Biomass-normalized dark respiration and net photosynthesis rates in coral and algae as a function of pCO2 where LEDR (light-enhanced dark respiration) was measured (OA coral adaptation project)

Website: https://www.bco-dmo.org/dataset/648416
Data Type: experimental
Version:
Version Date: 2016-05-11

Project
» Collaborative Research: Ocean Acidification and Coral Reefs: Scale Dependence and Adaptive Capacity (OA coral adaptation)

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

Contributors	Affiliation	Role
Carpenter, Robert	California State University Northridge (CSUN)	Co-Principal Investigator
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Dataset Description

Related Reference: Comeau, S., Carpenter, R.C., Edmunds, P.J. Effects of pCO2 on photosynthesis and respiration of tropical scleractinian corals and calcified algae. ICES Journal of Marine Science doi:10.1093/icesjms/fsv267. Figures 3 and 4.

Methods & Sampling

Changes in dissolved oxygen in coral and algal samples were monitored during 30 min incubations with PreSens dipping oxygen optodes (PSt3) connected to Fibox 3 transmitters (Precision Sensing GmbH, Germany). The oxygen probes were calibrated every morning using a 2-point calibration in water-saturated air (100%) and anoxic seawater created by supersaturating seawater with sodium dithionite (Na2S2O4). Temperature was held constant during incubations by circulating water in a water jacket surrounding the incubation chamber. Chambers were positioned on magnetic stir plates, and seawater flow inside the chambers was regulated with magnetic stir bar that created vigorous and turbulent water motion. A similar

irradiance to that used during incubations (i.e. 700 mmol quanta m22 s21) was maintained while the organisms were in the acrylic chambers by placing an LED lamp (75-W, Sol LED Module, Aquaillumination) above the chambers. On the same day that net photosynthesis was measured, and after at least 2 h of darkness (i.e. after 20:00 h), dark respiration was measured using an identical procedure to that used for photosynthesis, except the chamber was kept in darkness.

Data Processing Description

An Akaike information criterion (AIC) approach was used to determine if linear, logarithmic, or polynomial models best described the functional relationships of dark respiration, LDER, net photosynthesis, and gross photosynthesis against pCO2 for each species (see details in Comeau et al., 2013)

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

BCO-DMO Processing:
- added conventional header with dataset name, PI name, version date, reference information
- renamed parameters to BCO-DMO standard
- added site, lab, lat, lon columns

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Data Files

File	
resp_photo_II_sort.csv	(Comma Separated Values (.csv), 28.51 KB) MD5:a783e92afa507b30bf72d2d41a68ceb9
Primary data file for dataset ID 648416	

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Parameters

Parameter	Description	Units
site	location of experiments	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
taxon	taxonomic group	unitless
species	species name	unitless
pCO2	Partial pressure of carbon dioxide in the water body	uatm
dark_respi	dark respiration	ug O2/h/g
Net_Production	net production	ug O2/h/g
light_respi	light respiration	ug O2/h/g
photosynthesis	rate of net photosynthesis normalized to biomass	ug O2/h/g
dark_respi_biomass	dark respiration - normalized for biomass	ug O2/h/g
net_production_biomass	net production - normalized for biomass	ug O2/h/g
light_respi_biomass	light respiration - normalized for biomass	ug O2/h/g
photosynthesis_biomass	photosynthesis rate - normalized for biomass	ug O2/h/g

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Conductivity Meter
Dataset-specific Description	YSI 3100
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	LI-COR LI-193 PAR Sensor
Dataset-specific Description	4-pi quantum sensor LI-193 and a LiCor LI-1400 meter data logger.
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	Optode
Dataset-specific Description	PreSens dipping oxygen optodes (PSt3) connected to Fibox 3 transmitters (Precision Sensing GmbH, Germany).
Generic Instrument Description	An optode or optrode is an optical sensor device that optically measures a specific substance usually with the aid of a chemical transducer.

Dataset-specific Instrument Name	
Generic Instrument Name	pH Sensor
Dataset-specific Description	Orion, 3-stars mobile mounted with a MettlerDG115-SCpHelectrode
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	
Generic Instrument Name	Titrator
Dataset-specific Description	open cell, potentiometric titrations (automatic titrator T50, Mettler-Toledo)
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

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

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; CO2 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 pCO2 in the coral Acropora pulchra and the alga Lithophyllum kotschyanum. 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 pCO2 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

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-1415268

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