MEGA MICRO MACRO

SCRIPPS STUDENT SYMPOSIUM

September 24, 2015
Scripps Seaside Forum

Dear SIO Community,

Thank you for coming to the 2nd annual Scripps Student Symposium (S^3). The original idea for this symposium came out of a conversation two years ago at GeoTea, a weekly tea hour that the geologically-oriented graduate students have during the school year. A few like-minded graduate students were discussing the fact that, outside our individual areas of study, we didn't really know about much of the really neat research that goes on at Scripps. This was especially true for the research that is student-driven. And on that day, the idea for S^3 was born, with the goal of inspiring connections and collaborations between the different research groups, students and disciplines at SIO.

This year, we realized that S^3 could be a great introduction for the new crop of students arriving to start their graduate career at SIO. What better way to let the first-years know that they made the best decision of their lives than by showcasing the wide-variety of research paths Scripps has to offer on (literally) Day 1. [Happy first day of classes, by the way!] We're excited about the great science that is being shared and hope that today's symposium helps to foster cross-disciplinary collaborations, increases communication amongst our fellow graduate students, and, perhaps most importantly, provides a warm welcome to our newest colleagues.

We would like to thank the organizers of last year's inaugural S^3 for leading the way for establishing a new Scripps tradition; we hope that Year 2 of S^3 will live up to the incredible standard set in Year 1 and that this symposium will continue on for many years to come.

All the best,
The 2015 S^3 Organizing Committee

Mariela Brooks
Soli Garcia
Brian House
Matt Siegfried
Josefin Stiller
Lynn Waterhouse

Agenda

Tuesday, September 24th 2015
Keynote Speaker: Dr. Kurt Schwehr, Scripps alumnus 2006
Head of Ocean Engineering, Google
Affiliate Associate Professor, University of New Hampshire

0800 - 0830	Registration Opens, Check-in.
0830 - 0845	Welcome from Prof. Catherine Constable, Department Vice Chair
0845 - 1015	Oral Session 1: Micro
1015 - 1030	Poster Session and Coffee Break
1030 - 1200	Oral Session 2: Macro
1200 - 1210	Group Photo
1210 - 1300	Lunch
1300 - 1430	Oral Session 3: Mega
1430 - 1600	Judged Poster Session and Coffee
1600 - 1615	UC Ship Funds Presentation (Bruce Appelgate)
1615 - 1700	Keynote Address (Dr. Kurt Schwehr)
1700 - 1730	Awards Ceremony and Closing
1730 - 1830	Happy Hour and Poster Session

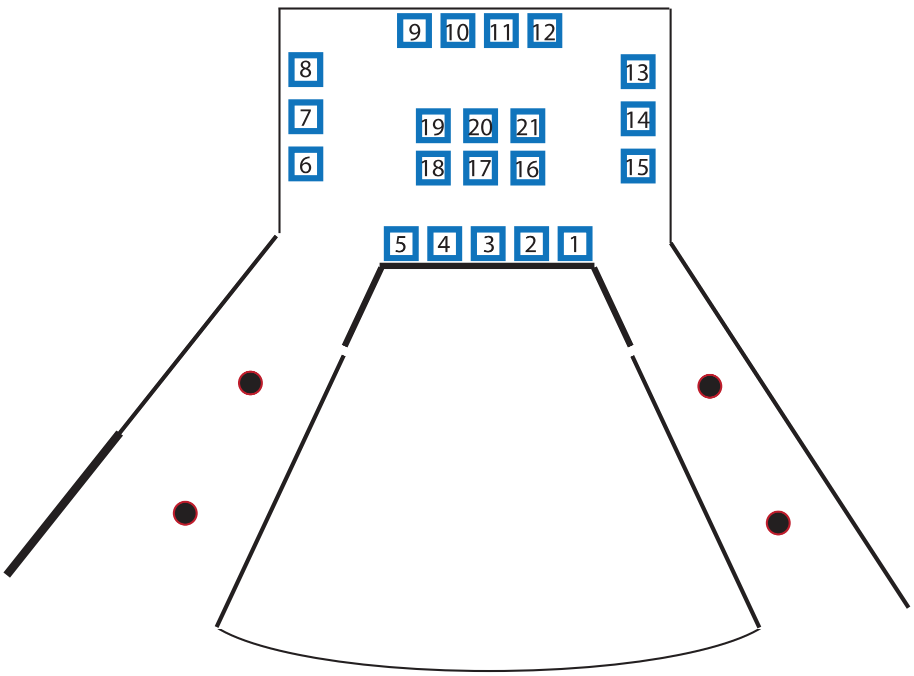
Oral Sessions

Micro

Macro

Mega

Poster Map



Contents

Genome and Methylome Of A Candidate Biofuel Organism: How 'Omic' Studies Will Be Crucial to Improving Productivity

Jesse Traller[1 †], David Lopez[2], Shawn Cokus[2], Olga Gaidarenko[1], Orna Cook[1], Aubrey Davis[1], Sean Gallaher[2], Marco Morselli[2], Artur Jaroszewicz[2], Sabeeha Merchant, Matteo Pellegrini[2], Mark Hildebrand[1]

Cyclotella cryptica is a marine diatom that was previously studied during the DOE's Aquatic Species Program and deemed a strain of microalgae suitable for large-scale biofuel production. Today, with a myriad of advancements and techniques in high throughput sequencing, it is becoming feasible to obtain high quality, cost-efficient genomic data on potential production strains, such as C. cryptica. In order to understand how diatoms accumulate lipid, the precursor to biofuel, we sequenced the genome and methylome of C. cryptica. We compared results in C. cryptica to other species of microalgae and found distinct differences in central carbon metabolism that are likely to cause differences in carbon flux toward lipid. This study allows for a greater understanding of carbon metabolism in diatoms with the results will aide in developing strategies to improve efficiencies in large-scale, outdoor microalgal cultivation and biofuel production.

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Santa Ana Winds of Southern California: Their Hourly Climatology and Variability Spanning 6½ Decades

Janin Guzman-Morales[1 †], Alexander Gershunov[1], Jurgen Theiss[2], Haiqin Li[3], Daniel R. Cayan[1,4]

Santa Ana Winds (SAWs) are an integral feature of the regional climate of Southern California/Northern Baja California region. In spite of their tremendous episodic impacts on the health, economy and mood of the region, climate-scale behavior of SAW is poorly understood. In the present work, we identify SAWs in mesoscale dynamical downscaling of a global reanalysis product and construct an hourly SAW catalogue spanning 65 years. We describe the long-term SAW climatology at relevant time-space resolutions, i.e, we developed local and regional SAW indices and analyse their variability on hourly, daily, annual, and multi-decadal timescales. At interdecadal time scales, we find that seasonal SAW activity is sensitive to prominent large-scale low-frequency modes of climate variability rooted in the tropical and north Pacific ocean-atmosphere system that are also known to affect the hydroclimate of this region. Lastly, we do not find any long-term trend in SAW frequency and intensity as previously reported. Instead, we identify a significant long-term trend in SAW behavior whereby contribution of extreme SAW events to total seasonal SAW activity has been increasing at the expense of moderate events. These findings motivate further investigation on SAW evolution in future climate.

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Oceans of image data

Eric Orenstein[1] †, Paul L.D. Roberts[1], Jules S. Jaffe[1]

Technological advances in instrumentation and computing have allowed scientists across all disciplines to collect unprecedented amounts of data, driving the need for automated processing to the forefront. The Scripps Plankton Camera System (SPCS: spc.ucsd.edu) is emblematic of this trend. It is currently deployed in situ from the Scripps Pier where it is continuously capturing images; yielding thousands to hundreds of thousands of samples per day. In the short time it has been deployed, the SPCS has revealed episodic blooms of fragile diatom chains, many delicate gelatinous organisms, and a form of parasitism not previously reported in the Pacific. This growing, high-resolution time series undoubtedly contains other valuable insights into the seasonal dynamics of local plankton populations. Extracting this information, however, is a challenge due to the huge volume of images being captured; at the current collection rate, the system will yield ∼50 million images every year. Manual annotation of the data is unattractive since it requires trained experts, is time consuming, and error prone. This talk will present a framework, taken from the computer vision and machine learning communities, to automate the processing. Initial findings, future work, and perspectives on these potentially transformative techniques will be discussed.

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The Chemical Role of Marine Bacteria in Sediments

Nastassia Patin[1 †], Michelle Schorn[1], Paul Jensen[1]

Many marine bacteria produce chemical compounds with potent biological activity, including antibiotics and cytotoxins. These compounds are studied by isolating strains in the laboratory and growing large batch cultures. As a consequence, very little is known about their ecological functions and under what circumstances they are produced in nature. Our model bacterial organism, the genus Salinispora, is found in tropical marine sediments and consists of 3 species. Each species produces a distinct suite of compounds, including the antibiotic rifamycin and the anticancer agent salinosporamide. Using a combination of field and laboratory experiments, I have identified how two of the species employ distinct competitive strategies mediated in part by their secondary metabolite production. Further, I have observed significant changes in the native sediment microbial community with exposure to Salinispora secondary metabolites. I will present these results and their importance in the context of the field of chemical ecology.

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A New Method for Remotely Estimating Vertical Current Profiles from X-Band Radar Observations of Ocean Waves

Jeffrey Campana[1 †], Eric Terrill[1], Tony de Paolo[1]

As the field of oceanography progresses, it is becoming apparent that the interaction between physical phenomena (marine and atmospheric) of different spatial scales is important to all disciplines of oceanography. As environmental models advance to capture smaller scale dynamics over larger space and time scales, observational technology must also evolve to validate new models, supply boundary conditions and/or supplement data-assimilation. One example of this phenomenon is occurring in the upper ocean, where wave models are evolving from forecasting general wave properties (e.g. average wave period and direction) to having the capability to propagate individual waves for multiple kilometers. These new models rely on large scale measurements (O(10km)) of small scale (O(1m)) depth-varying currents to accurately estimate the evolution of the wavefield. Modern current measurement technology can supply either current-depth profiles (acoustically) or large scale surface currents (HF radar), but not both. I will present a new method of current extraction from X-Band radar backscatter, which aims to remotely supply estimates of O(10m) deep vertical current profiles out to 5 km away. First, an introduction to X-Band radar and relevant wave theory will result in a simple model relating observable wavefield properties with the underlying current profile. Then, by taking advantage of the unique affect current-depth profiles have on accelerating different size waves, X-Band measurements of the broad band wavefield will be inverted to estimate the underlying current profiles to approximately 20 m depth and compared to ADCP current measurements in the Mouth of the Columbia River. Extending this method to ship-borne observations in deep water will be discussed along with potential scientific impacts including 3-dimensional plume tracking and observations of biological-physical interactions within current fronts and in river inlets.

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Geochemical constraints on the magmatic history of Piton de la Fournaise, Réunion Island from combined cumulate and lava analysis

Bradley J. Peters[1 †], James M.D. Day[1], Lawrence A. Taylor[2]

Although the geochemical characteristics of lavas reveal important information regarding the structure and origin of volcanoes, they present only one perspective on magmatic processes occurring within a volcanic edifice. During magma ascent, periodic stagnation in crustal chambers may induce cooling such that minerals begin to precipitate from the magma, causing a change in magma composition. This process may occur throughout the magma's ascent through the crust before it erupts, effectively masking the composition of the original, primary magma. However, the minerals precipitated in magma chambers may collect into cumulate rocks that can be ejected from a chamber during a strong eruption. We present geochemical and isotopic data from such cumulate rocks collected from Piton de la Fouranise, the main active volcanic complex of Réunion Island, an active hotspot. We compare these data to the geochemistry of Piton de la Fournaise lavas, including some that are host the cumulates. In consideration of both groups, we quantitatively resolve the composition of the Piton de la Fournaise primary magma and provide constraints on the pressure (depth) and temperature conditions under which both the primary magma and the cumulates formed. Using highly siderophile element data, we further distinguish the geochemical characteristics of the primary magma and provide constraints on the origin of Réunion hotspot magmatism, which cannot be explained by traditional tenets of plate tectonics. The overall geochemical signature of Réunion lavas and cumulates is remarkably consistent, a unique feature amongst global hotspots. For this reason, some researchers surmise that the source of Réunion magmas represents a fundamental mantle reservoir that is present, though more obscured, in other hotspots. Our new constraints provide information about the composition and melting characteristics of this reservoir, and may inform hypotheses about the ultimate origin of hotspot magmatism.

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Mountain Cloud Variability and Its Relation to California Snowmelt

Edwin Sumargo[1 †], Daniel R. Cayan[1,2]

California derives over a half of its water supply from snow-fed rivers originating in the mountains. A primary source of uncertainties in springtime snowmelt and thus water supply predictions is cloud cover variability, which is responsible for modulating the amount of solar radiation reaching the surface. My research is aimed at describing cloudiness variations over the mountains in the western U.S., with a focus on California, and furthermore to understand how cloud-driven radiation affects fluctuations of snowmelt and runoff. To accomplish this, we utilize a new remote-sensed dataset, which provides high resolution and broad spatial coverage and finely resolved temporal samplesthe dataset is 19 years (1996-2014) of Geostationary Operational Environmental Satellite (GOES) albedo with 4-km spatial pixels and 30-minute temporal sampling over the western U.S. The effects of changing surface properties are removed to isolate the effects of cloud cover. To simplify the analyses, daytime scenes of the half-hourly dataset are aggregated to a daily average. Lower elevations (<800m) are masked to focus on mountain cloud variability. The seasonal cycle of each pixel's cloud albedo record is removed to study anomalous variations, from daily to several month time scales. When these processed, daily western U.S. anomalous cloud albedo data are decomposed using Rotated Empirical Orthogonal Function (REOF) analysis. The leading mode is found to be highly weighted over central and northern California and Oregon, accounting for 20% of the total variance with a pronunciation in the spring when snowmelt is most active. To verify this, fluctuations in this cloud albedo mode are correlated with springtime snowpack and streamflows in mountain snow-fed watersheds over the California region. The data indicate that diminished snowmelt and lower streamflows coincide with cloudier springs and vice versa, confirming the significance of cloud-shading effect on snowmelt.

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Distribution, Adaptation, and Feeding Ecology of Demersal Fishes in Oxygen Minimum Zones

Natalya D. Gallo[1 †], Erin C. Navarro[2], Aissa Yazzie[3], Jim P. Barry[4], Lisa A. Levin[1]

Oxygen minimum zones are deep-sea environments where organisms experience chronic hypoxic and suboxic conditions. While fish have been identified as being one of the most sensitive marine groups to hypoxia, representative demersal fish species in the orders Cottiformes, Scorpaeniformes, Pleuronectiformes, Gobiiformes, and Gadiformes have evolved to exploit these physiologically extreme environments. These species have been able to evolve hypoxia tolerance through a suite of adaptations that reflect their life histories. Using a literature review of studies from oxygen minimum zones in the Pacific, Atlantic, and Indian Ocean, along with new data from recent cruises, the fish communities in these extreme environments will be characterized and compared to the surrounding better-oxygenated continental margin. Trophic shifts and food web differences in these low oxygen areas will also be examined through stable isotope analysis of the fish community in the Southern California Bight. This study aims to understand the oxygen minimum zone as an interacting ecological zone within the continental margin ecosystem and provides an important foundation for understanding how demersal fish communities on the continental margins will respond as oxygen minimum zones expand with climate change.

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Insight into the Pacific SST- North American hydroclimate connection from an Eastern Tropical North Pacific coral record

Sara Sanchez[1 †], Christopher Charles[1], Jose Carriquiry[2]

The last few years of record-breaking climate anomalies across North America have been linked to anomalous Pacific sea surface temperatures, prompting important questions on the relatedness between the unusual phenomena and extreme expressions of known Pacific decadal modes, such as the North Pacific Gyre Oscillation (NPGO). These questions motivate our pursuit to cover multiple realizations of decadal variability during periods of dynamic radiative forcing. Here we introduce a 178 year, seasonally resolved Porites coral record from Clarion Island (18N, 115W), the westernmost island of the Revillagigedo Archipelago, a region both highly influenced by NPGO SST and SSS variability and critical for NPGO tropical-extratropical communication through the Seasonal Footprinting Mechanism. When coupled with tree ring records from the western United States (Griffin Anchukaitis 2014, MacDonald Case 2005) and coral records from the central tropical Pacific (Cobb et al. 2001), the δ18O signal from the Clarion coral supports an extended framework of cohesive continental hydroclimate and oceanic variability across the Pacific basin beyond the instrumental record. Over the last 200 years, we find stark similarities in the timing, magnitude and spatial expression of decadal variability amongst the proxy records. Even more, this multi-proxy schema developed using the Clarion record can be extended to investigate the proposed framework of NPGO-like decadal variability during intervals of varying radiative forcing.

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Glider Observations of the 2014-2015 Warming Anomaly in the Southern California Current System

Katherine Zaba[1 †], Daniel L. Rudnick[1]

During 2014-2015, positive temperature anomalies persisted in the surface waters of the North Pacific Ocean. We present the regional physical and biological effects of the warming, as measured by our underwater gliders in the southern California Current System. Initiated in 2006, the California Glider Network provides sustained subsurface observations of the coastal ocean. Spray underwater gliders have continuously occupied CalCOFI lines 66.7, 80 and 90 for nearly nine years. Following a sawtooth trajectory, the gliders complete each dive in approximately 3 hours and over 3 km, along repeat sections that extend to 350-500 km across-shore distance and 500 m depth. Measured variables include pressure, temperature, salinity, chlorophyll fluorescence, and velocity. For each of the three lines, a comprehensive climatology has been constructed from the multiyear timeseries. To date, the largest interannual signal in the glider climatology is the ongoing surface-intensified warming anomaly, which began in early 2014 and persists through present. Positive temperature anomalies have been strongest in the upper 50 meters and reached up to 5C during the last 18 months. The timing of the warming was in phase along each glider line but out of phase with equatorial SST anomalies, suggesting a decoupling of tropical and coastal subtropical dynamics. Concurrent coastal anomalies include a depressed thermocline, high stratification, and a deepening of the subsurface chlorophyll fluorescence maximum. We use atmospheric data to show that anomalous surface forcing, namely high heat flux and weak winds, caused the unusual oceanic conditions.

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Detailed rupture imaging of the 25 April 2015 Nepal earthquake using teleseismic P waves

Wenyuan Fan[1 †], Peter Shearer[1]

We analyze the rupture process of the 25 April 2015 Nepal earthquake with globally recorded teleseismic P waves. The rupture propagated east-southeast from the hypocenter for about 160 km with a duration of 55 s. Backprojection of both high-frequency (HF, 0.2 to 3 Hz) and low-frequency (LF, 0.05 to 0.2 Hz) P waves suggest a multistage rupture process. From the low-frequency images, we resolve an initial slow downdip (northward) rupture near the nucleation area for the first 20 s (Stage 1), followed by two faster updip ruptures (20 to 40 s for Stage 2 and 40 to 55 s for Stage 3), which released most of the radiated energy northeast of Kathmandu. The centroid rupture power from LF backprojection agrees well with the Global Centroid Moment Tensor solution. The spatial resolution of the backprojection images is validated by applying similar analysis to nearby aftershocks. The overall rupture pattern agrees well with the aftershock distribution. A multiple-asperity model could explain the observed multistage rupture and aftershock distribution.

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Is iron acquisition by marine phytoplankton mediated by phytotransferrin?

Jeff McQuaid[1 †], Adam Kustka[2], Katherine Barbeau[1], Andrew Allen[1,3]

The lack of iron limits phytoplankton growth in areas of the ocean regarded as climatologically important , yet the mechanism by which plankton acquire iron from the marine environment is poorly understood. Using a combination of reverse genetics and fluorescence microscopy, we show that the iron binding protein ISIP-2a from the diatom Phaeodactylum tricornutum is a type of transferrin which binds iron at the cell surface and is directly internalized via endocytosis. Knocking out the ISIP-2a gene reduced the ability of P. tricornutum to acquire free iron by >90%. Site directed mutagenesis of the proposed iron binding sites demonstrates that both ISIP-2a and metazoan transferrin coordinate iron via the same di-tyrosine mechanism, and complementation of the knockout strain with human transferrin partially restored the ability of P. tricornutum to grow in low iron media. Live cell microscopy of the fluorescently labeled ISIP-2a protein revealed endocytosis and interactions with other iron-sensitive proteins. An analysis of environmental genomic and transcriptional data from the Southern Ocean and the Ross Sea shows that ISIP-2a is abundant and widely distributed among all major phytoplankton taxa, demonstrating that it is an important mechanism for acquiring iron from the marine environment. All transferrins require a molecule of carbonate to coordinate the binding of iron, and P. tricornutum was unable to acquire free iron in the absence of carbonate. This demonstrates a potential negative interaction between iron acquisition in phytoplankton and the reduction of dissolved carbonate via ocean acidification.

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Counting the world's boats

Andrew F. Johnson[1 †], Marcia Moreno-Baez[2], Alfredo Giron-Nava[1], Julia Corominas[3], Brad Erisman[4], Lynn Waterhouse[1], Brian Stock[1], Octavio Aburto-Oropeza[1]

Despite global catch per unit effort having redoubled since the 1950's, the global fishing fleet is estimated to be twice the size that the oceans can sustainably support. In order to gauge the collateral impacts of fishing intensity, we must be able to estimate the spatial extent and amount of fishing vessels in the oceans. Methods that do currently exist are built around electronic tracking and log book systems and generally focus on industrial fisheries. Spatial extent for small-scale fisheries therefore remains elusive for many small-scale fishing fleets; even though these fisheries land the same biomass for human consumption as industrial fisheries. Current methods are data-intensive and require extensive extrapolation when estimated across large spatial scales. We present an accessible, spatial method of calculating the extent of small-scale fisheries based on two simple measures that are available, or at least easily estimable, in even the most data poor fisheries: the number of boats and the local coastal human population. We demonstrate this method is fishery-type independent and can be used to quantitatively evaluate the efficacy of growth in small-scale fisheries. This method provides an important first step towards estimating the fishing extent of the small-scale fleet, globally.

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Sources and sinks of momentum in the Southern Ocean

Jessica Masich[1 †], Teri Chereskin[1], Matt Mazloff[1]

The Southern Ocean acts as an essential nexus of carbon and heat exchange between the atmosphere and the deep ocean, and the momentum balance in the Southern Ocean governs the dynamics that set this exchange. Winds over the Southern Ocean input the momentum that drives the world's largest current, the Antarctic Circumpolar Current (ACC), on an unbroken path around Antarctica. As these winds have increased over the last 30 years, ACC transport has remained stable (Boning et al., 2008), implying that some internal mechanism must be dumping this excess momentum out of the ocean system. We use a high-resolution data-assimilating model of the full Southern Ocean to diagnose these momentum sinks. We find that most of the momentum leaves the ocean system via topographic form stress, wherein a pressure difference across topography transfers momentum from the fluid to the solid earth. Topographic form stress concentrates at shallow ridges and across the continents that lie within the Antarctic Circumpolar Current (ACC) latitudes – primarily Kerguelen Plateau, the Macquarie Ridge region, and South America and the Drake Passage fracture zones. We find that the form stress across these four regions balances 95% of the zonal momentum input via wind stress.

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The Evolution of Temperature and Carbon Storage within the Deep Southeast Atlantic Ocean Across the Last Glacial/Interglacial Cycle

Alan Foreman[1 †], Christopher Charles[1], James Rae[2], Jess Adkins[3], Niall Slowey[4]

Understanding the role of deep ocean circulation in regulating global ice age cycles has been a longstanding goal of paleoceanography, and is one of great importance, given that the coupled ocean-atmosphere models tasked with projecting future climate change are often evaluated based on their ability to simulate ice ages. Several decades of research have made clear that the cyclic fluctuation between colder 'ice age' and warmer 'interglacial' periods over the last million years is linked to oscillations in Earth's orbit, and that changes in atmospheric carbon dioxide (CO2) act as a positive feedback with these oscillations to drive the observed variability in global climate. Furthermore, we can be confident that changes in deep ocean circulation are a fundamental driver of CO2 variability, given the size of the deep ocean inorganic carbon reservoir and its rate of exposure to the atmosphere. Despite this certainty, the timing and mechanisms involved in the evolution of deep ocean circulation and carbon storage are not well known. In the past, the availability and sparse geographic distribution of sediment cores have hindered paleographic reconstructions of proxies sensitive to changes in carbon storage and ocean circulation that would answer these questions. Here I present proxy data from a set of 16 sediment cores taken in the Southeast Atlantic across a variety of ocean depths and in close geographic proximity to each other. By correlating these cores on a single age scale, we can create paleo-CTD casts that present a snapshot of the vertical structure of the intermediate and deep ocean at 5 key time periods throughout the evolution of the most recent full glacial/interglacial cycle. Observations of proxies for temperature and carbon storage recorded by benthic microfossils allow us to arrive a picture of how the deep ocean arrived at glacial conditions, and begin to understand potential mechanisms associated with these changes.

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Microbial community structure and function in the Mariana Trench

Logan Peoples[1 †], Douglas Bartlett[1]

The deepest and least studied portion of the ocean is known as the hadal zone. Microorganisms living in these extreme environments must cope with high hydrostatic pressures, low temperatures, and sporadic inputs of organic carbon, but little is known about their in situ ecological roles, adaptations, or composition at these depths. A diverse sample set of seawater, sediment, and amphipods were collected from the Mariana and Kermadec Trenches to characterize the microbial communities within and between two hadal sites. The first ecologically relevant estimates of in situ microbial activity at hadal depths suggest that these communities are indeed adapted to high hydrostatic pressures. The continued isolation of members of the Colwellia, Shewanella, and Moritella genera at high pressure suggest they have a widespread distribution in trench ecosystems. However, many piezosensitive isolates obtained under atmospheric conditions were also conserved between trenches. These findings suggest that the deep ocean may select for microbes both adapted to and able to withstand the extreme conditions found at these depths.

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The effect of continental growth on global sea level

Shi Sim[1] †, David Stegman[1], Nicolas Coltice[2]

The Earth's oceans have played an important role in the evolution of life and tectonics on Earth, and yet our understanding of basic connections between these remains limited. One of the central, and still unanswered questions, are whether Earth's oceans have been present all of Earth's history, and how deep were the oceans that may have existed. Global tectonics provide a large influence on sea level through varying the volume of ocean basins and growing continents. We establish a relationship between sea level and the age-area distribution of oceanic plates using reconstructed oceanic plate age for recent 140 Myr from Muller et al. (2008), accounting for ice sheets, large igneous provinces and sediments. We then extend this methodology back to early Earth by using synthetic plate reconstructions derived from numerical models of mantle convection in 3D spherical geometry (Coltice et al 2012,2014). To approximate conditions for early Earth, we consider higher Rayleigh number. This results in faster surface velocities and, on-average, younger seafloor. Here we show the importance of growing continents on global sea level on a geological time-scale and how along with the changing age distribution of oceanic seafloor, sea level has remained fairly constant since Earth's formation.

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Global Environmental Leadership for Sustainability: Learning Science Policy with High Schoolers

Samuel J. Wilson[1 †], Veronica Tamsitt[1]

A two week high school course was developed through the combined efforts of SIO Graduate Students and UCSD Extension. For the high schoolers involved, one week was spent at SIO researching climate-related topics, and one week was spent in Washington D.C. lobbying Congress for an Environmental Issue of their choosing. The specific goals were to empower high school students to (1) collect and analyze scientific data, (2) develop and deliver a policy message, and (3) understand and experience change. In this first year, 10 high schoolers conducted research on two scientific topics; sea level rise using pier temperature data and California rainfall statistics using weather stations. Simultaneous lessons on policy messaging helped students learn how to focus scientific information for non-scientists. In combining the importance of statistics from their Science lessons with effective communication from their Policy lessons, the high schoolers developed issue papers which highlighted a problem, the solution, and the reason their solution is most effective. The course culminated in two days of meetings on Capitol Hill, where they discussed their solution, listened to policymakers, and addressed any concerns. Through the process, high schoolers effectively defined arguments for an environmental topic in a program developed by SIO Graduate Students.

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Poster Map

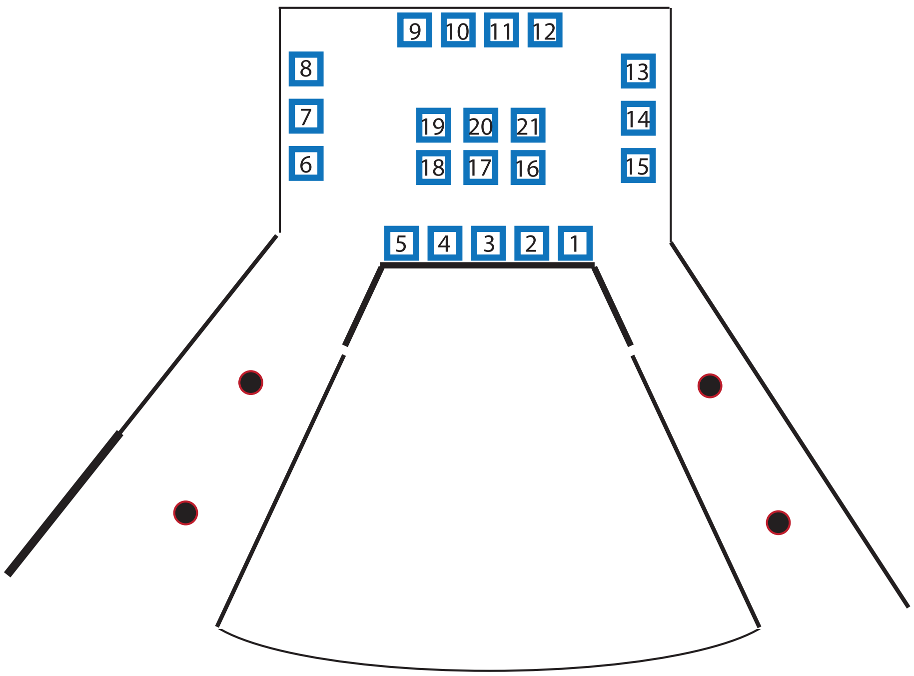

Plate Bending at Subduction Zones and Plate Weakening Related to Seafloor Faults

Emmanuel S. Garcia[1 †], David T. Sandwell[1], Dan G. Bassett[1]

We investigated the links between the large-scale bending of the seafloor at deep-sea trenches and how that affects the mechanical competence of the subducting tectonic plate. At subduction zones, the bending of the plate forms a prominent feature seaward of the trench called the outer rise. Extension of the plate at the outer rise is often accompanied by the formation of faults, which can reduce the elastic strength of the plate, which is referred to as its rigidity. In turn, variations in structural rigidity determine the amount of stress that can be supported within the plate. We fit thin elastic plate models to bathymetry and marine gravity data outboard of subduction zones. Our novel approach allows the plate rigidity to vary in directions perpendicular and parallel to the trench. Preliminary results from circum-Pacific subduction zones show that the plate rigidity progressively decreases with increasing proximity to the trench axis. These zones of plate weakening correspond to the occurrence of trench-parallel seafloor fractures at the outer trench wall as seen in high-resolution bathymetry data. We are interested in whether a correlation exists between the distribution of these fractures and the rigidity variations in the incoming plate.

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Quantifying California Current Plankton Samples with Efficient Machine Learning Techniques

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Quantifying plankton is important but using humans to count individual plankters time consuming and expensive. We present results on using machine learning to classify images of preserved plankton samples. Cheaper identification through automation enables more numerous and higher frequency observations in the future as well as unlocking information trapped in collected samples from the past. The data used in this study consist of 725516 individual images taken from 46 different transects within California Current Ecosystem (CCE) from July 2005 to July 2012. Our investigation focuses on the efficacy of simple geometric features (image attributes) for plankton identification. We also quantify the volume of data required to recognize classes of plankton, which algorithms perform best, and how size fractionation can be used to accomplish machine learning more efficiently.

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The heterogeneity spectrum of Earth's upper mantle constrained by global observations of scattered P-waves

Nicholas Mancinelli[1 †], Peter Shearer[1], David Stegman[1], Qinya Liu[2]

Placing observational constraints on the spectrum of seismic-wavespeed fluctuations throughout Earth's mantle improves understanding of processes that generate, preserve, and destroy heterogeneity. Constraints on the heterogeneity spectrum from tomography have been limited to very large (>1000 km) length scales, but scattered energy in high-frequency waveforms suggest that significant structure exists at smaller scales (∼10 km). Here we present constraints on intermediate scales in the upper mantle from globally-averaged P-coda amplitudes. Using a particle-based phonon method to generate synthetics, we find that heterogeneity power is inversely proportional to wavenumber at length scales between 5 and 500 km. The best-fitting r.m.s. velocity perturbation over this range of length scales is 6%, assuming that the heterogeneous layer is 600 km thick. Calculations using a spectral-element method verify this result for periods longer than 17 seconds. It has been proposed that mantle convection produces strains that stretch, fold, and stir subducted lithosphere to smaller scales. To test if this process provides a viable explanation for the observed heterogeneity spectrum, we plan to simulate 5 billion years of heterogeneity production, subduction, and stirring. Using relationships from mineral physics, the final compositional field can be converted to a three-dimensional velocity model, for which synthetic seismograms can be computed and compared with actual data.

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Glider observations in the Philippine Sea: Large-scale currents to fine-scale thermohaline structure

Martha C. Schonau[1 †], Daniel L. Rudnick[1]

The Philippine Sea in the western tropical North Pacific is an area of water mass mixing and exchange. Subtropical water masses that are stirred and mixed as they are advected by the North Equatorial Current (NEC) and the Mindanao Current (MC) later upwell near the equator to force both regional and local climate. The structure and variability of these currents, especially that of the MC, are not well understood. Autonomous underwater Spray gliders provide observations of the NEC and from 2009 to 2014. Glider observations have provided a combined 11,000 vertical profiles of these currents and horizontal distance traveled of 46,200 km. These observations reveal the geostrophic structure the NEC and MC and their thermohaline structure at length scales of 6 to 1000 km. The NEC is a broad, westward current with little transport variability, and more variable yet persistent eastward undercurrents. The MC is a strong, narrow western boundary current also with a highly variable yet persistent undercurrent. Tracing water masses in the region shows connectivity between the undercurrents, and the influence of both stirring and diffusion on the decay of subsurface salinity extrema.

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Eye see the light! . . . Or maybe not. Evaluating the effects of oxygen and light on visual organisms

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Ocean deoxygenation has been an increasing concern in the last 20 years, in part developing from the warming of ocean water increasing stratification and lowering nutrient circulation and biological productivity. This effect is particularly exacerbated in the Eastern Pacific, where naturally low oxygen concentrations are combined with upwelling events. Hypoxia, usually defined as oxygen concentrations <60 mol kg^{-1}, has the potential to greatly impact organisms that rely on specific oxygen levels to maintain their metabolism, particularly those with advanced brain function or sensory organs. For example, eyes have high oxygen requirements; in highly visual organisms, the retina is the tissue with one of the highest oxygen consumptions in the body. Hypoxia is known to cause changes in visual sensitivity in humans (tested in high altitude pilots) and a change in behavior from marine organisms such as fish, crustaceans, and mollusks. Loss of visual function from low oxygen may cause marine organisms highly dependent on vision such as cephalopods to alter behavior and/or distribution. However, full visual function also requires an adequate light level, and the intensity of light changes rapidly, an exponential decay with depth, in the water column. Visual organisms will therefore need to stay in areas where the oxygen concentration and light intensity are suitable for visual function. Data from both a stationary mooring (SeapHOx deLUX) measuring changes in light and oxygen across time, and CTD casts measuring the same variables vertically in the water column will be used to determine specific combinations of light and oxygen. These lumoxy scapes can provide a framework to determine vision-induced effects of hypoxia on the distribution and behavior of visual marine organisms.

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Amphibious Magnetotelluric Investigation of the Aleutian Arc: Mantle Melt Generation and Migration beneath Okmok Caldera

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Okmok, located on the northeastern portion of Umnak Island in Alaska, is among the most active volcanoes in the Aleutian Arc. In addition to two caldera-forming events in the Holocene, there have been numerous eruptions in the past century, with the most recent in 2008 having less than five hours of precursory seismic events. This history of activity indicates a robust magmatic supply, and previous coarse resolution seismic studies have inferred a crustal magma reservoir. We carried out an amphibious geophysical survey across the arc in June-July 2015 in order to investigate various aspects of the magmatic system of Okmok, including: how fluids impact melting and how melt then ascends through the corner flow regime of the mantle wedge, how melt migrates and is stored within the upper mantle and crust, and how this impacts explosive caldera forming eruptions. Because melt and aqueous fluids are a few orders of magnitude more electrically conductive than melted peridotite, the conductivity-mapping magnetotelluric (MT) method is well-suited to imaging fluids and melt beneath arc volcanoes. Twenty-nine onshore MT stations and 10 offshore stations were collected in a 3D array covering Okmok. An additional 43 offshore MT stations completed a 300km amphibious profile starting at the trench and crossing the forearc, arc, and backarc. Thirteen onshore passive seismic stations were also installed and will remain in place for one year to supplement the twelve permanent seismic stations on the island. Data collected by this project will be used to map seismic velocity and electrical conductivity variations within the arc, providing unique constraints on temperature, mineralogy, and fluid content related to arc magmatism. Here we discuss preliminary work using data from the 300km long amphibious MT profile.

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Trophic niche assessment of two congeneric thornyhead fish species, Sebasolobus altivelis and Sebastolobus alascanus, in the Southern California Bight

Erin C. Navarro[1 †], Natalya D. Gallo[2], Lisa A. Levin[2]

Natural and anthropogenic changes in oceanic physicochemical conditions along the Southern California Bight may impact the distribution and interaction of benthic and pelagic communities that include critical fisheries species. Two congeneric thornyhead species, Sebastolobus altivelis and Sebastolobus alascanus, are among these important fisheries species and exhibit similar depth distributions and morphology. Although subject to similar environmental temperature, oxygen, and pressure conditions, they exhibit differing life history distributions and metabolic activity levels, yet are still able to co-exist along the local benthic continental margin in a region of intense and relatively permanent hypoxia. Through gut content and stable isotope analyses, this research explores the trophic niches and trophic interactions between the congeneric thornyhead species across multiple depth ranges, seeking to identify trophic niche separation, overlap, consistency, and interaction with physicochemical conditions such as oxygen concentration. A look at their community-level trophic interactions may help inform future operations in sustaining these and other fisheries species inhabiting areas of expanding hypoxia in the California Current.

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Near Shore Island Response in Palau to Typhoon Haiyan

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In November of 2013 Typhoon Haiyan tracked across the Western Topical Pacific as a category 5 system and passed through the island chain of Palau. The ocean response to the storm was seen in fore-reef currents, wave field, and temperature time series around the island's barrier reef. Sustained winds upward of 155 knots presented a broad band forcing to the local oceanographic environment. The temperature and water level observations indicate the presence of an island-trapped internal Kelvin wave which propagated around the barrier reef of Palau. Phase speed and modal structure of trapped Kelvin waves are governed by the local stratification and topographic variability around the islands. The Brink Chapman model is used to examine the variability in the wave guide at multiple locations around Palau, helping to understand mechanics of wave energy propagation and dissipation in the area. We compare observations to the Brink Chapman model to help identify the propagating wave modes observed after Typhoon Haiyan.

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Using Radio Occultation and Dropsondes from the 2010 Concordiasi Campaign for Assessing Antarctic NWP model Accuracy

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Changes in the sea ice distribution in Antarctica depend strongly on changes in dynamic forcing by winds, in addition to temperature changes. Modeling this atmosphere-ocean interaction relies heavily on remote sensing observations, with little ability to evaluate their effectiveness, given the sparsity of in-situ data. We are creating a new dataset of stratospheric balloon-borne GPS radio occultation (RO) observations for several Antarctic cyclogenesis events where strong winds at the ice edge are expected to have an impact on ice transport. The Concordiasi dropsonde dataset will serve to assess the overall accuracy of several models for these events, in particular, analyses and forecasts from the National Center for Environmental Prediction and the European Center for Medium-range Weather Forecasts. The proof of concept for balloon-borne radio occultation has already been demonstrated. Through further analysis of this dataset, we will be able to determine its utility as an additional resource to assess model accuracy for remote cyclogenesis events in Antarctica. Results of processing of the GPS RO observational dataset are compared to analyses and forecasts including NCEP and locally run WRF runs that focus on the time periods of observations. Quality of the derived refractivity and temperature profiles from the GPS RO dataset are assessed to determine the potential impact of assimilating these insitu observations into modeling including WRF. Particular areas of focus for the reliability of model profiles, include regions of cyclogenesis, and along the sea ice edge.

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A comparison of classification methods for detection population structure in social cetaceans

Amy M. Van Cise[1,2 †], Jay Barlow[1,2], Marie A. Roch[3], Shannon Rankin[2]

Variation in call repertoires is correlated with population structure in many species of birds and mammals. In the marine environment, killer whales exhibit acoustic variation in their call structure, which has recently been quantitatively studied in order to improve understanding of socially-driven population structure. Here we compare recently published methods used to characterize killer whale calls by applying these techniques to another social cetacean, the short-finned pilot whale. Pilot whale vocalizations exist along a continuum from burst pulse to whistles, and we found that many calls exhibit simultaneous burst pulse and whistle components. They also exhibit repeated complex calls made of several independent subunits. Two genetically and morphologically distinct types of short-finned pilot whale have been identified in the Pacific Ocean, with non-overlapping distributions. Recordings from both types reveal qualitative differences in the complexity and frequency distribution of social vocalizations from the two types. In order to compare the efficacy of previously published call characterization techniques, we used each method to characterize 300 calls from 10 encounters for each type of short-finned pilot whale. We then use a Gaussian Mixture Model look for acoustic variability in calls between the two types. The results of the characterizations are compared to determine which method performs best in characterizing call variability in short-finned pilot whales. We anticipate that including population-specific information may improve species classification for short-finned pilot whales.

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Improvement of stratospheric balloon positioning and the impact on gravity wave parameter estimation for the Concordiasi campaign in Antarctica

Weixing Zhang[1 †], Jennifer S. Haase[1]

Gravity waves (GWs) play an important role in transferring energy and momentum from the troposphere to the middle atmosphere. However, shorter scale GWs are generally not explicitly resolved in general circulation models but need to be parameterized instead. Super pressure balloons, which float on isopycnic surfaces, provide direct access to measure GW characteristics as a function of wave intrinsic frequency that are needed for these parameterizations. The 30 s sampling rate of the GPS receivers carried on the balloons deployed in the 2010 Concordiasi campaign in the Antarctic region is much higher compared to the previous campaigns and can cover the full range of the GW spectrum. Two among 19 balloons in the Concordiasi campaign are also equipped with the high-accuracy dual-frequency GPS receivers initially developed for GPS radio occultation research in addition to the regular single-frequency receivers, which are expected to provide higher accuracy balloon positions for the purpose of GW momentum flux estimates. The positions are estimated using the Precise Point Positioning with Ambiguity Resolution (PPPAR) method based on the GPS phase data. Improvements of the positions are significant, from ∼3-10 m horizontal and ∼5 m vertical to ∼0.1 and 0.2 m, respectively, which makes it possible to resolve the Eulerian pressure independently of height for the estimation of the intrinsic phase speed. The impacts of the position improvements on the final GW parameters (momentum flux and intrinsic phase speed) retrievals are highlighted, with ∼0.54 mPa difference of the mean absolute momentum flux in the Antarctic region and considerable difference in the distribution of the intrinsic phase speed.

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On the Decadal Scale Correlation Between African Dust and Sahel Rainfall: the Role of Saharan Heat Low-Forced Winds

Weijie Wang[1 †], Amato Evan[1], Cyrille Flamant[2], Christophe Lavaysse[3]

A large body of work has shown that year-to-year variations in North African dust emission are inversely proportional to previous year monsoon rainfall in the Sahel, implying that African dust emission is highly sensitive to vegetation changes in this narrow transitional zone. However, such a theory is not supported by field observations or modeling studies, as both suggest that interannual variability in dust is due to changes in wind speeds over the major emitting regions, which lie to the north of the Sahelian vegetated zone. Here we reconcile this contradiction showing that interannual variability in Sahelian rainfall, and surface wind speeds over the Sahara, are the result of changes in lower tropospheric air temperatures over the Saharan Heat Low (SHL). As the SHL warms an anomalous tropospheric circulation develops that reduces wind-speeds over the Sahara and displaces the monsoonal rainfall northward, thus simultaneously increasing Sahelian rainfall and reducing dust emission from the major dust hot-spots in the Sahara. Our results shed light on why climate models are, to-date, unable to reproduce observed historical variability in dust emission and transport from this region.

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Asymmetry in Growth and Decay of Geomagnetic Dipole Revealed in Seafloor Magnetization

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Motion of liquid-iron in Earth's outer-core generates the geomagnetic field and records of past geomagnetic intensity provide important constraints on outer core processes. Sediments and newly forming igneous rocks record the field at Earth's surface. PADM2M is a reconstruction of the 0 to 2 Ma axial dipole moment primarily based on global sediment records calibrated by absolute paleointensity data. Ziegler & Constable (2011) showed that for periods longer than 25 kyr the dipole spends more time decaying than growing: thus its average growth rate is greater than its decay rate. The observed asymmetry is not limited to times when the field is reversing, and may reveal a critical dynamic of the outer core. We explore the possibility of identifying the asymmetry in alternative recording media and at other epochs. A long-term record of geomagnetic intensity should also be preserved by the remanence of oceanic crust generated by episodic eruptions at spreading ridges. Stacks of marine magnetic anomalies are inverted to provide an independent means of assessing the asymmetry seen in PADM2M. We first examine a 0 to 780 kyr record from the East Pacific Rise near 19S finding that the percent time growing (pg) departures from 50% are not statistically significant. We believe the record is too short and noisy. Overall coherence with PADM2M is low and, despite the presence of obvious long-term geomagnetic signals in the record, the primary signals at periods of 25- 50ky are almost certainly due to variations in crustal accretion. A better candidate for analysis is a stack of near-bottom records from chron C5 in the NE Pacific. Multiple nearby records have high coherence, corresponding to global lineations extending over a 2My interval. Here we find pg is significantly less than 50% at periods similar to PADM2M. This result indicates that other recording media carry a record of the asymmetric behavior first found in PADM2M and that it was present at other times.

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Nitrogen Isotopes in the California Current Ecosystem-LTER Domain

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Organic and inorganic nitrogen stable isotopes collected during the August 2014 California Current Ecosystem Long-term Ecological Research (CCE-LTER) cruise allow comparison of trophic implications across highly productive coast to nearby oligotrophic ocean gyre. Despite highly varied ecosystem conditions, the primary nutrient source nitrate and sinking particulate organic matter collected from drifting sediment trap arrays (3-day deployment) exhibit inter-cycle ranges of 1-2 . However, the broader isotopic range from inter-cycle suspended organic nitrogen (2-4) suggests contributions to primary producers from a nutrient source other than subsurface nitrate. Alternative nutrient sources entering the suspended organic pool could include isotopically-depleted nutrients recycled within the euphotic zone like that of ammonium (Checkley and Miller, 1989) or nitrification-derived NO2 (Santoro et al., 2013). Visual inspection of sinking organic matter suggest that isolated material consisted of ~50% fecal pellets of micro- and mesozooplankton origin, organisms with typical body N-isotopes of 10-12 (Ohman et al., 2011). For most ecosystem conditions studied here, subsurface suspended organic matter likely arrives at depth primarily from disaggregating sinking organic matter (Altabet, 1988); however, we find sinking and suspended material to not be in alignment for the most productive nearshore environment suggesting that both lateral and vertical advection plays an increasing role in N cycling of coastal upwelling zones. A Rayleigh-based isotopic nitrogen budget for the California Current Ecosystem highlights potential for nearshore-derived nutrients to contribute to nearby oligotrophic environments.

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Long-term Evolution of Seismicity Rates in California Geothermal Fields

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Geothermal energy is an important source of renewable energy for the state of California, yet the fluid extraction and subsequent reinjection required for energy production carries with it the potential for induced seismicity and associated hazard. Here we provide a quantitative comparison of the temporal changes in seismicity in three of the largest geothermal fields in California - the Geysers, Salton Sea, and Coso - each of which has experienced a unique history of energy production. Our central focus is the temporal evolution of seismicity rates, which provide important observational constraints on the ways in which the subsurface within each geothermal field responds to anthropogenic stresses and natural loading. We develop an iterative, regularized inversion procedure to partition the observed seismicity rate into two primary components: (1) the interaction seismicity rate due to earthquake-earthquake triggering, and (2) the time-varying background seismicity rate controlled by other time-dependent stresses, including anthropogenic forcing. We apply our methodology to compare long-term changes in seismicity rates at each geothermal field to monthly records of fluid injection and withdrawal. At the Geysers, we find that the background seismicity rate is highly correlated with fluid injection, with the mean rate increasing by approximately 50 percent and exhibiting strong seasonal fluctuations following the completion of the Santa Rosa pipeline. In contrast, at both the Salton Sea and Coso geothermal fields, the background seismicity rate has remained relatively stable since 1990, though both fields experience short-term rate fluctuations that are not obviously modulated by geothermal field operation. At each of the three geothermal fields, we also observe significant temporal variations in both the magnitude and depth distributions of earthquakes, consistent with previous observational and theoretical studies of induced seismicity.

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Reactivity-guided isolation for the discovery of epoxide pharmacophores

Gabriel Castro-Falcon[1 †], Dongyup Hahn[1], Chambers C. Hughes[1]

Actinobacteria is a phylum of gram-positive bacteria known to produce a wide number of molecules with antibacterial, antifungal, and anticancer activities. Genetic studies have revealed that the number of genes encoding the biosynthesis of natural products is much more than the molecules found through conventional drug discovery programs. Thus, the employment of new methods that emphasize on expression of the biosynthetic gene clusters and the detection their products will gain better access to the untapped source of structural motifs that may be of upmost importance to human health. This situation has inspired us to develop a direct method called reactivity-guided isolation to discover medicinally relevant compounds in a targeted manner. By utilizing tuned synthetic probes that react chemoselectively with molecular scaffolds known to be essential for biological activity (the pharmacophores) we can thereby improve the detection and subsequent isolation of molecules that have the potential to become medicines. One such probe has been validated to react with epoxide pharmacophores on known natural products, even in crude extracts. Finally, it has been effective in the discovery of an epoxide-containing natural product named tirandalydigin, a biologically active compound isolated from the Salinispora genus for the first time.

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Low magnitude limits on seismogeodesy with MEMS accelerometers for events in the Salton Trough and the San Francisco Bay Area

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We assess the field performance of seismogeodetic stations equipped with SIO Geodetic Modules and low-cost MEMS accelerometer packages (GAPs) using four intermediate-sized (∼M4.0) earthquakes. The current seismogeodetic network consists of 15 stations in southern California and 10 stations in the San Francisco Bay Area. The seismogeodetic approach optimally combines accelerometer data with collocated high-rate GNSS position observations to obtain accurate broadband displacements and seismic velocities in the near field. Previous shake table testing demonstrated that for large magnitude earthquakes the GAP seismogeodetic combination yields displacements and velocities on par with the combination using observatory-grade accelerometers. In this study we show that the field-deployed MEMS accelerometers at epicentral distances of 3 to 40 km recorded strong motion from four events: a M4.2 and a M4.1 near the southern end of the Salton Sea as well as two M4.0 earthquakes in the San Francisco Bay Area. The GAP seismogeodetic combinations produced stable displacement and velocity time series with increased precision compared to GNSS-only solutions. While the velocities showed significant ground motion and that an event was occurring, the displacements, as would be expected for these intermediate magnitude events, did not exhibit significant variations. This null result provided definite evidence that the events were not developing into large ruptures, an important datum for whether or not to issue an early warning of an earthquake of consequence. Our results with intermediate magnitude earthquakes demonstrate that the GAP-upgraded stations will be able to provide important complementary confirmation of seismic earthquake early warning products.

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Bacterial Community Response to Iron Availability in the California Current Ecosystem

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Due to its low solubility, iron(III) is quickly removed from seawater through precipitation as iron oxides. This results in very low (∼100 pM) iron concentrations in surface water of the open ocean, and iron is now recognized as an important control on marine primary productivity. However, iron is not only a key element in the reactions of photosynthesis. It is a necessary nutrient for practically all forms of life and is a crucial cofactor in many of the redox steps facilitating the breakdown and respiration of organic matter. Given this, we hypothesize that iron availability may directly affect the species and size distribution of the marine heterotrophic bacterial community as well as the ability of these bacteria to transform and/or remineralize available organic matter. My research thus far has focused on addressing this hypothesis through a number of incubation experiments conducted in the California Current Ecosystem aimed at assessing the effects of iron availability on such measures as bacterial size and abundance, species distribution, bacterial carbon production, and iron ligand speciation.

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The Role of Real-Time GNSS in Earthquake and Tsunami Early Warning

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For earthquake and near-shore tsunami early warning, prompt and accurate information is crucial for reducing casualties. Maximizing warning time relies on the use of near-field data, where ground motion due to large magnitude events creates unique challenges for seismic instruments. This was seen during the 2011 Tohoku-Oki event, in which the earthquake magnitude was severely underestimated due to saturation effects associated with seismic instrumentation. GNSS (GPS and other navigation satellites) is well suited for the near field as the signal to noise ratio increases with the size of the displacement. It also has the advantage of direct measurement of coseismic displacement, and is unaffected by saturation. We discuss a prototype system for earthquake and tsunami early warning based on real-time combination of GNSS and accelerometer data using precise point positioning with ambiguity resolution and accelerometer (PPP-ARA) software to estimate the broadband coseismic displacement and velocity waveforms with a latency of 1-2 seconds. These data allow for accurate detection of P-wave arrivals for near-source medium size earthquakes and greater. We demonstrate the capabilities of automated P-wave detection using a modified STA/LTA algorithm and subsequent hypocenter estimation. With data from the 2010 Mw 7.2 El Mayor-Cucapah, 2011 Mw 9.0 Tohoki-Oki, and 2014 Mw 8.2 Iquique earthquakes, we establish the advantages of this combination data type for magnitude estimation using Pd and PGD scaling. Further, we demonstrate its use for finite-source centroid moment tensor (CMT) solutions, which can be used to indicate tsunami risk following a seismic event. Finally, we show that slip inversions using our combination data type assist with tsunami modeling to provide a better assessment of the geographical extent of evacuation, which would minimize injuries and loss of life.

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A MOORED DESCRIPTION OF THE ANNUAL SPRING BLOOM IN THE NORTHWEST MEDITERRANEAN SEA

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The BOUSSOLE bio-optical mooring offers a detailed understanding of oceanographic quantities for the ocean's surface in the Ligurian Basin of the Mediterranean Sea. Downward irradiance is measured by Multi-Spectral Radiometers on the mooring, one at the surface, one at 4m, and one at 9m; these measurements allow an attenuation spectrum for the upper ocean layer to be computed. The mooring's attenuation spectrum is optimized to locally-derived optical coefficients, arriving at high-frequency, depth-averaged chlorophyll concentrations. The result is a new bio-optical technique for determining chlorophyll from a moored platform. The annual chlorophyll bloom is immediately evident in the signal, normally peaking in March with values of approximately 5 mg/mˆ3, before returning to values less than 1 mg/mˆ3 in the summer. The BOUSSOLE time-series length shows an interannual variability of two months in bloom initiation of and a factor of 3 in the bloom magnitude (2-6 mg/mˆ3). Before bloom initiation hypotheses could potentially be discussed, a full understanding of the preconditioning, heat budgets, and chlorophyll magnitude must be described. To this goal, the monthly hydrographic cruises give a synoptic, full-profile understanding, while the mooring provides frequent surface conditions during the dynamic Spring Bloom.

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Observing internally-driven, episodic accelerations of an Antarctic ice stream

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Ice streams drain >90% of the Antarctic ice sheet and therefore understanding their motion and its variability is critical to projecting the future behavior of Antarctica in a changing environment. Water at the ice-bed interface controls the rate at which Antarctica's glaciers and ice streams flow towards the ocean, but a calibrated, quantitative link between ice flow and subglacial hydrology remains elusive, largely due to a lack of suitable observations. Active subglacial lakes, which fill and drain on sub-decadal timescales, can be indirectly observed via surface displacements. Under ice streams, these lakes potentially alter ice motion by sequestering and episodically releasing up to cubic kilometers of subglacial meltwater generated in the upstream catchment. Here, we use five years (2010-2015) of continuous Global Positioning System (GPS) data on the Whillans and Mercer ice streams, West Antarctica, to observe cascading subglacial floods and their impact on ice flow. These connected events caused two years of enhanced ice flow, with episodic velocity fluctuations of nearly 4% correlated to lake drainage evolution, and an eleven-month disruption of the tidally-paced stick-slip cycle that dominates regional ice motion. Our continuous, long-term observations allow assessment of inherent dynamic ice-stream variability and indicate that episodic processes may bias typical campaign-style observations.

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