In situ measurements used for coral and reef-scale calcification structural equation modeling including environmental and chemical measurements, and coral calcification rates in Bermuda from 2010 to 2012 (BEACON project)

Website: https://www.bco-dmo.org/dataset/720788
Data Type: model results
Version:
Version Date: 2018-03-02

Project
» BErmuda ocean Acidification and COral reef iNvestigation (BEACON)

Program
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
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Coverage

Spatial Extent: **N**:32.457333 **E**:-64.797469 **S**:32.400777 **W**:-64.834759
Temporal Extent: 2010-09 - 2012-09

Dataset Description

This dataset includes data used for structural equation modeling of Bermuda coral and reef-scale calcification including *Porites* and *Diploria* coral calcification rates, temperature, pH, salinity, chlorophyll a, dissolved inorganic carbon, total alkalinity, pCO2, seawater saturation state with respect to aragonite, light levels, and nutrients from a principal component analysis.

Sampling locations: Bermuda Platform: Hog Reef (32.45733, -64.83476) and Crescent Reef (32.40078, -64.79747).

These data were utilized in the following publication:

Courtney, T. A., Lebrato, M., Bates, N. R., Collins, A., de Putron, S. J., Garley, R., ... & Andersson, A. J. (2017).

Environmental controls on modern scleractinian coral and reef-scale calcification. Science advances, 3(11), e1701356. doi: 10.1126/sciadv.1701356

Methods & Sampling

Data represented is either monthly averages for columns with 'nd' for day or as contemporaneous as daily as possible for columns with a date for the day column. Chl-a data is from the 4-km-resolution Moderate Resolution Imaging Spectroradiometer chlorophyll a product. Temperature and light were measured on the benthos at each location using HOBO Temperature and Light loggers (i.e. see accompanying temperature and light dataset). Salinity was aggregated from surface YSI Multimeter and Autosalinometer measurements (i.e. see accompanying carbonate chemistry dataset). Omega, pHsw, and CO2 were calculated from measured TA, DIC, temperature, and salinity (i.e. from accompanying carbonate chemistry dataset) using the program CO2SYS with the K1 and K2 dissociation constants from Mehrbach et al. (1973) refit by Dickson and Millero (1987), KHSO4 from Dickson (1990), and pH on the seawater scale. Nutrients_PC1 is the principal components axis 1 from the measured NH4, NiO2+NiO3, SiO4 (see Carbonate Chemistry and Light Dataset: http://lod.bco-dmo.org/id/dataset/719535). Porites and Dlab are %/day mean calcification rates interpolated to monthly means from 24 colonies of each species per reef location (i.e. see accompanying coral calcification dataset). NEC is net ecosystem calcification calculated for Hog Reef utilizing the change in seawater TA relative to offshore over a given reference time and seawater depth. Please see Courtney et al. (2017) for a complete description of methods.

Data Processing Description

All data are either monthly averages or were daily measurements as contemporaneous as possible for the NEC measurements as described above. Please see Courtney et al. (2017) for a complete description of data processing.

BCO-DMO Data Manager Processing Notes:
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions
* Added Lat,Lon to data with locations for Cres and Hog reefs

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Data Files

File
SEM_data.csv (Comma Separated Values (.csv), 10.95 KB) MD5:5c1b4944481ec15852b23bd28d09a61c Primary data file for dataset ID 720788

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Related Publications

Courtney, T. A., Lebrato, M., Bates, N. R., Collins, A., de Putron, S. J., Garley, R., ... Andersson, A. J. (2017). Environmental controls on modern scleractinian coral and reef-scale calcification. Science Advances, 3(11), e1701356. doi:10.1126/sciadv.1701356
Results

,
Methods

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Parameters

Parameter	Description	Units
Site	Location of sampling (Hog = Hog Reef, Bermuda or Cres = Crescent Reef, Bermuda)	unitless
Lat	Latitude of site	decimal degrees
Lon	Longitude of site	decimal degrees
Year	Year of sampling in format YYYY	unitless
Month	Month of sampling in format MM	unitless
Day	Day of sampling in format DD	unitless
Chla	Sea surface chlorophyll a	milligrams per liter (mg/L)
Temp	Bottom temperature	degrees Celsius (°C)
Light	Bottom light levels	lumens per meter squared (lux)
Sal	Sea surface salinity	parts per thousand (ppt)
Omega	Seawater saturation with respect to aragonite	dimensionless
pHsw	Seawater pH	pH units (seawater scale)
DIC	Seawater dissolved inorganic carbon	micromoles per kilogram (µmol/kg)
TA	Seawater total alkalinity	micromoles per kilogram (µmol/kg)
CO2	Seawater pCO2	microatmospheres (µatm)
Nutrients_PC1	PC1 of NH4,NiO2+NiO3,SiO4	unitless
Porites	Calcification by Porites colonies	percent weight increase per day (%/day)
Dlab	Calcification by Diploria colonies	percent weight increase per day (%/day)

NEC	Net ecosystem calcification	kilograms per meter squared per year (kg m^-2 yr-1)

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Instruments

Dataset-specific Instrument Name	Autosal Salinometer 8400B (Salinity)
Generic Instrument Name	Autosal salinometer
Dataset-specific Description	Samples for salinity were collected in glass bottles and later analyzed using an autosalinometer (Guildline Instruments)
Generic Instrument Description	The salinometer is an instrument for measuring the salinity of a water sample.

Dataset-specific Instrument Name	HOBO Temperature and Light loggers
Generic Instrument Name	Light Meter
Generic Instrument Description	Light meters are instruments that measure light intensity. Common units of measure for light intensity are umol/m2/s or uE/m2/s (micromoles per meter squared per second or microEinsteins per meter squared per second). (example: LI-COR 250A)

Dataset-specific Instrument Name	YSI 556 Handheld Multiparameter Instrument
Generic Instrument Name	Multi Parameter Portable Meter
Dataset-specific Description	A YSI 556 Handheld Multiparameter Instrument was used to measure in situ temperature (accuracy ± 0.15°C), and salinity (accuracy ± 1%).
Generic Instrument Description	An analytical instrument that can measure multiple parameters, such as pH, EC, TDS, DO and temperature with one device and is portable or hand-held.

Dataset-specific Instrument Name	4-km-resolution Moderate Resolution Imaging Spectrodradiometer
Generic Instrument Name	Spectroradiometer
Generic Instrument Description	A Spectroradiometer or Spectraradiometer is an instrument that measures the intensity and nature of electromagnetic radiation. An ocean color radiometer makes the measurements in a manner optimized for the determination of ocean chlorophyll concentration.

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Deployments

BIOS_BEACON

Website	https://www.bco-dmo.org/deployment/626096
Platform	BIOS_Small_Boat
Start Date	2007-06-15
End Date	2012-09-18
Description	Sample collection platforms for the BEACON Project. The samples were collected from a small boat (27 ft Twin Vee or 26 ft Seadance)

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Project Information

BErmuda ocean Acidification and COral reef iNvestigation (BEACON)

Website: https://scripps.ucsd.edu/research/projects/bermuda-ocean-acidification-and-coral-reef-investigation-beacon

Coverage: Bermuda

NSF abstract:

Ocean acidification owing to anthropogenic emission of CO2 is a significant and imminent threat to marine calcifying organisms and ecosystems such as corals and coral reefs. As a result of future ocean acidification, i.e., increasing seawater CO2, and decreasing pH, carbonate ion concentration [CO3], and carbonate saturation state, it is likely that marine calcifiers will have difficulty growing their shells and skeletons of calcium carbonate (CaCO3) at their present rates. Dissolution of carbonate sediments and structures are also likely to increase, and could ultimately exceed calcification and CaCO3 production, leading to a transition from net accumulation to a net loss in carbonate material of individual coral colonies, coral communities and coral reef ecosystems. Because of Bermuda's relatively high-latitude location (32° N), the annual average surface seawater [CO3] is lower in Bermuda than regions closer to the tropics. As a consequence, the Bermuda coral reef is likely to experience critical [CO3] values and net dissolution before its tropical counterparts as a result of continued ocean acidification. Furthermore, a natural gradient in [CO3] exists along the Bermuda reef with environmental parameters such as, light, temperature, and nutrients being near identical. This gradient allows for unique cross-comparisons of calcification of individual calcifiers and calcifying communities under different [CO3] in a natural environment.

In this study, researchers at the Bermuda Institute of Ocean Science (BIOS) will launch the BEACON project to further our understanding of the consequences of ocean acidification to the process of calcification and CaCO3 production at three different spatial scales including (1) individual coral colonies, (2) local reef communities, and (3) regional coral reef ecosystems. They will conduct (1) in situ and in vitro experiments to assess growth and evaluate net calcification of individual coral colonies of three different species common to Bermuda and the Caribbean exposed to different [CO3] under both natural and controlled experimental conditions; (2) diel and quasi-lagrangian calcification experiments to evaluate net calcification of local reef communities and in moving water masses along the natural [CO3] gradient existent on the Bermuda platform; and (3) time series data collected across the Bermuda platform and offshore, to evaluate net calcification and CaCO3 production of the Bermuda coral reef ecosystem and platform over seasonal and annual cycles.

Broader impacts: This project will provide fundamental data on the consequences of ocean acidification to coral reefs on different temporal and spatial scales. Combined, knowledge at each of the scales will contribute to an improved understanding of this problem in a broader context, i.e., the effect on coral reefs as a global entity and role in the global carbon cycle during past, present and future seawater chemical conditions. As the meaning implies, the research team envisions BEACON to serve as a guiding light to assist researchers and policymakers in framing future strategies and making decisions regarding the management of coral reefs and CO2 emission policies in order to establish CO2 stabilization targets. Scientific understanding and research products from the project will be specifically used in the BIOS explorer program, CoE POGO ocean acidification module, and the coral reef ecology class taught at BIOS. It will also contribute to developing the research and

technical skills of one graduate student and one research technician at BIOS, and will include the involvement of interns and NSF REU fellowship students each year of the project.

Based on the findings of the BEACON project, and especially the results published in Andersson et al. (Nature Climate Change, 4, 56-61, 2014) and Yeakel et al. (PNAS, 112, 14512-14517, 2015), BEACON II (https://www.bco-dmo.org/project/737955) aims to assess the links between offshore and reef biogeochemistry by continuing and expanding on the physical and chemical measurements on the Bermuda coral reef and in the surrounding Sargasso Sea.

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Program Information

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-0928406

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