Global reconstructions of particle biovolume, size distribution, and carbon export flux validated for the upper 2000m of the water column from particle profiles conducted during cruises from 2008 to 2020

Website: https://www.bco-dmo.org/dataset/939274
Data Type: model results
Version: 1
Version Date: 2024-10-03

Project
» Collaborative Research: Opening the black box of oxygen deficient zone biogeochemistry through integrative tracers (O2 Deficient Zone Tracers)

Contributors	Affiliation	Role
Clements, Daniel	University of California-Los Angeles (UCLA)	Principal Investigator
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Abstract
Global reconstructions of particle biovolume, size distribution, and carbon export flux validated for the upper 2000m of the water column. Products are generated from particle profiles conducted during cruises from 2008 to 2020.

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Coverage

Location: Global
Spatial Extent: **N**:90 **E**:180 **S**:-90 **W**:-180
Temporal Extent: 2008 - 2018

Dataset Description

These data will be published in the pending results paper Clements et al. (2024) "Modeling the Diel Vertical Migration and Active Carbon Transport of zooplankton."

Methods & Sampling

This work is based on the compilation of over 6800 profiles of particulate matter observations from Underwater Vision Profilers (UVP5) (Rainer, 2021). The biovolume of the particle size distribution is calculated

as the equivalent spherical volume of the particle size distribution (PSD), by summing the product of particle counts time particle volume in each size class. The slope of the PSD is calculated assuming a power law distribution for the particle abundance, by linear least square fit of the log of particle counts vs. the log of particle size. These quantities are estimated for the upper 2000m of the water column (Global_POC_Export_2024.nc). To convert sparse observations to a global climatology, we trained 50 ensembles of regressions trees (Random Forests, RF) to predict biovolume and slope based on their relationship to well-sampled physical and biogeochemical predictors (predictors_3D.mat).

We calculate the particle sinking speed and carbon content by combining PSD reconstruction (biovolume and slope) with an empirical relationship between particle size, carbon content and sinking speed, the parameters of which are optimized to match in situ particle flux observations (Mouw et al. 2016). The flux values are calculated as the sum of the PSD times the sinking carbon parameters, for each grid cell. The error for reconstructed quantities is given by the standard deviation of 50 independent realizations of the RF reconstructions.

Note: The "Deployments" section of this dataset is empty. See the supplemental file "Cruise List" cruise_list.csv which contains the cruise identifier in EcoPart (EcoTaxa), year (2008-2020), and number of profiles conducted during the cruise. More information about these cruises can be found at EcoTaxa (http://ecotaxa.obs-vlfr.fr).

Data Processing Description

The code used to produce these datasets can be found on a public GitHub repository at https://github.com/djclements1/Global-POC-Flux (DOI: 10.5281/zenodo.12976820).

BCO-DMO Processing Description

* Submitted .nc output file attached as the primary data file for this dataset. predictor .mat and .csv parameter descriptions were added as supplemental files.

.nc header information obtained using the Panoply software (since was not able to use "ncdump -h" as configured on our system due to the HDF5 format.

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Supplemental Files

File
Cruise List filename: cruise_list.csv (Comma Separated Values (.csv), 2.72 KB) MD5:d7697c97f905330988429eaf9dd1a136 A list of cruises during which the particle profiles were conducted. More information about these cruises can be found at EcoTaxa (http://ecotaxa.obs-vlfr.fr). Parameters (data column name, and description): "Cruise", Cruise identifier in EcoPart (EcoTaxa) "Year_of_cruise_start",Year of cruise start in format yyyy "Number_of_profiles", Number of profiles from the cruise

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Related Publications

Bianchi, D., & Clements, D. (2023). *Global reconstructions of particle biovolume, size distribution, and carbon export flux from the seasonal euphotic zone and maximum winter time mixed layer from particle profiles*

conducted during cruises from 2008 to 2020 (Version 2) [Data set]. Biological and Chemical Oceanography Data Management Office (BCO-DMO). https://doi.org/10.26008/1912/BCO-DMO.856942.2 https://doi.org/10.26008/1912/bco-dmo.856942.2
Methods

Clements et al. (2024). Modeling the Diel Vertical Migration and Active Carbon Transport of zooplankton. Submitted
Results

Clements, D. J., Yang, S., Weber, T., McDonnell, A. M. P., Kiko, R., Stemmann, L., & Bianchi, D. (2022). Constraining the Particle Size Distribution of Large Marine Particles in the Global Ocean With In Situ Optical Observations and Supervised Learning. Global Biogeochemical Cycles, 36(5). Portico. https://doi.org/10.1029/2021gb007276 https://doi.org/10.1029/2021GB007276
Methods

Clements, D. J., Yang, S., Weber, T., McDonnell, A. M. P., Kiko, R., Stemmann, L., & Bianchi, D. (2023). New Estimate of Organic Carbon Export From Optical Measurements Reveals the Role of Particle Size Distribution and Export Horizon. Global Biogeochemical Cycles, 37(3). Portico. https://doi.org/10.1029/2022gb007633 https://doi.org/10.1029/2022GB007633
Methods

Kiko, Rainer (2021): The global marine particle size distribution dataset obtained with the Underwater Vision Profiler 5 - version 1. PANGAEA, https://doi.pangaea.de/10.1594/PANGAEA.924375
References

Mouw, C. B., Barnett, A., McKinley, G. A., Gloege, L., & Pilcher, D. (2016). Global ocean particulate organic carbon flux merged with satellite parameters. Earth System Science Data, 8(2), 531–541. https://doi.org/10.5194/essd-8-531-2016
Methods

Picheral M, Colin S, Irisson J-O (2017). EcoTaxa, a tool for the taxonomic classification of images. http://ecotaxa.obs-vlfr.fr
IsDerivedFrom

djclements1. (2024). djclements1/Global-POC-Flux: V1.0 (Version V1.0) [Computer software]. Zenodo. https://doi.org/10.5281/ZENODO.12976820 https://doi.org/10.5281/zenodo.12976820
Software

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Related Datasets

IsRelatedTo

Bianchi, D., Clements, D. (2023) **Global reconstructions of particle biovolume, size distribution, and carbon export flux from the seasonal euphotic zone and maximum winter time mixed layer from particle profiles conducted during cruises from 2008 to 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 2) Version Date 2023-02-02 doi:10.26008/1912/bco-dmo.856942.2 [view at BCO-DMO]
Relationship Description: Dataset related to the same cruise list.

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Underwater Vision Profiler, version 5 (UVP5).
Generic Instrument Name	Underwater Vision Profiler
Dataset-specific Description	Observations of particle abundance and biovolume were made with the Underwater Vision Profiler, version 5 (UVP5).
Generic Instrument Description	A description of the UVP instrument can be found in the following publication: Picheral, M., L. Guidi, L. Stemmann, D. M. Karl, G. Iddaoud, and G. Gorsky. 2010. The Underwater Vision Profiler 5: An advanced instrument for high spatial resolution studies of particle size spectra and zooplankton. Limnol. Oceanogr. Meth. 8: 462-473. (access the PDF at URL: http://cmore.soest.hawaii.edu/cmoredata/LMO/Guidi/Picheral_2010.pdf)

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Project Information

Collaborative Research: Opening the black box of oxygen deficient zone biogeochemistry through integrative tracers (O2 Deficient Zone Tracers)

Coverage: eastern tropical North Pacific ocean

NSF abstract:

The oxygen deficient zones are regions in the ocean where dissolved oxygen disappears. These regions harbor unique ecosystems only found in waters without oxygen, and they are important for Earth's climate. Specifically, the production of nitrogen gas by two microbial processes, anammox and denitrification can control how productive the oceans are. Yet how much each process shapes ocean chemistry within these areas remains unknown. This project aims to study the oxygen deficient waters of the eastern tropical North Pacific ocean to better understand the mechanisms shaping marine nitrogen and carbon chemistry. Through this work, the project will train undergraduate and graduate students at three universities. The project aims to broaden participation in and understanding of ocean sciences by developing public videos about the methods used and the science behind the project.

The investigators will conduct a research cruise in the eastern tropical North Pacific ocean, the largest oxygen deficient zone. They will measure many nutrients including inorganic carbon and nitrogen and natural abundance stable isotopes of nitrogen compounds. They will use these patterns to establish how the major reactions work together to control nitrogen cycling and gaseous nitrogen production. In addition, a high-resolution model of the ocean will reveal the influence of ocean mixing, set the timescales for reactions, and enable synthesis of the measurements into a global context. The work will determine how the input of oxygen through mixing controls chemistry, and it will distinguish between the processes restricted to the permanently anoxic core vs. those that tolerate (or are enhanced by) occasional oxygenation. Overall, the project will provide new information about nitrogen cycling pathways (anammox, denitrification, and nitrite oxidation) across the region and link the resulting isotopic signals to the global nitrogen budget.

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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2342988

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