

HANA O KE KAI

“Work of the Ocean”

NEWSLETTER OF THE OCEAN AND RESOURCES ENGINEERING DEPARTMENT, Fall 2012, Volume 15,

Chair’s Message

Bruce M. Howe, Chair



We are extremely pleased that our students continue to receive scholarships (see Student News).

Yaprak Onat continues to do a great job in collecting good articles for this newsletter from current students, alumni, and others. Mahalo!

Thank you Richard Carter for your service the last three years as a TA for the Department. You’ve done a great job in keeping our computer infrastructure running. Now you will have a little more time available to finish up your thesis! We welcome Andrew Schwartz as Richard’s replacement starting Spring semester.

Some of the faculty have been working on a department “self-study” report that is part of a larger SOEST effort. An external review team will come in April to review SOEST.

Lastly, we wish John Casilio and Matthew Morita all the best after their graduation this term, as they continue their careers.

Lora Van Uffelen will be teaching ORE 601 Ocean Engineering Lab this Spring. Lora is an enthusiastic assistant researcher, and author of an article in this issue.

Happy Holidays - Hau’oli Lanui! and Happy New Year - Hau’oli Makahiki Hou!

Editor’s Corner

Yaprak Onat, TA



In this issue of the newsletter, I wanted focus on student achievements reflected in international conferences, papers and presentations and recent department research. The issue completed with alumni contributions. Thank you so

much to all faculty members, students and alumni for helping me to prepare this issue. Any suggestions and comments for future issues are always welcomed. I hope you’ll enjoy this Hana O Ke Kai! Mele Kalikimaka Hau’oli Makahiki Hou!

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Student News

- **Jerica Nolte**, was awarded to an IEEE Oceanic Society Scholarship to study hydrodynamic forces of a WEC buoy tethered to a sea anchor. The award amount is \$2,000 for the 2012-2013 academic year.
- **Betsy Seiffert** was awarded a \$1000 GSO student grant for her conference expenses.
- **Yaprak Onat** was awarded a \$740 GSO student grant for her conference expenses.
- **John Casilio** defended his MS Plan B thesis about “ Thermal analysis of ROV electromechanical cables during anticipated operational phases” on November 13th.
- **Matthew Morita** defended his MS Plan B thesis about “Impact of sea level rise on tsunami inundation on Oahu’s south shore” on November 27th.

Congratulations and very best wishes for your future and successful career!

Publications & Events

Some Recent ORE Publications

- Bingham, B., N. Kraus, **B. M. Howe**, L. Freitag, K. Ball, P. Koski, and E. Gallimore.(2012). Passive and active acoustics using an autonomous wave glider, *J. Field Robotics*, DOI: 10.1002/rob.21424
- Das, S. and **Cheung, K.F.** (2012). Hydroelasticity of marine vessels advancing in a seaway. *Journal of Fluids and Structures*, 34, 271-290.
- Ertekin, R.C.**, Hayatdavoodi, M. and Seiffert, B. (2012), "Numerical Modeling of Solitary and Cnoidal waves over a Submerged Bridge Deck," *Proc. of the Joint Hawaii-Korea Workshop on Engineering of Coastal Structures for Tsunami and Coastal Storm Surge Hazards*, Eds., H.R. Riggs and S. Lee, 12-13 June, Dept. of Civil and Environmental Engineering, Univ. of Hawaii, Honolulu, HI, pp. III-1 to III-15,
- Hayatdavoodi, M. and **Ertekin, R.C.** (2012), "Nonlinear forces on a Submerged, Horizontal Plate: The G-N Theory," *Proc. of the 27th Int. Workshop on Water Waves and Floating Bodies*, 22-25 April, Copenhagen, Denmark, 4pp.
- Howe, B. M.**, F. K. Duennebieer, R. Butler, R. B. Lukas, Scientific uses of submarine cables: Evolutionary development leading to the ALOHA Cabled Observatory, Mains'1 Haul, *J. Pacific Maritime History*, 48, 100-119, 2012.
- Kennedy, A.B., Westerink, J.J., Smith, J.M., Hope, M.E., Hartman, M., Taflanidis, A.A., Tanaka, S., Westerink, H, **Cheung, K.F.**, Smith, T., Hamann, M., Minamide, M., Ota, A. (2012). Tropical cyclone inundation potential on the Hawaiian Islands of Oahu and Kauai. *Ocean Modelling*, 52, 54-68.
- Korde, U. and **Ertekin, R.C.** (2012), "An active-controlled submerged wave energy device with energy focusing," *Proc. International Conference on Ocean Energy, ICOE '2012, Dublin, Ireland, 17-19 October, 6pp.*
- Nihous, G.C.** (2012). Wave power extraction by arbitrary arrays of non-diffracting oscillating water columns, *Journal of Ocean Engineering*, 51, 94-105.
- Olsen, M.J., **Cheung, K.F.**, †Yamazaki, Y., Butcher, S., Garlock, M., Yim, S., McGarity, S., Robertson, I.N., Burgos, L., and Young, Y.L. (2012). Damage assessment of the 2010 Chile earthquake and tsunami using ground-based LiDAR. *Earthquake Spectra*, 28(S1), 179-197.
- Onat, Y. and Yalciner, A.C. (2012). "Tsunami Analysis for Southern Aegean Sea", ISOPE'12, 17-22 June, Rhodes, Greece.
- Roeber, V. and **Cheung, K.F.**(2012) Boussinesq-type model for wave transformation over fringing reefs. *Coastal Engineering*, 70, 1-20.
- Seiffert, B. and **Ertekin, R.C.** (2012), "Numerical Modeling of Solitary and Cnoidal waves over a Submerged Bridge Deck," *Proc. of Ocean 2012, MTS/IEEE, 21-24 May, Yeosu, Korea, 4pp.*
- Stopa, J.E., **Cheung, K.F.**, Garcé, M.A., and Badger, N. (2012). Atmospheric Infrasound from nonlinear wave interactions during Hurricanes Felicia and Neki of 2009. *Journal of Geophysical Research*, 117, C12017, Doi: 10.1029/2012JC008257.

Upcoming Meetings and Conferences

- 32nd International Conference on Ocean, Offshore and Arctic Engineering (OMAE2013) in Nantes, France from June 9-14, 2013.
Deadline: December 31, 2012 <http://www.asmeconferences.org/OMAE2013/>
- OCEANS'13 MTS/IEEE Conference in Bergen, Norway, from 10-13 June 2013. Deadline: 18 January 2013.
<http://www.oceans13mtsieeebergen.org/index.cfm>
- 23rd International Offshore (Ocean) and Polar Engineering Conference will be held in Anchorage, Alaska, USA from June 30 to July 5, 2013. <http://www.iso2013.org/>
- ICCOE 2013 : International Conference on Coastal and Ocean Engineering in Zurich, Switzerland January 14-15, 2013. <https://www.waset.org/conferences/2013/zurich/iccoe/>

ORE Student Research

In-ocean Experiments of a Wave Energy Conversion Device with Multiple Mooring Configurations



Jerica Nolte

The principle of operation of the heaving wave energy converter (WEC) device is to convert upward heave displacement into a rotational action, which generates electrical power. The heave displacement is created by the WEC system riding incoming waves relative to an anchoring system. The first anchoring system tested had the WEC system moored to the sea floor, while the second anchoring system tested was a freely floating system utilizing a conical drogue (sea anchor) to maintain a stable anchor point relative to the wave motion.

The experimental testing was carried out on the South shore of Oahu on June 19, 2012. The WEC buoy shown in the picture was equipped with sensors to measure the heave displacement of the buoy and power generation. To collect undisturbed measurement of surface elevation of the incoming waves, the

University of Hawaii's scientific dive team attached an independent Aquadopp pressure sensor to the seafloor roughly 1 meter up-wave of the WEC location. Real time experimental data was collected and analyzed to determine the power spectrum and heave response amplitude operator (RAO) of the WEC for both tested cases.

The WEC system provided a maximum power output of 87 Watts from one generator when moored in 0.3m to 0.6m seas. In a market ready model, the WEC system has been designed to have two generators and maximum power output of 84 Watts when moored in 0.3 m to 0.6m seas. A freely floating WEC system anchored to a drogue would have less power generation than a moored WEC. However, with proper sizing of a drogue for a WEC, which will be determined by the modeling program, the freely floating WEC system can have power output similar to a moored WEC system.

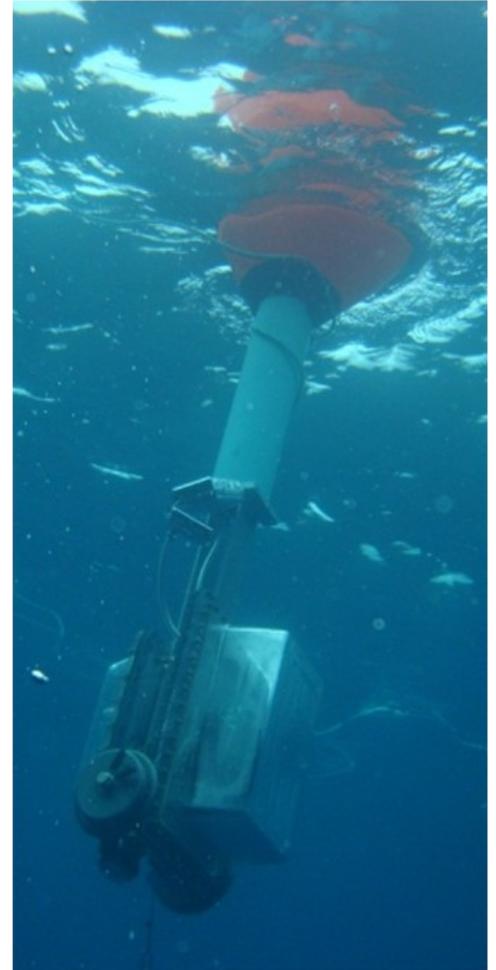


Figure 1: WEC device in testing

This project (Modeling and Simulation of an Ocean Wave Energy Extraction Device for Sensor Applications) was sponsored by the Office of Naval Research through a grant to Prof. Cengiz Ertekin.

ORE Student Research

SeaBASS Bioacoustics Summer School and Underwater Passive Acoustic Localization of Pacific Walruses in the Northeastern Chukchi Sea



Brendan Rideout

From June 17 - 22, I took part in the 2012 SeaBASS Bioacoustics Summer School at The Pennsylvania State University in State College, Pennsylvania. This summer school is held once every two years (this was the second time it has been offered) as a way to impart a broad background in marine biology and underwater acoustics to young researchers with backgrounds in marine bioacoustics and to foster relationships with other researchers in the field. Approximately 30 graduate students from countries including the United States, Canada, Austria, and Italy attended lectures, short courses, and informal talks throughout the week on topics such as acoustic propagation, marine mammal sound production and reception mechanisms, and fisheries acoustics. There was also a poster session, at which I presented the results of my MSc thesis research (completed at the University of Victoria [British Columbia, Can-

ada]) on passive acoustic localization of pacific walruses in the northeastern Chukchi Sea.

From October 10-12, I attended the annual conference of the Canadian Acoustical Association (CAA), held this year at the Banff Park Lodge in Banff, Alberta. I was a member of the organizing committee for this event in addition to designing and updating the conference website. Every year, approximately 100 papers from all fields of acoustics (e.g., architectural, noise, psychological, and bioacoustics) are delivered at this conference. I have been a member of the CAA for years, dating back to the start of my MSc degree in Earth and Ocean Science at the University of Victoria. This was the third CAA conference I have presented at, and the second one I have helped organize. Several interesting plenary talks were given at this years conference, including a fascinating talk by Dr. Colleen Reichmuth (principal investiga-

tor at the Pinniped Cognition & Sensory Systems Laboratory, Long Marine Lab, University of California Santa Cruz) on sound reception, perception, and production in amphibious marine mammals. I gave a talk at this conference entitled, "Underwater Passive Acoustic Localization of Pacific Walruses in the Northeastern Chukchi Sea" based on my MSc research. The abstract for this talk is included below:

This paper develops a linearized Bayesian approach for estimating the three-dimensional (3D) location of a vocalizing underwater marine mammal using acoustic arrival-time measurements at three spatially separated receivers which also provides rigorous location uncertainties. To properly account for the uncertainty in receiver parameters (3D locations and synchronization times) and environmental parameters (water depth and sound speed correction), these quantities are treated as unknown

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ORE Student Research

SeaBASS Bioacoustics Summer School and Underwater Passive Acoustic Localization of Pacific Walrus in the Northeastern Chukchi Sea

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constrained with prior estimates and prior uncertainties. Unknown scaling factors on both the prior and data uncertainties are estimated by minimizing the Akaike Bayesian information criterion. Maximum a posteriori estimates for sound source locations and times, receiver parameters, and environmental parameters are calculated simultaneously. Posterior uncertainties calculated for all unknowns incorporate data and prior uncertainties. Monte Carlo simulation results demonstrate that, for the case considered here, linearization errors are generally small. The primary motivation for this work was to develop an algorithm for locating underwater Pacific walrus in the coastal waters northwest of Alaska. Three underwater acoustic receivers were placed in a triangular arrangement approximately 400 m apart near the Hanna Shoal in the northeastern Chukchi Sea from August to October 2009 to record marine mammal vocalizations. A sequence of walrus vocalizations from this data set is processed using the localization algorithm, yielding a track with relative uncertainties of 1-2 m and an estimated swim speed that is consistent with knowledge of normal walrus speeds.

SeaBASS: http://www.arl.psu.edu/education_seabass.php
CAA: http://caa-aca.ca/conferences/Banff2012/index_en.html

Nonlinear Forces on a Submerged, Horizontal Plate: The G-N Theory



Masoud Hayatdavoodi

The 27th International Workshop on Water Waves and Floating Bodies was held in Copenhagen, Denmark from April 22nd to April 25th, 2012. A paper by Professor Ertekin and Masoud was accepted and presented in the conference. The workshop is an annual meeting of engineers and scientists with interests in water waves and wave interaction with floating or submerged bodies. Proceedings of the conference is available online on the workshop's website (<http://www.iwwwfb.org/Workshops/27.htm>). Below is the abstract of the paper presented in the workshop.

Propagation of nonlinear waves of solitary and cnoidal type over a submerged horizontal, fixed flat plate is studied. The nonlinear and unsteady Green-Naghdi equations (Level I) are solved to estimate the pressure distribution on top and bottom of the plate and the wave-induced vertical and horizontal forces. Results are compared with the available laboratory experiments. A parametric study is conducted to find an expression for the shallow water wave-induced loads on the structure based on the structure geometry and wave characteristics.

ORE Student Research

Numerical Modeling of Solitary and Cnoidal Waves Propagating over a Submerged Bridge Deck



Betsy Seiffert

OCEANS'12 conference was well attended by the international scientific community with a strong presence from the Korea Ocean Research & Development Institute (KORDI), Korea Advanced Institute of Science and Technology (KAIST) and several Korean Universities. The technical sessions included material from a wide range of disciplines including marine renewable energy, marine vehicles, underwater acoustics, coastal hazards, remote sensing and oceanographic instrumentation. The conference also featured a gala dinner held at the World Expo where local Korean cuisine was served followed by an "ocean play" held at the Expo centerpiece, the "Big-O" floating stage. Below is the abstract of the paper presented in the conference:

An initial component in the study of tsunami and storm surge wave forces on a sub-

merged bridge deck is the development of a two-dimensional numerical model of solitary and cnoidal waves propagating over a submerged plate based on the Navier-Stokes (N-S) equations. Results are compared with numerical models based on a nonlinear dispersive shallow water wave theory known as the Green-Naghdi (G-N) theory of water waves. Solitary and cnoidal waves are modeled using the open source computational fluid dynamics library OpenFOAM which solves the N-S equations by use of the finite volume method. Solitary waves are initiated by implementing a user defined velocity boundary condition based on the G-N theory and cnoidal waves are initiated using Waves2Foam, a wave generation toolbox developed for OpenFOAM.

Results for the surface elevation on and around the bridge deck obtained by solving the N-S equations are compared with the numerical results obtained



through the G-N theory. Even though these are two different solvers, solving two different sets of equations, preliminary analysis shows generally good agreement between the N-S and G-N solvers, with the propagation speed, wave amplitude and soliton fission being nearly identical. By solving these problems by two different methods, we are able to increase our confidence in the accuracy of our predictions of wave loads on coastal bridge.

ORE Student Research

Tsunami Analysis for Southern Aegean Sea

Yaprak Onat



The International Offshore and Polar Engineering Conference (ISOPE-2012) was held June 17-22, at Rhodes, Greece. The conference featured 150 sessions of peer-reviewed papers. ISOPE was my first conference that I had a chance to present. Attending this kind of large conference helped me to meet with academic colleagues and visualize the importance of scientific developments. This paper was prepared by me and Prof. Ahmet Cevdet Yalciner from METU. Below is the abstract of the paper:

There are different types of tsunami sources in Southern Aegean Sea. Wider awareness, proper preparedness and effective mitigation strategies against tsunamis need better understanding of tsunamis.

Tsunami assessment study covers the exchange and enhancement of available earthquake and tsunami data, development of bathymetric and topographic data in sufficient resolution, selection of possible or credible tsunami scenarios, selection and application of the valid and verified numerical tools for tsunami generation, propagation, coastal amplification, inundation and visualization. From this point of view, tsunami analysis is applied to Southern Aegean Sea. Different tsunami sources are selected. The difficulties in defining the input parameters and uncertainties in the selected tsunami source characteristics are discussed. The simulations in nested domains for selected regions in Southern Aegean are performed using the tsunami numerical code NAMI DANCE. Moreover, the



performance and efficiency of the numerical code, the estimations on near shore tsunami parameters (maximum water level, run-up, and inundation distance and arrival time) are discussed.

SNAME Annual Meeting of UH and West Coast Chapters

The latest SNAME meeting was held on December 5th. ORE Master students Andrew Schwartz, John Casilio, Michael Frederick, Austin Barnes, and Jerica Nolte (from left to right) presented their project titled "The Conceptual Design of a Floating Offshore Wind Farm for Oahu, Hawaii". This semester is the last for John Casilio who served three semesters as UH SNAME Student Chapter Chair. We congratulate Jerica Nolte who is taking over the torch from John Casilio for Spring 2013.



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How much ocean thermal energy can be converted to electricity?

G rard C. Nihous &
Krishnakumar Rajagopalan

Ocean Thermal Energy Conversion (OTEC) relies on the availability of temperature differences of the order of 20 C in the upper water column. Water from different vertical layers can then provide a heat source and a heat sink to sustain the operation of a thermal power plant. The geographic area of interest covers about a third of all oceans. Intense solar radiation keeps the surface layer of most tropical seas warm, as large surface heat fluxes between the ocean and the atmosphere reach a subtle balance. The existence of a pool of deep cold seawater at low latitudes is less obvious, and was not discovered until the 18th Century. In fact, it takes a vast network of planetary currents to transport sinking polar water virtually everywhere. Because OTEC seawater temperature differentials are small, their maintenance is essential, while relatively large seawater flow rates must be used in OTEC plants.

This brings out an interesting question about the size of the OTEC resource. Could a massive

deployment of this technology affect ocean temperatures on which the process itself depends? In other words, could OTEC be self limiting? For hydroelectric power, an equivalent question would be whether drawing too much water between the high and low reservoirs could reduce the available head. The answer is clearly positive in this analogy because for any given plant, a natural scale exists for flow rate, i.e. that of the river connecting the reservoirs. In the case of OTEC, the situation is far more complex. The strength of the currents that globally replenish deep seawater in a time frame of centuries may provide an order of magnitude for OTEC flow rate scale, but only a loose one.

Some years ago, this theoretical OTEC sustainability question was tentatively addressed with very simple one-dimensional models, where the ocean is reduced to a vertical water column with idealized boundaries. Although it makes the problem readily solvable, an important shortcoming of this approach is that horizontal transport between the OTEC re-

gion and the rest of the oceans is not represented. This leads to an expected magnification of OTEC impacts on the thermal structure of the water column. Results suggested that OTEC resources might have a limit of about 3 to 5 TW [Nihous, G.C., *Journal of Energy Resources Technology*, **129**(1), 10-17, 2007]. Although such estimates seem disappointing when weighed against environmental fluxes, they still represent an enormous potential given mankind's total primary energy use of 16 TW today (1 TW = 10¹² W).

To frame the problem correctly, however, the complex interplay between planetary heat fluxes, a fully three-dimensional oceanic general circulation and potentially large OTEC intakes and discharges spread over more than 100 million square kilometers would have to be captured with state-of-the-art analytical and numerical tools. First steps in that direction were taken over the past two years, with support from the U.S. Department of Energy's Hawaii National Marine Renewable Energy Center.

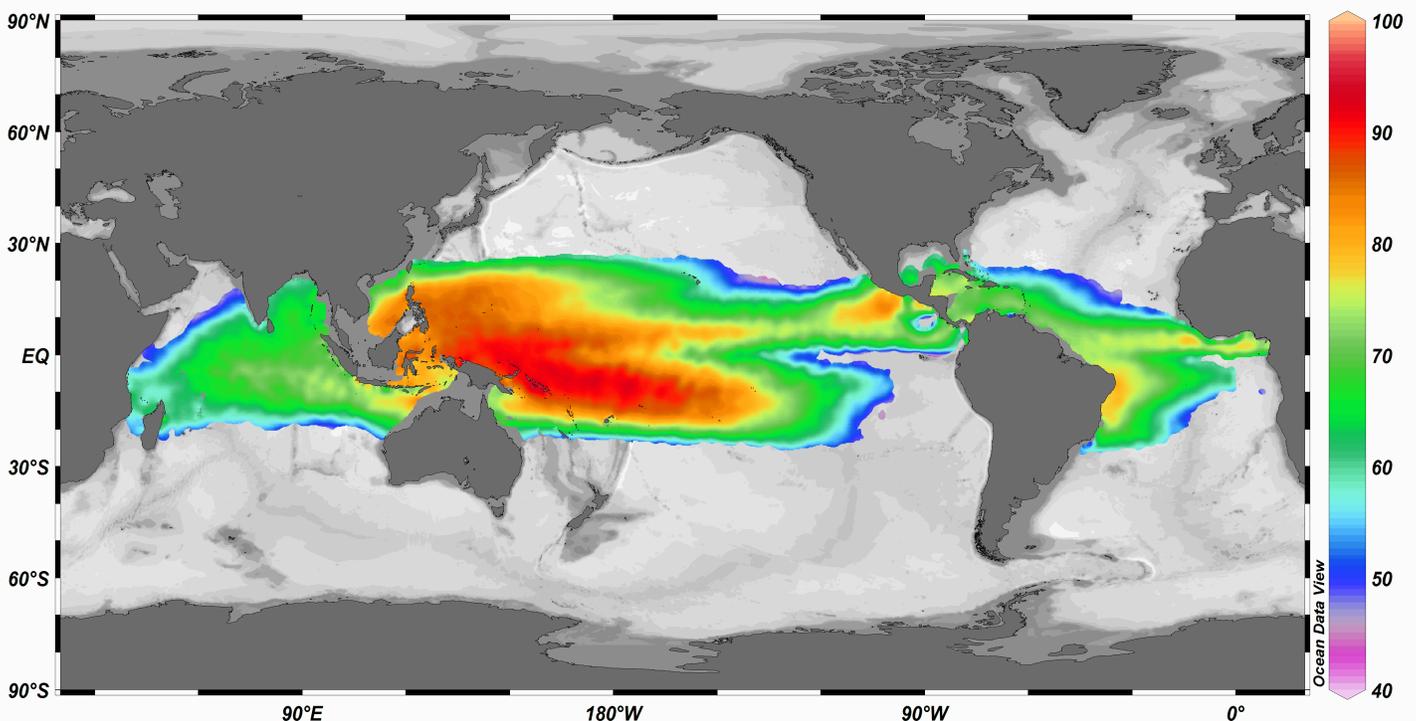
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Preliminary results were recently published [Rajagopalan, K. and G.C. Nihous, *Renewable Energy*, **50**, 532-540, 2013]. This effort and more recent work confirmed a maximum for global OTEC power production, but a significantly higher one (≈ 20 TW). As OTEC flow rates increase, the erosion of vertical seawater temperature gradients is much slower in three-dimensional ocean models, because any heat locally added to the system can be horizontally transported and re-distributed at a relatively fast rate. Another distinctive feature of the model results is the persistence of slightly cooler surface waters in the OTEC region. This is compensated, however, by a warming trend at higher latitudes. A boost of the planetary circulation responsible for the overall supply of deep cold seawater is also shown. Taken at face value, predicted environmental effects at maximal OTEC power production suggest that lower outputs should be considered. On a positive note, a more modest OTEC scenario with a global potential of the order of 7 TW showed little impact. The corresponding net power density is shown in the accompanying Figure, and should be interpreted as cautiously conservative. Work with better numerical resolution and improved physics is under way.



OTEC power density estimates (kW per km²) for a global production of 7 TW

Inside ORE

Redefining the "G" in GPS: The Potential for a Glider Positioning System



Lora VanUffelen

What is your position on the globe in latitude and longitude right now? If I asked you this question, all you would have to do is whip out the appropriate app on your smart phone, which would utilize the phone's GPS receiver to present you with your current coordinates in a matter of seconds. GPS has become ubiquitous and is used in everything from sophisticated military robots to pet-tracking devices. The iRobot Seaglider also utilizes GPS... when it's at the sea surface, that

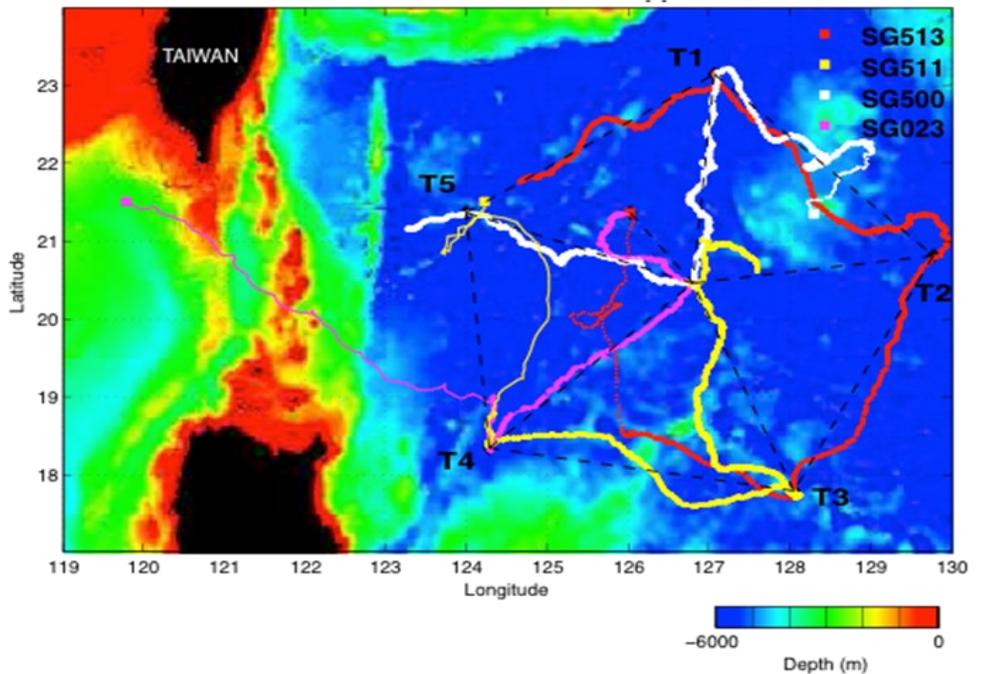


Figure 1: Acoustic Seaglider tracks in the Philippine Sea overlaid on Smith-Sandwell bathymetry. Heavy lines indicate surface positions of gliders while collecting data. Lightlines indicate glider position after data collection had ended.



Figure 2: Recovery of a Seaglider in the Philippine Sea. Photo by Kevin Hardy.

is. Electromagnetic waves are quickly attenuated underwater, however, so while the glider is diving it is unable to acquire a GPS position fix.

Unlike electromagnetic signals, acoustic signals can travel for hundreds of kilometers underwater. In 2010-2011, four Seagliders equipped with acoustic receivers recorded transmissions from five broadband acoustic sources (~200-300 Hz) moored in the Philippine Sea as part of a large, multi-institution field program spon-

sored by the Office of Naval Research (ONR). The gliders transited around the source moorings (T1-T5) along the tracks shown in Figure 1, diving from the surface to 1000 m depth. During the course of the experiment, the gliders recorded over 2000 source transmissions at ranges up to 700 km. The recovery of one of the gliders from the *R/V Roger Revelle* is pictured in Figure 2.

The gliders were underwater for up to 9 hours at a time, usually traveling

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several kilometers during a single dive. One of the goals of the experiment was to explore the possibility of using acoustic travel-time measurements from the gliders in inversions for ocean temperature, a technique called ocean acoustic tomography. Traditional ocean acoustic tomography requires pre-

cise measurements of acoustic travel times between geographically-fixed sources and receivers with positions known to within a few meters. The positions of the gliders at the time of acoustic reception were not known to this precision due to the limitations of GPS; however, glider latitude and longitude during the dives were estimated using surface GPS fixes immediately prior to and following each dive.

The acoustic arrival pattern at the

glider's estimated position can be predicted using acoustic ray models incorporating a representative profile of sound-speed as a function of depth. The acoustic sources in this experiment were moored at approximately the depth of the sound channel axis, i.e., the depth at which sound speed is at a minimum (~1500 m in the Philippine Sea). Above this depth, sound speed increases due to warmer temperatures in the upper ocean, and below sound-speed increases due to higher pressure. Acoustic energy is sent out from the source in all directions. The acoustic energy that is sent out horizontally from the source remains in this region of low sound speed, and the acoustic energy that is sent out at higher angles travels through regions of increased sound speed in the deep and shallow ocean along ray paths that obey Snell's Law of refraction. The acoustic arrival received at a glider a few hundred kilometers away from the source is therefore spread out over several seconds. The rays that were sent out at steeper angles arrive first and the horizontal rays, which remained in the region of lowest sound-speed, arrive last.

Acoustic predictions were performed for

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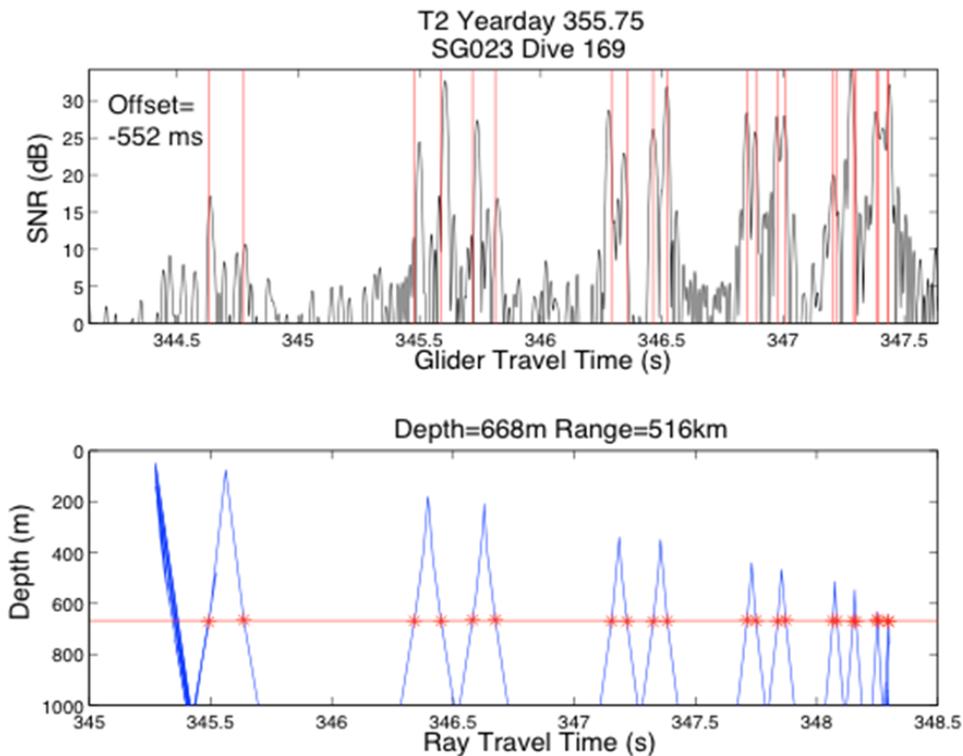


Figure 3: Acoustic reception on SG023 transmitted from Source T2 on 2010 Year-day 355 at 1800 GMT (top), and predicted acoustic arrival times as a function of depth for the top 1000 m of the ocean (lower panel). Red stars indicate the arrivals predicted to be captured by the glider at its measured depth of 668 m at the time of reception. In the top panel, the travel times of these predicted arrivals are shifted by 552 ms to match the pattern of arrivals measured by the glider, as shown by the vertical red lines.

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the estimated glider position for each of the source receptions collected by the gliders along the tracks shown in Figure 1. It was found that the acoustic arrival patterns measured by the gliders corresponded well with the predicted arrival patterns, but they were offset in time. A relatively small change in range will not affect the dispersion pattern of arrivals by much, but it will affect the overall travel time of the acoustic signal. Figure 3 shows an example of a recorded acoustic arrival pattern as well as the prediction for an arrival at the estimated glider position. In this case the measured and predicted travel-times were offset by 552 ms.

Travel-time offsets between the meas-

ured and predicted arrivals were estimated for each of the acoustic recordings and were translated into range offsets by multiplying by 1500 m/s, a representative ocean sound speed. A compilation of these range offsets showed that they were normally distributed with a mean of -18 m and a standard deviation of 639 m. These deviations from the glider-estimated positions are likely caused by advection of the glider due to tides and currents in the oceanographically complex Philippine Sea region and give an indication of the uncertainty in the position of the glider while it is underwater.

RAFOS floats, which remain underwater for months during a typical mission, use transmissions from narrowband acoustic sources to determine their position, with uncertainties of a few kilometers. The broadband acoustic arrivals measured by the Seaglidors in the Philippine Sea

can be used in a similar way. Due to the nature of the broadband source signals, these arrivals have much better travel-time resolution, which would result in greater positioning accuracy. Although the Philippine Sea sources do not transmit simultaneously (they transmit sequentially at intervals of 9 minutes), a system such as this has the potential to be used for precise underwater positioning and navigation of gliders, thereby acting as a "Glider Positioning System," an underwater acoustic analog to the Global Positioning System that we rely on above the water.

This work was supported by ONR and has been recently been submitted for publication to the Journal of the Acoustical Society of America. Other SOEST researchers involved in this project are Eva-Marie Nosal, Bruce Howe, and Glenn Carter.

The Conceptual Design of a Floating Offshore Wind Farm for Oahu, Hawaii

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The use of renewable energy sources, particularly wind power generation, is an attractive proposition to help offset Hawaii's use of oil for power production. Hawaii has exceptional offshore wind resources close to shore, but due to the primarily steep bathymetry, typical monopile type farms, such as

those used in shallow water zones are not feasible. The commercialization of new technology is currently underway to harness these resources in deep-water environments. Advancements in turbine technology and innovation in semi-submersible platforms are quickly bringing floating wind into the economic horizon. A conceptual design of a 196 MW offshore wind farm consisting of 24 floating platform based wind turbines is proposed for deployment in 550 m water depth, to include presentation

of: site selection, layout and orientation of the farm, selection and analysis of a deepwater mooring system, electrical collection and transmission systems, economic feasibility analysis. Considerations for construction, delivery, emplacement, maintenance and logistic needs are presented. Using site specific data for analysis of extremal and operational design conditions, the feasibility of using Wind-Float platforms is studied using numerical and economic methods.

Some thoughts about the physics of tsunamis

Prof. Harold Loomis
(Retired 1995)

For the last couple of decades tsunami professionals have been focused on computer models hoping to make accurate predictions of tsunami wave heights from different source assumptions. Some attention has been given to choosing the best wave equations to program. However, at several levels below that complexity there are interesting questions at the sophomore physics level that are fun to think about and may perhaps even lead to useful ideas for describing tsunamis.

A simple example is this. Consider a tsunami generated by a vertical displacement of the ocean floor by a fixed amount. The vertical deformation of the ocean surface is independent of the depth of the ocean, yet the amount of work done by the displacement depends on the depth of the water. The work done is (force) x (distance) and the force is greater in deeper water. So, how does the deep water generation differ from the shallower water generation? Where does the extra work go? Is this a significant issue in looking at the generation of tsunamis?

One usually doesn't look at the momentum of a traveling wave, but in the tsunami case it is the horizontal momentum of the tsunami that does the damage when the wave comes ashore. The momentum is scattered in various directions due to collisions with objects. The sum of the integrals of (force) x (time) on various objects has to add up to the original tsunami momentum. This process scatters the incoming momentum in various direc-

tions including even the reverse direction of the incoming wave and altering that incoming wave.

It is easy to calculate the momentum of a traveling wave by integrating the particle velocity over a vertical plane perpendicular to the direction of travel in the same way that the propagation of energy is calculated. In linear long wave theory, the particle velocity is constant over the vertical plane and is given by

$$v = \eta \sqrt{g/h}.$$

Multiplying this by the height of the water column ($h + \eta$) and taking only the first term you get the simple formula

$$\text{Momentum} = \eta \times \sqrt{gh} \text{ or } \eta \times C.$$

Note that the eta is there because velocity is proportional to eta, not because of the extra eta of water which is small compared to h in this theory. Momentum for intermediate wave theory will work out similarly.

How about the momentum in the generating area? To begin with there are various horizontal forces during generation producing horizontal momentum, but usually the main source of horizontal momentum will be the unbalanced hydrodynamic forces in the elevated mound of water. This is worth a lot of thought, because it determines the distribution of horizontal momentum along the generated wave. It doesn't fit into an article in the newsletter mostly because it hasn't been discovered yet.

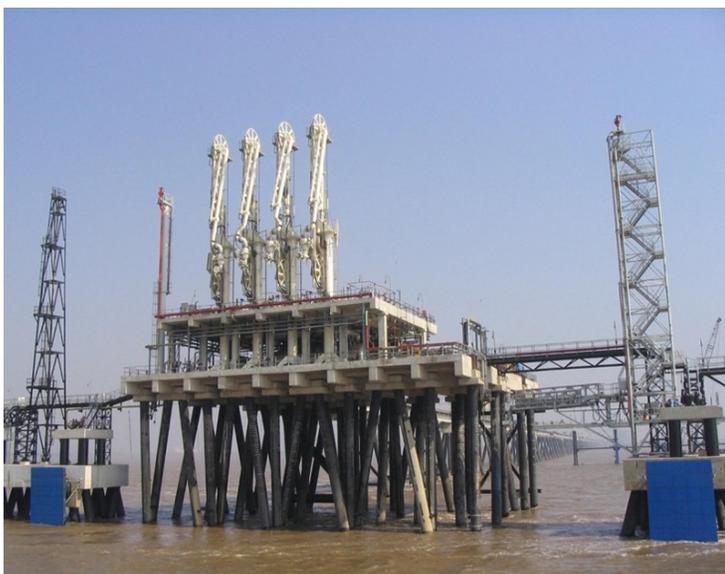
ORE Alumni

LNG Jetty in India

Vasco Nunes

It has been 7 years now that I have finished my Master's degree at the ORE Department and since then I have been lucky to have worked exclusively in marine related projects. But more than that, it is with great satisfaction that I realize that the ORE department has helped me achieving a greater personal goal.

In 2011, the company I work for (PROES) was awarded the construction design project of a LNG Jetty in India where I took the role as project coordinator. Design conditions were extremely stringent. The berth area is designed for LNG tankers ranging from QMax (266,000 m³) to 138,000 m³ tankers. Conditions are ground swells from S-SW directly from the Indian Ocean with significant wave heights of 4.2 m at 12.5 s. The site is located in the outlet of two local rivers and there are strong daily currents with operational velocities at surface of 3.2 m/s, a design scouring of up to 10 m and tidal range of 11



Unloading platform with two of the berthing dolphins. The approach trestle can be seen in the back disappearing towards land.



Inspecting local conditions at neighbouring and very similar jetty

m. Due to local bathymetry, the approach trestle is 2.4 km long built on a steel pile foundation and pre-stress beams linking the 102 bents separated 24m apart.

This approach trestle comprises of an access road, two 32" LNG pipes, one 10" gas pipe, fire water pipe and power and communications cabling. The berthing area is comprised of an unloading platform with four 70 tons unloading arms, 4 berthing dolphins and 8 mooring dolphins.

At the time of writing, work is already underway. The experience I have earned with this project is priceless, and I am thankful to the solid foundation I learned at ORE, and in particular to the faculty. A big mahalo to ORE and best wishes for a greater future.

New in ORE

ORE Family is extending. Four students joined on Fall 2012. To get to know them better, couple of questions asked. They are ordered according to their last names.

Questions:

Name

1. *When did you enroll?*
2. *Level of study*
3. *Your academic background*
4. *Your research topic in the department*
5. *Your advisor*
6. *Where is your office?*
7. *Personal interests*

Kenan Knieriem

1. Fall 2012
2. MS
3. US Naval Academy

Linyan Li

1. Fall 2012
2. Ph.D.
3. Master degree of Environmental Engineering
4. Tsunami modeling
5. Prof. Cheung
6. Holmes 408
7. Travel



Roberto Porro

1. Fall 2012
2. MS
3. BS Ocean Engineering, FIT 2003
4. Artificial Reefs for Coastal/Harbor Protection (CEE Dept)
5. Prof. Ertekin
6. Holmes 407
7. Surfing, music, soccer



Kara Silver

1. Fall 2012
2. MS
3. Mechanical Engineering



Final Page

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Hana O Ke Kai

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ENGINEERING THE OCEANS SINCE 1966!

*"You can never cross the Ocean
 unless you have the courage to
 loose sight of the shore"*