ORE OCEAN AND RESOURCES ENGINEERING since 1966
IN THE SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY AT THE UNIVERSITY OF HAWAI'I AT MĀNOA

HANA O KE KAI

"Work of the Ocean"

NEWSLETTER OF THE OCEAN AND RESOURCES ENGINEERING DEPARTMENT, Spring 2021, Volume 24, Issue 1

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Chair's Message

Eva-Marie Nosal, Chair

We've blazed past the 1 year mark of the COVID-19 pandemic so suddenly, deeply and directly altering our work and lives. I'm very thankful for the way that students, faculty, and staff have adapted with resilience, creativity, and compassion. ORE has sailed steadily onward, with an efficient shift to remote operations, improvements to our graduate programs, progress on impactful research and engineering projects, development of new labs, and increased research productivity and grantsmanship.

ORE has seen several large changes since our last newsletter. We welcomed new faculty member Dr. Ellen Briggs as Assistant Professor in the Summer of 2020. Dr. Briggs specializes in marine sensor development and instrumentation, and her expertise bring a very welcome addition to the "hands on", instrumentation, and oceanographic engineering capacity of the department. You can read more about Ellen's work in this newsletter. In another personnel development, ORE bid farewell to Natalie Nagai, who retired in early 2021 after over 12 years of service as the ORE administrative staff, and over 30 years of service at UH. Ho'omaika'i 'Ana Ma Kou Likaia Natalie. Despite extreme uncertainty and budgetary strain, UH leadership graciously granted ORE an exception to the UH-wide hiring freeze that allows us to re-hire to fill the essential role of ORE administrative staff. In the meantime, the efficient and ever-positive Kellie Terada has been keeping the ORE office running smoothly. Thank you Kellie, and thank you to the many others across SOEST who have stepped up to help. In a program development, ORE rolled out an Individual Development Plan (IDP) program for students. IPDs are modeled after a highly successful program developed for UH's 'Ike Wai project (many thanks to Barb Bruno of the Hawaii Institute for Geophyics and Planetology and Deb Eason of Earth Sciences for developing and sharing the programs). IDPs are "a personal action plan designed to help graduate students and postdoctoral scholars set and achieve their academic and career goals. By providing a simple framework for self-reflection and long-term goal-setting, they help trainees be proactive and purposeful about their professional development". You can read more about IDP's here and here. Among other successes, I'm also very proud of and excited for Team Halona, who won the Department of Energy sponsored 2020 Marine Energy Collegiate Competition and the 2021 Ocean Observing Prize – read more about their successes in this edition.

We are very fortunate that many members of the UH community have already been vaccinated, and that there has been significant progress of vaccinations state and nation-wide. UH leadership is moving carefully and purposefully towards a reopening of the UHM campus for the Fall 2021 semester (details as updates available here). I extend my sincere gratitude to my colleagues, ORE students, staff, engineers, co-workers and SOEST and UH leadership for your perseverance and forward-moving energy. I look forward to tackling the next few months with you, and hopefully to seeing you in person soon.

Inside ORE

SMART Cables for Observing the Ocean and Earth

Bruce Howe,
ORE Research Professor,
Chair JTF SMART Cables

The Joint Task Force for Science Monitoring And Reliable Telecommunications (JTF SMART) Subsea Cables is facilitating the integration of environmental sensors into trans-ocean commercial submarine telecommunications cables toward a planetary scale array that monitors ocean climate and sea level rise. The network will revolutionize real-time warning systems for earthquake and tsunami disaster mitigation. The first major SMART project is underway in Portugal.

The Portuguese Government, with guidance from its telecom regulatory agency ANACOM, directed that the new CAM ring (Continent-Azores-Madeira) "… enhance the use of submarine cables … such as seismic detection, environmental monitoring … Oceanography, Geophysics and Environment …." This culminated in the announcement in September describing the scope, implementation and funding for deployment starting 2024.

Continued on page 3

Editor's Corner

Grant Peel, ORE TA

Another semester is in the books. While Covid-19 has continued to keep us physically separated, and Zoom still fills most of our days, we finally have a light at the end of the proverbial tunnel. With vaccinations becoming more widespread and case numbers beginning to decline; it is looking like we will be able to enjoy a more traditional academic year. After starting my academics during the pandemic and operating remotely from Alaska, I cannot wait to meet some of the wonderful folks I've been told so much about. I'd like to thank the ORE department as a whole for welcoming me as not only a new student, but also one of the department TA's. I hope you all enjoy this version of Hana O Ke Kai!

Department News

David Leyva defended his MS Thesis "Uncertainties of Multi-Decadal Buoy and Altimeter Observations" in July 2020

Lin Sun defended her MS Thesis "Relationships Between Tsunami Size and Earthquake Magnitude Improved by Fault Parameters" in August 2020

Cameron Morrow defended his MS Thesis "A Fatigue Analysis of the No-WEC Mooring System at the U.S. Navy Wave Energy Test Site off O'ahu, Hawai'i" in December 2020

The UH Student Section was honored as the 2020 Outstanding Student Section of the Marine Technology Society

Inside ORE

SMART Cables for Observing the Ocean and Earth continued from p.2

To complement this, Alcatel Submarine Networks issued a press release: "Climate change is one of the major challenges that our society as a whole is facing today. … Our entire portfolio will benefit from this new "CC" (Climate Change) philosophy to propose dedicated applications such as TEWS (tsunami early warning system), monitoring of underwater seismic activity, global warming, and water temperature and level. … From now on, tackling climate change is an intrinsic part of our strategy and will drive our decisions."

These two events together show there is a demand (with funding) and a supplier willing to implement, two steps the JTF has been striving toward for the last decade. The CAM system and others in various stages of planning and funding are perfect examples of the "Big Tech" Blue Economy, potentially (and optimistically!) about 10 percent of the $5B/y global submarine telecommunications industry.

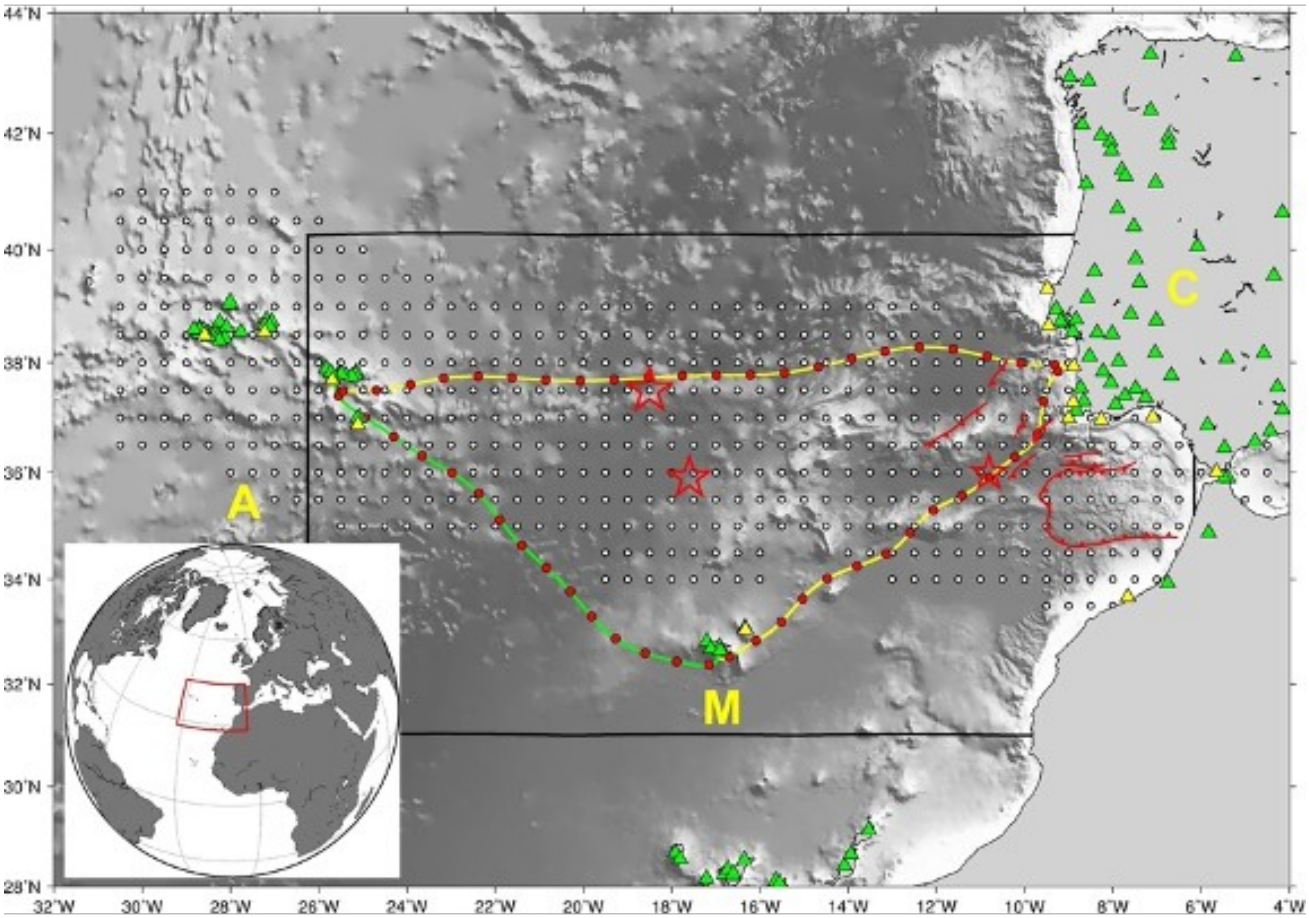

Figure. The CAM system with repeaters and sensors shown in red (seismometers (green triangles) and tide gages (yellow triangles); white dots represent a simulation test grid; this map is preliminary). The red stars show the location of 3 M>7.7 large earthquakes that occurred in the 20th century and caused small tsunamis. The location of the 1st November 1755 earthquake is uncertain; shown are the tectonic faults that have been suggested to be at the source of that event. There are 3700 km of cable, about 50 repeaters, estimated cost €120M, and ready for service in the 2024 time frame. The science group Listening to the Earth under the Atlantic (LEA) is working with Infrastructure Portugal Telecom to implement the system.

Inside ORE

Team Hālona WEC wins the 2020 Marine Energy Collegiate Competition

Stefan Mrozewski, ORE MS Student

Nic Ulm, ORE PhD Student

Led by the Office of Energy Efficiency and Renewable Energy and managed by the National Renewable Energy Laboratory on behalf of the U.S. DOE's Water and Power Technologies Office, the 2020 Marine Energy Collegiate Competition (MECC) challenged multidisciplinary teams comprised of undergraduate and graduate students to develop adaptable solutions to support the "blue economy". The blue economy is defined as "the sustainable use of ocean resources for economic growth, improved livelihoods and jobs while preserving the heath of each ocean". MECC teams were asked to design and explore new opportunities that support blue economy, while furthering the marine energy industry through a business plan competition.

University of Hawaii at Mānoa's team—named the Halona WEC Team—included members from ORE and from the College of Engineering. Graduate students Nic Ulm, Stefan Mrozweski, an Jonathan Wallen and Undergraduate student Maddy Jeske were mentored Dr. Patrick Cross, Program Manager of Marine Energy at Hawaii Natural Energy Institute and ORE cooperating graduate faculty member, with support from 5 additional faculty advisors.

The Halona WEC Team focused on creating a self-charging mobile WEC powered platform that can charge observation platforms and autonomous underwater vehicles. The WEC powered platform is based on the PhD Dissertation work of Nic Ulm and Jonathan Wallen around WEC-based autonomous underwater vehicle docking stations. The geometry of the WEC is inspired by the Halona blowhole on Oahu, which gives the device its name.

Prior to the WEC powered platform's conception, the Halona WEC Team interviewed various government agency oceanographers, professionals at NAVFAC EXWC, offshore industry personnel and marine industry professionals to assess industry needs in order to best design their business plan. Based on their responses, the Halona WEC Team developed a business plan and assessed their marketplace applicability and potential integration as part of the MECC project guidelines. After countless months of work, the University of Hawaii at Mānoa beat out 13 other teams to place first as an overall winner of the MECC, in addition to winning the individual category of best pitch.

"The University of Hawaii at Mānoa's MECC victory is another feather in our cap as we push for greater involvement in the advancement of wave energy for the U.S. Navy, the U.S., and globally," said Cross. "This victory provides us with a very gratifying recognition of our efforts in this area, as we work to expand our research in wave energy generally at University of Hawaii at Mānoa by involving more faculty and students—obviously the students are the critical core of that community."

Additional information is available on the UH Manoa press release:
https://www.hawaii.edu/news/2020/07/30/underwater-vehicle-charging-station/

Figure 1. Picture of the Winning Team!!!

Inside ORE

Team Hālona wins 2021 DOE/NOAA Ocean Observing Prize

Patrick Cross,
ORE Cooperating Faculty Member,
HNEI Marine /Ocean Energy Program Manager

UH Team Hālona was selected as one of seven winners in the joint DOE/NOAA Ocean Observing Prize: DESIGN Contest. Teams were challenged to design a wave-powered ocean observing system capable of collecting key ocean parameters in the context of understanding and forecasting hurricanes/typhoons. Team Hālona proposed a 2-body system – a wave energy converter (WEC) on the surface and a "resident AUV" that can receive a charge and upload its data after docking at the base of the WEC. The AUV is configured to host required sensors – ADCP and CTD – as well as acoustic comms for homing. The system is shown conceptually here:

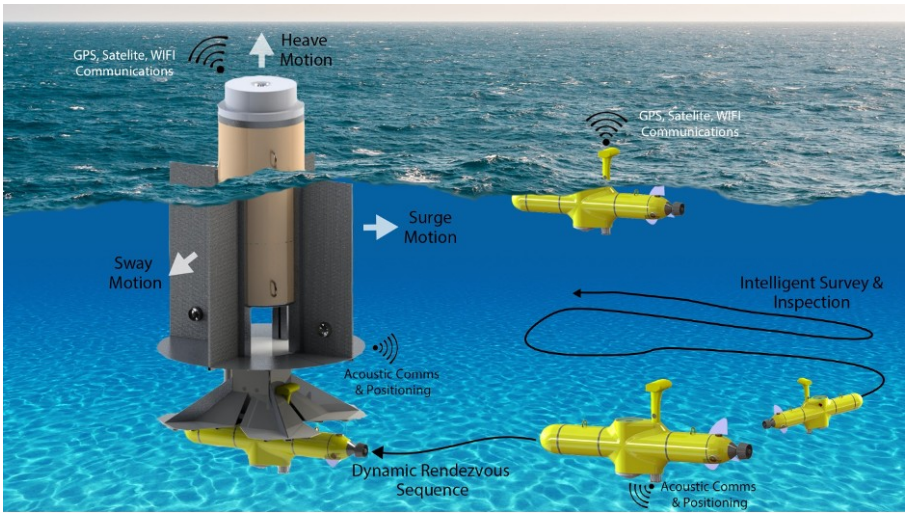

Figure 1. The AUV is configured to host required sensors – ADCP and CTD – as well as acoustic comms for homing

The team was led by PhD students Nic Ulm of ORE and Jonathan Wallen of UHM College of Engineering (CoE), with substantial contributions on the AUV side from Allison Chua of Dalhousie University in Halifax. CoE Masters student Maddyson Jeske made important contributions to the AUV docking design. Team Hālona is advised by Pat Cross, Kumar Rajagopalan (HNEI Assistant Researcher; WEC hydrodynamics), and Kevin Davies (HNEI Assistant Researcher; power management), and Zhuoyuan Song (ME Assistant Professor and ORE cooperating faculty member; AUV docking).

The DESIGN Contest is the first in a 3 part Powering the Blue Economy Initiative by DOE and NOAA. This win qualifies Team Hālona for the next phase – the BUILD Contest – in which they will create prototypes of the Hālona WEC Based Mobile AUV Docking Station. The BUILD Contest will culminate in testing at the Navy's Maneuvering and Seakeeping (MASK) Basin in Carderock, MD in Jan/Feb 2022. The DESIGN winner award pool of $400k will be shared by 6 other winning teams to support their prototypes. Read more here: https://www.energy.gov/eere/articles/doe-and-noaa-announce-winners-ocean-observing-prize-design-contest-launch-build, and stay tuned for future updates. The win builds off a prior victory for Team Hālona in the 2020 Marine Energy Collegiate Competition (the feature of another article in this newsletter).

Team Hālona is seeking support of all flavors in the BUILD phase; please contact Pat Cross (pscross [at] hawaii [dot] edu) or Nic Ulm (ulmn [at] hawaii [dot] edu) if you are interested in helping to fuel their progress.

Inside ORE

New course:

ORE 203 Surf Science & Culture

Justin Stopa, ORE Assistant Professor

Ellen Briggs, ORE Assistant Professor

Justin Stopa, new faculty as of Fall 2018 and a graduate of the ORE department in 2013, created a new course entitled ORE203 "Surf Science and Culture". The course gives an overview of wave science, an essential aspect of ocean engineering. It is meant to serve the undergraduate population at the University of Hawai`i and be an introduction to ocean science and engineering. All course material always back to "surfing". It covers topics such as principles of fluid mechanics, wind-wave growth, wave dispersion, hydrodynamics, nearshore dynamics, and coastal engineering. The course includes typical Western science content and is unique by incorporating other perspectives from Indigenous science, personal intuition, and contemporary perspectives from community members. Several folks from the community participated in the course by providing their perspectives and intuitive observations of ocean dynamics. Some provided unique insights from their cultural background and upbringing in Hawai`i. The course was first offered in Fall 2020 in an online format and had 21 students from a diverse range of majors including students from social and natural sciences. There are currently 11 students enrolled in the Spring 2021 semester.

In Spring 2020, the course was selected by the Center of Teaching Excellence for the enhancement of place-based-learning. The Center of Teaching Excellence will support the purchase of a drone. The drone will be used to capture wave dynamics such as depth-induced breaking waves and link these conditions to the rich description of breaking waves in the Hawaiian language. The images and videos captured will reinforce the course material through visual observations. In addition, the act of planning such field drone missions to capture specific wave conditions reinforces the scientific process and analytical problem-solving skills.

Ellen Briggs (introduced elsewhere in this newsletter) taught the hands-on laboratory position of the course that reinforces the course content. Fall 2020 was the first semester that ORE 203(L) was offered and due to the pandemic, the course was taught in hybrid mode, with some online and some in person activities. The class attracted a variety of non-science majors and for some this may be the only lab class they will take during their undergraduate education. For this reason, Ellen thought it critical to have some hands-on experience which required a little more creativity than in non-pandemic times. A popular lab amongst the students was building DIY tide gauges and deploying out at the UH Marine Center. The class went through an exercise to stepwise assemble and communicate with various parts of the tide gauges including lighting up LEDs, writing to a screen, and saving data from a rangefinder to an SD card all over Zoom. The next week the class met at the Marine Center to build a structure to then deploy the tide gauges over the edge of a seawall and record the distance between the sensor and seawater over the next week. Everyone seemed to enjoy meeting together outside and taking a break from all the screen time! Plus, they got to learn about all the operations that are typically carried out at the Marine Center. Students also performed wave flume experiments, learned about the Kilo Nalu Observatory, and looked at coastal physical data from around Oahu.

Figure 1. Students enjoying their ORE 203 field experience

Inside ORE

New course:

ORE 657 Autonomous Marine Systems

Mike Krieg,
ORE Assistant Professor

A new course has been added to the ORE program to address a lack of material covering maritime robotics. `ORE 657: Autonomous Marine Systems' was developed by Prof. Mike Krieg, one of the department's recent faculty hires, and is intended to introduce the specific design principles and modeling techniques for autonomous surface and underwater vehicles to students with a cursory knowledge of robotics and control theory.

Despite being located next to one of the largest naval shipyards in the country, there is a surprising lack of course material fitting within the category of `Naval Architecture' at UH Manoa. The ORE department already has one of the only exceptions, as the core requirement `ORE 411: Buoyancy and Stability' covers the pitch/roll stability of floating ships and other structures. This new course helps fill in many of the remaining gaps in course offerings. In addition to naval architecture and ship design, oceanic vehicles/robots are a critical component of both the Offshore Engineering and Oceanographic Engineering specialties, which are central components of ORE's program.

The new course is designed to combine traditional analysis techniques with more modern control strategies developed recently to address the unique challenges of marine vessels and give students a well rounded knowledge base. Specifically, this course covers material that is applicable to all mobile robotics, such as coordinate transformations and rigid body mechanics for objects described in non-inertial reference frames. The course covers material that can be considered standard naval architecture analysis, such as modeling performance of marine propulsion, matching ship propulsion to ship resistance, and standard dynamic plant models (e.g. ship steering dynamics). But the course also covers controller design and navigation techniques for marine systems, ranging from traditional linear methods which are sufficient for the majority of applications to more modern, and often non-linear, control strategies such as model-based, sliding-mode, adaptive, and neural-network based controllers. Prof. Krieg hopes that this course will become popular among ORE students and allow for greater specialization in marine robotics.

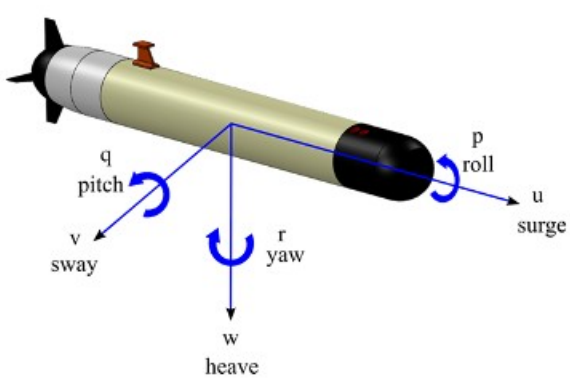

Figure 1. Body-fixed velocities

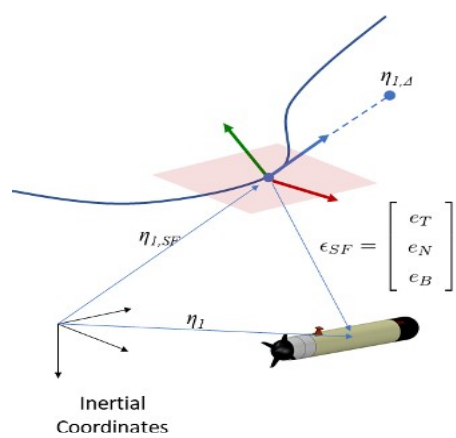

Figure 2. Vehicle position in the Serret-Frenet coordinate system; a trajectory fixed reference frame

New in ORE

Ellen Briggs, ORE Assistant Professor

Dr. Ellen Briggs joined ORE as an Assistant Professor in July 2020 and her primary research interests focus on developing new chemical sensors and advancing chemical sensing technologies for oceanographic research. Briggs received her BS in Chemistry at the University of Illinois at Urbana-Champaign and then received her MS in Earth Science (2014) and PhD in Oceanography (2017) from Scripps Institution of Oceanography, University of California at San Diego.

Briggs is the lead developer of a novel sensor capable of rapid (<60s) and near simultaneous measurement of pH and Total Alkalinity (A_T). Its solid-state construction, small footprint, very low volume requirements, low power consumption, and zero reagent requirements make this sensor ideal for monitoring the aqueous carbon dioxide system *in situ* and from a variety of autonomous platforms. This sensor has numerous potential applications for local- to regional- scale biogeochemical studies including forming carbon budgets and monitoring the marine carbon cycle under climate change, ocean acidification research, porewater studies, and geo-engineering efforts for evaluating ocean-based carbon removal methods to name a few. The ultimate goal is to commercialize the pH-A_T sensor to make it more readily available to the oceanographic community and Briggs' personal benchmark goal is to add this sensor to profiling floats.

Briggs is currently working on a collaborative NSF funded project with lead PI, Christopher Sabine (UH) and Todd Martz (Scripps Institution of Oceanography) to deploy the pH-A_T sensor in Kaneohe Bay on 2 moorings and on 2 drifter packages in order to detect high frequency changes in the aqueous carbon dioxide system due to coral reef metabolism. The primary outcomes of this project are to advance the technology readiness level of the pH-A_T sensor through rigorous field testing and also to better establish the net ecosystem calcification on scales previously not possible with available technologies.

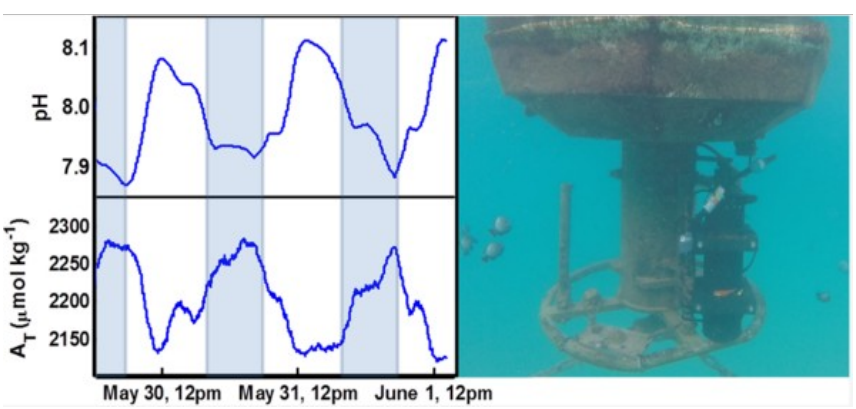

Figure 1. pH and A_T data (left) from the autonomous pH−A_T sensor at CRIMP-2 buoy (right) in Kaneohe Bay demonstrating large diel variability due to the calcifying ecosystem.

Another collaborative NSF grant was awarded this year (lead PI's: Ellen Briggs and Keisha Bahr (Texas A&M), co-I's: Christopher Sabine and Ku'ulei Rodgers (UHM)) to use the pH-A_T sensor for a mesocosm study of which carbonate species (bicarbonate or carbonate ion) is utilized by coral during calcification. The pH-A_T sensor will be used for *in situ* monitoring of the bulk seawater chemistry and additionally, the sensor package will be modified into a microfluidic-type device in order to probe (for the first time ever!) the inorganic carbon chemistry within the boundary layer surrounding the coral head (~mm's).

New in ORE

Jonathan Chapman, ORE MS Student

Jonathan Chapman is a first year graduate student focusing on Oceanographic Engineering and enjoys exploring the various nooks and crannies of the island though surfing, hiking, and snorkeling in his spare time. His research is to determine various oceanographic characteristics from SAR satellite images using machine learning.

Gary Glass Jr., ORE MS Student

Gary Glass is a first year Ocean and Resource Engineering student planning on studying marine robotics and autonomous systems and control. When Gary isn't in class or studying, he likes to spend his time running or in the gym.

Kyle Pappas, ORE MS Student

Kyle Pappas is a first year student, who after spending the spring semester here at UH Manoa plans to join the Ocean and Resource Engineering Department. Kyle plans to focus his studies on wave energy conversion and renewable energy. In his free time, he enjoys playing board games with friends, painting and photography.

Grant Peel, ORE MS Student

Grant Peel is a first year Ocean and Resource Engineering Student. Grant plans to focus his studies on hydrodynamics, coastal and offshore engineering. In his spare time, Grant is the captain of a charter fishing boat that runs out of Homer, Alaska..

Alexander Sidelev, ORE MS Student

Alexander Sidelev is a first year Ocean and Resource Engineering Student. Alexander plans to focus his studies on offshore engineering. In his spare time, he like to work out, go to the beach and read books.

Andrew Storey II, ORE MS Student

Drew Storey is a first year Ocean and Resource Engineering Graduate Student. He is pursuing the coastal engineering track with hopes of applying his knowledge in service to the US Army Corps of Engineers in a future assignment with the Army. Outside of his studies, he enjoys playing board games with friends and celebrating time in Hawaii exploring the outdoors and surfing.

New in ORE

Pat Cross, ORE Cooperating Faculty

Dr. Cross joined ORE as Cooperating Graduate Faculty in the Summer of 2020. Cross is a Specialist at the Hawai'i Natural Energy Institute (HNEI) and holds a PhD in Meteorology from the Naval Postgraduate School. His career includes 20 years as a Naval officer in submarines and meteorology/oceanography, which culminated in a tour as Force Oceanographer for the Pacific submarine force based at Pearl Harbor. Cross spent several years working with a small company managing Navy-funded research projects related to underwater acoustics, including the use of autonomous vehicles and advanced signal processing. He joined HNEI in 2013 to serve as Program Manager for Marine/Ocean Energy programs, including the Navy Wave Energy Test Site (WETS) off Marine Corps Base Hawaii at Kaneohe.

Some Recent ORE Publications

Ainslie, M. A., R. K. Andrew, **B. M. How**e, and J. A. Mercer, Temperature-driven seasonal and longer term changes in spatially averaged deep ocean ambient sound at frequencies 63–125 Hz, J. Acous. Soc. Am., 149 , 2531-2545 (2021) https://doi.org/10.1121/10.0003960

Sharma, S. K., **B. M. Howe**, A. K. Misra, M. R. Rognstad, J. N. Porter, T. E. Acosta-Maeda, and M. J. Egan, Underwater Time-Gated Standoff Raman Sensor for In Situ Chemical Sensing, Applied Spectroscopy, Appl Spectrosc. 2021 Mar 12:37028211001923. doi: 10.1177/00037028211001923, 2021.

Quach, B., Y. Glaser, **J. E. Stopa**, A. Mouche, P. Sadowski, 2020. Deep Learning for Predicting Significant Wave Height from Synthetic Aperture Radar, IEEE Transactions on Geoscience and Remote Sensing, pgs 1-9 doi:10.1109/TGRS.2020.3003839

Cheng, S., **J. E. Stopa**, F. Ardhuin, H. H. Shen, 2020. Spectral attenuation of ocean waves in pack ice and its application in calibrating viscoelastic wave-in-ice models, The Cryosphere, 14(6) doi:10.5194/tc-14-2053-2020.

Bosserelle, C., Williams, **S., Cheung, K.F.**, Lay, T., **Yamazaki, Y.**, Simi, T., Roeber, V., Lane, E., Paulik, R., and Simanu, L. (2020). Effects of source faulting and fringing reefs on the 2009 South Pacific tsunami inundation in southeast Upolu, Samoa. Journal of Geophysical Research: Oceans, 125(12), e2020JC016537

Larson, K.M., Lay, T., **Yamazaki, Y.**, **Cheung, K.F**., Ye, L., Williams, S.D.P., and Davis, J.L. (2021). Dynamic sea level variation from GNSS: 2020 Shumagin earthquake tsunami resonance and Hurricane Laura. Geophysical Research Letters, 48(4), e2020GL091378

Li, N., **Cheung, K.F.**, and Cross, P. (2020). Numerical wave modeling for operational and survival analyses of wave energy converters at the US Navy Wave Energy Test Site. Renewable Energy, 161, 240-256.

Continued on page 11

New in ORE

Some Recent ORE Publications

continued from p.10

Ye, L., Lay, T., Kanamori, H., **Yamazaki, Y**., and **Cheung, K.F**. (2021). The 22 July 2020 Mw 7.8 Shumagin seismic gap earthquake: partial rupture of a weakly coupled megathrust. Earth and Planetary Science Letters, 562, 116879.

M. Krieg & K. Mohseni, A new kinematic criterion for vortex ring pinch-off, Physics of Fluids, 33, 037120, 2021

Lee, CH., **Huang, Z.** Multi-phase flow simulation of impulsive waves generated by a sub-aerial granular landslide on an erodible slope. Landslides 18, 881–895 (2021).

Li, H., **E.D. Gedikli**, R. Lubbad (2021). Laboratory study of wave-induced flexural motion of ice floes. Journal of Cold Regions Science and Technology :

Li, H., **E.D. Gedikli,** R. Lubbad (2020). Exploring time-delay-based numerical differentiation using principal component analysis, Physica A: Statistical Mechanics and its Applications :

Gedikli, E.D., D. Chelidze and J. Dahl (2020). Empirical mode analysis identifying hysteresis in vortex-induced vibrations of a bending-dominated flexible cylinder, Int. J. of Offshore and Polar Eng.: https://www.onepetro.org/journal-paper/ISOPE-20-30-2-186

Li H., **E.D. Gedikli**, R. Lubbad, TS Nord (2020). Laboratory study of wave-induced ice-ice collisions using robust principal component analysis and sensor fusion, Cold Reg. Sci. and Tech. : https://doi.org/10.1016/j.coldregions.2020.103010

Li P, Liu X, Palmer† K, Fleishman E, Gillespie D, **Nosal E-M**, Shiu Y, Klinck H, Cholewiak D, Helble T, Roch M (2020). Learning Deep Models from Synthetic Data for Extracting Dolphin Whistle Contours. International Joint Conference on Neural Networks 2020 Glasgow, UK.

While we celebrate the recent revamping and revival that ORE has enjoyed over the past several years, ORE anticipates facing severe budget limitations and shortfalls over the next several years as a fallout from COVID-19. We are also keenly aware and appreciate that external support and giving may be especially difficult at this time for many in the ORE 'Ohana, so we will be especially grateful for any support that you can provide to help sustain our momentum. Your gift will be used directly in support of our programs, resources and infrastructure, and to help talented students reach their potential for impactful contribution to the Ocean State of Hawaii, and to a dynamic world that increasingly relies on well-trained engineers who are prepared to work in, on, and around the ocean. Please consider donating to ORE today:

https://giving.uhfoundation.org/funds/12373104

To pay by check, please make payable to University of Hawaii Foundation, indicate the donation is for "ORE 12373104", and send to:

ORE Enrichment Fund Administrator
Department of Ocean and Resource Engineering
University of Hawaii at Manoa
2540 Dole Street, Holmes Hall 402
Honolulu, HI 96822 USA

If you are interested in making an in-kind donation, if you have any questions about your donation or about how ORE is using donor support, or if you would like to explore other avenues of support, please don't hesitate to contact Eva-Marie Nosal at 808-956-7686 or nosal@hawaii.edu.

Hana O Ke Kai
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ENGINEERING THE OCEANS SINCE 1966!