SCRIPPS STUDENT SYMPOSIUM

September 27, 2017
Scripps Seaside Forum

Dear SIO Community,

Thank you for joining us for the 4th annual Scripps Student Symposium (S^3). The goal of S^3 is to provide a platform for Scripps graduate students to present and discuss their research with colleagues from all curricular groups. This student-inspired symposium was created to foster interdisciplinary collaboration amongst the student population and to introduce the new first-years to the wide variety of research Scripps has to offer.

In addition to enjoying the student presentations, we hope that everyone is excited to hear from our keynote speaker, Dr. Loren Shure. Dr. Shure received her Ph.D. in Geophysics from Scripps Institution of Oceanography in 1982 and has since made major contributions to the design and functionality of the MATLAB language, working as a Consulting Application Engineer for Mathworks.

We would like to thank the organizers of last year's S^3 for continuing this newly formed Scripps tradition; we hope that Year 4 of S^3 will continue to inspire students for many years to come!

All the best,
The 2017 S^3 Organizing Committee

Kaitlin Creamer
Jessica C. Garwood
Gabriel Castro
Brian Stock

Agenda

Wednesday, September 27th 2017
Keynote Speaker: Dr. Loren Shure, "The Power of And", SIO 1982 Geophysics
Consulting Application Engineer, Mathworks

0830 - 0850	Registration Open
0850 - 0900	Welcome Address
0900 - 1015	Oral Session 1: Onshore
1015 - 1115	Poster Session #1 and Coffee + Refreshments
1115 - 1130	Welcome by Cathy Constable
1130 - 1245	Oral Session 2: Nearshore
1245 - 1345	Group Photo + Lunch
1345 - 1500	Oral Session 3: Offshore
1500 - 1515	UC Ship Funds Presentation (Bruce Appelgate)
1515 - 1615	Poster Session #2 and Coffee + Refreshments
1615 - 1705	Keynote Address: Loren Shure, Ph.D. SIO '82, "The Power of And"
1705 - 1730	Awards Ceremony and Closing
1730 - 1830	Social Hour with Refreshments in Surfside

Oral Sessions

Onshore

Nearshore

Offshore

Contents

KatharoSeq enables high-throughput microbiome analysis from low-biomass samples

Jeremiah Minich[1], Kasthuri Venkateswaran[2], Russ Vetter[3], Jae Kim[4], Eric Allen[5,6], Rob Knight[6,7,8] †

Microbiome analyses of low-biomass samples are challenging because of contamination and inefficiencies, leading many investigators to employ low-throughput methods with minimal controls. We compared widely used DNA extraction kits and demonstrate that the high-throughput PowerMag kit outperforms the single tube extractions while processing four times faster. By leveraging negative and positive controls, KatharoSeq reveals the whole bacterial community from inputs as little as 50 cells while at 500 cells, correctly identified 92.1% (S.E. 0.87) of reads. To demonstrate the broad utility of this application, we applied this method to the 16S rDNA and shotgun metagenome analyses of the Jet Propulsion Lab Spacecraft Assembly Facility, SAF, (n=192, 96), 52 rooms from a Neonatal Intensive Care Unit, NICU, (n=480, 384), and an endangered abalone rearing facility (n=192, 192) demonstrating spatially resolved, unique microbiomes, reproducible across hundreds of samples. The SAF contains four primary sOTUs with three (Acinetobacter lwoffi, Paracoccus marcusii, and Mycobacterium sp.) being present in over 75 % of the samples. Using microbial spatial topography, the most abundant cleanroom contaminant, A. lwoffi, is related to human foot traffic exposure. In the NICU, we provide evidence for a microbial gradient related to health care professional activity and predict a patient disease outcome from the built environment. Microbial communities in the abalone facility reflect the marine environment rather than human origin. Various abalone species have host specific microbiota including dominance by a gastropod associated Vibrio species. This study demonstrates the feasibility and utility of large-scale, low biomass metagenomics projects using the KatharoSeq protocol.

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A ratchet to shore: evidence of nonlinear internal waves transporting quasi-Lagrangian plankton mimics

Jessica Garwood[1] †, Peter Franks[1], Perry Naughton[2], Paul Roberts[1], Drew Lucas[1], Jules Jaffe[1]

Many coastal organisms have larval stages that are vulnerable to ocean currents, yet need to return to the coast where adult populations are found. Nonlinear internal waves are one of the mechanisms that can return offshore larvae to shallow waters. Plankton transport by internal waves has previously been inferred at SIO from surface floats and debris, as well as increased plankton concentrations in propagating internal waves. Unfortunately, without the ability to track plankton, the influence of swimming behavior on transport remains elusive. In June 2016, we deployed a swarm of robotic plankton developed by the Jaffe Laboratory for Underwater Imaging off Mission Beach, CA to investigate internal wave transport of depth-keeping organisms. Results from one deployment show that the depth at which the plankton mimics were deployed influenced the direction and intensity of transport. Onshore velocities of shallower floats also increased when nonlinear internal waves propagated through the swarm, with measured Lagrangian velocities of up to 20 cm/s, suggesting that internal waves can ratchet planktonic organisms to shore.

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Fending off predators. . . and ocean acidification? Impacts of decreased pH on California spiny lobsters' predator defenses

Kaitlyn Lowder[1] †, Maya deVries[1], Cierra Kelly[2], Jennifer Taylor[1]

California spiny lobsters (*Panulirus interruptus*) face predation from humans during the October to March fishing season, but they must also contend with octopuses, morays, and large fish. Spiny lobsters may employ a variety of defense behaviors and rely on multiple aspects of their morphology to prevent predation. While chemically-sensing nearby predators and using a tail-flipping escape response may keep lobsters far from danger, the spiny lobster exoskeleton (or shell) is equipped with close-range defenses. These structures include the spine-laden, armored carapace, the sharp horns above the eyes, and the jabbing antennae. The specific composition, ultrastructure, and material properties that make these effective defenses, however, may be compromised by stressors such as ocean acidification (decreased pH). Here, we exposed juvenile *P. interruptus* to ocean acidification-like conditions for three months and studied these exoskeletal characteristics as well as chemosensory ability. Preliminary analyses indicate that changes to exoskeletal material properties are pH-level specific, but the thickness of the underlying ultrastructure that supports these material properties is not altered. Additionally, lobsters taste the surrounding water less frequently for chemical cues under decreased pH. These results suggest that different spiny lobster predator defenses may be differentially-impacted by ocean acidification, and they provide a more complete insight into how changes in ocean chemistry may alter crustacean exoskeletons.

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From deserts to plankton: developing and exploring interaction webs built from the dynamics up

Chase James[1] †

Understanding the commonalities shared amongst ecosystems has been a long-standing goal of ecology. Traditionally, ecologists have used food webs to explore generalities between systems such as energy flow, interaction strength, and network properties like stability and resilience. However, food webs fail to capture the many non-predatory interactions that are important to natural systems (competition, mutualism, cascading effects. We use convergent-cross mapping, an empirical dynamic approach that considers the nonlinear, interdependent interactions present in natural systems. We demonstrate that this method is capable of not only detecting, but also quantifying many types of interactions under a unified approach. For this study we used five different ecosystems, ranging from an open ocean planktonic system to a desert. Our results suggest that food web interactions account for roughly half of the most important interactions in natural systems. The method we present, wherein all-inclusive interaction webs are constructed from long-term ecological data, provides a new avenue by which to explore ecological concepts such as stability, prey switching and resiliency to human perturbation.

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Observations Of Barrier Berm Formation In A San Diego Lagoon And Its Effects On Estuarine Hydrodynamics

Madeleine Harvey[1] †, Sarah Giddings[1], Geno Pawlak[2]

Many of the estuaries in California are classified as intermittently open estuaries (IOE) lagoons where wave-induced sediment transport causes a sandbar sill to form near the estuary mouth. When the sill accretes to above the offshore high tide elevation, the estuary-ocean exchange is blocked off. The height of the sill impacts the circulation, inundation, stratification, and dissolved oxygen content in a lagoon. A better understanding of the lagoon circulation during open states and the mechanisms behind sill formation and closures will help coastal managers develop more effective management strategies. Ongoing observations of salinity, temperature, waves, and currents have been conducted since December 2014 in Los Penasquitos Lagoon (LPL) to assess how lagoons respond to closures, storms, wave events, and El Nino's. LPL is a small, low-inflow estuary in San Diego County that closes up to several times annually. Sand and cobbles are transported into the inlet through a combination of bedload and suspended-sediment transport from offshore waves propagating into and dissipating in the lagoon. Following closures freshwater inflows (from precipitation and dry-weather urban drool) cause water levels in the lagoon to rise and stratification to develop. The enhanced stratification can cause hypoxic conditions in the system to develop between 3 and 18 days.

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Explaining Patterns in Chemical Composition and Snapping Shrimp Inhabitation for a Guamanian Cyanobacterium

Christopher Leber[1] †, Andres Reyes[2], Nathan Moss[1], Jason Biggs[2], William Gerwick[1]

A fascinating yet mostly unexplored example of symbiosis is the association between the filamentous cyanobacterium *Moorea bouillonii* and the snapping shrimp *Alpheus frontalis*. *M. bouillonii* produces a wide array of biologically active molecules, including potent cytotoxins, that have been hypothesized to serve in anti-feedant or allelopathic capacities. This, however, does not dissuade *A. frontalis* from engaging with the cyanobacterium. Mating pairs of shrimp weave the cyanobacterial filaments into elaborate structures of tubes and chambers on coral reefs, then using these as shelters and as food sources. On reefs surrounding the island of Guam, the curious observation was made that *M. bouillonii* can be found in close proximity existing in two different forms: one which is associated with *A. frontalis* and produces a particular suite of chemistry, and another that grows without the shrimp and possesses a closely related yet distinct chemical composition. This talk will inform on our ever-expanding knowledge of the chemical ecology behind this symbiosis, with specific focus on answering the question: what drives the correlation between chemical composition and *A. frontalis* inhabitation in growths of *M. bouillonii* on Guamanian reefs?

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Marine Room Mixer: turbulent processes in the La Jolla Canyon System

Madeleine Hamann[1] †

Submarine canyons are common features of the coastal ocean. Their complex topographies host dynamical processes on a variety of scales enhancing upwelling, forcing hydraulic jumps over abrupt bends, and focusing internal waves, to name a few. Many of these processes are associated with small-scale turbulence so that canyons are also hotspots of energy dissipation and mixing. Globally, these processes contribute to diapycnal transport 2-3 times that of the open ocean. Regionally, this mixing influences the distribution of tracers such as nutrients, oxygen, carbon, and heat.

In order to elucidate dynamics driving mixing in a shelf-incising canyon (common off of California), a suite of observations were undertaken beginning in September 2016 in the La Jolla Canyon System in San Diego. Eight cross-canyon sections were occupied with a towed body for 24-hours apiece revealing enhanced dissipation driven by both tidal and mean flows. Turbulence occurs both near the bottom and in mid-depth regions where stratification is stronger and resulting mixing can significantly modify water mass properties. Turbulent mean flow separation occurs on offshore lines where along-shore flow is not blocked by the southern headland. Most dissipation, however, is tidally driven.

In addition to shipboard surveys, time series from 3 moorings along the canyon axis capture temporal variability of energetics and mixing patterns. Changes in stratification that occur over fortnightly timescales are linked to spring-neap cycles in energy and dissipation. These shifts alter the reflectivity of the system and thus the distribution of tidally driven mixing. The high-resolution, wave-powered WireWalker profiling mooring deployed at the head of the canyon has continued for the whole year, revealing dynamics and biogeochemical signals on seasonal, event, tidal, and higher frequency timescales and proving novel, real-time insight into the canyon's role in the environment on the adjacent shelf near Scripps Institution of Oceanography.

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The hidden beauty of biodiversity: what fish stomachs and traditional surveys can tell us about the state of coral reefs

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Coral reefs support important fisheries for hundreds of millions of people, and fish biodiversity within the ecosystem has been shown to provide buffering capacity against climate change. Furthermore, niche partitioning and functional versatility are known to influence patterns of speciation among coral reef fishes, contributing to the overall diversity exhibited on coral reefs. Current trophic designations of reef fishes are coarse, however, and fine-scale differences in diet beyond that of traditional designations are likely, but perhaps undescribed. Hawkfishes in the genus *Paracirrhites* are an apt model system with respect to speciation and ecological niche differentiation, exhibiting striking differences in coloration in addition to described differences in habitat and potential foraging preferences. These small-bodied reef predators also rely on coral cover of *Pocillopora* and *Acropora* for sheltering or perching, taxa which are highly susceptible to anthropogenic and natural disturbances. To begin to address niche differentiation, fish from four *Paracirrhites* species were collected from Flint Atoll in the Southern Line Islands of the Republic of Kiribati. Analysis of the metagenomic data from hindgut samples revealed differences in taxonomic composition of microbiomes. Two species (*P. arcatus* and *P. bicolor*) showed non-significant separation of microbiome taxonomy (including comparability of two color morphs of *P. arcatus*), while *P. nisus* and *P. xanthus* revealed distinct gut flora. Intriguingly, an analysis of overall metagenomic data (including presumed prey abundance) revealed further evidence of partitioning among species. This included separate clustering of the two color morphs of *P. arcatus*, thus potentially reflecting an example of incipient speciation driven in part by foraging preferences. These findings are combined with abundance data of hawkfish species from belt transect surveys across the central Pacific to provide a wider view of potential functional redundancy among these conspicuous reef predators in the Pacific.

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Quantifying the predictability of ENSO and its impacts over the California Current System.

Nathali CorderoQuiros[1] †

Several studies explain the influence of ENSO over surface land temperature and precipitation in different regions of the US. However, there is much less information about how this phenomenon impacts different physical and biogeochemical variables in the oceans, and what are the key factors that determine the local predictability of ENSO. In this study, we use the NMME (North American Multimodel Ensemble) to quantify the skill and the uncertainty of the current coupled climate models over California Current System (CCS). We also use CESM (Community Earth System Model) hindcast simulations to develop composite variables of different physical responses of the CCS (e.g. thermocline depth) to ENSO as well as CCS biogeochemical variables. Results show the evolution of ENSO-related variability over CCS during 13 different El Nino events in the period from 1948 to 2010, and how they compare to observations.

Future work includes using the predictable atmospheric components from NMME to force a regional model and evaluate the ecosystem response, using the composites as a base line for the expected patterns of variability.

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Trials and tribulations of a "fishy" field season

Camille Pagniello[1] †, Jack Butler[1], Annie Rosen[2], Annette Brennan[3], Paul Roberts[4], Jules Jaffe[4], Ed Parnell[5], Ana Sirovic[1]

The kelp forests off the coast of southern California are highly productive communities. Marine protected areas (MPAs) have been established to ensure the persistence and resiliency of these habitats and the species inhabiting them. However, it is difficult to quantify if these areas are actually protecting the targeted species and if they are really helping to keep the ecosystem healthy. Passive acoustics are a promising method for monitoring animal activities, diversity, biomass and other environmental features. As such, a step towards aiding current MPA management techniques was the deployment of long-term passive acoustic recorders. In May 2015 and May-June 2016, a low-frequency fish chorus of unknown species was recorded near the kelp forests off La Jolla, California. To identify the chorusing fish species, a new Fish Optical and Acoustic Sensor Identification System (FishOASIS) is being developed. This diver-deployed instrument combines a 20-m aperture array in a tetrahedral-shaped configuration with a low-light Sony 7s II camera to take concurrent sound recordings and pictures. FishOASIS will be a novel cost-effective tool that can link the fishy components of the soundscape with the knowledge of the species producing the sounds. Results from system tests during the summer 2017 (May-September) will be presented. Tests have occurred both off the SIO pier and in the kelp forest located in the South La Jolla Marine Reserve.

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Simultaneous quantum yield measurements of carbon uptake and oxygen evolution in microalgal cultures

Niu Du[1] †

The photosynthetic quantum yield (), defined as carbon fixed or oxygen evolved per unit of light absorbed, is a fundamental but rarely determined biophysical parameter. A method of estimating for both carbon uptake and oxygen evolution simultaneously can provide significant insight into energy and mass fluxes. Here we present details for a novel system that allows quantification of carbon fluxes using pH oscillation (pHOS) and simultaneous oxygen fluxes by integration with a membrane inlet mass spectrometer (MIMS). The pHOS system was validated using Phaeodactylum tricornutum (CCMP 2561) cultured with continuous illumination of 110 mole quanta m-2 s-1 at 25C. Furthermore, simultaneous measurements of carbon and oxygen flux using the pHOS-MIMS and photon flux based on spectral absorption were carried out to explore the kinetics of in P. tricornutum during its acclimation from low to high light (40 to 750 mole quanta m-2 s-1). Comparing 0 and 24 hours we observed strong decreases in, cellular chlorophyll a (Chla, 0.58 to 0.21 pg cell-1), Fv/Fm (0.71 to 0.59) and maximum CO2 (0.019 to 0.004) and O2 (0.028 to 0.007), confirming the transition toward high light acclimation. The time-series indicated a non-synchronized acclimation response between carbon uptake and oxygen evolution, which has been previously inferred based on transcriptomic changes for a similar experimental design without physiological data. The integrated pHOS-MIMS system can provide simultaneous carbon and oxygen measurements accurately, and at the time-resolution required to provide high-resolution carbon and oxygen physiological dynamics.

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An absolute self-calibrating pressure recorder used for measuring vertical seafloor deformation in the Cascadia subduction zone

Matthew Cook[1] [†], Glenn Sasagawa[1], Mark Zumberge[1], David Schmidt[2], William Wilcock[2], Emily Roland[2]

Understanding crustal deformation is crucial for characterizing earthquake potential at plate margins. This is especially true at subduction zones, where earthquakes can generate large tsunamis. Measuring plate deformation underwater is challenging since many methods used on land cannot be extended to the seafloor environment since they often rely on unperturbed transmission of electromagnetic radiation or cannot sustain the high pressures exerted at the bottom of the ocean. Ocean bottom pressure is one way to measure seafloor deformation since small seafloor height changes produce measurable pressure changes. However, detecting small, slow secular signals is difficult since pressure gauges experience long-term drift. Instruments typically drift at rates (10 cm/yr) that exceed expected deformation signals (1 cm/yr). An absolute self-calibrating pressure recorder (ASCPR) was built to circumvent the issue of drift. The pressure gauges alternate between observing the seawater pressure and the pressure produced by a deadweight calibrator, which is used as an absolute reference value. The difference between the known reference pressure and the observed seafloor pressure allows offsets and transients to be corrected to determine the true, absolute seafloor pressure. These measurements provide a great utility as they can be used as epoch points in a long-term time series or as calibration values for other continuous records. Starting in 2014, we deployed seven concrete benchmarks along a profile perpendicular to the Cascadia subduction zone trench. Each station has data that spans one to three years. The repeatability of our measurements is currently 3 4 cm, but we anticipate accuracy on the order of 1 cm with improvements to the instrument metrology and processing tidal and non-tidal oceanographic signals.

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A supercool mechanism for secondary sea ice formation

Margaret Lindeman[1] †, Mary-Louise Timmermans[2], Andrew Wells[3]

Sea ice forms rapidly in gaps in ice cover, driven by large heat fluxes from the ocean to the atmosphere. The resulting brine rejection forms a cold, salty water mass that sinks and flows away from its source. Here, we present a mechanism for secondary ice formation due to supercooling at the interface between this water mass and the relatively fresh mixed layer overlying it. Motivated by Ice-Tethered Profiler (ITP) measurements from the Canada Basin that show the onset and persistence of these conditions, we develop a model for supercooling-driven frazil ice formation that can be generalized to the Arctic or Antarctic. We quantify the contribution of the frazil ice formed through this mechanism to the thickness of the overlying sea ice and the resulting evolution of the mixed layer temperature and salinity fields.

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Leveraging Contextual Data To Improve Machine Learning Classifications Of Marine Zooplankton

Jeffrey Ellen[1,2] †, Mark Ohman[3,4]

'Deep Learning' has led to many recent breakthroughs in automated recognition of diverse types of objects. However current out-of-the-box deep learning architectures have not performed as well with some types of digital images, including those of zooplankton. Current algorithms can only look for patterns within the pixels presented in the image that was captured. In this work, we investigate techniques for providing contextual metadata to Convolutional Neural Network algorithms applied to digital images acquired with two digital imaging devices: our new Zooglider and the ZooScan. We augment pixels with physical measurements, hydrographic information, and other contextual information and examine the effects on the algorithm's accuracy. We also compare the efficacy of Deep Learning classification with more conventional feature-based algorithms (Support Vector Machine and Random Forest). We suggest that our results are not unique to zooplankton imagery, but this approach is also translatable to other oceanographic machine learning tasks.

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A tale of local winds: Why are surfing conditions in California so choppy in spring and summer?

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Surface waves are crucial for the dynamics of the upper ocean not only because they mediate exchanges of momentum, heat, energy, and gases between the ocean and the atmosphere, but also because they determine the sea state. The surface wave field in a given region is set by the combination of local and remote forcing. The present work characterizes the seasonal variability of the deep–water surface wave field in the California Current region, as retrieved from over two decades of satellite altimetry data combined with wave buoys and wave model hindcast (WaveWatch III). In particular, the extent to which the local wind modulates the variability of the significant wave height, peak period, and peak direction is assessed. During spring/summer, regional–scale wind events of up to 10 m/s are the dominant forcing for waves off the California coast, leading to relatively short period waves (8-10 s) that come predominantly from the north–northwest. The wave climatology throughout the California Current region shows average significant wave heights exceeding 2 m during most of the year, which may have implications for the planning and retrieval methods of the Surface Water and Ocean Topography (SWOT) satellite mission.

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Simple and accurate corrections for indicator perturbation in spectrophotometric pH measurements

Michael Fong[1] †

Although spectrophotometric pH is a fairly straightforward measurement compared to other seawater inorganic carbon parameters, there are a couple of areas that could be improved in efficiency. For repeatable and accurate measurements, corrections must be made for the effect of adding the indicator dye to the sample. Typically, dye corrections are done empirically by characterizing the magnitude of perturbation for each batch of dye. As the empirical method requires multiple measurements of samples, it expends both time and dye in most systems. The uncertainty of empirical corrections also grows with decreasing cell pathlengths, from less than 0.002 pH units in 5 and 10 cm cells to ∼0.01 in 1 cm cells. A chemical equilibrium model to predict dye perturbation was developed as a potentially simpler alternative to the empirical correction methods, and its reliability was evaluated in seawater certified reference materials (CRMs) for dissolved inorganic carbon and total alkalinity. Model errors were on the same order of magnitude as the empirical dye correction uncertainties. With optimization, model-based dye perturbations can potentially provide a more accurate method for dye correction in widely-available 1 cm cells, which are suited for small volume measurements.

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Growing awareness of coral reef conservation at SIO

Brant Chlebowski[1] †

How can we increase awareness of the science being done at SIO by visitors simply passing through campus? By installing living educational exhibit such as the Eckart Coral Reef Garden. Working with the Smith and Sandin labs two CMBC students, Brant Chlebowski and Nina Rosen have gathered a team of scientists, landscape architects and plant experts to design and plant a living coral reef themed garden of succulents and cacti. The garden will be imaged using the same photo mosaic technology used by the 100 Island Challenge team to study coral reefs in some of the most remote parts of the ocean. Using educational exhibits and 3-d printing the educational exhibits around the garden will display the the products of the research including 3-d printed models showing the annual growth of the garden annually. The ultimate goal is to feature the research conducted at SIO and educate the public as they enjoy passing through campus as a part of the Coastal Meander Trail.

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The effects of light availability on the localization of vacuolar H+ ATPase in the coral species Orbicella franksi.

Mikayla Ortega[1] †, Davey I. Kline[1]

Coral reefs are one of the most biologically diverse ecosystems on earth. Corals are experiencing increased ocean temperature, acidity and pollution; however, the lack of understanding of coral physiology from the cellular and molecular perspective makes it difficult to predict their responses and resiliency to changing ocean conditions. In addition, different coral species might have developed specific mechanisms for essential processes such as photosynthesis and calcification, which could result in species-specific responses to stress. Previous studies demonstrated that the enzyme vacuolar H+ ATPase (VHA) 'pumps' protons into the symbiosome space in Acropora yongei and Stylophora pistillata, as part of a CO2-concentrating mechanism that promotes photosynthesis by their symbiotic algae. The goal of this study was to compare and explore the VHA localization in Orbicella franksi corals from different depths, as well as in corals maintained in an aquarium and exposed to equivalent light levels. Using immunohistochemistry, a difference in VHA localization was observed between corals collected at 3 meters and 8 meters depth. In corals from both depths, VHA was found in the symbiosome space, while in 8 m coral VHA was additionally highly abundant in the oral ectoderm, the epidermal layer in contact with seawater. While these results suggested the differential VHA localization was related to light intensity, light is not the only factor that varies with depth. Thus, experiments were conducted under controlled aquarium conditions in which the only difference was light intensity. A subset of the 3m corals were exposed to high light intensity that mimicked their original environment, and another group was exposed to the lower light intensity found at 8m. Conversely, a subset of 8m corals were exposed to their natural low light intensity, and another group was exposed to the higher light intensity equivalent to 3 m depth. The results confirmed that the cellular localization of VHA depends on light intensity, as VHA was abundant in the oral ectoderm of corals exposed to low light intensity regardless of the depth they were collected. Future experiments will characterize the role(s) of VHA in the oral ectoderm of corals exposed to low light conditions. This study contributes to our understanding on how coral can survive and thrive at various depths, and can ultimately help us better predict and understand how coral will respond to environmental stress.

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Characterization of Cellular Mechanisms for Calcification, Photosynthesis, and Nitrogen Metabolism in the Coral*Acropora yongei*

Angus Thies[1] [†], Megan Barron[1], Martin Tresguerres[1]

Coral reefs are among the most ecologically and economically important onshore ecosystems on the planet. The colonial invertebrates which form the backbone of these communities, corals, build intricate skeletons which increase habitat complexity and provide nursery habitat for multiple species. Corals have developed mutualistic relationships with an extensive microbiome and with photosynthetic dinoflagellate algae of the genus *Symbiodinium* that reside inside their cells. This endosymbiosis involves the transport of diverse molecules such as sugars, oxygen, and carbon dioxide between coral and algae that sustain the metabolism of both parties. Nitrogenous ammonia, a main component of proteins and a waste product of protein catabolism, may also be transported. Although sugars received from their symbiotic algae is a major food source, corals further exhibit heterotrophy by capturing prey with their polyps. Predatory behavior is characterized by an influx of nitrogen-rich amino acids which must be metabolized. Corals also experience a nitrogen flux from nitrogen-fixing cyanobacteria in their mucus. These factors point to high levels of biologically available nitrogen in corals without a clear transport mechanism. Despite their ecological importance, very little is understood about coral cell biology. This study focuses on the cellular mechanisms that enable corals to thrive in a dynamic marine environment. The purpose is to illuminate the processes by which corals calcify and transport metabolic substrates and products between their own cells and symbionts. Our aims are to explore the physiological roles of several *Acropora yongei* proteins in vitro including an NH4+ transporter/NH3 channel (Rh), a vacuolar H+-ATPase (VHA), the Na+/K+-ATPase (NKA), a Na+/Ca2+ exchanger (NCX), and a plasma membrane Ca2+-ATPase (PMCA). To achieve these goals we utilize immunohistochemistry, protein blotting, and epifluorescence microscopy methods. We have found trends in differential membrane localization of VHA and NKA between areas of rapid calcification and established regions of *A. yongei* branches. This study is also the first to localize proteins to coral desmocytes, cells that anchor living tissue to the skeleton. Rh, VHA, and NKA all colocalize in these cells, where they may be involved in mediating interactions between the overlying organic mesoglea and the CaCO3 skeleton below.

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Ocean Commitments Under the Paris Agreement

Natalya Gallo[1] †, David Victor[2], Lisa Levin[3]

Under the Paris Agreement, nations made pledges known as Nationally Determined Contributions (NDCs) that indicate how national governments are evaluating climate risks and policy opportunities. We find that NDCs reveal important systematic patterns about national interests and capabilities. Because the ocean plays a critical role in climate mitigation and adaptation, we created a quantitative marine focus factor (MFF) to compare how governments address marine issues in 161 NDCs. In contrast to the past, when oceans received minimal attention in climate negotiations, 70% of NDCs include marine issues. Despite having large exclusive economic zones (EEZs) and important fisheries, the highly developed countries listed in Annex I of the United Nations Framework Convention on Climate Change (UNFCCC) are systematically much less likely to include marine issues than developing countries. Being a Small Island Developing State (SIDS) and having a high percentage of the population living in low-lying areas positively influences MFF, while increasing EEZ area, marine protected area, and fisheries value have no effect. The analysis reveals large gaps between scientific and government attention, such as on ocean deoxygenation, which is barely mentioned. Governments display a keen interest in expanding marine research on climate priorities, suggesting opportunities for engagement with ocean scientists.

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Mining the Biosynthetic 'Dark Matter' of Natural Product Rich Cyanobacteria

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Secondary metabolites, also known as natural products, have been major inspirational sources of therapeutic agents used to treat cancer, bacterial infections, inflammation and many other disease states. Historically, natural products (NP) have been discovered via metabolomic and bioassay-guided approaches. Despite many significant findings via these traditional methods, the number of new molecules discovered per year has remained constant over the past few decades. This is interesting because the genomics revolution has revealed that only a fraction of the "microbial natural product universe" has been accessed via traditional approaches. Those compounds only perceived by DNA sequence information have been referred to as "biosynthetic dark matter". In particular, cyanobacteria are among the most prolific microbes for NP discovery and some members of this phyla harbor a prolific, distinctive and underexplored biosynthetic potential. Despite the importance of genomics and cyanobacteria for natural products research, cyanobacterial genomes represent less than 1% of all prokaryotic genomes. This low sequence coverage of cyanobacterial species has hindered genome-guided discovery of new drug-like molecules. Obtaining more cyanobacterial genomes, especially from the prolific marine filamentous strains, can provide fundamental understanding of those unexplored biosynthetic pathways. Therefore, we combined different sequencing and assembly techniques to obtain 208 high-quality draft genomes and to increase by 50% the number of cyanobacterial genomes publically available, including several NP rich marine cyanobacteria. This improved coverage gives new insights into the distribution and diversity of cyanobacterial biosynthetic pathways. Next, we are developing a pattern-based correlation tool for connecting biosynthetic gene clusters to molecules (ions identified via mass spectrometry). This workflow would be able to automatically identify the most novel biosynthetic genes and their uncharacterized NP molecules, an unprecedented capability that can accelerate NP discovery.

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The Biomechanics of Mangrove Crabs

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Mangrove crabs(Aratus Pisonii) are crab species that live among mangroves. They have distinct shapes, movements, and living forms. The study focuses on the biomechanics that are employed by mangrove crabs. The patterns of the appendage movements, the heights which the crabs maintain during their crawling, and the angles of which crabs bend their appendage tips are investigated. The differences between the vertical crawling and horizontal crawling are also studied.

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An Improved Method to Determine Coda-Q, Earthquake Magnitude, and Site Amplification: Theory and Application to Southern California

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The wavetrain following direct P and S is called the coda and is caused by scattered energy. Coda waves play an important role in seismology for measuring the attenuation of media, earthquake magnitude, and site amplification. We have developed an improved multi-station and multi-event method (MSMEM) to determine these three important seismic parameters simultaneously. We analyze 621 representative local (<= 100 km) and shallow (<= 20 km) earthquakes with catalog magnitudes from 1.8 to 5.4 in southern California at multiple frequency bands centered at 1.5, 3, 6, and 12 Hz. We find that the length of the moving average time window can affect the measurement of coda attenuation Q_C, but our tests indicate that the optimal window length is about 15 times the dominant data period. We use linear regression to fit each coda section and use only those portions that agree with the model decay rate with a correlation coefficient larger than 0.9. Our results indicate that the estimated frequency-dependent coda-Q (Q_C=Q_0 f^a) at 1 Hz (Q_0) and the power a-value ranges are 110–305 and 0.69–1.49, respectively. Our coda magnitude estimates are linearly correlated with catalog magnitude and calibrated to moment with b-value 1.30, and our observed lateral variations in coda-Q and our site amplification factors are in general agreement with previous results, although there are notable differences at some locations. Our results suggest that this approach provides a unified, accurate and stable method to measure coda-Q, earthquake magnitude, and site amplification using coda waves of locally recorded earthquakes.

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Strong correlation between stress drop and peak ground acceleration for recent seismicity in the San Francisco Bay Area

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Theoretical and observational studies have suggested that between-event variability in the median ground motions of larger (M>5) earthquakes is controlled primarily by the dynamic properties of the earthquake source, such as Brune-type stress drop. Analogous results remain equivocal for smaller events due to the lack of comprehensive and overlapping ground motion and source parameter datasets in this regime. Here we investigate the relationship between peak ground acceleration (PGA) and dynamic stress drop for a new dataset of 5297 M1.5+ events occurring in the San Francisco Bay Area from 2002 through 2016. For each event, we measure peak ground acceleration on horizontal-component channels of stations within 100km distance and estimate stress drop from P-wave spectra recorded on vertical-component channels from the same stations. We then develop a nonparametric ground motion prediction equation using a mixed-effects generalization of the Random Forest algorithm that we use to model the joint influence of magnitude, distance, and near-site effects on observed PGA. We find a strong correlation between dynamic stress drop and the residual PGA of each event, with the events with higher-than-expected PGA associated with higher values of stress drop. The strength of this correlation increases as a function of magnitude but remains significant even for smaller magnitude events with corner frequencies that approach the observable bandwidth of the acceleration records. Mainshock events are characterized by systematically higher stress drop and PGA than aftershocks of equivalent magnitude. Coherent local variations in the distribution of dynamic stress drop provide observational constraints to support the future development of nonergodic ground motion prediction equations that account for variations in median stress drop at different source locations.

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Estimating the presence of major "minor" alkalinity in coastal and estuarine waters

May-Linn Paulsen[1] †

Total alkalinity (TA), measured by titration, is commonly used as one of the master variables when studying the aquatic CO2 system. The presence of unidentified, or assumed to be minor, acids can cause significant error in the measurement. The concentration of such acids, largely organic, can be high in coastal and estuarine waters which can lead to erroneous calculation of e.g. pH and air-sea CO2 gas flux. Here we quantify the error in measured TA due to the presence of unidentified acids using simulated open-cell titrations. We also estimate the amount of acid present from the modelled titration data.

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The Zooglider Rendezvous Cruise: A comparison of mesozooplankton abundances between the Zooglider and MOCNESS net tows

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When observed at fine (1-10 m) and micro (< 1 m) scales, planktonic organisms are highly patchy. At these same scales, suspended detrital particles or aggregates (marine snow) are also highly patchy. These patches can have significant ecological consequences (e.g., enhanced water column productivity, increased encounter rates, differential grazing rates, altered carbon cycling). However, conventional sampling techniques (e.g., net-based methods) do not adequately resolve the scales of patchiness (< 5 m) and predator-prey interactions (<< 1 m) in the planktonic ocean environment. The Zooglider, is an enhanced Spray glider equipped with a low-power optical imaging system and dual-frequency sonars (200/1000 kHz) tuned for sampling zooplankton. The Zooglider can resolve mesozooplankton within a well-defined sampling volume, at a vertical scale of 5 cm, while making concurrent physical and acoustic measurements.

In March of 2017, the Zooglider was deployed in the San Diego Trough to resolve vertical micro-scale distributions of mesozooplankton and marine snow. During this deployment, MOCNESS net tows and EK-60 surveys were also conducted, aboard the RV Sally Ride, within 1 km of the Zooglider's last reported position. I will present the data from these concurrent deployments and analyze what potential ecological consequences could result from the different data collection methods.

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Detection of viable enzymes in coastal aerosol

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Marine bacteria express enzymes to cleave off compounds from marine organic material that they can utilize for their nutritional requirements (Azam & Malfatti 2007). The enzymes are found "free" in the seawater and attached to the outer surface of the microbes. The transfer of bacteria in sea spray aerosol (SSA) indicates that SSA should contain viable enzymes (Pósfai et al. 2003, Aller et al. 2005, Mayol et al. 2014, Xia et al. 2015). Recent work (Malfatti and Lee, in prep) has confirmed in the laboratory the presence of viable enzymes in freshly emitted SSA. Here we report the first enzyme activities measured from aerosol collected outside the laboratory. Aerosols were sampled from the Scripps Institution of Oceanography pier and were analyzed in solution using the fluorogenic substrate method. Our detection of viable enzymes in coastal aerosol demonstrates the possibility for bacterial enzymes to change the composition of sea spray aerosol post ejection. This could be one mechanism for the observed yet unexplained differences between nascent SSA and marine aerosols.

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Loop Current features as drivers of delphinid abundance and community composition in the Gulf of Mexico

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Populations of marine mammals, highly mobile top predators, are closely tied to prey fields and are therefore sensitive to the large scale and mesoscale oceanographic features which define a region by shaping prey habitats and communities. Understanding these complex relationships between physical conditions and the trophic webs arising from them can aid in management and conservation efforts of both economically important prey species and ecologically important predators. In the Gulf of Mexico the Loop Current fuels different trophic regimes in different areas according to the frequency of warm-core and cold-core eddy formation and the nutrient and density profiles created by these features. The top predators in these areas are primarily odontocetes, mostly delphinids, which feed on deep scattering layer and mesopelagic vertebrate and invertebrate species. We examined the relationship between Loop Current features and the densities of two representative delphinid species at two continental slope sites with different oceanographic conditions over a period of five years using passive acoustic monitoring data. Satellite altimetry-derived sea surface height anomaly (SSHA) data was applied to detect eddies via the Okubo-Weiss method, and generalized additive models were used to investigate the impact of these physical features on delphinid densities. Future work will incorporate additional physical and biological variables to better elucidate the drivers of delphinid population distributions and shifts in community composition in the Gulf of Mexico.

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Tracking the origins of fish populationsin the Eastern Tropical Pacific using otolith microchemistry

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The Eastern Tropical Pacific extends along 5000 km and is home to hundreds of fishing communities that heavily depend on marine resources. The warming of the region over the past 50 years and the coastal development have both threatened the maintenance of important nursery habitats, which are critical during the early-life stages of commercially important fish populations. Given such conditions, how do local environmental conditions of these mangroves sites affect the growth of fish juveniles and their future recruitment into adult stocks? To address this question, we quantified trace element signatures in 265 otoliths of yellow snapper (Lutjanus argentiventris) juveniles inhabiting mangrove forests from two regions of the Eastern Pacific, the Gulf of California and the Galapagos Archipelago. We used Laser Ablation ICP-MS to estimate the concentration of nine trace elements (Mg, Mn, Cu, Zn, Sr, Ba, Pb, Rb and Li). Given that the life stages of yellow snapper can be roughly estimated from total length, and considering the linear relationship between ablated otolith length and fish total length (R = 0.9, p < 0.05), we calculated the mean concentration for each element per life stage (larvae, settlers, post-settlers and migratory immatures).

We found significant differences in the concentration of 6 elements (Mn, Cu, Sr, Ba, Rb and Li) between the otoliths of juveniles collected in the Gulf of California and Galapagos. Ba and Mn concentrations were higher in the Gulf of California, suggesting freshwater and hypoxic conditions inside mangroves. Otoliths from Galapagos showed higher concentrations of Li, presumably associated to hydrothermal activity along mid-oceanic ridges. The otolith fingerprint showed significant differences among the mangroves of the Gulf of California, suggesting high heterogeneity in the temperature, salinity and chemical conditions in these sites, in accordance with the size of the sampled region (∼600 km) and the local coastal oceanographic conditions. Conversely, the otolith fingerprint in Galapagos fishes were more homogeneous among the mangroves, probably reflecting the higher mixing rates in the region driven by constant upwelling and the convergence of water masses and oceanographic currents. For the Galapagos, fish otoliths from western, central-eastern and southern biogeographical regions could be differentiated. Future research may shed light on how oceanographic processes and coastal human activities affect the traceability of chemical signatures in the otoliths. This information will allow to assess the importance of different mangroves for the sustainability of regional snapper populations.

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Mapping fine-scale dispersal of Nassau Grouper (*Epinephelus striatus*) eggs from a spawning aggregation with a novel plankton imaging system

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Nassau Grouper (*Epinephelus striatus*) populations have declined throughout the Caribbean largely due to overexploitation of fish spawning aggregations (FSAs). The FSA off the west end of Little Cayman Island is one of the largest remaining of the species and has dramatically increased in size since protections took effect in 2003. However, it remains unclear how this increased reproductive capacity will support population recovery and productivity via recruitment. Understanding the mechanisms underlying recruitment is important to linking changes in adult numbers to future, long-term population status. Here, we use novel *in situ* plankton imaging to investigate the fine-scale dispersal of Nassau Grouper eggs, as well as the ocean conditions and plankton community of the waters they were spawned into. We successfully followed one cohort in February 2016 (4 hours) and three cohorts in February 2017 (16, 36, and 6 hours), mapping the density of eggs at fine spatial scale (10s of meters horizontal, 1s of meters vertical). We observed eggs from cohort #2 in 2017 hatching into yolk-sac larvae. Ocean conditions at the FSA were anomalously calm in 2017, and all five drifters released with cohort #2 stayed within 2km of Little Cayman Island and grounded on the reef. Finally, we develop and evaluate the ability of a physical advection-diffusion model to calculate expected egg concentrations in time and space. Our work to develop mechanistic understanding of how eggs survive to become spawning adults will allow for appropriate management to help protect this species.

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Leveraging Antarctic citizen science to understand climate change impacts on polar phytoplankton

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The Antarctic Peninsula has experienced rapid warming for decades, which has led to an increase in glacial meltwater input within the coastal fjords. This freshwater is released at the glacier front within fjords creating transition zones in which to study physical and chemical changes that may drastically impact various levels of the food web, particularly at the level of primary producers. Though scientific monitoring has been established in the region for decades providing invaluable information for the continental shelf and open ocean, greater detail regarding phytoplankton phenology and changes in community composition within fjords is not available. A great opportunity exists for scientists to collect this vital data without imposing a significant cost by leveraging the tourism community in Antarctica. Tourists visiting steadily throughout the year occupy the coastal fjords during times when scientists are unable to sample, thus offering a chance to tap into an already present group of people who can collect simple scientific data to fill the phenology and composition gap. By creating a simple program in which tourists can participate, we can supplement our current scientific datasets during the austral growth period (4.5 months per year) to get a more comprehensive view of phytoplankton community structure and bloom dynamics in the Antarctic Fjords. This new knowledge will provide a better understanding of glacial meltwater impacts on biodiversity and ecology within the fjords, increase public engagement and understanding of science, and contribute information for decisive conservation measures surrounding the region.

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