Carbonate chemistry of Ulva lactuca culture pots testing the effects of pCO2 variability (Seaweed OA Resilience project)

Website: https://www.bco-dmo.org/dataset/732177
Data Type: experimental
Version: 1
Version Date: 2018-03-22

Project
» Ocean Acidification: Scope for Resilience to Ocean Acidification in Macroalgae (Seaweed OA Resilience)

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

Contributors	Affiliation	Role
Kubler, Janet E.	California State University Northridge (CSUN)	Principal Investigator
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Abstract
This dataset reports the carbonate chemistry along with temperature, salinity and pH of Ulva lactuca grown in closed culture pots at varying pCO2 levels.

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Coverage

Spatial Extent: **N**:34 **E**:-118 **S**:33 **W**:-119
Temporal Extent: 2015-05-11 - 2015-07-27

Dataset Description

This dataset reports the carbonate chemistry along with temperature, salinity and pH of Ulva lactuca grown in closed culture pots at varying pCO2 levels.

Related Datasets:
Ulva: Chl a: Chlorophyll a per unit biomass in Ulva lactuca under ocean acidification (OA) conditions (Seaweed OA Resilience project)
Ulva: CHN and stable isotopes: Stable isotope ratios and mass of carbon and nitrogen in Ulva cells under ocean acidification conditions (Seaweed OA Resilience project)
Ulva: Growth: Growth rates of Ulva exposed to different average and variability of pCO2 (Seaweed OA Resilience project)
Ulva: pH and temperature time-series: Time-series at 10 minute sampling interval of pH and temperature in Ulva culture pots (Seaweed OA Resilience project)

Ulva: pH Drift: Carbonate chemistry over a time course with Ulva in pH drift experiments (Seaweed OA Resilience project)
Ulva: Photosynthesis and respiration: Rates of photosynthesis and respiration by Ulva exposed to different average and variability of pCO2 (Seaweed OA Resilience project)
Ulva: seawater delta13C: Stable isotope ratio and concentration of carbon in seawater from Ulva OA experiments (Seaweed OA Resilience project)

Methods & Sampling

Culture pots were placed in large thermally insulated coolers in a temperature-controlled water bath at 15° C under saturating illumination of ~550 µmoles photons/m^2/s on a 12:12 L:D cycle. pCO2 treatments were supplied to closed culture pots by use of a gas mixing system combining Nitrogen, Oxygen and Carbon Dioxide to specific CO2 partial pressures, 20.9% oxygen and the balance being Nitrogen.

Carbonate chemistry parameters were measured by sampling pH and total alkalinity (TA) of water samples. Seawater samples from each culture pot during all 3 trials were collected 2-3 times per week in 50 ml Falcon tubes to monitor the average and variability of experimental treatment conditions. Water samples were measured usually within 1-2 hours of sample collection. pH was determined using the m-cresol indicator dye method in a spectrophotometer (Dickson et al. 2007). TA samples were analyzed by potentiometric titration coupled to a pH electrode calibrated using certified reference material (CRM) from the Dickson laboratory at Scripps Oceanographic Institute and the pH electrode calibrated using TRIS buffer (Dickson et al. 2007). TA and carbonate parameters were calculated from potentiometric titration data and spectrophotometric pH data.

Carbonate chemistry parameters (CO2 concentration, CO2 partial pressure, CO2 fugacity, HCO3, CO3, DIC, Omega Aragonite, Omega Calcite) and total scale pH at in situ temperature were calculated using the seacarb package (V3.0.14) in R (Lavigne et al. 2011).

Data Processing Description

BCO-DMO Processing Notes:
- added a conventional header with dataset name and description, PI names, version date
- modified parameter names to conform with BCO-DMO naming conventions
- reformatted date from m/d/yyyy to yyyy-mm-dd

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Data Files

File
C-Chem_Ulva_pCO2.csv (Comma Separated Values (.csv), 25.96 KB) MD5:d0455532cce36df4e5387ccca6129214 Primary data file for dataset ID 732177

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Related Publications

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO2 measurements. PICES Special Publication 3, 191 pp. ISBN: 1-897176-07-4. URL: https://www.nodc.noaa.gov/ocads/oceans/Handbook_2007.html https://hdl.handle.net/11329/249
Methods

Lavigne H, Epitalon, JM, Gattuso JP, 2011. Seacarb: seawater carbonate chemistry with R. https://cran.r-project.org/web/packages/seacarb/index.html
Software

Lavigne H, Gattuso JP (2014) Seacarb: seawater carbonate chemistry with R, R package version 3.0. Available from http://CRAN.R-project.org/package=seacarb
Methods

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Parameters

Parameter	Description	Units
Culture_Pot_ID	Identification number of culture	unitless
Exp_Trial	Trial consisting of a range of average of pCO2 levels crossed with either or low or high variability around the average pCO2 effect	unitless
Date	Date formatted as yyyy-mm-dd	unitless
days_diff	Number of days between present and subsequent seawater samples to measure carbonate chemistry parameters	days
pCO2weights	Product of days_diff and pCO2: used to generated weighted estimates of the average and standard deviation carbonate chemistry parameters for each culture pot in each experimental trial	microatmosphere days (µatm.days)
wt_avg_pCO2	Weighted average of pCO2 partial pressure in seawater tanks	microatmospheres (µatm)
wt_sd_pCO2	Weighted standard deviation of pCO2 partial pressure in seawater tanks	microatmospheres (µatm)
Sal_in	Salinity in situ	parts per thousand (ppt)
Temp_in	Temperature in situ	degrees Celsius
pH25	pH in Total scale at 25 deg C	unitless
pHin	pH-Total scale in situ temperature	unitless
CO2	Carbon dioxide concentration	micromoles/kilogram
pCO2	CO2 partial pressure	microatmospheres (µatm)
fCO2	CO2 fugacity	microatmospheres (µatm)
HCO3	Bicarbonate ion concentration	micromoles/kilogram
CO3	Carbonate ion concentration	micromoles/kilogram
DIC	Total dissolved inorganic carbon	micromoles/kilogram
ALK	Total Alkalinity measured	micromoles/kilogram
OmegaAragonite	Aragonite saturation state	unitless
OmegaCalcite	Calcite Saturation State	unitless

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Instruments

Dataset-specific Instrument Name	Temperature control chiller: Aqua Logic Cyclone Chiller
Generic Instrument Name	Aquarium chiller
Generic Instrument Description	Immersible or in-line liquid cooling device, usually with temperature control.

Dataset-specific Instrument Name	Mettler Toledo T50 equipped with Rondolino
Generic Instrument Name	Automatic titrator
Dataset-specific Description	Used to measure total alkalinity.
Generic Instrument Description	Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

Dataset-specific Instrument Name	Qubit Systems Mass Flow Controllers (MFC)
Generic Instrument Name	Mass Flow Controller
Dataset-specific Description	Settings: Nitrogen, 1 L/min; Oxygen, 250 ml/min; CO2, 2 ml/min.
Generic Instrument Description	Mass Flow Controller (MFC) - A device used to measure and control the flow of fluids and gases

Dataset-specific Instrument Name	Thermo Fisher Orion Star 329
Generic Instrument Name	Multi Parameter Bench Meter
Dataset-specific Description	Used to measure pH, temperature and dissolved oxygen.
Generic Instrument Description	An analytical instrument that can measure multiple parameters, such as pH, EC, TDS, DO and Temperature with one device.

Dataset-specific Instrument Name	Shimadzu UV-2450 UV-visible spectrophotometer
Generic Instrument Name	UV Spectrophotometer-Shimadzu
Dataset-specific Description	Used to measure pH total scale at 25C.
Generic Instrument Description	The Shimadzu UV Spectrophotometer is manufactured by Shimadzu Scientific Instruments (ssi.shimadzu.com). Shimadzu manufacturers several models of spectrophotometer; refer to dataset for make/model information.

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Project Information

Ocean Acidification: Scope for Resilience to Ocean Acidification in Macroalgae (Seaweed OA Resilience)

Coverage: Temperate coastal waters of the USA (30 - 45 N latitude, -66 to -88 W and -117 to -125 W longitude)

Benthic macroalgae contribute to intensely productive near shore ecosystems and little is known about the potential effects of ocean acidification on non-calcifying macroalgae. Kübler and Dudgeon will test hypotheses about two macroalgae, *Ulva* spp. and *Plocamium cartilagineum*, which, for different reasons, are hypothesized to be more productive and undergo ecological expansions under predicted changes in ocean chemistry. They have designed laboratory culture-based experiments to quantify the scope for response to ocean acidification in *Plocamium*, which relies solely on diffusive uptake of CO2, and populations of *Ulva* spp., which have an inducible concentrating mechanism (CCM). The investigators will culture these algae in media equilibrated at 8 different pCO2 levels ranging from 380 to 940 ppm to address three key hypotheses. The first is that macroalgae (such as Plocamium cartilagineum) that are not able to acquire inorganic carbon in changed form will benefit, in terms of photosynthetic and growth rates, from ocean acidification. There is little existing data to support this common assumption. The second hypothesis is that enhanced growth of Ulva sp. under OA will result from the energetic savings from down regulating the CCM, rather than from enhanced photosynthesis per se. Their approach will detect existing genetic variation for adaptive plasticity. The third key hypothesis to be addressed in short-term culture experiments is that there will be a significant interaction between ocean acidification and nitrogen limited growth of *Ulva* spp., which are indicator species of eutrophication. Kübler and Dudgeon will be able to quantify the individual effects of ocean acidification and nitrogenous nutrient addition on *Ulva* spp. and also, the synergistic effects, which will inevitably apply in many highly productive, shallow coastal areas. The three hypotheses being addressed have been broadly identified as urgent needs in our growing understanding of the impacts of ocean acidification.

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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)

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1316198

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