Carbonate chemistry over a time-course in pH drift experiments with Plocamium growth collected at Catalina Island, 2014-2015 (Seaweed OA Resilience project)

Website: https://www.bco-dmo.org/dataset/726480
Data Type: experimental
Version: 1
Version Date: 2018-02-07

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
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Abstract
Carbonate chemistry over a time-course in pH drift experiments with Plocamium growth collected at Catalina Island, 2014-2015.

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Coverage

Spatial Extent: **N**:34 **E**:-118 **S**:33 **W**:-119
Temporal Extent: 2014-06 - 2015-02

Dataset Description

This dataset includes measurements of pH drift of seawater samples taken over 30-hour time periods in the presence or absence of *Plocamium cartilagineum*, with two carbonic anhydrase inhibitors, and with three pCO2 levels. Carbonate chemistry is reported at six time intervals.

Related Datasets:
Plocamium carbon nitrogen and stable isotopes: Plocamium carbon and nitrogen content and stable isotope values, 2014-2015 (Seaweed OA Resilience project)

Plocamium culture carbonate chemistry: Carbonate chemistry in experimental cultures of Plocamium cartilagineum cultured at different temperatures and pCO2 levels (Seaweed OA Resilience project)

Plocamium culture: seawater delta13C: Stable isotope ratio and concentration of carbon in seawater during Plocamium culture experiments, 2014-2015 (Seaweed OA Resilience project)

Plocamium cultures pH and temperature: Plocamium culture pot pH and temperature time-series at 10 minute sampling intervals from 2014-2015 (Seaweed OA Resilience project)

Plocamium exptl treatments summary: Summary of pCO2 and temperature treatment combinations for each culture pot and experimental trial (Seaweed OA Resilience project)

Plocamium growth and biomass: Experimental results of Plocamium cartilagineum growth and biomass as a function of pCO2 and temperature (Seaweed OA Resilience project)

Plocamium pigments: Photosynthetic pigment concentrations in Plocamium cartilagineum, trials 3-8, 2014-2015 (Seaweed OA Resilience project)

Rapid Light Curves_PAM: Measurements of fluorescence of photosystem II in Plocamium cartilagineum under various and pCO2 and temperature conditions

Methods & Sampling

Plocamium cartilagineum was collected from Catalina Island in June - Nov. 2014 and Jan. 2015.

Seawater samples were collected over a 30-hour time course of pH drift experiments with *Plocamium cartilagineum* to test mechanism of carbon acquisition by alga and the effect on carbonate chemistry parameters reported in these datasets. Samples were collected at 0, 2, 6, 20, 24 and 30 hours and parameters of carbonate chemistry were measured (DIC,CO2, HCO3,CO3-described below). pH drift assay experiments consisted of 2 independent variables; inhibitor treatment and algal presence, with 3 and 2 levels, respectively for each independent variable (see parameters section). Two replicate water samples were collected from each of 9 experimental culture pots of algae grown for 3 weeks at different combinations of pCO2 and temperature during each of 7 experimental trials.

Carbonate chemistry parameters were measured by sampling pH and total alkalinity (TA) of water samples. 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.

Methodology Reference:
Dickson AG, Sabine CL, Christian JR (2007). Guide to Best Practices for Ocean CO2 Measurements.

Note: Trial 1 was a pilot test of culture system and methodological procedures so was not used for data collection in the testing of hypotheses.

See Supplemental Files for a table of culture conditions for each of the 8 trials (pdf).

Data Processing Description

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).

Lavigne H, Epitalon, JM, Gattuso JP, 2011. Seacarb: seawater carbonate chemistry with R.
R package version 3.0. http://CRAN.R-project.org/package=seacarb

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- combined data from the 8 submitted trial files

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Data Files

File
pH_drift.csv (Comma Separated Values (.csv), 125.10 KB) MD5:8f5b1bc528b68ce3b4fcc2d82ae8729a Primary data file for dataset ID 726480

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Supplemental Files

File
Table of culture conditions for each of the 8 trials filename: Dudgeon_seaweed_trial_meta_2018-01.pdf (Portable Document Format (.pdf), 429.04 KB) MD5:5a4a9cbd3cb5092a419b4883c96979b8 Notes: Trial 1 was a pilot test of culture system and methodological procedures so was not used for data collection in the testing of hypotheses. In each culture pot, pCO2 was set by the supply rate of CO2 in the corresponding mass-flow controlled gas mixing system to be within a target range of either near ambient, moderately elevated or highly elevated in each trial. The near-ambient range was narrower than the other target ranges (set points typically ~380 - 390 micro-atm) as it served as the control range in each trial. However, actual pCO2 in solution in each culture pot varied slightly from constant target values on a diurnal cycle associated with the metabolic activities of the algae contained within each pot. Unique average values of pCO2 in each culture pot based on different set values for each mass-flow controlled mixer within the qualitative ranges of ambient, moderate and highly increased pCO2 levels that were replicated in each trial of the experiment enabled a more powerful regression-type experimental design. With a regression type approach we could estimate the functional relationship between response variables and pCO2, which was not possible with a simple categorical treatment design.

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

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
trial	experimental trial identifier	unitless
ID	4-level code (separated by dashes) identifies water sample to treatment combinations of (1) Carbonic anhydrase inhibitor; (2) alga presence/absence; (3) pCO2 level/Culture pot number; (4) replicate number. 1st code: Inhibitor Treatment: SW = seawater; A=Acetazolamide; E=Ethoxyzolamide; 2nd code: A = Algae present; NA = No algae; 3rd code: culture pot number for alga present treatments; 4th code: replicate number in treatment combination.	unitless

sal_insitu	Salinity in situ	parts per thousand (ppt)
temp_insitu	Temperature in situ	degrees Celsius
ALK	Total alkalinity used in seacarb calculations	micromol/kilogram (umol/kg)
pH_t0	pH in Total scale at in situ temperature at time = 0 (start of experiment)	unitless
pH_t2	pH in Total scale at in situ temperature at time = 2 hours	unitless
pH_t6	pH in Total scale at in situ temperature at time = 6 hours	unitless
pH_t20	pH in Total scale at in situ temperature at time = 20 hours	unitless
pH_t24	pH in Total scale at in situ temperature at time = 24 hours	unitless
pH_t30	pH in Total scale at in situ temperature at time = 30 hours	unitless
t0_DIC_x_1e06	Total carbon; dissolved inorganic carbon at time = 0 (start of experiment)	micromol/kilogram (umol/kg)
t2_DIC_x_1e06	Total carbon; dissolved inorganic carbon at time=2 hours	micromol/kilogram (umol/kg)
t6_DIC_x_1e06	Total carbon; dissolved inorganic carbon at time=6 hours	micromol/kilogram (umol/kg)
t20_DIC_x_1e06	Total carbon; dissolved inorganic carbon at time=20 hours	micromol/kilogram (umol/kg)
t24_DIC_x_1e06	Total carbon; dissolved inorganic carbon at time=24 hours	micromol/kilogram (umol/kg)
t30_DIC_x_1e06	Total carbon; dissolved inorganic carbon at time=30 hours	micromol/kilogram (umol/kg)
t0_CO2_x_1e06	Carbon dioxide concentration at time = 0 (start of experiment)	micromol/kilogram (umol/kg)
t2_CO2_x_1e06	Carbon dioxide concentration at time=2 hours	micromol/kilogram (umol/kg)
t6_CO2_x_1e06	Carbon dioxide concentration at time=6 hours	micromol/kilogram (umol/kg)
t20_CO2_x_1e06	Carbon dioxide concentration at time=20 hours	micromol/kilogram (umol/kg)
t24_CO2_x_1e06	Carbon dioxide concentration at time=24 hours	micromol/kilogram (umol/kg)
t30_CO2_x_1e06	Carbon dioxide concentration at time=30 hours	micromol/kilogram (umol/kg)
t0_HCO3_x_1e06	Bicarbonate ion concentration at time = 0 (start of experiment)	micromol/kilogram (umol/kg)
t2_HCO3_x_1e06	Bicarbonate ion concentration at time=2 hours	micromol/kilogram (umol/kg)
t6_HCO3_x_1e06	Bicarbonate ion concentration at time=6 hours	micromol/kilogram (umol/kg)
t20_HCO3_x_1e06	Bicarbonate ion concentration at time=20 hours	micromol/kilogram (umol/kg)
t24_HCO3_x_1e06	Bicarbonate ion concentration at time=24 hours	micromol/kilogram (umol/kg)
t30_HCO3_x_1e06	Bicarbonate ion concentration at time=30 hours	micromol/kilogram (umol/kg)

t0_CO3_x_1e06	Carbonate ion concentration at time = 0 (start of experiment)	micromol/kilogram (umol/kg)
t2_CO3_x_1e06	Carbonate ion concentration at time=2 hours	micromol/kilogram (umol/kg)
t6_CO3_x_1e06	Carbonate ion concentration at time=6 hours	micromol/kilogram (umol/kg)
t20_CO3_x_1e06	Carbonate ion concentration at time=20 hours	micromol/kilogram (umol/kg)
t24_CO3_x_1e06	Carbonate ion concentration at time=24 hours	micromol/kilogram (umol/kg)
t30_CO3_x_1e06	Carbonate ion concentration at time=30 hours	micromol/kilogram (umol/kg)

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Instruments

Dataset-specific Instrument Name	Mettler Toledo T50
Generic Instrument Name	Automatic titrator
Dataset-specific Description	Used to measure total alkalinity; equipped with Rondolino automated titration stand.
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	
Generic Instrument Name	Multi Parameter Portable Meter
Dataset-specific Description	YSI 556 MPS (Trials 1-5) and Thermo Fisher Orion Star 329 (trials 6-8) used to measure salinity and temperature.
Generic Instrument Description	An analytical instrument that can measure multiple parameters, such as pH, EC, TDS, DO and temperature with one device and is portable or hand-held.

Dataset-specific Instrument Name	Shimadzu UV-2450 UV-visible spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	Used to measure pH (at temperature 25 C)
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

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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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