# Experimental results of calcification rates of corals at variable pCO2 from the Richard B Gump Research Station, Moorea, French Polynesia in 2011 (MCR LTER project, OA_Corals project)

**Website**: https://www.bco-dmo.org/dataset/518462
**Data Type**: experimental
**Version**: 2014-07-09

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

**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 |
|---|---|---|
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## Dataset Description

These data were obtained during an experiment performed in August-September-October 2011 and 2012 in French Polynesia. Calcification rates were measured in 8 corals *(Porites rus, massive Porites, Porites irregularis, Pocillopora damicornis, Pocillopora verrucosa, Psammacora profundacella, Pavona cactus, Acropora pulchra)* at 6 pCO2.

**Related References:**


Comeau, S., Edmunds, P. J., Spindel, N. B., Carpenter, R. C. (2014). Fast coral reef calcifiers are more sensitive to ocean acidification in short-term laboratory incubations. Limnology and Oceanography, 59(3), 1081–1091. doi:10.4319/lo.2014.59.3.1081

Comeau, S., Edmunds, P. J., Spindel, N. B., Carpenter, R. C. (2013) The responses of eight coral reef calcifiers to increasing partial pressure of CO2 do not exhibit a tipping point. *Limnol. Oceanogr.* 58, 388–398.


**Related datasets:**
algae_calcification
carbonate_chemistry
light_dark_calcification
mean_calcification
calcification rates - flume expt
carbonate chemistry - flume expt

### Methods & Sampling

For the carbonate chemistry:

Seawater pH was measured twice a day (08:00 hrs and 18:00 hrs) in each incubation tank, using a pH meter (Orion, 3-stars mobile) calibrated every 2-3 d on the total scale using Tris/HCl buffers (Dickson, San Diego, USA) with a salinity of 34.5. Total alkalinity of the seawater in the tanks was measured every 2 d, using single samples drawn from each tank in glass-stoppered bottles (250 mL). Samples were analyzed for total alkalinity within 1 d using open cell, potentiometric titration and an automatic titrator (T50, Mettler-Toledo). Titrations were conducted on 50-mL samples at ~ 24 °C, and total alkalinity calculated as described by Dickson et al. [2007]. Titrations of certified reference materials (CRM) provided by A. G. Dickson (batch 105) yielded total alkalinity values within 3.8 umol kg-1 of the nominal value (SD = 3.1 umol kg-1; n = 19). Salinity in the experimental tanks was measured every 2 d using a conductivity meter (YSI 3100). Total alkalinity, pH on the total scale (pHT), temperature, and salinity were used to calculate the carbonate chemsitry using the seacarb package (Lavigne and Gattuso 2012) running in R software (R Foundation for Statistical Computing).

Calcification:

Buoyant weight (± 1 mg) was recorded before and after the 15 d of incubation (following 15 d of acclimation), and the difference between the two was converted to dry weight using an aragonite density of 2.93 g cm^-3 for corals. Calcification was normalized to surface area estimated using aluminum foil for corals.

### Data Processing Description

Parameters of the carbonate system in seawater were calculated from salinity, temperature, *AT* and pHT using the R package seacarb (Lavigne and Gattuso 2011).

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## Data Files

| File |
|---|
| **coral_calc.csv** (Comma Separated Values (.csv), 42.65 KB)<br>MD5:236a36683e3205dc755dca43bafb83ee<br>Primary data file for dataset ID 518462 |

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## Parameters

| Parameter | Description | Units |
|---|---|---|
| species_coral | Coral species used during experiment. | dimensionless |
| treatment_pCO2 | pCO2 concentration for each species treatment. | microatmospheres |
| rate_calcification | Calcification in corals normalized by surface area. | mg CaCO3 cm-2 d-1 |
| lab | Name of laboratory where experiments were conducted. | dimensionless |
| lat | Latitude component of geographic location of laboratory. | decimal degrees |
| lon | Longitude component of geographic location of laboratory. | decimal degrees |

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## Instruments

| | |
|---|---|
| **Dataset-specific Instrument Name** | pH Sensor |
| **Generic Instrument Name** | pH Sensor |
| **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** | Automatic titrator |
| **Generic Instrument Name** | Titrator |
| **Generic Instrument Description** | Titrators are instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached. |

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## Deployments

**lab_Carpenter_Moorea**

| | |
|---|---|
| **Website** | https://www.bco-dmo.org/deployment/58885 |
| **Platform** | Richard B Gump Research Station - Moorea LTER |
| **Start Date** | 2011-07-17 |
| **End Date** | 2011-08-12 |
| **Description** | Laboratory experiments carried out by R. Carpenter and P. Edmunds of California State University Northridge at the Richard B. Gump Research Station in French Polynesia, for the 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". |

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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

**NSF Award Abstract:**

Coral reefs provide important benefits to society, from food to exceptional biodiversity to shoreline protection and recreation, but they are threatened by natural perturbations and human activities, including those causing global-scale changes. These pressures increasingly are causing coral reefs to undergo large, often abrupt, ecological changes where corals are being replaced by seaweeds or other undesirable organisms. Historically, the major agent of disturbance to coral reefs has been powerful storms, but in recent decades, episodes of mass coral bleaching from marine heat waves have become more frequent and severe as the temperature of ocean surface waters continues to rise. Coral reefs are further stressed by local human activities that cause nutrient pollution and deplete herbivorous fishes that control growth of seaweeds. Studying how coral reefs respond to these two types of disturbance under different levels of nutrient pollution and fishing provides essential information on what affects the ability of coral reefs to buffer environmental change and disturbances without collapsing to a persistent, degraded condition. The fundamental goals of the Moorea Coral Reef Long Term Ecological Research program (MCR LTER) are to understand how and why coral reefs change over time, to assess the consequences of these changes, and to contribute scientific knowledge needed to sustain coral reef ecosystems and the important societal services they provide. This research improves understanding and management of coral reefs, which benefits all groups concerned with the welfare of this ecologically, economically and culturally important ecosystem. In addition to academic communities, scientific findings are communicated to interested individuals, non-governmental organizations, island communities and governmental entities. These findings also are integrated into K-12, undergraduate, graduate and public education activities through a multi-pronged program that includes inquiry-based curricula, interactive and media-based public education programs, and internet-based resources. MCR?s research, training, education and outreach efforts all emphasize broadening participation in STEM fields and strengthening STEM literacy.

New research activities build on MCR LTER?s powerful foundation of long-term observations and broad ecological understanding of oceanic coral reefs to address the following core issues: How is the changing disturbance regime (recurrent heat waves in addition to cyclonic storms) altering the resilience of coral reefs, and what are the ecological consequences of altered resilience? Research activities are organized around a unifying framework that explicitly addresses how reef communities are affected by the nature and history of coral-killing disturbances, and how those responses to disturbance are influenced by the pattern of local human stressors. New studies answer three focal questions: (1) How do different disturbance types, which either remove (storms) or retain (heat waves) dead coral skeletons, affect community dynamics, abrupt changes in ecological state, and resilience? (2) How do local stressors interact with new disturbance regimes to create spatial heterogeneity in community dynamics, ecosystem processes, and spatial resilience? And (3) What attributes of coral and coral reef communities influence their capacity to remain resilient under current and future environmental conditions? These questions provide an unparalleled opportunity to test hypotheses and advance theory regarding ecological resilience and the causes and consequences of abrupt ecological change, which is broadly relevant across aquatic and terrestrial ecosystems.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

**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

**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

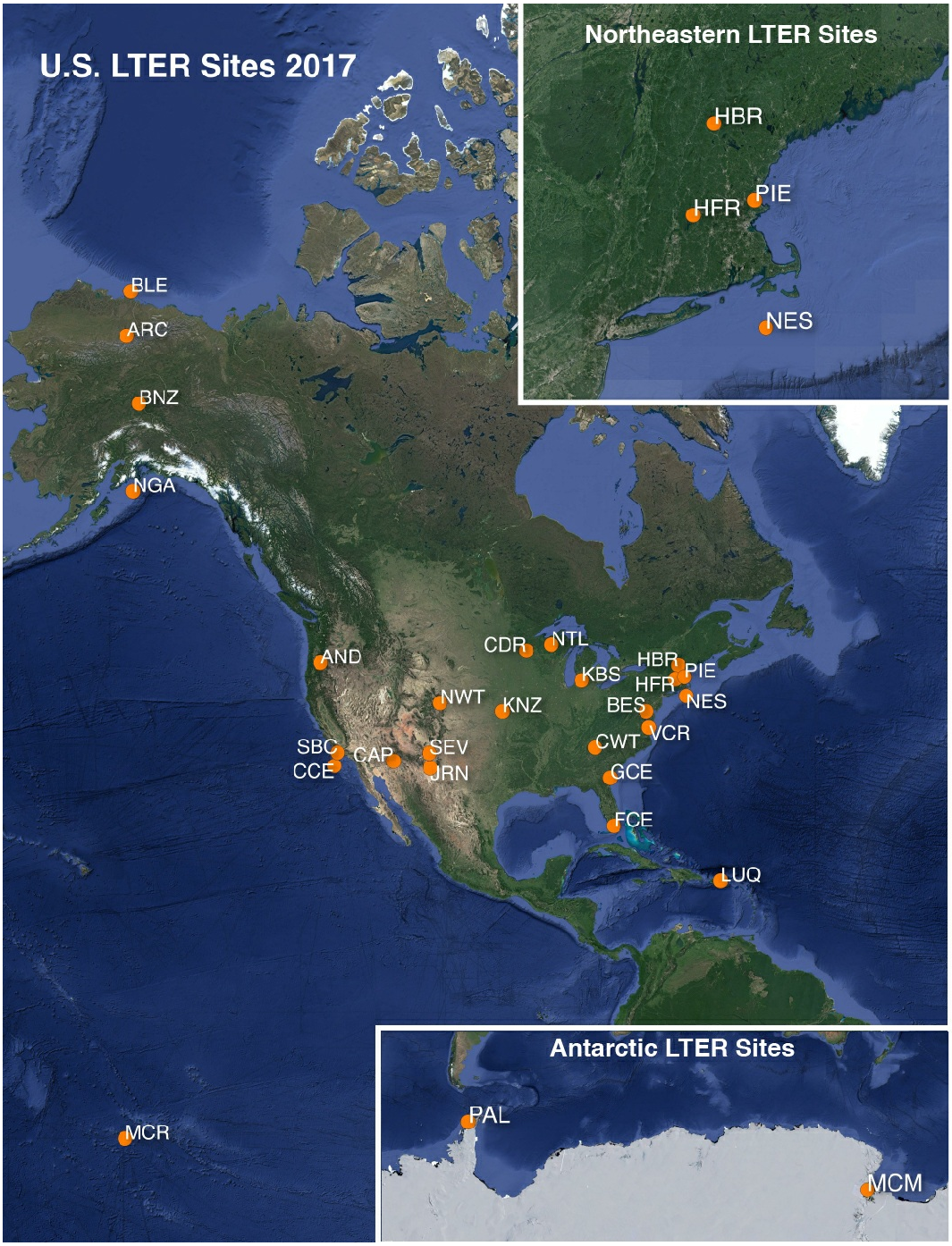
**Long Term Ecological Research network (LTER)**

**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 L |
| NES | Northeast U.S. Shelf LTE |
| NGA | Northern Gulf of Alaska L |
| 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)

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## Funding


| Funding Source | Award |
|---|---|
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1041270 |


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