Dissolved trace metal (Mn, Fe, Co, Ni, Cu, Zn, Cd, Pb) and labile particulate elemental (P, V, Mn, Fe, Co, Ni, Cu, Zn, Cd, Pb) concentrations from shipboard incubation experiments conducted on the 2018 EXPORTS cruise (RR1813) near Ocean Station PAPA

Website: https://www.bco-dmo.org/dataset/896884
Data Type: Cruise Results
Version: 1
Version Date: 2023-06-06

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
Buck, Kristen	University of South Florida (USF)	Principal Investigator, Contact
Brzezinski, Mark A.	University of California-Santa Barbara (UCSB-MSI)	Co-Principal Investigator
Jenkins, Bethany D.	University of Rhode Island (URI)	Co-Principal Investigator
Burns, Shannon M.	University of South Florida (USF)	Student
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Abstract
This dataset includes concentrations of dissolved (<0.4 micrometers (µm)) and labile particulate (0.4-5 µm and >5 µm) phosphorus (P), vanadium (V), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), cadmium (Cd), and lead (Pb) in shipboard incubation samples collected during the EXports Processes in the Oceans from RemoTe Sensing (EXPORTS) North Pacific (NP) cruise RR1813 on the R/V Roger Revelle near Ocean Station PAPA (Station P).

Table of Contents

Coverage

Temporal Extent: 2018-08-15 - 2018-09-06

Methods & Sampling

Seawater for six shipboard incubation experiments was collected using a surface towfish (Mellett and Buck 2020) at ~2 meters (m) depth on the R/V Roger Revelle between 15 August 2018 and 29 August 2018. Water was prefiltered through a 150-µm mesh to remove large grazers. For incubations (Inc) 1-2 and 4-5, water was homogenized into 20-liter (L) carboys, and three carboys were amended for each treatment indicated in Table 1 (see Supplemental Files), yielding triplicates for each treatment and timepoint sampled. Each carboy was sampled once at the indicated timepoints. Control carboys sampled at the beginning and end of each incubation were unique to the timepoint (i.e., no carboy was resampled over time). For Incs 3 and 6, water was first homogenized into two 20-L carboys, from which 4-L bottles were filled and amended with the treatments indicated in Table 1. Three 4-L bottles were amended for each treatment, and each 4-L bottle was sampled once at the indicated timepoints, yielding triplicates.

Incubations 1 and 4 were carried out for 24 hours, Inc 2 and 3 for 6 days, and Inc 5 and 6 for 8 days (Table 1). The nutrient amendments for each experiment were selected to induce nutrient stress. For Inc 2 and Inc 5, we refer to the +20 µM nitrate +1.25 µM phosphate +20 µM silicic acid treatment as "AllButFe" and the +20 µM nitrate +1.25 µM phosphate +5 nM $^{57}FeCl_3$ treatment as "AllButSi".

Dissolved (<0.4 µm) trace metal samples were collected in acid-cleaned 125-milliliter (mL) low-density polyethylene (LDPE, Nalgene) bottles, and acidified to 0.024 M hydrochloric acid (HCl, Fisher Optima). Dissolved trace metal (Fe, Cu, Mn, Co, Ni, Cu, Zn, Cd, Pb) concentrations were determined by high-resolution inductively coupled plasma mass spectrometry (HR-ICP-MS) at the University of South Florida (USF) on an Element XR (Hollister et al. 2020; Burns et al. 2023).

Leachable particulate trace metals were collected on 0.4-µm and 5-µm polycarbonate track etch (PCTE) filters, transferred into 1.5-mL high-density polyethylene (HDPE) snap-cap vials, and frozen at -20 degrees Celsius until processed. Filters were leached in a heated 25% acetic acid leach with a reducing step, "Berger Leach", at National High Magnetic Field Laboratory (NHMFL) to extract the leachable particulate trace metals (Berger et al. 2008). Leachable particulate elemental (P, V, Fe, Cu, Mn, Co, Ni, Cu, Zn, Cd, Pb) concentrations were determined by high-resolution inductively coupled plasma mass spectrometry (HR-ICP-MS) on an Element 2 with the assistance of Dr. Peter Morton of Florida State University (FSU).

Sample analyses for dissolved trace metals and leachable particulate trace metals were performed by Shannon Burns (USF). Detection limits and quality control results are presented in Table 2 (see Supplemental Files).

Data Processing Description

Data Processing:
Data were processed using ESI SC version 2.9.0.380.

Data Quality Flags:
The standard Ocean Data View (ODV) / SeaDataNet qualifying flags were used (reference all flags at http://vocab.nerc.ac.uk/collection/L20/current/). The notation 'na' = 'not applicable' was used for samples not analyzed.

1: Good Value: Good quality data value that is not part of any identified malfunction and has been verified as consistent with real phenomena during the quality control process. [Used when replicates were in good agreement and/or when dataset agreed with previously published results].
2: Probably Good Value: Data value that is probably consistent with real phenomena but this is unconfirmed. [Used when no replicates or published datasets to compare.]
3: Probably Bad Value: Data value recognized as unusual during quality control that forms part of a feature that is probably inconsistent with real phenomena. [Used when data not oceanographically consistent but replicate analyses agreed.]
4: Bad Value: An obviously erroneous data value. [Used when replicates did not agree].
5: Changed Value: Data value adjusted during quality control. [Not used.]
6: Value Below Detection Limit: The level of the measured phenomenon was too small to be quantified by the technique employed to measure it. Values are replaced with 'nd' for 'not detectable'. [See Table 2 for detection limits.]
7: Value in Excess: The level of the measured phenomenon was too large to be quantified by the technique employed to measure it. The accompanying value is the measurement limit for the technique. [Not used.]

BCO-DMO Processing:

- converted SAMPLE_DATE column to YYYY-MM-DD format;
- renamed fields to comply with BCO-DMO naming conventions.

[table of contents | back to top]

Data Files

File	
exports-np_tm_incubations.csv	(Comma Separated Values (.csv), 28.19 KB) MD5:fff85b20767752e649af094eb18a5d44
Primary data file for dataset ID 896884.	

[table of contents | back to top]

Supplemental Files

File	
Table 1 filename: Dataset_896884_Table_1.pdf	(Portable Document Format (.pdf), 465.06 KB) MD5:b68fd442193d2338055f03cd70f35d3e
Supplemental Table 1 to dataset ID 896884. Identifies incubation treatments and sampling points.	
Table 2 filename: Dataset_896884_Table_2.pdf	(Portable Document Format (.pdf), 504.65 KB) MD5:52e423b151b847e86600e9c063e69a27
Supplemental Table 2 to dataset ID 896884. Contains the average (Avg) concentration ± standard deviation (SD) for air (dissolved) and Milli-Q (MQ; filter) blanks, quality controls (QCs), and reference materials during dissolved and leachable particulate trace metal analyses. The limit of detection (LOD) for dissolved and leachable particulate trace analyses were determined from three times the standard deviation of the air blanks. An internal QC surface seawater sample was made from the North Pacific (NP) EXPORTS cruise in August 2018. Reference materials (SAFe S, GSP) with consensus values available on the GEOTRACES website (https://www.geotraces.org/standards-and-reference-materials/) were used. Notation 'na' = 'not applicable' was used when no value was available.	

[table of contents | back to top]

Related Publications

Berger, C. J. M., Lippiatt, S. M., Lawrence, M. G., & Bruland, K. W. (2008). Application of a chemical leach technique for estimating labile particulate aluminum, iron, and manganese in the Columbia River plume and coastal waters off Oregon and Washington. Journal of Geophysical Research, 113. doi:10.1029/2007jc004703 https://doi.org/10.1029/2007JC004703
Methods

Burns, S. M., Bundy, R. M., Abbott, W., Abdala, Z., Sterling, A. R., Chappell, P. D., Jenkins, B. D., & Buck, K. N. (2023). Interactions of bioactive trace metals in shipboard Southern Ocean incubation experiments. Limnology and Oceanography, 68(3), 525–543. Portico. https://doi.org/10.1002/lno.12290
Methods

Hollister, A. P., Kerr, M., Malki, K., Muhlbach, E., Robert, M., Tilney, C. L., Hubbard, K.A., & Buck, K. N. (2020). Regeneration of macronutrients and trace metals during phytoplankton decay: An experimental study. Limnology and Oceanography. doi:10.1002/lno.11429
Methods

Mellett, T., & Buck, K. N. (2020). Spatial and temporal variability of trace metals (Fe, Cu, Mn, Zn, Co, Ni, Cd, Pb), iron and copper speciation, and electroactive Fe-binding humic substances in surface waters of the eastern Gulf of Mexico. Marine Chemistry, 227: 103891. doi:10.1016/j.marchem.2020.103891
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
SAMPLE_DATE	Date when incubation sample was collected.	unitless
JULIAN_DAY	Day of year sampled.	unitless
EPOCH	Assigned time block (8 or 9 days each) during the cruise, #1-3.	unitless
EPOCH_DAY	Day within the epoch time block.	unitless
INCUBATION	Incubation number, #1-6.	unitless
TIMEPOINT	Stage of incubation, initial or final.	unitless
TREATMENT	Nutrient amendment; see Table 1 (Supplemental File)	unitless
REPLICATE	Incubations were conducted with triplicate bottles or carboys per treatment. Carboy (20-liters) or bottle (4-liters), #1-3.	unitless
Mn_D_CONC	Concentration of dissolved manganese (Mn).	nanomoles per liter (nM)
Mn_D_CONC_STDEV	Standard deviation of replicate analyses of this sample, or difference about the mean if n=2. When no replicate analyses were performed, the notation 'na' = 'not applicable' was used.	nanomoles per liter (nM)
Mn_D_CONC_n	Number of times this sample was analyzed.	unitless
Mn_D_CONC_Flag	Ocean Data View quality flag (see Processing Description for definitions) for Mn_D_CONC.	unitless
Fe_D_CONC	Concentration of total dissolved iron (Fe) in a sample. NOTE: Dissolved Fe concentrations in the incubations were higher than the towfish surface samples collected during incubation initiation. These samples were likely contaminated during incubation setup or sampling and are accompanied by Flag 3.	nanomoles per liter (nM)
Fe_D_CONC_STDEV	Standard deviation of replicate analyses of this sample, or difference about the mean if n=2. When no replicate analyses were performed, the notation 'na' = 'not applicable' was used.	nanomoles per liter (nM)
Fe_D_CONC_n	Number of times this sample was analyzed.	unitless
Fe_D_CONC_Flag	Ocean Data View quality flag (see Processing Description for definitions) for Fe_D_CONC.	unitless
ADD_Fe57_D_CONC	Concentration of added Fe-57 in a sample. In the treatments where no 57Fe was added, the notation 'na' = 'not applicable' was used.	nanomoles per liter (nM)
ADD_Fe57_D_CONC_STDEV	Standard deviation of replicate analyses of this sample, or difference about the mean if n=2. When no replicate analyses were performed, the notation 'na' = 'not applicable' was used.	nanomoles per liter (nM)
ADD_Fe57_D_CONC_n	Number of times this sample was analyzed.	unitless
ADD_Fe57_D_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for ADD_Fe57_D_CONC.	unitless
Co_D_CONC	Concentration of dissolved cobalt (Co).	picomoles per liter (pM)
Co_D_CONC_STDEV	Standard deviation of replicate analyses of this sample, or difference about the mean if n=2. When no replicate analyses were performed, the notation 'na' = 'not applicable' was used.	picomoles per liter (pM)
Co_D_CONC_n	Number of times this sample was analyzed.	unitless

Co_D_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Co_D_CONC.	unitless
Ni_D_CONC	Concentration of dissolved nickel (Ni).	nanomoles per liter (nM)
Ni_D_CONC_STDEV	Standard deviation of replicate analyses of this sample, or difference about the mean if n=2. When no replicate analyses were performed, the notation 'na' = 'not applicable' was used.	nanomoles per liter (nM)
Ni_D_CONC_n	Number of times this sample was analyzed.	unitless
Ni_D_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Ni_D_CONC.	unitless
Cu_D_CONC	Concentration of dissolved copper (Cu).	nanomoles per liter (nM)
Cu_D_CONC_STDEV	Standard deviation of replicate analyses of this sample, or difference about the mean if n=2. When no replicate analyses were performed, the notation 'na' = 'not applicable' was used.	nanomoles per liter (nM)
Cu_D_CONC_n	Number of times this sample was analyzed.	unitless
Cu_D_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Cu_D_CONC.	unitless
Zn_D_CONC	Concentration of dissolved zinc (Zn). NOTE: Dissolved Zn concentrations in the incubations were higher than the towfish surface samples collected during incubation initiation. These samples were likely contaminated during incubation setup or sampling and are accompanied by Flag 3.	nanomoles per liter (nM)
Zn_D_CONC_STDEV	Standard deviation of replicate analyses of this sample, or difference about the mean if n=2. When no replicate analyses were performed, the notation 'na' = 'not applicable' was used.	nanomoles per liter (nM)
Zn_D_CONC_n	Number of times this sample was analyzed.	unitless
Zn_D_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Zn_D_CONC.	unitless
Cd_D_CONC	Concentration of dissolved cadmium (Cd).	picomoles per liter (pM)
Cd_D_CONC_STDEV	Standard deviation of replicate analyses of this sample, or difference about the mean if n=2. When no replicate analyses were performed, the notation 'na' = 'not applicable' was used.	picomoles per liter (pM)
Cd_D_CONC_n	Number of times this sample was analyzed.	unitless
Cd_D_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Cd_D_CONC.	unitless
Pb_D_CONC	Concentration of dissolved lead (Pb).	picomoles per liter (pM)
Pb_D_CONC_STDEV	Standard deviation of replicate analyses of this sample, or difference about the mean if n=2. When no replicate analyses were performed, the notation 'na' = 'not applicable' was used.	picomoles per liter (pM)
Pb_D_CONC_n	Number of times this sample was analyzed.	unitless
Pb_D_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Pb_D_CONC.	unitless

P_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) phosphorus (P). The notation 'na' = 'not applicable' was used for samples not analyzed.	nanomoles per liter (nM)
P_SLP_CONC_Flag	Ocean Data View quality flag (see Processing Description for definitions) for P_SLP_CONC.	unitless
V_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) vanadium (V). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
V_SLP_CONC_Flag	Ocean Data View quality flag (see Processing Description for definitions) for V_SLP_CONC.	unitless
Mn_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) manganese (Mn). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
Mn_SLP_CONC_Flag	Ocean Data View quality flag (see Processing Description for definitions) for Mn_SLP_CONC.	unitless
Fe_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) iron (Fe). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
Fe_SLP_CONC_Flag	Ocean Data View quality flag (see Processing Description for definitions) for Fe_SLP_CONC.	unitless
ADD_Fe57_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) added iron-57 (Fe57). In the treatments where no 57Fe was added, the notation 'na' = 'not applicable' was used. The notation 'na' = 'not applicable' was also used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
ADD_Fe57_SLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for ADD_Fe57_SLP_CONC.	unitless
Co_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) cobalt (Co). The 'na' = 'not applicable' was used for samples not analyzed.	picomoles per liter (pM)
Co_SLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Co_SLP_CONC.	unitless
Ni_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) nickel (Ni). The 'na' = 'not applicable' was used for samples not analyzed.	nanomoles per liter (nM)
Ni_SLP_CONC_flag	Data quality flag for	unitless
Cu_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) copper (Cu). The notation 'na' = 'not applicable' was used for samples not analyzed.	nanomoles per liter (nM)
Cu_SLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Cu_SLP_CONC.	unitless
Zn_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) zinc (Zn). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)

Zn_SLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Zn_SLP_CONC.	unitless
Cd_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) cadmium (Cd). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	picomoles per liter (pM)
Cd_SLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Cd_SLP_CONC.	unitless
Pb_SLP_CONC	Concentration of small leachable particulate (SLP; 0.4-5 micrometer (um) size fraction) lead (Pb). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	picomoles per liter (pM)
Pb_SLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for P_SLP_CONC.	unitless
P_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) phosphorus (P). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
P_LLP_CONC_Flag	Ocean Data View quality flag (see Processing Description for definitions) for P_LLP_CONC.	unitless
V_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) vanadium (V). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
V_LLP_CONC_Flag	Ocean Data View quality flag (see Processing Description for definitions) for	unitless
Mn_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) manganese (Mn). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
Mn_LLP_CONC_Flag	Ocean Data View quality flag (see Processing Description for definitions) for Mn_LLP_CONC.	unitless
Fe_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) iron (Fe). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
Fe_LLP_CONC_Flag	Ocean Data View quality flag (see Processing Description for definitions) for Mn_LLP_CONC.	unitless
ADD_Fe57_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) added iron-57 (Fe57). In the treatments where no 57Fe was added, the notation 'na' = 'not applicable' was used. The notation 'na' = 'not applicable' was also used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
ADD_Fe57_LLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for ADD_Fe57_LLP_CONC.	unitless

Co_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) cobalt (Co). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	picomoles per liter (pM)
Co_LLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Co_LLP_CONC.	unitless
Ni_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) nickel (Ni). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
Ni_LLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Ni_LLP_CONC.	unitless
Cu_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) copper (Cu). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
Cu_LLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Cu_LLP_CONC.	unitless
Zn_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) zinc (Zn). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	nanomoles per liter (nM)
Zn_LLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Zn_LLP_CONC.	unitless
Cd_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) cadmium (Cd). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	picomoles per liter (pM)
Cd_LLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Cd_LLP_CONC.	unitless
Pb_LLP_CONC	Concentration of large leachable particulate (LLP; >5 micrometers (um) size fraction) lead (Pb). The notation 'na' = 'not applicable' was used for samples not analyzed. Values below the limit of detection [see Table 2 for detection limits] are replaced with 'nd' for 'not detectable' and accompanied by Flag 6 in the dataset.	picomoles per liter (pM)
Pb_LLP_CONC_flag	Ocean Data View quality flag (see Processing Description for definitions) for Pb_LLP_CONC.	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Element XR Inductively Coupled Plasma Mass Spectrophotometer
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	Element 2 Inductively Coupled Plasma Mass Spectrophotometer
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	SeaFAST pico
Generic Instrument Name	SeaFAST Automated Preconcentration System
Generic Instrument Description	The seaFAST is an automated sample introduction system for analysis of seawater and other high matrix samples for analyses by ICPMS (Inductively Coupled Plasma Mass Spectrometry).

Dataset-specific Instrument Name	surface towfish
Generic Instrument Name	towed unmanned submersible
Generic Instrument Description	A vehicle towed by rigid cable through the water column at fixed or varying depth with no propulsion and no human operator (e.g. Towfish, Scanfish, UOR, SeaSoar).

[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-1756816
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[table of contents | back to top]