PICO biogeochemical data collected from Duke Marine Lab dock from 2011-2022

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Project
» Pivers Island Coastal Observatory (PICO)
» Collaborative Research: BoCP-Design: A multidomain microbial consortium to interrogate organic matter decomposition in a changing ocean (Synthetic Microbiomes)
» NSF2026: EAGER: Identifying microbes' population-level environmental responses using Bayesian modeling (Bayesian modeling microbes)

Program
» Biodiversity on a Changing Planet (BoCP)

Contributors	Affiliation	Role
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Abstract
Core biogeochemical data from the Pivers Island Coastal Observatory (PICO), first described in Johnson et al. 2013. This dataset includes time-series data from ~weekly sampling near Pivers Island at the Duke University Marine Laboratory dock in Beaufort North Carolina USA. 34.7181 °N 76.6707 °W. Current dataset is from 2011-2021 and includes a variety of primary physical, chemical and biological variables.

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Coverage

Location: Duke University Marine Laboratory, Pivers Island, Beaufort, North Carolina, USA. 34.7181 °N 76.6707 °W, Coastal Marine / Estuary Environment
Spatial Extent: **Lat**:34.7181 **Lon**:-76.6707
Temporal Extent: 2011 - 2022

Dataset Description

Time-series dataset is supported by 3 separate NSF projects (see project and funding resources).

Methods & Sampling

Water was sampled at ~10:30am local from a dock using a 5 L niskin bottle centered at 1 m with a bottle length of 0.7 m. Subsamples were processed immediately following water collection.

DIC: DIC was measured on mercuric chloride poisoned samples by acidification and subsequent quantification of released CO_2 using a CO_2 detector (Li-Cor 7000). DIC samples were collected following recommended procedures {Dickson et al., 2007} and measurements were calibrated against Certified Reference Materials provided by Dr. A. G. Dickson at Scripps Institution of Oceanography (SIO), University of California, San Diego (UCSD) (Dickson et al., 2007)

Chlorophyll: Methods described in Johnson et al. 2010: Chlorophyll concentrations were measured by filtering 25 mL of seawater sample onto a 0.22 µm pore size polycarbonate filter using gentle vacuum (<100 mm Hg) and extracting in 100% MeOH at -20°C in the dark for >24 h following (Holm-Hansen and Riemann, 1978). Fluorescence was measured using a Turner Designs 10-AU fluorometer following (Welschmeyer, 1994) that was calibrated against a standard chlorophyll solution (Ritchie, 2006).

Secchi Depth: Secchi depth was measured in duplicate using a 20 cm disk with four alternating white and black quadrants by lowering the disk until no longer visible and recording the depth.

Salinity: Salinity was measured using a calibrated handheld digital refractometer (Atago PAL-06S), using a refractometer (Vista A366ATC), YSI Pro30, YSI ProODO, YSI ProSolo or using a Guideline Portasal 8410A all according to manufacturer's instructions and calibrated against known reference materials.

Turbidity: Turbidity reported in Nephelometric Turbidity Units [NTU] was measured in duplicate on discrete samples using a calibrated handheld turbidimeter (Orion AQ4500) according to manufacturer's instructions.

Temperature: Temperature was measured in duplicate using NIST traceable thermocouples (VWR#23609-232) from bottle water or from in situ probes YSI Pro30, YSI ProODO or YSI ProSolo according to manufacturer's instructions.

pH: pH was measured spectrophotometrically (Clayton and Byrne, 1993) in triplicate at standard temperature (25 degrees C) immediately following collection. pH samples were collected following recommended procedures (Dickson et al., 2007).

Bacteria, *Synechococcus*, picocyanobacteria, pico-photosynthetic eukaryotes: Bacterioplankton ("bacteria", DNA containing, non-red fluorescing populations), *Synechococcus* (small, red and orange fluorescing populations), "picocyanobacteria" (small, red fluorescing populations; includes *Prochlorococcus* and 'green' *Synechococcus*), and "picoeukaryotes" (DNA containing, red and orange fluorescing populations) were measured flow cytometrically as previously described (Johnson et al., 2010) using a BD FACSCalibur, or using Hoechst 34580 or Sybr Green I DNA stains using an Attune NxT with 405 nm excitation and 440±25, 512±13, 603±24, 710±25 nm emission and 488 nm excitation and 530±15, 574±13, 695±20, 780±30 nm emission as previously described (Selph 2021).

Inorganic Nutrients (NH4, NO3, SiOH4): Water was filtered through a 0.22 um Sterivex cartridge filter, Millipore #SVGPL10RC using a peristaltic pump input line at 1 m for later nutrient analysis (NO3, NH4, SiOH4). Water was sampled in duplicate into HCl-cleaned HDPE bottles (VWR#414004-110) and stored at -80 degrees C until later analysis using an Astoria-Pacific A2 autoanalyzer (NO3 and SiOH4), following the manufacturer's recommended protocols by running each replicate sample in duplicate. NH4 was measured in triplicate following Holmes et al. 1999 using a Turner 10-AU fluorometer. For some time points inorganic nutrients were processed by the Scripps Institute of Oceanography STS/ODF chemistry laboratory

Certified reference materials were used to verify protocols (Inorganic Ventures: QCP-NT, QCP-NUT-1, CGSI1-1). The detection limits were: NO2 = 0.05 uM, NO3 = 0.1 uM, PO4 = 0.05 uM, SiOH4 = 0.2 uM. Values measured below these limits are reported as zero.

Production and Respiration: Production and respiration quantified using Winkler oxygen (Labasque et al., 2004) were measured using the light/dark bottle technique with 24 h incubations at ambient temperature in a sinusoidal incubator (Sanyo MLR-351H) with ~1000 µmol quanta m^{-2} sec^{-1} peak PAR.

Data Processing Description

Means, where replicates were available, were calculated and reported with standard deviations. All variable means represent n=2, except pH and DIC where n=3.

blank = missing data

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Related Publications

Clayton, T. D., & Byrne, R. H. (1993). Spectrophotometric seawater pH measurements: total hydrogen ion concentration scale calibration of m-cresol purple and at-sea results. Deep Sea Research Part I: Oceanographic Research Papers, 40(10), 2115–2129. doi:10.1016/0967-0637(93)90048-8
Methods

Dickson, A.G.; Sabine, C.L. and Christian, J.R. (eds) (2007) Guide to best practices for ocean CO2 measurement. Sidney, British Columbia, North Pacific Marine Science Organization, 191pp. (PICES Special Publication 3; IOCCP Report 8). DOI: https://doi.org/10.25607/OBP-1342
Methods

Holm-Hansen, O., & Riemann, B. (1978). Chlorophyll a Determination: Improvements in Methodology. Oikos, 30(3), 438. doi:10.2307/3543338
Methods

Johnson, Z. I., Shyam, R., Ritchie, A. E., Mioni, C., Lance, V. P., Murray, J. W., & Zinser, E. R. (2010). The effect of iron- and light-limitation on phytoplankton communities of deep chlorophyll maxima of the western Pacific Ocean. Journal of Marine Research, 68(2), 283–308. doi:10.1357/002224010793721433
Methods

Johnson, Z. I., Wheeler, B. J., Blinebry, S. K., Carlson, C. M., Ward, C. S., & Hunt, D. E. (2013). Dramatic Variability of the Carbonate System at a Temperate Coastal Ocean Site (Beaufort, North Carolina, USA) Is Regulated by Physical and Biogeochemical Processes on Multiple Timescales. PLoS ONE, 8(12), e85117. https://doi.org/10.1371/journal.pone.0085117
Results

Ritchie, R. J. (2008). Universal chlorophyll equations for estimating chlorophylls a, b, c, and d and total chlorophylls in natural assemblages of photosynthetic organisms using acetone, methanol, or ethanol solvents. Photosynthetica, 46(1), 115–126. doi:10.1007/s11099-008-0019-7
Methods

Selph, K. E. (2021). Enumeration of marine microbial organisms by flow cytometry using near-UV excitation of Hoechst 34580-stained DNA. Limnology and Oceanography: Methods, 19(10), 692–701. Portico. https://doi.org/10.1002/lom3.10454
Methods

Welschmeyer, N. A. (1994). Fluorometric analysis of chlorophyll a in the presence of chlorophyll b and pheopigments. Limnology and Oceanography, 39(8), 1985–1992. doi:10.4319/lo.1994.39.8.1985
Methods

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Parameters

Parameter	Description	Units
PICONumber	sequential sample ID	unitless
Depth	depth	m
Latitude	latitude	degreesN

Longitude	longitude	degreesE
DecimalYear	Decimal Year (local time)	year
Chl	mean Chlorophyll a	µg/L
ChlStd	standard deviation Chlorophyll a	µg/L
DIC	mean Dissolved Inorganic Carbon	µM
DICStd	standard deviation Dissolved Inorganic Carbon	µM
NH4	mean NH4	nM
NH4Std	standard deviation NH4	nM
NO3	mean NO3	µM
NO3Std	standard deviation NO3	µM
pH	mean pH	unitless
pHStd	standard deviation pH	unitless
Salinity	mean salinity	unitless
SalinityStd	standard deviation salinity	unitless
SecchiDepth	mean Secchi depth	m
SecchiDepthStd	standard deviation	m
SiOH4	mean SiOH4	µM
SiOHStd	standard deviation SiOH4	µM
Temperature	mean temperature	°C

TemperatureStd	standard deviation temperature	°C
Turbidity	mean turbidity	NTU
TurbidityStd	standard deviation turbidity	NTU
Bacteria	mean bacterioplankton	cells/mL
BacteriaStd	standard deviation bacterioplankton	cells/mL
Synechococcus	mean Synechococcus	cells/mL
SynechococcusStd	standard deviation Synechococcus	cells/mL
picocyanobacteria	mean picocyanobacteria	cells/mL
picocyanobacteriaStd	standard deviation picocyanobacteria	cells/mL
picoeuks	mean picophotosynthetic eukaryotes	cells/mL
picoeuksStd	standard deviation picophotosynthetic eukaryotes	cells/mL
O2Respiration	mean 24h oxygen dark respiration	mgO2/L/day
O2RespirationStd	standard deviation 24h oxygen dark respiration	mgO2/L/day
O2Production	mean 24h gross oxygen production	mgO2/L/day
O2ProductionStd	standard deviation 24h gross oxygen production	mgO2/L/day

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Apollo SciTech AS-C3 Dissolved Inorganic Carbon (DIC) analyzer
Generic Instrument Description	A Dissolved Inorganic Carbon (DIC) analyzer, for use in aquatic carbon dioxide parameter analysis of coastal waters, sediment pore-waters, and time-series incubation samples. The analyzer consists of a solid state infrared CO2 detector, a mass-flow controller, and a digital pump for transferring accurate amounts of reagent and sample. The analyzer uses an electronic cooling system to keep the reactor temperature below 3 degrees Celsius, and a Nafion dry tube to reduce the water vapour and keep the analyzer drift-free and maintenance-free for longer. The analyzer can handle sample volumes from 0.1 - 1.5 milliliters, however the best results are obtained from sample volumes between 0.5 - 1 milliliters. It takes approximately 3 minutes per analysis, and measurement precision is plus or minus 2 micromoles per kilogram or higher for surface seawater. It is designed for both land based and shipboard laboratory use.

Dataset-specific Instrument Name	
Generic Instrument Name	BD FACSCalibur Flow Cytometer
Dataset-specific Description	Flow Cytometer: BD FACSCalibur or Invitrogen Attune NxT
Generic Instrument Description	The FACSCalibur flow cytometer is an autonomous benchtop flow cytometer designed for routine cell analysis, assay development, verification and identification of cellular populations. It is equipped with a blue (488 nm) air-cooled argon laser and a red (635 nm) diode laser. For each particle (cell), five optical parameters can be recorded from the 488 nm laser beam excitation: two light scatter signals, namely forward and right angle, and three fluorescences corresponding to emissions in green (530/30 nm BP), orange (585/42 nm BP) and red (670 nm LP) wavelength ranges. A far red fluorescence (661/16 nm BP) induced by the red diode can also be recorded. Data are analysed using BD Biosciences CellQuest software. Optional features include a cell sorting option, allowing users to identify and isolate a population of interest and a HTS option (High-throughput (HT) or Standard (STD) mode), where sample volumes range from 2-10 microlitres in HT mode and 2-200 microlitres in STD mode. An optional BD FACS Loader tube-lifter can be used to verify tube position and rack identification. The instrument has a capture rate of 300 cells per second, supports 40 (12 x 75 mm) tubes per rack, and has an operating temperature ranging from 16-29 degC.

Dataset-specific Instrument Name	Invitrogen Attune NxT
Generic Instrument Name	Flow Cytometer
Generic Instrument Description	Flow cytometers (FC or FCM) are automated instruments that quantitate properties of single cells, one cell at a time. They can measure cell size, cell granularity, the amounts of cell components such as total DNA, newly synthesized DNA, gene expression as the amount messenger RNA for a particular gene, amounts of specific surface receptors, amounts of intracellular proteins, or transient signalling events in living cells. (from: http://www.bio.umass.edu/micro/immunology/facs542/facswhat.htm)

Dataset-specific Instrument Name	Astoria-Pacific A2 autoanalyzer
Generic Instrument Name	Nutrient Autoanalyzer
Dataset-specific Description	Inorganic Nutrients: Astoria-Pacific A2 autoanalyzer (NO3 and SiOH4); Turner 10-AU (NH4)
Generic Instrument Description	Nutrient Autoanalyzer is a generic term used when specific type, make and model were not specified. In general, a Nutrient Autoanalyzer is an automated flow-thru system for doing nutrient analysis (nitrate, ammonium, orthophosphate, and silicate) on seawater samples.

Dataset-specific Instrument Name	YSI ProODO
Generic Instrument Name	Oxygen Sensor
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

Dataset-specific Instrument Name	Atago PAL-06S
Generic Instrument Name	Refractometer
Generic Instrument Description	A refractometer is a laboratory or field device for the measurement of an index of refraction (refractometry). The index of refraction is calculated from Snell's law and can be calculated from the composition of the material using the Gladstone-Dale relation. In optics the refractive index (or index of refraction) n of a substance (optical medium) is a dimensionless number that describes how light, or any other radiation, propagates through that medium.

Dataset-specific Instrument Name	Vista A366ATC
Generic Instrument Name	Refractometer
Generic Instrument Description	A refractometer is a laboratory or field device for the measurement of an index of refraction (refractometry). The index of refraction is calculated from Snell's law and can be calculated from the composition of the material using the Gladstone-Dale relation. In optics the refractive index (or index of refraction) n of a substance (optical medium) is a dimensionless number that describes how light, or any other radiation, propagates through that medium.

Dataset-specific Instrument Name	YSI Pro30
Generic Instrument Name	Refractometer
Generic Instrument Description	A refractometer is a laboratory or field device for the measurement of an index of refraction (refractometry). The index of refraction is calculated from Snell's law and can be calculated from the composition of the material using the Gladstone-Dale relation. In optics the refractive index (or index of refraction) n of a substance (optical medium) is a dimensionless number that describes how light, or any other radiation, propagates through that medium.

Dataset-specific Instrument Name	YSI ProSolo or Guideline Portasal 8410A
Generic Instrument Name	Salinometer
Generic Instrument Description	A salinometer is a device designed to measure the salinity, or dissolved salt content, of a solution.

Dataset-specific Instrument Name	Cary 4000
Generic Instrument Name	Spectrometer
Dataset-specific Description	pH: Spectrophotometer Cary 4000 with 10 cm cylindrical cell or Genesys 10A VIS with a 10 cm cylindrical cell
Generic Instrument Description	A spectrometer is an optical instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.

Dataset-specific Instrument Name	Genesys 10A VIS
Generic Instrument Name	Spectrometer
Dataset-specific Description	Production and respiration: Incubator: Sanyo MLR-351H; Spectrophotometer: Genesys 10A VIS
Generic Instrument Description	A spectrometer is an optical instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.

Dataset-specific Instrument Name	Orion AQ4500
Generic Instrument Name	Turbidity Meter
Generic Instrument Description	A turbidity meter measures the clarity of a water sample. A beam of light is shown through a water sample. The turbidity, or its converse clarity, is read on a numerical scale. Turbidity determined by this technique is referred to as the nephelometric method from the root meaning "cloudiness". This word is used to form the name of the unit of turbidity, the NTU (Nephelometric Turbidity Unit). The meter reading cannot be used to compare the turbidity of different water samples unless the instrument is calibrated. Description from: http://www.gvsu.edu/wri/education/instructor-s-manual-turbidity-10.htm (One example is the Orion AQ4500 Turbidimeter)

Dataset-specific Instrument Name	
Generic Instrument Name	Turner Designs Fluorometer 10-AU
Generic Instrument Description	The Turner Designs 10-AU Field Fluorometer is used to measure Chlorophyll fluorescence. The 10AU Fluorometer can be set up for continuous-flow monitoring or discrete sample analyses. A variety of compounds can be measured using application-specific optical filters available from the manufacturer (read more from Turner Designs, turnerdesigns.com, Sunnyvale, CA, USA).

Dataset-specific Instrument Name	
Generic Instrument Name	Water Temperature Sensor
Dataset-specific Description	Temperature: Thermocouples (VWR#23609-232) in niskin bottle or from in situ probes YSI Pro30, YSI ProODO or YSI ProSo
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

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Project Information

Pivers Island Coastal Observatory (PICO)

Website: http://oceanography.ml.duke.edu/johnson/research/pico/

Coverage: 34.7181 deg N, 76.6707 deg W

From the project website:
Carbon dioxide is rising at ~3% per year in the atmosphere and oceans leading to increases in dissolved inorganic carbon and a reduction in pH. This trend is expected to continue for the foreseeable future and ocean pH is predicted to decrease substantially making the ocean more acidic, potentially affecting the marine ecosystem. However, coastal estuaries are highly dynamic systems that often experience dramatic changes in environmental variables over short periods of times. In this study, the investigators are measuring key variables of the marine carbon system along with other potential forcing variables and characteristics of the ecosystem that may be affected by these pH changes. The goal of this project is to determine the time-scales and magnitude of natural variability that will be superimposed on any long term trends in ocean chemistry.

Other PICO-related projects in BCO-DMO:
Ocean Acidification: microbes as sentinels of adaptive responses to multiple stressors: contrasting estuarine and open ocean environments

Collaborative Research: BoCP-Design: A multidomain microbial consortium to interrogate organic matter decomposition in a changing ocean

NSF2026: EAGER: Identifying microbes' population-level environmental responses using Bayesian modeling

Collaborative Research: BoCP-Design: A multidomain microbial consortium to interrogate organic matter decomposition in a changing ocean (Synthetic Microbiomes)

Coverage: Temperate Coastal Ocean

NSF Award Abstract:
Despite low standing biomass, extensive carbon processing occurs in the oceans, largely by diverse microbial consumers. Until recently, bacteria were considered the main degraders of organic matter, while non-bacterial consumers' role in carbon cycling was largely been ignored. However, eukaryotes such as fungi exhibit distinct metabolic capacities and responses to environmental variables, suggesting global change may alter the balance of microbial activities in the oceans and potentially alter the fate of marine carbon. Here, researchers integrate field data with modeling and laboratory experiments with representative cultures to identify microbes' functional roles in marine organic matter degradation and to determine their response to changing environmental conditions. This project will open new windows into the diversity of microbial metabolisms and how these dynamics will shift with global change driven increases in temperature and other environmental factors. Additionally, this projects builds a new scientific research team and expands scientific training at levels ranging from K-5 teachers, to undergraduate and PhD students.

This project will leverage a decade-long, coastal microbial time series, the Piver's Island Coastal Observatory (PICO), to examine how diverse heterotrophic microbial communities (bacteria, phytoplankton, fungi and Labyrinthulomycetes protists) metabolize carbon compounds under different thermal regimes. This project will develop a model microbial consortium that has the potential to transform perception of carbon cycling in coastal systems by integrating functional, organismal-interaction and environment-dependent responses into a modeling framework. Empirical Dynamic Modeling will identify drivers of the observed dynamics, differentiate causation from correlation, infer effects of possibly unobserved variables (e.g. predation), and quantify interactions between organisms. This data will further be used to develop a culturable model consortium whose members metabolize distinct components of phytoplankton-derived organic matter. To test both model predictions and how well the consortium represents complex microbiomes, both the model consortium and a "wild" coastal seawater microbiome will be assayed for changes in function (phytoplankton DOM degradation) as temperatures increase (+4 °C). These experiments will compare outcomes for individual isolates, the consortium, and a wild coastal microbiome in composition/abundance, gene expression and degradation of specific compounds. Finally, experimental results will be used to parameterize and refine an Ensemble Sparse Identification of Nonlinear Dynamics model that can predict the fate and transformation of carbon in marine systems under varying climate scenarios. While this research leverages existing expertise in marine microbiomes, this model consortium approach can be applied to diverse systems to answer questions about environmental filtering, organismal interactions and functional diversity critical to predicting ecosystem-level responses to environmental change.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

This project is closely related to Pivers Island Coastal Observatory: https://www.bco-dmo.org/project/2281

NSF2026: EAGER: Identifying microbes' population-level environmental responses using Bayesian modeling (Bayesian modeling microbes)

Coverage: Temperate Coastal Ocean

NSF Award Abstract:
With support from the Directorate for Geosciences and the NSF 2026 Fund Program in the Office of Integrated Activities, Professors Dana Hunt, Mark Borsuk, and James Clark at Duke University conduct research that provides new insights into the factors that shape microbial productivity and function in the oceans as well as how this change during extreme events such as hurricanes. The driver of this research comes from the fact that marine microbes provide essential ecosystem services, including primary production (photosynthesis) and organic matter turnover, that sustains all marine organisms. That said, it still remains unclear as to what extent microbiomes are shaped by environmental factors, such as temperature and primary productivity, that can be altered by season, disturbances, global change, and other factors. This research combines long-term observations at a coastal site at Beaufort Island, North Carolina and uses these data to capture annual changes in microbiomes and their environments using high frequency measurements that were taken before and after hurricanes Florence (2018) and Dorian (2019). Examining the impact of

hurricanes on marine biomes is important because hurricanes are multi-factor disturbances that introduce both foreign freshwater and terrestrial microbes into a stable system while altering salinity, nutrients, and organic matter in the coastal ocean. This work combines information from field observations and modeling to develop new approaches that will allow the differentiation of factors that often co-occur in field samples, such as warmer temperatures and higher primary production that occur during the summer months in the coastal Atlantic Ocean. By integrating multiple aspects of microbiome research, this work deepens current understanding of the coastal ocean microbiome system and its functionality. It also develops new testable hypothesis to guide future research. Broader impacts of the work include advanced training for undergraduate, graduate, and postdoctoral students, as well as translating research results into products for K-12 students and the public. Additional impacts include the production of detailed user manuals and training materials for software developed in the course of the project to facilitate the use of research results for future microbiome research and undergraduate education.

This research leverages an established decade-long microbial time-series, the Piver's Island Coastal Observatory (PICO, Beaufort Inlet, NC USA) to improve the modeling of microbial populations and their relationship to changing environments. With 10 years of weekly (or more frequent) microbial community SSU rRNA gene sequence datasets, coupled with the suite of sample, in-situ, and environmental parameters, the PICO dataset is one of the most complete, long-term datasets for coastal ocean microbiomes. The work carried out uses the application of Bayesian modeling to the PICO time series to improve understanding and predictions of microbiome responses to ocean conditions. Bayesian models are well suited to microbial systems because they have the ability to handle sparse datasets, capture non-linear responses to environmental changes, and include impacts of disturbances. This research integrates microbiome applications and the Bayesian model gjamTime. This combination has the potential to transform microbial ecology by leveraging advances in multivariate time-series methods that accommodate the dependence among individual taxa and their environment over time. One goal of the project is to test model predictions using time-series data from natural disturbances (i.e., hurricanes) at the Beaufort Inlet site and explore various key environmental parameters such as temperature (+3 °C) and primary production as key environmental parameters. Similar work will be done more broadly for the ocean. Impacts of the research extend beyond the targeted coastal dataset as, if successful, the approach can be applied to other diverse study systems such as soil and human microbiomes. It can also be used to address questions about environmental filtering, disturbance and stochasticity, each of which is critical to understanding the factors and processes that govern microbial responses to environmental change.

This project responds to the NSF2026 Idea Machine winning entries of "Global Microbiome in a Changing Planet" and "Imagine a Life with Clean Oceans"

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

This project is closely related to Pivers Island Coastal Observatory: https://www.bco-dmo.org/project/2281

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Program Information

Biodiversity on a Changing Planet (BoCP)

Website: https://new.nsf.gov/funding/opportunities/bocp-biodiversity-changing-planet

Coverage: Global

The biodiversity found in nature is essential for healthy ecosystems and human well-being. However, the disruption and decline of Earth's biodiversity is currently occurring at an unprecedented rate. The resulting shifts in biodiversity dynamics — including changes in the scope and structure of biodiversity — are increasingly significant but not well understood. Shifting biodiversity dynamics (i.e., shifts in scope, structure, and interactions of biodiversity) in turn influence functional biodiversity, which includes the roles of traits, organisms, species, communities, and ecosystem processes in natural systems. Changes in biodiversity dynamics and functional biodiversity are components of future planetary resilience under environmental

change, including climate change. The connection between functional biodiversity and biodiversity dynamics on a changing planet is the main focus of the Biodiversity on a Changing Planet (BoCP) program. The program encourages proposals that integrate ecological and evolutionary approaches in the context of the continual gain, loss, and reorganization of biodiversity on a changing planet. To advance a comprehensive understanding of functional biodiversity requires a highly integrative approach – including consideration of spatial and temporal dimensions from the organismal to the ecosystem level, and from recent to deep timescales.

The BoCP program is a cross-directorate and international program led by NSF that invites submission of interdisciplinary proposals addressing grand challenges in biodiversity science within the context of unprecedented environmental change, including climate change. Successful BoCP proposals will test novel hypotheses about functional biodiversity and its connections to shifting biodiversity on a changing planet, with respect to both how environmental change affects taxonomic and functional biodiversity, as well as how the resulting functional biodiversity across lineages feeds back on the environment. Proposals that seek to improve predictive capability about functional biodiversity across temporal and spatial scales by considering the linkages between past, present, and future biological, climatic, and geological processes are also encouraged. While this focus complements several core programs at NSF, it differs by requiring an integrative approach to understanding functional biodiversity as it relates to shifting biodiversity under changing environmental conditions.

The program supports both US-only collaborative proposals and proposals with international partnerships with the National Natural Science Foundation of China (NSFC), the São Paulo Research Foundation (FAPESP) of Brazil, and the National Research Foundation (NRF) of South Africa. International collaborative proposals are to be submitted jointly, with the US PIs submitting to NSF and the collaborating Chinese, Brazilian, or South African PIs submitting to their appropriate national funding agencies. These agreements do not preclude other international collaborations (see solicitation for additional details).

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Funding

Funding Source	Award
NSF Ocean Sciences Research Initiation Grants (NSF OCE-RIG)	OCE-RIG-1322950
NSF Division of Environmental Biology (NSF DEB)	DEB-2409874
NSF Division of Environmental Biology (NSF DEB)	DEB-2224819
NSF Divsion of Integrative and Collaborative Education and Research (NSF ICER)	ICER-2033934

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