Data from reciprocal transplant experiments conducted on Porites coral collected on Palau in December 2012

Website: https://www.bco-dmo.org/dataset/705851
Data Type: Other Field Results
Version: 1
Version Date: 2017-06-23

Project
» Toward Predicting the Impact of Ocean Acidification on Net Calcification by a Broad Range of Coral Reef Ecosystems: Identifying Patterns and Underlying Causes (Coral Reef Ecosystem OA Impact)

Programs
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
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Abstract
Data from reciprocal transplant experiments conducted on Porites coral collected on Palau in December 2012.

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Coverage

Spatial Extent: **N**:7.324 **E**:134.522 **S**:7.324 **W**:134.493
Temporal Extent: 2012-12-01 - 2013-05-31

Dataset Description

Data from reciprocal transplant experiments on Palau Porites coral.

These data were originally published in figures 4 and 5 of:
Barkley, H. C., Cohen, A. L., McCorkle, D. C., & Golbuu, Y. (2017). Mechanisms and thresholds for pH tolerance in Palau corals. Journal of Experimental Marine Biology and Ecology, 489, 7–14. doi:10.1016/j.jembe.2017.01.003

Acquisition Description

Methods reprinted from Barkley et al. 2017:
Coral collection: Coral plugs were collected in December 2012 from massive *Porites* colonies at a naturally low-Ωar reef site (7.324 N, 134.493 E; mean Ωar = 2.3; n = 78) and a naturally high-Ωar reef site (7.268 N, 134.522 E; mean Ωar = 3.7; n = 75). At each reef site, small skeletal cores (diameter = 3.5 cm) were removed from massive colonies (one core per colony) at 2-3m depth using underwater pneumatic drills, and cores were cut with a lapidary table saw to approximately 1 cm below the tissue layer. The plugs were affixed to nylon square base screws with marine epoxy, secured to egg crate racks, and returned to their original reefs to allow the corals to recover from the coring procedure. All corals survived two months of recovery on the reef and on all corals living tissue had fully overgrown the sides of the plugs so that no underlying skeleton was exposed. Corals were recovered in February 2013.

Reciprocal transplant experiment: The reciprocal transplant experiment was conducted concurrently with the CO2 manipulation experiment. Initial buoyant weight measurements were obtained for all corals prior to transplantation. Of the corals collected from the low-Ωar reef and from the high-Ωar reef (n = 44 for each reef), approximately half of the corals in each group was returned to their reef of origin (low-Ωar to low-Ωar: n = 23, high-Ωar to high-Ωar: n = 21), while

the remaining corals were transplanted to the opposite reef (low-Ωar to high-Ωar: n = 21, high-Ωar to low-Ωar: n = 23). All corals were transplanted to the same depth (5m). In May 2013, after eight weeks in the field (and at the end of the CO2 manipulation experiment), approximately half of the corals from each reef (n = 10-12 per transplant group) were recovered and weighed. The remaining corals were left out on the two reefs for 17 months (n = 10-11 per group). In August 2014, these corals were recovered from the reef. Corals were evaluated for partial or total mortality, and were judged to be alive (no visible tissue death observed), partially dead (visible tissue death and/or tissue recession but some living tissue remaining), or dead (no living tissue remaining). Buoyant weights were collected for all corals to determine overall calcification rates during the reciprocal transplant period. Because coral tissue is assumed to be neutrally buoyant (i.e. it does not contribute to buoyant weight measurements) and the timing of tissue death during the 17-month transplant was unknown, the overall change in skeletal mass was calculated and reported for all corals regardless of mortality status.

Processing Description

Parameter names have been modified to comply with BCO-DMO naming conventions.

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Related Publications

Barkley, H. C., Cohen, A. L., Golbuu, Y., Starczak, V. R., DeCarlo, T. M., & Shamberger, K. E. F. (2015). Changes in coral reef communities across a natural gradient in seawater pH. Science Advances, 1(5), e1500328–e1500328. doi:10.1126/sciadv.1500328

Barkley, H. C., Cohen, A. L., McCorkle, D. C., & Golbuu, Y. (2017). Mechanisms and thresholds for pH tolerance in Palau corals. Journal of Experimental Marine Biology and Ecology, 489, 7–14. doi:10.1016/j.jembe.2017.01.003

Shamberger, K. E. F., Cohen, A. L., Golbuu, Y., McCorkle, D. C., Lentz, S. J., & Barkley, H. C. (2014). Diverse coral communities in naturally acidified waters of a Western Pacific reef. Geophysical Research Letters, 41(2), 499–504. doi:10.1002/2013GL058489

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Parameters

Parameter	Description	Units
coral_id	Unique identification number for each transplanted coral	unitless
transplant_duration	Length of transplant experiment (2 or 17 months)	months
original_omegaAR	Aragonite saturation state of reef where coral was collected	unitless
transplant_omegaAR	Aragonite saturation state of reef where coral was transplanted	unitless
treatment_code	Indicates return to reef of origin (O) or transplanted to opposite reef (T)	unitless
calc_rate	Calcification rate of corals measured by buoyant weight	milligrams per square centimeter per month (mg/cm2/month)
status	Health status of corals at end of transplant experiment (live, partially dead, or dead)	unitless

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Instruments

Dataset-specific Instrument Name	pneumatic drill
Generic Instrument Name	Manual Biota Sampler
Dataset-specific Description	At each reef site, small skeletal cores (diameter = 3.5 cm) were removed from massive colonies (one core per colony) at 2–3mdepth using underwater pneumatic drills.
Generic Instrument Description	Manual Biota Sampler indicates that a sample was collected in situ by a person, possibly using a hand-held collection device such as a jar, a net or their hands.

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Deployments

Palau_reefs_2011-13

Website	https://www.bco-dmo.org/deployment/489112
Platform	PICRC Small Boats
Start Date	2011-09-19
End Date	2013-11-12
Description	Between September 2011 and November 2013, samples were collected from sites throughout the Palauan archipelago. Sampling was performed from small boats taken out daily from the Palau International Coral Reef Center (PICRC). Sampling was done as part of the project, "An Investigation of the Role of Nutrition in the Coral Calcification Response to Ocean Acidification".

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Project Information

Toward Predicting the Impact of Ocean Acidification on Net Calcification by a Broad Range of Coral Reef Ecosystems: Identifying Patterns and Underlying Causes (Coral Reef Ecosystem OA Impact)

Coverage: Republic of Palau, Caroline Islands, Micronesia, western Pacific Ocean; Dongsha Atoll, Pratas Islands, South China Sea; Kingman Reef, US Northern Line Islands, 6 deg. 23 N, 162 deg. 25 W

text copied from the NSF award abstract: Much of our understanding of the impact of ocean acidification on coral reef calcification comes from laboratory manipulation experiments in which reef organisms are removed from their natural habitat and reared under conditions of calcium carbonate saturation (Omega) predicted for the tropical oceans at the end of this century. By comparison, there is a paucity of in situ data describing the sensitivity of coral reef ecosystems to changes in calcium carbonate saturation. Yet emerging evidence suggests there may be critical differences between the calcification response of organisms in culture and

the net calcification response of a coral reef ecosystem, to the same degree of change in calcium carbonate saturation. In the majority of cases, the sensitivity of net reef calcification to changing calcium carbonate saturation is more severe than laboratory manipulation experiments predict. Clearly, accurate predictions of the response of coral reef ecosystems to 21st century ocean acidification will depend on a robust characterization of ecosystem-scale responses and an understanding of the fundamental processes that shape them. Using existing data, the investigators show that the sensitivity of coral reef ecosystem calcification to Delta calcium carbonate saturation conforms to the empirical rate equation R=k(Aragonite saturation state -1)n, which also describes the relationship between the rate of net abiogenic CaCO3 precipitation (R) and the degree of Aragonite supersaturation (Aragonite saturation state-1). By implication, the net ecosystem calcification (NEC) response to ocean acidification is governed by fundamental laws of physical chemistry and is potentially predictable across space and time. When viewed this way, the existing, albeit sparse, dataset of NEC reveals distinct patterns that, if verified, have important implications for how different coral reef ecosystems will respond to 21st century ocean acidification. The investigators have outlined a research program designed to build on this proposition. The project expands the currently sparse dataset of ecosystem-scale observations at four strategically placed reef sites: 2 sites in the Republic of Palau, Caroline Islands, Micronesia, western Pacific Ocean; a third at Dongsha Atoll, Pratas Islands, South China Sea; and the fourth at Kingman Reef, US Northern Line Islands, 6 deg. 23 N, 162 deg. 25 W. The four selected sites will allow investigators to test the following hypotheses: (1) The sensitivity ("n" in the rate equation) of coral reef ecosystem calcification to Delta Aragonite saturation state decreases with decreasing Aragonite saturation state. By implication, the rate at which reef calcification declines will slow as ocean acidification progresses over the course of this century. (2) The energetic status of the calcifying community is a key determinant of absolute rates of net ecosystem calcification ("k" in the rate equation), which, combined with n, defines the Aragonite saturation state value at which NEC approaches zero. By implication, the shift from net calcification to net dissolution will be delayed in healthy, energetically replete coral reef ecosystems and accelerated in perturbed, energetically depleted ecosystems. and (3) The calcification response of individual colonies of dominant reef calcifiers (corals and algae) is weaker than the measured ecosystem-scale response to the same change in Aragonite saturation state. By implication, processes not adequately captured in laboratory experiments, such as bioerosion and dissolution, will play an important role in the coral reef response to ocean acidification. Broader Impacts: Ocean acidification threatens the livelihoods of 500 million people worldwide who depend on coral reefs to provide habitable and agricultural land, food, building materials, coastal protection and income from tourism. Yet data emerging from ocean acidification (OA) studies point to critical gaps in our knowledge of reef ecosystem-scale responses to OA that currently limit our ability to predict the timing and severity of its impact on different reefs in different parts of the world. Using existing data generated by the investigators and others, this project will address a series of related hypotheses, which, if verified by the research, will have an immediate, direct impact

on predictions of coral reef resilience in a high CO2 world. This project brings together expertise in coral reef biogeochemistry, chemical oceanography and physical oceanography to focus on a problem that has enormous societal, economic and conservation relevance. In addition to sharing the resultant data via BCO-DMO, project data will also be contributed to the Ocean Acidification International Coordination Centre (OA-ICC) data collection hosted at the PANGAEA Open Access library (http://www.pangaea.de).

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Program Information

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

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). 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-FY2011NSF 12-500, FY 2012NSF 12-600, FY 2013NSF 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)

Ocean Carbon and Biogeochemistry (OCB)

Website: http://us-ocb.org/

Coverage: Global

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF. The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems. The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO2 and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two. The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen

conditions in the coastal and open oceans.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1220529

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