Rates of primary and bacterial production measured in situ under ambient and elevated pCO2 (750 µatm) from the Hawaiian Ocean Time Series near Station ALOHA from 2010-2011.

Website: https://www.bco-dmo.org/dataset/726341
Data Type: Cruise Results
Version: 1
Version Date: 2018-03-15

Project
» Oceanic diazotroph community structure and activities in a high carbon dioxide world (DIAZOTROPHS-CO2)

Program
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
Church, Matthew J.	University of Hawaii (UH)	Principal Investigator
Letelier, Ricardo	Oregon State University (OSU-CEOAS)	Co-Principal Investigator
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Abstract
Rates of primary and bacterial production measured in situ under ambient and elevated pCO2 (750 µatm) from the Hawaiian Ocean Time Series near Station ALOHA from 2010-2011.

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Coverage

Spatial Extent: **N**:25.4193 **E**:-160.7528 **S**:22.7485 **W**:-167.9648
Temporal Extent: 2010-08-21 - 2011-03-16

Dataset Description

This data was used in Viviani et al (2018). For related research of experimental work done on some of the same cruises and drawn from some of the same experiments but reporting different parameters, see Bottjer et al (2014).

Methods & Sampling

Rates of primary production were assessed using the 14C-bicarbonate incorporation technique. Rates of bacterial production were assessed using incorporation of 3H-leucine. Whole seawater samples from six discrete depths (5, 25, 45, 75, 100, and 125 m) were collected into duplicate acid-washed 20 L carboys. Control carboys were unamended; 43 mL of 1.0 N HCl and 4 mmol sodium bicarbonate were added to a treatment carboy at each depth, to increase the pCO2 to ~750 µatm, while minimizing changes to total alkalinity. Water from control and treatment carboys were then each subsampled into acid washed 500 mL polycarbonate bottles, with triplicate bottles per depth and treatment. To each bottle, was then added ~1.85 MBq 14C-bicarbonate. Water from each depth and treatment was also added to acid-cleaned 40 mL polycarbonate centrifuge tubes, each tube was then inoculated with 3H-leucine to a final concentration of 20 nmol L-1. For each depth and treatment, there was a dark (in a opaque cloth bag) and light incubation. Time zero blanks were immediately subsampled from each tube, by aliquoting 1.5 mL of seawater into 2 mL microcentrifuge tubes each containing 100 µL of 100% TCA. Following addition of radioactive substrates, the bottles and tubes were affixed to a free-drifting array and incubated *in situ* at the original depth of sample collection from dawn to dusk.

Upon recovery of the array, the total radioactivity added to each primary production sample bottle was determined by subsampling 250 µL aliquots of seawater into scintillation vials containing 500 µL of β-phenylethylamine. 400 mL from each 500 mL sample bottle was filtered at low vacuum (<50 mm Hg) onto 25 mm diameter, 10 µm porosity polycarbonate membrane filters. The filtrate was collected and filtered onto 25 mm diameter 2 µm porosity polycarbonate membrane filters. 100 mL of that filtrate was then filtered onto 25 mm diameter 0.2 µm porosity polycarbonate membrane filters. Filters were stored frozen in 20 mL scintillation vials until analysis. Analysis consisted of acidification via addition of 1 mL of 2 N hydrochloric acid, and passively venting at least 24 hours in a fume hood to remove all inorganic 14C. Addition of 10 mL Ultima Gold LLT liquid scintillation cocktail and counting on a Perkin Elmer 2600 liquid scintillation counter completed the primary production analysis.

Upon recovery of the array, triplicate 1.5 mL subsamples were removed from each polycarbonate tube for bacterial production rate measurements, and aliquoted into 2 mL microcentrifuge tubes containing 100 µL of 100% TCA. The microcentrifuge tubes were frozen (-20°C) for subsequent processing, following the procedures described in Smith and Azam 1992.

Samples for the determination of dissolved inorganic carbon and total alkalinity were collected from each carboy and analyzed according to the protocols of the Hawaii Ocean Time-series (Dore et al. 2009; Winn et al. 1998). DIC and TA samples were collected into precombusted 300 mL borosilicate bottles. Care was taken to avoid introduction of air bubbles into samples during filling; bottles were allowed to overflow three times during filling. Once filled, samples were immediately fixed with 100 µL of a saturated solution of mercuric chloride; bottles were capped with a grease seal, and stored in the dark for later analysis.

Samples for measurement of fluorometric chlorophyll *a* were collected according to the protocols of the Hawaii Ocean Time-series; analysis was performed following Letelier et al. (1996).

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Data Files

File
726341.csv (Comma Separated Values (.csv), 6.78 KB) MD5:a0ee8f48464bbf09d0fa7972e8aabb1a Primary data file for dataset ID 726341

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Related Publications

Böttjer, D., Karl, D. M., Letelier, R. M., Viviani, D. A., & Church, M. J. (2014). Experimental assessment of diazotroph responses to elevated seawaterpCO2in the North Pacific Subtropical Gyre. Global Biogeochemical Cycles, 28(6), 601–616. doi:10.1002/2013gb004690 https://doi.org/10.1002/2013GB004690
Related Research

Dore, J. E., Lukas, R., Sadler, D. W., Church, M. J., & Karl, D. M. (2009). Physical and biogeochemical modulation

of ocean acidification in the central North Pacific. Proceedings of the National Academy of Sciences, 106(30), 12235–12240. doi:10.1073/pnas.0906044106
Methods

Letelier, R. ., Dore, J. E., Winn, C. D., & Karl, D. M. (1996). Seasonal and interannual variations in photosynthetic carbon assimilation at Station. Deep Sea Research Part II: Topical Studies in Oceanography, 43(2-3), 467–490. doi:10.1016/0967-0645(96)00006-9
Methods

Smith, D.C. and F. Azam (1992). A simple, economical method for measuring bacterial protein synthesis rates in seawater using 3H-leucine. Marine Microbial Food Webs 6:107-114
http://www.gso.uri.edu/dcsmith/page3/page19/assets/smithazam92.PDF
Methods

Viviani, D. A., Böttjer, D., Letelier, R. M., & Church, M. J. (2018). The influence of abrupt increases in seawater pCO2 on plankton productivity in the subtropical North Pacific Ocean. PLOS ONE, 13(4), e0193405. doi:10.1371/journal.pone.0193405
Results

Winn, C. D., Li, Y.-H., Mackenzie, F. T., & Karl, D. M. (1998). Rising surface ocean dissolved inorganic carbon at the Hawaii Ocean Time-series site. Marine Chemistry, 60(1-2), 33–47. doi:10.1016/s0304-4203(97)00085-6
https://doi.org/10.1016/S0304-4203(97)00085-6
Methods

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Parameters

Parameter	Description	Units
cruise_id	cruise identification number	no units
station	station number	text
cast	cast number	unitless
date	date sampling began; format: YYYYMMDD	unitless
year	year of sample; format: YYYY	unitless
month	month of sample; format: MM	unitless
day	day of sample; format: DD	unitless
time	time of sampling; format: hhmm	unitless
lat	latitude	decimal degrees
lon	longitude	decimal degrees
depth	depth from which sample was collected	meters
PP_mean_10um	mean 14C-Primary Production rate from 10 micron filters	micromol C/liter/day
PP_std_dev_10um	standard deviation of 14C-Primary Production rate from 10 micron filters	micromol C/liter/day
PP_num_obs_10um	number of samples used in calculation of PP rate mean and standard deviation	unitless
PP_mean_750uatm_pco2_10um	mean 14C-Primary Production rate from 10 micron filters incubated at 750 microatm pCO2	micromol C/liter/day

PP_std_dev_750uatm_pco2_10um	standard deviation of 14C-Primary Production rate from 10 micron filters incubated at 750 microatm pCO2	micromol C/liter/day
PP_num_obs_750uatm_pco2_10um	number of samples used in calculation of PP rate mean and standard deviation	unitless
PP_mean_2um	mean 14C-Primary Production rate from 2 micron filters	micromol C/liter/day
PP_std_dev_2um	standard deviation of 14C-Primary Production rate from 2 micron filters	micromol C/liter/day
PP_num_obs_2um	number of samples used in calculation of PP rate mean and standard deviation	unitless
PP_mean_750uatm_pco2_2um	mean 14C-Primary Production rate from 2 micron filters incubated at 750 microatm pCO2	micromol C/liter/day
PP_std_dev_750uatm_pco2_2um	standard deviation of 14C-Primary Production rate from 2 micron filters incubated at 750 microatm pCO2	micromol C/liter/day
PP_num_obs_750uatm_pco2_2um	number of samples used in calculation of PP rate mean and standard deviation	unitless
PP_mean_0pt2um	mean 14C-Primary Production rate from 0.2 micron filters	micromol C/liter/day
PP_std_dev_0pt2um	standard deviation of 14C-Primary Production rate from 0.2 micron filters	micromol C/liter/day
PP_num_obs_0pt2um	number of samples used in calculation of PP rate mean and standard deviation	unitless
PP_mean_750uatm_pco2_0pt2um	mean 14C-Primary Production rate from 0.2 micron filters incubated at 750 microatm pCO2	micromol C/liter/day
PP_std_dev_750uatm_pco2_0pt2um	standard deviation of 14C-Primary Production rate from 0.2 micron filters incubated at 750 microatm pCO2	micromol C/liter/day
PP_num_obs_750uatm_pco2_0pt2um	number of samples used in calculation of PP rate mean and standard deviation	unitless
dissolved_inorganic_carbon	dissolved inorganic carbon of seawater used for PP and 3H_leuc incubations at ambient conditions	micromol/kilogram seawater
dissolved_inorganic_carbon_750uatm_pco2	dissolved inorganic carbon of seawater used for PP and 3H_leuc incubations at 750 microatm pCO2	micromol/kilogram seawater
total_alkalinity	total alkalinity of seawater used for PP and 3H_leuc incubations at ambient conditions	microequivalents/kilogram seawater

total_alkalinity_750uatm_pco2	total alkalinity of seawater used for PP and 3H_leuc incubations at 750 microatm pCO2	microequivalents/kilogram seawater
chlorophyll	chlorophyll a	micrograms/liter
leuc_3H_light_incorp_mean	mean 3H-Leucine (light incubated) incorporation rates	picomol leucine/liter/hour
leuc_3H_light_incorp_std_dev	standard deviation 3H-Leucine (light incubated) incorporation rates	picomol leucine/liter/hour
leuc_3H_light_num_obs	number of samples used in calculation of 3H-leucine incorporation rate mean and standard deviation	unitless
leuc_3H_light_incorp_mean_750uatm_pco2	mean 3H-Leucine (light incubated) incorporation rates at 750 microatm pCO2	picomol leucine/liter/hour
leuc_3H_light_incorp_std_dev_750uatm_pco2	standard deviation 3H-Leucine (light incubated) incorporation rates at 750 microatm pCO2	picomol leucine/liter/hour
leuc_3H_light_num_obs_750uatm_pco2	number of samples used in calculation of 3H-leucine incorporation rate mean and standard deviation	unitless
leuc_3H_dark_incorp_mean	Mean 3H-Leucine (dark incubated) incorporation rates	picomol leucine/liter/hour
leuc_3H_dark_incorp_std_dev	standard deviation 3H-Leucine (dark incubated) incorporation rates	picomol leucine/liter/hour
leuc_3H_dark_num_obs	number of samples used in calculation of 3H-leucine incorporation rate mean and standard deviation	unitless
leuc_3H_dark_incorp_mean_750uatm_pco2	mean 3H-Leucine (dark incubated) incorporation rates at 750 microatm pCO2	picomol leucine/liter/hour
leuc_3H_dark_incorp_std_dev_750uatm_pco2	standard deviation 3H-Leucine dark incubated) incorporation rates at 750 microatm pCO2	picomol leucine/liter/hour
leuc_3H_dark_num_obs_750uatm_pco2	number of samples used in calculation of 3H-leucine incorporation rate mean and standard deviation	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	CTD - profiler
Generic Instrument Description	The Conductivity, Temperature, Depth (CTD) unit is an integrated instrument package designed to measure the conductivity, temperature, and pressure (depth) of the water column. The instrument is lowered via cable through the water column. It permits scientists to observe the physical properties in real-time via a conducting cable, which is typically connected to a CTD to a deck unit and computer on a ship. The CTD is often configured with additional optional sensors including fluorometers, transmissometers and/or radiometers. It is often combined with a Rosette of water sampling bottles (e.g. Niskin, GO-FLO) for collecting discrete water samples during the cast. This term applies to profiling CTDs. For fixed CTDs, see https://www.bco-dmo.org/instrument/869934.

Dataset-specific Instrument Name	Perkin Elmer 2600 liquid scintillation counter
Generic Instrument Name	Liquid Scintillation Counter
Generic Instrument Description	Liquid scintillation counting is an analytical technique which is defined by the incorporation of the radiolabeled analyte into uniform distribution with a liquid chemical medium capable of converting the kinetic energy of nuclear emissions into light energy. Although the liquid scintillation counter is a sophisticated laboratory counting system used the quantify the activity of particulate emitting (ß and a) radioactive samples, it can also detect the auger electrons emitted from 51Cr and 125I samples.

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Deployments

KM1110

Website	https://www.bco-dmo.org/deployment/59056
Platform	R/V Kilo Moana
Report	http://dmoserv3.bco-dmo.org/jg/serv/BCO-DMO/DIAZOTROPHS_CO2/726342.html1%7Bdir=dmoserv3.whoi.edu/jg/dir/BCO-DMO/DIAZOTROPHS_CO2/,info=dmoserv3.bco-dmo.org/jg/info/BCO-DMO/DIAZOTROPHS_CO2/CO2_experimental%7D?cruise_id_eq_km1110
Start Date	2011-03-12
End Date	2011-03-23

KM1016

Website	https://www.bco-dmo.org/deployment/59055
Platform	R/V Kilo Moana
Report	http://dmoserv3.bco-dmo.org/jg/serv/BCO-DMO/DIAZOTROPHS_CO2/726342.html1%7Bdir=dmoserv3.whoi.edu/jg/dir/BCO-DMO/DIAZOTROPHS_CO2/,info=dmoserv3.bco-dmo.org/jg/info/BCO-DMO/DIAZOTROPHS_CO2/CO2_experimental%7D?cruise_id_eq_km1016
Start Date	2010-08-20
End Date	2010-08-30
Description	Cruise information and original data are available from the NSF R2R data catalog.

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Project Information

Oceanic diazotroph community structure and activities in a high carbon dioxide world (DIAZOTROPHS-CO2)

The North Pacific Subtropical Gyre (NPSG) is the largest ocean ecosystem on Earth, playing a prominent role in global carbon cycling and forming an important reservoir of marine biodiversity. Nitrogen (N2) fixing bacteria (termed diazotrophs) provide a major source of new nitrogen to the oligotrophic waters of the NPSG, thereby exerting direct control on the carbon cycle. Oceanic uptake of CO2 causes long-term changes in the partial pressure of CO2 (pCO2) in the seawater of this ecosystem. Therefore, understanding how carbon system perturbations may influence ocean biogeochemistry is an important and timely undertaking.

In this project, the investigators will examine how natural assemblages of N2 fixing microorganisms respond to perturbations in seawater carbon chemistry. Laboratory and field-based experiments will be placed in the context of monthly time series measurements on the activities and abundances of N2 fixing microorganism abundances. Together, the project will provide insight into the dependence of N2 fixing microorganism physiology on variations in CO2. The broad objectives of the research are: (1) Quantify the responses and consequences of changes in seawater pCO2 on the growth and community structure of naturally-occurring assemblages of ocean diazotrophs; (2) Identify why and how changes in seawater pCO2 influence the growth and carbon acquisition strategies of two model marine diazotrophs (Trichodesmium and Crocosphaera); and (3) Quantify temporal variability in diazotroph community structure and activities at Station ALOHA.

This is a Collaborative Research award.

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Program Information

Ocean Carbon and Biogeochemistry (OCB)

Website: http://us-ocb.org/

Coverage: Global

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate

Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF.

The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems.

The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO2 and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two.

The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen conditions in the coastal and open oceans.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0850827

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