



Scripps Student Symposium

September 26, 2018
Scripps Seaside Forum



Welcome

Wednesday, September 26th, 2018. Seaside Forum.

Dear SIO Community,

Thank you for joining us for the 5th Annual Scripps Student Symposium (S³). The primary goal of S³ is to provide a platform for Scripps graduate students to present and discuss their research with colleagues from across SIO. This student-inspired symposium was created to foster interdisciplinary collaboration amongst the student population and to introduce incoming students to the wide variety of research going on at SIO. As we celebrate the 5th anniversary of the symposium, S³ has grown into an event that not only promotes the tradition of exceptional research here at SIO, but celebrates the synergistic, outreach-oriented and artistic nature of the Scripps community.

Today's schedule includes oral and poster presentations from graduate students in all research sections of SIO, as well as a presentation by Director of Ship Operations Bruce Appelgate and remarks from Department Vice-Chair Peter Franks. We welcome students from Kearny Mesa High School, who are here to learn about the exciting world of ocean and earth sciences. Representatives from local biotechnology, engineering, and consulting firms have joined us for the day to network with Scripps graduate students and learn about the cutting-edge research they are conducting. Please take a moment today to reconnect with fellow scientists, meet new friends, and to celebrate!

In addition to showcasing graduate student work, we are excited to welcome Dr. Ayana Elizabeth Johnson back to SIO as our keynote speaker. Dr. Johnson received her Ph.D. in Marine Biology from Scripps Institution of Oceanography in 2011 and has since helped lead the charge in ocean conservation grounded in social justice through the foundation of Ocean Collectiv. Dr. Johnson's forward-thinking approach to ocean conservation focuses on ways to utilize the ocean and the resources it has available in a sustainably, economically, and culturally respectful way.

We would like to thank each of you for joining us for this day of science, art, and community; we hope that S³ will continue to inspire students for many years to come!

All the best,

The 2018 S³ Organizing Committee

Nathali Cordero-Quiros
Kaitlin Creamer
Erica Ferrer
Kelli Mullane
Wendy Muraoka
Camille Pagniello
Stephanie Sommer

Agenda

Wednesday, September 26th, 2018. Seaside Forum.

- 08:00-08:50** Registration & Poster Setup
- 08:50-09:00** Welcome Address: S³ Committee
- 09:00-09:15** Welcome by Peter Franks
- 09:15-10:30** Oral Session 1 - Computational
- 10:30-11:30** Poster Session 1
- 11:30-12:45** Oral Session 2 - Experimental
- 12:45-13:45** Group Photo, Lunch
- 13:45-15:00** Oral Session 3 - Observational
- 15:00-15:15** UC Ship Funds Presentation: Bruce Appelgate
- 15:15-16:15** Poster Session 2
- 16:15-17:05** Keynote Speaker: Dr. Ayana Elizabeth Johnson, MS '09, PhD '11
Founder and President of Ocean Collectiv
- 17:05-17:30** Awards Ceremony and Closing
- 17:30-19:30** Symposium Social Hour and Scientific Art Show: Surfside



Oral Sessions

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Computational

- 09:15-09:30 **Michael Fong**, “Insights into the CO₂ and other acid-base systems in seawater from high quality shipboard measurements” (C01)
- 09:30-09:45 **Julia Dohner**, “When Will the Keeling Curve Bend?” (C02)
- 09:45-10:00 **Dillon Amaya**, “Going Against the Grain: Quantifying Extratropical-to-Tropical Teleconnections in the Pacific” (C03)
- 10:00-10:15 **Momme Hell**, “Biases in Southern Ocean storm positions from seismic observations in the Ross Ice Shelf. Or, why is the SoCal south swell forecast often wrong?” (C04)
- 10:15-10:30 **Travis Schramek**, “Depth-dependent thermal stress around corals in the tropical Pacific Ocean” (C05)

Experimental

- 11:30-11:45 **Irina Koester**, “Investigating distinct microbiomes and metabolomes of *Pseudonitzschia*” (E01)
- 11:45-12:00 **Corinne Amir**, “Spatial distribution of coral transplants impacts growth and recruitment at a restoration site on Palmyra Atoll” (E02)
- 12:00-12:15 **Lauren Manck**, “Insights into the Molecular Mechanisms of Iron Acquisition in Copiotrophic Marine Bacteria” (E03)
- 12:15-12:30 **Olivia Pereira**, “Influence of Methane Seeps on Trophic Dynamics of Carbonate Macrofauna of Seep and Surrounding Communities off the Coast of Costa Rica” (E04)
- 12:30-12:45 **Katherine Bauman**, “Connecting genes to chemistry: bioengineering to awaken natural product biosynthesis in marine *Streptomyces* bacteria” (E05)

Observational

- 13:45-14:00 **Shane Finnerty**, “Osmoregulation by Ionocytes: Tracking the Transition from the Skin to the Gills in Larval White Seabass (*Atractoscion nobilis*)” (O01)
- 14:00-14:15 **Margot White**, “Stable isotopes of nitrate in the surface waters of the California Current Ecosystem” (O02)
- 14:15-14:30 **Benjamin Whitmore**, “How does the *Zooglider* compare with conventional mesozooplankton sampling techniques?” (O03)
- 14:30-14:45 **Michael Kovatch**, “Breakdown of a Headland Wake by a Non-Linear Internal Wave” (O04)
- 14:45-15:00 **Allison Lee**, “Citizen Scientists in Antarctica: a new approach to understand climate change affected environments with FjordPhyto” (O05)

Poster Sessions

Wednesday, September 26th, 2018. Seaside Forum.

Poster Session 1: 10:30-11:30

- MP01** Bacterioplankton utilization of colloidal organic matter: experimental degradation of the large and abundant protein RuBisCO, **Josefa Rivera**
- MP02** Observing internal waves in the eastern subtropical north Atlantic with Deep Argo, **Cassandra Henderson**
- MP03** Statistical prediction of minimum and maximum air temperature in the Western North America, **Daniela Faggiana Dias**
- MP04** A comparison of OTU vs. phylogenetic placement approaches for the analysis of microbial community structure and metabolic inference, **Natalia Erazo**
- MP05** Bio-inspired algal-bacterial hydrogels for space efficient microalgal growth, **Noah Martin & Tatum Bernat**
- MP06** Simulated ground motions for a 12-story structure in Oklahoma in a region of induced seismicity, **Jessie Saunders**
- MP07** A Sentinel-1 study of Mount Okmok volcanic deformation using InSAR time series analysis, **Sandra Slead**
- MP08** Iron limitation of a coastal filament in the southern California Current Ecosystem, **Kiefer Forsch**
- MP09** Engaging the first line of defense: Behavioral responses of California killifish to two trematode parasite species, **Rebecca Hernandez**
- MP10** Assessing the impact of climate change-related lower pH and lower salinity conditions on the physiology of a luminous marine invertebrate, **Kira LaFace**
- MP11** On the Structural Origins of the *Chaetopterus* Tube Resilience, **Zida Liu**
- MP12** Dynamics of Biogenic Silica in a coastal upwelling filament in the California Current Ecosystem, **Kayleen Fulton**

Poster Session 2: 15:15-16:15

- AP01** Getting Cozy with Greenlandic Icebergs, **Margaret Lindeman**
- AP02** Biogeochemical observations and baseline CO₂ conditions in the Agua Hedionda Lagoon, **Kenisha Shipley**
- AP03** Achieving Accurate pH Measurements with a Commercially-Available Indicator Dye, **Trisha Nguyen**
- AP04** Strombine dehydrogenase and malate dehydrogenase activity in response to elevated ammonium and CO₂ levels in the corals *Orbicella franksi* and *Porites asteroides*, **Cameron Hassibi**
- AP05** Extending Stochastic Representations of Geomagnetic Axial Dipole Evolution, **Mayuri Sadhasivan**
- AP06** Determining the association between microbial community structure and aerosol formation with CALIPSO, **Srishti Dasarathy**
- AP07** Development of a high throughput low cost metagenomics pipeline reveals seasonal dynamics of the mucosal microbiome of a marine fish, *Scomber japonicus*, **Jeremiah Minich**
- AP08** Calibrated pressure measurements for marine geodesy, **Matthew Cook**

- AP09** Identification of domoic acid biosynthetic genes in *Pseudo-nitzschia* diatoms, **Patrick Brunson**
- AP10** Effect of high hydrostatic pressure on the activity of hydrocarbon-degrading bacteria, **Tianhan Xu**
- AP11** Toughening Strategies in Tubule Architectures, **Audrey Velasco-Hogan**
- AP12** Identification of a Sodium/Hydrogen Exchanger in Coral: a potential role in biomineralization, **Mikayla Ortega**

Abstracts

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Insights into the CO₂ and other acid-base systems in seawater from high quality shipboard measurements

Michael B. Fong¹, and Andrew G. Dickson¹

Studying the ocean's carbon chemistry requires reliable CO₂ measurements and an accurate model of the reactions of CO₂ and other acid-base systems in seawater. A model of acid-base systems in seawater allows the calculation of parameters of the CO₂ system that were not or could not be directly measured from parameters that were/can be directly measured. However, these model calculations do not always agree with the direct measurements, suggesting systematic errors in the measurements and/or the model. In particular, a large number of carefully calibrated, state-of-the-art measurements made on repeat hydrography cruises have shown a significant discrepancy between directly measured pH and pH calculated from dissolved inorganic carbon (DIC) and total alkalinity (TA), that is a function of pH. From an analysis of four cruise datasets, we found that systematic errors in the seawater acid-base model (i.e., errors in acid dissociation constants and estimates of total concentration) and small errors in DIC and TA measurements could be responsible for some, but not all of the observed pH discrepancy. The residual discrepancy can only be explained if there was an unidentified organic base present in seawater that is not accounted for in the traditional seawater acid-base model. Our analysis suggests that a small, but meaningful amount of such an organic base exists in the open ocean. Because of various uncertainties in our understanding of seawater acid-base systems, direct measurements of CO₂ parameters are often more reliable than calculated parameters.

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When Will the Keeling Curve Bend?

Julia L. Dohner¹, and Ralph F. Keeling¹

The Paris Agreement efforts to reduce CO₂ emissions are underway, but whether we will be able to observe a resulting change in atmospheric CO₂ levels remains unclear. Detecting a change requires an understanding of atmospheric CO₂ variability in recent decades, and using a simple model highlights the fundamental carbon cycle mechanisms that control this variability. We revisit a simple four-box global carbon model described in Rafelski et al. (2009) with three goals: 1) to test if this model can account for the observed CO₂ rise since the paper's publication, 2) to examine how inputs affect the model's ability to replicate past CO₂ changes, and 3) to identify the elements of the model that are critical to its success. We find that the model resolves the recent CO₂ growth rate, including a slowing related to the warming hiatus between 2000 and 2014. Next, we find that the model's ability to replicate past CO₂ depends on the land-use change emissions record (the most uncertain of the inputs), suggesting that atmospheric CO₂ measurements can also play a role in verifying estimates of land-use change emissions. Finally, we are in the process of comparing this four-box model to simple statistical models to highlight the features responsible for the box model's success. We hope to eventually use this model to verify that Paris emission reductions are being met, as well as to predict future changes in atmospheric CO₂ resulting from the Agreement.

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Going Against the Grain: Quantifying Extratropical-to-Tropical Teleconnections in the Pacific

Dillon J. Amaya¹, Yu Kosaka², Wenyu Zhou¹, Shang-Ping Xie¹, and Arthur J. Miller¹

The Pacific Meridional Mode (PMM) is a coupled mode of climate variability found in the subtropical North and South Pacific that integrates extratropical surface wind variability into a propagating pattern of SST/wind anomalies that stretches into the deep tropics. In recent years, many studies have indicated that the PMM can act as a precursor and predictor of the El Niño-Southern Oscillation (ENSO) due to this propagation; however, there has been little effort to put these extratropical-tropical interactions into the context of ENSO events in the historical record. To quantify the role of the extratropics in pacing the timing and magnitude of historical ENSO events, we use a fully-coupled climate model to produce an ensemble of North Pacific Ocean-Global Atmosphere (nPOGA) pacemaker simulations, which are forced by the observed trajectory of North Pacific (>15°N) SST anomalies in addition to historical radiative forcing. We are then able to utilize the ensemble mean of nPOGA to analyze the relationship between extratropical atmospheric variability, the PMM, and ENSO. We find that North Pacific SST variability accounts for approximately 16% of total ENSO variance, but can be a much larger contributor on an event-by-event basis. For example, nPOGA reproduces the complicated 2014-2016 ENSO cycle remarkably well. Our results illustrate the significant role of extratropical noise in pacing the initiation and magnitude of ENSO events and may improve the predictability of ENSO on seasonal timescales.

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Biases in Southern Ocean storm positions from seismic observations in the Ross Ice Shelf. Or, why is the SoCal south swell forecast often wrong?

Momme C. Hell¹, Sarah T. Gille¹, Bruce Cornelle¹, Arthur Miller¹, Peter Bromirski¹, and Alex D. Crawford²

Surface winds from Southern Ocean cyclones generate large waves events that travel across the Pacific. These swell spectra contain characteristic information about the wind speed and intensity of the storms. Two years of seismic observations from the Ross Ice Shelf, combined with modern optimization (machine learning) techniques are used to trace the origins of wave events in the Southern Ocean with an accuracy of 110 km and 2 hours from a hypothetical point source. The observed spectra attenuate within sea ice and in the ice shelf, but retain characteristics that can be compared to parametric wave models.

Comparison the MERRA2 and ERA5 reanalysis suggest that about 60% of the observed wave events cannot be matched with Southern Ocean high wind events. The reanalysis cyclones and winds are often miss placed by about 450 km/7 hours in MERRA2 or 360 km/5 hours in ERA5 compared to the most likely position inferred from the seismic data. These Southern Ocean wind biases feed into wave and lead to wrong arrival times of south swell in wave forecasts. In future work, the observations are also used to measure critical sea-ice properties, such as thickness and wave attenuation.

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Depth-dependent thermal stress around corals in the tropical Pacific Ocean

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Thermally driven bleaching events are a growing concern for reef ecosystems across the tropics. To assess and predict thermal stress impacts on reefs, remotely observed sea surface temperature (SST) commonly is used, however, reef communities typically extend to depths where SST alone may not be an accurate measure of in-situ variability. Here, nearly two decades of temperature observations (2-90 m depth) at three stations around Palau are used to develop an empirical model of temperature variability versus depth based on SST and sea level anomaly (SLA). The technique yields depth-averaged R^2 values > 0.87 , with SLA predicting fore-reef temperatures near the thermocline and SST capturing upper mixed layer temperatures. SLA complements SST by providing a proxy for vertical isotherm displacements driven by local and remote winds on intraseasonal to interannual time scales. Utilizing this concept, thermal stress on corals can be predicted from the surface through the mesophotic zone.

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Investigating distinct microbiomes and metabolomes of *Pseudo-nitzschia*

Irina Koester¹, Daniel Petras³, Louis-Félix Nothias³, John K. Brunson^{1,2}, Margot E. White¹, Kai Dührkop⁴, Sebastian Böcker⁴, Farooq Azam¹, Rob Knight⁵, Andrew E. Allen^{1,2}, Pieter C. Dorrestein³, and Lihini I. Aluwihare¹

Microbial interactions in the ocean are mediated by organic molecules. These organic molecules are extremely diverse, just like the microorganisms that produce them. This diversity likely allows for highly complex and exclusive phytoplankton-bacteria interactions. In our study, we examined 5 species of the diatom genus *Pseudo-nitzschia* to characterize their microbiomes (“bacterial world”) as well as their metabolomes (“chemical world”). *Pseudo-nitzschia* is an ecologically relevant diatom, since some species can produce domoic acid, a potent neurotoxin periodically responsible for Harmful Algal Blooms, which have negative impacts on wildlife and human wellbeing.

Microbiomes of each *Pseudo-nitzschia* culture were determined based on 16S rDNA, and these were found to be distinctive and species-specific. The metabolomes of the cultures also differed but identifying molecules that differentiated each species was more challenging since most organic molecules in the ocean are unknown. To identify the suite of compounds unique to each species, we combined an innovative, untargeted mass spectrometry technique with novel bioinformatics tools, like molecular networking, *in-silico* sum formula annotation and machine learning based prediction of compound categories. These methods provide new insights into the exo-metabolome of distinct *Pseudo-nitzschia*-microbial partnership and present a new step toward a better understanding of microbial interactions in the ocean.

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Spatial distribution of coral transplants impacts growth and recruitment at a restoration site on Palmyra Atoll

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Invasive and opportunistic species are known to cause turnovers in dominant biota within ecosystems, often leading to alternative stable states that dramatically change ecosystem function. Alternative stable states are very difficult to reverse even when human intervention occurs. On Palmyra Atoll, the corallimorph *Rhodactis howesii* has dramatically increased in abundance, now dominating >3 km² of reef, displacing corals and other dominant biota in the process. To curtail further degradation, ecological restoration commenced in 2014 at the epicenter of the corallimorph outbreak. Dense aggregations of corallimorph were tented and smothered with granulated chlorine to create a bare CaCO₃ substrate. Next, 9 out of 12 treated plots received coral fragments of *Acropora accuminata* (n=27), *Pocillopora damicornis* (n=27), and *Montipora capitata* (n=27). The remaining 3 were designated as treatment controls. Fragments were transplanted in same-species aggregations, multi-species aggregations, and non-aggregated arrangements to determine how multiple forms of aggregation may impact growth among corals with varying competitive abilities. Four years post-establishment, the treatment plots have experienced a ~300% increase in coral cover. An additional ~100% increase in coral cover was recorded in the multi-species aggregation treatment. Corallimorph reinvasion in treatment plots has been negligible suggesting the techniques used here can be applied to other locations around Palmyra to mitigate further expansion of the corallimorph. Moreover, aspects of these methods, such as multi-species coral transplant aggregation and substrate preparation, can benefit coral restoration programs and biological invasion management throughout the world.

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Insights into the Molecular Mechanisms of Iron Acquisition in Copiotrophic Marine Bacteria

Lauren Manck¹, Christopher Dupont², and Katherine Barbeau¹

Dissolved iron is a necessary micronutrient for microbial growth in the marine environment and is tightly linked to the cycling of carbon and other macronutrients. However, the low solubility of iron(III) oxyhydroxides in oxygenated seawater results in extremely low dissolved iron concentrations in most regions of the world's oceans, and it is now recognized that iron limits primary productivity in one-third of the global surface ocean. In order to circumvent these issues of iron scarcity, marine microbes have developed specialized pathways for acquiring iron from their environment – over 99% of which consists of iron bound to a heterogeneous pool of organic ligands. The ability of marine bacteria to acquire specific compounds within the diverse range of these iron-ligand complexes will play an important role in iron cycling, impacting the degree to which iron is recycled and kept bioavailable for further use. Here we present the results from a detailed study investigating the molecular mechanisms of iron uptake in a copiotrophic marine strain *Alteromonas macleodii* ATCC 27126. Transcriptomic results indicate that substrate transport in *A. macleodii* is highly specific and that the expression of individual transporters is tightly regulated by environmental conditions suggesting specific regulatory mechanisms. A knockout mutant for siderophore biosynthesis in *A. macleodii* has also been generated in order to investigate the role of siderophores in the uptake of a wide range of iron sources. Together, these molecular mechanisms make *A. macleodii* an efficient iron scavenger with an important role in both iron and carbon biogeochemical cycling.

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Influence of Methane Seeps on Trophic Dynamics of Carbonate Macrofauna of Seep and Surrounding Communities off the Coast of Costa Rica

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Methane seeps are of interest due to increasing disturbance from direct human activity on margins and from climate change. Because they provide key ecosystem services, we need to understand their resilience and adaptations to such stressors. Seeps host a diverse fauna on carbonate rocks, by-products of anaerobic oxidation of methane carried out by microbial consortia. These structures remain with lesser or cessation of activity, attracting species from its surroundings and promoting an interaction between seep and background. Using three approaches, our goal was to study the trophic influence of seeps on carbonate macrofauna. We observed a shift in community composition and isotopic signatures of macrofaunal species on rocks with increasing distance from seepage, with a transition site where both seep and background influence the community. By deploying rocks for 7 years at active and transition sites, the carbonate macrofaunal community achieved similar successional stage as in situ rocks. Finally, macrofauna from wood and bone, also deployed for 7 years, were compared to the rock fauna. The experiment revealed a major role of seepage activity, as the community and its isotopic signatures were similar in different substrates at active sites and they shared species at sites of lesser activity, supporting the stepping stones hypothesis that seeps and organic falls can function as metacommunities. These experiments showed that seeps are not isolated ecosystems but have multiple interactions with the surrounding communities, exchanging food and fauna. It is of great importance to understand seep functioning to predict and manage consequences of increasing disturbances.

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Connecting genes to chemistry: bioengineering to awaken natural product biosynthesis in marine *Streptomyces* bacteria

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Small molecule secondary metabolites provide a fundamental means by which microorganisms interact with each other and their environment. Not only are these gene-encoded metabolites of ecological import, but they have proved incredibly valuable to humankind as well, most famously as pharmaceuticals. The plummeting cost of genomic sequencing and resulting flood of genetic information has revealed the tremendous biosynthetic potential of the microbial world, particularly in the world's oceans.

The marine actinomycete *Streptomyces* sp. CNB-091 is known as the native producer of the salinamides, which remain the only metabolites reported for this strain. Bioinformatic analysis of the CNB-091 genome identified 41 putative biosynthetic gene clusters (BGCs), revealing its astounding biosynthetic potential and demonstrating the disconnect between predicted biosynthetic potential and actual chemical profiles of microorganisms. We present here the discovery, cloning, and engineering of a cryptic phenazine-type BGC from CNB-091. This BGC represents an expansion on the biosynthetic and chemical logic of phenazine metabolites, which are known for their diverse and therapeutically relevant bioactivities. Consistent overexpression of the engineered pathway resulted in an incredible increase in chemical diversity of phenazine metabolites, including the production of novel compounds containing an unprecedented formylglycine moiety. Importantly, the synthetic biology tools used in this work are generalizable approaches that can be applied to other BGCs with therapeutic potential, and help connect genotypes to the phenotypes they produce. Ultimately, using biology to inform chemistry in this way to reliably regulate BGC expression is fundamental in discovering, understanding, and governing the chemistry of our natural world.

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Osmoregulation by Ionocytes: Tracking the Transition from the Skin to the Gills in Larval White Seabass (*Atractoscion nobilis*)

Shane H. Finnerty¹, Garfield T. Kwan¹, and Martin Tresguerres¹

The NaCl concentration in the blood of bony fish is more diluted than seawater and therefore are in a constant state of dehydration. To maintain homeostasis, marine bony fish must ingest seawater, absorb water across their intestine, and excrete salts to maintain internal osmotic and ionic composition. As juveniles and adults, NaCl excretion occurs predominantly across the gills via specialized cells called ionocytes. However, young larvae lack functioning gills during early development, thus the bulk of NaCl excretion occurs across the skin. As fish grow and the gills begin to develop, NaCl excretion transitions from skin to gill ionocytes. However, the dynamics of this transition is poorly understood, and there are species-specific differences and environmentally dependent responses. The goal of my study is to provide information about the timing of this transition in high temporal resolution in White Seabass, a local fish with high ecological and commercial value.

White Seabass larvae were collected from Hubbs SeaWorld Research Institute every day from 1 to 32 days post hatching. These larvae were then processed for immunohistochemistry to detect ionocytes, and imaged using light microscopy. Additionally, scanning electron microscopy will be conducted to investigate the external skin and gill ionocyte morphology throughout development. The data gained from this experiment will be of value to local aquaculture managers - providing basic and baseline knowledge for future experimental treatments, and lending insights about how marine bony fish may respond to changing ocean conditions.

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Stable isotopes of nitrate in the surface waters of the California Current Ecosystem

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The California Current Ecosystem (CCE) is a productive eastern boundary current system where strong upwelling brings deep, nutrient-rich waters to the surface. In this often nitrogen-limited environment, the supply of nitrate is essential to sustaining surface productivity. Stable isotopes of nitrate ($\delta^{15}\text{N}$ and $\delta^{18}\text{O}$) can be used to trace biogeochemical processes due to the way that these reactions selectively utilize either the heavy or the light isotope. We measured nitrate isotopes on 14 CalCOFI cruises between 2010 and 2016. These data reveal a wide diversity in euphotic zone nitrate utilization spatially and temporally, with potentially important implications for offshore nutrient transport. The largest changes are associated with the El Niño conditions of late 2015 and early 2016, where nitrate supply appears to have been reduced, leading to greater isotopic enrichment.

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How does the Zooglider compare with conventional mesozooplankton sampling techniques?

Benjamin M. Whitmore¹ and Mark D. Ohman¹

It is easy to observe that organisms are patchily distributed in both terrestrial and littoral habitats. However, patchiness is difficult to observe in the pelagic ocean, in particular with planktonic ecosystems, as it must be measured in a dynamic marine environment and at micro (<1 m) to fine (1-10 m) scales. The fine scale is important as many planktonic patches have been shown to have a vertical extent of under 5 m. The micro scale is important as the size of many planktonic organisms is on the order of μm 's to mm's and as such these organisms interact on scales much less than 1 m. However, conventional sampling techniques (e.g., net-based systems) do not resolve the fine scales of patchiness and predator-prey interactions in the planktonic ocean environment. The Zooglider, a novel autonomous zooplankton-sensing glider, is equipped with a low-power optical imaging system (Zoocam) and dual-frequency Zonar (200, 1000 kHz). 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 Rendezvous Cruise was conducted near the San Diego Trough. During this cruise, the Zooglider was compared with traditional ship-based zooplankton sampling techniques aboard the R/V Sally Ride. Here we present the results of the different sampling techniques. Specifically, we focused on how eight different mesozooplankton taxa varied with respect to total abundance, size distribution, and vertical microstructure.

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Breakdown of a Headland Wake by a Non-Linear Internal Wave

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In the fall 2017, observations were collected around Point Sal, one of several small headlands north of Point Conception, CA. As with other headlands, the rapid change in coastline results in flow separation and recirculation. As the tidal velocities change direction, the recirculation has the potential to release from the coast and advect away in the form of a headland eddy. In addition to the headland processes, the greater Point Sal region is consistently inundated with nonlinear internal waves. Shipboard and drifter observations have shown that the convergent wave fronts trap and advect tracers toward shore. Increased mixing is also observed at the leading edge of the impinging waves. While internal wave and eddy impacts have been studied separately in the past, these two processes occur in unison at Point Sal, resulting in a novel and complex study area. Moored observations provide long records of high temporal resolution but the lower spatial resolution makes observing the spatial variability of small-scale phenomena challenging. With the addition of vessel-, airplane-, and radar-based measurements, the details can be more clearly resolved. Flow separation fronts have noticeably different cross- and along-front structure, as well as propagation behavior, compared to internal wave fronts. The behavior and structure of each respective front before and after interaction with the other will be characterized using the vast array of available measurements. This project is part of the ONR funded “Inner-Shelf Departmental Research Initiative” involving many institutions and investigators.

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Citizen Scientists in Antarctica: a new approach to understand climate change affected environments with FjordPhyto

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Travelers visiting the polar regions are helping scientists monitor change in coastal fjords through the FjordPhyto citizen science project. Due to climate change, the west Antarctic Peninsula (WAP) is undergoing the most rapid rates of warming seen globally. As temperatures rise, glaciers begin to melt. This melted glacial water enters the ocean along coastal fjords and can alter the marine ecosystem. The first organisms to experience this change, are phytoplankton. These microscopic photosynthetic organisms drift in the ocean and are responsible for producing over 50% of the Earth's oxygen, providing food energy to the rest of the ecosystem. Freshwater input may favor different types of phytoplankton and shift the timing of blooms during the growth season. Current hypotheses suggest there will be a shift in phytoplankton size from large diatoms to smaller nanoplanktonic cells in the WAP. Detailed information on these dynamics does not exist for coastal fjords. With the help from tour operators with the International Association of Antarctic Tour Operators (IAATO), polar guide staff, and passenger citizen scientists, data has been gathered from multiple fjords throughout the spring and summer season (November – March). Data reveals temporal trends in phytoplankton blooms and shifts in dominance species composition between fjords. This new knowledge will not only provide a better understanding of glacial meltwater impacts on phytoplankton diversity and phenology, but also increase tourism engagement and understanding of science.

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Bacterioplankton utilization of colloidal organic matter: experimental degradation of the large and abundant protein RuBisCO

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Discrete influxes of colloidal dissolved organic matter can drive specific changes within the bacterial community composition and its biochemical activity. As the frequency of algal blooms may increase with rising temperature of marine surface water, it is important to understand how dissolved organic matter derived from such events will influence bacterioplankton activity and impact biogeochemical cycles. Here, an ubiquitous protein abundant in surface waters and involved in carbon fixation, RuBisCO (3,5 – ribulose biphosphate carboxylase) was used as model colloidal DOM to investigate how the introduction of specific nutrients influences changes within natural microbial assemblages. In studies with whole seawater and with bacteria isolated from RuBisCO enrichments, we quantified how the bacterial community and individuals respond to influxes of colloidal protein. We observed growth of bacteria and changes in biochemical activity from proteinase activity measurements using fluorescent amino acid analogs in response to RuBisCO enrichment. These observations offer new insights into how bacteria will respond to direct influxes of proteins resulting from phytoplankton blooms and how this may affect the recycling of colloidal organic matter in surface waters.

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Observing internal waves in the eastern subtropical north Atlantic with Deep Argo

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In March of 2017, six Deep Argo floats were deployed along 24.5 °N between 55 °W and 70 °W the North Atlantic. Each float vertically profiles pressure, temperature and salinity from the surface to the bottom every 15 days, with target accuracy of 0.001 °C, 0.002 PSS-78, and 3 dbar, respectively. Early analysis of the first 16 months of this pilot array reveals westward propagating temperature and salinity anomalies within the deep thermocline at ~4900m between the warmer saltier North Atlantic Deep Water (NADW) and colder fresher Antarctic Bottom Water (AABW). The anomaly is driven by isopycnal heave, seen as a ~50 m uniform displacement of the deep thermocline. Here, we characterize the wavelength and propagation speed of the deep internal waves captured by the Deep Argo floats and compare to previous observations of Rossby Waves in the region. In addition, we find the deep steric variability associated with these deep internal waves accounts for ~10% of the total steric sea level anomaly and inclusion of the full depth steric variability improves agreement with satellite altimetry.

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Statistical prediction of minimum and maximum air temperature in the Western North America

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Development of reliable probabilistic forecasts has the potential to improve energy sector management in North America's highly variable and changing climate. For instance, simple statistical models that relate patterns of variability of different variables can be used with certain confidence to develop the aforementioned forecasts. The advantage of such models is that they are easy and economical to implement. This work uses a statistical model based on canonical correlation analysis (CCA) to explore the seasonal predictions of minimum and maximum air temperature in the Western North America. Remote and local predictors were used. The first predictor variable field are the sea surface temperature anomalies (SST) across the tropical and northern Pacific basin, representing the influence of large-scale climate variability patterns, which in turn affect local surface air temperature. The second predictor variable field is soil moisture (SM) anomalies, which is thought to exert a local or regional influence on temperatures near the surface by influencing the surface energy balance. The results indicate that statistical methods can provide modest predictability for seasonal anomalies of air temperature over much of the region. However, they demonstrate that there is considerable variability across seasons in the forecast skill across seasons in models predictors and forecast performance of seasonal air temperature. If the forecasts uncertainties associated with the variability across seasons and model predictors can be better understood, there may be opportunities to perform real-time air temperature forecasts at one season lead times using the linear statistical model developed here, in order to inform decision makers.

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A comparison of OTU vs. phylogenetic placement approaches for the analysis of microbial community structure and metabolic inference

Natalia Erazo¹ and Jeff Bowman²

High-throughput sequencing of 16S ribosomal RNA gene amplicons has greatly improved our understanding of microbial community structure and composition. The standard approach for 16S amplicon analysis involves clustering sequences within a percent sequence similarity threshold, normally 97% but increasingly at the level of unique sequences, into Operational Taxonomic Units (OTUs). An alternate approach is to use phylogenetic methods to place query reads on a phylogenetic tree. In this approach the edges of the tree take the place of OTUs for downstream analysis. In this study we compare these two approaches as implemented by QIIME and Pathway Prediction by Phylogenetic placement, paprica. Here we evaluated these two approaches on three large community structure datasets: Human Microbiome Project, Earth Microbiome Project and *Tara* Oceans Global Ocean Microbiome. We found good agreement in patterns of alpha and beta diversity. These results suggest that phylogenetic placement can be a viable alternative to OTU clustering for community structure analysis.

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Bio-inspired algal-bacterial hydrogels for space efficient microalgal growth

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Microscopic photosynthesizing algae are an attractive source of biomass energy, but commercial production of microalgae is hampered by low spatial efficiency and high production costs due to artificial illumination, water usage, and antibacterial treatments. In the present study, we use a bio-inspired approach to develop a symbiotic, photosynthetic tissue mimic with minimal maintenance costs. We developed a gelatin-based hydrogel system that grows a commercially relevant microalgae strain (*Marinichlorella kaistiae* KAS603) together with a strain of *Alphaproteobacteria*. We tested the performance of our hydrogel based photobioreactor system using a combination of chlorophyll-*a* fluorescence imaging and PSII fluorimetry, O₂ microsensing, fiber optic reflectance measurements, and cell density counts. Our results showed that growth rates in algal-bacterial hydrogels were about 3-fold enhanced compared to hydrogels immobilized with algae alone. Chlorophyll *a* fluorimetry based light curves suggested that electron transport rates were enhanced about 20% at light intensities of 50 to 250 $\mu\text{mol photons m}^{-2} \text{s}^{-1}$ for algal-bacterial hydrogels. We further show that our algal-bacterial community is stable and that hydrogels exposed to foreign bacterial communities remain viable. The findings of our study indicate the benefits of algal-bacterial co-culture in a hydrogel system and provide simple bio-inspired solutions to a range of key problems limiting the efficient cultivation of microalgae for commercial biofuel production.

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Simulated ground motions for a 12-story structure in Oklahoma in a region of induced seismicity

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Oklahoma has been experiencing an increase in seismicity due to wastewater injection from oil and natural gas production. As many buildings in Oklahoma were constructed before this increase, it is imperative to determine the response of these buildings to significant ground motion. We use a multi-instrument approach to monitor a 12-story reinforced concrete building at Oklahoma State University (OSU), where several buildings experienced damage from the 2016 M5.8 Pawnee earthquake. Combined GPS/seismic monitoring on the roof can provide a broadband view of shaking, particularly low-frequency motion and static offset information necessary for determining damage. Since instrument installation in July 2017, we have recorded over 10 M4+ earthquakes. The maximum magnitude of induced earthquakes is not known and remains controversial, however estimates of acceleration levels with a given probability of exceedance are now calculated annually using methodology consistent with the National Probabilistic Seismic Hazard Assessment maps. To build on that effort, we are calculating scenario ground motions for the OSU study site to be made available for estimating the expected building response to larger earthquakes. We first generate synthetic ruptures along the Sooner Lake Fault, which ruptured in the 2016 Pawnee earthquake. We compare our synthetic waveforms with observations from the 2016 Pawnee earthquake to verify the approach. We also assess the consistency of the simulations with new observed data at the study site. For the future scenario calculations, the ruptures will be based on two known faults near OSU, the Stillwater and Lake Carl Blackwell faults.

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A Sentinel-1 study of Mount Okmok volcanic deformation using InSAR time series analysis

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Interferometric Synthetic Aperture Radar (InSAR) provides a method for mapping large-scale ground deformation at millimeter level accuracy. One application of InSAR is monitoring volcanic processes in the form of line-of-sight surface displacement resulting from magmatic activities. Large spatial coverage is especially valuable in this case because it allows for a contextual overview of volcanic activity across an entire area, as opposed to that offered by the low spatial density of ground-based measurements. The Sentinel-1 satellite constellation carries a C-band synthetic aperture radar and offers a 12 day repeat cycle for each satellite (6 days when combining data collected by both). Availability of this data and good coverage over the Aleutian volcanic arc has made it possible to construct a time series of 237 interferograms of Mount Okmok spanning early 2015 to the present. These interferograms were stacked using the Small Baseline Subset (SBAS) technique in order to acquire line-of-sight velocity measurements that correspond to vertical displacement of the ground surface. These measurements were then compared to those produced by magma chamber parameters obtained by implementing the Mogi model.

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Iron limitation of a coastal filament in the southern California Current Ecosystem

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Substantial amounts of biomass accumulate in the California Current Ecosystem (CCE), due to rapid growth of phytoplankton in response to episodic nutrient supply. During periods of intense coastal upwelling, the micronutrient iron is supplied to the mixed layer from nearshore sedimentary sources and is an important bottom-up control on the distribution and growth of phytoplankton in the CCE. In this upwelling region, mesoscale filament features distribute iron laterally, leading to distinct iron-influenced ecological zones. Presented here are broad spatial patterns of iron concentrations and proxies of iron-stress of diatoms, including results from microcosm amendment studies conducted during a cruise in June 2017. We find that dissolved iron concentrations in the surface mixed layer were elevated nearshore (~1.3 nM), reflecting its source waters, but were reduced to growth-limiting levels (~0.2 nM) over a short time-evolution of the filament, implying intense removal processes had occurred. These results highlight rapid removal of iron from a recently upwelled water mass, leading to diminished supply for downstream, offshore primary producers.

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Engaging the first line of defense: Behavioral responses of California killifish to two trematode parasite species

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Parasites are ubiquitous organisms that can greatly impact their hosts, from damaging tissues to altering host metabolic demands to modifying host behavior in ways that increase host death rates. As a result, many animals have been selected to use behavioral mechanisms to defend against the ever-present threat of parasitism. There is a diverse array of behavioral forms of defense, including avoidance of infected habitats/conspecifics, grooming, grouping, altering swimming behavior, visiting cleaner stations, or even self-inducing behavioral fevers. Populations of infected California killifish, common to Southern California and Baja California estuaries, can be found in sites where California horn snails are present. In some cases, infected killifish have been found to experience infections from up to seven different trematode species, which await trophic transmission to the final bird host. One of these trematode species, in particular, is known to modify killifish behavior to increase death rates. In this study, we examined whether lab-reared California killifish responded behaviorally to two of its trematode species, *Euhaplorchis californiensis* (EUHA) and Small cyathocotylid (SMCY), by altering its vertical position, shoal size, activity levels and number of conspicuous behaviors. Vertical position and shoal size were assessed using image stills while activity levels and number of conspicuous behaviors were quantified through the use of videos all processed at nine different video key points. We hope that by assessing these types of behaviors in a laboratory setting, we can better understand the methods that killifish use to decrease their risk of infection in their natural habitat.

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Assessing the impact of climate change-related lower pH and lower salinity conditions on the physiology of a luminous marine invertebrate

Kira M.P. LaFace¹ and Dimitri D. Deheyn¹

The consequences of climate change, such as ocean acidification as a result of decreased ocean pH and lower salinity as a result of glacial ice sheets melting and increased precipitation could have an impact on the physiology of marine invertebrates, and affect their predator defense mechanisms. The brittlestar *Amphipholis squamata* (Echinodermata) has displayed alterations in its bioluminescent ability, regenerative capabilities, and neuro-coordination abilities upon exposure to such conditions. Some of these effects include stunted arm regenerative growth in the low salinity, low pH, and low salinity low pH treatments. A slowed flipping response time in conditions of both reduced pH levels and reduced salinity levels was also observed. This indicates that the brittlestars neuro-coordination was impaired when exposed to these treatments. Nervous impairment was highlighted by high levels of spontaneous light, which led to a lower light emission in both the low pH low salinity and low salinity treatments when stimulated by neuromediators. The simultaneous occurrence of both low pH and low salinity seemed to cancel out their respective effects. This condition was also remarkably similar to the control treatment and had less of an impact on the brittlestars' behavior overall. Recovery of the brittlestars from these conditions was also assessed. The brittlestars showed the most difficulty in recovering normal nervous control in the low salinity condition. Overall, the research shows that both pH and salinity when considered individually can affect invertebrate physiology when lowered within the framework of climate change prediction.

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On the Structural Origins of the *Chaetopterus* Tube Resilience

Zida Liu^{1,2} and Dimitri D. Deheyn¹

The housing material that the marine *Chaetopterus* worm creates exhibits thermal stability up to 250°C and resistance to large changes in pH (3-10). Interestingly, no glass transition is observed in the tube material through dynamic mechanical thermal analysis in both water and air, and its viscoelastic properties were observed to be remarkably stable and reversible. Scanning electron micrographs (SEM) demonstrate a composite structure of nanofibrils in a highly oriented arrangement, with non-woven layers arranged discretely on top of one another. Within each layer, sheets of interwoven nanofibrils are progressively rotated respect to the previous sheets by 45°. Energy Dispersive X-Ray Spectroscopy (EDX) and Fourier Transform Infrared Spectroscopy (FTIR) reveal a compositional gradient along the longitudinal axis of the tube, where the percentage of inorganic mass increases with the age of the tube. Likely a result from uptaking environmental substrate, this compositional gradient yields tube material with superior mechanical properties at regions of high inorganic mass concentrations. The microstructure of the tube contributes to the its overall endurance to mechanical stresses and ability to facilitate rapid growth and repair.

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Dynamics of Biogenic Silica in a coastal upwelling filament in the California Current Ecosystem

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Previous studies have shown that iron limitation affects silicic acid to carbon (Si:C) and silicic acid to nitrate (Si:N) uptake ratios in marine diatoms. Changes in these elemental ratios result in enhanced silica ballasting and protection from grazing via thicker frustules. These physiological responses have the potential to increase export, while decreases in organic material growth can counter this effect. Results are presented from a Lagrangian study of the dynamics of biogenic silica throughout the progression, from nutrient-replete to iron-limited, of a coastal upwelling filament in the California Current Ecosystem. Changing Si:N and Si:C ratios were observed in growth and export with the onset of iron limitation.

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Getting Cozy with Greenlandic Icebergs

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When an iceberg calves from Helheim Glacier in Southeast Greenland, its fate is sealed: As it moves through Sermilik Fjord toward the open ocean, it will melt. But will it break into small pieces first, ensuring that the meltwater is added to the ocean near the surface? Or will it stay intact, mixing cold freshwater into the warmer deep layer as it melts? Will the whole iceberg melt inside the fjord, or will part of it float out onto the shelf and beyond? For each iceberg, the answers to these questions are different, and often unpredictable. But they hold important clues to solving the bigger puzzle of how Greenland's icebergs collectively affect the ocean.

A group of scientists and engineers, armed with a remote-controlled kayak, an underwater drone, and a few more traditional oceanographic instruments, spent two weeks getting to know some of the most interesting icebergs in Sermilik Fjord – from a safe distance, of course. I will present some of the creative approaches our team employed in surveying icebergs this summer, along with preliminary results and discussion.

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Biogeochemical observations and baseline CO₂ conditions in the Agua Hedionda Lagoon

Kenisha Shipley¹ and Todd Martz¹

Estuarine environments are uniquely diverse coastal subsystems located at the land-river-ocean interface. Across different systems, carbon dioxide (CO₂) parameters and anthropogenic inputs can vary greatly given the heterogeneity between individual estuarine systems, which makes it difficult to characterize coastal ocean systems as a whole. The Agua Hedionda Lagoon (AHL) is a local estuary located in Carlsbad, CA comprising three interconnected basins, which make up a total of about 400 acres off the Pacific coast. This lagoon is highly impacted by the surrounding urbanization, land use, and densely populated community, making it susceptible to anthropogenic impacts. One of the primary features operating at the lagoon is the Carlsbad Aquafarm (CAF), which raises over one million pounds of Mediterranean Blue Mussels (*Mytilus edulis*) and Pacific oysters (*Crassostrea gigas*) every year. Understanding the baseline chemical distribution and variability will provide critical information needed by the stakeholders to manage the CAF and lagoon ecosystem. To assess the variable conditions in the AHL, an autonomous shore station system is employed at the CAF to collect continuous measurements for total dissolved CO₂ (TCO₂) every hour, and the partial pressure of CO₂ (pCO₂), pH, temperature, and salinity are all taken every 15 seconds. Additional sensor deployments in the adjacent lagoon basins will collect in situ data for salinity, temperature, dissolved oxygen, pH, and pressure, every 30 minutes. Data collection is underway and will continue over the next year to expand observational data both spatially and temporally, leading to a better understanding of the changing estuarine CO₂ conditions.

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Achieving Accurate pH Measurements with a Commercially-Available Indicator Dye

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Due to its apparent robustness and excellent short-term precision (~ 0.0004 in pH), measurement of seawater pH with a colorimetric indicator dye (i.e., spectrophotometric pH) has become an increasingly popular analysis method for studies of the ocean CO₂ system and ocean acidification research. However, its accuracy can be significantly compromised by impurities in commercially-available indicator dyes, leading to measurement biases as large as 0.02 pH units. A recent study (Douglass and Byrne, 2017) proposed a method for correcting for impurities in commercial dyes, without calibration against expensive purified dyes, to potentially achieve an accuracy of 0.003 pH units, which is required for studying long-term anthropogenically-driven changes in ocean carbon chemistry. We evaluated the method, investigated potential sources of uncertainty, and considered ways to optimize the procedure.

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Strombine dehydrogenase and malate dehydrogenase activity in response to elevated ammonium and CO₂ levels in the corals *Orbicella franksi* and *Porites asteroides*

Cameron Hassibi¹ and Martin Tresguerres¹

To better understand how corals organisms alter their anaerobic metabolism in the presence of environmental stress, the activities of two key enzymes—strombine dehydrogenase and malate dehydrogenase—involved in anaerobic metabolism were measured in two species of coral: *Orbicella franksi* and *Porites asteroides*. Corals were subjected to elevated ammonium and CO₂ (low pH) concentrations for 3 weeks. The activities of these two enzymes were then calculated for each experimental treatment group by measuring the change in absorbance of each coral sample over a 5-minute interval. This study revealed that *O. franksi* downregulated strombine dehydrogenase activity and upregulated malate dehydrogenase activity when exposed to elevated ammonium and high CO₂/low pH concentrations while *P. asteroides* generally did the opposite. These findings illustrate the unique and significant role anaerobic metabolism plays in coral health and survival.

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Extending Stochastic Representations of Geomagnetic Axial Dipole Evolution

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Stochastic models are used to describe processes that appear to be random and whose origins are difficult to observe. Several stochastic models have been developed to describe the axial dipole moment of the geomagnetic field, which is sustained by fluid motions in Earth's outer core. One such model is the Langevin model, which describes time variations in the axial dipole moment as a nonlinear tug-of-war between the slow drift of the field towards and higher-frequency fluctuations away from its steady state. Another such model is the continuous-autoregressive model, which is a linear differential equation driven by white noise. Both models are parameterized by timescales $\{\tau_i\}$ governing the drift and fluctuations, as well as the diffusion coefficient (Deq.), which weighs the relative influence between the drift and the fluctuations. Stochastic models developed so far have failed to capture the high frequencies in observed variations of the geomagnetic axial dipole moment. In this study we recast the Langevin models as a continuous-autoregressive models, propose a higher-order model for Earth's axial dipole, and evaluate our new model by comparing its theoretical frequency spectrum with a recently-published empirical spectrum for the axial dipole moment. Our new model contains the timescales $\{\tau_1, \tau_2\}$ by which fluctuations away from steady state occur while τ_s is the drift timescale. Numerical realizations of our new model are strikingly similar to the composite spectrum, which is flat at low frequencies, goes like f^{-2} at intermediate frequencies, f^{-4} at higher frequencies and f^{-6} at highest frequencies. The model parameters facilitate such a shape; Deq. dictates the scale of the spectrum and $\{\tau_s, \tau_1, \tau_2\}$ dictate the transition frequencies between adjacent spectral regimes. Our stochastic model ultimately unveils characteristic timescales for possible geodynamo processes driving field variations.

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Determining the association between microbial community structure and aerosol formation with CALIPSO

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I will determine marine biological communities most responsible for global aerosol precursor emission and secondary organic aerosol (SOA) formation. Although the formation of SOA from volatile organic compounds (VOC) released by terrestrial biota has been well-explored, despite considerable effort, major questions remain in examining aerosol formation from biogenic marine VOC. This results in part from the fluid nature of the marine environment, and the complex ecology that arises from the highly diverse marine microbial populations that are responsible for marine SOA precursor formation. The incomplete characterization of the role of ocean ecology is seen as a major obstacle for the improved understanding of radiative balance and its effect on global climate. As such, I propose integrating diverse microbial community assemblage data across spatiotemporal scales with remote sensing and *in-situ* aerosol data from NASA's Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO). My guiding hypothesis is that distinct microbial taxa are associated with aerosol precursor emissions, aerosol plumes, and SOA formation patterns. My integration of global microbial community structure with aerosol and physiochemical data from CALIPSO will ultimately improve our ability to forecast biogenic aerosol formation and aerosol plume structure worldwide. Creating a more thorough understanding of the interaction between biological communities and SOA formation is necessary to understand the role of marine ecology on global climate.

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Development of a high throughput low cost metagenomics pipeline reveals seasonal dynamics of the mucosal microbiome of a marine fish, *Scomber japonicus*

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Next Generation Sequencing technologies have enabled many advances across biology with microbial ecology benefiting primarily through expanded sample sizes. Although the cost of running sequencing instruments has decreased substantially over time, the price of library preparation methods has largely remained unchanged. In this study, we developed a low cost, miniaturized (5 μ L), high-throughput (384-sample), amplicon library preparation method with the Echo 550 acoustic liquid handler. Our method reduces costs of library preparation to \$1.42 USD per sample, a 58% reduction compared to existing automated methods and a 21-fold reduction from commercial kits, without compromising sequencing success or distorting the microbial community composition analysis. We further validated the optimized method by sampling five body sites from 46 Pacific chub mackerel fish caught across 16 sampling events over seven months from the Scripps Institution of Oceanography pier in La Jolla, CA. Fish microbiome samples were processed with the miniaturized 5 μ L reaction with 0.2 μ L of gDNA and the standard 25 μ L reaction with 1 μ L of gDNA. Between the two methods, alpha diversity was highly correlated ($R^2 > 0.95$), while distances of technical replicates were much lower than within body site variation ($P < 0.0001$), further validating the method. The cost savings of implementing the miniaturized library preparation (going from triplicate 25 μ L reactions to triplicate 5 μ L reactions) are large enough to cover a MiSeq sequencing run for 768 samples, while preserving accurate microbiome measurements.

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Calibrated pressure measurements for marine geodesy

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Seafloor pressure gauges are widely used to measure seawater and seafloor height changes because small height changes produce easily measurable pressure changes. Most pressure sensors can resolve mm-level changes over short periods of time (seconds to hours). However, long-term measurements (days to years) become unreliable due to inherent sensor drift, which typically exceeds secular rates of plate motion and deformation and sea level change. Over the last decade, methods to correct sensor drift have been demonstrated, including our self-calibrating pressure recorder (SCPR). The SCPR uses a deadweight tester to provide a well-known reference pressure whose value can be accurately determined. Transients and offsets in the reference pressure, which are attributed to sensor effects, are measured and then removed from the entire time series to produce a drift-free record. One SCPR was deployed at Axial Seamount, an underwater volcano off the coast of Oregon, to monitor volcanic inflation and eruptive activity. A second absolute SCPR was used to conduct absolute pressure surveys in the earthquake and tsunami-generating Cascadia subduction zone over a four-year period. Those measurements are some of the first offshore vertical deformation measurements providing important constraints for geodetic studies there. Calibrated pressure measurements are especially useful for long-term studies because they can be used as calibration points or validation for other datasets, such as other co-located sensors or satellite remote sensing methods, or as individual data points in long-term time series that do not require continuous occupations.

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Identification of domoic acid biosynthetic genes in *Pseudo-nitzschia* diatoms

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Oceanic harmful algal blooms of *Pseudo-nitzschia* diatoms produce the potent mammalian neurotoxin domoic acid (DA). Consumption of DA in contaminated seafoods can cause Amnesic Shellfish Poisoning in humans, a life-threatening illness characterized by seizures, short-term memory loss, and coma. Low-level, chronic exposure to the toxin can also cause additional human health complications, highlighting the importance of monitoring *Pseudo-nitzschia* blooms and DA production. Despite decades of research, the molecular basis for DA biosynthesis is not known. By employing growth conditions known to induce DA production in *P. multiseries*, we implemented transcriptome sequencing to identify DA biosynthesis genes upregulated during active toxin production. We biochemically investigated the recombinant DA biosynthetic enzymes and linked their mechanisms to the construction of DA's characteristic kainoid skeleton, thereby establishing a model for DA biosynthesis. We were also able to find the genes encoding domoic acid biosynthesis in two other *Pseudo-nitzschia* diatoms. Notably, these genes were absent from all other sequenced microalgae. Knowledge of the genetic basis for toxin production may provide a transcription-based approach to bloom monitoring, thereby facilitating further study of the environmental factors that drive oceanic DA production.

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Effect of high hydrostatic pressure on the activity of hydrocarbon-degrading bacteria

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The oil and gas blow out that led to an explosion on the Deepwater Horizon drilling rig in April, 2010 led to one of the world's largest marine oil spills in history. This spill was unique in that a large proportion of the hydrocarbon released remained in the deep ocean, forming a plume of dissolved and dispersed hydrocarbons between 800 and 1,200m. Microbial communities present in the Gulf of Mexico rapidly responded to the oil spill. In order to understand the process of hydrocarbon degradation by deep-sea microbes, it is important to determine when and under which conditions they are metabolically active. Here we report on the impact of high hydrostatic pressure on the metabolic activity of hydrocarbon-degrading microbes isolated from the Gulf of Mexico.

Bioorthogonal noncanonical amino acid tagging (BONCAT) is a method that uses a methionine analog to fluorescently tag cells undergoing active protein synthesis. Here we use BONCAT to follow the activity of microbes under atmospheric and high pressure. Actively growing cells that take up these methionine analogs are subsequently fluorescently tagged using click chemistry, and assessed microscopically or by flow cytometry (FCM). The results indicate that, high hydrostatic pressure (25 MPa) inhibit the activity of these hydrocarbon-degrading isolates. However, after decompression, cells grown at high pressure immediately recover and display activity levels equivalent to those seen at atmospheric pressure. These results indicate that pressures equivalent to 2.5 km depth can inhibit the activity of oil-degrading microbes, but these effects are reversible.

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Toughening Strategies in Tubule Architectures

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Many remarkable energy absorbent materials are found in nature including bones, teeth, horns, and hooves. These materials harness energy absorbing strategies, despite being composed of relatively weak constituents, through structural organization. One design strategy of interest is the tubule architecture. Tubules are organized porosity typically found along the primary loading direction. While the tubule architecture is known to absorb energy, the effects of the degree of porosity not been fully understood. Herein, 3D printing is used to generate systematic tubule architecture composites with various degrees of porosity. These architectures are mechanically tested under quasi-static compression and three-point bending to investigate the damage resistance. Further quantification of the toughening mechanisms is analyzed with finite element models. Our analysis allowed us to study the effect of porosity, stress distribution, and energy dissipation mechanisms.

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Identification of a Sodium/Hydrogen Exchanger in Coral: a potential role in biomineralization

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The cellular mechanisms behind coral biomineralization are largely unknown, however, they do require the transport of Ca^{2+} and dissolved inorganic carbon to the site of skeleton formation. Additionally, H^+ are constantly produced as a byproduct of calcium carbonate precipitation and must be removed to prevent acidification that would impair biomineralization. Although Na^+/H^+ Exchangers (NHEs) are proteins essential for H^+ secretion and pH regulation across the animal kingdom, they have not been characterized in corals. BLAST searches identified several genes encoding for NHE-like proteins in *Acropora*, *Stylophora* and *Orbicella* corals. We focused on an *Acropora* gene that shares the strongest homology with mammalian NHEs 1-5. Bioinformatic analyses predicted *Acropora*NHE is ~93 kDa in size, has 10 transmembrane domains, a long extracellular C-terminus tail, and abundant potential glycosylation sites. To further characterize *Acropora*NHE, we generated specific antibodies and studied its abundance and cellular localization in *A. yongei*. Western blotting on membrane-enriched fractions detected a specific protein of ~114 kDa. The discrepancy with the smaller predicted size is due to glycosylation. Immunohistochemical analysis revealed *Acropora*NHE was highly abundant in calcifying cells, suggesting it is important for intracellular pH regulation and H^+ removal from the site of skeleton formation. However, those roles must be confirmed by functional experiments. Understanding the cellular mechanisms behind coral biomineralization is essential to predict responses to environmental change, as well as to identify potential species-specific mechanisms that determine differential vulnerability and resilience. This work was funded by the National Science Foundation Ocean Sciences #1538495 and Emerging Frontiers #1220641.

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