Carbonate chemistry sampled during Acropora pulchra calcification experiments that took place in Moorea, French Polynesia from Jul to Nov of 2015

Website: https://www.bco-dmo.org/dataset/684605
Data Type: experimental
Version: 1
Version Date: 2017-03-20

Project
» Moorea Coral Reef Long-Term Ecological Research site (MCR LTER)
» Collaborative Research: Ocean Acidification and Coral Reefs: Scale Dependence and Adaptive Capacity (OA coral adaptation)

Programs
» Long Term Ecological Research network (LTER)
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Contributors	Affiliation	Role
Edmunds, Peter J.	California State University Northridge (CSUN)	Principal Investigator
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Abstract
Carbonate chemistry was measured during two experiments that tested calcification rates of Acropora pulchra under approximated ambient and elevated temperature and pCO2 levels. The experiments took place between July and December of 2015 at the Richard B Gump Research Station, Moorea, French Polynesia.

Table of Contents

Coverage

Spatial Extent: **Lat**:-17.4907 **Lon**:-149.826
Temporal Extent: 2015-07-12 - 2015-12-29

Dataset Description

These data were utilized in Shaw et al., 2016.

Related datasets also utilized in Shaw et al. 2016:
* These calcification rate datasets took place while these carbonate chemistry measurements were being taken .
Acropora pulchra calcification experiment 1
Acropora pulchra calcification experiment 2

Methods & Sampling

Determinations of seawater pH on the total scale were completed daily using a Mettler DGi-115 pH electrode, which was calibrated with TRIS buffers [SOP 6a (Dickson et al. 2007)]. Total alkalinity (AT) was measured every 3 days using the open cell method of acidimetric titration [SOP 3b, Dickson et al. (2007)]. Accuracy of AT analyses was determined through analysis of certified reference materials (CRMs; from A. Dickson Laboratory, Scripps Institution of Oceanography). The mean (+-SE) difference between measured and certified values of CRMs (i.e., accuracy) was 1.3 +- 0.3 µmol kg−1 (n = 34), and the precision was 1.8 +- 0.1 µmol kg−1 (n = 475).

Data Processing Description

The full carbonate system of parameters was calculated using measured pH, AT, temperature, and salinity with the R package seacarb (Lavigne and Gattuso 2010). Calculations were done using the carbonic acid dissociation constants of Lueker et al. (2000), the KSO4 for the bisulfate ion from Dickson (1990), and the Kf constant of Perez and Fraga (1987).

BCO-DMO Data Manager Processing Notes:
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions
* All values were rounded to three decimal places if more than that.
* latitude and longitude added for experiment location

[table of contents | back to top]

Data Files

File
carb_chem.csv (Comma Separated Values (.csv), 23.14 KB) MD5:e44b8cd858458296acdf53bb601c0c23 Primary data file for dataset ID 684605

[table of contents | back to top]

Related Publications

Comeau, S., Carpenter, R. C., Lantz, C. A., & Edmunds, P. J. (2016). Parameterization of the response of calcification to temperature and pCO2 in the coral Acropora pulchra and the alga Lithophyllum kotschyanum. Coral Reefs, 35(3), 929–939. doi:10.1007/s00338-016-1425-0
Related Research

Dickson, A. G. (1990). Standard potential of the reaction: AgCl(s) + 1/2 H2(g) = Ag(s) + HCl(aq) and the standard acidity constant of the ion HSO4− in synthetic sea water from 273.15 to 318.15 K. The Journal of Chemical Thermodynamics, 22(2), 113–127. doi:10.1016/0021-9614(90)90074-z https://doi.org/10.1016/0021-9614(90)90074-Z
Methods

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, Gattuso J (2013) Seacarb: seawater carbonate chemistry with R. R package version 2.4.10. Available from http://CRAN.R-project.org/package=seacarb
Software

Lueker, T. J., Dickson, A. G., & Keeling, C. D. (2000). Ocean pCO2 calculated from dissolved inorganic carbon, alkalinity, and equations for K1 and K2: validation based on laboratory measurements of CO2 in gas and seawater at equilibrium. Marine Chemistry, 70(1-3), 105–119. doi:10.1016/s0304-4203(00)00022-0 https://doi.org/10.1016/S0304-4203(00)00022-0
Methods

Perez, F. F., & Fraga, F. (1987). Association constant of fluoride and hydrogen ions in seawater. Marine Chemistry, 21(2), 161–168. doi:10.1016/0304-4203(87)90036-3
Methods

Shaw, E. C., Carpenter, R. C., Lantz, C. A., & Edmunds, P. J. (2016). Intraspecific variability in the response to ocean warming and acidification in the scleractinian coral Acropora pulchra. Marine Biology, 163(10). doi:10.1007/s00227-016-2986-8
Results

[table of contents | back to top]

Parameters

Parameter	Description	Units
exp_id	Experiment number (1 or 2)	unitless
date	Date of sampling in format yyyy-mm-dd	unitless
treatment	CO2 treament identifier with format pCO2-temp or pCO2 type alone (Amb or Ambient = 400 uatm; High = 1000 uatm; temp in degrees C)	unitless
tank	Tank identifier	unitless
sal	Salinity of tank	parts per thousand (ppt)
temp	Temperature of tank	degrees Celsius
patm	surface atmospheric pressure of tank	standard atmospheres (atm)
pH	pH of tank	total pH scale
CO2	carbon dioxide concentration of tank	micromoles per kilogram seawater (umol kgSW-1)
fCO2	CO2 fugacity computed at in situ temperature and atmospheric pressure for tank	micro atmospheres (uatm)
pCO2	CO2 partial pressure computed at in situ temperature and atmospheric pressure for tank	micro atmospheres (uatm)
HCO3	Bicarbonate concentration	micromoles per kilogram seawater (umol kgSW-1)
CO3	Carbonate concentration	micromoles per kilogram seawater (umol kgSW-1)
DIC	Dissolved inorganic carbon concentration for tank	micromoles per kilogram seawater (umol kgSW-1)
TA	Total alkalinity for tank	micromoles per kilogram seawater (umol kgSW-1)
omega_argonite	Aragonite saturation state for a given tank	dimensionless
omega_calcite	Calcite saturation state for a given tank	dimensionless
site	Location of experiment; MCR is shorthand for Moorea Coral Reef Long-Term Ecological Research site	unitless
lat	Latitude of sampling location	decimal degrees
lon	Longitude of sampling location; west is negative	decimal degrees

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	certified digital thermometer
Generic Instrument Name	digital thermometer
Dataset-specific Description	Temperatures of each tank were measured daily using a certified digital thermometer (Fisher Scientific, 15-007-8, ±0.05 C)
Generic Instrument Description	An instrument that measures temperature digitally.

Dataset-specific Instrument Name	Mettler DGi-115 pH electrode
Generic Instrument Name	pH Sensor
Dataset-specific Description	Mettler DGi-115 pH electrode, which was calibrated with TRIS buffers [SOP 6a (Dickson et al. 2007)]
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+).

[table of contents | back to top]

Deployments

MCR_Edmunds

Website	https://www.bco-dmo.org/deployment/640059
Platform	Richard B Gump Research Station - Moorea LTER
Start Date	2010-01-01
End Date	2016-12-31
Description	Ongoing studies on corals

[table of contents | back to top]

Project Information

Moorea Coral Reef Long-Term Ecological Research site (MCR LTER)

Website: http://mcr.lternet.edu/

Coverage: Island of Moorea, French Polynesia

From http://www.lternet.edu/sites/mcr/ and http://mcr.lternet.edu/:
The Moorea Coral Reef LTER site encompasses the coral reef complex that surrounds the island of Moorea, French Polynesia (17°30'S, 149°50'W). Moorea is a small, triangular volcanic island 20 km west of Tahiti in the Society Islands of French Polynesia. An offshore barrier reef forms a system of shallow (mean depth ~ 5-7 m), narrow (~0.8-1.5 km wide) lagoons around the 60 km perimeter of Moorea. All major coral reef types (e.g., fringing reef, lagoon patch reefs, back reef, barrier reef and fore reef) are present and accessible by small boat.

The MCR LTER was established in 2004 by the US National Science Foundation (NSF) and is a partnership between the University of California Santa Barbara and California State University, Northridge. MCR researchers include marine scientists from the UC Santa Barbara, CSU Northridge, UC Davis, UC Santa Cruz, UC San Diego, CSU San Marcos, Duke University and the University of Hawaii. Field operations are conducted from the UC Berkeley Richard B. Gump South Pacific Research Station on the island of Moorea, French Polynesia.

MCR LTER Data: The Moorea Coral Reef (MCR) LTER data are managed by and available directly from the MCR project data site URL shown above. The datasets listed below were collected at or near the MCR LTER sampling locations, and funded by NSF OCE as ancillary projects related to the MCR LTER core research themes.

This project is supported by continuing grants with slight name variations:

- LTER: Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR II - Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR IIB: Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR III: Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR IV: Long-Term Dynamics of a Coral Reef Ecosystem

Collaborative Research: Ocean Acidification and Coral Reefs: Scale Dependence and Adaptive Capacity (OA coral adaptation)

Website: http://mcr.lternet.edu

Coverage: Moorea, French Polynesia

Extracted from the NSF award abstract:

This project focuses on the most serious threat to marine ecosystems, Ocean Acidification (OA), and addresses the problem in the most diverse and beautiful ecosystem on the planet, coral reefs. The research utilizes Moorea, French Polynesia as a model system, and builds from the NSF investment in the Moorea Coral Reef Long Term Ecological Research Site (LTER) to exploit physical and biological monitoring of coral reefs as a context for a program of studies focused on the ways in which OA will affect corals, calcified algae, and coral reef ecosystems. The project builds on a four-year NSF award with research in five new directions: (1) experiments of year-long duration, (2) studies of coral reefs to 20-m depth, (3) experiments in which carbon dioxide will be administered to plots of coral reef underwater, (4) measurements of the capacity of coral reef organisms to change through evolutionary and induced responses to improve their resistance to OA, and (5) application of emerging theories to couple studies of individual organisms to studies of whole coral reefs. Broader impacts will accrue through a better understanding of the ways in which OA will affect coral reefs that are the poster child for demonstrating climate change effects in the marine environment, and which provide income, food, and coastal protection to millions of people living in coastal areas, including in the United States.

This project focuses on the effects of Ocean Acidification on tropical coral reefs and builds on a program of research results from an existing 4-year award, and closely interfaces with the technical, hardware, and information infrastructure provided through the Moorea Coral Reef (MCR) LTER. The MCR-LTER, provides an unparalleled opportunity to partner with a study of OA effects on a coral reef with a location that arguably is better instrumented and studied in more ecological detail than any other coral reef in the world. Therefore, the results can be both contextualized by a high degree of ecological and physical relevance, and readily integrated into emerging theory seeking to predict the structure and function of coral reefs in warmer and more acidic future oceans. The existing award has involved a program of study in Moorea that has focused mostly on short-term organismic and ecological responses of corals and calcified algae, experiments conducted in mesocosms and flumes, and measurements of reef-scale calcification. This new award involves three new technical advances: for the first time, experiments will be conducted of year-long duration in replicate outdoor flumes; CO2 treatments will be administered to fully intact reef ecosystems in situ using replicated underwater flumes; and replicated common garden cultivation techniques will be used to explore within-species genetic variation in the response to OA conditions. Together, these tools will be used to support research on corals and calcified algae in three thematic areas: (1) tests for long-term (1 year) effects of OA on growth, performance, and fitness, (2) tests for depth-dependent effects of OA on reef communities at 20-m depth where light regimes are attenuated compared to shallow water, and (3) tests for beneficial responses to OA through intrinsic, within-species genetic variability and phenotypic plasticity. Some of the key experiments in these thematic areas will be designed to exploit integral projection models (IPMs) to couple organism with community responses, and to support the use of the metabolic theory of ecology (MTE) to address scale-dependence of OA effects on coral reef organisms and the function of the communities they build.

The following publications and data resulted from this project:

Comeau S, Carpenter RC, Lantz CA, Edmunds PJ. (2016) Parameterization of the response of calcification to temperature and pCO2 in the coral Acropora pulchra and the alga Lithophyllum kotschyanum. Coral Reefs 2016. DOI 10.1007/s00338-016-1425-0.
calcification rates (2014)
calcification rates (2010)

Comeau, S., Carpenter, R.C., Edmunds, P.J. (2016) Effects of pCO2 on photosynthesis and respiration of tropical scleractinian corals and calcified algae. ICES Journal of Marine Science doi:10.1093/icesjms/fsv267.
respiration and photosynthesis I
respiration and photosynthesis II

Evensen, N.R. & Edmunds P. J. (2016) Interactive effects of ocean acidification and neighboring corals on the growth of Pocillopora verrucosa. Marine Biology, 163:148.
doi: 10.1007/s00227-016-2921-z
coral growth
seawater chemistry
coral colony interactions

[table of contents | back to top]

Program Information

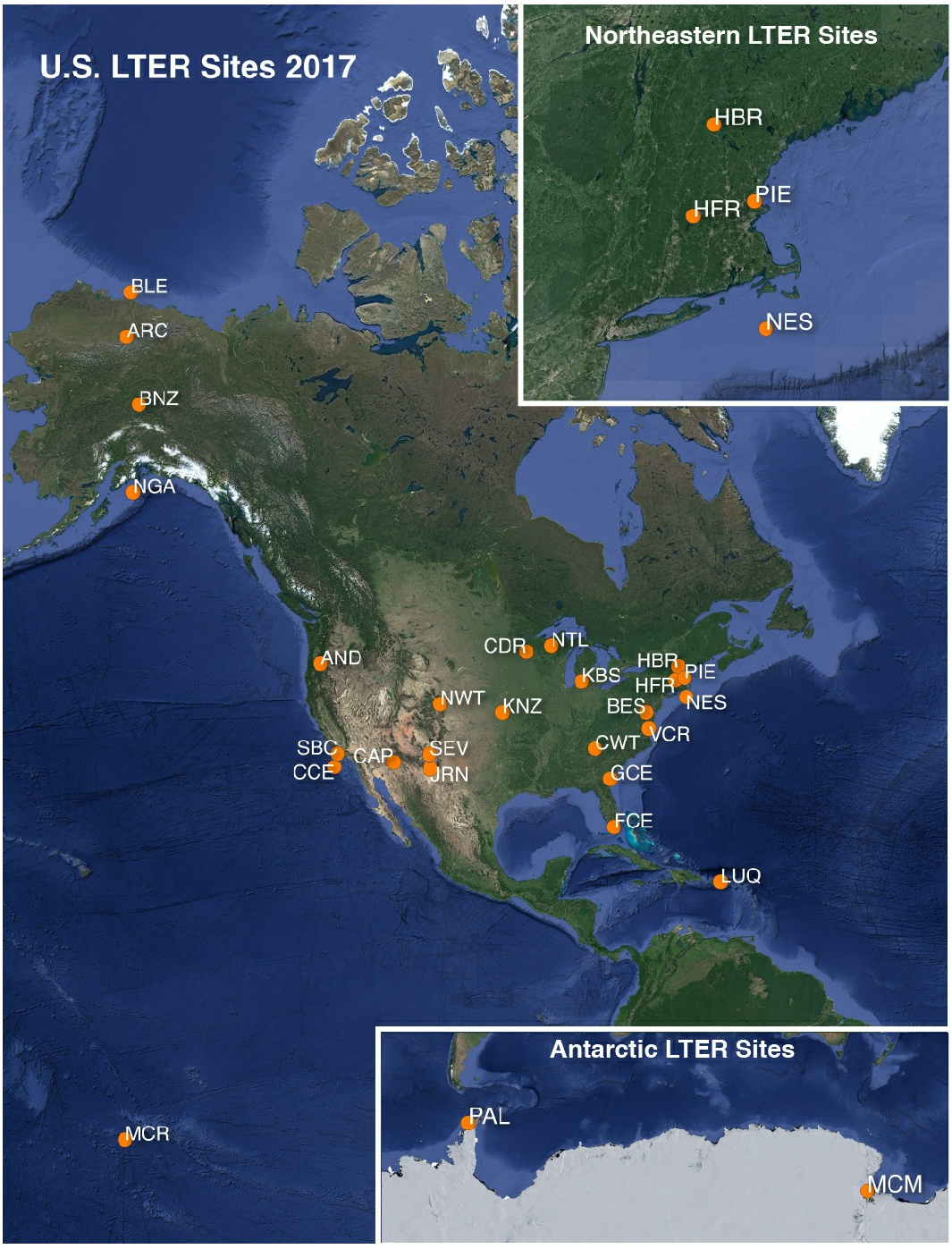
Long Term Ecological Research network (LTER)

Website: http://www.lternet.edu/

Coverage: United States

adapted from http://www.lternet.edu/

The National Science Foundation established the LTER program in 1980 to support research on long-term ecological phenomena in the United States. The Long Term Ecological Research (LTER) Network is a collaborative effort involving more than 1800 scientists and students investigating ecological processes over long temporal and broad spatial scales. The LTER Network promotes synthesis and comparative research across sites and ecosystems and among other related national and international research programs. The LTER research sites represent diverse ecosystems with emphasis on different research themes, and cross-site communication, network publications, and research-planning activities are coordinated through the LTER Network Office.



Site Codes

AND	Andrews Forest LTER
ARC	Arctic LTER
BES	Baltimore Ecosystem Stu
BLE	Beaufort Lagoon Ecosystems LTER
BNZ	Bonanza Creek LTER
CCE	California Current Ecosystem LTER
CDR	Cedar Creek Ecosystem Science Reserve
CAP	Central Arizona-Phoenix LTER
CWT	Coweeta LTER
FCE	Florida Coastal Everglades LTER
GCE	Georgia Coastal Ecosystems LTER
HFR	Harvard Forest LTER
HBR	Hubbard Brook LTER
JRN	Jornada Basin LTER
KBS	Kellogg Biological Station LTER
KNZ	Konza Prairie LTER
LUQ	Luquillo LTER
MCM	McMurdo Dry Valleys LT
MCR	Moorea Coral Reef LTEF
NWT	Niwot Ridge LTER
NTL	North Temperate Lakes I
NES	Northeast U.S. Shelf LTE
NGA	Northern Gulf of Alaska I
PAL	Palmer Antarctica LTER
PIE	Plum Island Ecosystems LTER
SBC	Santa Barbara Coastal L
SEV	Sevilleta LTER
VCR	Virginia Coast Reserve L

2017 LTER research site map obtained from https://lternet.edu/site/lter-network/

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-1415300
NSF Division of Ocean Sciences (NSF OCE)	OCE-1415268

[table of contents | back to top]