

Tank seawater conditions from Coral/Temperature/pCO₂ Experiments at LTER site in Moorea, French Polynesia, 2011 (OA_Corals project)

Website: <https://www.bco-dmo.org/dataset/641759>

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
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Coverage

Spatial Extent: Lat:-17.4907 Lon:-149.826

Temporal Extent: 2011-01-01 - 2011-04-30

Dataset Description

Summary of conditions in the eight tanks assigned randomly to create four treatments of AT-ACO₂.

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: calcification and biomass](#)

Methods & Sampling

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.

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 to 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.

Carbonate chemistry and pH analysis

To evaluate dissolved inorganic carbon (DIC) conditions in the 8 tanks, total alkalinity (TA) and pH of the seawater were recorded every third day of the experiment. Seawater was collected between 07:00-09:00 hrs using stoppered glass bottles, equilibrated to room temperature (25.0°C), and processed within 2-3 hrs of collection. TA was determined using an open cell potentiometric titrator (Model T50, Mettler-Toledo, Columbus, OH) fitted with a DG115-SC pH probe (Mettler-Toledo, Columbus, OH) calibrated daily using NBS buffers (pH 4.00, 7.00 and 10.00, Fisher Scientific, 15-0787-8, ± 0.05 °C), and used to perform gran titrations using standard operating procedure 3 (SOP) of Dickson et al. (2007). Seawater pH was determined spectrophotometrically using the dye m-cresol purple (SOP 6b of Dickson et al. 2007), where pH was expressed on the total scale. The results of the gran titrations together with seawater salinity (YSI 3100 conductivity meter) and seawater temperature were used to calculate TA, pCO₂, HCO₃⁻, CO₃²⁻ and aragonite saturation state (Omega) using CO2SYS (Lewis and Wallace 1998), with the constants of Mehrbach et al. (1973) and pH on the total scale.

To evaluate the accuracy and precision of TA analyses, certified reference materials (CRM, batch 105 from A. Dickson, Scripps Institution of Oceanography) were processed before each set of seawater samples. CRMs were evaluated with a mean error of 0.37% (~ 8 micro-mol kg⁻¹, n = 11) relative to the certified values. The precision and accuracy of pH measurements were evaluated using standardized Tris buffers (Batch 5 from A. D 193 Dickson Laboratory, Scripps Institution of Oceanography) that were processed spectrophotometrically with m-cresol as described above. Percent average error from the known pH of the Tris buffer was 0.16% (0.01 pH units, n = 13).

Incubation schedule and dependent variables

On April 24th 2011, nubbins and cores were buoyant weighed (± 1 mg, Spencer-Davies 1989) and randomly placed in the mesocosm, with four taxa and two replicates per taxon in each tank. Over the following 24 h, seawater temperature and pCO₂ were adjusted to target values. Corals remained in the treatments for 19 d, and were moved randomly within the tanks daily to eliminate position effects. Individual corals, along with the racks holding them, were cleaned every 5 d by wiping algal growth from walls of the tanks, racks, and PVC coral holders. On May 12th, the experiment ended and the corals were again buoyant weighed and the area of living tissue determined using aluminum foil (Marsh 1970).

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

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Data Files

File
chem.csv (Comma Separated Values (.csv), 2.21 KB) MD5:a1aebf5aa9d8acd57dbd702a52963a4c Primary data file for dataset ID 641759

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Parameters

Parameter	Description	Units
location	location of experiment	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
tank	tank number	unitless
temp	tank temperature: AT=ambient (28.0 C); HT=high (30.1 C)	unitless
pCO2	ambient (ACO2) and high (HCO2) CO2 concentration levels measured throughout the experiment	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
pCO2_uatm	pCO2 concentration levels measured weekly throughout the experiment per tank	micro-atmospheres

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Instruments

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 $\mu\text{mol s}^{-1} \text{m}^{-2}$. 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 $\mu\text{mol/m}^2/\text{s}$ or $\text{uE/m}^2/\text{s}$ (micromoles per meter squared per second or microEinsteins per meter squared per second). (example: LI-COR 250A)

Dataset-specific Instrument Name	
Generic Instrument Name	Titration
Dataset-specific Description	Open cell potentiometric titration (Model T50, Mettler-Toledo, Columbus, OH) fitted with a DG115-SC pH probe (Mettler-Toledo, Columbus, OH)
Generic Instrument Description	Titration is an instrument that incrementally adds 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	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).

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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

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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.

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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)

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

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