OCEAN EXPLORATION COOPERATIVE INSTITUTE | EXPLORING THE NATION'S BLUE FRONTIER
OCEAN EXPLORATION TRUST | UNIVERSITY OF NEW HAMPSHIRE | UNIVERSITY OF RHODE ISLAND
UNIVERSITY OF SOUTHERN MISSISSIPPI | WOODS HOLE OCEANOGRAPHIC INSTITUTION

Dear Fellow Explorers,

As summer wanes and we get our last few beach days in, OECI is continuing to keep up the pace of activities. I'm looking forward to two expeditions that are soon-to-be underway. The first is led by Dr. Leila Hamdan in her investigation of the microbiomes of shipwrecks in Keathley Canyon aboard the R/V *Point Sur* and the second is the Ala ʻAumoana Kai Uli expedition aboard E/V *Nautilus* that will explore in the Papahānaumokuākea Marine National Monument (PMNM), including the site of wrecks near Midway Island. These two expeditions highlight how our cultural heritage is preserved in the marine environment and is closely tied to ocean exploration science questions. Keep a lookout for udpates from these expeditions (an E/V *Nautilus* expedition preview is below) or follow along live.

Adam

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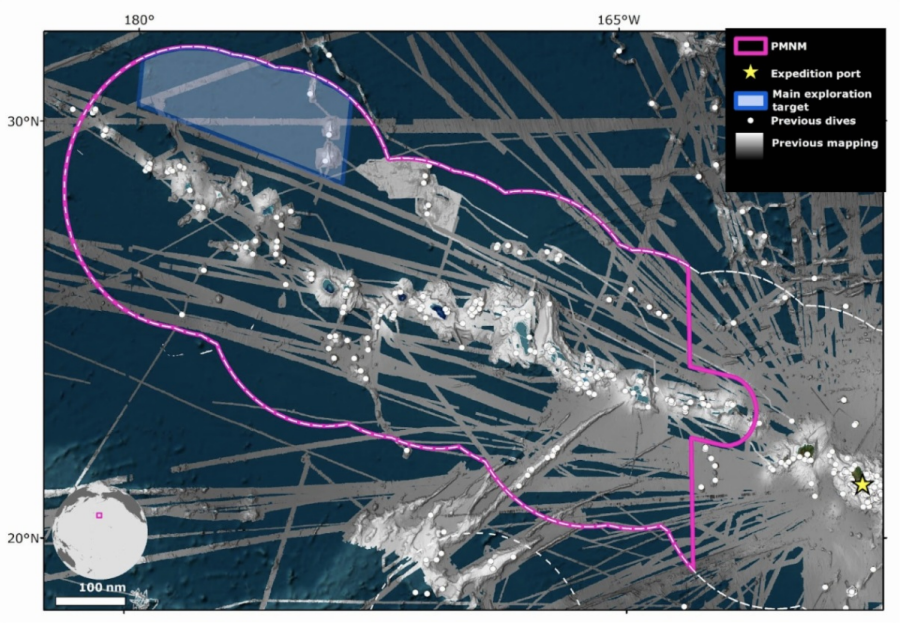
Expedition Preview: Ala ʻAumoana Kai Uli - ROV exploration of the Papahānaumokuākea Marine National Monument (NA154)

From **September 1-28, 2023**, E/V *Nautilus* will conduct a telepresence-enabled expedition that will involve remotely operated vehicle (ROV) dives and seafloor mapping in the Papahānaumokuākea Marine National Monument (PMNM). Funded by NOAA Ocean Exploration via the Ocean Exploration Cooperative Institute (OECI), the expedition will target the largely unexplored northwestern section of the Monument. This area includes numerous previously unexplored seamounts of biological and geological significance, as well as several underwater cultural heritage sites associated with the Battle of Midway.

Like all OECI-funded E/V *Nautilus* expeditions, the mission will include several opportunities to participate remotely, including by signing up as Scientists Ashore, watching live streams, accessing expedition content online, scheduling a ship-to-shore interaction with the team at sea, or following the expedition via Ocean Exploration Trust's YouTube, TikTok, Instagram, Twitter, Facebook or LinkedIn social media accounts.



Cloud-based, Bathymetric Data Access and Processing for the Future

A fundamental component of ocean exploration is the bathymetry of the seafloor, which provides a base map for all other studies. Generating a stable, reliable estimate of the seafloor depths from raw data is not trivial, and requires specialist software and training for the operators. Since it may not be possible to have specialists on board each expedition, there is significant benefit in having the data leave the ship for a cloud-based storage, and allowing the specialists to operate on it from shore. Keeping the data in the cloud also makes it simpler to manage the data, and move it through all stages of its life cycle.

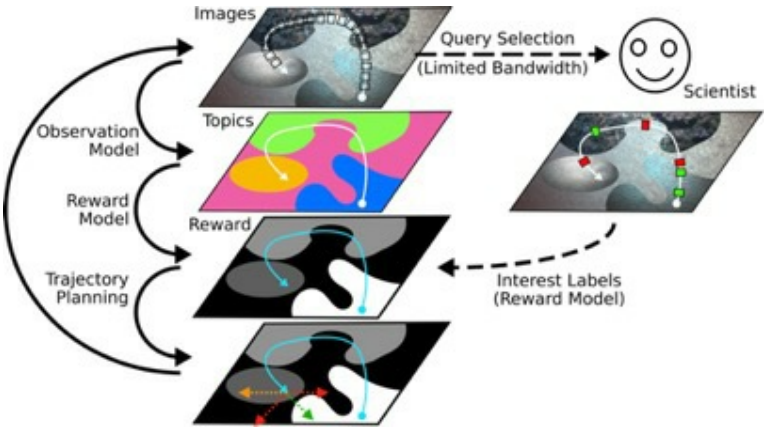
Having previously demonstrated that current (desktop) software deployed in the cloud was unable to take advantage of cloud-style resources, the CloudMap project aims to facilitate a cloud-based future by prototyping a cloud-native bathymetry processing system. This will allow multiple users to simultaneously access and process a single collection of bathymetric data using advanced Virtual Reality (VR) interaction techniques, and a compute system that scales according to the data such that the response time to data changes is always (essentially) imperceptible. Currently, the CloudMap team is building the components of the (micro-service) architecture, and expect to have a prototype system for testing by the end of 2023.

Advancing AUV Autonomy with Machine Learning and Co-Exploration

Presently, ocean exploration and mapping using autonomous underwater vehicles (AUVs) is efficient and convenient in terms of logistics and costs. However, this approach may be limited by the narrow bandwidth of acoustic communications, which impedes multibeam survey data and/or seafloor images from being analyzed in real time and/or transferred to the supporting ship.

This project is a joint effort between the University of Southern Mississippi (USM), in partnership with the University of Louisiana Lafayette (ULLA), Center for Computational Geosciences, and the Woods Hole Oceanographic Institution (WHOI). The project is organized into three complementary components. Two components are devoted to the development of machine learning (ML) algorithms for in-situ seabed exploration, and a third component consists of Co-Exploration (CoEx) hardware and software development necessary to run these algorithms on subsea platforms. Currently, the USM-ULLA team is exploring a "supervised approach" for seabed

classification. Standard supervised ML tools such as Direct Neural Networks, Dictionary Methods, and Support Vector Machines are being tested on legacy multibeam data collected by the AUV *Sentry*. The team is trying to rapidly analyze a large amount of multibeam data to directly identify "geomorphic units" such as seeps, coral reefs, mounds, etc.



The WHOI team is working on a complementary approach based on "unsupervised" terrain characterization on high resolution video images. This method relies on operators supplying annotations in real time and directly leverages a Co-Ex guided mission strategy. The unsupervised learning is used to compute a low-dimensional semantic (topic) representation of the world in real-time. The system then produces autonomously generated annotation queries to learn a reward function that represents the scientist's interest. The WHOI team conducted preliminary testing of this approach to control the vision speed of a CUREE robot, training it on the fly to slow down over coral covered regions, and speed up over other regions. This initial experimentation did not use acoustic communications, but instead, simulated low bandwidth by limiting the rate of images that are sent topside for annotation.

This dual effort combines the strengths of both supervised and unsupervised approaches, the first being suited for sites similar to existing labelled data, the second suited to new and unknown environments.

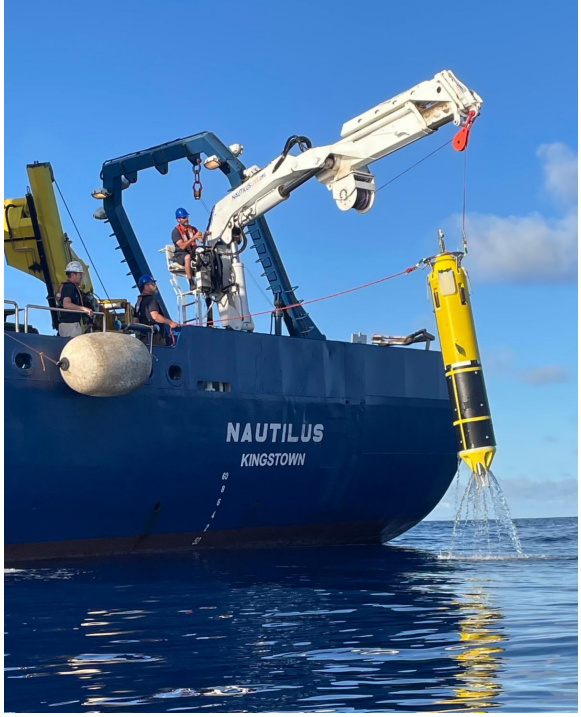
Carbon Sequestration: Sinking Carbon Flux in the Gulf of Mexico

Unlike on land, the base of the oceanic food chain is on the top, where sunlight reaches. Plants like algae can grow there, which in turn are eaten by small animals called zooplankton, which are then food for fishes and larger animals. Sloppy feeding by fishes as well as the breakdown of all of this organic matter leads to the sinking of "marine snow", or particles that sink into the ocean depths carrying carbon into the deep that was originally carbon dioxide from the atmosphere.

OECI-supported researchers are exploring the sinking rate of this carbon in different areas of the ocean, first in northern Gulf of Mexico, by deploying water pumps on a wire from a ship that can filter out all of the marine snow at different depths in the water. By making some chemical measurements on the collected particles, they can quantify the sinking of carbon which is important both for the global climate as well as the food supply for deep sea communities that live on the seafloor.

Ocean Technology Innovation to Explore the Hadal Zone

The Hadal Water Column Profiler (HWCP) is a unique, autonomous, multidisciplinary instrument developed at the University of Hawai'i to study the water column in the hadal



zone (the deepest region of the ocean, extending from 6,000 to 11,000 meters [3.7 to 6.8 miles]). Deep ocean trenches remain at the frontier of ocean exploration due to the immense pressures and difficulties with wire-lowered instrumentation at these depths.

The HWCP measures temperature, conductivity, dissolved oxygen (each with redundant sensors), horizontal current velocity, turbulent mixing (microstructure), video, and 200 kHz bioacoustics, as well as having a small 11-bottle water sampler. Initial tests showed that the HWCP was a fully functional, deep ocean profiler but needed more sea time to optimize descent, ascent, and rotation rates. Scientists and engineers were fortunate to be offered time on the E/V *Nautilus* shakedown cruise (NA147) in April 2023 to begin this optimization process, conducting five successful deployments. An additional three, 4-day cruises (NSF funded) are planned aboard the RV *Kilo Moana* for testing and optimization over the next six months.

Announcements, Events, and Opportunities

2024 US GO-SHIP Post-Doctoral Fellowship Announcement

Applications are now being accepted for U.S. GO-SHIP Post-doctoral Fellowship positions beginning in 2024. This position is for two years. It includes a choice of GO-SHIP associated advisor and the option of becoming the co-chief scientist on an upcoming U.S. GO-SHIP cruise. **Deadline for applications is September 22, 2023.**

Please see the US GO-SHIP website for more details. Questions can be directed to Alison Macdonald (amacdonald@whoi.edu).

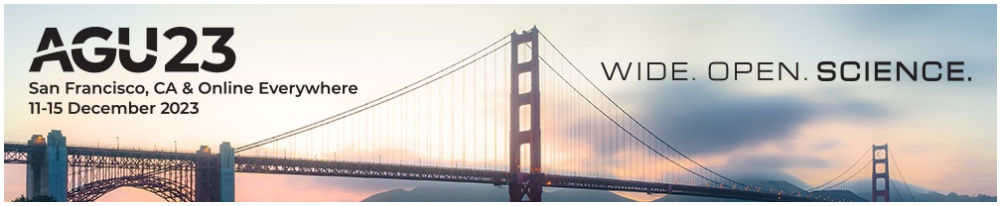
OCEANS 2023, September 25-28, 2023

The OCEANS 2023 Gulf Coast conference is coming up at the end of this month at the Mississippi Coast Coliseum & Convention Center! Several OECI-affiliated scientists and students will be in attendance and/or presenting. We hope to see you there!

AGU Fall Meeting, December 11-15, 2023

Will you be attending and or presenting about your OECI-funded research at the upcoming

American Geophysical Union (AGU) December 2023 conference? Please be sure to let the OECI Executive Office know (email holly_morin@uri.edu) as we are compiling a list of sessions to share in a future newsletter!



Ocean Sciences Meeting, February 18-23, 2024

The **abstract submission deadline** is quickly approaching (**23:59 EDT/03:59 +1 GMT on September 13, 2023**) for the next Ocean Sciences Meeting in New Orleans, LA. A diversity of scientists, students, journalists, policymakers, educators, and other professionals are encouraged to submit an abstract to 2024 event.

Please make note there are several NOAA Ocean Exploration and/or OECI-aligned sessions to submit to including:

- ***Collective Solutions to Global Deep Sea Challenges: Advancing Ocean Exploration and Observing Through Large-Scale Collaborations and Technological Advances*** (Deep Sea Processes and Exploration, DS002)
- ***Building a More Equitable, Inclusive, and Diverse Ocean Workforce Through Mitigating Barriers and Broadening Access to STEM Education and Early Career Opportunities*** (Education and Public Engagement, ED003)
- ***Increasing Ocean Literacy, Action, and Responsible Decision-making for the Ocean*** (Education and Public Engagement, ED008)
- ***Oceans Tell Stories Through People*** (Education and Public Engagement, ED016)
- ***One Byte at a Time: Sharing Best Practices, Standard Operating Procedures (SOP), and Data Standards to Support Ocean Mapping, Exploration, and Characterization*** (Education and Public Engagement, ED017)

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