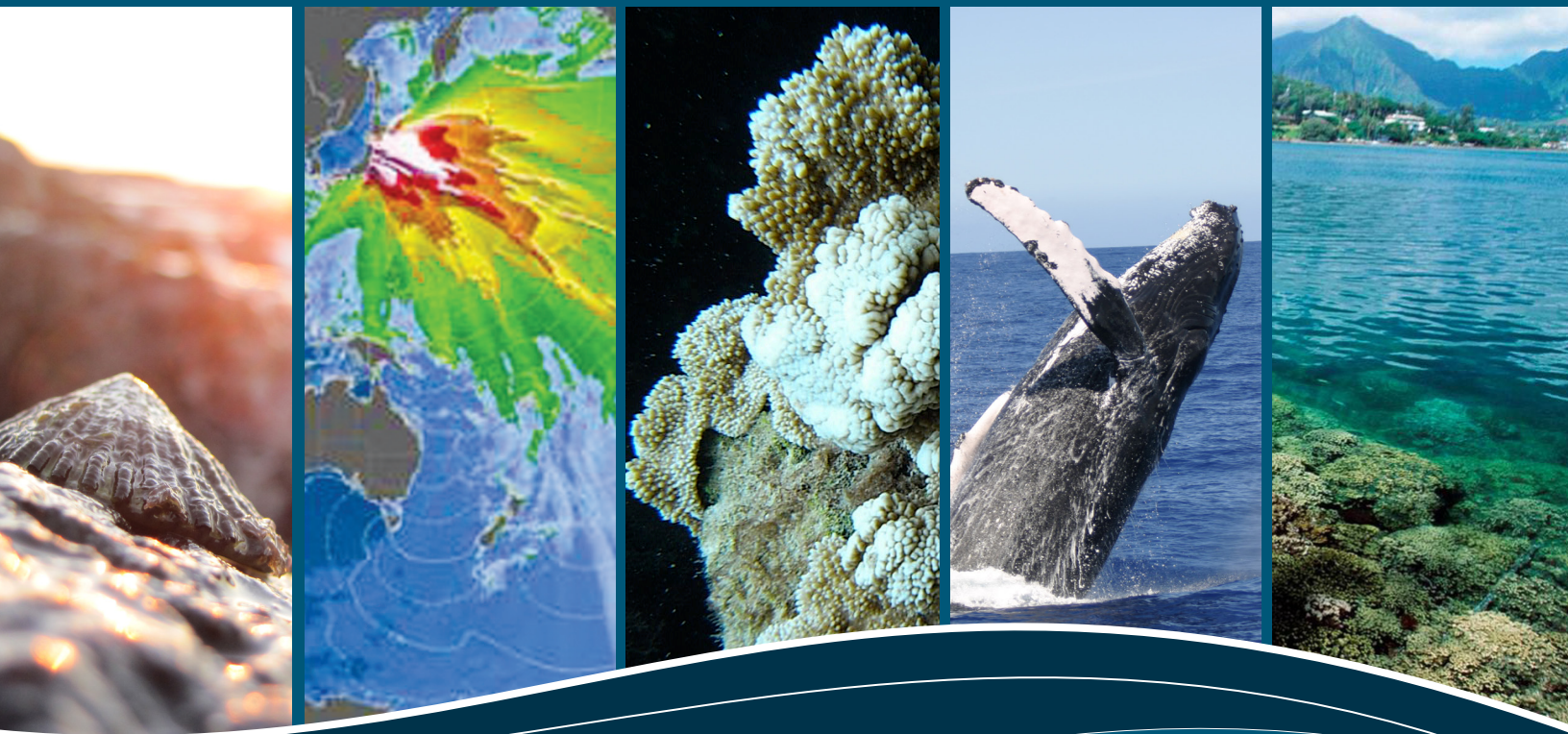


University of Hawai'i and University of Tokyo

Joint Symposium on Ocean, Coastal, and Atmospheric Sciences

PROGRAM AND ABSTRACTS

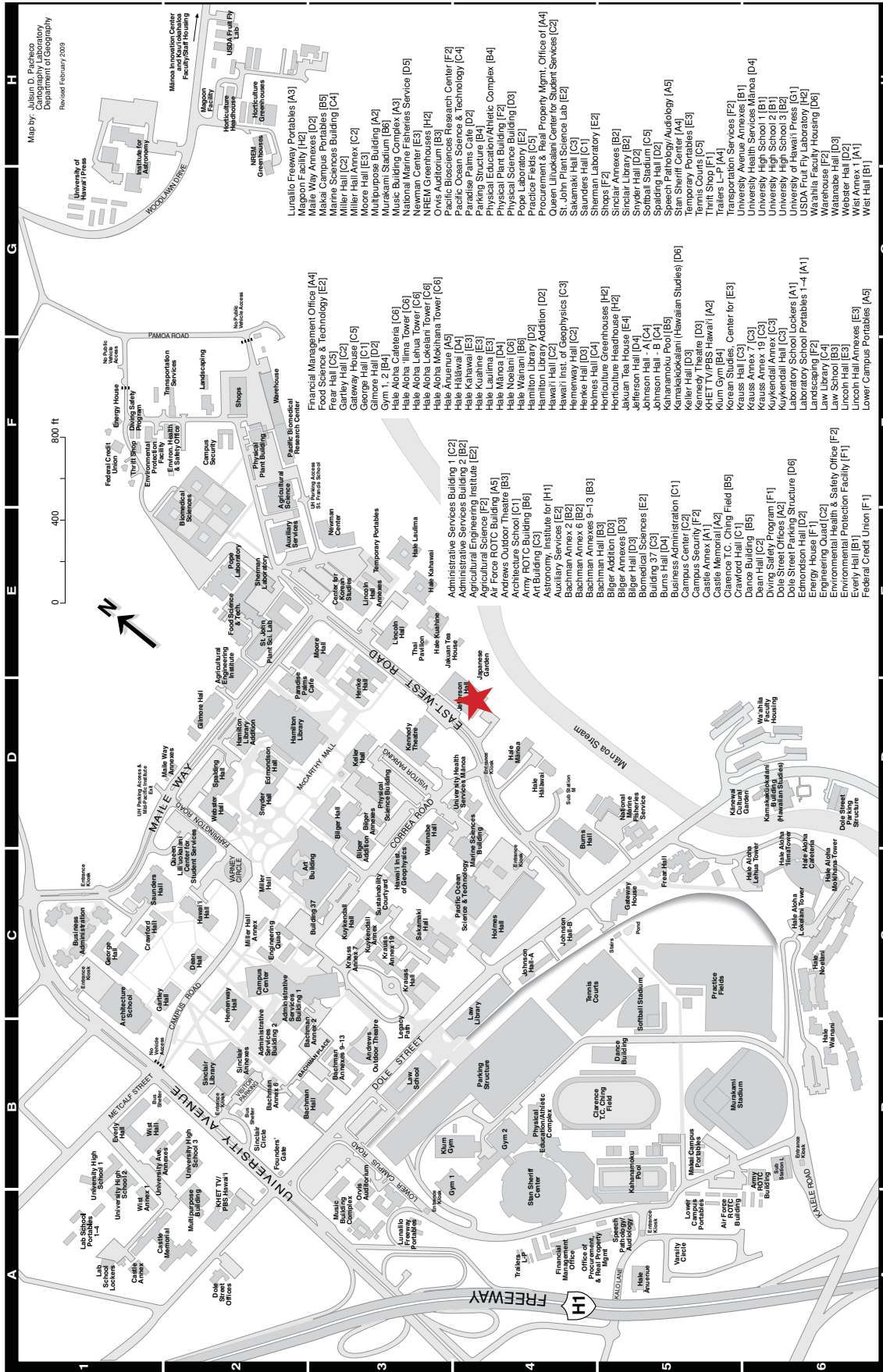
JUNE 13-15, 2012



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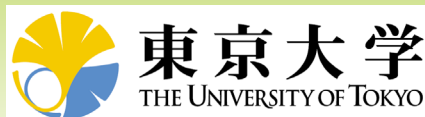
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★ East-West Center, Keoni Room

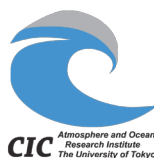
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PROGRAM

TUESDAY JUNE 12, 2012

5:00 p.m. - 7:00 p.m. Ice breaker at the Sheraton Waikiki - Rum Fire

WEDNESDAY, JUNE 13, 2012

7:30 a.m.	Bus from Princess Kaiulani Hotel to East-West Center, University of Hawaii at Manoa East-West Center, Keoni Room	
8:00 a.m. - 8:30 a.m.	Continental breakfast (Keoni Room)	
8:35 a.m. - 9:00 a.m.	Welcome	Brian Taylor and Hiroshi Niino
	Session I: Ocean-Atmosphere Interactions and Climate Change Chairs: Yusuke Yokoyama and Kevin Hamilton	
9:00 a.m. - 9:25 a.m.	<i>Strong Vertical Vortices in the Atmospheres and the Oceans</i>	Hiroshi Niino
9:30 a.m. - 9:55 a.m.	<i>Scale Interactions in the Tropical Pacific</i>	Kelvin Richards
10:00 a.m. - 10:25 a.m.	<i>Statistical Analysis of Cyclone Environments in the Tropics, Sub-Tropics and Extra-Tropics</i>	Wataru Yanase
10:30 a.m. - 10:45 a.m.	Break (poster setup in the Wailana Room)	
10:50 a.m. - 11:15 a.m.	<i>Characteristics of Sea-Level Rise and Coastal Erosion in Hawaii and the Pacific</i>	Charles Fletcher
11:20 a.m. - 11:45 a.m.	<i>Sea Level and Paleoclimate for the Last 140,000 Years</i>	Yusuke Yokoyama
11:50 a.m. - 1:00 p.m.	Lunch (Makana Room)	
	Session I (continued) Chairs: Wataru Yanase and Oliver Timm	
1:00 p.m. - 1:25 p.m.	<i>Paleoclimate Research at the International Pacific Research Center</i>	Axel Timmermann
1:30 p.m. - 1:55 p.m.	<i>Glacial Stage 6 North Atlantic Conditions Indicate an Anomalously Stable Laurentide Ice Sheet</i>	Stephen Obrochta
2:00 p.m. - 2:25 p.m.	<i>Global Climate Change during Ice-Age Cycles of the Last 400,000 Years</i>	Oliver Elison Timm
2:30 p.m. - 2:45 p.m.	Break (poster setup in the Wailana Room)	
	Session II: Marine Biology and Ecosystem-based Management Chairs: Koji Inoue and Alexander Culley	
2:50 p.m. - 3:15 p.m.	<i>Defining Boundaries for Ecosystem-Based Management: A Multispecies Case Study of Marine Connectivity Across the Hawaiian Archipelago</i>	Rob Toonen
3:20 p.m. - 3:45 p.m.	<i>Function of 'Yo-Yo' Vertical Movements of Pelagic Sharks</i>	Katsufumi Sato
3:50 p.m. - 4:15 p.m.	<i>Sharks versus Monk Seals in Papahānaumokuākea Marine National Monument: A Conservation Conundrum</i>	Carl Meyer
4:15 p.m. - 4:30 p.m.	Poster introductions (Keoni Room)	
4:30 p.m. - 6:30 p.m.	Poster session (Wailana Room)	
6:30 p.m.	Dinner on your own	

PROGRAM

THURSDAY, JUNE 14, 2012

7:30 a.m.	Bus from Princess Kaiulani Hotel to East-West Center, University of Hawaii at Manoa East-West Center, Keoni Room	
8:00 a.m. - 8:30 a.m.	Continental breakfast (Keoni Room)	
8:30 a.m. - 8:45 a.m.	Welcome - announcements	
	<u>Session III: Environmental Physiology and Microbiology</u> Chairs: Susumu Hyodo and Andre Seale	
8:45 a.m. - 9:10 a.m.	<i>Multiple Gut Function in Marine Fish: Roles in Osmoregulation and Environment</i>	Yoshio Takei
9:15 a.m. - 9:40 a.m.	<i>Environmental Modulation of the Osmoreceptive PRL Cell in Tilapia, Oreochromis mossambicus</i>	Andre Seale
9:45 a.m. - 10:10 a.m.	<i>Urea-Based Body Fluid Regulation in Cartilaginous Fish</i>	Susumu Hyodo
10:15 a.m. - 10:40 a.m.	<i>Mechanisms of Adaptation to Hydrothermal Vents Using Taurine-Related Amino Acids</i>	Koji Inoue
10:40 a.m. - 10:55 a.m.	Break	
11:00 a.m. - 11:25 a.m.	<i>From Viruses to Vibrios: Research in the Marine Viral Ecology Laboratory (MarVEL)</i>	Alexander Culley
11:30 a.m. - 11:55 a.m.	<i>Quantitative Estimation of Contribution of Proteorhodopsin to Energy Cycle in the Ocean</i>	Susumu Yoshizawa
12:00 p.m. - 1:15 p.m.	Lunch (Makana Room)	
	<u>Session IV: Ocean Dynamics and Biogeochemistry</u> Chairs: Eitarou Oka and Niklas Schneider	
1:15 p.m. - 1:40 p.m.	<i>Linkages in Biogeochemical Cycles Between Surface Ocean and Lower Atmosphere over the Western North Pacific Ocean</i>	Mitsuo Uematsu
1:45 p.m. - 2:10 p.m.	<i>Spatial and Temporal Analysis of Physical Stressors in Near Shore Environments</i>	Florence Thomas
2:15 p.m. - 2:40 p.m.	<i>Past Daily Light Cycle Recorded in the Strontium/Calcium Ratios of Giant Clam Shells</i>	Yuji Sano
2:45 p.m. - 3:10 p.m.	<i>An Extended Framework for Decadal North Pacific Variability</i>	Niklas Schneider
3:15 p.m. - 3:30 p.m.	Break	
3:35 p.m. - 4:00 p.m.	<i>Decadal Seesaw of the Central and Subtropical Mode Water Formation Associated with the Kuroshio Extension Variability</i>	Eitarou Oka
4:05 p.m. - 4:30 p.m.	<i>Ocean Circulation in the Western North Pacific</i>	Nikolai Maximenko
4:35 p.m. - 5:00 p.m.	<i>Current Velocity Properties of the Deep Circulation in the Western North Pacific Revealed by Direct Current Measurements with Mooring Systems</i>	Daigo Yanagimoto
5:00 p.m.	Pau	
6:30 p.m. - 9:30 p.m.	Reception (Sheraton Waikiki - Kai Market)	

FRIDAY, JUNE 15, 2012

9:00 a.m. - 12:00 p.m.	Self-organized lab tours and collaborative discussions	
2:00 p.m.	Bus from Princess Kaiulani Hotel to Hanauma Bay (pick up from Hanauma Bay at 5:00 p.m.)	

FROM VIRUSES TO VIBRIOS: RESEARCH IN THE MARINE VIRAL ECOLOGY LABORATORY (MARVEL)

Alexander Culley, Olivia Nigro, Jaclyn Mueller, Christopher Schvarcz, Gordon Walker, Shaun Giancaterino, La'Toya James, and Grieg Steward

Center for Microbial Oceanography Research and Education, Department of Oceanography, University of Hawaii at Manoa, USA

The MarVEL group focuses on two primary lines of research 1) the ecology and diversity of marine viruses and 2) the ecology of pathogenic vibrios (*V. cholerae*, *V. parahaemolyticus*, and *V. vulnificus*). We study the molecular diversity of marine viruses and their ecological effects on plankton communities. We are also cultivating and characterizing new viruses that infect bacteria and phytoplankton from coastal to open ocean, and polar to tropical waters. We have isolated the smallest and largest phytoplankton viruses reported to date and recently shown that RNA viruses that infect protists are more abundant in the ocean than previously thought. Our work on vibrios involves lab and field studies designed to determine how environmental conditions control the abundance of virulent strains of pathogenic vibrios in coastal waters. Our data reveal that the temporal patterns in vibrio abundance in tropical waters of Hawaii are driven primarily by rainfall influencing salinity, in contrast to the temperature-driven seasonal changes observed in temperate waters. In collaboration with our colleagues in the Department of Oceanography, we plan to couple pathogen population models with a physical circulation model to make real-time predictions of where and when risks of infection are highest. We will also use the coupled biological-physical model as a tool to predict the ecological effects of coastal engineering projects on coastal water quality.

CHARACTERISTICS OF SEA-LEVEL RISE AND COASTAL EROSION IN HAWAII AND THE PACIFIC

Charles Fletcher

School of Ocean and Earth Science and Technology, University of Hawaii at Manoa, USA

Research currently indicates that global mean sea level may reach approximately 32 cm by mid-century and 0.75 to 1.9 m by the end of the century, but there are significant unknowns in predicting future sea level including high local variability, and differences in model results. Nonetheless, these values provide science-based planning targets for local decision-makers to implement sea level rise adaptation programs. We use the empirical projections of Vermeer and Rahmstorf (2009) for the IPCC B1, A2, and A1F1 economic scenarios to estimate the 95 percentile elevations at risk to future flooding; including marine inundation and groundwater drainage problems. It is difficult to predict how sea level rise will impact sandy coastlines other than to broadly say it is likely to accelerate erosion trends. A first step to assessing coastal vulnerability to sea level impacts is to map the location and rate of eroding beaches assuming these are the first and foremost to experience accelerated erosion due to sea level rise. Shoreline change is measured every 20 m along the beaches of Kauai, Oahu, and Maui (Hawaii; 12,000 measurements) using historical shorelines digitized from aerial photographs and survey charts. Erosion dominates shoreline change in Hawaii with 70% of beaches erosional (long-term; 1900 to present), including 9% (21 km) that was completely lost to erosion (e.g. seawalls), and an average shoreline change rate of -0.11 ± 0.01 m/yr. Short-term (1960 to present) results are somewhat less erosional (63% erosional, average rate -0.06 ± 0.01 m/yr).

UREA-BASED BODY FLUID REGULATION IN CARTILAGINOUS FISH

Susumu Hyodo, Keigo Kakumura, Souichiro Takabe, Wataru Takagi, and Yoko Yamaguchi

Physiology Section, Department of Marine Bioscience, Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba, Japan

Cartilaginous fish (sharks, skates, rays and chimaeras) maintain their plasma osmolality slightly hyperosmotic to surrounding seawater primarily through the retention of urea to overcome hyperosmotic stress in a marine environment. Many organs including the kidney, liver and gill contribute to the synthesis and the retention of urea in the body. In the kidney, more than 90% of filtered urea is reabsorbed from primary urine, and we have clarified that coordinated function of transporting molecules for urea, ions and water in the highly elaborate renal tubules is important for the urea reabsorption (Hyodo et al., 2004; Kakumura et al., 2009; Yamaguchi et al., 2009). We recently found a novel aggregate structure, follicularly-arranged NKA-rich cells, on the gill septum of sharks, suggesting that the elasmobranch gill probably contributes more importantly to body fluid homeostasis than previously thought (Takabe et al., 2012). In addition to the adult fish, we have focused on the body fluid regulation in developing embryos. In the symposium, I introduce our recent progress on the above topics and discuss about future collaboration in cartilaginous fish physiology field.

MECHANISMS OF ADAPTATION TO HYDROTHERMAL VENTS USING TAURINE-RELATED AMINO ACIDS

Koji Inoue

Molecular Marine Biology Section, Department of Marine Bioscience, Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba, Japan

Deep-sea hydrothermal vents are characterized by high levels of hydrogen sulfide, which is toxic to most animals. However, rich communities of invertebrates are found in such harsh environments. It is supposed that the invertebrates in the hydrothermal-vent ecosystems have evolved mechanisms to cope with toxic sulfides. A possible way for adaptation to sulfides is the use of hypotaurine, which can react with sulfide and generate non-toxic thiotaurine. We are studying the taurine transporter (TAUT), which is likely to accumulate hypotaurine across the cell membrane, of the deep-sea mussel *Bathymodiolus septemdiarium* collected at hydrothermal vents in Myojin Knoll and *B. platifrons* obtained at methane seeps in Sagami Bay. We have already cloned TAUT cDNA from the two species and demonstrated that the TAUT actually has the ability to transport hypotaurine. We have also demonstrated that the TAUT mRNA level increase when the mussel reared in the presence of sulfide. Thus, it is probable that the mussels accumulate hypotaurine using TAUT. It is known that shallow-water mussels accumulate taurine for osmotic adaptation using TAUT. The deep-sea mussels may have applied TAUT, which had been used for osmotic regulation, to adapt to the sulfide-rich environments.

OCEAN CIRCULATION IN THE WESTERN NORTH PACIFIC

Nikolai Maximenko

International Pacific Research Center, School of Ocean and Earth Science and Technology, University of Hawaii at Manoa, USA

The Kuroshio Extension / Subarctic (KE/SF) frontal zone was attracting in recent decades international research because of its unique role in the North Pacific, complexity of its dynamics, and importance for practical applications to fishing, navigation, climate study, etc.

I will overview multi-year progress in understanding the dynamics of the frontal zone with the bias towards own and collaborative research and with the emphasis on questions that remain to be answered.

The structure of the regional surface circulation will be discussed using high-resolution synthetic mean dynamic topography, suggesting that in the presence of extremely high variability time-averaged fronts/jets remain amazingly sharp and some fronts branching from KE and SF are in fact trapped Rossby waves. Drifters reveal the role of the zone as a barrier for meridional exchange of surface waters and hints on the possibility of a westward countercurrent between the eastward-flowing jets. Data of current meters from the “Megapolygon-87” experiment suggest that structures and origin of eddies above and below the thermocline may be completely different.

New research opportunities emerge from unprecedented development of multi-component observing system. Near-realtime satellite altimetry and scatterometry allow diagnostic simulation of consequences of such disasters as March 11, 2011 tsunami in Japan. The SCUD (Surface Currents from Diagnostic) is used at IPRC to assess motion of debris, generated by the tsunami. The array of Argo floats does not only supply vertical profiles of water properties but can also be used to assess subsurface ocean currents. Regional maps of YoMaHa (Yoshinari-Maximenko-Hacker) dataset will be discussed.

SHARKS VERSUS MONK SEALS IN PAPAĀNAUMOKUĀKEA MARINE NATIONAL MONUMENT: A CONSERVATION CONUNDRUMCarl G. Meyer^{1*}, Yannis P. Papastamatiou², Jonathan J. Dale³, and Kim N. Holland¹*¹Hawaii Institute of Marine Biology, University of Hawaii, Kaneohe, Hawaii; ²Florida Museum of Natural History, University of Florida, Gainesville, Florida; ³Hopkins Marine Station, Stanford University, Pacific Grove, California*

French Frigate Shoals (FFS) in Papahānaumokuākea Marine National Monument is a historical stronghold for the critically endangered Hawaiian Monk Seal (*Monachus schauinslandi*). Once the most populous breeding site, FFS has experienced a precipitous decline in seal numbers in recent decades. Shark predation on pre-weaned seal pups is one of the most significant factors impacting the seal population at this location. Anecdotal observations suggest a few large Galapagos sharks are perhaps responsible for most of the pup losses, and that selective culling of a small number of Galapagos sharks might dramatically improve monk seal pup survivorship. However, most confirmed shark predation on seal pups occurs unseen, hence the actual number and species of sharks responsible is unknown. To address these knowledge gaps, we captured and acoustically-tagged over 100 large Galapagos and tiger sharks at FFS in 2009, and deployed acoustic receiver ‘curtains’ around seal pupping sites. Over a two year monitoring period (2009-2011) we detected 7 (10%) Galapagos sharks regularly visiting seal pupping sites while 6 others were occasional visitors. Approximately half of all tagged tiger sharks visited the same habitats. Our results suggest a relatively small number of Galapagos sharks are involved in pup predation whereas the role of tiger sharks in pup predation remains unclear. Overall patterns of detection suggest Galapagos shark recruitment to seal pupping sites may be ongoing, hence culling sharks may reduce seal pup predation in the short term but is unlikely to provide a permanent solution.

STRONG VERTICAL VORTICES IN THE ATMOSPHERES AND THE OCEANS

Hiroshi Niino¹, Akira T. Noda², Junshi Ito¹, Takashi Kitagawa³, Takashi Nakagawa⁴, Ryuji Kimura⁵, and Shingo Kimura³

¹*Dynamic Marine Meteorology Section, Department of Physical Oceanography, Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba;* ²*Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Kanagawa;* ³*Biological Oceanography Section, Department of Collaborative Research, Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba;* ⁴*Kappa-Tai, Nerima, Tokyo;* and ⁵*The Open University of Japan, Mihama, Chiba, Japan.*

A variety of vortices exist in the atmospheres (of planets) and the oceans. Vortices such as typhoons and extratropical cyclones in the atmosphere, and meso-scale eddies and salt lens in the oceans have small aspect ratios, which are defined as their vertical scales divided by their horizontal scales. In this talk, however, we will be confined to strong vertical vortices that have large aspect ratios. These include tornadoes and dust devils in the atmospheres, and vortices caused by submarine groundwater discharge and those produced by schooling behavior of arabesque greenling.

These vortices are considered to develop when strong vertical motions and a slow ambient rotation are present. However, the manner in which these two factors are prepared is different from vortices to vortices. The vortices caused by schooling behavior of arabesque greenling are especially interesting since they provide an efficient way to feed mesozooplankton to the fish which are staying well below the sea surface where the risk of predation by sea birds is large. The origins of rotation for tornadoes and dust devils are still in veils, and our recent efforts to unveil the origins will be also presented.

GLACIAL STAGE 6 NORTH ATLANTIC CONDITIONS INDICATE AN ANOMALOUSLY STABLE LAURENTIDE ICE SHEET

Stephen Obrochta and Yusuke Yokoyama

Ocean Floor Geotectonics Section, Department of Ocean Floor Geoscience, Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba, Japan

We will model ice partitioning between the major Northern Hemisphere ice sheets during the penultimate glaciation. While the configuration of the North American Laurentide Ice Sheet (LIS) is not well constrained, a detailed reconstruction of the Eurasian Ice Sheet (EIS) exists. The EIS was significantly larger during the penultimate glaciation, while sea level was very similar to the last glaciation. This requires the LIS to have been of significantly lower volume. This information coupled with the location of North American moraines provide necessary constraints to solve for potential configurations of the LIS. Glacial stability during Stage 6 could have been the result of a small LIS that was less prone to surging and large freshwater release.

DECADAL SEESAW OF THE CENTRAL AND SUBTROPICAL MODE WATER FORMATION ASSOCIATED WITH THE KUROSHIO EXTENSION VARIABILITY

Eitarou Oka¹, Bo Qiu², Shinya Kouketsu³, Kazuyuki Uehara⁴, and Toshio Suga^{3,5}

¹*Ocean Circulation Section, Department of Physical Oceanography, Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba, Japan;* ²*Department of Oceanography, University of Hawaii at Manoa, Honolulu, USA;* ³*Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan;* ⁴*Department of Marine Science, School of Marine Science and Technology, Tokai University, Shizuoka, Japan;* ⁵*Department of Geophysics, Graduate School of Science, Tohoku University, Aoba-ku, Sendai, Japan*

Available Argo profiling float data from 2002–11 were analyzed to examine the effect of the Kuroshio Extension (KE) current system variability in association with the Pacific decadal oscillations (PDOs) on the formation of central mode water (CMW). Just north of the upstream portion of the KE at 140°–152°E, formation of a lighter variety of CMW (L-CMW) in winter was active during the unstable period of the upstream KE in 2006–09 and was reduced when the upstream KE was in the stable period of 2002–05 and 2010–11. This decadal L-CMW formation variability in the western part of its formation region has the same longitude range and is out of phase with that of the subtropical mode water (STMW) just south of the KE. It is hypothesized that the enhanced (reduced) L-CMW formation is generated by active (inactive) detachment of anticyclonic eddies from the KE into the L-CMW formation region during the unstable (stable) period.

SCALE INTERACTIONS IN THE TROPICAL PACIFIC

Kelvin J. Richards¹, Andrei Natarov¹, Yuji Kashino², and Wataru Sasaki³

¹*International Pacific Research Center, University of Hawaii at Manoa;* ²*RIGC, Japan Agency for Marine Earth Science and Technology, Yokohama, Japan;* ³*Application Laboratory, Japan Agency for Marine Earth Science and Technology, Yokohama, Japan*

The coupling between the ocean and atmosphere in the tropics on ENSO timescales is heavily influenced by the state of the thermocline in the equatorial ocean, which in turn is very much affected by oceanic mixing. We present recent observations and numerical experimentation that show that both conventional measurements and climate models are missing a significant source of that mixing. High resolution measurements reveal that the vertical shear in the thermocline is dominated by small vertical scale features that are strongly related to regions of active mixing. Sources for this small scale activity include wind-generated near-inertial waves and instabilities of the current system. Accounting for this mixing in a coupled GCM induces a large change in the state of both the ocean and atmosphere. The nature of the generation mechanism of the small scale features suggests the potential for significant feedbacks between ocean mixing and the low frequency variability of the coupled system, such as ENSO.

PAST DAILY LIGHT CYCLE RECORDED IN THE STRONTIUM/CALCIUM RATIOS OF GIANT CLAM SHELLS

Yuji Sano¹, Sayumi Kobayashi¹, Kotaro Shirai¹, Naoto Takahata¹, Katsumi Matsumoto², Tsuyoshi Watanabe³, Kohki Sowa³, and Kenji Iwai⁴

¹Marine Analytical Chemistry Section, Department of Chemical Oceanography, Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba, Japan; ²Department of Earth Sciences, University of Minnesota, Minneapolis, Minnesota, USA; ³Department of Earth and Planetary Sciences, Hokkaido University, Kitaku, Sapporo; and ⁴Ishigaki Branch, Research Center of Fishery and Oceanography at Okinawa Prefecture, Ishigaki, Okinawa, Japan

The historical record of daily light cycle in tropical and subtropical regions is short. Moreover, it remains difficult to extract this cycle in the past from natural archives such as biogenic marine carbonates. Here we describe the precise analysis of Sr/Ca, Mg/Ca, and Ba/Ca ratios in a cultivated giant clam shell, using a laterally high-resolution secondary ion mass spectrometer with 2 μm resolution. The Sr/Ca ratio exhibits striking diurnal variations, reflecting the daily light cycle. A clear seasonal variation in Sr/Ca is also observed in another longer set of measurements with 50 μm resolution. Light-enhanced calcification and elemental transportation processes, in giant clam and symbiotic algae, may explain these diurnal and annual variations. This opens the possibility to develop the Sr/Ca ratio from a giant clam shell as an effective proxy for parameters of the daily light cycle.

FUNCTION OF 'YO-YO' VERTICAL MOVEMENTS OF PELAGIC SHARKS

Katsufumi Sato¹, Itsumi Nakamura¹, and Carl Meyer²

¹Coastal Conservation Section, International Coastal Research Center, Atmosphere and Ocean Research Institute, University of Tokyo, Japan; and ²Hawaii Institute of Marine Biology, University of Hawaii, USA

“Bio-Logging” is a method for investigating phenomena in or around free-ranging organisms that are beyond the boundary of our visibility or experience. Animal-borne recorders enable scientists to investigate behavior and surrounding environments of aquatic animals under natural conditions. Although fish are the oldest and most diverse group of aquatic organisms, they were the last animals to which animal-borne data loggers were applied because of difficulty in retrieving the instruments. Recent developments in circumjacent technology, such as timed-release systems, are making it possible to apply these modern data-collection technologies to fishes. Through the collaboration between University of Hawaii and Atmosphere and Ocean Research Institute, University of Tokyo, we are investigating swimming behavior of tiger sharks *Galeocerdo cuvier*, using animal-borne accelerometers and cameras. Tiger sharks swim continuously with frequent vertical ‘yo-yo’ movements through the water column at mean swim speed of 0.5 to 0.9 m/s. Tail-beating was continuous except for sporadic powerless gliding during descent. Burst swimming events, which might represent prey pursuits, were observed during all phases of vertical movements. Camera images showed a variety of potential prey. These results suggest that function of the vertical movement is not primarily for energy conservation, but probably an effective search strategy for this pelagic shark.

AN EXTENDED FRAMEWORK FOR DECADAL NORTH PACIFIC VARIABILITY

Niklas Schneider

International Pacific Research Center, School of Ocean and Earth Sciences and Technology, Department of Oceanography, University of Hawaii at Manoa, USA

The classical framework of decadal North Pacific variability invoke first baroclinic mode Rossby waves that transmit Central and Eastern North Pacific wind stress curl fluctuations to the Kuroshio and the Kuroshio Extension. The focus of this talk is on the response and subsequent evolution of subsurface water masses in the mixed-water region of the Kuroshio/Oyashio extension that separates warm and salty subtropical from cool and fresh subpolar waters. Changes of the western boundary currents displace these gradients, and cause density compensated anomalies of temperature and salinity. Following the mean currents, these move eastward, while their surface temperature expression are damped by air-sea fluxes. This process is hypothesized to lead to anomalies of mode waters that then propagate in the thermocline toward the lower latitudes.

ENVIRONMENTAL MODULATION OF THE OSMORECEPTIVE PRL CELL IN TILAPIA, *OREOCHROMIS MOSSAMBICUS*Andre P. Seale¹, Soichi Watanabe², Toyoji Kaneko², Darren T. Lerner^{1,3}, and E. Gordon Grau^{1,3}*¹Hawai'i Institute of Marine Biology, University of Hawaii at Manoa, USA; ²Department of Aquatic Bioscience, University of Tokyo, Tokyo, Japan; ³Sea Grant College Program, University of Hawai'i at Manoa, USA*

Osmoreception is the first step in osmoregulation, and is required to activate the mechanisms that maintain hydromineral balance in vertebrates. Progress in characterizing the mechanisms that mediate osmoreception has been made possible by using a uniquely accessible cell model, the prolactin (PRL) cell of the euryhaline tilapia, *Oreochromis mossambicus*. Prolactin (PRL) is well established as a central regulator of hydromineral balance in teleosts inhabiting fresh water (FW). Consistent with this role, PRL release is directly regulated by extracellular osmolality *in vitro* and *in vivo*. A decrease in extracellular osmolality increases PRL cell volume, which leads to a rapid influx of Ca²⁺ through stretch-gated channels (transient potential receptor vanilloid -TRPV4), and triggers PRL release. Transcriptional and secretory responses of PRL cells to alterations in extracellular osmolality *in vitro* are further modulated by previous acclimation salinity. *In vitro* PRL release from the cells of FW tilapia is more robust following a decrease in osmolality than that from PRL cells of SW fish. Interestingly, a hyposmotically-induced increase in PRL gene expression is observed only in cells from SW fish; possibly because expression is already maximal in FW PRL cells. Expression of TRPV4 in PRL cells is also osmosensitive, increasing in direct proportion to extracellular osmolality, *in vivo* and *in vitro*. While the Ca²⁺ ionophore, A23187, and the phosphodiesterase inhibitor, IBMX, stimulate PRL release, they reduce TRPV4 gene expression. Together, these data suggest that TRPV4 expression may be regulated through the same second messenger pathways involved in hyposmotically-induced PRL release.

MULTIPLE GUT FUNCTION IN MARINE FISH: ROLES IN OSMOREGULATION AND ENVIRONMENT

Yoshio Takei, Yosuke Makita, and Masaaki Ando

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Marine fish drink copiously to compensate for water lost osmotically via the gills and absorb >90% of imbibed water by the gut. This is realized because luminal water osmolality is decreased by removing Mg and Ca that accumulate in the luminal fluid. Marine fish secrete HCO_3^- into the gut lumen and precipitate these ions as Mg/CaCO_3 . We found several candidate transporters/channels that are involved in HCO_3^- secretion in the genome database of medaka, whose gene expression is up-regulated after adaptation to seawater. We also found that guanylin, an intestinal hormone that is synthesized only in the gut and act locally in a paracrine/autocrine fashion, enhances HCO_3^- secretion via one of the candidate channels, CFTR-type anion channel in the eel.

Because of such active secretion, the rectal fluid that is excreted into the environment contains ca. 150 mM HCO_3^- and its pH is >9.0. Thus the excreta will stimulate the growth of CaCO_3 skeleton of corals, foraminifera and coccolithophore and may also ameliorate ocean acidification. It is also suggested that Mg/CaCO_3 precipitates (magnesian calcite) contribute to 3-15% of whole oceanic carbon cycle, thereby counter global warming by accumulated atmospheric CO_2 .

SPATIAL AND TEMPORAL ANALYSIS OF PHYSICAL STRESSORS IN NEAR SHORE ENVIRONMENTS

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The persistence of sensitive nearshore habitats is under increasing pressure from global climate change. Growth and degradation within these habitats are tightly coupled to environmental parameters and stressors such as temperature, light, and nutrient loading. Our understanding of how these parameters vary over time is primarily based on long-term changes in average values. However, organisms experience fluctuations in the environment on smaller temporal and spatial scales than are captured in these average values. Faced with the need to manage nearshore environments in the face of changing climate it is important to understand how variation in parameters that control resilience vary at scales that are relevant to the organisms themselves – long term averages that are meant to represent large spatial scales may not provide the information needed for best management practices. Here we present the development of time series analysis that is designed to examine variation in environmental variables at organism relevant temporal and spatial scales. We examine how some physical parameters vary among habitats within Papahānaumokuākea and Kaneohe Bay. We present a new approach to spatial and temporal analysis of physical data that is essential for management of nearshore systems.

GLOBAL CLIMATE CHANGE DURING ICE-AGE CYCLES OF THE LAST 400,000 YEARS

Oliver Elison Timm

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The climate of last 400,000 years is characterized by large changes in global mean temperatures that were accompanied by dramatic changes in the land ice masses and global sea level changes of more than 100m. According to the Milankovitch theory the ultimate driver for ice-age cycles are changes in the Earth's orbit around the sun and subsequently the solar insolation. However, the internal processes and feedbacks involved in the formation of cold glacial and warm interglacial climates are still under scientific investigation. At the IPRC, we study the role of external forcings and internal feedbacks by means of Earth System Models of Intermediate Complexity. Together with paleoclimate researchers at JAMSTEC, Yokohama, and the University of Tokyo, we are conducting computer simulations of the coupled ocean-atmosphere-ice-vegetation system that will improve our understanding of past climate changes. Furthermore, we combine our model results with indirect ('paleoproxy') evidence of past climate changes such as ice core data and deep sea sediment core samples to constrain model uncertainties as well as to improve climatic interpretations of paleoproxies. I will present first results of our research with focus on the interdisciplinary aspects linked with understanding climate and global sea level changes over the past 400,000 years.

PALEOCLIMATE RESEARCH AT THE INTERNATIONAL PACIFIC RESEARCH CENTER

Axel Timmermann

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This talk will provide an overview of ongoing paleo-climate research activities at the IPRC. Current projects focus on: climate-ice sheet interactions using a newly developed ice-sheet climate modeling system (iLove); transient modeling of glacial cycles with comprehensive earth-system models; paleo-data model comparisons (North Pacific deep ventilation, Mg/Ca versus alkenone-based temperature reconstructions, last glacial termination in the Pacific, interpretation of Neodymium proxies in the context of abrupt climate change); carbon-cycle climate interactions (Southern Ocean ventilation and the origin of deglacial CO₂ increases, glacial storage of CO₂ in the deep ocean); abrupt climate change (Influence of North Atlantic Heinrich and Dansgaard-Oeschger events on global climate and the large-scale conveyor belt circulation, climate response to Antarctic meltwater pulses); El Nino's sensitivity to past and future climate change (reconstructing ENSO variability using multi-proxy compilations and modeling ENSO's response to changing boundary conditions); past and future sea-level rise in the context of instabilities of the West Antarctic Ice-sheet (ice-shelf/sheet ocean interactions in Antarctica, origin of orbital-scale and millennial-scale variability of the WAIS); validation of paleoceanographic tracers in comprehensive earth system models (carbon isotope modeling and Neodymium modeling and how it can help to interpret proxy data); carbon-isotope-based climate reconstructions using trees from high elevation sites on Mauna Kea and Haleakala (reconstructing hydroclimate variability in Hawaii using d13C variations in Mamane tree slabs); paleo-drought and potential predictability of future drought regimes in subtropical regions (Mechanisms of megadroughts in subtropical regions, response to external forcings, initialized climate change projection experiments using CESM earth system model to identify physical sources for predictability).

DEFINING BOUNDARIES FOR ECOSYSTEM-BASED MANAGEMENT: A MULTISPECIES CASE STUDY OF MARINE CONNECTIVITY ACROSS THE HAWAIIAN ARCHIPELAGO

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Determining the geographic scale at which to apply ecosystem-based management (EBM) has proven to be an obstacle for many marine conservation programs. Generalizations based on geographic proximity, taxonomy or life history characteristics (such as PLD) provide little predictive power in determining overall patterns of connectivity, and therefore offer little in terms of delineating boundaries for marine spatial management areas. Here, we provide a case study of more than 50 taxonomically and ecologically diverse species (including reef fishes, marine mammals, gastropods, echinoderms, cnidarians, crustaceans and an elasmobranch) that reveal five concordant barriers to dispersal within the Hawaiian Archipelago which are not detected in any single-species exemplar study. We discuss various approaches to combining multispecies population genetic data and contend that this multispecies approach to determine concordant patterns of connectivity is an objective and logical way in which to define the minimum number of management units. Using this approach, we show that EBM in the Hawaiian Archipelago requires at least six spatially managed regions that do not correspond to predictions of physical oceanographic models of larval dispersal.

LINKAGES IN BIOGEOCHEMICAL CYCLES BETWEEN SURFACE OCEAN AND LOWER ATMOSPHERE OVER THE WESTERN NORTH PACIFIC OCEAN

Mitsuo Uematsu

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The deposition of atmospheric aerosols containing iron and other essential trace elements is important for biogeochemical cycles in the oceans because this source of nutrients helps sustain primary production and affects food-web structure; these effects in turn influence the chemical properties of marine atmosphere. Dissolved organic matter and particulate material scavenged from the water column and injected into the air by bursting bubbles, can be recycled between ocean and atmosphere.

From an atmospheric chemistry standpoint, sea-salt aerosols produced by strong winds and marine biogenic gases emitted from highly productive waters affect the physicochemical characteristics of marine aerosols. As phytoplankton populations are patchy and atmospheric processes sporadic, the interactions between atmospheric chemical constituents and marine biota vary for different regions as well as seasonally and over longer timescales.

The W-PASS (Western Pacific Air-Sea interaction Study) project was funded for 5 years as a part of IGBP/SOLAS-Japan activity in the summer of 2006. We aim to resolve air-sea interaction through field observation studies mainly using research vessels and island observatories over the western Pacific.

Some topics from recent W-PASS activities will be presented such as long range transport of Asian dust, characteristics of various patches of phytoplankton bloom in the semi-pelagic region during the Asian dust season in spring, impacts of atmospheric input of anthropogenic substances to the East China Sea, biological responses to typhoon passing in the subtropical North Pacific and its marginal seas, and so on.

CURRENT VELOCITY PROPERTIES OF THE DEEP CIRCULATION IN THE WESTERN NORTH PACIFIC REVEALED BY DIRECT CURRENT MEASUREMENTS WITH MOORING SYSTEMS

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The pathway and current variability of the Pacific deep circulation has been known in the western North Pacific by our current velocity measurements with mooring systems deployed at Wake Island Passage, in the Mercator Basin (around 33N, 165E), and southwest of the Shatsky Rise. We challenged its long-term current variations with operating six-year deep moorings east of Honshu Island, where the deep circulation would merge into the trench current. The most dominant current variation has 100- to 200-day time scale, and its strength varies temporally. This variation is examined for its relation to the sea surface height anomaly variation.

STATISTICAL ANALYSIS OF CYCLONE ENVIRONMENTS IN THE TROPICS, SUB-TROPICS AND EXTRA-TROPICS

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It is well known that warm-core cyclones including typhoons and hurricanes develop in the tropical environment (e.g., high sea surface temperature), whereas cold-core or frontal cyclones develop in the extra-tropical environment (e.g., large horizontal gradient of atmospheric temperature). A question arises as to why cyclones are inactive in the sub-tropical environment in between the two regions of active cyclone development. There are two possible reasons: (1) environmental fields change drastically in the sub-tropics; (2) cyclone dynamics change drastically in the sub-tropical environments.

To clarify which reason is more important for the bimodal cyclone distribution, environmental fields of developing cyclones are quantitatively assessed using JRA/JCDAS reanalysis for 1982-2011. The summer season in the Southern Hemisphere is analyzed, because both tropical and extra-tropical cyclones develop. Developing cyclones are objectively categorized into warm-core and cold-core cyclones using the Cyclone Phase Space analysis. Instead of the geographical (longitude-latitude) space, the environmental parameter space is analyzed to assess (1) how frequent each environmental value appears (area frequency) and (2) how frequent cyclones develop in each environment (cyclone frequency). By comparing the area frequency and the cyclone frequency in the parameter space, it is clarified that the inactive cyclone formation in the sub-tropics is related more closely to the change in cyclone dynamics than to the change in the environmental field.

QUANTITATIVE ESTIMATION OF CONTRIBUTION OF PROTEORHODOPSIN TO ENERGY CYCLE IN THE OCEAN

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Proteorhodopsin (PR) genes are widely distributed among marine prokaryotes and functions as light-driven proton pump when expressed heterologously in *Escherichia coli*, suggesting that light energy passing through PR may be substantial in marine environment. However, there are no data on PR proton pump activities in native marine bacteria. Here, we demonstrate light-driven proton pump activity (c. $124 \text{ H}^+ \text{ PR}^{-1} \text{ min}^{-1}$) in recently isolated marine Flavobacteria. Among 75 isolates, 38 possessed the PR gene. Illumination of cell suspensions from all eight tested strains in five genera triggered marked pH drops. The action spectrum of proton pump activity closely matched the spectral distribution of the sea surface green light field. Addition of hydroxylamine to a solubilized membrane fraction shifted the spectrum to a form characteristic of PR photobleached into retinal oxime, indicating that PRs in flavobacterial cell membranes transform the photon dose in incident radiation into energy in the form of membrane potential. We estimate that the total energy passing through flavobacterial PR is 0.3–15.0% of total open ocean bacterial respiration.

SEA LEVEL AND PALEOCLIMATE FOR THE LAST 140,000 YEARS

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Climate variations and sea level changes are often discussed interchangeably, yet climate change need not always result in sea level change. Perturbations in Earth's orbit cause major climate changes, and the resulting variations in the amount and distribution of solar radiation at ground level follow cycles lasting for thousands of years. Research done in the last decade shows that climate can change on centennial or shorter time scales. These more rapid changes appear to be related to modifications in ocean circulation initiated during the last glacial period either by injections of fresh meltwater or huge ice discharges into the North Atlantic. When first detected, these rapid climate changes were characterized as episodes decoupled from any significant change in sea level. New data clearly show a direct connection between climate and sea level, and even more surprising, this link may extend to times of glacial-interglacial transitions and possibly also to interglacials. The full extent of this sea level/climate coupling is unknown and is the subject of current research.

PATHWAY AND VARIABILITY OF DEEP CIRCULATION AROUND 40°N IN THE NORTHWEST PACIFIC OCEAN

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To clarify the most downstream of the global deep-water circulation, we conducted current observations with seven moorings at 40°N east of Japan in the northwest Pacific from May 2007 to October 2008, together with hydrographic observations. By analyzing data while taking into consideration that the deep circulation has a northward component in this region and carries low-silica, high-dissolved-oxygen water, we clarified that the deep circulation flows within the region between 144°30'E and 146°10'E at 40°N on and east of the eastern slope of the Japan Trench with marked variability; the deep circulation flows partly on the eastern slope of the trench and mainly to the east during P1 (10 May – 24 November 2007), is confined to the eastern slope of the trench during P2 (25 November 2007 – 20 May 2008), and flows on and to the immediate east of the eastern slope of the trench during P3 (21 May – 15 October 2008). The width of the main part of the deep circulation changes between 40 and 100 km. It was concluded that the eastern branch of the deep circulation flows westward at 38°N and then northward to the east of the trench, finally joining the western branch around 40°N during P1 and P3, whereas the eastern branch passes westward south of 38°N, joins the western branch around 38°N, and flows northward on the eastern slope of the trench during P2. The confluence flows northeastward along the Kuril-Kamchatka Trench, forming the northern route.

WIND-FORCED BAROCLINIC BETA-PLUMES: APPLICATION TO THE HAWAIIAN LEE COUNTERCURRENT

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An idealized primitive-equation ocean model is used to study the baroclinic response to weak localized wind stress curl, also known as a wind-forced β -plume. Vertical mixing (both viscosity and diffusion) is found to damp preferentially higher vertical modes, inducing a westward vertical stretching of the plume, resulting in a decay of surface zonal jets and the appearance of deep jets far to the west of the forcing region. The associated zonal scales vary monotonically with the meridional scale of the forcing, in agreement with theory. An eddy-resolving global ocean model shows that the Hawaiian Lee Countercurrent (HLCC) has a vertical structure similar to that of idealized β -plumes and similar sensitivity to the wind stress curl meridional length scale. The model reveals a previously unknown deep extension of the HLCC, which is confirmed by velocity data derived from Argo float trajectories.

CORAL CONSERVATION GENETICS: HYBRIDIZATION, PHENOTYPIC PLASTICITY, AND THE IDENTIFICATION OF CRYPTIC BIODIVERSITY

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Molecular markers reveal that many coral morphospecies, some of which are considered rare or endangered, are members of closely related species complexes that are difficult to resolve. Most molecular studies within these complexes, show some disagreement between genetic and morphological data, and incongruence between molecular markers. Introgressive hybridization and incomplete lineage sorting have often been invoked as explanations, but extreme phenotypic polymorphism is an alternative hypothesis that has received less consideration despite well-documented and numerous examples of phenotypic plasticity. We will present integrated molecular and morphological data from several case studies illustrating that colony-level morphology can be far more flexible than previously thought. These studies show that taxonomy based on colony-level appearances can be deceiving and is in need of revision for several of the most widespread and abundant genera of reef building Pacific corals. Additionally, genetic data have revealed several cryptic taxa that appear to have a limited geographic range. Along with increased taxonomic, genetic, and geographic sampling, more integrated molecular and morphometric approaches have the potential to shed new light on the evolution and biodiversity of reef building corals. There is a need for increased standardization and larger scale collaborative efforts across the globe. These efforts are critically important to understand the past, present, and uncertain future of coral reefs in the face of the present biodiversity crisis.

SCALES OF VARIABILITY OF WATER COLUMN PARAMETERS IN A SUBTROPICAL CORAL REEF SYSTEM (KANEHOE BAY, HAWAII)

Òscar Guadayol and Florence Thomas

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In general, planktonic organisms have life spans and processing rates that are comparable to high frequency short (minutes to days) fluctuations and are faster than benthonic organisms. Phytoplankton may, for example, respond in a matter of minutes to changes in radiance caused by passing clouds. Responses of plankton are well known for seasonal and decadal oscillations, however, little is known about responses at higher frequencies, which may be especially important in productive coastal areas. Alterations in the frequency, intensity and duration of meteorological and hydrological events have been observed and predicted in the context of global climate change. Thus, understanding how the coastal planktonic systems respond to high frequency small-scale variability in physical and chemical stressors is a crucial first step towards understanding long term responses of planktonic communities to climate change.

In order to determine the scales of variability of both physical stressors (temperature, salinity, current velocity, turbulence and turbidity), and chemical (pH, O₂) and biological (chlorophyll concentration, cyanobacteria abundance) response variables, we use a high frequency time series obtained from an array of sensors deployed in a shallow subtropical coral reef system (Kaneohe Bay, Hawaii). We identify the dominant scales of variability in the frequency domain of both stressors and response variables at different periods of the seasonal cycle using single and cross-spectral analyses.

SIMULATING ICE SHEET-CLIMATE INTERACTIONS WITH iLOVE: THE LAST GLACIAL CYCLE

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We present results from a new ice sheet-climate model named iLove, which consists of the atmosphere, ocean, sea ice, and land vegetation model of intermediate complexity LOVECLIM, bidirectionally coupled to the 3D Ice sheet model for Integrated Earth system Studies (ICES).

First coupled, transient simulations of the Northern Hemisphere ice sheets over the Last Glacial Cycle (the last 125 thousand years) are promising. The coupled climate-ice sheet model simulates a glacial cycle in response to prescribed orbital parameter and greenhouse gas (GHG) changes, approximately reproducing the reconstructed global ice sheet volume for the last and current interglacial and the Last Glacial Maximum (LGM). However, the simulated glacial inception is not as gradual as inferred from reconstructed sea level changes. Moreover, despite several perturbed physics experiments, it proves difficult to match the southward extent of the Labrador ice sheet during the LGM.

Sensitivity experiments with respect to GHG and orbital parameter changes illustrate that, in our model setup, most of the ice sheet changes during the glacial cycle can be attributed to obliquity rather than to precessional forcing. Moreover, the Last Glacial Cycle cannot be reproduced assuming constant, preindustrial GHG concentrations. The Milankovitch forcing alone, without GHG changes, is not enough to drive the Last Glacial Cycle.

DISTRIBUTION AND CHARACTERIZATION OF HALOPHILIC ARCHAEA IN MARINE ENVIRONMENTS

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Haloarchaea, members of the family *Halobacteriaceae*, have been regarded as extremophiles that requires at least 10% NaCl for growth and does not thrive in marine environments because of lower salinities. Nevertheless, the 16S rRNA gene signatures of the haloarchaea have been detected frequently in non-hypersaline environments including marine environments. Besides, recent isolation of the haloarchaeal strains from marine environments by ourselves may lead a necessity of reevaluation the haloarchaeal habitats. Here we describe the isolation, preliminary physiological characterization, and phylogeny of the isolates from several seawater samples. The samples collected from Arabian Sea, Japan Sea, Sagami Bay, Saroma Lagoon (blackish-water) and the seawater aquarium at the Ocean Research Institute, the University of Tokyo, were filtrated and incubated on high-sodium chloride agar plates. As a result, 69 strains of haloarchaea were isolated and the 16S rRNA gene sequence analysis divided them into nine genera. To our knowledge, this is the first report of the isolation of the haloarchaea from an open ocean water column. The evolutionary process, distribution and ecological significance of haloarchaea in marine environments will be discussed.

EFFECT OF AMBIENT ROTATION ON DUST DEVIL-LIKE VORTICESJunshi Ito¹, Hiroshi Niino¹, and Mikio Nakanishi²

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Dust devils are sub-convective scale strong vertical vortices and can be visualized in the convective mixed layers on deserts where dust particles that can be lifted by strong tangential winds of vortices are presented. Previous studies by means of large eddy simulations have been reproduced formation of dust devil-like vortices in convective mixed layer without ambient rotation. Although terrestrial planetary vorticity is believed to have little effect on such small scale vortices, our sensitivity study with varying the Coriolis force shows that the ambient rotation whose magnitude is 10 times as large as that of the mid-latitudes in the Earth can significantly affect the preferred direction of rotation in dust devil-like vortices. This result is consistent with the findings in recent Doppler-lidar observations on dust-like vortices for which the heat island circulations, which are typical meso-scale atmospheric disturbances that have a larger rotation than the planetary one, supposedly affect. A further increase in the ambient rotation changes the structure of convection in the convective mixed layer and suppresses horizontal convergence, so that vertical vorticity is reduced. The manner in which the ambient rotation affects the vertical vorticity of dust devil-like vortices indicates that horizontal transport of angular momentum generated by turbulent convection is responsible for the formation of dust devil-like vortices in an environment without ambient rotation.

SEASONAL AND INTERANNUAL VARIATION OF NORTH PACIFIC TROPICAL WATER IN ITS FORMATION REGION, 2003–2010

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Seasonal and interannual variations of the North Pacific Tropical Water (NPTW) in its formation region and their mechanisms were investigated by using Argo profiling float data and surface flux data in 2003–2010.

The mixed layer salinity (MLS) variations in the NPTW formation region are significantly different between the western and eastern parts of the region. Seasonal variation is dominant in the eastern part, while interannual one is dominant in the western part, possibly related to the El Niño-Southern Oscillation. The MLS variation in the eastern part is controlled mainly by evaporation, precipitation, and entrainment, and is closely related to the seasonal variation of mixed layer depth. In the western part where the effect of entrainment is small, excess evaporation over precipitation is expected to increase MLS throughout the year. This is consistent with the rapid MLS increase in 2008–2010, but fails to explain the MLS variation before 2008.

EVOLUTIONARY HISTORY OF THE GABA TRANSPORTER GROUP REVEALED BY MARINE INVERTEBRATE GAT-1 GENES

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The GABA transporter (GAT) group is one of the main groups in a gene family of transmembrane proteins called the solute carrier 6 (SLC6) family. In mammals, the group consists of four GABA transporters (GAT-1, -2, -3, -4), a taurine transporter (TAUT), and a creatine transporter (CT1). In marine invertebrates such as bivalves, however, only TAUT has been discovered and found to play important roles in their environmental adaptation, and the existence of other members of the GAT group is still unknown. To understand the evolutionary history of the GAT group, I cloned the cDNAs encoding GAT-1 from two protostome species, *Bathymodiolus septemdierum* and *Euphausia superba*. Using sequencing information, phylogenetic, and synteny analyses of the GAT group transporters of vertebrates and invertebrates were performed. The existence of the GAT-1 gene in the two protosome species as well as the results of phylogenetic analysis indicated that GAT-1 was separated from the other members first, and CT1 was formed subsequently, before the protosome/deuterostome divergence. Then TAUT and GAT-3 have been derived from the CT1 lineage, but the time of their occurrence is unclear. GAT-2 and GAT-4, phylogenetically close to GAT-3, were possibly formed in the vertebrate lineage. The findings of this study would contribute to future functional studies of the GAT group in marine invertebrates.

ANALYSIS OF TROPICAL TROPOPAUSE LAYER USING THE NONHYDROSTATIC ICOSAHEDRAL ATMOSPHERIC MODEL (NICAM)

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The roles of deep convection and generated waves in the Tropical Tropopause Layer (TTL) are investigated using a global nonhydrostatic model, the Nonhydrostatic ICosahedral Atmospheric Model (NICAM), which runs on the Earth Simulator with a horizontal spacing of 7 km. The experimental data which successfully simulated a Madden-Julian Oscillation (MJO) event for the period between 15 December 2006 and 15 January 2007, are analyzed. Deep convective activity that reaches the TTL was observed over southern Africa, the Indian Ocean, the Indonesian maritime continent, the western Pacific, and southern America. Deep convection over the continents was most active during the local evening period. Over the oceans, high clouds reaching the tropopause were seen over the Indian Ocean and the seas around Java, where two tropical cyclones were generated. Prominent diurnal variations in tropopause temperature associated with deep convection occurred over the Indonesian maritime continent. These diurnal variations were superimposed on large, low frequency temperature variations associated with equatorial Kelvin waves generated by the MJO convection. The two tropical cyclones caused relatively large tropopause temperature variations with a cyclone scale (500 km horizontally). The gravity waves generated by tropical cyclones cause small tropopause temperature variations that extend for 1000 km from the cyclone. We conclude that the Kelvin waves associated with the MJO convection cause the largest amplitude of temperature variations in the TTL and that tropical cyclones and diurnal variations of convective activity have large local impacts on temperature variations in the TTL.

PALEO-PH RECONSTRUCTION USING BORON ISOTOPE COMPOSITION OF REEF-BUILDING CORAL

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Reef-building corals (e.g., Poritidae, Acroporidae) are unique archives of paleo-environments since they can preserve seawater histories in their skeleton. One such example is boron isotopes that has a potential as a proxy for paleo-pH of seawater. This presentation introduces efforts that have been made by our group to reconstruct pH in the past. We have been successfully cultured corals under the different environments including pH using AICAL device (Acidification Impact on CALcifers). They are used to test the boron isotopes to evaluate as pH meter in the past. The presentation contains also recent experiments using corals obtained from Tahiti under the program of IODP (Integrated Ocean Drilling Program) to reconstruct marine environmental changes since the last ice age.

VARIATIONS IN THE INDIAN MONSOON INFERRED FROM THE GEOCHEMISTRY OF LAKE SEDIMENTS

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The Asian monsoon is an important component of the Earth's climate system to understand regional and global climate dynamics. While geological reconstructions indicate that the Asian summer monsoon intensity gradually decreased through Holocene, a clear and coherent picture of millennial and centennial scale variability has yet to emerge (e.g., Overpeck and Cole, 2007). The Himalayas are a key location for understanding centennial to millennial scale variations in the Asian monsoon, yet few studies have been conducted in this sensitive area. Direct evidence for shifts in monsoonal wind strength is often limited to marine proxy records, while terrestrial reconstructions (e.g., lake levels and speleothems) focus on precipitation. Here, we present the first evidence of terrestrial summer monsoon wind strength changes from lake sediments. Mn/Ti data, a proxy for lake stratification, provide the first direct comparison of the Indian summer monsoon wind intensity between the terrestrial Himalayan region and the marine Arabian Sea region (Gupta et al., 2003) during mid-late Holocene. Centennial to millennial scale variability found in those records are synchronous, with the weak wind intervals corresponding to drier periods of East Asian. Strong similarities suggest that the influence of Indian summer monsoon penetrates into southeastern China, which should be taken into account when interpreting paleomonsoon reconstructions (Nakamura et al., 2012).

MARINE VIRUSES NEAR AND FAR, GREAT AND SMALL

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Viruses are abundant and ubiquitous in the marine realm. They are found from the ocean surface to deep into the sediments of the seafloor, and from the tropics to the polar regions, and contribute to the ecology and evolution of all marine life. We are studying the ecology and diversity of marine viruses in a wide range of marine habitats. Our work is resulting in many exciting discoveries including the discovery of both the smallest and the largest phytoplankton-infecting viruses ever reported, and the first estimates of the contribution of RNA viruses to the viroplankton. We are developing new methods to identify uncultivated virus-host systems and have recently completed the genome sequences for a number of cultivated marine model virus-host systems that are the first of their kind. These include the first reported genome for a bacteriophage infecting the bacterial pathogen, *Vibrio vulnificus*, the first two genomes reported for viruses infecting pennate diatoms, and a phage infecting an abundant coastal methylophilic bacterium. Having cultivated model virus-host systems allows us to obtain whole genome sequences, investigate virus-host interactions, and determine the critical variables influencing the viral replication cycle. These data are needed to parameterize viral processes so that viral infections, a major source of plankton mortality, can be properly incorporated into models of the marine food web.

EAST CHINA SEA MID-HOLOCENE SEA SURFACE TEMPERATURE RECONSTRUCTED FROM SR/CA MEASUREMENT FOR FOSSIL CORALS

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Monsoon is playing a pivotal role to the climate in East China Sea region and reconstructions of past variations provide better constraints on climate models. It has been suggested that variations in incoming solar heat distributions (solar insolation) are responsible to produce the variations, yet the mechanisms to operate the monsoon system is still under debate. We, therefore, reconstructed SST (sea surface temperature) using Sr/Ca ratio in fossil coral skeletons (3,800 and 4,500 years old). In 4.5 cal kyr BP, SST shows slightly warmer condition, whereas colder SST was detected for the 3,800 years old coral. The latter cooling might be corresponding the event previously reported using foraminifers from sediment cores in the same region. The current data suggest that oceanic system could be another important player to control the climate in East China Sea region other than insolation related monsoon changes. Further geochemical data will serve to better understand the East Asian monsoon system.

UREA PRODUCTION IN ADULTS AND DEVELOPING EMBRYOS OF OVIPAROUS CARTILAGINOUS FISH

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Marine cartilaginous fish retain high levels of urea in their body to overcome hyperosmotic stress in a marine environment. However, little is known about osmoregulatory mechanisms in developing embryos in which osmoregulatory organs are not fully developed. I have used holocephalan elephant fish, *Callorhynchus milii*, as a model to investigate urea-based osmoregulation in developing embryos. Elephant fish has attracted attention because of the availability of the public genome database. We first examined the ornithine urea cycle (OUC) enzymes that contribute to urea biosynthesis in the elephant fish. In addition to carbamoyl phosphate synthetase III (cmCPSIII) and ornithine transcarbamylase (cmOTC), mRNAs encoding two glutamine synthetases (cmGS) and two arginases (cmARG) were obtained. A high mRNA expression and activity of each enzyme was found in the liver, suggesting that the liver is the primary organ to maintain a high concentration of urea in plasma of elephant fish. In addition, extrahepatic tissues such as the kidney and muscle most likely also contribute to the urea production in adult fish (Takagi et al., 2012). In embryos, expression of the OUC enzyme genes was increased in the liver of later developmental stages. In contrast, expression of the OUC enzyme genes was not prominent in the body during the early stages of development; we found a critical contribution of yolk sac membrane in the urea production.

ATTACHED BACTERIA REDUCE SETTLING VELOCITY OF ORGANIC AGGREGATES IN SEAWATER

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Organic aggregates play a major role in the vertical organic carbon delivery in the oceans, yet controlling mechanisms of aggregate settling velocity are not entirely clear. This study examined if attached bacteria affect settling velocity of organic aggregates. Model aggregates consisting of two kinds of polysaccharide compounds (fucoidan and chitosan) were incubated in either 0.8- μm - or 0.2- μm -filtered coastal seawater to prepare the aggregates with different levels of bacterial colonization. For the aggregates belonging to the same size category (range, 62-119 μm), the settling velocity of the aggregates densely colonized by bacteria was much lower (2-5 fold) than that of the aggregates less densely colonized by bacteria. This reduction in the settling velocity could not be explained by bacterial density effect, since bacterial density exceeded the density of polysaccharide matrices. Rather, the settling velocity reduction appeared to be largely accounted for by the increase in aggregate porosity associated with bacterial colonization. Our results support the notion that bacterially-mediated structural modifications of polysaccharide matrices play an important role in determining settling velocity of aggregates in marine environments.

IDENTIFICATION OF A FIFTH NEUROHYPOPHYSIAL HORMONE RECEPTOR (V4R) IN VERTEBRATES

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The neurohypophysial peptides of the vasopressin (VP) and oxytocin (OT) families regulate salt and water homeostasis and reproduction through distinct G protein-coupled receptors. The current thinking is that there are four neurohypophysial hormone receptors (V1R or V1aR, V2R, V3R or V1bR, and OTR) in vertebrates, and their evolutionary history is still debated. Cartilaginous fish, the earliest diverged extant gnathostomes, is a key group for understanding the evolution of the vertebrate neurohypophysial hormone system. Their receptors, however, have not been previously studied. In the present study, we successfully cloned multiple neurohypophysial hormone receptors from the holocephalan elephant fish. Surprisingly, we found a unique VP-family receptor, which we have designated V4R. This receptor is related to V2R in sequence, but induced Ca²⁺ signaling in response to vasotocin (VT), the non-mammalian VP ortholog; such signaling is typical of V1R and V3R. Further screening revealed that orthologous V4Rs are widely distributed throughout the jawed vertebrates, and that the V4R family is subdivided into two types: the fish specific type-1, and type-2, which is characteristically found in tetrapods. The V4R gene could have been lost in placental mammals. Based on molecular phylogenetic, synteny and functional analyses, we propose a new evolutionary history for the neurohypophysial hormone receptors in vertebrates as follows: the first duplication of an ancestral receptor gene generated V1R/V3R/OTR and V2R/V4R lineages; after divergence from the V4R lineage, the V2Rs evolved to use cAMP as a second messenger, while the V4Rs retained the original Ca²⁺ signaling system.

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