32Si and 14C production data (experimental) from EXPORTS cruise RR1813 on R/V Roger Revelle in the Subarctic North Pacific near Station PAPA from August to September 2018

Website: https://www.bco-dmo.org/dataset/786013
Data Type: Cruise Results, experimental
Version: 1
Version Date: 2020-01-06

Project
» Collaborative Research: Diatoms, Food Webs and Carbon Export - Leveraging NASA EXPORTS to Test the Role of Diatom Physiology in the Biological Carbon Pump (Diatoms and carbon export)

Program
» EXport Processes in the Ocean from Remote Sensing (EXPORTS)

Contributors	Affiliation	Role
Brzezinski, Mark A.	University of California-Santa Barbara (UCSB-MSI)	Principal Investigator
Buck, Kristen	University of South Florida (USF)	Co-Principal Investigator
Jenkins, Bethany D.	University of Rhode Island (URI)	Co-Principal Investigator
Jones, Janice L.	University of California-Santa Barbara (UCSB)	Contact
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset includes 32Si and 14C production data (experimental) from EXPORTS cruise RR1813. The EXPORTS field campaign in the subarctic North Pacific sampled an ecosystem characterized as high nutrient low chlorophyll (HNLC) due to low iron (Fe) levels that are primary controllers constraining phytoplankton utilization of other nutrients. It has been a paradigm in low Fe, HNLC systems that diatoms grow at elevated Si:C and Si:N ratios and should be efficiently exported as particles significantly enriched in Si relative to C. However, Fe limitation also alters diatoms species composition and the high Si demand imposed by low Fe can drive HNLC regions to Si limitation or Si/Fe co-limitation. Thus, the degree of Si and/or Fe stress in HNLC waters can all alter diatom taxonomic composition, the elemental composition of diatom cells, and the path cells follow through the food web ultimately altering diatom carbon export. Within each ecosystem state examined in the EXPORTS program, nutrient biogeochemistry, diatom and phytoplankton community structure, and global diatom gene expression patterns (metatranscriptomics) are characterized in the lit ocean. Nutrient amendment experiments with tracer addition (14C, 32Si) are used to quantify the level of Si and Fe stress being experienced by the phytoplankton and to contextualize taxa-specific metatranscriptome responses for resolving gene expression profiles in the in situ communities.

Table of Contents

Coverage

Spatial Extent: **N**:50.5828 **E**:-144.691 **S**:50.1496 **W**:-145.1413
Temporal Extent: 2018-08-16 - 2018-09-07

Dataset Description

Depth profiles in the euphotic zone of nutrient (nitrate, silicate, phosphate) concentrations, profiles of silicic acid uptake rates and assessment of limitation by Si and Fe on both silicic acid uptake and carbon fixation.

See related dataset: https://www.bco-dmo.org/dataset/785856

Methods & Sampling

Seawater samples were collected using an epoxy coated CTD-rosette mounted with Go-Flo samplers and a Sea-Bird Electronics CTD (SBE9plus). Go-Flo bottles were transferred to a trace metal clean van for subsampling into polypropylene tubes (nutrients), polypropylene bottle (biogenic silica and particulate carbon and nitrogen) or TM acid-cleaned polycarbonate incubation bottles (Si-32 & C-14 incubation experiments).

Nutrient samples were filtered through 0.2 µm polycarbonate filters and frozen at -20°C. Samples for biogenic silica concentrations were size fractionated by serial filtration through 5 µm and 0.6 µm polycarbonate filters. Filters were stored frozen at -20°C. Particulate organic carbon and nitrogen were measured on samples from experiments examining the effect of added Fe and Si on carbon fixation. These samples were filtered through precombusted GFF filters placed in glass scintillation vials and frozen at -20°C.

Samples for silicic acid uptake profiles were spiked with the radioisotope Si-32. Nutrient limitation assays were performed on pairs of samples where rate of silicic acid uptake (Si-32) or carbon fixation (C-14 in paired light/dark bottles) were determined in unaltered controlled samples and in samples augmented with either silicic acid (20 µM) or iron chloride (1 nM). All samples were incubated on deck in simulated in situ incubators cooled with flowing surface seawater from 24 h. Profiles samples six depths from near surface to the 1% light level. Nutrient limitation assays were performed at the 40% and 10% light levels.

Particles from incubated samples were size fractionated by serial filtration through 5 µm and 0.6 µm 25 mm polycarbonate filters. For C-14 incubations, total radioactivity in each sample was determined by sampling 100 µl of sample seawater prior to filtration. Filters from Si-32 incubations were placed on plastic planchettes and dried before covering with mylar film and stored or analysis ashore using low level beta counters (Riso Inc). Filters from C-14 incubations were acidified in glass scintillation vials, scintillation cocktail (Ultima Gold XR) added followed by liquid scintillation counting. Total radioactivity samples received 100 µL of b-phenethylamine and 5 mL of scintillation cocktail prior to analysis at sea using a Beckman 8500 scintillation counter.

For more information, see the Protocol documents (under Supplemental Files).

Data Processing Description

Silicon uptake was calculated as the product of the fraction of total Si-32 radioactivity taken up and the ambient silicic acid concertation. Rates of primary production were calculated as the product of the fraction of total C-14 radioactivity taken up and a DIC value of 2132 µmol kg-1 correcting for isotope discrimination (x 1.05).

Nutrient concentrations were adjusted using certified JAMSTEC CRMs.

BCO-DMO Processing:
- formatted date to yyyy-mm-dd (was dd/mon/yy);
- modified parameter names (replaced spaces and symbols with underscores, removed units);
- replaced "~" and blanks with "nd" (no data);
- created ISO_DateTime_UTC field.

[table of contents | back to top]

Data Files

File
14C_32Si_exp.csv (Comma Separated Values (.csv), 13.68 KB) MD5:9ee1ba69e3123a8b067a7f0006d44bb2 Primary data file for dataset ID 786013

[table of contents | back to top]

Supplemental Files

File
Brzezinski Lab 14C Primary Production Protocols filename: 14C_Primary_Production.pdf (Portable Document Format (.pdf), 287.04 KB) MD5:98b17db0d497db8baef492b6f642dd05 Brzezinski Lab 14C Primary Production Protocols
Brzezinski Lab 32Si Sample Processing Protocols filename: 32Si_Sample_Processing.pdf (Portable Document Format (.pdf), 218.87 KB) MD5:a4958e873573df157b6a20b4a2028c35 Brzezinski Lab 32Si Sample Processing Protocols
Brzezinski Lab bSi Protocols filename: bSi_Protocol.pdf (Portable Document Format (.pdf), 214.54 KB) MD5:32afa2b8fe4d9ce0cde6b78bc9687248 Brzezinski Lab bSi Protocols
Brzezinski Lab dSi Analysis Protocols filename: dSi_Analysis.pdf (Portable Document Format (.pdf), 353.66 KB) MD5:4d0670cfab1c27d77e33dc865448f489 Brzezinski Lab dSi Analysis Protocols

[table of contents | back to top]

Related Datasets

IsRelatedTo

Brzezinski, M., Buck, K., Jenkins, B. (2020) **32Si data from EXPORTS cruise RR1813 on R/V Roger Revelle in the Subarctic North Pacific near Station PAPA from August to September 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2020-01-03 doi:10.1575/1912/bco-dmo.785856.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
Cruise	cruise during which sample was collected	unitless
Date_Zulu	UTC date; format: yyyy-mm-dd	unitless
Time_Zulu	UTC time; format: HH:MM:SS	unitless
Event_num	event number from R2R event log	unitless
Activity	which instrument was used for sample collection	unitless
Station	station identifier	unitless
Cast	cast type (CTD or experiment) and number	unitless

Latitude	latitude in decimal degrees	decimal degrees North
Longitude	longitude in decimal degrees	decimal degrees East
Rosette_Bottle	rosette bottle number	unitless
Target_Depth	target depth for sample collection	meters
pcnt_lo	percent light level (PAR sensor)	unitless (percent)
TRMT	experimental sample treatment defined as follows: CTRL = no nutrient additions; +Si = addition of 320 uL of 20 mM Na2SiO3 to increase ambient dissolved silicon by 20uM (measured total Fe in 20nM Si stock indicates that increasing dissolved Si by 20uM increases total dissolved Fe by 0.05nM); +Fe = addition of 32uL of 10uM FeCl3 for a total concentration of 1nM; +Si+Fe = addition of both above.	unitless
PO4	Macronutrients (PO4) - dissolved phosphate concentration in micromoles - analyzed in UCSB MSI Analytical lab	mmol m-3
PO4_flag	data flag set as 1 (good) 2 (manual badflag) 3 (below detection limit) 9 (missing) as per Norm Nelson and his Seabass submission	unitless
SiO4	Macronutrients (SiO4) - silicic acid concentration in micromoles (also known as dissolved silicon concentration or dSi)	mmol m-3
SiO4_flag	data flag set as 1 (good) 2 (manual badflag) 3 (below detection limit) 9 (missing) as per Norm Nelson and his Seabass submission	unitless
NO2	Macronutrients (NO2) - dissolved nitrite concentration in micromoles - analyzed in UCSB MSI Analytical lab	mmol m-3
NO2_flag	data flag set as 1 (good) 2 (manual badflag) 3 (below detection limit) 9 (missing) as per Norm Nelson and his Seabass submission	unitless
NO2_NO3	dissolved nitrate+nitrite concentration in micromoles - analyzed in UCSB MSI Analytical lab	mmol m-3
NO2_NO3_flag	data flag set as 1 (good) 2 (manual badflag) 3 (below detection limit) 9 (missing) as per Norm Nelson and his Seabass submission	unitless
POC	Macronutrients (POC) - particulate organic carbon in micromoles - analyzed in UCSB MSI Analytical lab	mg m-3
POC_flag	data flag set as 1 (good) 2 (manual badflag) 3 (below detection limit) 9 (missing) as per Norm Nelson and his Seabass submission	unitless
PON	Macronutrients (PON) - particulate organic nitrogen in micromoles - analyzed in UCSB MSI Analytical lab	mg m-3

PON_flag	data flag set as 1 (good) 2 (manual badflag) 3 (below detection limit) 9 (missing) as per Norm Nelson and his Seabass submission	unitless
BSi_0_6umfilt_5umprefilt	particulate biogenic silica in nanomoles Si per litre - 0.6-5um fraction	umol m-3
BSi_5umfilt	particulate biogenic silica in nanomoles Si per litre - >5um fraction	umol m-3
rate_32Si_uptake_24hr_0_6umfilt_5umprefilt	size fractionated silicic acid 32Si uptake 0.6-5um fraction	nmol Si L-1 d-1
rate_32Si_uptake_specific_24hr_0_6umfilt_5umprefilt	size fractionated specific silicic acid 32Si uptake 0.6-5um fraction	d-1
rate_32Si_uptake_24hr_5umfilt	size fractionated silicic acid 32Si uptake >5um fraction	nmol Si L-1 d-1
rate_32Si_uptake_specific_24hr_5umfilt	size fractionated specific silicic acid 32Si uptake >5um fraction	d-1
rate_14C_uptake_24hr_0_6umfilt_5umprefilt	size fractionated primary production 14C uptake 0.6-5um fraction	umol C L-1 d-1
rate_14C_uptake_24hr_5umfilt	size fractionated primary production 14C uptake >5um fraction	umol C L-1 d-1
ISO_DateTime_UTC	Date and time foramtted to ISO8601 standard; format: yyyy-mm-ddTHH:MM:SS	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Sea-Bird Electronics CTD (SBE9plus)
Generic Instrument Name	CTD Sea-Bird 9
Generic Instrument Description	The Sea-Bird SBE 9 is a type of CTD instrument package. The SBE 9 is the Underwater Unit and is most often combined with the SBE 11 Deck Unit (for real-time readout using conductive wire) when deployed from a research vessel. The combination of the SBE 9 and SBE 11 is called a SBE 911. The SBE 9 uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 and SBE 4). The SBE 9 CTD can be configured with auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorometer, altimeter, etc.). Note that in most cases, it is more accurate to specify SBE 911 than SBE 9 since it is likely a SBE 11 deck unit was used. more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Lachat Instruments QuikChem 8500 Series 2 anayzer
Generic Instrument Name	Flow Injection Analyzer
Generic Instrument Description	An instrument that performs flow injection analysis. Flow injection analysis (FIA) is an approach to chemical analysis that is accomplished by injecting a plug of sample into a flowing carrier stream. FIA is an automated method in which a sample is injected into a continuous flow of a carrier solution that mixes with other continuously flowing solutions before reaching a detector. Precision is dramatically increased when FIA is used instead of manual injections and as a result very specific FIA systems have been developed for a wide array of analytical techniques.

Dataset-specific Instrument Name	Go-Flo samplers
Generic Instrument Name	GO-FLO Bottle
Generic Instrument Description	GO-FLO bottle cast used to collect water samples for pigment, nutrient, plankton, etc. The GO-FLO sampling bottle is specially designed to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

Dataset-specific Instrument Name	
Generic Instrument Name	Light-Dark Bottle
Generic Instrument Description	The light/dark bottle is a way of measuring primary production by comparing before and after concentrations of dissolved oxygen. Bottles containing seawater samples with phytoplankton are incubated for a predetermined period of time under light and dark conditions. Incubation is preferably carried out in situ, at the depth from which the samples were collected. Alternatively, the light and dark bottles are incubated in a water trough on deck, and neutral density filters are used to approximate the light conditions at the collection depth.Rates of net and gross photosynthesis and respiration can be determined from measurements of dissolved oxygen concentration in the sample bottles.

[table of contents | back to top]

Deployments

RR1813

Website	https://www.bco-dmo.org/deployment/772777
Platform	R/V Roger Revelle
Report	https://datadocs.bco-dmo.org/docs/EXPORTS/data_docs/RR1813_Cruise_Report.pdf
Start Date	2018-08-10
End Date	2018-09-12
Description	Additional cruise information is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/RR1813

[table of contents | back to top]

Project Information

Collaborative Research: Diatoms, Food Webs and Carbon Export - Leveraging NASA EXPORTS to Test the Role of Diatom Physiology in the Biological Carbon Pump (Diatoms and carbon export)

Coverage: Sub-Arctic Pacific, Ocean Station Papa

NSF Award Abstract:
This project focuses on a group of microscopic single-celled photosynthetic organisms in the ocean called diatoms. Diatoms float in the surface ocean as part of a group of organisms collectively called phytoplankton. There are thousands of different species of diatoms distributed across the global ocean. A famous oceanographer Henry Bigelow once said "All fish is diatoms" reflecting the importance of diatoms as the base of the food chain that supports the world's largest fisheries. Despite their small size, diatom photosynthesis produces 20% of the oxygen on earth each year. That's more than all of the tropical rain forests on land. The major objective of the research is to understand how the metabolic differences among diatom species affects the amount of diatom organic carbon that is carried, or exported, from the surface ocean to the deep ocean. As diatoms are photo-synthesizers like green plants, their biological carbon comes from converting carbon dioxide dissolved in seawater from the atmosphere into organic forms. Diatoms also require a series of other nurtrients supplied by the ocean such as nitrogen and phosphorous and, uniquely for diatoms, the silicon used to construct their glass shells. This research will investigate how genetic and physiological differences among diatoms influence how each species react to changes in nutrient levels in the ocean and how those shifts affect the export of diatom carbon to the deep sea. The link between diatoms' physiological response and their carbon export comes about because shifts in physiology affect diatom attributes like how fast they sink and how tasty they are to predators. So if we can relate the physiological condition of different diatoms to the food-web pathways followed by different species, we can ultimately use knowledge of diatom physiological status and food web structure to predict how much diatom carbon gets to the deep sea. The research involves investigators with expertise in the physiology and genomics of diatoms and in the ocean's chemistry. The work will initially take place in the subarctic North Pacific in conjunction with the NASA Export Processes in the Ocean from RemoTe Sensing (EXPORTS) field program. The EXPORTS program is using a wide variety of methods to quantify the export and fate of photo-synthetically fixed carbon in the upper ocean. The research supports the training of undergraduate students, graduate students and a postdoctoral scholar. The research will also serve as the basis for activities aimed at K-12 and junior high school students.

The research will broadly impact our understanding of the biology of the biological pump (the transport of photo-synthetically fixed organic carbon to the deep sea) by forming a mechanistic basis for predicting the export of diatom carbon. It is hypothesized that the type and degree of diatom physiological stress are vital aspects of ecosystem state that drive export. To test this hypothesis, the genetic composition, rates of nutrient use and growth response of diatom communities will be evaluated and supported with measurements of silicon and iron stress to evaluate stress as a predictor of the path of diatom carbon export. The subarctic N. Pacific ecosystem is characterized as high nutrient low chlorophyll (HNLC) due to low iron (Fe) levels that are primary controllers constraining phytoplankton utilization of other nutrients. It has been a paradigm in low Fe, HNLC systems that diatoms grow at elevated Si:C and Si:N ratios and should be efficiently exported as particles significantly enriched in Si relative to C. However, Fe limitation also alters diatoms species composition and the high Si demand imposed by low Fe can drive HNLC regions to Si limitation or Si/Fe co-limitation. Thus, the degree of Si and/or Fe stress in HNLC waters can all alter diatom taxonomic composition, the elemental

composition of diatom cells, and the path cells follow through the food web ultimately altering diatom carbon export.

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.

[table of contents | back to top]

Program Information

EXport Processes in the Ocean from Remote Sensing (EXPORTS)

Website: http://oceanexports.org/

EXport Processes in the Ocean from Remote Sensing (EXPORTS) is a large-scale NASA-led field campaign that will provide critical information for quantifying the export and fate of upper ocean net primary production (NPP) using satellite observations and state of the art ocean technologies.

Ocean ecosystems play a critical role in the Earth’s carbon cycle and the quantification of their impacts for both present conditions and for predictions into the future remains one of the greatest challenges in oceanography. The goal of the EXport Processes in the Ocean from Remote Sensing (EXPORTS) Science Plan is to develop a predictive understanding of the export and fate of global ocean net primary production (NPP) and its implications for present and future climates. The achievement of this goal requires a quantification of the mechanisms that control the export of carbon from the euphotic zone as well as its fate in the underlying "twilight zone" where some fraction of exported carbon will be sequestered in the ocean’s interior on time scales of months to millennia. In particular, EXPORTS will advance satellite diagnostic and numerical prognostic models by comparing relationships among the ecological, biogeochemical and physical oceanographic processes that control carbon cycling across a range of ecosystem and carbon cycling states. EXPORTS will achieve this through a combination of ship and robotic field sampling, satellite remote sensing and numerical modeling. Through a coordinated, process-oriented approach, EXPORTS will foster new insights on ocean carbon cycling that maximizes its societal relevance through the achievement of U.S. and International research agency goals and will be a key step towards our understanding of the Earth as an integrated system.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756442

[table of contents | back to top]