SWAN wave model to version 41.01B.
- Updated the downloading scripts for the wave models in response to the release of a new NOAA NCEP FTP site.
- Updated the model bathymetry to reflect the latest harbor survey data from USACE.

Coastal Hazards

- Continued maintenance of existing PacIOOS products, including operational code.
- New Kwajalein inundation forecast now live on PacIOOS website.
- Improved Majuro inundation forecast (output and usability/readability).
- Continued re-analysis of PacIOOS Wave Run-Up Forecasts along the North Shore of O‘ahu in order to improve forecast process for multiple locations along the coast.
- Continued field validation of inundation forecasts by PacIOOS liaisons and volunteer observers. This highly useful information, including photos, is being used to build up a validation archive and to fine-tune the inundation forecast.
- PacIOOS forecasts for potential wave inundation featured in new “Homeowner’s Handbook to Prepare for Natural Hazards in the RMI.”

Water Quality

- Co-investigators agreed upon QARTOD tests that make sense for the region to employ.
- Continual maintenance of all 13 water quality sensors (NSS) throughout region.
- Continual service of Hilo Bay water quality buoy (WQB) off Hawai‘i Island.
- Received and vetted proposals for the pilot project called the PacIOOS Water Quality Partnership Program. Choose 2 initial projects—one with the Coral Reef Research Foundation to monitor a mesotrophic reef in Palau, and one in Pohnpei, FSM with Dr. Kevin Rhoades to measure water quality at a grouper spawning aggregation site.
- Mentored undergraduate students that help maintain the PacIOOS NSS.
- Continued discussions with Kiholo Bay community over concerns of WQB in seascape.
- Leveraged funding from UH Sea Grant, PacIOOS, and NOAA OAP to maintain existing MApCO₂ buoys off O‘ahu.
- Numerous presentations and several new peer-reviewed journal contributions associated with the automated CO₂ measurements using MApCO₂ buoys.
- “Climatology” paper in progress to include all 2015 MApCO₂ buoy data in progress.
- Forged collaboration with Dr. Andersson at SIO to study how bleaching affects the inorganic carbon geochemistry of reef waters in Kāne‘ohe Bay. Sampled Bay at more than 60 locations to calculate the entire inorganic carbon system.
- Continued background synoptic (bottle) sampling of seawater at the MApCO₂ buoys.
- Data from the MApCO₂ buoys are available online at PMEL website and accessible via PacIOOS Ocean Acidification project page.
- MApCO₂ buoys serve as test-beds for new instruments. Entered new collaboration with PMEL to develop/test benthic inorganic carbon sensors in Kāne‘ohe Bay.

Ecosystems and Living Marine Resources

- Quantitative modeling and analysis of movement patterns of tiger sharks around Maui and O‘ahu in order to prepare the results for publication.
- Positional data from previously tagged sharks continued to be collected via Argos and land-based receivers.
- Inspections of sites for future installation of land-based receivers; systems ordered.
- One adult Hammerhead shark was tagged off Kāne‘ohe Bay with a fin-mount SPOT tag in order to assess the utility of hammerheads for future studies - results very good so far.
- PacIOOS-supported tracking data were presented at two international Symposia (Halifax, Canada and Plymouth, UK).

2.5 Data Management and Communications (DMAC)

PacIOOS data management group (DMG) ensures the data collected by PacIOOS are stored and accessible to users via standard services. In addition, the DMG develops tools and products based on the collected data. DMG accomplishments include the following:

- Over 3,000 unique visitors (via direct external access to our servers) accessed more than 730,000 pages in our servers and transferred over 290 GB of data.
- New data holdings added to the PacIOOS servers and Voyager include:
 - O‘ahu HFR surface currents extended for the leeward coast;
 - Hilo Bay HFR surface currents;
 - 55 new bathymetry data sets and various enhancements (e.g., hillshades, etc.) for locations throughout the PacIOOS region;
 - New dolphin and whale tracks from Cascadia Research Collective;
 - Day/Night indicator;
 - Global cloud imagery;
 - PacIOOS Kwajalein Wave Run-Up Forecast; and
 - Digital Elevation Models (DEMs) for locations throughout the PacIOOS region.
- Completed new Liquid Robotics Wave Glider® project page.
- Continuously work with data and technical staff in each of the focus areas to improve user experiences and access to products and data.
- All of DMG continues to work toward meeting all of the IOOS goals and requirements.
- Revised the DMS plan to address requirements for certification application.
- Collected information from researchers for QARTOD implementation.

2.6 Education, Outreach and Public Awareness

PacIOOS Website/Brand Development

- During this reporting period, the PacIOOS website was visited by over 112,000 users and had more than 665,000 page views. Shark tracking and wave buoy pages continue to be the most visited pages on the website.
- To provide web users with a modern and more user-friendly website, PacIOOS initiated a website redesign. During this reporting period, the emphasis was to develop the custom built design and navigation in conjunction with a content management system (CMS). The team continues testing the integration of PacIOOS data tools into the CMS.
- A new brand identity for PacIOOS will be revealed with the website launch.

PacIOOS Social Media

- Enhanced presence on social media, especially Facebook and Twitter, with increased frequency of posts to continuously engage audience.
- PacIOOS' Ocean Tech job opening reached more than 8,000 users on Facebook (through both organic and paid reach); PacIOOS experienced an increase to nearly 1,200 page "Likes" on Facebook; 160 users are following PacIOOS on Twitter.

PacIOOS Communications

- Continue to publish and distribute monthly e-newsletters.
- Over 70 new contacts added to newsletter mailing list, for a total of 1,370 recipients.
- Presentations at various events, including Waikīkī Aquarium's World Ocean's Month series; Teacher Training Workshop on Majuro, Marshall Islands; Climate Change Observations Workshop in Noumea, New Caledonia; Career Mixer at Kapiolani Community College; NOAA's Marine Planning Portal Network on Citizen Science data.
- Continue to produce updated and relevant flyers and materials for workshops, conferences, partner meetings, and general outreach.
- Collected/published success stories illustrating value of PacIOOS data and services.
- Increased public awareness and interest in PacIOOS with targeted, engaging press releases resulting in media coverage in Honolulu Star Advertiser, UH media, Kaselehlie Press, Micronesia Challenge News, and Saipan Tribune.
- Additional media coverage in a variety of news outlets, including Civil Beat, Huffington Post, Saipan Tribune, Midweek, Palau Community College Mesekiu's News, and St. Croix Source.

Collaborative Efforts/Events

- Continue to run kiosks in collaboration with COSEE Island Earth at University of Guam, College of Marshall Islands, Windward Community College Library, Hawai'i State Art Museum, Kailua Sailboards & Kayaks, Maui Ocean Center, Whalers Village (Lahaina, Maui), UH Maui College, Dolphin Quest (Kohala Coast, Big Island), Mokupāpapa Discovery Center (Hilo), and Kauai Community College.
- Initiated partnerships with high schools on O'ahu - Punahou, Iolani, and Kamehameha Schools to access and use real-time water quality data on Voyager.
- Continued partnership with C-MORE Scholars to mentor undergraduate students to help maintain PacIOOS water quality sensors and complete a project using the sensor data.
- Exhibits and partner support at multiple events, including North Shore Ocean Fest, Kewalo Basin Clean-up, SOEST Open House, Family Night at the Waikīkī Aquarium, Marine Educators' Night.
- Public Service Announcement in American Samoa to raise awareness about wave buoy.

2.7 National and International Collaborations

- PacIOOS continues to participate in all IOOS and IOOS Association calls and meetings.
- Melissa Iwamoto served on the Executive Committee of the IOOS Association Board.
- Chris Ostrander also remains a member of the IOOS Association Board.
- Chris Ostrander continues to serve on the IOOS Federal Advisory Committee.

- Chris Ostrander continues to serve on the Indo-Pacific Oceanography Reference Group (UNESCO-IOC).
- Chris Ostrander and Jim Potemra continue as members of the Advisory Committee for the Pacific Islands Global Ocean Observing System (PI-GOOS).
- Jim Potemra participates in monthly DMAC conference calls and marine portal forum.
- Melissa Iwamoto and Chris Ostrander represented PacIOOS at the annual IOOS Association meeting in September in St. Petersburg, FL.

3.0 SCOPE of WORK (Plans for next 6 months)

3.1 User Needs, Stakeholder Input and Partnerships

- Continue to work with partners to identify user needs and areas of synergy/collaboration.
- Visit interisland stakeholders within Hawai'i (e.g., Maui and Kona, Hawai'i Island).
- Visits planned to FSM, Guam, Saipan, and RMI planned for next reporting period.
- Continue increased engagement with PacIOOS MOA partners.
- Continue working with Young Brothers, Ltd. to determine how to best address their boat captains' needs regarding information inside the Lāna'i boat harbor.
- Continue to explore how to best meet needs of US Pacific Fleet with regard to navigation just outside of Pearl Harbor channel.

3.2 Governance and Administration

- Host Governing Council Executive Committee meeting in Pohnpei, FSM in March 2016.
- Continue to participate in national IOOS activities.
- Continue to meet frequently with PacIOOS PIs and focus area groups.
- Provide staff brief to reinforce the larger vision/big picture of IOOS system.
- Conduct PacIOOS administration and effectively staff the program.

3.3 Business/Operations Plan

- Conduct annual internal evaluation.
- Continue to identify and leverage funding and partnership opportunities with partners.
- Continuously update DMAC Plan and begin to collect input for update of Strategic Plan.

3.4 Observing System Implementation Activities

Ocean-State

- Maintain array of 13 wave buoys throughout PacIOOS region.
- Buoy/mooring swaps planned for Ipan (Guam) and Pauwela (Maui).
- Finalize new location for Majuro wave buoy with partners.
- Wave buoy redeployments planned for Ipan, Aunu'u (American Samoa), and Majuro.
- Potential site visit of wave buoy staff to CDIP to learn more about their operations.
- Continue to implement new back-up line with all new wave buoy moorings deployed.
- Nine of the PacIOOS wave buoys need a firmware upgrade for the GPS board replacement. Will look into cost benefit of various options to implement the upgrade.
- Continue to maintain and operated 7 HFR stations on O'ahu and Hawai'i Island.
- Increase operating antennae at Chevron HFR from 8 to 16.
- Move remaining 5 HFR stations over to new frequency (13.5 MHz) for ocean observing.
- Conduct boat calibration for all HFR sites.

- Repair fence at Kalaeloa site, which is deteriorating due to salt-spray corrosion.
- Work on obtaining a renewal of our FCC license for HFR stations in Hawai‘i (current license expires in summer 2016).
- Work on obtaining new Intergovernmental Agreement with City and County of Honolulu for Kokohead HFR installation.

Forecasting

- Continue to operate and maintain PacIOOS ROMS, WRF, WW3 and SWAN models.
- GOES-R will be launched in 2016. In collaboration with NWS, PacIOOS will conduct applications of satellite data for model initialization and verification to improve weather forecasting in Hawai‘i.
- Work with ATN to assimilate oceanographic data from animal tags into ROMS.
- We have not yet been able to launch a PacIOOS glider run this fiscal year as planned due to hardware issues and a lack of available gliders from the UH Glider Facility.
- Ingest new HFR data into ROMS models.
- Develop an ensemble ROM forecast to increase accuracy.

Coastal Hazards

- Ongoing maintenance of existing products.
- Continue re-analysis of PacIOOS Wave Run-Up Forecasts along the North Shore of O‘ahu in order to improve forecast process for multiple locations along the coast.
- Continued field validation of the inundation forecasts to fine-tune the inundation forecast.
- Finalize an automated solution to monitor uptime for PacIOOS performance measures.
- Examine methods and potential to forecast inundation events on Majuro due to Westerly winds, which are caused by a shift in the regional systems due to El Niño and are catching people off-guard.

Water Quality

- Continue service and maintenance of all 13 water quality sensors (NSS).
- Continue to maintain Hilo Bay water quality buoy (WQB).
- Continue student projects associated with Hilo Bay WQB.
- Continue implementation projects in Palau and Pohnpei, FSM under PacIOOS Water Quality Partnership Program; initial phases of instrument pool implementation.
- Deploy Kawaihae WQ Buoy (Pelekane Bay) in NOAA Habitat Blueprint area.
- Previous agreement reached with community to deploy Kiholo Bay WQB again for a pre-determined time frame now not acceptable to community. Now discussing locations.
- Continued maintenance of existing MA_pCO₂ buoy in Kāne‘ohe Bay.
- Complete “climatology” paper to include all 2015 MA_pCO₂ buoy data in progress.
- Continued collaboration with Dr. Andersson at SIO to study how bleaching affects the inorganic carbon geochemistry of reef waters in Kāne‘ohe Bay.
- Continued background synoptic (bottle) sampling of seawater at the MA_pCO₂ buoys.
- Data from the MA_pCO₂ buoys will continue to be available online at PMEL website and accessible via PacIOOS Ocean Acidification project page.
- MA_pCO₂ buoys will continue serving as test-beds for new instruments, including PMEL collaboration to develop and test benthic inorganic carbon sensors in Kāne‘ohe Bay.

Ecosystems and Living Marine Resources

- Continue participation in IOOS ATN Initiative with acoustic receivers.
- Continue to provide near real-time shark tracks on PacIOOS website.
- Deploy land-based receivers on O‘ahu to implement next phase of operational system for acquiring and disseminating oceanographic and behavioral data telemetered from tagged sharks around the main Hawaiian Islands.

3.5 Data Management and Communications Subsystem (DMAC)

- Continue to maintain the system and address data management issues as they arise.
- Continue close collaboration with PacIOOS management and communications.
- Continue to create relevant Project Pages for partners.
- Continue expansion and addition of data into PacIOOS Voyager and Voyager mobile.
- Continue improvement of utility and map styles for Voyager.
- Continue meeting IOOS DMAC protocols.
- Hire replacement to fill empty web product developer position (former developer left to pursue graduate school in New York).
- Finalize internal QARTOD implementation, as described in RICE certification MOA.
- Continue migration of data services to newer machine.
- Test functionality of new web pages.
- Continue with efforts to include real-time weather station data into PacIOOS data servers (e.g., Palau and Kāne‘ohe examples).

3.6 Education, Outreach and Public Awareness

PacIOOS Website/Brand Development

- Finalize redesign of PacIOOS website to enhance user-friendly access to available tools and data. This outcome has been delayed due to technical difficulties encountered with integrating our interactive data tools with the new website architecture.
- Incorporate new PacIOOS branding into outreach and communications materials, in conjunction with release of new website.

PacIOOS Social Media

- Continue to engage stakeholders through regular social media posts.

PacIOOS Communications

- Continue to provide and create electronic and printed outreach materials.
- Continue to publish and distribute press releases on compelling aspects of PacIOOS.
- Continue to identify and publish PacIOOS success stories.
- Target specific user groups to conduct more outreach (e.g. fishing clubs).

Collaborative Events/Efforts

- Continue to present and participate in local events (Waikīkī Aquarium, NOAA Pacific Risk Management ‘Ohana, etc.).
- Increase usage of PacIOOS Voyager classroom activities to raise awareness and enthusiasm for ocean data in secondary and undergraduate classrooms.

- Continue to work with high schools on O‘ahu - Punahou, Iolani, and Kamehameha Schools - to access and use real-time water quality data on Voyager.
- Continue to partner with C-MORE Scholars to mentor undergraduate students to maintain PacIOOS water quality sensors and complete projects using sensor data.
- Collaborate with UH Hilo and Mokuāpapa Discovery Center to develop curriculum based on the Hilo HFR data.

3.7 National and International Collaborations

- IOOS Meeting and IOOS Board Meeting in Washington, D.C., March 2016.
- Continue participation in IOOS Association, IOOS FAC, and IOOS DMAC.
- Continue participation with the WMO/IOC Data Buoy Collaboration Panel (DBCP) efforts to build capacity for observations and data applications in the Pacific Islands.

4.0 Personnel and Organizational Structure

No changes in key scientific or management personnel occurred during this reporting period.

5.0 Budget Analysis

Spending is mostly on track with projected program expenditures; however, due to some extenuating circumstances, including staff turnover and vehicle availability limitations with the UH glider facility, some individual component spending has been delayed. In addition, funding for the 2-year NWS-supported project for ship-based tsunami detection and characterization was not received until June 2015. We anticipate that we will need to request a no-cost extension during the next reporting period, as we have been unable to quickly fill some DMAC and technical staff positions following the departure of individuals.

The University of Hawai‘i Office of Research Services submitted a semi-annual financial report for the period ending 9/30/2015, through Grants Online. That report showed total receipts of \$9,889,567.26.

As of 11/30/2015, internal budget tracking shows receipts of \$10,420,780.84, representing a draw down of 85% of the Federal funding for this award near the end of the performance period.

Semi-Annual Supplemental Information (from December 1, 2014 - November 30, 2015)

Products and Services

- Regional Products or Services
 - The main PacIOOS servers (for website and modeling) were re-located to the new UH IT Center for an improved uptime.
 - **PacIOOS Voyager** improvements include:
 - New format for coordinates, based on user feedback and requests;
 - Improved loading time of Voyager by 3 fold, responding to user feedback;
 - Aloha Cabled Observatory live acoustic and video feeds;
 - Plots of the ALOHA station data (T, salinity, O₂, and currents);
 - Expansion of underwater cables data set;
 - New biology-related satellite data sets derived from the MODIS:
 - Chromophoric (colored) dissolved organic matter (CDOM),
 - Particulate organic carbon (POC), and
 - Particulate inorganic carbon (PIC);
 - NOAA Sea Level Rise data sets;
 - High Resolution Global 1-km Sea Surface Temperature (GISST) daily composite produced by NASA JPL;
 - Coastlines of islands in PacIOOS region;
 - O‘ahu HFR surface currents extended for the leeward coast;
 - Hilo Bay HFR surface currents;
 - 55 new bathymetry data sets and various enhancements (e.g., hillshades, etc.) for locations throughout the PacIOOS region;
 - New dolphin and whale tracks from Cascadia Research Collective;
 - Day/Night indicator;
 - Global cloud imagery;
 - PacIOOS Kwajalein Wave Run-Up Forecast; and
 - Digital Elevation Models (DEMs) throughout the PacIOOS region.
 - PacIOOS “**Project Pages**” - serving as a repository of ocean and coastal program and project data collected by researchers, NGOs, community groups, and partners throughout the Pacific for a service fee. New “project pages” include:
 - Ocean Acidification page with an interactive map viewer, in partnership with NOAA PMEL;
 - Page for City and County of Honolulu’s Mamala Bay study;
 - Beta version of a project page with an interactive map viewer on the estimated coral cover in Hawai‘i in partnership with the Hawai‘i Institute of Marine Biology;
 - Interactive map viewer on predicted shorelines based on erosion rates and sea level rise in partnership with the UH Coastal Geology Group and the State of Hawai‘i Office for Coastal and Conservation Lands for the Hawai‘i Interagency Climate Adaptation Committee.
 - Liquid Robotics Wave Glider® project page.
 - Revised PacIOOS Wave Run-Up Forecast for Majuro.
 - Released new PacIOOS Wave Run-Up Forecast for Kwajalein.

- National Products or Services
 - Continue to make regional assets available to national data centers and repositories.

Data Management

- PacIOOS is continuously working toward a standards-based foundation for DMAC capabilities. The PacIOOS data management group (DMG) is tasked with ensuring the data collected by PacIOOS are stored and accessible to users via standard services. The utilization of standard web services, in particular OPeNDAP, SOS, and OGC, ensure that PacIOOS has DMAC capabilities that are compatible with the larger IOOS effort. All PacIOOS data services are standards-based, all data are open (although some are redistributed), and the PacIOOS system is service-oriented and uses common vocabulary.
- Updated progress:
 - Open Data Sharing. The PacIOOS DMG provides a mechanism for partners and various individuals to expose their data in standard formats and services.
 - Provision of data to WMO GTS. PacIOOS relies on NDBC to put data on the GTS. Whatever data NDBC receives from PacIOOS servers goes to the GTS. At this point, this includes HFR and wave buoy data.
 - Implementation of a service-oriented architecture. Architecture is the same as before and is considered SOA. Due to instabilities in the host setting, PacIOOS moved to a more robust facility with 24/7 operations.
 - Use of common vocabularies and identifiers. All PacIOOS data are netCDF CF compliant. When there are no appropriate CF names, the PacIOOS DMG uses community standards.
 - PacIOOS continues to use standard metadata conventions. PacIOOS data search tool takes advantage of these metadata and provides both ISO and FGDC formats.
 - Data storage and archiving. Data storage continued throughout the reporting period. Additional data storage include high-resolution wave model output for the extended Hawaiian Islands and additional near-shore sensors in the insular Pacific. Federal archiving is still being worked out with the National Center for Environmental Information (NCEI).
- Examples of on-going program-level participation in data management planning and coordination include:
 - Monthly IOOS DMAC conference calls.
 - Member of IOOS Glider Plan Development Team.
 - Participation in Hawai'i regional Marine Debris response plan (providing data and services)
 - Member of IOOS Biological Data Working Group.
 - Numerous local meetings with regional stakeholders and data providers.

Observing Assets

- Ocean Acidification Platforms: Real-time atmospheric and oceanic carbon dioxide data from 13 moored buoys across the insular Pacific. The three-hourly data are obtained from NOAA's Pacific Marine Environmental Laboratory (PMEL). These data are

available in a new 'ocean acidification' category on Voyager and on the PacIOOS website on an Ocean Acidification project page. The data are also made available for participation in and population of the new IOOS Pacific Ocean Acidification Portal, <http://www.ipacoa.org/>.

In addition, the two $MApCO_2$ buoys in Kāneʻohe Bay continue to be used as test-beds for new instrumentation. Currently, NOAA PMEL is collaborating with Dr. Eric DeCarlo to develop and test benthic inorganic carbon sensors in Kāneʻohe Bay.

- Please see included excel spreadsheet for detailed list of observing assets.