Size fractionated organic C and N concentrations and stable isotopes from the Eastern Tropical North Pacific on the R/V Kilo Moana cruise KM1920 in October 2019

Website: https://www.bco-dmo.org/dataset/948682
Data Type: Cruise Results
Version: 1
Version Date: 2025-02-03

Project
» Dimensions: Diversity, assembly and function of microbial communities on suspended and sinking particles in a marine Oxygen Deficient Zone (ETNP_ParticleOmics)

Program
» Dimensions of Biodiversity (Dimensions of Biodiversity)

Contributors	Affiliation	Role
Cram, Jacob A.	University of Maryland Center for Environmental Science (UMCES/HPL)	Principal Investigator
Fuchsman, Clara	University of Maryland Center for Environmental Science (UMCES/HPL)	Principal Investigator

Abstract
Size fractionated Organic Particle Carbon and Nitrogen concentrations and stable C and N isotopes from the Eastern Tropical North Pacific were obtained from the R/V Kilo Moana on cruise KM1920 in the Eastern Tropical North Pacific at two stations in October 2019: St P2 (16.9°N 107°W) and St P3 (21.8°N 109.9°W). These two stations included an anoxic Oxygen Deficient Zone from 110-820 m for St P2 and 160-650 m for St P3. For size fractionated particulate organic C and N analyses, water was obtained from Niskin bottles on a CTD rosette, by opening the bottom of the Niskin bottle. Water was gravity filtered through stacked mesh with the following pore sizes: 500 um, 180 um, 53 um, 20 um, and 5 um. Each fraction was resuspended off the mesh and vacuum filtered it onto pre-combusted GF/C filters (nominal pore size 1.2 um). Samples were wafted with HCl to remove carbonate and sent to the UC Davis Stable Isotope Facility (Davis, CA) for C and N analysis utilizing an elemental analyzer attached to an isotope ratio mass spectrometer. The samples were obtained to determine particle size to carbon and nitrogen relationships for models, while gaining insights into the origins of particulate organic matter in the Oxygen Deficient Zone. Samples were collected by Jacob Cram of Horn Point Laboratory (University of Maryland Center for Environmental Science) and his lab members. Filters were prepped in the lab, and data were analyzed by Clara Fuchsman of Horn Point Laboratory, a part of the University of Maryland Center for Environmental Science.

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Coverage

Location: Eastern Tropical North Pacific Oxygen Deficient ZoneDepth profiles at two stations in October 2019: St P2 (16.9ºN 107ºW) and St P3 (21.8°N 109.9°W)
Spatial Extent: **N**:22.05 **E**:-106.82 **S**:16.76 **W**:-109.97
Temporal Extent: 2019-10-03 - 2019-10-18

Dataset Description

These data were supported by NSF award DEB-1542240 and Horn Point Laboratory startup funds.

Results publication in review:
Fuchsman, C.A. and Cram, J.A. (in review) Size fractionated suspended organic carbon and nitrogen from the offshore Eastern Tropical North Pacific Oxygen Deficient Zone suggest contributions of picocyanobacteria and vertically migrating metazoans to organic matter. Global Biogeochemical Cycles
*preprint available at ESS Open Archive (Fuchsman & Cram 2024, doi:10.22541/essoar.173046855.50289201/v1)

Methods & Sampling

For size fractionated suspended particulate organic matter in October 2019, samples were obtained from Niskin bottles but were collected by opening the bottom of the Niskin bottle into an acid cleaned bucket. This ensured that particles that had sunk below the spigot of the Niskin bottle were included. Between 100 and 120 L of water was gravity filtered, in sequence, through nylon mesh (142 mm diameter) of decreasing pore size (500, 180, 53, 20 µm) and a subset of this 20 µm filtered water (~20 L) was then filtered through a 5 µm mesh. For mesh sizes 20 µm and above, the large diameter of the mesh and abundance of functional pore-space prevented clogging, and water flowed through the mesh quickly, indicating that clogging did not occur. Water filtered more slowly through the 5 µm mesh (on the order of 30 minutes). After filtration, each nylon mesh was back rinsed with ~500 ml of prefiltered “rinse water” to produce a resuspension of particulate matter from particles from each size class. The “rinse water” had been generated during transit by pumping surface water in sequence through water filters of size 10, 5, 1 µm to remove particles, followed by a 0.2 µm filter (Pall AcroPak 1500 Capsule with a Supor Polyethersulfone membrane) capsule which removes bacteria and a 30 kd tangential flow filter which removed viruses (Pillicon Capsule with Ultracel Membrane 0.1 m^2; Millipore PCC030C01). After back-rinsing, the resuspended particles were split with one half used for particulate matter measurements. In all cases the actual volumes were carefully recorded and used for normalization during analysis. The resuspended particulate matter from each sample and size class was collected by vacuum filtration through a 1.2 µm nominal pore size, 25 mm diameter, GF/C glass fiber filter (Whatman WHA1822025). These filters had been previously pre-combusted for at least two hours at 400°C. One to two depths were sampled per day and multiple days were combined to represent each station. Nine depths were obtained at St P2 (16.9ºN 107ºW), five depths were obtained at St P3 (21.8°N 109.9°W).

At Horn Point, samples were wafted with HCl overnight to remove carbonate, dried at 40°C, packed in both silver and tin capsules, and sent to the UC Davis Stable Isotope Facility for C and N analysis utilizing an Elemental Analyzer (Elementar Vario EL Cube) attached to an Isotope Ratio Mass Spectrometer (Isoprim VisION). Blank combusted GF/C filters were included in analyses and did not show measurable material.

Data Processing Description

ug of C and N were converted to concentrations in Microsoft Excel using volumes filtered.

BCO-DMO Processing Description

Version 1:

* Sheet 1 of submitted file "ETNP_2019_size_fractionated_POM.xlsx" was imported into the BCO-DMO data system. Table will appear as Data File: 948682_v1_etnp-pom_2019-sizefrac.csv (along with other download

format options).
* Upon import, values in the table "missing" were interpreted as missing data identifiers. They will display as BCO-DMO default missing data as further described below. An additional Comment column was added with "Filter lost (see Problems/Issues section)" for those rows that contained "missing" values.
** In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

* Completely blank rows removed within table.

* Date converted to ISO 8601 format

* Lat lon converted to decimal degrees (south and west are negative, degree symbols and directional NSEW removed)

* Supplemental reference table was attached without format changes.

* 2025-02-23 Data were revised from submitted file "948682_v1_etnp-pom_2019-sizefrac_fixed_cf.csv" and will appear in this dataset as "948682_v1_etnp-pom_2019-sizefrac.csv". Submitter revised data to fix column alignment issue in provided file. After final review, this will the first published version of this dataset "version 1".
* BCO-DMO corrected an issue in the revised data where size fraction "5-20" had been changed to "20-May" inadvertently. It was set back to "5-20" in size fraction column. Date columnformats changed to ISO format.

Problem Description

One filter went missing-- from St P3, 127m, the 180-500 um size fraction.

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Data Files

File
Size fractionated organic C and N concentrations and stable isotopes ETNP October 2019 filename: 948682_v1_etnp-pom_2019-sizefrac.csv (Comma Separated Values (.csv), 4.63 KB) MD5:94453b46e4a499e1aa01f1b665849089 Primary data file for dataset ID 948682, version 1. Size fractionated organic carbon and nitrogen concentrations and stable isotopes from the Eastern Tropical North Pacific Oxygen Deficient Zone in October 2019. Water from Niskin bottles was size fractionated in the following: 5-20 um, 20-53 um, 53-180 um, 180-500 um, and >500 um. Two stations were sampled.

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Supplemental Files

File
Comparison of Standards to known values filename: ETNP_Sizefractions_POM_Standard_information.xlsx (Microsoft Excel, 10.73 KB) MD5:b3e1813f1f459cae2dca88036a84e717 Comparison of the relevant reference isotopic values to known values for those references, from UC Davis Stable Isotope Facility.

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Related Publications

Fuchsman, C. A., & Cram, J. A. (2024). Size fractionated suspended organic carbon and nitrogen from the offshore Eastern Tropical North Pacific Oxygen Deficient Zone suggest contributions of picocyanobacteria and vertically migrating metazoans to organic matter. https://doi.org/10.22541/essoar.173046855.50289201/v1
Results

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Parameters

Parameter	Description	Units
Station	station sampled	unitless
latitude	location sampled (latitude)	decimal degrees
longitude	location sampled (longitude)	decimal degrees
Date	date sampled (ISO 8601 format)	unitless
Depth	depth sampled	meters (m)
Size_Fraction	particle size range description (e.g. "> 500", "180 - 500")	micron (um)
d13C_VPDB	isotopic composition of C (d13C with respect to reference standard VPDB="Vienna Pee Dee Belemnite")	permil (0/00)
d15N_Air	isotopic composition of N (d15N with respect to reference standard air)	permil (0/00)
Carbon	concentration of organic C. Detection limit for C is 30 ug.	micromolar (uM)
Nitrogen	concentration of organic N. Detection limit for N is 5 ug	micromolar (uM)
C_to_N	ratio of molar carbon to nitrogen concentrations (C:N)	unitless
Comment	Comment to provide context for missing data. See Problems/Issues section for more details.	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Elementar Vario EL Cube elemental analyzer
Dataset-specific Description	At the UC Davis Stable Isotope Facility samples were analyzed utilizing an Elemental Analyzer (Elementar Vario EL Cube) attached to an Isotope Ratio Mass Spectrometer (Isoprim VisION).
Generic Instrument Description	A laboratory instrument used for quantifying organic elements. It can measure C, H, N and S and optionally O, Cl and TIC. It was first developed in 2006 as a successor to the vario EL III. It uses a high-temperature combustion unit that is able to complete sample digestion at up to 1200 deg C (or 1800 deg C at the point of combustion when tin foil is used) and a jet injection of oxygen directly to the sample during combustion. Separation of gas components are performed on up to 3 gas-selective columns which trap gases until they are heated up and the prior gas peak has reached the baseline during detection. It uses a Thermal Conductivity Detector (TCD) as standard. An infrared (IR) detector for sulfur and oxygen and electrochemical detector for chlorine are optionally available. The instrument can measure C / N elemental ratios of up to 12,000:1 and provides an elemental detection limit of < 40 ppm (TCD).

Dataset-specific Instrument Name	Isoprim VisION
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	At the UC Davis Stable Isotope Facility samples were analyzed utilizing an Elemental Analyzer (Elementar Vario EL Cube) attached to an Isotope Ratio Mass Spectrometer (Isoprim VisION).
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

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Deployments

KM1920

Website	https://www.bco-dmo.org/deployment/849547
Platform	R/V Kilo Moana
Start Date	2019-10-02
End Date	2019-10-22
Description	More information is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/km1920 Cruise DOI: 10.7284/908379

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Project Information

Dimensions: Diversity, assembly and function of microbial communities on suspended and sinking particles in a marine Oxygen Deficient Zone (ETNP_ParticleOmics)

Coverage: Eastern Tropical North Pacific

Extracted from the NSF award abstract:

Marine oxygen deficient zones (ODZs) are waters that are functionally devoid of oxygen. Without oxygen, some microbes are capable of converting nitrogen in the water into N2 gas, which then leaves the ocean and enters the atmosphere. This loss of an important nutrient from the ocean has impacts on phytoplankton growth and marine food webs. While oxygen deficient zones occupy a very small percentage of the ocean, they account for as much as half of the oceanic loss of N as N2. Moreover, the size of these regions is predicted to expand during this century due to climate change. The microbes that are capable of producing N2 gas are extremely diverse, and use several different biochemical pathways to carry out this process. They may occur both free-floating in the water and attached to small particles that are suspended or sinking from the surface waters and providing them a carbon source. However the importance of these two lifestyles (free-living vs particle attached) in terms of contributions to N loss from the oceans is not well understood. This project will identify the major organisms that result in N2 gas production on both suspended and sinking particles, the chemical reactions they carry out, and the rates at which this occurs. This information will be used to improve global climate models to better predict rates of N loss in a future ocean. Elementary and middle school teachers enrolled in a Masters in Science for Science Teachers program will be involved in the project and the graduate students and post-doctoral researchers supported by the project will have opportunities to participate in their classrooms. Underserved populations will also be integrated into the research at the undergraduate and middle school level through a series of summer internships.

ODZs have very complex elemental cycles, implying great microbial diversity. Intertwined with the microbial complexity of ODZ regions is the relatively unexplored interplay between free-living bacteria and those living on either suspended or sinking particles. Determining how these communities and niches interact and relate is one of the most challenging components of ODZ system studies today. Current climate models portray the dynamics of particles in the ODZs and throughout the deep ocean through prescribed functions based on sparse data from the oxic ocean with microbes represented only by the net chemical reactions of the community. However, in reality a phylogenetically and metabolically diverse group of microbes, likely acting in consortia, are responsible for the nitrogen transformations that ultimately result in the production of N2. To explore the processes maintaining the genetic diversity and functional redundancy in N loss processes, four research areas will be integrated: the community phylogenetic diversity (both taxonomic and genomic diversity) the genetic diversity of the proteins that carry out key N transformation processes (as seen through quantitative proteomics), the resulting biogeochemical functions (15N labeled nitrogen transformation rate measurements) and predictions about how this diversity and corresponding function may change in response to climate change (biogeochemical modeling). The approach will be to assay both phylogenetic (16S rRNA tag sequencing) and functional genetic diversity (genomics) on sinking particles collected using large-volume sediment traps. Phylogenetic and genomic studies will be intimately tied to measurements of activity - who is doing key biogeochemical transformations (proteomics) and what are the in situ rates at which they are doing them (using novel incubation systems). Data will then be used to model how diversity and corresponding function change on a range of time and space scales, from the sinking of a single particle to seasonal cycles. To understand the relationship of community diversity and function on suspended and sinking particles, a series of three cruises will be conducted in the Eastern Tropical North Pacific ODZ.

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Program Information

Dimensions of Biodiversity (Dimensions of Biodiversity)

Website: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503446

Coverage: global

(adapted from the NSF Synopsis of Program)
Dimensions of Biodiversity is a program solicitation from the NSF Directorate for Biological Sciences. FY 2010 was year one of the program. [MORE from NSF]

The NSF Dimensions of Biodiversity program seeks to characterize biodiversity on Earth by using integrative, innovative approaches to fill rapidly the most substantial gaps in our understanding. The program will take a broad view of biodiversity, and in its initial phase will focus on the integration of genetic, taxonomic, and functional dimensions of biodiversity. Project investigators are encouraged to integrate these three dimensions to understand the interactions and feedbacks among them. While this focus complements several core NSF programs, it differs by requiring that multiple dimensions of biodiversity be addressed simultaneously, to understand the roles of biodiversity in critical ecological and evolutionary processes.

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Funding

Funding Source	Award
NSF Division of Environmental Biology (NSF DEB)	DEB-1542240

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