2A: Partitioning of carbon as a function of pCO2 and temperature during growth of Dactyliosolen fragilissimus from U.C. Santa Barbara Marine Science Institute Passow Lab from 2009 to 2010 (OA - Effects of High CO2 project)

Website: https://www.bco-dmo.org/dataset/4047
Data Type: experimental
Version: 1
Version Date: 2013-09-19

Project
» Will high CO2 conditions affect production, partitioning and fate of organic matter? (OA - Effects of High CO2)

Programs
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
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Carlson, Craig A.	University of California-Santa Barbara (UCSB-MSI)	Co-Principal Investigator
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Abstract
Data Set #2A: Partitioning of carbon as a function of pCO2 and temperature during growth of Dactyliosolen fragilissimus. Experiments with the diatom Dactyliosolen fragilissimus on impact of temperature and carbonate chemistry on carbon uptake and partitioning into particulate and dissolved organic matter. Experiments were conducted in March and May 2013 in Santa Barbara California, Passow lab. Treatments included mulitfactorial analysis with 2 temperature treatments (15, 20C) and two ocean acidification treatments (400 and 1000 micro-atm). Daily sampling after the light cycle (14/10) was completed.

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Coverage

Spatial Extent: **Lat**:34.4126 **Lon**:-119.842
Temporal Extent: 2013 - 2013

Dataset Description

Experiments with the diatom *Dactyliosolen fragilissimus* on impact of temperature and carbonate chemistry on carbon uptake and partitioning into particulate and dissolved organic matter

Experiments conducted in March and May 2013 in Santa Barbara California, Passow lab
Treatments: mulitfactorial analysis with 2 temperature treatments (15, 20C) and two ocean acidification treatments (400 and 1000 µatm)

Daily sampling after light cycle (14/10) was completed

See related publication Thaucher et al (2015).

Methods & Sampling

Methods:
Two experiments, one with *Thalassiosira weissflogii* and one with *Dacyliosolen fragilissimus* were conducted. Replicates of each treatment (2 temperatures by 2 pCO2 conditions) were grown in eight 20 L gas-tight polyethylene bags. *T. weissflogii* and *D. fragilissimus*, respectively, were grown in artificial and natural seawater based, modified f/2 media. Initial nitrate addition was 15 µmol L-1 NO3 for both species, and 6 and 8 µmol L-1 PO4, and 16 and 50 µmol L-1 SiO3 for *T. weissflogii* and *D. fragilissimus*, respectively. Trace metals and vitamins were added according to f/8. Cultures were grown under a light / dark cycle of 14/10 hours at ~90 – 100 µE m-2 s-1 at 15 °C and 20 °C. Partial pressure levels of CO2 were set without bubbling to 400 and 1000 µatm for both temperatures; by appropriate addition of HCO3 and HCl.

Prior to the experiments the diatoms were acclimatized to the respective target conditions growing semi-continuously in gas-tight polycarbonate bottles for at least a week. At the onset of the experiment bags were inoculated with ~1000 cells ml-1 for *T. weissflogii* and ~500 cells ml-1 for the larger *D. fragilissimus*. Daily sampling conducted immediately after the end of each light cycle, was continued for at least 6 days after NO3 depletion.

For the determination of particulate organic carbon and nitrogen (POC and PON), samples were filtered onto precombusted (5 hours at 450 °C) glassfibre filters (Whatman, GF/F, 0.7 µm nominal poresize), dried at ~60 °C for 24 hours and analyzed on a CHN organic elemental analyzer (Control Equipment Corp., CEC 440HA). Samples for dissolved inorganic nitrate, nitrite, phosphate and silicate were filtered through 0.2 µm filters and measured on a flow injection analyzer (Lachat Instruments Div., QuikChem 8000). Samples for dissolved organic carbon (DOC) were gravity-filtered through precombusted GF/F filters, with the filtrate being collecting collected in acid-washed (HCl, 10%) and precombusted glass vials and frozen (at -20 °C). The analysis was carried out via high temperature combustion on a modified Shimadzu TOC-V analyzers. Dissolved inorganic carbon (DIC) was measured on a non-dispersive infrared (NDIR) analyzer. Samples were filtered through glassfibre filters (GF/F) and stored in gas-tight ~400 ml borosilicate bottles until analysis.

pH (total scale) was measured spetrophotometrically at 25ºC (Thermo Scientific Genesys 105 VIS Spetrophotometer with a SPG 1A air-cooled single cell Peltier element), using m-cresol as an indicator dye. The dye was calibrated against certified reference material (A. Dickson, La Jolla, California). Samples for transparent exopolymer particles (TEP) were filtered onto 0.4 µm polycarbonate filters (Poretics) and subsequently stained with Alcian Blue following the procedure of Passow and Alldredge (1995).

Data Processing Description

BCO-DMO Processing Notes
Original file: "Data_Mastersheet_TWeiss_DactyFrag_2013_JT.xlsx" contributed by Uta Passow
Sheet: "Dacty.frag. 2013"
- Approx Lat/Lon of Passow Lab appended to enable data discovery in MapServer
- "nd" (no data) inserted into blank cells
- Parameter names edited to conform to BCO-DMO parameter naming conventions

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Data Files

File
DataSet2a_DactyFrag_2013.csv (Comma Separated Values (.csv), 8.11 KB) MD5:14c0a96e21996e59433805f30b189c15 Primary data file for dataset ID 4047

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Related Publications

Taucher, J., Jones, J., James, A., Brzezinski, M. A., Carlson, C. A., Riebesell, U., & Passow, U. (2015). Combined effects of CO2and temperature on carbon uptake and partitioning by the marine diatomsThalassiosira weissflogiiandDactyliosolen fragilissimus. Limnology and Oceanography, 60(3), 901–919. doi:10.1002/lno.10063
Results

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Parameters

Parameter	Description	Units
Lab_Id	Lab Id - Lab identifier where experiments were conducted	text
Lat	Approximate Latitude Position of Lab; South is negative	decimal degrees
Lon	Approximate Longitude Position of Lab; West is negative	decimal degrees
Temp	Temperature	Degrees C
pCO2	pCO2 conditions	micro atm
replicate	number of replicates	dimensionless
sampling	day of experiment	dimensionless
pH_at_25C	pH at 25 C	total scale
DIC	DIC - Dissolved Inorganic Carbon	micro mol C L-1
fluorescence	Fluorescence - Instantaneous Chlorophyll Fluorescence (FT from AquaPen)	(tbd)
NO3	NO3 - Dissolved Inorganic Nitrate	micro mol N L-1

PO4	PO4 - Dissolved Inorganic Phosphate	micro mol P L-1
Si	Si - Dissolved Inorganic Silicate	micro mol Si L-1
POC	POC - Particulate Organic Carbon	micro mol C L-1
PON	PON - Particulate Organic Nitrogen	micro mol N L-1
DOC	DOC - Dissolved Organic Carbon	micro mol C L-1
DON	DON - Dissolved Organic Nitrogen	micro mol N L-1
TEP	TEP - Transparent Exopolymer Particles in Gxeq (xanthan gum equivalent) per liter. This is an absorbance equivalence.	GXEQ L-1
bacteria_production	Bacteria production	pmol leucine L-1 hr-1

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Instruments

Dataset-specific Instrument Name	Control Equipment Corp., CEC 440HA
Generic Instrument Name	CHN Elemental Analyzer
Dataset-specific Description	For the determination of particulate organic carbon and nitrogen (POC and PON), samples were filtered onto precombusted (5 hours at 450 °C) glassfibre filters (Whatman, GF/F, 0.7 µm nominal poresize), dried at ~60 °C for 24 hours and analyzed on a CHN organic elemental analyzer (Control Equipment Corp., CEC 440HA)
Generic Instrument Description	A CHN Elemental Analyzer is used for the determination of carbon, hydrogen, and nitrogen content in organic and other types of materials, including solids, liquids, volatile, and viscous samples.

Dataset-specific Instrument Name	Lachat Instruments Div., QuikChem 8000
Generic Instrument Name	Flow Injection Analyzer
Dataset-specific Description	Samples for dissolved inorganic nitrate, nitrite, phosphate and silicate were filtered through 0.2 µm filters and measured on a flow injection analyzer (Lachat Instruments Div., QuikChem 8000).
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	NDIR Gas Analyzer
Generic Instrument Name	LI-COR LI-840 Gas Analyzer
Dataset-specific Description	Dissolved inorganic carbon (DIC) was measured on a non-dispersive infrared (NDIR) analyzer.
Generic Instrument Description	The LI-COR LI-840 is an absolute, non-dispersive infrared gas analyzer based on a single path, dual wavelength, and thermostatically controlled infrared detection system. It has an operating temperature range of -20 to +40 degrees Celsius. CO2 is measured in the range 0-3,000 ppm with an accuracy of better than 1.5 percent of the reading. H2O is measured in the range 0-80 ppt with an accuracy of better than 1.5 percent of reading.

Dataset-specific Instrument Name	Thermo Scientific Genesys 105 VIS Spetrophotometer with a SPG 1A air-cooled single cell Peltier element
Generic Instrument Name	pH Sensor
Dataset-specific Description	pH (total scale) was measured spetrophotometrically at 25ºC (Thermo Scientific Genesys 105 VIS Spetrophotometer with a SPG 1A air-cooled single cell Peltier element), using m-cresol as an indicator dye.
Generic Instrument Description	An instrument that measures the hydrogen ion activity in solutions. The overall concentration of hydrogen ions is inversely related to its pH. The pH scale ranges from 0 to 14 and indicates whether acidic (more H+) or basic (less H+).

Dataset-specific Instrument Name	Shimadzu TOC-V Analyzer
Generic Instrument Name	Shimadzu TOC-V Analyzer
Dataset-specific Description	Samples for dissolved organic carbon (DOC) were gravity-filtered through precombusted GF/F filters, with the filtrate being collecting collected in acid-washed (HCl, 10%) and precombusted glass vials and frozen (at -20 °C). The analysis was carried out via high temperature combustion on a modified Shimadzu TOC-V analyzers.
Generic Instrument Description	A Shimadzu TOC-V Analyzer measures DOC by high temperature combustion method.

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Deployments

lab_UCSB_MSI_Passow

Website	https://www.bco-dmo.org/deployment/58780
Platform	UCSB MSI Passow
Report	http://www.msi.ucsb.edu/people/research-scientists/uta-passow
Start Date	2009-09-01
End Date	2016-01-22
Description	Results form a series of controlled laboratory experiments investigating the effect of altered carbonate system chemistry on the abiotic formation of TEP

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Project Information

Will high CO2 conditions affect production, partitioning and fate of organic matter? (OA - Effects of High CO2)

Website: http://www.msi.ucsb.edu/people/research-scientists/uta-passow

Coverage: Passow Lab, Marine Science Institute, University of California Santa Barbara

From the NSF Award Abstract

Coastal waters are already experiencing episodic exposure to carbonate conditions that were not expected until the end of the century making understanding the response to these episodic events as important as understanding the long-term mean response. Among the most striking examples are those associated with coastal upwelling along the west coast of the US, where the pH of surface waters may drop to 7.6 and pCO2 can reach 1100 uatm. Upwelling systems are responsible for a significant fraction of global carbon export making them prime targets for investigations on how ocean acidification is already affecting the biological pump today.

In this study, researchers at the University of California at Santa Barbara will investigate the potential effects of ocean acidification on the strength of the biological pump under the transient increases in CO2 experienced due to upwelling. Increases in CO2 are expected to alter the path and processing of carbon through marine

food webs thereby strengthening the biological pump. Increases in inorganic carbon without proportional increases in nutrients result in carbon over-consumption by phytoplankton. How carbon over-consumption affects the strength of the biological pump will depend on the fate of the extra carbon that is either incorporated into phytoplankton cells forming particulate organic matter (POM), or is excreted as dissolved organic matter (DOM). Results from mesocosm experiments demonstrate that the mechanisms controlling the partitioning of fixed carbon between the particulate and dissolved phases, and the processing of those materials, are obscured when both processes operate simultaneously under natural or semi-natural conditions. Here, POM and DOM production and the heterotrophic processing of these materials will be separated experimentally across a range of CO2 concentrations by conducting basic laboratory culture experiments. In this way the mechanisms whereby elevated CO2 alters the flow of carbon along these paths can be elucidated and better understood for use in mechanistic forecasting models.

Broader Impacts- The need to understand the effects of ocean acidification for the future of society is clear. In addition to research education, both formal and informal, will be important for informing the public. Within this project 1-2 graduate students and 2-3 minority students will be recruited as interns from the CAMP program (California Alliance for Minority Participation). Within the 'Ocean to Classrooms' program run by outreach personnel from UCSB's Marine Science Institute an educational unit for K-12 students will be developed. Advice and support is also given to the Education Coordinator of NOAA, Channel Islands National Marine Sanctuary for the development of an education unit on ocean acidification.

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH

Arnosti C, Grossart H-P, Muehling M, Joint I, Passow U. "Dynamics of extracellular enzyme activities in seawater under changed atmsopheric pCO2: A mesocosm investigation.," Aquatic Microbial Ecology, v.64, 2011, p. 285.

Passow U. "The Abiotic Formation of TEP under Ocean Acidification Scenarios.," Marine Chemistry, v.128-129, 2011, p. 72.

Passow, Uta; Carlson, Craig A.. "The biological pump in a high CO2 world," MARINE ECOLOGY PROGRESS SERIES, v.470, 2012, p. 249-271.

Gaerdes, Astrid; Ramaye, Yannic; Grossart, Hans-Peter; Passow, Uta; Ullrich, Matthias S.. "Effects of Marinobacter adhaerens HP15 on polymer exudation by Thalassiosira weissflogii at different N:P ratios," MARINE ECOLOGY PROGRESS SERIES, v.461, 2012, p. 1-14.

Philip Boyd, Tatiana Rynearson, Evelyn Armstrong, Feixue Fu, Kendra Hayashi, Zhangi Hu, David Hutchins, Raphe Kudela, Elena Litchman, Margaret Mulholland, Uta Passow, Robert Strzepek, Kerry Whittaker, Elizabeth Yu, Mridul Thomas. "Marine Phytoplankton Temperature versus Growth Responses from Polar to Tropical Waters - Outcome of a Scientific Community-Wide Study," PLOS One 8, v.8, 2013, p. e63091.

Arnosti, C., B. M. Fuchs, R. Amann, and U. Passow. "Contrasting extracellular enzyme activities of particle-associated bacteria from distinct provinces of the North Atlantic Ocean," Frontiers in Microbiology, v.3, 2012, p. 1.

Koch, B.P., Kattner, G., Witt, M., Passow, U., 2014. Molecular insights into the microbial formation of marine dissolved organic matter: recalcitrant or labile? Biogeosciences Discuss. 11 (2), 3065-3111.

Taucher, J., Brzezinski, M., Carlson, C., James, A., Jones, J., Passow, U., Riebesell, U., submitted. Effects of warming and elevated pCO2 on carbon uptake and partitioning of the marine diatoms Thalassiosira weissflogii and Dactyliosolen fragilissimus. Limnology and Oceanography

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Program Information

Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Website: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503477

Coverage: global

NSF Climate Research Investment (CRI) activities that were initiated in 2010 are now included under Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES). SEES is a portfolio of activities that highlights NSF's unique role in helping society address the challenge(s) of achieving sustainability. Detailed information about the SEES program is available from NSF (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504707).

In recognition of the need for basic research concerning the nature, extent and impact of ocean acidification on oceanic environments in the past, present and future, the goal of the SEES: OA program is to understand (a) the chemistry and physical chemistry of ocean acidification; (b) how ocean acidification interacts with processes at the organismal level; and (c) how the earth system history informs our understanding of the effects of ocean acidification on the present day and future ocean.

Solicitations issued under this program:
NSF 10-530, FY 2010-FY2011
NSF 12-500, FY 2012
NSF 12-600, FY 2013
NSF 13-586, FY 2014
NSF 13-586 was the final solicitation that will be released for this program.

PI Meetings:
1st U.S. Ocean Acidification PI Meeting(March 22-24, 2011, Woods Hole, MA)
2nd U.S. Ocean Acidification PI Meeting(Sept. 18-20, 2013, Washington, DC)
3rd U.S. Ocean Acidification PI Meeting (June 9-11, 2015, Woods Hole, MA – Tentative)

NSF media releases for the Ocean Acidification Program:

Press Release 10-186 NSF Awards Grants to Study Effects of Ocean Acidification

Discovery Blue Mussels "Hang On" Along Rocky Shores: For How Long?

Discovery nsf.gov - National Science Foundation (NSF) Discoveries - Trouble in Paradise: Ocean Acidification This Way Comes - US National Science Foundation (NSF)

Press Release 12-179 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: Finding New Answers Through National Science Foundation Research Grants - US National Science Foundation (NSF)

Press Release 13-102 World Oceans Month Brings Mixed News for Oysters

Press Release 13-108 nsf.gov - National Science Foundation (NSF) News - Natural Underwater Springs Show How Coral Reefs Respond to Ocean Acidification - US National Science Foundation (NSF)

Press Release 13-148 Ocean acidification: Making new discoveries through National Science Foundation research grants

Press Release 13-148 - Video nsf.gov - News - Video - NSF Ocean Sciences Division Director David Conover answers questions about ocean acidification. - US National Science Foundation (NSF)

Press Release 14-010 nsf.gov - National Science Foundation (NSF) News - Palau's coral reefs surprisingly resistant to ocean acidification - US National Science Foundation (NSF)

Press Release 14-116 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: NSF awards $11.4 million in new grants to study effects on marine ecosystems - US National Science Foundation (NSF)

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

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-1041038

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