# Carbonate chemistry over a time course with Ulva in pH drift experiments (Seaweed OA Resilience project)

**Website**: https://www.bco-dmo.org/dataset/732464
**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 |
| Dudgeon, Steve | California State University Northridge (CSUN) | Co-Principal Investigator |
| Copley, Nancy | Woods Hole Oceanographic Institution (WHOI BCO-DMO) | BCO-DMO Data Manager |

**Abstract**
Carbonate chemistry measurements over a time course with Ulva in pH drift experiments.

## Table of Contents



## Coverage

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

## Dataset Description

Seawater samples were collected from a pH drift experiment with Ulva lactuca to test the mechanism of carbon acquisition by the alga and the effect on carbonate chemistry parameters reported in these datasets. This dataset reports the pH, dissolved inorganic carbon (DIC), carbon diaoxide (CO2), bicarbonate and carbonate concentrations of seawater at initial and 24 hour times from pH drift experiment that used Ulva lactuca grown in closed culture pots at varying pCO2 levels.

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

Samples were collected at 0 (initial) and 24 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 4 and 2 levels, respectively for each independent variable. The inhibitor treatments included: seawater only (control), Acetazolamide (A), 4,4'-Diisothiocyano-2,2'-stilbenedisulfonic acid (DIDS), and Ethoxyzolamide (E). Algae were either present or absent (control) in a vial. Two replicate water samples were collected from each of 10 experimental culture pots of algae grown for 3 weeks at different combinations of average and standard deviations of pCO2 level during each of 3 experimental trials and assayed after 24 hours with or without the presence of Ulva and combinations of inhibitor treatments. In addition, 3 different levels of pCO2 in seawater generated independently of the seawater in algal culture that represented the range of pCO2 levels assayed across the entire experiment were assayed over the same 24 hour period.

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.

### BCO-DMO Processing Description

- added a conventional header with dataset name and description, PI names, version date
- modified parameter names to conform with BCO-DMO naming conventions

[ table of contents | back to top ]

## Data Files

| File |
|---|
| **pH_Drift_Ulva.csv** (Comma Separated Values (.csv), 44.63 KB) MD5:8165c0d890071849e9e4c473bd1f7247 Primary data file for dataset ID 732464 |

[ table of contents | back to top ]

## 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*
,
*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*

[ table of contents | back to top ]

## Parameters

| Parameter | Description | Units |
|---|---|---|
| Label | Trial number-pot number.frozen tissue replicate | unitless |
| pCO2_avg | Average pCO2 partial pressure in seawater tanks | microatmospheres (µatm) |
| pCO2_sd | Variability of pCO2 partial pressure - standard deviation | microatmospheres (µatm) |
| Sal_in | Salinity in situ | parts per thousand (ppt) |
| Temp_in | Temperature in situ | degrees Celsius |
| ALK | Total Alkalinity measured | micromoles/kilogram |
| pH_t0 | initial pH of vial | unitless |
| pH_t24 | pH of vial after 24 hours | unitless |
| DIC_t0 | initial dissolved inorganic carbon in vial | micromoles/kilogram (µmol/kg) |
| DIC_t24 | Dissolved inorganic carbon after 24 hours | micromoles/kilogram (µmol/kg) |
| CO2_t0 | Initial value of CO2 in vial | micromoles/kilogram (µmol/kg) |
| CO2_t24 | CO2 in vial after 24 hours | micromoles/kilogram (µmol/kg) |
| HCO3_t0 | Initial bicarbonate in vial | micromoles/kilogram (µmol/kg) |
| HCO3_t24 | Bicarbonate in vial after 24 hours | micromoles/kilogram (µmol/kg) |
| CO3_t0 | Initial carbonate in vial | micromoles/kilogram (µmol/kg) |
| CO3_t24 | Carbonate in vial after 24 hours | micromoles/kilogram (µmol/kg) |

[ table of contents | back to top ]

## 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. |

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|---|---|
| **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 pH, temperature and dissolved oxygen meter |
| **Generic Instrument Name** | Multi Parameter Bench Meter |
| **Dataset-specific Description** | 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. |

| | |
|---|---|
| **Dataset-specific Instrument Name** | Shimadzu UV-2450 UV-visible spectrophotometer |
| **Generic Instrument Name** | UV Spectrophotometer-Shimadzu |
| **Dataset-specific Description** | Used to measure pH in 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. |

[ table of contents | back to top ]

## 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.

[ table of contents | back to top ]

## 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)

[ table of contents | back to top ]

## Funding


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


[ table of contents | back to top ]