Rates of primary and bacterial production, and chlorophyll concentrations measured experimentally under ambient and elevated pCO2 (750 or 1100 µatm) from Hawaii Ocean Time-series near Station ALOHA from 2010-2011.

Website: https://www.bco-dmo.org/dataset/726342
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
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Abstract
Rates of primary and bacterial production, and chlorophyll concentrations measured experimentally under ambient and elevated pCO2 (750 or 1100 µatm) from Hawaii Ocean Time-series near Station ALOHA from 2010-2011.

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Coverage

Spatial Extent: **N**:24.0037 **E**:-157.96755 **S**:21.4469 **W**:-158.3118
Temporal Extent: 2010-08-07 - 2012-09-09

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 near-surface seawater was collected into acid-washed 20 L carboys. Control carboys were bubbled with air; treatment carboys were bubbled with a mixture of air and CO2, to increase the pCO2 to either ~750 or 1100 µatm. Sampling of each time point was conducted before dawn, experiments lasted between 2 and 5 days. Water from each carboy was subsampled into acid washed 500 mL polycarbonate bottles for primary production rate measurements. To each bottle, was then added ~1.85 MBq 14C-bicarbonate. Water from each carboy was also collected in an opaque polyethylene amber bottles and then subsampled into six 1.5 mL microcentrifuge tubes for bacterial production rate measurements. Each tube was then inoculated with 3H-leucine to a final concentration of 20 nmol L-1. Three tubes from each carboy were incubated in the dark (in a opaque cloth bag) and three in the light. Time zero blanks were immediately subsampled from each amber bottle, 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 primary production bottles and bacterial production tubes were placed in shaded (~50% irradiance) surface seawater-cooled incubators for the duration of the photoperiod.

After sunset, 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. 100 mL from each 500 mL sample bottle was filtered at low vacuum (<50 mm Hg) onto 25 mm diameter, 0.2 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.

After sunset, 100 µL of 100% TCA was added to each microcentrifuge tube. 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
726342.csv (Comma Separated Values (.csv), 8.71 KB) MD5:d6920bd0cbb5f02007c6f83e6e89b940 Primary data file for dataset ID 726342

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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
PP_num_obs_750uatm_pco2_gt_0pt2um	number of samples used in calculation of PP rate mean and standard deviation	unitless
PP_mean_1100uatm_pco2_gt_0pt2um	mean 14C-Primary Production rate from 0.2 micron filters incubated at 1100 microatm pCO2	micromol C/liter/day
PP_std_dev_1100uatm_pco2_gt_0pt2um	standard deviation of 14C-Primary Production rate from 0.2 micron filters incubated at 1100 microatm pCO2	micromol C/liter/day
PP_num_obs_1100uatm_pco2_gt_0pt2um	number of samples used in calculation of PP rate mean and standard deviation	unitless
dissolved_inorganic_carbon_mean	mean dissolved inorganic carbon of seawater used for experimental control conditions	micromol/kilogram seawater

dissolved_inorganic_carbon_stdev	standard deviation of dissolved inorganic carbon of seawater used for experimental control conditions	micromol/kilogram seawater
dissolved_inorganic_carbon_num_obs	number of samples used in calculation of dissolved inorganic carbon	unitless
dissolved_inorganic_carbon_750uatm_pco2_mean	mean dissolved inorganic carbon of seawater used for experimental 750 microatm pCO2 treatments	micromol/kilogram seawater
dissolved_inorganic_carbon_750uatm_pco2_stdev	standard deviation of dissolved inorganic carbon of seawater used for experimental 750 microatm pCO2 treatments	micromol/kilogram seawater
dissolved_inorganic_carbon_750uatm_pco2_num_obs	number of samples used in calculation of dissolved inorganic carbon	unitless
dissolved_inorganic_carbon_1100uatm_pco2_mean	mean dissolved inorganic carbon of seawater used for experimental 1100 microatm pCO2 treatments	micromol/kilogram seawater
dissolved_inorganic_carbon_1100uatm_pco2_stdev	standard deviation of dissolved inorganic carbon of seawater used for experimental 1100 microatm pCO2 treatments	micromol/kilogram seawater
dissolved_inorganic_carbon_1100uatm_pco2_num_obs	number of samples used in calculation of dissolved inorganic carbon	unitless
total_alkalinity_mean	mean total alkalinity of seawater used for experimental control conditions	microequivalents/kilogram seawater

total_alkalinity_stdev	standard deviation of total alkalinity of seawater used for experimental control conditions	microequivalents/kilogram seawater
total_alkalinity_num_obs	number of samples used in total alkalinity	unitless
total_alkalinity_750uatm_pco2_mean	mean total alkalinity of seawater used for experimental 750 microatm pCO2 treatments	microequivalents/kilogram seawater
total_alkalinity_750uatm_pco2_stdev	standard deviation of total alkalinity of seawater used for experimental 750 microatm pCO2 treatments	microequivalents/kilogram seawater
total_alkalinity_750uatm_pco2_num_obs	number of samples used in calculation of total alkalinity	unitless
total_alkalinity_1100uatm_pco2_mean	mean total alkalinity of seawater used for experimental 1100 microatm pCO2 treatments	microequivalents/kilogram seawater
total_alkalinity_1100uatm_pco2_stdev	standard deviation of total alkalinity of seawater used for experimental 1100 microatm pCO2 treatments	microequivalents/kilogram seawater
total_alkalinity_1100uatm_pco2_num_obs	number of samples used in calculation of total alkalinity	unitless
chlorophyll	mean chlorophyll a in experimental controls	micrograms/liter
chlorophyll_stdev	standard deviation of chlorophyll a in experimental controls	micrograms/liter

chlorophyll_num_obs	number of samples used to calculate chlorophyll a mean and standard deviation	unitless
chlorophyll_750uatm_pco2	mean chlorophyll a in 750 microatm pco2 treatments	micrograms/liter
chlorophyll_750uatm_pco2_stdev	standard deviation of chlorophyll a in 750 microatm pco2 treatments	micrograms/liter
chlorophyll_750uatm_pco2_num_obs	number of samples used to calculate chlorophyll a mean and standard deviation	unitless
chorophyll_1100uatm_pco2	mean chlorophyll a in 1100 microatm pco2 treatments	micrograms/liter
chorophyll_1100uatm_pco2_stdev	standard deviation of chlorophyll a in 1100 microatm pco2 treatments	micrograms/liter
chorophyll_1100uatm_pco2_num_obs	number of samples used to calculate chlorophyll a mean and standard deviation	unitless
leuc_3H_light_incorp_mean	mean 3H-Leucine (light incubated) incorporation rates	picomol leucine/liter/hour
leuc_3H_light_incorp_stdev	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	picomole 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_light_incorp_mean_1100uatm_pco2	mean 3H-Leucine (light incubated) incorporation rates at 1100 microatm pCO2	picomol leucine/liter/hour
leuc_3H_light_incorp_std_dev_1100uatm_pco2	standard deviation 3H-Leucine (light incubated) incorporation rates at 1100 microatm pCO2	picomol leucine/liter/hour
leuc_3H_light_num_obs_1100uatm_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
leuc_3H_dark_incorp_mean_1100uatm_pco2	mean 3H-Leucine (dark incubated) incorporation rates at 1100 microatm pCO2	picomol leucine/liter/hour
leuc_3H_dark_incorp_std_dev_1100uatm_pco2	standard deviation 3H-Leucine dark incubated) incorporation rates at 1100 microatm pCO2	picomol leucine/liter/hour
leuc_3H_dark_num_obs_1100uatm_pco2	number of samples used in calculation of 3H-leucine incorporation rate mean and standard deviation	unitless
cruise_id	cruise identification number	unitless
cast	cast number	unitless
date	Date sampling began	unitless
year	Year of sample	unitless
month	month of sample	unitless
day	day of sample	unitless

lat	latitude; negative denotes South	decimal degrees
lon	longitude; negative denotes West	decimal degrees
depth	depth from which sample was collected	meters
PP_mean_gt_0pt2um	mean 14C-Primary Production rate from 0.2 micron filters	micromol C/liter/day
PP_std_dev_gt_0pt2um	standard deviation of 14C-Primary Production rate from 0.2 micron filters	micromol C/liter/day
PP_num_obs_gt_0pt2um	number of samples used in calculation of PP rate mean and standard deviation	unitless
PP_mean_750uatm_pco2_gt_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_gt_0pt2um	standard deviation of 14C-Primary Production rate from 0.2 micron filters, incubated at 750 microatm pCO2	micromol C/liter/day

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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 to quantify the activity of particulate emitting (ß and a) radioactive samples, it can also detect the auger electrons emitted from 51Cr and 125I samples. Liquid scintillation counters are instruments assaying alpha and beta radiation by quantitative detection of visible light produced by the passage of rays or particles through a suitable scintillant incorporated into the sample.

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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.

KM1219

Website	https://www.bco-dmo.org/deployment/59105
Platform	R/V Kilo Moana
Start Date	2012-08-22
End Date	2012-09-11
Description	In the summer of 2012, C-MORE conducted a "continuous" long-term field experiment at Station ALOHA to observe and interpret temporal variability in microbial processes, and the consequences for ecological dynamics and biogeochemical cycling. Special focus was given to time-space coupling because proper scale sampling of the marine environment is an imperative, but generally neglected aspect of marine microbiology. Hawaii Ocean Experiment - Dynamics of Light and Nutrients (HOE-DYLAN)

KM1017

Website	https://www.bco-dmo.org/deployment/731815
Platform	R/V Kilo Moana
Start Date	2010-09-02
End Date	2010-09-02

KM1019

Website	https://www.bco-dmo.org/deployment/731862
Platform	R/V Kilo Moana
Start Date	2010-10-02
End Date	2010-10-06

KM1101

Website	https://www.bco-dmo.org/deployment/731907
Platform	R/V Kilo Moana
Start Date	2011-01-08
End Date	2011-01-10

KM1108

Website	https://www.bco-dmo.org/deployment/731928
Platform	R/V Kilo Moana
Start Date	2011-02-27
End Date	2011-03-03
Description	Project: Hawaii Ocean Timeseries (HOT), Cruise 230

KM1113

Website	https://www.bco-dmo.org/deployment/731963
Platform	R/V Kilo Moana
Start Date	2011-04-10
End Date	2011-04-14

KM1015

Website	https://www.bco-dmo.org/deployment/731500
Platform	R/V Kilo Moana
Start Date	2010-08-06
End Date	2010-08-10

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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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