Dissolved and particulate Fe and Sc concentrations, chlorophyll, nutrients from a scandium incubation experiment during the PUPCYCLE I R/V Ocean cruise 1905B in the California Current System in 2019

Website: https://www.bco-dmo.org/dataset/940093
Data Type: Cruise Results, experimental
Version: 1
Version Date: 2024-10-10

Project
» CAREER: An integrated molecular and physiological approach to examining the dynamics of upwelled phytoplankton in current and changing oceans (Upwelled Phytoplankton Dynamics)

Contributors	Affiliation	Role
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Abstract
We performed an incubation experiment with added dissolved scandium and/or iron in waters sampled in the California Current System during the PUPCYCLE I cruise in 2019 with Chief Scientist Adrian Marchetti. PUPCYCLE I (Phytoplankton response to the UPwelling CYCLE) took place in summer 2019 onboard the R/V Oceanus (OC 1905b). Water for the incubation was collected from 15 m just off the Big Sur coast 2 June 2019. This was in a region with an extremely narrow shelf. There were five total treatments run in triplicate: control (no addition), +5 nmol/kg dissolved Fe, +5 nmol/kg dissolved Sc, +5 nmol/kg dissolved Fe and +5 nmol/kg dissolved Sc, and filtered seawater with +5 nmol/kg dissolved Fe and +5 nmol/kg dissolved Sc. After 24 hours incubating, the incubation was harvested and analyzed for chlorophyll, nutrients, and dissolved and particulate Fe and Sc concentrations. The effort was to investigate similarities and differences in the oceanic chemical cycling of Fe and Sc.

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Coverage

Location: California Current System, just offshore the Big Sur coast, 35°55.4'N, 121°32.4'W

Spatial Extent: **Lat**:35.92333 **Lon**:-121.54
Temporal Extent: 2019-06-02

Dataset Description

See the "Related Datasets" section for other datasets from this experiment.

Methods & Sampling

Sampling:

Seawater for the incubation was collected from ~15m at 35°55.4'N, 121°32.4'W using acid-cleaned HDPE tubing taped directly to the amsteel blue line. A lead weight coated with fiberglass and epoxy paint was at the bottom of the line. The pump was a teflon Wilden air-operated double-diaphragm pump. The tubing was run into a trace metal clean positive pressure bubble, where it was homogenized in acid-cleaned 50 gallon plastic barrels. From there, 4L cubitainers for the different treatments were rinsed and filled with the homogenized seawater, and then spiked appropriately based on treatment. These cubitainers had been pre-cleaned using the methods of Crawford et al. 2003.

The incubation setup:

We had five different treatments, with three replicates each:
control: no addition
+Fe: 5 nmol/kg added dissolved Fe
+Sc: 5 nmol/kg added dissolved Sc
+Fe and +Sc: 5 nmol/kg each of dissolved Sc and Fe added

filtered +Fe and + Sc: the seawater was filtered with 0.2 micrometer pre-cleaned supor Acropak filter before rinsing and filling the cubitainer, and then spiking with 5 nmol/kg each of dissolved Sc and Fe.

The cubitainers were incubated in an on-deck plexiglass incubator that was surface-seawater chilled and covered with a screening to achieve 30% of the incident irradiance. After 24 hours, the incubation was ended and each treatment was harvested.

Sample analysis:

Dissolved metals: Samples were filtered in a trace metal clean bubble to 0.2 micrometers with a pre-cleaned supor Acropak filter, and acidified to pH 1.8 at sea with optima HCl. Samples were analyzed post-cruise using the methods of Biller and Bruland (2012) with modifications as described in Parker et al. (2016). Briefly this method involves preconcentrating the metals of interest on a PA1 chelating resin at pH 6.0 +/- 0.2 and analyzing the extracts on an Element 2 Extended Range ICP-MS. Standard addition curves are made in low-metal seawater for calibration, and blanks are quantified by loading less than 0.5 mL of low-metal seawater on the columns and extracting as usual. Rhodium is used as an internal standard. Samples were analyzed in the Till lab by PI Till and undergraduate Freiberger.

Nutrients samples were filtered to 0.2 micrometers using the same Acropak filters and frozen at sea. They were analyzed by the Wetland Biogeochemistry Analytical Services at Louisiana State University using OI Analytical Flow Solutions IV segmented flow auto analyzer methologies.

Chlorophyll concentrations were measured by Emily Pierce and YuanYu Lin in the Marchetti lab, with two different filter sizes: 0.7 and 5 micrometers. Chlorophyll a (Chl a) measurements were obtained by gravity filtering seawater through a 5 µm polycarbonate filter followed by vacuum filtration through a GF/F filter using a series filter cascade for size fractionation. Filters were frozen at −80degC until analysis. Extractions were performed ship-board using 90% acetone kept at −20decC for 24 h followed by fluorometric quantification with a Turner Designs 10-AU fluorometer using the acidification method (Parsons et al. 1984).

BCO-DMO Processing Description

* Sheet 1 of submitted file "May 2019 Sc incubation for BCO-DMO.xlsx" was imported into the BCO-DMO data

system for this dataset.
** In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]

* and additional column was added "dissolved_Sc_flag" to contain the "

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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

Crawford, D. W., Lipsen, M. S., Purdie, D. A., Lohan, M. C., Statham, P. J., Whitney, F. A., Putland, J. N., Johnson, W. K., Sutherland, N., Peterson, T. D., Harrison, P. J., & Wong, C. S. (2003). Influence of zinc and iron enrichments on phytoplankton growth in the northeastern subarctic Pacific. Limnology and Oceanography, 48(4), 1583–1600. Portico. https://doi.org/10.4319/lo.2003.48.4.1583
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
Methods

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Related Datasets

IsRelatedTo

Hurst, M. P., Till, C. P., Marchetti, A. (2024) **Particulate metals from a scandium incubation experiment during the PUPCYCLE I R/V Ocean cruise 1905B in the California Current System in 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-10-10 http://lod.bco-dmo.org/id/dataset/940088 [view at BCO-DMO]
Relationship Description: Dataset "A scandium incubation experiment during the PUPCYCLE I cruise in the California Current System in 2019" (940093) is the leachable particulate data for the same incubation experiment as "Particulate metals from the scandium incubation experiment on PUPCYCLE I in the California Current System in 2019" dataset (940088).

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Parameters

Parameter	Description	Units
Label	The name of each sample	unitless
Timepoint	Timepoint (hours). how long the particular sample incubated for (24 hours in most cases; 0 hours for measurements of the initial conditions before the incubation)	hours
Treatment	Description of the treatment for the particular sample	unitless
Replicate	There were three replicates for each treatment. This parameter serves to disambiguate them.	unitless
Chl_gt_5um	Chlorophyll concentration for the greater than 5 micrometers size fraction	micrograms per liter (ug/L)
Chl_gt_0pt7um	Chlorophyll concentration for the greater than 0.7 micrometers size fraction	micrograms per liter (ug/L)
NO3	Nitrate concentration	micromolar (uM)
PO4	Phosphate concentration	micromolar (uM)
SiO2	Silicate concentration (silicon dioxide)	micromolar (uM)
dissolved_Fe	Dissolved (less than 0.2 micrometers) iron concentration	nanomoles per kilogram (nmol/kg)
dissolved_Sc	dissolved (less than 0.2 micrometers) scandium concentration. Detection limits, defined as 3x the standard deviation of the blank, were 0.1 nmol/kg for Fe and 1.4 pmol/kg for Sc. See column "dissolved_Sc_flag" for information about where measurements were below detection limit.	picomoles per kilogram (pmol/kg)
dissolved_Sc_flag	Flag for the dissolved_Sc column. The value "<LOD" is indicated where dissolved_Sc was below detection limit and came out negative. The one datapoint that was below detection limit but came out positive is left in the dataset as an indication of magnitude. Detection limits, defined as 3x the standard deviation of the blank, were 0.1 nmol/kg for Fe and 1.4 pmol/kg for Sc.	unitless

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Instruments

Dataset-specific Instrument Name	Thermo Element XR
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Trace metal extracts were analyzed with a Thermo Element XR magnetic sector inductively coupled plasma mass spectrometer (ICP-MS)
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	
Generic Instrument Name	Turner Designs Fluorometer 10-AU
Dataset-specific Description	Chlorophyll measurements were made with a Turner Designs 10-AU fluorometer
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

OC1905B

Website	https://www.bco-dmo.org/deployment/940128
Platform	R/V Oceanus
Start Date	2019-05-24
End Date	2019-06-06

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Project Information

CAREER: An integrated molecular and physiological approach to examining the dynamics of upwelled phytoplankton in current and changing oceans (Upwelled Phytoplankton Dynamics)

Coverage: California Upwelling Zone

NSF Award Abstract:
Upwelling zones are hotspots of photosynthesis that are very dynamic in space and time. Microsocopic algae, known as phytoplankton, bloom when deep, nutrient-rich waters are upwelled into sunlit surface layers of the

ocean, providing nourishment that supports productive food webs and draws down carbon dioxide (CO2) from the atmosphere to the deep ocean. Photosynthetic microbes in these regions must constantly adapt to changes in their chemical and physical environments. For example, subsurface populations respond to changes in light as they approach the surface. When upwelled waters move offshore, cells sink out of the illuminated zone, establishing seed populations that remain inactive until the next upwelling event. This process is called the upwelling conveyor belt cycle (UCBC). How phytoplankton respond to these changes in environmental conditions and how they may influence their nutrient requirements remains unknown. With future ocean changes predicted to alter seawater chemistry, including ocean acidification and decreased iron availability, some phytoplankton groups may be more vulnerable than others. Accompanying educational activities provide learning experiences to enhance understanding and awareness of marine microbes. The development of a research hub at UNC aims to provide infrastructure and support for scientists and students conducting research on environmental genomics. A laboratory component for an upper-level undergraduate course focused on marine phytoplankton is being developed. Educational outreach activities to broader communities include creation of a lesson plan on phytoplankton in upwelling zones and a virtual research cruise experience for middle-school students, as well as a hands-on lab activity for a local museum focused on marine phytoplankton and the important roles they play in shaping our planet.

The project examines how phytoplankton respond at the molecular and physiological level to the different UCBC stages, which seed populations (i.e., surface versus subsurface) contribute most to phytoplankton blooms during upwelling events of varying intensity, how phytoplankton elemental compositions are altered throughout UCBC stages, and how future predicted ocean conditions will affect the phytoplankton responses to UCBC conditions. This project contains both laboratory and fieldwork. In the laboratory, phytoplankton isolates recently obtained from upwelling regions are exposed to simulated UCBC conditions to examine changes in gene expression, growth and photosynthetic characteristics and elemental composition. Cultures are subjected to both current and future ocean conditions, including reduced iron availability and higher CO2. In the field, research cruises within upwelling regions study the dynamics of natural phytoplankton communities (both surface and subsurface) experiencing upwelling and relaxation and within simulated upwelling incubation experiments. Knowledge of how phytoplankton are affected by UCBC conditions at an integrated molecular, physiological and elemental level under both current and future scenarios is imperative for the proper conservation and management of these critically important ecosystems.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1751805

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