Dissolved trace metal (Mn, Fe, Co, Ni, Cu, Zn, Cd, Pb) concentration data from surface (towfish) samples collected during 2018 EXPORTS North Pacific cruise to the subarctic North Pacific near Ocean Station PAPA (Station P) on R/V Roger Revelle RR1813.

Website: https://www.bco-dmo.org/dataset/869683
Data Type: Other Field Results
Version: 1
Version Date: 2022-03-10

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
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Abstract
Concentrations of dissolved (<0.2 µm) manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), cadmium (Cd), lead (Pb) in surface (~2 m) samples collected between 15 August 2018 and 6 September 2018 during EXports Processes in the Oceans from RemoTe Sensing (EXPORTS) cruise aboard RV Roger Revelle RR1813 at Ocean Station PAPA (Station P).

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Coverage

Spatial Extent: **N**:50.6634 **E**:-144.581 **S**:49.991 **W**:-145.419
Temporal Extent: 2018-08-15 - 2018-09-06

Acquisition Description

Surface (~2 m) water samples for dissolved trace metal concentrations were collected using a custom trace metal clean “towfish” sampling system (Mellett and Buck 2020) on the *R/V Roger Revelle* between 18 August and 6 September 2018. A total of 24 samples were filtered (<0.2 µm, Pall Acropak) inline, collected in acid-cleaned 125-mL low density polyethylene (LDPE, Nalgene) bottles, and acidified to 0.024 M hydrochloric acid (HCl, Fisher Optima). Samples were collected at sea by PhD student Travis Mellett (USF) and Dr. Salvatore Caprara (USF).

Processing Description

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 (Hollister et al. 2020). Data processing done with ESI SC version 2.9.0.380. Sample analyses for dissolved trace metals were performed by Shannon Burns (USF) with assistance from Dr. Salvatore Caprara (USF).

The standard Ocean Data View qualifying flags were used (reference all flags at http://vocab.nerc.ac.uk/collection/L20/current/).

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.
2: Probably Good Value: Data value that is probably consistent with real phenomena but this is unconfirmed [no replicates].
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. The accompanying value is the detection limit for the technique or zero if that value is unknown. [See Table 1 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].
8: Interpolated Value: This value has been derived by interpolation from other values in the data object. [Not used].
9: Missing Value: The data value is missing. Any accompanying value will be a magic number representing absent data. [Not used].
A: Value Phenomenon Uncertain: There is uncertainty in the description of the measured phenomenon associated with the value such as chemical species or biological entity. [Not used.]

Table 1 (see supplemental files): Average concentration ± standard deviation for relevant quality control samples (QCs), reference materials, and Milli-Q (MQ) blanks during dissolved trace metal analyses. A set of air blanks was run every seaFAST run. The limit of detection (LOD) for each dissolved element was calculated as 3 times the average SD of the air blanks. The QC surface seawater used was from the North Pacific (NP) EXPORTS cruise in August 2018. Reference materials (SAFe S, GSP) with consensus values were used. Consensus values for SAFe S and GSP are available on the GEOTRACES website (https://www.geotraces.org/standards-and-reference-materials/). *Dissolved Co and Cu concentrations are reported for UV-oxidized samples only. **Consensus values were converted to units of nM (Mn, Fe, Ni, Cu, and Zn) or pM (Co, Cd, and Pb) using average seawater density of 1.025 kg/L.

BCO-DMO processing notes:
* Added ISO_DateTime_UTC column to dataset.

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Supplemental Files

File
Quality control samples filename: quality_control_samples.pdf (Portable Document Format (.pdf), 161.95 KB) MD5:ea7987a6aec4bd74876d2eb960cfed5b *Average concentration ± standard deviation for relevant quality control samples (QCs), reference materials, and Milli-Q (MQ) blanks during dissolved trace metal analyses.*

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Related Publications

Hollister, A. P., Kerr, M., Malki, K., Muhlbach, E., Robert, M., Tilney, C. L., ... 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

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Parameters

Parameter	Description	Units
DATE	UTC date when sample was pulled from the towfish, in format YYYY-MM-DD	unitless
TIME_LOCAL	Local time (Alaska Standard Time, GMT-9) of sampling, in format HH:MM	unitless
TIME_UTC	UTC time of sampling, in format HH:MM	unitless
JULIAN_DAY	Day of year sampled.	unitless
ID	Sample ID, where TF stands for towfish.	unitless
LATITUDE	Latitude in decimal degrees North, north is positive.	decimal degrees
LONGITUDE	Longitude in decimal degrees East, west is negative	decimal degrees
Mn_D_CONC	Concentration of dissolved manganese (Mn)	nanomoles per liter (nM)
Mn_D_CONC_Flag	Standard Ocean Data View qualifying flag for dissolved manganese concentration. (1 = Good Value, 2 = Probably Good Value, 3 = Probably Bad Value, 4 = Bad Value, 5 = Changed Value, 6 = Value Below Detection Limit, 7 = Value in Excess, 8 = Interpolated Value, 9 = Missing Value, A = Value Phenomenon Uncertain). See Processing Notes for full flag details.	unitless
Fe_D_CONC	Concentration of total dissolved iron (Fe) in a sample. Some values were below the limit of detection (Flag 6) and the accompanying value is half of the detection limit for the technique (see Table 1).	nanomoles per liter (nM)
Fe_D_CONC_Flag	Standard Ocean Data View qualifying flag for dissolved iron concentration. (1 = Good Value, 2 = Probably Good Value, 3 = Probably Bad Value, 4 = Bad Value, 5 = Changed Value, 6 = Value Below Detection Limit, 7 = Value in Excess, 8 = Interpolated Value, 9 = Missing Value, A = Value Phenomenon Uncertain). See Processing Notes for full flag details.	unitless
Co_D_CONC	Concentration of dissolved cobalt (Co)	picomoles per liter (pM)

Co_D_CONC_flag	Standard Ocean Data View qualifying flag for dissolved cobalt concentration. (1 = Good Value, 2 = Probably Good Value, 3 = Probably Bad Value, 4 = Bad Value, 5 = Changed Value, 6 = Value Below Detection Limit, 7 = Value in Excess, 8 = Interpolated Value, 9 = Missing Value, A = Value Phenomenon Uncertain). See Processing Notes for full flag details.	unitless
Ni_D_CONC	Concentration of dissolved nickel (Ni)	nanomoles per liter (nM)
Ni_D_CONC_flag	Standard Ocean Data View qualifying flag for dissolved nickel concentration. (1 = Good Value, 2 = Probably Good Value, 3 = Probably Bad Value, 4 = Bad Value, 5 = Changed Value, 6 = Value Below Detection Limit, 7 = Value in Excess, 8 = Interpolated Value, 9 = Missing Value, A = Value Phenomenon Uncertain). See Processing Notes for full flag details.	unitless
Cu_D_CONC	Concentration of dissolved copper (Cu)	nanomoles per liter (nM)
Cu_D_CONC_flag	Standard Ocean Data View qualifying flag for dissolved copper concentration. (1 = Good Value, 2 = Probably Good Value, 3 = Probably Bad Value, 4 = Bad Value, 5 = Changed Value, 6 = Value Below Detection Limit, 7 = Value in Excess, 8 = Interpolated Value, 9 = Missing Value, A = Value Phenomenon Uncertain). See Processing Notes for full flag details.	unitless
Zn_D_CONC	Concentration of dissolved zinc (Zn). Some values were below the limit of detection (Flag 6) and the accompanying value is half of the detection limit for the technique (see Table 1).	nanomoles per liter (nM)
Zn_D_CONC_flag	Standard Ocean Data View qualifying flag for dissolved zinc concentration. (1 = Good Value, 2 = Probably Good Value, 3 = Probably Bad Value, 4 = Bad Value, 5 = Changed Value, 6 = Value Below Detection Limit, 7 = Value in Excess, 8 = Interpolated Value, 9 = Missing Value, A = Value Phenomenon Uncertain). See Processing Notes for full flag details.	unitless
Cd_D_CONC	Concentration of dissolved cadmium (Cd)	picomoles per liter (pM)
Cd_D_CONC_flag	Standard Ocean Data View qualifying flag for dissolved cadmium concentration. (1 = Good Value, 2 = Probably Good Value, 3 = Probably Bad Value, 4 = Bad Value, 5 = Changed Value, 6 = Value Below Detection Limit, 7 = Value in Excess, 8 = Interpolated Value, 9 = Missing Value, A = Value Phenomenon Uncertain). See Processing Notes for full flag details.	unitless
Pb_D_CONC	Concentration of dissolved lead (Pb)	picomoles per liter (pM)
Pb_D_CONC_flag	Standard Ocean Data View qualifying flag for dissolved lead concentration. (1 = Good Value, 2 = Probably Good Value, 3 = Probably Bad Value, 4 = Bad Value, 5 = Changed Value, 6 = Value Below Detection Limit, 7 = Value in Excess, 8 = Interpolated Value, 9 = Missing Value, A = Value Phenomenon Uncertain). See Processing Notes for full flag details.	unitless
ISO_DateTime_UTC	ISO notation of date and time of sampling, UTC timezone	unitless

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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	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).

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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

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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.

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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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756816
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756433
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756442

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