Carbon, biogenic Silica, and mass fluxes from Neutrally Buoyant Sediment Trap (NBST) deployments in the North Pacific on R/V Falkor FK170124 in Jan-Feb 2017

Website: https://www.bco-dmo.org/dataset/765429
Data Type: Cruise Results
Version: 1
Version Date: 2019-04-22

Project
» Collaborative Research: EAGER: Particle-specific DNA sequencing to directly observe ecological mechanisms of the biological pump (EAGER DNA BioPump)

Contributors	Affiliation	Role
Estapa, Margaret L.	Skidmore College	Principal Investigator
Durkin, Colleen	Moss Landing Marine Laboratories (MLML)	Co-Principal Investigator
Omand, Melissa	University of Rhode Island (URI)	Co-Principal Investigator
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Carbon, biogenic Silica, and mass fluxes from the Neutrally Buoyant Sediment Trap (NBST) deployments in the North Pacific on R/V Falkor FK170124 in Jan-Feb 2017

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Coverage

Spatial Extent: **N**:34.6768 **E**:-123.4767 **S**:21.5918 **W**:-151.9033
Temporal Extent: 2017-01-28 - 2017-02-14

Dataset Description

This dataset includes measurement from deployments of the Neutrally Buoyant Sediment Trap (NBST) in the North Pacific during R/V Falkor FK170124 in January and February 2017 as part of the Sea to Space Particle Investigation project (see https://schmidtocean.org/cruise/sea-space-particle-investigation/).

Methods & Sampling

Organic and inorganic carbon, biogenic silica, and mass flux measurements were made from neutrally-buoyant sediment trap deployments at three stations occupied during R/V Falkor cruise FK170124 from Honolulu, HI to Portland, OR in January 2017.

The NBST platforms were constructed around Sounding Oceanographic Lagrangian Observer (SOLO) profiling floats and carried four cylindrical sediment trap tubes with collection areas of 0.0113 m2 and an integrated transmissometer (WETLabs C-Rover 6b). Prior to deployment, three trap tubes were filled with filtered seawater from beneath the mixed layer. 500 mL of formalin-poisoned brine (70 ppt) was gravity-fed through tubing to form a layer below the filtered seawater to preserve settling particulate matter for carbon analysis. The fourth trap tube was not used for bulk flux determination.

NBSTs were programmed to descend to a single measurement depth (150 or 170 m), sample for 2–3 days until a burn wire mechanism closed the tube lids, and then ascend to the surface for recovery. NBSTs were programmed to hold depth within ±25 m of the measurement depth.

Upon recovery, NBST tubes were allowed to settle for at least 1 h in the laboratory. The overlying seawater layer was suctioned out of the tops of all tubes. The remaining brine layers from the three tubes were drained through a single, acid-cleaned, 350-µm nylon mesh screen and combined into a 4-L bottle. The screen was picked clean of zooplankton under a dissecting microscope, and the remaining screen contents were rinsed back into the 4-L bottle with filtered seawater. The 4-L bottle was split into eight fractions using a custom-built rotary splitter (Lamborg et al. 2008). One fraction was further split into two fractions to provide a subsample for collaborators. Laboratory space limitations prohibited the use of a shaker table to mix the 4-L bottle during splitting, and instead the bottle was agitated by hand.

Three splits were filtered onto precombusted GF/F filters (Whatman) and dried at 45 ± 5°C using a consumer-grade food dehydrator (blank comparisons vs. a standard laboratory oven showed no difference). Filters were stored dry at room temperature until analysis on shore. On shore, filters were gravimetrically split and half of each filter was analyzed for total carbon (TC) at the UC Davis Stable Isotope Facility. Split-to-split reproducibility was poor, possibly due to the lack of a shaker table during wet splitting.

Six splits (including the two 1/16th splits) were filtered onto pre-weighed, 25-mm diameter, 0.2-µm pore size polycarbonate membrane filters (Nuclepore) and rinsed with pH 8.5 borate-buffered Milli-Q water. All were dried as described above. Four of the six splits were stored dry at room temperature until analysis on shore for $CaCO_3$ and biogenic silica (bSi). Two of the six splits were shared with collaborators.

On shore, all polycarbonate filters were re-dried and weighed to constant mass on a microbalance with ±0.01 mg precision to determine mass flux. To increase the number of TC replicates and partially remedy the poor reproducibility of the TC splits (likely due to splitter variability stemming from hand agitation of the sample bottle), approximately ¼ of each polycarbonate filter was gravimetrically split and used for a second set of TC analyses at the University of Rhode Island Elemental Analysis facility. The specific carbon content (mass C per mass filter) of clean Nuclepore filters was determined empirically. The mass fraction of each ¼ split was used to calculate the carbon content of that split from the original sample filter tare mass. Then the sample carbon was determined by difference between the total carbon and the calculated filter carbon.

Two of the four ¾ polycarbonate splits remaining were analyzed for particulate inorganic carbon (PIC). Filters were extracted overnight in 5% nitric acid with 2% La (as La_2O_3) releasing agent. Extracts were analyzed using flame atomic absorption spectrometry for Ca (422.7 nm, air-acetylene flame) and Na (589 nm, air-acetylene flame). Sodium levels were used to correct Ca for residual sea salts, then PIC was calculated assuming all Ca was present as $CaCO_3$.

The remaining two ¾ polycarbonate splits were analyzed for bSi. Filters were extracted in 0.2 N NaOH for a total of 2 hours at 95°C, then neutralized with 1 N HCl. Subsamples were taken for immediate analysis for dissolved silicate following standard spectrophotometric methods.

A replicate set of trap tubes was prepared as described above, held in the shipboard laboratory during the deployment, and then analyzed in parallel to provide a process blank determination. The blanks from the three stations were averaged to determine the mean process blank for the cruise (Table 1, See Supplemental Docs, below).

Data Processing Description

For each analyte, the mean content of the process blank was subtracted from the corresponding sample value (Table 1), and blank-corrected values were divided by the trap collection area (0.0113 m2) and the deployment length to yield flux. The fluxes of each replicate sample at a given depth were averaged to yield the mean flux. Particulate organic carbon (POC) flux was computed as the difference between the mean TC flux and the mean PIC flux.

Problem report:
Station 1 was interrupted by a medical emergency requiring 48 hours to return to Honolulu. While the NBST lids closed on time, the trap sat at the surface an additional 48 hours prior to recovery. During Station 2, the NBST failed to stabilize at depth, oscillating between depths of 50 and 250 m. Upon recovery, this was found to be due to a malfunction in the trap's ability to retract its buoyancy piston, following saltwater leakage onto the controller. Station 2 flux observations are suspect but reported in order to illustrate consistency of analytical methods.

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- re-formatted date from yyyy/mm/dd to yyyy-mm-dd

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Data Files

File
NBST_flux.csv (Comma Separated Values (.csv), 745 bytes) MD5:cfab6d69854a8da96050631af168284f Primary data file for dataset ID 765429

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Supplemental Files

File
Table 1. sample analysis methods, means, replicates filename: NBST_flux_Table1.pdf (Portable Document Format (.pdf), 220.09 KB) MD5:995b47c77d56ec2790a7882b81f63b7a Table 1. sample analysis methods, means, replicates, and units

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Related Publications

Lamborg, C. H., Buesseler, K. O., Valdes, J., Bertrand, C. H., Bidigare, R., Manganini, S., Pike, S., Steinberg. D., Trull, T.,& Wilson, S. (2008). The flux of bio- and lithogenic material associated with sinking particles in the mesopelagic "twilight zone" of the northwest and North Central Pacific Ocean. Deep Sea Research Part II: Topical Studies in Oceanography, 55(14-15), 1540–1563. doi:10.1016/j.dsr2.2008.04.011
Methods

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Parameters

Parameter	Description	Units
station	station number	unitless
depth	target depth of NBST; programmed to hold depth within ±25 m	meters
date_start	date sampling began (GMT); formatted as yyyy-mm-dd	unitless

time_start	time sampling began (GMT); formatted as hh:mm:ss	unitless
date_end	date of tube lid closure (GMT); formatted as yyyy-mm-dd	unitless
time_end	time of tube lid closure (GMT); formatted as hh:mm:ss	unitless
date_recovery	date of package recovery (GMT); formatted as yyyy-mm-dd	unitless
time_recovery	time of package recovery (GMT); formatted as hh:mm:ss	unitless
lat_deploy	latitude of package deployment	decimal degs
lon_deploy	longitude of package deployment	decimal degs
lat_recover	latitude of package recovery	decimal degs
lon_recover	longitude of package recovery	decimal degs
deploy_length	length of sampling period	days
TC_f	total carbon flux	mmol/m^2/d
TC_f_err	standard deviation of total carbon flux replicate measurements	mmol/m^2/d
TC_f_replicates	number of replicates analyzed	replicates
PIC_f	particulate inorganic carbon flux	umol/m^2/d
PIC_f_err	standard deviation of particulate inorganic carbon flux replicate measurements	umol/m^2/d
PIC_f_replicates	number of replicates analyzed for particulate inorganic carbon	replicates
POC_f	particulate organic carbon flux; computed as the difference between mean TC flux and mean PIC flux	mmol/m^2/d
POC_f_err	standard deviation of the POC_f concentration calculated as: sdPOC_f = (sdTC_f^2 + sdPIC_f^2)^1/2	mmol/m^2/d

bSi_f	biogenic silica flux	umol/m^2/d
bSi_f_err	standard deviation of biogenic silica flux replicate measurements	umol/m^2/d
bSi_f_replicates	number of replicates analyzed	replicates
Mass_f	total mass flux	mg/m^2/d
Mass_f_err	standard deviation of total mass flux replicate measurements	mg/m^2/d
Mass_f_replicates	number of replicates analyzed	replicates

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Isotope-ratio Mass Spectrometer
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).

Dataset-specific Instrument Name	
Generic Instrument Name	Neutrally Buoyant Sediment Trap
Generic Instrument Description	In general, sediment traps are specially designed containers deployed in the water column for periods of time to collect particles from the water column falling toward the sea floor. The Neutrally Buoyant Sediment Trap (NBST) was designed by researchers at Woods Hole Oceanographic Institution. The central cylinder of the NBST controls buoyancy and houses a satellite transmitter. The other tubes collect sediment as the trap drifts in currents at a predetermined depth. The samples are collected when the tubes snap shut before the trap returns to the surface. (more: http://www.whoi.edu/instruments/viewInstrument.do?id=10286)

Dataset-specific Instrument Name	Spectrometer (flame atomic absorption)
Generic Instrument Name	Spectrometer
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	
Generic Instrument Name	Spectrophotometer
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

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Deployments

FK170124

Website	https://www.bco-dmo.org/deployment/732225
Platform	R/V Falkor
Report	https://datadocs.bco-dmo.org/docs/302/EAGER_DNA_BioPump/data_docs/DurkinOmandEstapa_Cruise_report.pdf
Start Date	2017-01-24
End Date	2017-02-20
Description	Station 1: 01/28/2017 17:45 to 02/02/2017 05:43 (GMT) Station2: 02/05/2017 16:06 to 02/08/2017 17:20 (GMT) Station3_dep1: 02/12/2017 04:23 to 02/13/2017 16:42 (GMT) Station3_dep2: 02/13/2017 17:48 to 02/14/2017 18:46 (GMT)

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Project Information

Collaborative Research: EAGER: Particle-specific DNA sequencing to directly observe ecological mechanisms of the biological pump (EAGER DNA BioPump)

Coverage: Eastern Pacific

NSF Award Abstract:
Carbon is fixed into organic matter by phytoplankton growing in the surface ocean, and is naturally sequestered in the ocean interior when particles and organisms sink: a process called the "biological pump." Because of its recognized influence on the global carbon cycle, ocean scientists have studied the biological pump for decades. However, we still do not have a sufficient understanding of the underlying processes to accurately quantify and predict carbon cycling. Much of this uncertainty stems from an inability to directly link specific plankton in the surface ocean with the types of particles sinking out of the surface ocean. To address this missing link in biological pump research, this work will directly observe how plankton are transported out of the surface ocean using novel, particle-specific observational approaches embedded within an interdisciplinary field program that will finely resolve upper ocean plankton groups and the resulting amount of sinking carbon across space and in time. The genetic identity of organisms within different types of sinking particles will be determined by sequencing the genetic contents of individually collected particles. This new application of a molecular method will definitively link surface plankton with sinking particles at five locations across the Pacific Ocean. This work has the potential to transform our understanding of the biological pump by identifying previously unknown links between surface ecosystems and sinking carbon particles. Because this work is embedded within an interdisciplinary field program, including biogeochemical modelers and remote sensing scientists, these data will feed directly into new models of the biological pump, improving our ability to quantify and predict carbon uptake by the ocean. This project will train 1 graduate student and at least 2

undergraduate researchers. Findings will be communicated to the non-scientific public through blogs, videos, and the public communication channels of participating institutions.

Accurate prediction of the global carbon cycle requires an understanding of the specific processes that link surface plankton communities and sinking particulate carbon flux (export) out of the surface ocean, but current methodological paradigms in biological pump research do not directly observe these processes. This project will comprehensively determine who is exported from the surface ocean and how using new, particle-resolving optical and molecular techniques embedded within a sampling scheme that characterizes export events at high time and space resolution. The investigation suggests that different plankton types in the surface waters are transported out of the surface ocean by distinct export pathways, and that an understanding of these connections is critical knowledge for global carbon cycle modeling. If successful, this work has the potential to transform our conceptual understanding of the biological pump by directly identifying mechanisms that link surface plankton with particle export, without relying on bulk sampling schemes and large-scale correlation analysis. Particle export environments will be studied at five open ocean locations during a cruise from Hawaii to Seattle in January-February 2017. The surface plankton communities will be characterized by a combination of satellite observations, sensors attached to a free-drifting, continuously profiling WireWalker, an in situ holographic camera, microscopy, and by sequencing 18S and 16S rRNA gene fragments. Exported particles will simultaneously be captured by various specialized sediment traps and their characteristics will be directly related to their sources in the surface community by identifying the genetic contents of individual particle types. Individual particles will be isolated from gel layers and the 16S and 18S rRNA gene fragments will be amplified and sequenced. This work would, for the first time, combine molecular approaches with particle-specific observations to enable simultaneous identification of both which organisms are exported and the processes responsible for their export.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1703664
NSF Division of Ocean Sciences (NSF OCE)	OCE-1703422
NSF Division of Ocean Sciences (NSF OCE)	OCE-1703336
National Aeronautics & Space Administration (NASA)	NASA-NNX14AM01G

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