Net calcification, gross calcification, and linear extension rates of fragments of 4 species of coral over a 93-day ocean acidification and warming laboratory experiment

Website: https://www.bco-dmo.org/dataset/735583
Data Type: experimental
Version: 1
Version Date: 2018-05-09

Project
» Investigating the influence of thermal history on coral growth response to recent and predicted end-of-century ocean warming across a cascade of ecological scales (Thermal History and Coral Growth)

Contributors	Affiliation	Role
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Abstract
This dataset includes measurements of calcification, linear extension, and surface area for four species of Caribbean reef-building corals (Siderastrea siderea, Pseudodiploria strigosa, Porites astreoides, and Undaria tenuifolia) after a 93-day ocean acidification (280-3200 µatm) and warming (28°C and 31°C) experiment. Both calcification, measured using a buoyant weight method, and surface area, quantified using image processing software on photos taken of each fragment, were assess every 30 days throughout the experiment. Linear extension was quantified at the end of the experiment for total linear growth.

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Coverage

Spatial Extent: **N**:16.1899 **E**:-88.2614 **S**:16.1167 **W**:-88.5728
Temporal Extent: 2015-06 - 2015-12

Dataset Description

This dataset includes measurements of calcification, linear extension, and surface area for four species of Caribbean reef-building corals (Siderastrea siderea, Pseudodiploria strigosa, Porites astreoides, and Undaria tenuifolia) after a 93-day ocean acidification (280-3200 µatm) and warming (28°C and 31°C) experiment. Both calcification, measured using a buoyant weight method, and surface area, quantified using image processing software on photos taken of each fragment, were assess every 30 days throughout the experiment. Linear extension was quantified at the end of the experiment for total linear growth. These data are presented in Bove et al (2019).

Methods & Sampling

Coral colonies were collected from inshore reefs (Port Honduras Marine Reserve; 16°11’23.5314”N, 88°34’21.9360”W) and from offshore reefs (Sapodilla Cayes Marine Reserve; 16°07’00.0114”N, 88°15’41.1834”W) along the Belize Mesoamerican Barrier Reef System (MBRS) in June 2015. The experiment was carried out from September 2015-December 2015 (recovery and acclimation June 2015-September 2015).

Net calcification rates were estimated using a buoyant weight method (Davies, 1989). Coral fragments were suspended in a 38 L aquarium 4 cm below the surface in seawater (temperature, 28.2°C; salinity, 32.4) using an aluminum wire hanging from balance. Each coral fragment was weighed three times and averaged. Buoyant weights of all fragments were quantified at the beginning of pre-acclimation and every 30 days throughout the duration of the. Net calcification rates were normalized to the surface area of each fragment and to the number of days between buoyant weights. Surface area was quantified in triplicate from photos of each nubbin taken at corresponding intervals using imaging software. A calcein spike was implanted into coral skeletons at the beginning of the experiment to establish a fluorescent mark that could be used to quantify linear extension throughout the experiment (Venti et al, 2014). Linear extension was measured as the total area of new growth above the calcein line, divided by the lateral length of the. Neither U. tenuifolia nor P. strigosa were included in linear extension analyses because their irregular morphologies prevented accurate measurements of linear extension.

Data were analyzed in R (3.3.2). NIH ImageJ was used to process images.

Data Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- reduced decimal precision of 'calc_gross' from 9 to 3
- converted scientific notation valued of linear_extension to decimal values so all in same format

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Data Files

File
Bove_growth.csv (Comma Separated Values (.csv), 139.96 KB) MD5:3bc7e1ef7e2e68232778adad9c6555f0 Primary data file for dataset ID 735583

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Related Publications

Bove, C. B., Ries, J. B., Davies, S. W., Westfield, I. T., Umbanhowar, J., & Castillo, K. D. (2019). Common Caribbean corals exhibit highly variable responses to future acidification and warming. Proceedings of the Royal Society B: Biological Sciences, 286(1900), 20182840. doi:10.1098/rspb.2018.2840
Results

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
Methods

Venti, A., Andersson, A., & Langdon, C. (2014). Multiple driving factors explain spatial and temporal variability in coral calcification rates on the Bermuda platform. Coral Reefs, 33(4), 979–997. doi:10.1007/s00338-014-1191-9
Methods

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Parameters

Parameter	Description	Units
reefzone	Collection reef zone of each fragment: N = inshore; F = offshore	unitless
species_code	Species code: S = S. siderea; P = P. strigosa; A = P. astreoides; T = U. tenuifolia	unitless
colony	ID of the coral colony	unitless
coral	Unique coral fragment ID	unitless
tank	Tank ID fragment was in	unitless
temp	Measured average experimental temperature	degrees Celsius
treatment	Experimental treatment fragment was in: first number represents target pCO2 value; second is the temperature treatment	unitless
pCO2	Measured average experimental pCO2	micro-atmospheres
temp_target	Temperature treatment factor label	degrees Celsius
pCO2_label	pCO2 treatment label: pre = pre-industrial (280); cur = current (400); eoc = end-of-century (700); ext = extreme (2800)	unitless
pCO2_target	pCO2 treatment factor label	micro-atmospheres
surface_area	Measured surface area of fragment	square centimeters
linear_extension	Measured linear extension	millimeters/day (mm day-1)
time_point	Time point: denotes the timepoint for net calcification rate. Pre = pre-acclimation to T0 net calcification rate; T30 = T0 to T30 net calcification rate; T60 = T30 to T60 net calcification rate; T90 = T60 to T90 net calcification rate; total = T0 - T90 net calcification	unitless

calc_rate	Net calcification rate	milligrams/centimeter^2/day (mg cm-2 day-1)
calc_gross	Gross calcification rate (only for full 90-day experiment)	milligrams/centimeter^2/day (mg cm-2 day-1)

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Microscope - Optical
Dataset-specific Description	Stereo microscope outfitted with a blue fluorescent adapter with excitation 440–460nm (NIGHTSEATM; Lexington, Massachusetts, USA).
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

Dataset-specific Instrument Name	Nimbus NBL 423e Precision Balance
Generic Instrument Name	scale or balance
Dataset-specific Description	Used to weigh coral samples. (±0.0002 precision, ±0.002 accuracy; AE Adam®; Oxford, Connecticut, USA)
Generic Instrument Description	Devices that determine the mass or weight of a sample.

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Project Information

Investigating the influence of thermal history on coral growth response to recent and predicted end-of-century ocean warming across a cascade of ecological scales (Thermal History and Coral Growth)

Website: http://www.unc.edu/~kdcastil/research.html

Coverage: Western Caribbean

Description from NSF award abstract:
Rising global ocean surface temperatures have reduced coral growth rates, thereby negatively impacting the health of coral reef ecosystems worldwide. Recent studies on tropical reef building corals reveal that corals' growth in response to ocean warming may be influenced by their previous seawater temperature exposure - their thermal history. Although these recent findings highlight significant variability in coral growth in response to climate change, uncertainty remains as to the spatial scale at which corals' thermal history influences how they have responded to ocean warming and how they will likely respond to predicted future increases in ocean

temperature. This study investigates the influence of thermal history on coral growth in response to recent and predicted seawater temperatures increases across four ecologically relevant spatial scales ranging from reef ecosystems, to reef communities, to reef populations, to an individual coral colony. By understanding how corals have responded in the past across a range of ecological scales, the Principal Investigator will be able to improve the ability to predict their susceptibility and resilience, which could then be applied to coral reef conservation in the face of climate change. This research project will broaden the participation of undergraduates from underrepresented groups and educate public radio listeners using minority voices and narratives. The scientist will leverage current and new partnerships to recruit and train minority undergraduates, thus allowing them to engage high school students near field sites in Florida, Belize, and Panama. Through peer advising, undergraduates will document this research on a digital news site for dissemination to the public. The voice of the undergraduates and scientist will ground the production of a public radio feature exploring the topic of acclimatization and resilience - a capacity for stress tolerance within coral reef ecosystems. This project will provide a postdoctoral researcher and several graduate students with opportunities for field and laboratory research training, teaching and mentoring, and professional development. The results will allow policy makers from Florida, the Mesoamerican Barrier Reef System countries, and several Central American countries to benefit from Caribbean-scale inferences that incorporate corals' physiological abilities, thereby improving coral reef management for the region.

Coral reefs are at significant risk due to a variety of local and global scale anthropogenic stressors. Although various stressors contribute to the observed decline in coral reef health, recent studies highlight rising seawater temperatures due to increasing atmospheric carbon dioxide concentration as one of the most significant stressors influencing coral growth rates. However, there is increasing recognition of problems of scale since a coral's growth response to an environmental stressor may be conditional on the scale of description. This research will investigate the following research questions: (1) How has seawater temperature on reef ecosystems (Florida Keys Reef Tract, USA; Belize Barrier Reef System, Belize; and Bocas Del Toro Reef Complex, Panama), reef communities (inshore and offshore reefs), reef populations (individual reefs), and near reef colonies (individual colonies), varied in the past? (2) How has seawater temperature influenced rates of coral growth and how does the seawater temperature-coral growth relationship vary across these four ecological spatial scales? (3) Does the seawater temperature-coral growth relationship forecast rates of coral growth under predicted end-of-century ocean warming at the four ecological spatial scales? Long term sea surface temperature records and small-scale high-resolution in situ seawater temperature measurements will be compared with growth chronologies for the reef building corals Siderastrea siderea and Orbicella faveolata, two keystone species ubiquitously distributed throughout the Caribbean Sea. Nutrients and irradiance will be quantified via satellite-derived observations, in situ measurements, and established colorimetric protocols. Field and laboratory experiments will be combined to examine seawater temperature-coral growth relationships under recent and predicted end-of-century ocean warming at four ecologically relevant spatial scales. The findings of this study will help us bridge the temperature-coral growth response gap across ecologically relevant spatial scales and thus improve our understanding of how corals have responded to recent warming. This will lead to more meaningful predictions about future coral growth response to climate change.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1459522

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