Biological, physical, and chemical data from surface Transect 5 on MV1405 (IRN-BRU)

Website: https://www.bco-dmo.org/dataset/876590
Data Type: Other Field Results
Version: 1
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Project
» OCE-RIG: Developing Molecular Bioassays for Evaluating Iron Status of Environmentally Relevant Diatoms (DiatomFeMolBio)
» Accomplishment Based Renewal: An iron limitation mosaic within the central California Current System (iron limitation mosaic)

Contributors	Affiliation	Role
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Abstract
Biological, physical, and chemical data from surface Transect 5 on MV1405 (IRN-BRU) collected in July 2014 in the California Current System.

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Coverage

Spatial Extent: **N**:39.4836 **E**:-124.412 **S**:37.5083 **W**:-127.317
Temporal Extent: 2014-07-13 - 2014-07-14

Dataset Description

The complete dataset for the ships underway system includes the following parameters: BOTTOM_DEPTH, TRUE_WIND_SPEED, BAROM_PRES, PAR, CORR_SST, CORR_SALINITY, FLUORESCENCE. This dataset is available via the Rolling Deck to Repository: rvdata.us/search/cruise/MV1405

Diatom 18S Amplicon Sequencing from California Current System Mesoscale Eddies. Available from: NCBI:BioProject: PRJNA743307

OCE-1259776 is credited since it generated the metal and nutrient data that are part of this dataset.

Methods & Sampling

Sampling location: California Current System 38 N -126 E depth of sampling ~2m

Nitrate-nitrite, Phosphate, Silicate: Samples were collected from a trace-metal clean towed-fish system (Bruland et al 2005), filtered through an acid-cleaned, seawater flushed 0.2 um Acropak filter capsule (Pall 500) and analyzed shortly after collection at sea using standard spectrophotometric methods (Parsons 1984) on a Lachat QuickChem 8000 Flow Injection Analysis System.

Dissolved iron and manganese samples were collected from a trace-metal clean towed-fish system (Bruland et al., 2005), filtered through an acid-cleaned, seawater flushed 0.2 um Acropak Supor 200 filter capsule (Pall), acidified at sea to pH 1.7-1.8 with quartz-distilled HCl and stored at room temperature until analysis. Once in the lab, samples were buffered to pH 6.0 +/- 0.2 with ammonium acetate and immediately pre-concentrated using Nobias-chelate PA1 chelating resin (concentration factor ~24). Extracts were analyzed on an Element XR High-Resolution Inductively Coupled Plasma Mass Spectrometer (HR ICP-MS) using techniques described initially in Biller and Bruland (2012) with adaptations listed in Parker et al. (2016).

Diatom Amplicon Sequencing: Whole seawater was collected from a trace-metal clean towed-fish system (Bruland et al 2005) and filtered onto 3 um polyester filters using a peristaltic pump system. Filters were preserved in RLTPlus buffer and immediately frozen in liquid nitrogen. For long term storage samples were maintained at -80 degrees celsius until extraction. DNA extraction, PCR amplification, and analysis followed that of Chappell et al. 2016 with modification listed in Oliver et al. 2021. Briefly, DNA and RNA were co-extracted using a Qiagen Allprep RNA/DNA mini kit. Diatom 18S was amplified from the DNA using diatom-specific primers modified for Illumina indexing. PCR products were purified, multiplexed using Illumina indices, and sequenced on an Illumina MiSeq desktop sequencer.

Data Processing Description

Processing of original SBE-45 data included interpolation between data points and identification of data where flow rate for sensors dropped below 1L/min (indicative of a filter clog or shipboard maintenance).

BCO-DMO Processing Notes:
* Added ISO formatted DateTime column

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Data Files

File	
ccst5_dataset_biogeochem-1.csv	(Comma Separated Values (.csv), 3.22 KB) MD5:98f3d1d38806058ff82f8a8a7200d578
Primary data file for dataset ID 876590	

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Related Publications

Biller, D. V., & Bruland, K. W. (2012). Analysis of Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb in seawater using the Nobias-chelate PA1 resin and magnetic sector inductively coupled plasma mass spectrometry (ICP-MS). Marine Chemistry, 130-131, 12–20. doi:10.1016/j.marchem.2011.12.001
Methods

Bruland, K. W., Rue, E. L., Smith, G. J., & DiTullio, G. R. (2005). Iron, macronutrients and diatom blooms in the Peru upwelling regime: brown and blue waters of Peru. Marine Chemistry, 93(2-4), 81–103. doi:10.1016/j.marchem.2004.06.011
Methods

Chappell, P., Armbrust, E., Barbeau, K., Bundy, R., Moffett, J., Vedamati, J., & Jenkins, B. (2019). Patterns of diatom diversity correlate with dissolved trace metal concentrations and longitudinal position in the northeast Pacific coastal-offshore transition zone. Marine Ecology Progress Series, 609, 69–86. doi:10.3354/meps12810
Methods

Old Dominion University. Diatom 18S Amplicon Sequencing from California Current System Mesoscale Cyclonic Eddies. 2021/07. Bethesda, MD: National Library of Medicine (US), National Center for Biotechnology Information; 2011-. Available from: http://www.ncbi.nlm.nih.gov/bioproject/PRJNA743307. NCBI:BioProject: PRJNA743307. https://www.ncbi.nlm.nih.gov/bioproject/PRJNA743307
References

Oliver, H., Zhang, W. G., Smith, W. O., Alatalo, P., Chappell, P. D., Hirzel, A. J., Selden, C. R., Sosik, H. M., Stanley, R. H. R., Zhu, Y., & McGillicuddy, D. J. (2021). Diatom Hotspots Driven by Western Boundary Current Instability. Geophysical Research Letters, 48(11). Portico. https://doi.org/10.1029/2020gl091943 https://doi.org/10.1029/2020GL091943
Methods

Parker, C. E., Brown, M. T., & Bruland, K. W. (2016). Scandium in the open ocean: A comparison with other group 3 trivalent metals. Geophysical Research Letters, 43(6), 2758–2764. Portico. https://doi.org/10.1002/2016gl067827 https://doi.org/10.1002/2016GL067827
Methods

Parsons, T. R., Maita, Y., & Lalli, C.M. (1984). A manual of chemical and biological methods for seawater analysis. Pergamon Press. doi:10.1016/c2009-0-07774-5 https://doi.org/10.1016/C2009-0-07774-5
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Parameters

Parameter	Description	Units
DATE_TIME	GMT date and time where samples were collected from underway system in MM/DD/YY HH:MM format	unitless
LATITUDE	Position of ship when samples were collected from underway system in decimal degrees N	decimal degrees
LONGITUDE	Position of ship when samples were collected from underway system in decimal degrees E	decimal degrees
T5_STN_NO	Station number given to the sample collection along the T5 transect	unitless
BOTTOM_DEPTH	Depth of the water column	meters (m)
TRUE_WIND_SPEED	Wind speed	meters (m) per second (s)
BAROM_PRES	Barometric Pressure	millibars (mb)
PAR	surface photoactive radiation	uE/second/meter^2
CORR_SST	Sea surface temperature	degrees celcius
CORR_SALINITY	salinity	unitless
FLUORESCENCE	chlorphyll fluroescence	ug/l
CORR_NO3	concentration of dissolved nitrate+nitrite	micromoles per liter (uM)
CORR_PO4	concentration of dissolved phosphate	micromoles per liter (uM)
CORR_SiO4	concentration of dissolved silicic acid	micromoles per liter (uM)
DFe	concentration of dissolved iron. Noted as na when no data available for this sample, no sample analyzed or obviously erroneous data value	nanomoles per kg seawater (nmol/kg)
DMn	concentration of dissolved manganese. Noted as na when no data available for this sample, no sample analyzed or obviously erroneous data value	nanomoles per kg seawater (nmol/kg)
BIOPROJECT_ACCESSION	NCBI SRA Bioproject accession number for diatom 18S amplicon sequencing.	unitless
BIOSAMPLE_ACCESSION	NCBI SRA Biosample accession number for diatom 18S amplicon sequencing.	unitless
ISO_DateTime_UTC	Date and time (UTC) where samples were collected from underway system in ISO format (yyyy-mm-ddThh:mmZ)	unitless

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Instruments

Dataset-specific Instrument Name	WindmasterPro Anemometer (Gill Instruments)
Generic Instrument Name	Anemometer
Dataset-specific Description	WindmasterPro Anemometer (Gill Instruments)
Generic Instrument Description	An anemometer is a device for measuring the velocity or the pressure of the wind. It is commonly used to measure wind speed. Aboard research vessels, it is often mounted with other meteorological instruments and sensors.

Dataset-specific Instrument Name	Illumina MiSeq desktop sequencer
Generic Instrument Name	Automated DNA Sequencer
Dataset-specific Description	Amplicon sequencing: PCRs were performed on a Life Technologies SimpliAmp Thermal Cycler and sequencing was performed using an Illumina MiSeq desktop sequencer.
Generic Instrument Description	General term for a laboratory instrument used for deciphering the order of bases in a strand of DNA. Sanger sequencers detect fluorescence from different dyes that are used to identify the A, C, G, and T extension reactions. Contemporary or Pyrosequencer methods are based on detecting the activity of DNA polymerase (a DNA synthesizing enzyme) with another chemoluminescent enzyme. Essentially, the method allows sequencing of a single strand of DNA by synthesizing the complementary strand along it, one base pair at a time, and detecting which base was actually added at each step.

Dataset-specific Instrument Name	Lachat QuickChem 8000 Flow Injection Analysis System
Generic Instrument Name	Flow Injection Analyzer
Dataset-specific Description	Nitrate-nitrite, Phosphate, Silicate: Lachat QuickChem 8000 Flow Injection Analysis System
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	ThermoFisher Element XR High-Resolution Inductively Coupled Plasma Mass Spectrometer
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Dissolved iron and manganese: ThermoFisher Element XR High-Resolution 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	Sea-Bird SBE-45
Generic Instrument Name	Sea-Bird SBE 45 MicroTSG Thermosalinograph
Dataset-specific Description	SST and Salinity: Sea-Bird SBE-45
Generic Instrument Description	A small externally powered, high-accuracy instrument, designed for shipboard determination of sea surface (pumped-water) conductivity and temperature. It is constructed of plastic and titanium to ensure long life with minimum maintenance. It may optionally be interfaced to an external SBE 38 hull temperature sensor. Sea Bird SBE 45 MicroTSG (Thermosalinograph)

Dataset-specific Instrument Name	Life Technologies SimpliAmp Thermal Cycler
Generic Instrument Name	Thermal Cycler
Dataset-specific Description	Amplicon sequencing: PCRs were performed on a Life Technologies SimpliAmp Thermal Cycler and sequencing was performed using an Illumina MiSeq desktop sequencer.
Generic Instrument Description	A thermal cycler or "thermocycler" is a general term for a type of laboratory apparatus, commonly used for performing polymerase chain reaction (PCR), that is capable of repeatedly altering and maintaining specific temperatures for defined periods of time. The device has a thermal block with holes where tubes with the PCR reaction mixtures can be inserted. The cycler then raises and lowers the temperature of the block in discrete, pre-programmed steps. They can also be used to facilitate other temperature-sensitive reactions, including restriction enzyme digestion or rapid diagnostics. (adapted from http://serc.carleton.edu/microbelife/research_methods/genomics/pcr.html)

Dataset-specific Instrument Name	Turner 10AU fluorometer
Generic Instrument Name	Turner Designs Fluorometer 10-AU
Dataset-specific Description	Fluorescence: Turner 10AU fluorometer (calibrated on ship using discrete chlorophyll analysis)
Generic Instrument Description	The Turner Designs 10-AU Field Fluorometer is used to measure Chlorophyll fluorescence. The 10AU Fluorometer can be set up for continuous-flow monitoring or discrete sample analyses. A variety of compounds can be measured using application-specific optical filters available from the manufacturer. (read more from Turner Designs, turnerdesigns.com, Sunnyvale, CA, USA)

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Deployments

MV1405

Website	https://www.bco-dmo.org/deployment/559966
Platform	R/V Melville
Start Date	2014-07-03
End Date	2014-07-26
Description	Deployment MV1405 on R/V Melville. Cruise took place during July 2014.

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Project Information

OCE-RIG: Developing Molecular Bioassays for Evaluating Iron Status of Environmentally Relevant Diatoms (DiatomFeMolBio)

This project focuses on an important group of photosynthetic algae, the diatoms, and how iron availability modulates their growth. Diatoms are important organisms at the base of the marine food web. Iron is required for the structure and function of proteins essential to diatom growth. Iron concentrations can be low in many areas of the ocean and exists in different forms classified by size and chemical characteristics. Recent efforts have increased understanding of the distribution of these different iron forms, but which forms individual phytoplankton can access remains unclear. The investigator will conduct experiments with important diatom species to develop and use assays that can assess whether iron provided in different forms or from different sources can be accessed by those species to alleviate iron stress. These data will help us understand the relationship between iron and an important group of organisms at the base of the food web, which will prove valuable to climate and food web modelers. This project will further the NSF goals of training new generations of scientists and making scientific discoveries available to the general public. The project supports the research of an early-career scientist, the training of undergraduate and high school students, including inner city middle and high school girls.

The project combines trace metal biogeochemistry, phytoplankton cultivation, and molecular biology to address questions about the bioavailability of various iron forms to environmentally relevant diatoms. Iron is an essential micronutrient for marine phytoplankton. While knowledge of the distribution of iron has increased significantly as a result of the ongoing GEOTRACES program, a mechanistic and quantitative understanding of the bioavailability of various forms of iron remains illusive. Previously, the investigator developed a calibrated

molecular bioassay capable of indicating when a specific oceanic diatom was experiencing iron stress. It has been used to evaluate iron stress in oceanic field samples and in incubation samples in response to additions of different iron fractions. The goal of this proposal is to develop additional calibrated molecular assays for iron stress in other environmentally relevant diatoms from both coastal and oceanic habitats and use them to asses the biological availability of iron from varying sources. The experimental plan includes culture experiments monitoring growth, photosynthetic physiology, and gene expression of iron stress response genes. The molecular assays will then be used to test whether iron from a variety of sources can alleviate iron stress in the different species. Results from this project will provide tools to answer fundamental questions about the bioavailability of various forms of iron to important phytoplankton. As such, this research will provide valuable information for biogeochemical modelers, increasing their ability to use the data generated from the GEOTRACES program to accurately predict future changes in ocean productivity.

Accomplishment Based Renewal: An iron limitation mosaic within the central California Current System (iron limitation mosaic)

NSF Award Tracking

Eastern boundary upwelling systems have long been recognized for their high phytoplankton productivity. Carr and Kearns (2003), in a detailed comparison of eastern boundary current systems, reported that biomass sustained by a given macronutrient concentration in Atlantic eastern boundary current systems was twice as large as those systems in the Pacific. The authors concluded "It is not clear whether the apparent difference in biomass supported by available nutrients is due to differences in the efficiency of the phytoplankton community, perhaps related to the availability of iron, or to grazing pressure." They suggested that the width of the shelf might be considered a proxy for the benthic availability of iron. The lowest biomass for a given macronutrient concentration was in the Peru-Humboldt Current and in the northern California region of the California Current System, both areas with low dust inputs and a relatively narrow shelf.

In this Accomplishment Based Renewal project, a marine trace metal geochemist at the University of California - Santa Cruz and his students and colleagues will continue a decades-old quest to understand the role of iron in the central California Current System (cCCS). Field efforts will combine continuous underway iron and nutrient data in surface waters and a series of vertical profiles. The focus will include three regions within the cCCS: a variety of active Fe-replete and Fe-deplete coastal upwelling regimes, the eddy-rich California Current transition zone that is Fe-limited and has elevated nitrate but relatively low and uniform chlorophyll concentrations, and the offshore, oligotrophic California Current. They will map surface and depth distributions of Fe and other micro- and macronutrients. There are four specific goals dealing with characterizing the organic Fe(III)-binding organic ligands, determining Fe(II) and Fe(III) concentrations in hypoxic waters over the shelf, examining the exchange between particulate and dissolved forms of Fe, and studying the roles of eddies in the eddy-rich transition waters of the cCCS.

Broader Impacts

Direct Benefits to Science: There is a great deal of interest in the CCS because of its importance in terms of phytoplankton productivity and the support of higher trophic levels. Until now, the emphasis in studies of the CCS has been on relationships between physics and biology. This study will insert the important role of micronutrient chemistry into the picture. It will also serve an important role in securing ship time in advance and providing logistical support for other collaborative studies. This is extremely valuable and cost effective for collaborating scientists since with the hydrography, nutrient and trace metal data provided, they can focus on their complimentary research efforts.

Outreach and Education: The project will provide funding for two current graduate students at UCSC, where they will also receive course training in a curriculum that includes i) scientific communication, ii) careers in marine science, and iii) grant writing. A broader impact goal of this project is to facilitate teaching and learning on marine science-related topics through translating research objectives into widely distributed educational materials for classroom use. To accomplish this, the team will partner with the Seymour Discovery Center at the Long Marine Lab, UCSC. The Discovery Center receives 14,000 visitors each year, and the project will provide funds to develop an interactive display on limiting nutrients and phytoplankton bloom development in the CCS.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1524482
NSF Division of Ocean Sciences (NSF OCE)	OCE-1259776

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