Measured and calculated water chemistry parameters throughout a 93-day acidification and warming experiment

Website: https://www.bco-dmo.org/dataset/735629
Data Type: experimental
Version: 1
Version Date: 2018-05-09

Project
» Investigating the influence of thermal history on coral growth response to recent and predicted end-of-century ocean warming across a cascade of ecological scales (Thermal History and Coral Growth)

Contributors	Affiliation	Role
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Abstract
This water chemistry data set includes water temperature, salinity, and pH of all 24 experimental aquaria measured every other day throughout the 93-day ocean acidification and warming experiment. Additionally, the data include the measured (temperature, salinity, total alkalinity, and dissolved inorganic carbon) and calculated (Dissolved CO2, carbonate ion concentration, bicarbonate ion concentration], pCO2, aragonite saturation state, and pH) carbonate parameters from water samples taken every 10 days during the experiment. These data were used to determine the experimental conditions of each treatment that the corals were exposed to.

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Coverage

Spatial Extent: **N**:16.1899 **E**:-88.2614 **S**:16.1167 **W**:-88.5728
Temporal Extent: 2015-06-01 - 2015-12-30

Dataset Description

This water chemistry data set includes water temperature, salinity, and pH of all 24 experimental aquaria measured every other day throughout the 93-day ocean acidification and warming experiment. Additionally, the data include the measured (temperature, salinity, total alkalinity, and dissolved inorganic carbon) and calculated (Dissolved CO2, carbonate ion concentration, bicarbonate ion concentration], pCO2, aragonite saturation state, and pH) carbonate parameters from water samples taken every 10 days during the experiment. These data were used to determine the experimental conditions of each treatment that the corals were exposed to. These data are presented in Bove et al (2019).

Related datasets:
OA and temp experiment - coral growth: https://www.bco-dmo.org/dataset/735583
OA and temp experiment - survival: https://www.bco-dmo.org/dataset/735609

Methods & Sampling

Temperature, salinity, and pH measurements were conducted every other day throughout the experimental period. Temperature was measured using a high precision partial-immersion glass thermometer (precision ±0.3%; accuracy ±0.4%). Salinity (±SD) was measured using a YSI 3200 conductivity meter and maintained at 31.7 (±0.2), with slight natural seasonal variation as expected in Massachusetts Bay waters. A pH probe calibrated with 7.00 and 10.01 NBS buffers kept at experimental temperatures was used to measure pH in each tank. Water samples were taken from each tank every ten days around 13:00 Eastern Time using 250 mL ground-glass-stoppered borosilicate glass bottles for analysis of total alkalinity (TA) and dissolved inorganic carbon (DIC). TA and DIC were measured via coulometry and closed-cell potentiometric Gran titration, respectively calibrated with certified Dickson DIC/TA standards. Dissolved CO2 ([CO2 (SW)]), carbonate ion concentration [CO32–], bicarbonate ion concentration [HCO3–], pCO2, aragonite saturation state, and pH of the seawater from all treatments were calculated from measured temperature, salinity, DIC, and TA using CO2SYS (Pierrot et al, 2006) with Roy et al. (1993) carbonic acid constants K1 and K2 and NBS (mol kg–1 H2O) pH scale.

CO2SYS v2.1 was used to calculate carbonate parameters. http://cdiac.ess-dive.lbl.gov/ftp/co2sys/

Data Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- reduced decimal precision of 'sal' from 8 to 3
- reformatted date from d-Mon-yy to yyyy-mm-dd

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Data Files

File
Bove_chem.csv (Comma Separated Values (.csv), 19.29 KB) MD5:82c6c976dcc5efe8ab0411a5b51453b5 Primary data file for dataset ID 735629

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Related Publications

Bove, C. B., Ries, J. B., Davies, S. W., Westfield, I. T., Umbanhowar, J., & Castillo, K. D. (2019). Common Caribbean corals exhibit highly variable responses to future acidification and warming. Proceedings of the Royal Society B: Biological Sciences, 286(1900), 20182840. doi:10.1098/rspb.2018.2840
Results

Pierrot, D. E. Lewis,and D. W. R. Wallace. 2006. MS Excel Program Developed for CO2 System Calculations. ORNL/CDIAC-105a. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee. doi: 10.3334/CDIAC/otg.CO2SYS_XLS_CDIAC105a.
Methods

Roy, R. N., Roy, L. N., Vogel, K. M., Porter-Moore, C., Pearson, T., Good, C. E., Millero, F. J., Campbell, D. M. (1993). The dissociation constants of carbonic acid in seawater at salinities 5 to 45 and temperatures 0 to 45°C. Marine Chemistry, 44(2-4), 249-267. doi:10.1016/0304-4203(93)90207-5
Methods

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Parameters

Parameter	Description	Units
date	Date of sample collection formatted as yyyy-mm-dd	unitless
treatment	Experimental treatment fragment was in: first number represents target pCO2 value; second is the temperature treatment	unitless
pCO2	Measured partial pressure of carbon dioxide in tank	micro-atmospheres
temp	Measured temperature in tank	degrees Celsius
sal	Measured salinity in tank	practical salinity units (psu)
pH	Measured pH in tank; NBS scale	unitless
alk	Calculated total alkalinity (TA)	millimol/kilogram (mmol kg-1)
DIC	Measured dissolved inorganic carbon (DIC)	millimol/kilogram (mmol kg-1)
pH_cal	Calculated pH (using CO2SYS); NBS scale	unitless
HCO3_cal	Calculated concentration of bicarbonate ion ([HCO3]-) (using CO2SYS)	millimol/kilogram (mmol kg-1)
CO2_cal	Calculated concentration of carbon dioxide (CO2) (using CO2SYS)	millimol/kilogram (mmol kg-1)
CO3_cal	Calculated concentration of carbonate ion ([CO3]2-) (using CO2SYS)	millimol/kilogram (mmol kg-1)
sat_cal	Calculated aragonite saturation state (using CO2SYS)	unitless

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Instruments

Dataset-specific Instrument Name	UIC 5400
Generic Instrument Name	CO2 Coulometer
Dataset-specific Description	Total alkalinity (TA) and dissolved inorganic carbon (DIC) were analyzed via coulometry (UIC 5400) and via closed-cell potentiometric Gran titration, respectively (Marianda, VINDTA 3C) calibrated with certified Dickson DIC/TA standards (Scripps Institution of Oceanography; San Diego, California, USA).
Generic Instrument Description	A CO2 coulometer semi-automatically controls the sample handling and extraction of CO2 from seawater samples. Samples are acidified and the CO2 gas is bubbled into a titration cell where CO2 is converted to hydroxyethylcarbonic acid which is then automatically titrated with a coulometrically-generated base to a colorimetric endpoint.

Dataset-specific Instrument Name	YSI 3200 conductivity meter with a 1.0 cm-1 cell (Yellow Springs, Ohio, USA).
Generic Instrument Name	Conductivity Meter
Dataset-specific Description	Used to measure salinity.
Generic Instrument Description	Conductivity Meter - An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. Commonly used in hydroponics, aquaculture and freshwater systems to monitor the amount of nutrients, salts or impurities in the water.

Dataset-specific Instrument Name	Marianda, VINDTA 3C
Generic Instrument Name	MARIANDA VINDTA 3C total inorganic carbon and titration alkalinity analyser
Dataset-specific Description	Used to measure dissolved inorganic carbon (DIC). Calibrated with certified Dickson DIC/TA standards (Scripps Institution of Oceanography; San Diego, California, USA).
Generic Instrument Description	The Versatile INstrument for the Determination of Total inorganic carbon and titration Alkalinity (VINDTA) 3C is a laboratory alkalinity titration system combined with an extraction unit for coulometric titration, which simultaneously determines the alkalinity and dissolved inorganic carbon content of a sample. The sample transport is performed with peristaltic pumps and acid is added to the sample using a membrane pump. No pressurizing system is required and only one gas supply (nitrogen or dry and CO2-free air) is necessary. The system uses a Metrohm Titrino 719S, an ORION-Ross pH electrode and a Metrohm reference electrode. The burette, the pipette and the analysis cell have a water jacket around them. Precision is typically +/- 1 umol/kg for TA and/or DIC in open ocean water.

Dataset-specific Instrument Name	accuFet Solid-State pH probe (Fisher Scientific Waltham, Massachusetts, USA)
Generic Instrument Name	pH Sensor
Dataset-specific Description	The pH probe was calibrated with 7.00 and 10.01 NBS buffers which were kept at experimental temperatures; used to measure pH.
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	high precision partial-immersion glass thermometer
Generic Instrument Name	Thermometer
Dataset-specific Description	Thermometer precision ±0.3%; accuracy ±0.4%; used to measure temperature.
Generic Instrument Description	A device designed to measure temperature.

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Project Information

Investigating the influence of thermal history on coral growth response to recent and predicted end-of-century ocean warming across a cascade of ecological scales (Thermal History and Coral Growth)

Website: http://www.unc.edu/~kdcastil/research.html

Coverage: Western Caribbean

Description from NSF award abstract:
Rising global ocean surface temperatures have reduced coral growth rates, thereby negatively impacting the health of coral reef ecosystems worldwide. Recent studies on tropical reef building corals reveal that corals' growth in response to ocean warming may be influenced by their previous seawater temperature exposure - their thermal history. Although these recent findings highlight significant variability in coral growth in response to climate change, uncertainty remains as to the spatial scale at which corals' thermal history influences how they have responded to ocean warming and how they will likely respond to predicted future increases in ocean temperature. This study investigates the influence of thermal history on coral growth in response to recent and predicted seawater temperatures increases across four ecologically relevant spatial scales ranging from reef ecosystems, to reef communities, to reef populations, to an individual coral colony. By understanding how corals have responded in the past across a range of ecological scales, the Principal Investigator will be able to improve the ability to predict their susceptibility and resilience, which could then be applied to coral reef conservation in the face of climate change. This research project will broaden the participation of undergraduates from underrepresented groups and educate public radio listeners using minority voices and narratives. The scientist will leverage current and new partnerships to recruit and train minority undergraduates, thus allowing them to engage high school students near field sites in Florida, Belize, and Panama. Through peer advising, undergraduates will document this research on a digital news site for dissemination to the public. The voice of the undergraduates and scientist will ground the production of a public radio feature exploring the topic of acclimatization and resilience - a capacity for stress tolerance within coral reef ecosystems. This project will provide a postdoctoral researcher and several graduate students with opportunities for field and laboratory research training, teaching and mentoring, and professional development. The results will allow policy makers from Florida, the Mesoamerican Barrier Reef System

countries, and several Central American countries to benefit from Caribbean-scale inferences that incorporate corals' physiological abilities, thereby improving coral reef management for the region.

Coral reefs are at significant risk due to a variety of local and global scale anthropogenic stressors. Although various stressors contribute to the observed decline in coral reef health, recent studies highlight rising seawater temperatures due to increasing atmospheric carbon dioxide concentration as one of the most significant stressors influencing coral growth rates. However, there is increasing recognition of problems of scale since a coral's growth response to an environmental stressor may be conditional on the scale of description. This research will investigate the following research questions: (1) How has seawater temperature on reef ecosystems (Florida Keys Reef Tract, USA; Belize Barrier Reef System, Belize; and Bocas Del Toro Reef Complex, Panama), reef communities (inshore and offshore reefs), reef populations (individual reefs), and near reef colonies (individual colonies), varied in the past? (2) How has seawater temperature influenced rates of coral growth and how does the seawater temperature-coral growth relationship vary across these four ecological spatial scales? (3) Does the seawater temperature-coral growth relationship forecast rates of coral growth under predicted end-of-century ocean warming at the four ecological spatial scales? Long term sea surface temperature records and small-scale high-resolution in situ seawater temperature measurements will be compared with growth chronologies for the reef building corals Siderastrea siderea and Orbicella faveolata, two keystone species ubiquitously distributed throughout the Caribbean Sea. Nutrients and irradiance will be quantified via satellite-derived observations, in situ measurements, and established colorimetric protocols. Field and laboratory experiments will be combined to examine seawater temperature-coral growth relationships under recent and predicted end-of-century ocean warming at four ecologically relevant spatial scales. The findings of this study will help us bridge the temperature-coral growth response gap across ecologically relevant spatial scales and thus improve our understanding of how corals have responded to recent warming. This will lead to more meaningful predictions about future coral growth response to climate change.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1459522

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