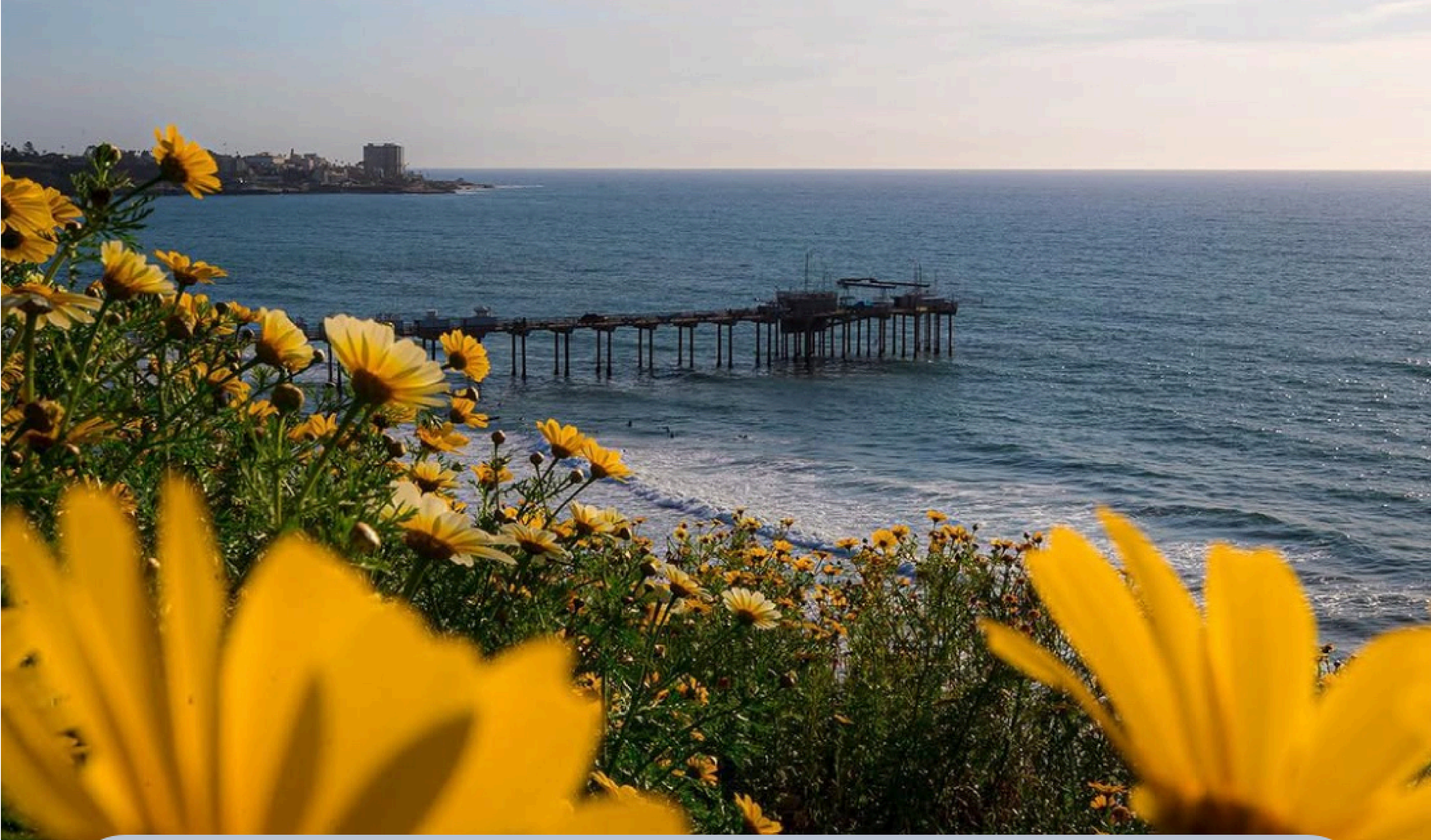
The 11th annual

Scripps Student Symposium 2025

Wednesday, September 24th

Scripps Seaside Forum



Scripps Student Symposium S3

UC San Diego

Scripps Institution of Oceanography

Photo: @erikjepsen

Dear SIO Community,

Firstly, thank you for joining us for the 11th annual Scripps Student Symposium (S^3).
This is an event entirely dedicated to, and entirely run by, Scripps graduate students to create a space for all of us to connect, talk science, and be inspired by some of the brilliant research happening across SIO. In light of the current challenges facing academic research in the United States, S^3 offers an opportunity to highlight the impactful work being done at SIO and to celebrate the collaborative, outreach-driven, and creative spirit of the Scripps graduate student community.

The event schedule includes oral and poster presentations from graduate students in all research sections of SIO, as well as a welcome address by both Professor Meenakshi Wadhwa, the new Vice Chancellor of Marine Sciences, Director of SIO, and Dean of the School of Marine, Earth and Atmospheric Sciences at UCSD and Professor Jack Gilbert, Deputy Director for Research at SIO and Associate Vice Chancellor for Marine Science at UCSD. We are also grateful to have representatives from Shinkei Systems joining us to network with our graduate students and explore the cutting-edge research happening at Scripps. Please take a moment today to (re)connect with fellow scientists, meet new friends, and learn something new!

In addition to showcasing our students, we are excited to welcome this year's keynote speaker: Paula Ezcurra. Paula currently works for the non-profit organization, the Climate Science Alliance, where she focuses on the preservation of natural resources in the face of a changing climate across the Californias. She is a graduate of the Climate Science & Policy Program at SIO where she studied the threat of climate change on coastal cultural heritage sites in Puerto Rico. Also at Scripps, Paula has previously worked as a research and communications associate for Dr. Octavio Aburto, distilling research on mangroves and conservation into policy and outreach materials intended for a non-scientific audience. She has also served as a project coordinator to the California Collaborative for Climate Change Solutions under Dr. Ram Ramanathan. We are thrilled to have Paula share insights from her journey post-SIO with us today!

Lastly, we would like to thank each and every one of you for joining us for this day of science and community, and we hope that S^3 will continue to inspire students for many years to come!

All the best,

The 2025 S^3 Organizing Committee
Ankitha Kannad, Kerstin Bergentz, Grant Meiners, Siara Mitchell, Kayli Matsuyoshi, Rachel Kepler, Jena Herbst, Vivian Hou, Melissa Brock, Bethany Walkinshaw-Campbell, Brandon Duran, Tommy Stone, Ben Mackay, Jessica Zhong, Marcela Prado-Zapata

Agenda

Wednesday, September 24th, 2025, Scripps Seaside Forum

08:00–08:45 Registration and poster set-up

08:45–09:00 Opening remarks by the S^3 organizing committee

09:00–09:30 Welcome address by Prof. Meenakshi Wadhwa and Prof. Jack Gilbert

09:30–10:30 Oral Session 1

10:30–11:30 Poster Session 1 & Art Show

11:30–12:30 Keynote Address by Paula Ezcurra

This year's keynote speaker Paula Ezcurra works for the non-profit organization the Climate Science Alliance where she has worn various hats, all in furtherance of the preservation of natural resources in the face of a changing climate across the Californias. As a graduate student in SIO's Climate Science & Policy program, Paula completed a capstone project on the threat that climate change impacts, particularly rising seas, pose to coastal cultural heritage sites in Puerto Rico. She has also studied carbon sequestration potential of Mexico's mangrove ecosystems and distilled research on mangroves and conservation into policy and outreach materials intended for a non-scientific audience. Before joining the Alliance, she also served as a project coordinator to the California Collaborate for Climate Change Solutions.

12:30–13:30 *Lunch*

13:30–13:45 Presentation on the SIO Scientific Diving and Small Boating Program by Christian McDonald

13:45–15:00 Oral Session 2

15:00–16:00 Poster Session 2 & Art Show

16:00–17:15 Oral Session 3

17:15–17:30 Closing remarks by the S^3 organizing committee

Thank you to this year's sponsor!

Shinkei

Oral Sessions

Wednesday, September 24th, 2025

Oral Session 1

09:30-09:45 **Anjali Narayanan, "**Multispectral and hyperspectral remote-sensing reflectance-based classification algorithms to discriminate microphytoplankton from non-microphytoplankton-dominated communities in the western Arctic seas**"**

09:45-10:00 **Max Titcomb, "**A 30-year Retrospective: Using Citizen Science Data to Model the Drivers of Caribbean Grouper Trends**"**

10:00-10:15 **Leila El Masri, "**Radical Initiated Oxidation of a Sewage Tracer Gas, H2S: How the Polluted Tijuana River Influences the Aerosol Forming Potential of the Region**"**

10:15-10:30 **Kayli Matsuyoshi, "**Airborne observations of wave-current interactions at a submesoscale front**"**

Oral Session 2

13:45-14:00 **Mel Golshan, "**Investigating the Combined Effects of Pressure and Salinity On Microbial Growth and Biochemical Profiles in Orca Basin**"**

14:00-14:15 **Ray Thicklin, "**Impact of Present Era Tropospheric Cycles and Trends on InSAR timeseries data**"**

14:15-14:30 **Andrea Rodriguez-Marin Freudmann, "**The Internal Surfzone: How Internal Waves Affect The Inner Shelf**"**

14:30-14:45 **Austin Green, "**Set phasers to stun: A phased array view of physical processes in the upper ocean**"**

14:45-15:00 **Grant Meiners, "**Seasonal Variability of Turbulent Mixing in Jan Mayen Channel from High-Resolution Thermistors**"**

Oral Session 3

16:00-16:15 **Hunter Edwards, "**Martian meteorites as probes into the geochemical evolution of stagnant-lid planets**"**

16:15-16:30 **Svenja Kling,** **“**Genome Engineering in the Sea Urchin Lytechinus pictus**”**

16:30-16:45 **Kylie Kinne,** **“**The Seasonality of Greenland Iceberg Melt and its Influences on Fjord Properties and Dynamics**”**

16:45-17:00 **Rhowan Ho,** **“**Investigating The Potential of Multiple Soldier Sub-Castes In Parasitic Eusocial Trematode Colonies**”**

17:00-17:15 **David Culver,** **“**Using Neural Networks for Functional Representations of Nearshore Ocean Waves**”**

Poster Sessions

Thursday, September 24th, 2025

Poster Session 1: 10:30-11:30

Erik Paulson
First look at species-specific mercury uptake by *Thalassiosira pseudonana* at oceanic sub-picomolar concentrations

Aurora Czajkowski
Characterizing the spatial and vertical distribution of the Tijuana river wastewater plume with physical oceanographic and chemical tracers

Nicole Clizzie
Does Earth's magnetic field ever converge to a stable average?

Aidan Blaser
Enhanced Lagrangian transport in steep focusing wave packets

Byeol Ryu
Expanding the Kahalalide Story: Integrated Metabolomics and Genomics Identify Cyanobacteria as a New Source

Sierra Byrne
Drivers of small river plumes and their transport following storms

Caique Dias Luko
Off-equatorial subsurface turbulent mixing in the Tropical Pacific: enhanced vertical heat fluxes, modulation of primary productivity and control of penetrative heating

Anna Golub
Defining the nitrogen isotopic signature of equatorial Pacific El Niño Southern Oscillation events over the last 150 years

Lindsey Kim
Mesozooplankton trophic structure in the Argo Basin, Northwest Australia

Cate O'Bryon
Lagrangian Particle Tracking to Trace Origins of Productivity in the Santa Lucia Escarpment

Kanoa Pick
The Effect of Submerged Engineered Reef Structures on Wave Overturn Shape

Reza Rahemi
Physics-Informed Risk Analysis of Anthropogenic Seismicity

Poster Session 2: 15:00-16:00

Sophia Riazi-Sekowski
The Tijuana River as a Source of Coastal and Air Pollution: A State-of-Knowledge Review

Sourita Saha
Importance of Size and Composition in CCN Activation of Natural Aerosols in the Arctic

Sophie Shapiro
Topographic controls on deep water upwelling at the crossing of the Antarctic Circumpolar Current and the Pacific Antarctic Ridge

Ethan Staats
On the Photobiology of Amphioxus in Relation to its Fluorescence

Gabriella Tanoto
Ocean on Fire: Initial characterization of the ash depositions of the LA fire on the Californian coast

Xenia Barnes
New swimming spaghetti worms (Terebellidae, Annelida) from the eastern Pacific Ocean

Emna Braham
Contribution of Large Marine Aerosols in Phytoplankton Dispersal

McKenna Carlson
Forty Years of UN Ocean Governance: Stakeholder Power and Policy Shifts (1982–2022)

Grace Constantian
Impacts of Marine Heatwaves on California Current Ecosystem Microbial Communities

Haley Lowes-Bicay
Sensitivity tests of model resolution of tropical waves using the Model Prediction Across Scales – Atmosphere (MPAS-A) and Balloon-borne Radio Occultation

Anamaria Navarrete
Evaluation of RRFS-Smoke Model Using Satellite and In-Situ Observations during the North American 2025 Fire Season

Karl-Erik Paulsson
Turbulent Mixing, Water-Mass Transformation and Deep Argo

Eliana Vargas
RamBO: randomized blocky Occam, a practical algorithm for generating blocky models and associated uncertainties from electromagnetic data

Helen Zhang
Regional Shelf Response to Low Frequency Coastal Trapped Waves

Abstracts

Wednesday, September 24th, 2025

Poster Session 1

Poster Session 2

Multispectral and hyperspectral remote-sensing reflectance-based classification algorithms to discriminate microphytoplankton from non-microphytoplankton-dominated communities in the western Arctic seas

Anjali Narayanan[1], Rick A. Reynolds[1], Ishan D. Joshi[1], Dariusz Stramski[1]

The Arctic marine ecosystem is experiencing significant climate-related environmental changes. Phytoplankton cell size-related shifts in Arctic phytoplankton community composition in response to environmental change have been reported. The dominant cell size of a phytoplankton community dictates its functioning. Because phytoplankton are strong light absorbers and scatterers, the spectral remote-sensing reflectance, R_{rs}, which to first order is driven by the ratio of inherent optical backscattering to absorption coefficients of seawater, may reveal such shifts. Moreover, R_{rs} is a direct data product of ocean color remote sensing, allowing monitoring of phytoplankton over extended spatiotemporal scales. Using an in-situ dataset of concurrent measurements of R_{rs} and phytoplankton pigments compiled from cruises in the Chukchi and Beaufort Seas, we developed a multispectral classification algorithm based on R_{rs} band ratios from the blue-green spectral region to classify samples dominated by microphytoplankton (cell size > 20 μm) vs. non-microphytoplankton. This algorithm is applicable to past and current multispectral satellite ocean color missions, potentially enabling the study of shifts in Arctic phytoplankton community structure over decades. Analysis of field data shows this algorithm classifies both micro- and non-micro-dominated samples with a success rate of ~80% or better relative to a reference pigment-based classification. A hyperspectral classification algorithm was also developed based on the second derivative of normalized R_{rs}. Compared to the multispectral algorithm, the hyperspectral algorithm improves classification success and is applicable to the PACE satellite mission with the hyperspectral OCI sensor. Application of both algorithms is demonstrated using example PACE OCI imagery in the study region.

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A 30-Year Retrospective: Using Citizen Science Data to Model the Drivers of Caribbean Grouper Trends

Max Titcomb[1], Brice X. Semmens[1]

Reef-associated groupers (family Epinephelidae) are iconic apex predators and critical ecological indicators of reef health, yet many Caribbean grouper populations are experiencing range-wide declines according to the IUCN Red List Index. Although informative, large variations in management across the Caribbean make this metric difficult to use for fisheries management on a national level. To evaluate species-specific sighting trends and their drivers across countries, we analyzed 30 years (1994–2024) of citizen-science Roving Diver surveys, employing binomial generalized linear mixed models with spatial and spatiotemporal random effects. Overall, we found regional declines in grouper occurrence, although trends varied between species and countries. Fishing intensity was the strongest predictor of grouper absence, with marked declines in sightings outside marine protected areas, whereas MPAs maintained higher and more stable encounter rates. Sea surface temperature variability also mediated grouper occurrence, suggesting that climate change may compound the effects of overfishing. Notably, we found strong evidence of species-specific localized rebounds where site-level protections were strong. Our results provide a high-resolution map of hindcasted changes in grouper distribution and occurrence over the past 30 years, and highlight the complex influence of human and environmental drivers on reef-associated grouper populations. They also underscore the value of citizen science for generating cost-effective, fine-scale metrics of reef predator status and management effectiveness—particularly for data-limited fisheries.

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Radical Initiated Oxidation of a Sewage Tracer Gas, H_2S: How the Polluted Tijuana River Influences the Aerosol Forming Potential of the Region

Leila El Masri[1], Patricia Morris[1], Kimberly Prather[1,2]

The San Diego South Bay (SDSB) is impacted by toxic gases and particulate pollution stemming from industrial waste and wastewater in the Tijuana River (TJR). The TJR crosses the US-Mexico border into San Ysidro, then moves into the community of Nestor, where it enters a series of culverts which increase river turbulence. These turbulent conditions located at the Saturn Boulevard River Crossing have been identified as a hotspot of air pollution and a particular odorous, toxic gas, H_2S. This hotspot is known as the Saturn Blvd. Hotspot (SBH), identified during a recent ambient monitoring campaign.

Measurements recorded near the SBH revealed the aerosol forming potential, or the likelihood of gases to form new aerosol particles, of H_2S, using a Potential Aerosol Mass Oxidative Flow Reactor (PAM-OFR) coupled with various sizing instruments and a H_2S analyzer. Measurements using a PAM-OFR in the field artificially aged ambient gases and particles near the SBH. Preliminary results suggest H_2S has a high aerosol forming potential. Peak H_2S emissions corresponded to new particle formation (NPF) events within the OFR, particularly during nighttime periods when the concentration of H_2S was highest, reaching up to 4,500 ppb. A strong positive correlation (R^2 = 0.9) between total aerosol number concentrations (N) formed in the PAM-OFR and H_2S concentrations was observed. This study identifies rivers as an underexplored source of aerosol and gas emissions, showing dangerously high H_2S levels in a residential area and subsequent particle formation in the PAM-OFR.

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Airborne observations of wave-current interactions at a submesoscale front

Kayli Matsuyoshi[1], Luc Lenain[1], Mara Freilich[2] , Nick Pizzo[3]

Climate balance depends on the communication of the ocean with the atmosphere and its ability to store and move matter and energy. Both surface gravity waves and submesoscale currents facilitate the necessary air-sea fluxes and upper ocean transports to achieve this balance, but their effects are not mutually exclusive. Interactions between surface gravity waves and submesoscale currents have impacts on ocean-atmosphere exchanges of mass, heat, and momentum that are not adequately understood. In this study, we explore locally enhanced wave steepening and breaking at a submesoscale front with colocated and coincident airborne observations of surface waves and currents. This unprecedented dataset was collected by the Modular Aerial Sensing System (MASS) during the NASA Sub-Mesoscale Ocean Dynamics Experiment (S-MODE). Near-surface Lagrangian current profiles are obtained using an airborne electro-optical sensor (DoppVis) and the linear deep water wave dispersion relationship. Additionally, directional and spectral properties of surface gravity waves derived from lidar sea surface topography swaths enable the computation of Stokes drift profiles along the track of the aircraft. Hyperspectral visible imagery was used to estimate wave breaking statistics, while infrared imagery provided sea surface temperature. Such observations allow for the quantification of wave contributions to near-surface vertical shear and short-wave modulation by submesoscale currents. These findings highlight the two-way coupling between waves and submesoscale currents and illustrate the role that their interactions play in the context of planetary ocean-atmosphere flux variability.

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Investigating the Combined Effects of Pressure and Salinity on Microbial Growth and Biochemical Profiles in Orca Basin

Mel Golshan[1], Miguel Desmarais[1], and Douglas Bartlett[1]

Earth is home to a variety of ecosystems, many of which push the boundaries of life. From hydrothermal vents to arid deserts, extreme environments are of interest for understanding biota both within and possibly outside of our planet. Of particular interest are deep hypersaline anoxic basins (DHABs), which mimic the expected conditions of the liquid ocean cores of icy moons like Europa and Enceladus. The lack of oxygen in these seafloor pools, as well as the high salinity and pressure conditions, make DHABs perfect candidates for extremophile studies. The purpose of this work is to investigate the possibility of synergies between elevations in pressure and salinity on microbial growth rates and membrane compositions. The ultimate goal is to elucidate the cellular and molecular mechanisms involved in polyextreme stress mitigation.

Here, we set up 158 targeted enrichments for seawater extracted from Orca Basin, a DHAB in the Gulf of Mexico. From these enrichments, we were able to isolate two novel microbes from the halocline, which is located directly above the anoxic brine. After a series of growth gradient experiments and phospholipid fatty acid analyses where we manipulated pressure and salinity parameters, we observed clear trends for the effects of polyextremes on these two isolates. All of the information obtained allows for a stronger understanding of life under multiple extreme conditions, as well as gives insight into DHAB microbial communities as a whole.

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Impact of Present Era Tropospheric Cycles and Trends on InSAR timeseries data

Raymond Thicklin[1]

A major scientific question in InSAR-GNSS integration is: How exactly do fluctuations in the troposphere impact InSAR interferograms? Tropospheric noise has been recognized as a significant source of InSAR artifacts and thus a substantial limiter to interferogram precision . Tropospheric noise has been noted as a major cause of distortion in InSAR data even after attempts to correct tropospheric error with current techniques. Addressing this question can significantly increase the accuracy and reliability of InSAR displacement products. Efforts to create strain and displacement maps for seismic hazard assessment have revealed significant levels of strain and motion not captured by GNSS-only models, emphasizing the critical need for accurate and reliable InSAR data. Global Positioning System (GPS) can play an important role in assessing atmospheric processes, which results in InSAR displacement data uncertainty. Studies of Tropospheric parameter Zenith Total Delay (ZTD) can identify various atmospheric processes, and there impact on InSAR displacement error. This study primarily presents the results of an analysis of a 10-year time series spanning the San Andreas fault zone concurrent with Sentinel-1 radar image acquisition. A power spectral density was taken of the dataset for the purpose of time series analysis. To determine seasonal variations and long-term trends, we applied Least Squares Estimation (LSE) to ZTD timeseries data. The Mann-Kendall trend test was then used to validate the linear trends identified by LSE. We also investigated the influence of time series length on trend calculations by comparing analyses performed on 10-year and 30-year time series datasets.

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The Internal Surf Zone: How Internal Waves Affect The Inner Shelf

Andrea Rodriguez-Marin Freudmann[1], Amy F. Waterhouse[1], Mark A. Merrifield[1], Sutara H. Suanda[2], Jennifer A. Mackinnon[1], Peter J.S. Franks[1]

The inner shelf is typically defined as the transition zone between the unstratified surf zone and the highly stratified outer continental shelf. Dynamical analyses for the inner shelf have typically concentrated on the barotropic momentum budget, which involves a balance between wind stress, pressure gradients, Coriolis and bottom drag. The baroclinic momentum budget is far less understood, particularly in regions where energetic and highly nonlinear breaking internal waves may play a significant role in vertical momentum fluxes. Additionally, the horizontal momentum flux associated with breaking internal waves may generate an “internal set up”, with consequent cross-shore circulation, analogous to the set-up created by breaking surface waves in the surf zone. Here we use data and model results from the 2017 ONR Inner Shelf Dynamics Experiment (ISDE) off of Point Sal, California to explore the momentum budget and the role of baroclinic processes on determining cross-shelf dynamics, such as sea surface set-up and depth-dependent flow patterns.

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Set phasers to stun: A phased array view of physical processes in the upper ocean

Austin Green[1], Jennifer Mackinnon[1]

Novel ways of observing the ocean are paramount to furthering our understanding of the upper ocean. The best approach to studying 3D systems is with instruments capable of measuring in 3 dimensions. High resolution coincident measurements with a bow chain, microstructure profiler and new phased array doppler sonar, highlight the detailed structure of turbulent mixing processes in the Ocean Surface Boundary Layer (OSBL). The observed processes vary in scale from meters to 10s of meters in both the horizontal and vertical scales, as they interact with each other. The data was collected during the 2024 EKAMSAT (Enhancing Knowledge of the Arabian Sea Marine environment through Science and Advanced Training) field program based out of the Bay of Bengal during the onset of the Indian Summer Monsoon. This program was one of the first targeted deployments of the new Towed Phased Array Doppler Sonar (TPADS) system, which was designed to observe three-dimensional coherent velocity structures of upper ocean phenomena. The enhanced view of velocity structures provided by TPADS, aims to address the limited view provided by conventional current profilers. Features in the dataset include Diurnal Warm Layers, nighttime convective cells, frontal instabilities, and their interactions, across a range of wind and wave conditions.

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Seasonal Variability of Turbulent Mixing in Jan Mayen Channel from High-Resolution Thermistors

Grant Meiners[1], Jennifer MacKinnon[1], Amy Waterhouse[1], Leah Johnson[2], and Harper Simmons[2]

Jan Mayen Channel is a key exchange point in the Nordic Seas, where waters from the Greenland and Norwegian Seas can stir and mix. Several processes contribute to mixing along the front between these two water masses, but observations are limited both spatially and temporally. From 2022 to 2023, a mooring was deployed on the south ridge of Jan Mayen Channel as part of the Office of Naval Research-funded Northern Ocean Rapid Surface Evolution (NORSE) project. In this project, we use the 1 Hz thermistor data on this mooring to characterize turbulent signals and ocean mixing on a seasonal timescale. We do this by calculating spectra of temperature time series and comparing to theoretical spectra given by the inertial-convective subrange of the Batchelor spectrum. From this method, we can determine an approximate value of temperature variance dissipation rate (χ), a signal of turbulent mixing. Turbulent mixing has strong depth-dependent seasonal variability, related in part to seasonal patterns of evolving stratification and wind-driven near-inertial internal waves. Turbulence is linked to locally generated internal tides throughout the year. The largest turbulent mixing event took place during the passage of an eddy which spun off the Mohn Ridge current, potentially relating to eddy-internal tide interactions This, combined with initial analysis of tidal modes on the ridge, hints at a strong, infrequent mixing event at the Arctic-Atlantic front influenced by eddy activity, internal tides, and local topography.

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Martian meteorites as probes into the geochemical evolution of stagnant-lid planets

Hunter R. Edwards[1], Yash Srivastava[1], Patrick Russo[1], and James M.D. Day[1]

Aside from rocks found on Earth, martian meteorites are the only available physical samples from terrestrial planets in the Solar System. Catastrophic bolide impacts on Mars eject these rocks into space, some of which eventually fall to Earth as meteorites. With over 200 individual specimens, representing martian mantle and crust compositions, these meteorites offer exceptional insight into the geochemical evolution of Mars, and more broadly, rocky planets with stagnant-lid tectonics.

Shergottites are the most common and geochemically diverse martian meteorites. These samples are basaltic rocks derived from partial melting of the mantle, and most like ocean island basalts (OIB) on Earth. However, shergottites demonstrate extreme isotope heterogeneity, unlike any OIB. The isotopic diversity of shergottites remains inconclusive and is strongly debated. There are two primary lines of thought explaining shergottite isotopic diversity: (1) the shergottite mantle-derived magma variably assimilated enriched martian crust or (2) unique mantle reservoirs formed very early in Mars' history source shergottite magmas. To date, most attempts to resolve the source of shergottite isotopic diversity utilize bulk-rock geochemistry, the history of which can be convoluted.

Instead of utilizing bulk-rock samples, measuring isotopic compositions of olivine, the first silicate mineral to crystallize from a shergottite melt can provide insight into the isotopic diversity of shergottites. Olivine can avoid geochemical overprinting caused by crustal assimilation and represent primary mantle-derived melt compositions. Here, we present a novel approach to reconcile the formation history of shergottites with implications for the geochemical evolution of mantles on planets that have stagnant-lid tectonics.

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Genome Engineering in the Sea Urchin *Lytechinus pictus*

Svenja Kling[1], Gloria Renaudin[1], Elliot Jackson[1], Evan Tjeerdema[1], Yoon Lee[1], and Amro Hamdoun[1]

The sea urchin has long been a favorite model for studying regulatory networks of development. However, it has been bottlenecked by the lack of stable genetics, limiting the use of fluorescent reporters and genetic perturbations to early developmental events. This has made it challenging to study development and function of the nervous system. The goal of my work has been to develop advanced transgenesis tools to enable studies of the nervous system throughout all of sea urchin development.

We recently generated the first transgenic sea urchin line using minos transposase. However, this strategy produces random integrations and limits the size of the integrated fragment. This can pose a problem for reproducible expression of reporters driven by large neural promoters. To circumvent this, I sought to adapt recombineering methods, developed in *Drosophila* and zebrafish, to generate stable landing pads with well-characterized and validated single-chromosome integration sites.

Using previously generated transgenic *Lytechinus pictus* lines, I identify stable safe harbor sites for integration of these landing pads. By measurement of variation in both fluorescence intensities and integration rates in the F2 generation, I was able to identify single-chromosome integrations. Next, I conducted proof of concept studies to identify a suitable recombinase for use at these sites. From these, Flippase and phiC31 were identified for use in sea urchins.

The development of a robust, stable site-specific transgenesis system will provide a powerful framework for studying neural gene function throughout all developmental stages of the sea urchin, from embryo to adulthood.

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The Seasonality of Greenland Iceberg Melt and its Influences on Fjord Properties and Dynamics

Kylie Kinne[1], Robert Sanchez[2,1], Lia Siegelman[1], Fiammetta Straneo[3,1], Kenneth Hughes[4]

Icebergs influence both the distribution of properties in Greenland's fjords and exchange with the open ocean, with consequences for fjord ecosystems. Iceberg melt cools and freshens ocean waters and contributes to the overturning circulation in fjords, facilitating the exchange of nutrients between the euphotic zone, shelf, and sea bed. Due to the inherent challenges of collecting wintertime data at high latitudes, the majority of iceberg studies are currently based on summertime data, and the seasonality of iceberg melt remains largely unknown. Here, we use a regional configuration of a numerical model, MITgcm, of Sermilik fjord to study the year-round melting of icebergs and how this process influences fjord properties and circulation. The model uses the IceBerg package to simulate iceberg melt and is realistically forced with ASTE, a state estimate of the Arctic and Subpolar Gyre, and ERA5 winds for three years from 2015-2017. We find that 38% of iceberg melt by volume occurs in the melange and has a melt peak earlier in the year than indicated by previous studies. Comparison with an identical run without icebergs shows that upwelling driven by subsurface iceberg melt drives a warming of the surface water in spring and winter. This subsurface melt drives a significant increase in vertical velocity in the melange, which may help maintain an overturning circulation year-round. Overall, our findings emphasize that icebergs must be included in simulations of fjords in order to correctly simulate water properties and circulation, including the substantial iceberg-driven upwelling. Representing these dynamics accurately is critical for understanding the impacts of icebergs on both fjord ecosystems and shelf dynamics.

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Investigating The Potential of Multiple Soldier Sub-Classes in Parasitic Eusocial Trematode Colonies

Rhowan Ho[1], Ryan Hechinger[1]

A physically and behaviorally specialized soldier caste has been documented across four families of parasitic flatworms, or trematodes. Previous works suggest that soldiers are juveniles in arrested development - they have the potential to mature into the reproductive caste following the death of a current reproductive via the activation of their reproductive organs, dubbed “germinal masses”. However, the anatomical basis and frequency of this transition remains unquantified. Here, address two competing hypotheses regarding the procession of soldiers into the reproductive caste: 1) all soldier morphs have innate reproductive potential, and 2) a portion of soldier morphs have reproductive potential while others are obligatorily sterile. We document soldier morphometrics and germinal mass developmental series, as well as the frequency of reproductives pregnant with new soldier morphs, with confirmatory immunostaining analyses within the context of our two hypotheses. This method enabled us to differentiate between soldiers with and without innate reproductive potential in the family *Heterophyidae*, and confirm the absence of an obligatorily sterile soldier caste in families *Himasthlidae* and *Philophthalmidae*. These results extend our understanding of the evolution of division of labor in trematodes and caste plasticity in eusocial colonial animals.

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Using Neural Networks for Functional Representations of Nearshore Ocean Waves

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We use neural networks (NN) and machine learning (ML) to approximate LiDAR data of nearshore ocean waves. We collected the data by flying a gas-electric drone equipped with a LiDAR sensor above breaking waves off China Rock in Monterey. The LiDAR sensor simultaneously projects multiple LiDAR scans perpendicular to the crests of the incoming waves, resolving the sea surface. The NNs are trained on LiDAR sea surface data. After training, the NNs output sea surface elevation as functions of spatial location. We improve on NNs by introducing wave physics via modification of the ML cost function. The additional terms target the derivative of the NN sea surface output, ensuring that sea surface reconstructions and extrapolations are smoothly varying alongshore. With this modification, the NNs can reliably extrapolate the LiDAR data and reconstruct nearshore waves with accuracy from a limited set of noisy data. Further, the NNs are continuous functions which can be precisely differentiated, which offers advantages over gridded approximation methods.

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First look at species-specific mercury uptake by *Thalassiosira pseudonana* at oceanic sub-picomolar concentrations

Erik T. Paulson[1], Johannes West[1], Julia M. Diaz[1], Amina T. Schartup[1]

The predominant forms of mercury in the ocean are monomethylmercury (MMHg), dimethylmercury (DMHg) and divalent mercury (HgII). MMHg is well known to bioconcentrate in phytoplankton, reaching concentrations 4-5 orders of magnitude higher than the sub-picomolar levels typically found in seawater. In contrast, HgII uptake is less well quantified because of widespread contamination and lower accumulation, which make it a challenging species to work with in laboratory settings. Similarly, DMHg uptake remains poorly characterized because of its volatility and toxicity. Here, we use species-specific stable isotope techniques to simultaneously investigate the uptake from seawater of all three mercury species in unialgal cultures of diatom Thalassiosira pseudonana. At cell densities similar to natural blooms and sub-picomolar concentrations of each Hg species, cellular uptake of MMHg and HgII plateaued within 1 h and 4.5 h of exposure, respectively. Cells removed around 95% of MMHg and 25% of HgII from seawater. DMHg was a small source of Hg to cells, with <2% taken up per day. To our knowledge, this is the first experiment to investigate Hg uptake by phytoplankton at sub-picomolar concentrations, as well as the first to simultaneously compare the uptake of MMHg, DMHg, and HgII in phytoplankton. This work advances our understanding of Hg accumulation at the base of marine food webs and is particularly relevant to high-productivity coastal areas that experience upwelling and subsequent phytoplankton blooms.

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Characterizing the spatial and vertical distribution of the Tijuana river wastewater plume with physical oceanographic and chemical tracers

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The Tijuana River Valley Sewage Crisis is a persistent environmental issue impacting coastal waters in Imperial Beach (IB), California. While previous studies have examined the biological and chemical composition of wastewater pollution at the sea surface, little is known about its vertical distribution throughout the water column. This study characterizes the spatial and vertical patterns of physical oceanographic and anthropogenic origin chemical compound wastewater tracers in the coastal ocean off IB through in situ and offline analytical techniques. Results from moored and ship-based observations reveal vertical and horizontal gradients in wastewater presence, providing insight into transport and mixing processes. These findings advance our understanding of pollution dispersion in the coastal ocean and can inform public health assessments and coastal water quality management strategies.

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Does Earth’s magnetic field ever converge to a stable average?

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The current geomagnetic field with its four high-latitude flux concentrations, is sometimes considered representative for a stationary statistical description of the long-term geomagnetic field. However, it does not include many features of the paleomagnetic field, such as excursions and polarity reversals, leaving open important questions such as, does the field have any kind of stable time average close to a geocentric axial dipole, and if so how long does it take to get there? What is needed to assess the validity of non-axial-dipole (NAD) structure? Are the time samples used in paleosecular variation studies and numerical simulations sufficient to represent actual temporal variability of the field? One approach to investigating long-term geomagnetic field behavior is to assess distinct numerical simulations with selected similarities to either the historical or paleomagnetic field. The statistical properties of simulated fields are dominated by core conditions controlled by non-dimensional control parameters, specific buoyancy sources and inner and outer core boundary conditions. Non-zonal boundary conditions at the core-mantle boundary (CMB) are known to influence the morphology of the time averaged field. We use very long simulations (> 8 diffusion times, τ_d) to assess the timescales needed to stabilize a time average and variation. When assessing the modern field with low variability, we use locked, almost drifting and drifting dynamos, and found the time average field for the axial dipole moment (ADM) to be bounded within 5% of the mean value after several τ_d. More variable simulations which include extreme secular variation events, could require more than 10 τ_d. The latter result is compatible with paleomagnetic results from PADM2M. Our results further indicate that identification of NAD structure in the time-average field and its variation require simulations that extend beyond the time for the ADM. Results obtained from a single τ_d or less should be considered with caution.

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Enhanced Lagrangian transport in steep focusing wave packets

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The transport of passive and non-passive tracers near the ocean surface is strongly influenced by the presence of surface gravity waves. In addition to their leading order orbital motion, the trajectories of individual fluid particles in irrotational surface waves are open, leading to a net transport in the direction of wave propagation commonly known as the Stokes drift. This vertically sheared mean Lagrangian drift, with typical surface magnitudes in the ocean ranging from several to tens of centimeters per second, can be a significant factor in determining the fate of buoyant tracers. Because Eulerian measurements do not include the wave-induced drift, it must often be inferred from the wave field when estimating Lagrangian transport. This is almost always done assuming linear theory -- the wave field is decomposed into a sum of linear plane waves, and the total mean Lagrangian drift is computed as the sum of each component's individual drift.

Here, we provide both laboratory and numerical evidence of the wave-induced surface Lagrangian transport of passive tracer particles in broad-banded wave packets, finding in certain cases that the transport can exceed the predictions of linear theory by up to 50%. In all cases, these enhancements occur when the wave field becomes locally steep due to dispersive focusing. By working directly in the Lagrangian reference frame, we then theoretically derive higher order corrections to the mean Lagrangian drift for two-dimensional slowly-varying wave fields which incorporate both the effects of finite steepness and bandwidth. These higher order terms predict an increase in the near surface drift during wave focusing and help to explain the observed enhancements. This work illustrates the limitations of linear theory when computing the mean Lagrangian drift for unsteady waves, and demonstrates the need to account for nonlinear wave-wave interactions when estimating wave-induced transport.

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Expanding the Kahalalide Story: Integrated Metabolomics and Genomics Identify Cyanobacteria as a New Source

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Kahalalide F (KF) is a cyclic depsipeptide with potent anticancer activity, was originally discovered from the green alga *Bryopsis* sp. and its molluscan predator *Elysia rufescens*. Subsequent research revealed that the actual producer is a bacterial endosymbiont of *Bryopsis*, *Candidatus* Endobryopsis kahalalidefaciens. Here, we report KF-like natural products from the marine cyanobacterium *Limnoraphis* sp., collected in the Las Perlas Islands, Panama for the first time. An integrated workflow combining LC-MS/MS molecular networking with artificial intelligence (AI)-based NMR annotation tools (SMART and DeepSAT) enabled rapid detection and structural prioritization of an unknown metabolite, identified as a new analog, kahalalide Z_5 (KZ_5), along with related congeners. Long read metagenomic sequencing revealed a high-quality cyanobacterium *Limnoraphis* genome encoding a 90.9 kb NRPS gene cluster consistent with KZ_5 biosynthesis.
This study establishes marine cyanobacteria as independent producers of KF-like compounds, expanding the phylogenetic diversity of known biosynthetic sources and demonstrating the value of modern metabolomics-genomics integration for accelerating natural product discovery.

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Drivers of small river plumes and their transport following storms

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River plumes serve as major sources of terrestrial runoff into the coastal ocean, potentially carrying a suite of land-based and estuary-modified particles, sediment, debris, and pollutants. Buoyant plumes from small-discharge (low-inflow estuary, LIE) systems are not very well studied, especially plumes resulting from intermittent precipitation events. To investigate plume transport, observations were collected during the NSF-funded "Plumes in Nearshore Conditions" experiment centered around the low-inflow Los Peñasquitos Lagoon in San Diego from mid Dec. 2022 – mid Feb. 2023. Based on a quantitative momentum-driven approach, a parameter is formed to differentiate the two regimes of plume formation: tidal and river. Three case studies of river regime plumes are investigated and show that, while wind forcing sets the direction of far-field transport, buoyancy contributes most of the speed. If a storm does not bring strong winds or waves, buoyancy can carry the plume with an atypically large cross-shore extent. To better represent the impacts of waves on small plumes, we define a new dynamic region, the surfzone-field (SZ-field). Wave-driven processes in the SZ-field impact the location and timing of plume arrival to the far-field, as well as influence far-field plume characteristics. The strength and timing of both the wind and wave forcings relative to precipitation and river discharge associated with each storm can alter transport, highlighting the sensitivity of small-discharge plumes to environmental condition variability.

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Off-equatorial subsurface turbulent mixing in the Tropical Pacific: enhanced vertical heat fluxes, modulation of primary productivity and control of penetrative heating

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Sea surface temperature (SST) variability in the Equatorial Pacific has profound impacts on atmospheric circulation, controlling the El Niño-Southern Oscillation (ENSO) and affecting weather patterns all across the globe. Tropical Instability Waves (TIWs), which happen more frequently during La Niña and neutral phases, play a key role in controlling the strength of the equatorial cold tongue. TIWs can: 1) increase SST through meridional heat transport (negative feedback to La Niña), and 2) drive SST cooling through subsurface turbulent mixing (positive feedback to La Niña). Numerical simulations suggest that other processes associated with TIWs, such as primary productivity and the modulation of penetrative heating, can significantly contribute to changes in SST and, thus, impact ENSO variability. In November 2024, as part of the MOTIVE (Mixing belOw Tropical Instability waVEs) project, we deployed three drifting Wirewalkers (from 0-750 m) on both the warm and cold sides of a TIW with the objective of measuring turbulence and its impacts on the heat budget and primary productivity. We observed enhanced off-equatorial mixing on TIW cold cusps, contributing to cool the sea surface and to support primary productivity. In addition, due to the shortwave energy attenuation by chlorophyll, we observe that turbulent mixing also modulates penetrative heating variability. The misrepresentation of subsurface mixing and its impacts on heat and primary productivity might contribute to model SST biases and misrepresentation of ENSO variability. Further process studies are needed in other TIWs and seasons to get a comprehensive view of TIW-turbulent scale interactions and their biogeochemical feedback.

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Defining the nitrogen isotopic signature of equatorial Pacific El Niño Southern Oscillation events over the last 150 years

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El Niño Southern Oscillation (ENSO) warm anomalies in the eastern and central tropical Pacific are typically characterized by a nutrient-depleted upper ocean, given the deeper nutricline and consequent reduction in nutrient upwelling rate. We might also expect to observe an increase in the nitrogen isotopic composition of nitrate in conjunction with enhanced nutrient utilization. Here we show that, contrary to such straightforward expectations, coral archives of surface ocean nitrogen isotopic composition from Fanning Island (3°51.600 N, 159°21.867 W) show no consistent excursions over ENSO events. We analyzed coral skeletal-bound nitrogen isotopes (CB-δ15N) over three of the strongest El Niño events of the past 150 years (1877-78, 1940-42, 1972-73). Despite evidence for massive warming in the co-registered oxygen isotopic composition of corals, the CB-δ15N signal differs across all three events. The lack of an ENSO signature in these records suggests not only that they must reflect the isotopic composition of subsurface nitrate, but also that the regional subsurface nitrate isotopic composition is not dynamic on ENSO timescales. Meanwhile, these Fanning corals also do not exhibit the same decadal pattern that is observed in other regional records to the north and east of Fanning. Though there are localized compensation processes that might account for a lack of any clear ENSO and decadal signal, we suggest that CB-δ15N at Fanning may simply reflect a weakly-varying subsurface nitrate pool sourced primarily from the western tropical Pacific. These analyses inform our understanding of tropical Pacific dynamics and of CB-δ15N as a proxy.

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Mesozooplankton trophic structure in the Argo Basin, Northwest Australia

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We used stable isotope analysis (SIA) and compound-specific isotope analysis of amino acids (CSIA-AA) to assess trophic positions (TP) of five zooplankton size fractions (0.1–5 mm) in the Southern Bluefin Tuna spawning region off northwest Australia. SIA was also used to assess relative trophic structure of nine zooplankton taxa. Size-fractioned SIA gave unrealistic TP ranges and large site variability. In contrast, SIA of taxonomic groups and size-fractioned CSIA-AA showed broadly similar TP ranges and relatively low site variability. Both indicated a TP range of less than one full trophic step. An additional size-variable component of 0 to 0.7 trophic steps was estimated for protistan consumers based on δ15N enrichment differences between the trophic amino acids alanine and glutamic acid. Appendicularians had low TP, indicating direct feeding on primary producers. A similar low TP of Oncaea spp. as well as lower-than-expected δ15N enrichment of taxa with carnivorous tendencies (*Corycaeus* and *Lucifer* spp.) suggest that discarded appendicularian houses with remnant filter-concentrated phytoplankton are broadly used as a dietary supplement within the zooplankton assemblage. Overall, our results indicate a compressed and efficient food web in which appendicularians play a central role in linking picophytoplankton-dominated productivity to tuna larvae, and where trophic steps for protistan grazers are mainly intermediate for >0.5 mm zooplankton size classes.

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Lagrangian Particle Tracking to Trace Origins of Productivity in the Santa Lucia Escarpment

Cate O’Bryon[1, 2], Victoria Boatwright[2]

The Santa Lucia Escarpment is an area of high biological productivity and biodiversity located in the recently designated Chumash National Marine Sanctuary. The region has been historically undersampled, leaving the physical drivers that transport plankton and nutrients not well understood. The goal of this research was to track how advective transport contributes to the high level of productivity in the escarpment by analyzing near surface velocities. In order to examine these processes, a Lagrangian approach was employed to track the movement of particles throughout the region. Particle backtracking was conducted using velocity field outputs from the West Coast Operational Forecast System, a California coastal data assimilation product implemented with the Regional Ocean Modeling System. Offline simulations were run with the Ocean Parcels Python framework to generate particle trajectories ranging from December 2024 to March 2025 preceding the SR2503 sampling cruise. By backtracking particle flows to simulate the movement of plankton and nutrients, coherent and consistent pathways were visually and quantitatively resolved. These simulations illustrate the origins of particles coming primarily from two regions: the coastal and shelf region surrounding the Southern California Bight, and an offshore region northwest of the California Coast. The results of this research illustrate how advective processes funnel and propagate productivity into this region of ecological importance, and help to resolve coherent pathways of advective transport. Further research on the seasonal and annual variation regarding these pathways is necessary to contextualize the long-term trends of advective processes in the Santa Lucia Escarpment.

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The Effect of Submerged Engineered Reef Structures on Wave Overturn Shape

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Wave overturn shape plays an important role in turbulence generation, bubble formation, sediment transport, and the loads applied to coastal infrastructure. Although some laboratory and numerical studies have examined overturn geometry on simple planar slopes, the effect of submerged engineered reef structures on wave overturn shape remains unexplored. To address this gap, we use the computational fluid dynamics (CFD) software, OpenFOAM, to simulate 2-D wave breaking over an idealized bathymetric profile representative of Scripps beach, with and without an engineered reef superimposed on the natural slope. The reef structure is modeled as a functional perturbation to the slope, defined by reef amplitude (A_r), cross-shore length (L_r), and position (X_r). A larger A_r indicates a more elevated reef crest relative to the surrounding bathymetry, while a larger L_r represents a longer reef in the cross-shore direction. A larger X_r corresponds to a reef located farther onshore. We perform simulations over a range of reef parameters, incident random wave parameters (e.g., significant wave height H_s, peak period f_p), and tide parameters. We investigate how these parameters modify overturn characteristics, including overturn area, jet area, aspect ratio, and overturn angle. Understanding these changes is important for predicting wave energy dissipation and informing the design of multi-benefit coastal resilience structures that can reduce beach erosion, foster marine habitat growth, and enhance surfing conditions. Our results show the differences between wave breaking on natural and engineered profiles, which can inform coastal infrastructure design.

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Physics-Informed Risk Analysis Of Anthropogenic Seismicity

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Since 2001, after decades of a steady rate of magnitude ≥3 earthquakes in the United States, the annual number of earthquakes has increased exponentially from approximately 20 events per year in 2001 to up to 188 events per year in 2011.This increase is suspected to be human-induced. Modern physics tools, such asBayesian Data Analysis, can elucidate processes that trigger seismicity, both anthropogenic and otherwise. This study introduces analytical methods and examines anthropogenic processes, such as wastewater and CO_2 injections, which can trigger seismicity. Statistical modeling of fluid injection and extraction has been enabled using Bayesian inference. The San Andreas Fault (SAF) and nearby lake fillings(e.g., Salton Sea) are analyzed as a complex system of interest. Results confirm thatBayesian inference improves fault parameter estimation, aiding short-term seismic forecasting. Implementing physics-informed data assimilation technologies discussed herein is recommended as a policy strategy.

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The Tijuana River as a Source of Coastal and Air Pollution: A State-of-Knowledge Review

Sophia Riazi-Sekowski[1], The Prather Lab[1,2], Kimberly Prather[1,2]

The Tijuana River transports millions of gallons per day of untreated wastewater and industrial pollutants across the U.S.-Mexico border into southern San Diego County, presenting a public health crisis that impacts primarily Hispanic and low-income communities. Ultimately, the Tijuana River drains into the Pacific Ocean, contributing to coastal pollution. Recent work has focused on characterizing the chemical composition of this wastewater effluent as well as its transport of pathogens such as norovirus and COVID-19. Of particular concern is the gaseous emission and aerosolization of these pollutants and pathogens from both the inland river flow and sea-spray aerosols. Reports of strong smells provided community-evidence for wastewater pollutants infiltrating the air we breathe. High levels of toxic H_2S gas have been sourced to a turbulent site along the river. Furthermore, airborne bacteria, illicit drugs and drug metabolites, pollutants from personal care products and tire chemicals have been found in both water and aerosol samples. Ongoing studies seek to further characterize new particle formation, transport of river pollutants along the coast, and time-of-day dynamics. Future studies consider the presence of heavy metals and the accumulation of PFAS and surfactants into river foam and their subsequent aerosolization. Results from these studies bring scientific context to tense bi-national relations, inadequate infrastructure, and environmental injustice.

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Title: Importance of size and composition in CCN Activation of Natural Aerosols in the Arctic

Sourita Saha[1], Lynn Russell[1], Patricia Quinn, Lucia Upchurch, W. Richard Leaitch

The ability of aerosols to act as cloud condensation nuclei (CCN) for a given cloud supersaturation depends on their size and chemical composition. In this study, we estimate the impact of both size and composition on CCN. Measurements of submicron aerosol particle number size distributions (PNSD), organic and inorganic aerosol composition and CCN from Utqiagvik (71° 17' N and 156° 47' W) in 2023 for the Sustaining the Utqiagvik Aerosol Record of Decades (STUARD) campaign show the two most frequent PNSD clusters in all seasons were accumulation-mode (20-80%) and high-Aitken (~20%) mode types. Organic components make up the largest fraction of aerosol submicron mass (46-61%). The organic fraction can explain a significant (57-79%) variability in the smallest activated aerosol diameter, also known as critical diameter, based on an assumption of constant chemical composition for submicron particles. The difference between the calculated critical diameter from a linear fit to the organic fraction is negatively correlated with organic acid and alcohol group mass fraction, as well as with sulfate and seasalt mass fraction. A comparison of composition-based CCN calculations with the measured CCN, (at 1% supersaturation), shows that calculated CCN are within $\pm$20% for most of time with the constant-submicron composition assumption. Varying the hygroscopicity used for the organic components showed the sensitivity of the calculated CCN to this value. CCN sensitivity have also been observed to be higher for high-Aitken mode type, in which the number of particles below the critical diameter is higher than the accumulation mode. This analysis provides insights into the important factors of CCN calculation from size and composition measurements.

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Topographic controls on deep water upwelling at the crossing of the Antarctic Circumpolar Current and the Pacific Antarctic Ridge

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The upwelling of Circumpolar Deep Water across the Antarctic Circumpolar Current (ACC) in the Southern Ocean closes “conveyor belt” of the global deep overturning circulation and is critical for the redistribution of heat, nutrients, and carbon between the atmosphere and deep ocean. This upwelling is concentrated in regions where the ACC navigates rough topography (Tamsitt et al., NCC 2017), such as at the Pacific Antarctic Ridge, where the ACC fronts are steered through fracture zones across the ridge. Using over 18,000 Argo profiles and associated float trajectories collected between 2005–2025, we assess how the flow adjusts downstream of the ridge. We map the mean path of the current by calculating geostrophic velocities from Argo profiles and trajectory data. We consider the dynamics of the region using Ertel potential vorticity and consider the spatial distribution of the energy conversion from large to eddy to small scales. By combining these analyses, we seek to understand how the ACC navigates the Pacific Antarctic Ridge and the consequences of this topographic interaction for the upwelling of Circumpolar Deep Water.

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On the Photobiology of Amphioxus in Relation to its Fluorescence

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Cephalochordates (also known as lancelets, or amphioxi) are marine chordate invertebrates. Thought to resemble the most derived invertebrates, and last common ancestor among chordates, they are thoroughly studied through genetics, genomics, morphology, and development as models for chordate and vertebrate evolution. In contrast, studies about their behavior and ecology are comparatively few. Interestingly, amphioxi are brightly green fluorescent, originating from Green Fluorescent Proteins (GFPs), when exposed to blue excitation light. These amphioxus GFPs, homologous with GFPs in cnidarians (jellyfishes, sea anemones, and their allies) and copepods, have radiated into diverse variants. Within the Florida lancelet, *Branchiostoma floridae*, there are 16 GFP variants, some very brightly fluorescent and some (chromoproteins) not fluorescent at all. What roles do GFPs and their variants play in amphioxus biology? Do they help with sensing light, as previously hypothesized? Studying Florida lancelets, we present two sets of studies of amphioxus behavior as it relates to light-sensing. Lancelets were reactive to experimental light stimulus on fluorescent body parts, even body parts not known to be photoreceptors. They were generally most reactive to a green spectrum (similar to a GFP-emitted spectrum), although a blue spectrum (similar to a GFP-excitation spectrum) also induced reaction. Choice and movement experiments further showed amphioxi were more likely to leave green-illuminated environments than environments of other spectra. We relate the results of these experiments to the photobiology of Florida lancelets, including the species' green fluorescence and the light environment of its native environment in the shallow waters of the coast of Florida, US.

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Ocean on Fire: Initial characterization of the ash depositions of the LA fire on the Californian coast

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The LA urban-wildfire catastrophe burned over 55,000 acres and destroyed more than 16,000 buildings. Due to its proximity to the California coast, strong hurricane-force Santa Ana winds carried the smoke plumes offshore, where incinerated urban particles were deposited into the Pacific Ocean. However, its effects on coastal marine ecosystems remain largely unknown.

Our research investigates how this influx of urban ash may affect the health of the California coastal ecosystem. As a first step, we identified and characterized ash particles in net samples collected during the 2025 CalCOFI Winter cruise, which coincidentally surveyed the region during the event. In the lab, the particles were dried, imaged, described, measured, and sorted by size. Preliminary results show a wide range in ash particle dimensions and compositions. We are assessing the distribution of particle size based on distance to land and other environmental parameters to better understand deposition patterns. Future chemical analyses (e.g., nutrients, heavy metals, and organic contaminants) on these sorted ashes will determine the potential fertilizing and toxic effects that burnt urban debris poses to the marine environment.

Understanding the physical and chemical profiles of urban ash will help improve existing atmospheric and oceanographic models used to track particle movement and to map the spread of the LA fire input in the coastal California ecosystem. These insights could help predict the long-term ecological effects of wildfire plumes and inform early-response strategies for future fire seasons.

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New swimming spaghetti worms (Terebellidae, Annelida) from the eastern Pacific Ocean

Xenia Barnes[1], Greg Rouse[1]

In 1971, Edward Bland, the pilot of the deep-sea submersible *Alvin*, noticed remarkable 'powder puff-like' animals on the seafloor between 597 - 635m depth off The Bahamas. On trying to collect them, they would swim away, and after an initial lack of success, two specimens were captured and brought to the surface. These specimens would become representatives of a new species of Terebellidae, a group not known for swimming. It was described as *Biremis blandi* in 1973 and was occasionally witnessed by other deep-sea vehicles over the decades. *Biremis* is part of the tribe Polycirrini within Terebellidae, a group characterized by the lack of any form of gills. There are currently 6 genera of Polycirrini, with most of the 122 accepted species belonging to *Polycirrus*. Here we describe two new species of *Biremis* from the Pacific Ocean, one from off Mexico and the other off Costa Rica, using morphology and DNA data. Unlike their other terebellid relatives, these animals were found lying like 'powder puffs' on the seafloor with no tubes and were also capable of swimming. We obtained a specimen of *Biremis blandi* for DNA sequencing, allowing us to provide the first mitochondrial genomes for Polycirrini. Surprisingly, the results show that the two Pacific species do not group together, but that the Costa Rica species is most closely related to *Biremis blandi*. Also, the genus *Biremis* appears nested inside *Polycirrus*, making the latter paraphyletic. Further sampling of *Polycirrus* for DNA analysis will be required to resolve this taxonomic issue.

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Contribution of Large Marine Aerosols in Phytoplankton Dispersal

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Aerosolization represents a potentially important, yet understudied, pathway for phytoplankton dispersal, with contributions from large (>20μm) aerosols largely ignored. This study provides the first direct airborne observations of large intact aerosolized phytoplankton cells. Using a combination of aerosol sizing and wet cyclonic air sampling, we quantify aerosol size distribution and aerosolized phytoplankton under various meteorological and ocean conditions. Concurrent seawater samples measured ambient phytoplankton community composition. Aerosol and water samples were analyzed via epifluorescence microscopy to identify and size intact phytoplankton cells, with particular emphasis on particles exceeding 20 μm in diameter. This size range is often excluded from atmospheric studies as particles were assumed to quickly fall back to the ocean surface. Results show the consistent presence of large aerosols up to 90 μm, including intact phytoplankton cells and aggregates ranging from 10–50 μm. These findings demonstrate that large-sized phytoplankton can be projected up to 10m high and can occur on spatial scales of several kilometers. We have shown that large aerosol production may be more abundant than commonly thought. This has potential consequences for long-range species transport, harmful algal bloom dispersal, and atmospheric processes such as cloud condensation and ice nucleation. Currently, bioaerosol contributions from large aerosols are assumed to be negligible, but this work highlights the need to include large biological aerosol estimates into coastal climate and public health models. Approaches used in this study are currently being implemented over inland waters, to better characterize airborne taxa in diverse regions.

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Forty Years of UN Ocean Governance: Stakeholder Power and Policy Shifts (1982–2022)

McKenna Eve Carlson[1], Tom Corringham[1], Fonna Forman[2]

This study employs natural language processing (NLP) methods to examine the evolution of global marine policy discourse and stakeholder influence in United Nations marine policy documents from 1982 to 2022. Drawing from a corpus of over 3,000 UN policy documents, including materials from UNCLOS, UNFCCC, UNOC, and biodiversity conventions, this research analyzes how marine policy priorities have shifted in response to climate change, scientific advancements, and increased participation by non-state actors such as youth, Indigenous groups, and NGOs. Using a GPT-based classification model, the study categorizes text spans by Sustainable Development Goal (SDG) 14 Targets and a set of marine policy concerns, quantifying changes in thematic focus over time and across conference types. The results reveal a growing emphasis on climate-integrated ocean strategies—such as blue carbon and ocean-based renewable energy—alongside declining attention to traditional biodiversity protection. Regression analyses indicate significant increases in references to ocean acidification and economic benefits for small island developing states (SIDS), suggesting emerging priorities shaped by both ecological concerns and growing political advocacy. Additionally, shifts in UNFCCC conference attendee demographics reflect the rising visibility of non-governmental stakeholders, whose growing presence correlates with broader changes in ocean policy discourse. These findings underscore the value of computational methods in analyzing long-term policy trends and stakeholder dynamics within international marine governance. Moreover, this work suggests that non-party stakeholders, including youth activists, Indigenous groups, and NGOs, have maintained a consistent presence within marine policy discussions, with certain demographics showing signs of growth. These findings support the broader understanding that stakeholder involvement—both from party and non-party actors—directly influences the trajectory of marine governance.

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Impacts of Marine Heatwaves on California Current Ecosystem Microbial Communities

Grace A. Constantian[1], Vivian Hou[1], and Andrew E. Allen[1]

Marine Heatwaves (MHW) in the California Current Ecosystem (CCE) have been occurring more frequently and severely within the last decade. In order to better understand the response and adaptation of the microbial community to MHW events, we conducted MHW and dilution experiments during P2402 CCE-LTER cruise from 5 different watermasses (Lagrangian cycles). Using 16S and 18SV4 rRNA Amplicons, Image Flowcytobot data (IFCB), and chlorophyll data from incubations, we were able to investigate the short term effect of rising temperature on community composition and taxon specific grazing rates. We observed distinct community compositions from different cycles, and shifts in shannon diversity with rising temperatures within cycles. Within cycles 1-4, we observed smaller cells with lower average chlorophyll levels, whereas in cycle 5, we observed larger cells with higher mean chlorophyll levels. We conducted further investigation to study how extending the MHW experiment to 48 and 72 hours would impact cycles 4 and 5. We observed a decrease in eukaryotic diversity in warm samples. This analysis provides an insight into what the microbial composition of the CCE looks like during MHW events. Further study will analyze how MHW impacts grazing rates and cellular metabolisms.

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Sensitivity tests of model resolution of tropical waves using the Model Prediction Across Scales – Atmosphere (MPAS-A) and Balloon-borne Radio Occultation

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Large-scale equatorial waves contribute to variability in atmospheric circulation patterns and radiative forcing in the tropical upper troposphere/lower stratosphere (UTLS) and are characterized by their propagation direction, horizontal -and vertical scales, and periods ranging from one to 30 days. Spaceborne radio occultation observations can deterministically resolve waves with shorter periods due to their sparse and random spatial sampling and insufficient temporal resolution. Therefore, climate models struggle to accurately resolve smaller scale equatorial waves even when assimilating observations. Previous studies show Kelvin waves with periods ranging from 3 to 30 days can be observed by balloon-borne radio occultation (BRO). Radio occultation receivers (ROCs) are onboard the Strateole-2 long-duration super-pressure balloons and measure dry temperature from the balloon flight altitude on both sides of the balloon trajectory in addition to in-situ temperature, pressure and winds. The campaign ran from late November 2019 to mid-January 2020 and retrieved just over 16 days of continuous data. In this experiment, we verify wave structures simulated in two 17-day forecast runs against the European Centre for Medium-range Weather Forecasting Reanalysis Version 5 (ERA5) and BRO. Both forecasts were initialized with either ERA5 or the National Center for Environmental Prediction Global Forecast System (GFS) and 18 hours before the first BRO measurement using the Model Prediction Across Scales-A (MPAS-A) framework. Our results show larger kelvin waves can be reproduced by MPAS under both initialization schemes. However, MPAS produced waves with lower amplitudes and different vertical wave numbers than the Kelvin waves observed in the BRO data.

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Evaluation of RRFS-Smoke Model Using Satellite and In-situ Observations during the North American 2025 Fire Season

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Earth is warming at an unprecedented rate, with the ten warmest years on record occurring in the most recent decade. As global temperatures rise, some regions will experience earlier snow and ice melt along with reduced precipitation rates. This combination exacerbates wildfire risk, making it crucial to deepen our understanding and improve current forecasting systems to better prepare communities. My research evaluates NOAA's next-generation coupled weather-smoke model, the Rapid Refresh Forecasting System (RRFS) with Smoke, by verifying its output against satellite and ground-based observations during recent North American wildfire events. In June and July 2025, numerous wildfires ignited in Canada and the Southwestern United States, producing massive smoke plumes that negatively impacted air quality and produced extreme fire weather conditions in surrounding regions. By analyzing the synoptic meteorological conditions in North America and smoke transport patterns during the events, we aim to determine how smoke plumes were transported into and throughout the country. To conduct this analysis, the Model EvaLuation using Observations, DIagnostics and Experiments Software (MELODIES) with the Model, and ObservatioN Evaluation Toolkit (MONET) was utilized. At the surface, aerosol optical depth, fine particulate matter or PM 2.5, and visibility were extracted to investigate smoke concentrations. Satellite products, such as fire radiative power, were also extracted to assess and verify fire intensity.

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Observing Water-Mass Transformation and Identifying Turbulent Mixing in the Samoan Passage with Deep Argo

Karl-Erik Paulsson[1], Dr. Gunnar Voet[1], Dr. Sarah Purkey[1]

The Samoan Passage is a critical bottleneck in the Global Overturning Circulation and the primary source for the abyssal water of the Pacific Ocean above the Equator. The Deep Western Boundary Current flowing northward interacts with the complex, constricted bathymetry of the passage and the mixing that results is a major determinant for the properties of the entire North Pacific. The dynamics of this mixing have been studied many times over the decades through expensive expeditions to deploy 5km-long moorings, and time-consuming ship-cast measurements. The goal of this study was to assess the capabilities of new Deep SOLO Argo floats, with only a basic complement of CTD sensors, in observing these dynamics. We assess water-mass transformation with the descending profile measurements of temperature, salinity, and calculated potential density, and use the trajectories, temperature variance and pressure anomalies during the 10-day parking phase to identify cycles during which the floats likely encounter turbulence, and possibly internal lee waves as the currents cross ridges in the passages that act as oceanic sills.

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RamBO: randomized blocky Occam, a practical algorithm for generating blocky models and associated uncertainties from electromagnetic data

Eliana Vargas-Huitzil [1], Matthias Morzfeld[1], and Steven Constable[1]

We consider electromagnetic (EM) inversion and uncertainty quantification (UQ) with total variation (TV) regularization. TV regularization allows us to invert “blocky,” piecewise constant models that are appropriate for problems with strong resistivity contrasts.

We describe a simple and computationally efficient implementation of these ideas. First, we extend the classical “Occam inversion” to include blocky model structure. At the core of our methodology is Split Bregman Method which reduces the minimization problem to a set of simpler subproblems to efficiently solve the l_1 regularized problem.

The use of Split Bregman enables us to implement blocky model structure with the routinely used Occam-machinery and at low computational cost. Second, we embed TV regularization within a Bayesian UQ and sample the Bayesian posterior distribution via a modified randomize-then-optimize (RTO) approach. The UQ algorithm, Randomized Blocky Occam (RamBO), uses the split Bregman scheme due to its efficiency and computational low cost.

We illustrate the use of Blocky Occam and RamBO on two data sets. For both data sets, our inversions and UQ are characterized by sharp boundaries as desired. Finally, we compare RamBO to a trans-dimensional Markov chain Monte Carlo and we find that RamBO gives essentially the same results, but at a reduced computational cost.

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Regional Shelf Response to Low Frequency Coastal Trapped Waves

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Wind-driven currents in the coastal Southern California Bight (SCB) are driven by a complex balance of relatively weak and variable local winds, and a strong remote influence entering the Bight in the form of coastal trapped waves (CTW). Remote wind events create local sea level disturbances which then travel polewards along the coastline as a wave, perturbing the alongshore pressure gradient (APG). Previous observations in La Jolla have shown that APG is the dominant driver of sub-inertial alongshore currents on the mid to outer shelf, and that it is correlated with wind stress hundreds of kilometers to the south along Baja California, while recent studies show that CTWs drive semi-diurnal flow on the inner shelf. However, there has been limited analysis of 3-dimensional CTW dynamics in the San Diego region with an emphasis on the regions south of the US/Mexico border.

Using a 2 km resolution ROMS model atmospherically forced by the ECMWF ERA5 reanalysis, a dynamical core of the West Coast Operating Forecast System (WCOFS), we isolate and examine the CTW signal for timescales between 7-30 days between Baja California Sur and Point Conception. Over the 1.5 year model run, we identified 26 wind relaxation events where the predominant southward alongshore winds weaken. We then demonstrate that the mean wind relaxation event corresponds to a positive sea level and surface velocity anomaly which propagates northwards with a speed of 130-150 km/day, consistent with estimated mode-1 CTW speeds in the region. This is validated against ADCPs in the mid to outer shelf (30m+) as well as five coastal tide gauges between Ensenada and Port San Luis. We then map the spatiotemporal patterns of CTWs along the SCB using the depth integrated wave energy flux. In general, the energy flux peaks between the 100m and 1000m isobaths and is constrained to within 50km of the coast, but it may meander and fluctuate around headlands and bays, illustrating the role of coastline features such as bays and promontories on the topographic steering of CTWs. The wave energy flux divergence is also more variable near these features, highlighting them as potential regions for CTW wave energy to be generated, dissipated, or modified. In particular, Sebastian Vizcaino Bay, a large coastal hook feature, emerges as a potential source of CTW energy through the whole region.

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