

# Calcification of coral from the start and end of experiments under elevated concentrations of temperature and carbon dioxide

**Website:** <https://www.bco-dmo.org/dataset/748383>

**Data Type:** Other Field Results, experimental

**Version:** 1

**Version Date:** 2018-10-16

## Project

- » [Moorea Coral Reef Long-Term Ecological Research site](#) (MCR LTER)
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## Programs

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- » [Science, Engineering and Education for Sustainability NSF-Wide Investment \(SEES\): Ocean Acidification \(formerly CRI-OA\)](#) (SEES-OA)

Contributors	Affiliation	Role
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## Abstract

Calcification of coral from the start and end of experiments under elevated concentrations of temperature and carbon dioxide.

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## Coverage

**Spatial Extent:** Lat:-17.5592 Lon:-149.8222

**Temporal Extent:** 2017-01-21 - 2017-02-06

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## Dataset Description

See Doo et al. (2018) for a detailed overview of the methodology.

## Acquisition Description

**Collection and experimental setup methods extracted from Doo et al. (2018):**

Colony collection: In January 2017, 48 colonies of *Pocillopora verrucosa* (Ellis and Solander 1786) were collected randomly on scuba from 5 m depth on the north shore of Mo'orea, French Polynesia (17° 28' 33"S, 149° 49' 20"W). Following 5 d of acclimation, 24 of the corals were selected randomly for removal of all trapeziid crabs and alpheid shrimps ("minus-ectosymbiont") by probing with a wooden stick (3 mm diameter). Crabs and shrimp were left in the other 24 corals ("plus-ectosymbiont"), which were subjected to a procedural control in which they were probed with a wooden stick.

Incubation setup: Twelve mesocosm tanks (150 L volume with sand-filtered seawater pumped from 14 m depth in Cooks' Bay and supplied to the tanks at ~200 mL min<sup>-1</sup>) were used in this experiment, with four colonies per tank in a split-plot design contrasting plus-ectosymbiont (n = 2 colonies/tank) and minus-ectosymbiont (n = 2 colonies/tank) corals.

**Daily measures of salinity, pH, and total alkalinity (TA):**

Temperature was recorded with a thermometer ( $\pm 0.05$  degrees C; ThermoFisher Traceable) and salinity was measured with a bench-top conductivity meter ( $\pm 0.1$  psu, YSI 3100). TA and pH were measured within one hour of sample collection. Seawater collected for TA was filtered (0.45  $\mu$ m; Chanson and Millero, 2007) and analyzed using potentiometric titrations with 0.1-N HCl using an automatic titrator (Mettler Toledo T50) (Dickson et al., 2007). Seawater pH was measured with spectrophotometric methods (Nemzer and Dickson, 2005).

**Buoyant weight:** was measured at start and end of experiment and difference between the two values was used to calculate an increase in dry skeletal weight (i.e., calcification) using the density of aragonite, and then normalized to the surface area of each coral (Davies 1989).

**Processing Description**

Buoyant weight was measured at start and end of experiment and difference between the two values was used to calculate an increase in dry skeletal weight (i.e., calcification) using the density of aragonite, and then normalized to the surface area of each coral (Davies 1989). All statistical analyses were performed with the R statistical software. pH data were calculated using spectrophotometric methods outlined by Dickson et al. (2007).

BCO-DMO Processing:

- replaced "#" with "number" in paratmer names.

## Related Publications

Chanson, M., & Millero, F. J. (2007). Effect of filtration on the total alkalinity of open-ocean seawater. *Limnology and Oceanography: Methods*, 5(10), 293–295.

doi:[10.4319/lom.2007.5.293](https://doi.org/10.4319/lom.2007.5.293)

Davies, P.S. (1989). Short-term growth measurements of corals using an accurate buoyant weighing technique. *Marine Biology*, 101(3), 389–395. doi:[10.1007/BF00428135](https://doi.org/10.1007/BF00428135)

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO<sub>2</sub> measurements. PICES Special Publication 3, 191 pp. ISBN: 1-897176-07-4. Handle: <http://hdl.handle.net/11329/249>. URL:

[https://www.nodc.noaa.gov/ocads/oceans/Handbook\\_2007.html](https://www.nodc.noaa.gov/ocads/oceans/Handbook_2007.html)

Doo, S. S., Carpenter, R. C., & Edmunds, P. J. (2018). Obligate ectosymbionts increase the physiological resilience of a scleractinian coral to high temperature and elevated pCO<sub>2</sub>. *Coral Reefs*. doi:[10.1007/s00338-018-1731-9](https://doi.org/10.1007/s00338-018-1731-9)

Ellis, J., & Solander, D. C. (1786). The natural history of many curious and uncommon zoophytes : collected from various parts of the globe /. doi:[10.5962/bhl.title.64985](https://doi.org/10.5962/bhl.title.64985)

Nemzer, B. V., & Dickson, A. G. (2005). The stability and reproducibility of Tris buffers in synthetic seawater. *Marine Chemistry*, 96(3-4), 237–242. doi:[10.1016/j.marchem.2005.01.004](https://doi.org/10.1016/j.marchem.2005.01.004)

## Parameters

Parameter	Description	Units
Coral_number	Unique coral colony identification number	unitless
pH	pH treatment	unitless
Temperature	Temperature treatment	unitless
Crab	Crab treatment: with (Yes) or without (No)	unitless
Growth	Change in weight (g) obtained by buoyant weighing pre and post experiment, and later converted to mass of CaCO <sub>3</sub> and normalized to surface area of coral tissue (Stimson and Kinzie 1991).	grams

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## Instruments

<b>Dataset-specific Instrument Name</b>	Mettler PB153-S balance
<b>Generic Instrument Name</b>	Scale
<b>Generic Instrument Description</b>	An instrument used to measure weight or mass.

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## 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. The following publications and data resulted from this project:  
2012 Edmunds PJ. Effect of pCO<sub>2</sub> on the growth, respiration, and photophysiology of massive *Porites* spp. in Moorea, French Polynesia. *Marine Biology* 159: 2149-2160.  
doi:10.1594/PANGAEA.820375 *Porites* growth\_respiration\_photophysDownload complete data for this publication (Excel file)

## **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; CO<sub>2</sub> 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 pCO<sub>2</sub> in the coral *Acropora pulchra* and the alga *Lithophyllum kotschyianum*. *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 pCO<sub>2</sub> 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

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## 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. 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:** [http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=503477](http://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 ([http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=504707](http://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)

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1026851</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1236905</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1415268</a>

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