Calcification Rates and Biomass of 4 Coral Species, 2 Temperatures and 2 pCO2 Levels from Experiments at LTER site in Moorea, French Polynesia, 2011 (OA_Corals project)

Website: https://www.bco-dmo.org/dataset/641479
Data Type: experimental
Version:
Version Date: 2016-04-04

Project
» RUI: Ocean Acidification- Category 1- The effects of ocean acidification on the organismic biology and community ecology of corals, calcified algae, and coral reefs (OA_Corals)

Program
» 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
Brown, Darren J	California State University Northridge (CSUN)	Student, Contact
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

Coverage

Spatial Extent: **Lat**:-17.4907 **Lon**:-149.826
Temporal Extent: 2011-01-01 - 2011-04-30

Dataset Description

Area-normalized calcification (mg cm-2 d-1) and biomass normalized calcification (mg mg-1) for *Pocillopora meandrina*, massive *Porites* spp., *Acropora pulchra* and *Millepora platyphylla*, as a function of pCO2 (408 µatm versus 913 µatm) and temperature (28.0°C and 30.1°C), collected in Moorea 2011.

Related Reference:
Darren Brown, Peter J. Edmunds. Differences in the responses of three scleractinians and the hydrocoral Millepora platyphylla to ocean acidification. Marine Biology, 2016 (in press).

Related Dataset:
MarBio. 2016: tank conditions

Methods & Sampling

Calcifying cnidarians were collected from the back reef (~ 4 m depth) on the north shore of Moorea, French Polynesia, during January and April 2011. Fragments of Acropora pulchra, Pocillopora meandrina, massive Porites spp. (15% P. lobata and 85% P. lutea [Edmunds 2009]), and Millepora platyphylla were used to evaluate the effect of pCO2 and temperature on calcification. Massive Porites spp. and M. platyphylla were sampled using a pneumatic drill (McMaster-Carr, part #27755A17) fitted with a 4.1 cm diamond tip hole saw (McMaster-Carr, part #6930A43). The hole saw was used to remove cores ~ 4 cm diameter and ~ 3.8 cm long from adult colonies, and the holes were filled with non-toxic modeling clay (Van Aken Part #10117). To increase the likelihood that cores were genetically distinct, one core was taken from each colony, with sampled colonies distributed over 3 km of reef.

Freshly collected cores were placed in bags filled with seawater and transported to the Richard B. Gump South Pacific Research Station where they were immersed in tanks supplied with a constant flow of seawater from Cook's Bay. Cores were prepared by removing excess skeleton extending > 1.5 cm below the living tissue, and attaching the cores to numbered polyvinyl chloride (PVC) pipes (4.4 cm diameter and 2.0 cm long) with epoxy (Z Spar, #A788). To eliminate the possibility of fouling organisms accessing freshly cut skeleton, bare skeleton was covered in epoxy. A plastic screw was epoxied to the bottom of each core that was later used to attach them upright in racks placed in the tanks used for incubations. Following preparation, cores were returned to ~ 4 m depth in the back reef, where they were left to recover for 6 weeks. Recovery was evaluated from the presence of healthy c 124 oral tissue covering the formerly damaged edge of the skeleton.

Single branches of A. pulchra and P. meandrina were cut from colonies using bone shears, with each colony sampled once. Sampled colonies were ~ 10 m apart to increase the likelihood that they were genetically distinct. Branches were transported to the Richard B. Gump South Pacific Research Station where they were immersed in flowing seawater. Similar to the methods used for coral cores, branches of A. pulchra and P. meandrina were attached using epoxy to pieces of PVC pipe to make nubbins (Birkeland 1976). Care was taken to cover freshly fractured skeleton with epoxy, and to avoid damaging coral tissue during preparation. A plastic screw was attached to the base of the nubbins and used to hold them upright in plastic racks. Prior to beginning the treatments, coral cores and nubbins were placed in 150 L tanks under ambient conditions of 28.0°C, 370 micro-atm pCO2 and where illuminated with 400 W metal halide lamps (True 10,000K Hamilton Technology, Gardena, CA to an irradiance of ~ 600 micro-mol quanta m2 s-1 (measured with a 4p LI-193 quantum sensor and a LiCor LI-1400 meter) for 5 d to recover from the preparation procedure. The sampling method limited tissue damage to A. pulchra and P. meandrina, and therefore a shorter acclimation period was needed in comparison to massive Porites spp. and M. platyphylla.

Experimental conditions and maintenance

Treatments were created in 8 tanks (Aqua Logic, San Diego), each holding 150 L of seawater and regulated independently for temperature, light, and pCO2. Tanks were operated as closed146 circuit systems with filtered seawater (50 micro-m) from Cook's Bay, with circulation provided by a pump (Rio 8HF, 2,082 L h-1). Light was supplied 147 by 400 W metal halide lamps (True 10,000K Hamilton Technology, Gardena, CA) at ~ 560 micro-mol quanta m-2s-1 (measured with a 4p LI-193 quantum sensor and a LiCor LI-1400 meter) in the range of photosynthetically active radiation (PAR, 400-700 nm). Lights were operated on a 12hr light-12hr dark photoperiod, beginning at 06:00 hrs and ending at 18:00 hrs. Temperatures were maintained at 28.0°C, which corresponded to the ambient seawater temperature in the back reef when the study was conducted, and 30.1°C which is close to the maximum temperature in this habitat (Putnam and Edmunds 2011). pCO2 treatments contrasted ambient conditions (~ 408 micro-atm) and 913 micro-atm pCO2, with the elevated value expected to occur within 100 y under the "stabilization without overshoot" representative concentration pathway (RCP 6.0) (van Vuuren et al. 2011). pCO2 treatments were created by bubbling ambient air or a mixture of ambient air and pure CO2 that was blended continually and monitored using an infrared gas analyzer (IRGA model S151, Qubit Systems). A solenoid-controlled, gas regulation system (Model A352, Qubit Systems, Ontario, Canada) regulated the flow of CO2 and air, with pCO2 logged on a PC running LabPro software (Vemier Software and Technology). Ambient air and the elevated pCO2 mixture were supplied at ~ 10-15 L min-1 to treatment tanks using pumps (Gast pump DOA-P704-AA, see Edmunds 2011).

The temperatures and pCO2 levels created four treatments with two tanks treatment-1: ambient temperature-ambient pCO2 (AT-ACO2), ambient temperature-high pCO2 (AT-HCO2), high temperature-ambient pCO2 (HT-ACO2) and high temperature-high pCO2 (HT-HCO2). Treatment conditions were monitored daily, with temperature measured at 08:00, 12:00 and 18:00 hrs using a digital thermometer (Fisher Scientific model #150778, ± 0.05 °C), and light intensities at 12:00 hrs using a Li-Cor LI-193 sensor attached t 170 o a LI-1400 meter. Seawater within each tank was replaced at 200 ml/min with filtered seawater (50 micro-m) pumped from Cook's Bay.

Data Processing Description

BCO-DMO Processing:

- added conventional header with dataset name, PI name, version date, reference information
- renamed parameters to BCO-DMO standard
- added location, lat and lon columns

[table of contents | back to top]

Data Files

File
calcif_biomass.csv (Comma Separated Values (.csv), 3.62 KB) MD5:c893cb935be382ea75f21f90e4d39c2c Primary data file for dataset ID 641479

[table of contents | back to top]

Parameters

Parameter	Description	Units
location	location of experiment	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
species	species used in the study: Ap (Acropora pulchra); Mipl (Millepora platyphylla); MP (massive Porites spp.) ; Pm (Pocillopora meandrina)	unitless
tank	tank number	unitless
temp	tank temperature: AT=ambient (28.0 C); HT=high (30.1 C)	unitless
pCO2	tank CO2 concentration levels: ACO2 for ambient (408 micro-atm) and HCO2 for high (913 micro-atm)	unitless
treatment	AT-ACO2 = ambient temperature; ambient CO2; AT-HCO2 = ambient temperature-high CO2; HT-ACO2 = high temperature-ambient CO2; HT-HCO2 = high temperature-high CO2	unitless
calcification	calcification rate: ACO2 for ambient (408 µatm) and HCO2 for high (913 µatm) CO2 concentration levels	cm-2 day-1
biomass	coral biomass	mg mg-1

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Automatic titrator
Dataset-specific Description	Open cell potentiometric titrator (Model T50, Mettler-Toledo, Columbus, OH) fitted with a DG115-SC pH probe (Mettler-Toledo, Columbus, OH)
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	Conductivity Meter
Dataset-specific Description	YSI 3100 conductivity meter
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	
Generic Instrument Name	In-situ incubator
Dataset-specific Description	150 L tanks
Generic Instrument Description	A device on a ship or in the laboratory that holds water samples under controlled conditions of temperature and possibly illumination.

Dataset-specific Instrument Name	
Generic Instrument Name	LI-COR LI-193 PAR Sensor
Dataset-specific Description	4p LI-193 quantum sensor
Generic Instrument Description	The LI-193 Underwater Spherical Quantum Sensor uses a Silicon Photodiode and glass filters encased in a waterproof housing to measure PAR (in the 400 to 700 nm waveband) in aquatic environments. Typical output is in micromol s-1 m-2. The LI-193 Sensor gives an added dimension to underwater PAR measurements as it measures photon flux from all directions. This measurement is referred to as Photosynthetic Photon Flux Fluence Rate (PPFFR) or Quantum Scalar Irradiance. This is important, for example, when studying phytoplankton, which utilize radiation from all directions for photosynthesis. LI-COR began producing Spherical Quantum Sensors in 1979; serial numbers for the LI-193 begin with SPQA-XXXXX (licor.com).

Dataset-specific Instrument Name	
Generic Instrument Name	Light Meter
Dataset-specific Description	LiCor LI-1400 meter
Generic Instrument Description	Light meters are instruments that measure light intensity. Common units of measure for light intensity are umol/m2/s or uE/m2/s (micromoles per meter squared per second or microEinsteins per meter squared per second). (example: LI-COR 250A)

Dataset-specific Instrument Name	
Generic Instrument Name	ultrasonic cell disrupter (sonicator)
Dataset-specific Description	Ultrasonic dismembrator (Fisher model 216 15-338-550; fitted with a 3.2 mm diameter probe, Fisher 15-338-67)
Generic Instrument Description	Instrument that applies sound energy to agitate particles in a sample.

Dataset-specific Instrument Name	
Generic Instrument Name	Water Temperature Sensor
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

[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

RUI: Ocean Acidification- Category 1- The effects of ocean acidification on the organismic biology and community ecology of corals, calcified algae, and coral reefs (OA_Corals)

Coverage: Moorea, French Polynesia

While coral reefs have undergone unprecedented changes in community structure in the past 50 y, they now may be exposed to their gravest threat since the Triassic. This threat is increasing atmospheric CO2, which equilibrates with seawater and causes ocean acidification (OA). In the marine environment, the resulting decline in carbonate saturation state (Omega) makes it energetically less feasible for calcifying taxa to mineralize; this is a major concern for coral reefs. It is possible that the scleractinian architects of reefs will cease to exist as a mineralized taxon within a century, and that calcifying algae will be severely impaired. While there is a rush to understand these effects and make recommendations leading to their mitigation, these efforts are influenced strongly by the notion that the impacts of pCO2 (which causes Omega to change) on calcifying taxa, and the mechanisms that drive them, are well-known. The investigators believe that many of the key processes of mineralization on reefs that are potentially affected by OA are only poorly known and that current knowledge is inadequate to support the scaling of OA effects to the community level. It is vital to measure organismal-scale calcification of key taxa, elucidate the mechanistic bases of these responses, evaluate community scale calcification, and finally, to conduct focused experiments to describe the functional relationships between these scales of mineralization.

This project is a 4-y effort focused on the effects of Ocean Acidification (OA) on coral reefs at multiple spatial and functional scales. The project focuses on the corals, calcified algae, and coral reefs of Moorea, French Polynesia, establishes baseline community-wide calcification data for the detection of OA effects on a decadal-scale, and builds on the research context and climate change focus of the Moorea Coral Reef LTER.

This project is a hypothesis-driven approach to compare the effects of OA on reef taxa and coral reefs in Moorea. The PIs will utilize microcosms to address the impacts and mechanisms of OA on biological processes, as well as the ecological processes shaping community structure. Additionally, studies of reef-wide metabolism will be used to evaluate the impacts of OA on intact reef ecosystems, to provide a context within which the experimental investigations can be scaled to the real world, and critically, to provide a much needed reference against which future changes can be gauged.

Datasets listed in the "Dataset Collection" section include references to results journal publications published as part of this project.

[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-0417412
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041270
NSF Division of Ocean Sciences (NSF OCE)	OCE-1026851

[table of contents | back to top]