Size fractionated and group-specific rates of 14C-primary production by Prochlorococcus, Synechococcus, and photosynthetic picoeukaryotes from samples collected during Hawaii Ocean Time-series (HOT) program cruises 230-252 between 2012 and 2013

Website: https://www.bco-dmo.org/dataset/713842
Data Type: Cruise Results
Version:
Version Date: 2017-08-25

Project
» Oligotrophic phytoplankton community response to changes in N substrates and the resulting impact on genetic, taxonomic and functional diversity (PhytoNsubResponse)

Program
» Dimensions of Biodiversity (Dimensions of Biodiversity)

Contributors	Affiliation	Role
Church, Matthew J.	University of Montana	Principal Investigator, Contact
Arrigo, Kevin R.	Stanford University	Co-Principal Investigator
Kolber, Zbigniew	University of California-Santa Cruz (UCSC)	Co-Principal Investigator
Zehr, Jonathan P.	University of California-Santa Cruz (UCSC)	Co-Principal Investigator
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

Coverage

Spatial Extent: **Lat**:22.75 **Lon**:-158
Temporal Extent: 2012-05-30 - 2013-05-18

Dataset Description

This dataset contains size fractionated rates of 14C-bicarbonate assimilation and the “group-specific” rates of 14C-bicarbonate assimilation. The group-specific rates were derived from flow cytometrically sorting radiolabeled cells (post-incubation) including Prochlorococcus, Synechococcus, and photosynthetic picoeukaryotes.

These results were published in the following publication:

Rii YM, Karl DM, Church MJ (2016) Temporal and vertical variability in picophytoplankton primary productivity in

the North Pacific Subtropical Gyre. Mar Ecol Prog Ser 562:1-18. https://doi.org/10.3354/meps11954

Methods & Sampling

Seawater was collected in 12-L polyvinylchloride bottles affixed to a 24-bottle rosette sampler, equipped with a Sea-Bird 911+ conductivity, temperature, and pressure profiler. Rates of size-fractionated (>3 µm and 0.2-3 um) and group-specific particulate 14C-based primary production were measured at six discrete depths (5, 25, 45, 75, 100, and 125 m) throughout the euphotic zone. Seawater samples from each depth were subsampled into triplicate 30-mL polycarbonate centrifuge tubes (Nalgene (TM) Oak Ridge) from a pre-dawn cast, inoculated under subdued light with 70 uL of NaH14CO3- (final activity = ~0.14 MBq/mL; MP Biomedicals 17441H), then incubated over the full photoperiod (~12-14 hours) in white mesh bags affixed to a floating in situ array at the corresponding depths where the water was collected. At the end of the incubation period (after sundown), each polycarbonate tube was sampled for size-fractionated and group-specific rates of 14C primary productivity. Aliquots (25 µl) were subsampled from each tube and stored in 20-mL glass scintillation vials containing 500 µL of B–phenylethylamine to determine the total activity of 14C added to each sample. Next, 5 mL of each sample was preserved in cryotubes containing 30 uL of 16% (final concentration 0.24% w/v) microscopy-grade paraformaldehyde (PFA, Alfa Aesar 43368), flash-frozen in liquid nitrogen, and stored at -80C for subsequent flow cytometric sorting. The remaining sample volume (~25 mL) was vacuum-filtered first onto a 25-mm diameter 3-µm pore size polycarbonate membrane (Millipore IsoporeTM), then the filtrate was vacuum-filtered onto a 25-mm diameter 0.2-um pore size polycarbonate membrane filter (GE Osmonics). After filtration, each filter was placed into a 20-mL glass scintillation vial and stored at -20C until analyzed back at the shore-based laboratory. Upon return to shore, vials were uncapped, 1 mL of 2 M hydrochloric acid was added to each filter, and vials were vented for at least 24 hours to remove remaining inorganic 14C. After venting, 10 mL of Ultima Gold liquid scintillation cocktail was added to each vial, and vials were placed in a liquid scintillation counter (Packard TRI-Carb 4640) for the determination of 14C activities. Group-specific rates of 14C-assimilation by *Prochlorococcus*, *Synechococcus*, and PPE were determined by measuring the amount of 14C assimilated into populations sorted using the BD InfluxTM (100-µm nozzle tip, 1X BioSure® sheath solution). Calibration of the # of cells sorted was conducted at the beginning of each sorting session; a known number of fluorescent microspherical beads (1 um, Fluoresbrite, Polysciences) were gated through the data acquisition software Spigot, sorted onto a slide, and checked for accuracy under the microscope. The ‘1.0 drop purity’ setting in the Spigot software was utilized as a conservative way of ensuring accuracy of the types of cells sorted into two 6.5-mL HDPE scintillation vials with the ‘two tube sort’ setting. Beads were included with the samples for size reference, and 0.2 x 103 to 4 x 103 beads were sorted for the determination of background levels of radioactivity (both organic 14C in the seawater and 14C absorbed to the beads). Picophytoplankton cells were triggered on forward scatter (FSC) and enumerated based on FSC and side scatter, chlorophyll-based red fluorescence (692 +- 20 nm), and phycoerythrin-based orange fluorescence (585 +- 20 nm) following excitation with two lasers, 488 nm (200 mW) and 457 nm (300 mW).

Data Processing Description

BCO-DMO Data Manager Processing Notes:
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions
* "na" values changed to "nd" for no data.
* split location column into two columns (lat,lon) in decimal degree format.
* removed the directional (N|W) and made longitude negative for west.
* changed comma delimited bottle list in one column to ; delimited
* added ISO_DateTime_UTC timestamp from date and time columns

[table of contents | back to top]

Data Files

File
14C_SizeFrac.csv (Comma Separated Values (.csv), 6.83 KB) MD5:0724382d99095482f08f99bc6236790b Primary data file for dataset ID 713842

[table of contents | back to top]

Parameters

Parameter	Description	Units
Cruise	Cruise identifier	unitless
Date	Date of cast in format mmddyy	unitless
Time	Time of cast in format hhmm (UTC)	unitless
ISO_DateTime_UTC	ISO timestamp based on the ISO 8601:2004(E) standard in format YYYY-mm-ddTHH:MM:SS[.xx]Z (UTC)	unitless
Lat	Latitude	decimal degrees
Lon	Longitude	decimal degrees
Cast	Cast number	unitless
Bottle	Bottle numbers samples came from (separated by semicolons)	unitless
Depth	Nominal bottle depth	meters
Pico_SzFxPP_mean	Mean picophytoplankton (size fraction between 0.2-3 um) primary production rate	mmol C/m3/d
Pico_SzfxPP_sd	Standard deviation of picophytoplankton (size fraction between 0.2-3 um) primary production rate	mmol C/m3/d
ndno_SzFxPP_mean	Mean picophytoplankton (size fraction greater thatn 3 um) primary production rate	mmol C/m3/d
ndno_SzfxPP_sd	Standard deviation of picophytoplankton (size fraction greater than 3 um) primary production rate	mmol C/m3/d
Pro_PP_mean	Mean Prochlorococcus primary production rate	mmolC/m3/d
Syn_PP_mean	Mean Synechococcus primary production rate	mmolC/m3/d
Peuk_PP_mean	Mean picoeukaryotes primary production rate	mmolC/m3/d

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Packard TRI-Carb 4640
Generic Instrument Name	Liquid Scintillation Counter
Generic Instrument Description	Liquid scintillation counting is an analytical technique which is defined by the incorporation of the radiolabeled analyte into uniform distribution with a liquid chemical medium capable of converting the kinetic energy of nuclear emissions into light energy. Although the liquid scintillation counter is a sophisticated laboratory counting system used the quantify the activity of particulate emitting (ß and a) radioactive samples, it can also detect the auger electrons emitted from 51Cr and 125I samples. Liquid scintillation counters are instruments assaying alpha and beta radiation by quantitative detection of visible light produced by the passage of rays or particles through a suitable scintillant incorporated into the sample.

[table of contents | back to top]

Deployments

HOT_cruises

Website	https://www.bco-dmo.org/deployment/58879
Platform	Multiple Vessels
Report	http://hahana.soest.hawaii.edu/hot/
Start Date	1988-10-31
Description	Since October 1988, the Hawaii Ocean Time-series (HOT) program has investigated temporal dynamics in biology, physics, and chemistry at Stn. ALOHA (22°45' N, 158°W), a deep ocean field site in the oligotrophic North Pacific Subtropical Gyre (NPSG). HOT conducts near monthly ship-based sampling and makes continuous observations from moored instruments to document and study NPSG climate and ecosystem variability over semi-diurnal to decadal time scales. **Methods & Sampling** Hawaii Ocean Time-series (HOT) program cruises 230-252

[table of contents | back to top]

Project Information

Oligotrophic phytoplankton community response to changes in N substrates and the resulting impact on genetic, taxonomic and functional diversity (PhytoNsubResponse)

Coverage: North Pacific Subtropical Gyre at Station ALOHA, and a transect from San Diego, CA to Hawaii

(Extracted from NSF award abstract)

Marine phytoplankton are a diverse group of Prokaryotic and Eukaryotic unicellular organisms that account for approximately 50% of global carbon fixation. Nitrogen (N) is an essential element for microbial growth, but concentrations of bioavailable nitrogen in vast regions of subtropical ocean gyres are extremely low (submicromolar to nanomolar concentrations), and generally limit phytoplankton growth. Phytoplankton taxa differ in their genetic capabilities to take up and assimilate nutrients, and thus competition for different

chemical forms of N (NH4+, NO3- and urea) and supply of these N-containing compounds are important controls on phytoplankton growth, productivity, and ultimately ecosystem function. The form and supply of N to phytoplankton have already been altered by anthropogenic activities, and with increasing environmental perturbations the effects will accelerate. To date however, there is limited information on how the N forms and fluxes impact the marine phytoplankton community composition and primary production. Similarly, determining the mechanisms of the response are crucial to assessing how ocean ecosystem function will respond to global climate change.

This project seeks to determine how taxonomic, genetic and functional dimensions of phytoplankton diversity are linked with community-level responses to the availability of different N substrates (NH4+, NO3-, and urea) in one of Earth's largest aquatic habitats, the North Pacific Subtropical Gyre. The project will characterize phytoplankton community composition change and gene expression, photosynthetic performance, carbon fixation, and single-cell level N and C uptake in different taxa within the phytoplankton assemblage in response to different N compounds. The research project is unique in investigating community-to-single-cell level function and species (strain)-specific gene expression patterns using state-of-the-art methods including fast repetition rate fluorometry, nanoscale secondary ion mass spectrometry and a comprehensive marine microbial community microarray. The results will provide predictive understanding of how changes in the availability of key nitrogen pools (N) may impact phytoplankton dynamics and function in the ocean.

References:

Karl, D. M., Bjorkman, K. M., Dore, J. E., Fujieki, L., Hebel, D. V., Houlihan, T., Letelier, R. M., Tupas, L. M. 2001. Ecological nitrogen-to-phosphorus stoichiometry at station ALOHA. Deep-Sea Research II. 48:1529 - 1566.

Karl, D. M., Letelier, R., Tupas, L., Dore, J., Christian, J. & Hebel, D. 1997. The role of nitrogen fixation in biogeochemical cycling in the subtropical North Pacific Ocean. Nature. 388:533-538.

McCarthy, J., Taylor, W. R., Taft, J. 1997. Nitrogenous nutrition of the plankton in the Chesapeake Bay. Limnology and Oceanography. 35:822 - 829.

Letelier, R., Karl, D. M. 1996. Role of Trichodesmium spp. in the productivity of the subtropical North Pacific Ocean. Marine Ecology Progress Series. 133:263 - 273.

Lipschultz, F. 1995. Nitrogen-specific uptake rates of marine phytoplankton isolated from natura populations of particles by flow cytometry. Marine Ecology Progress Series. 123:245-258.

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1241263

[table of contents | back to top]