Surface seawater carbonate chemistry parameters from the Bermuda coral reef platform timeseries, 2007-2012 (BEACON project)

Website: https://www.bco-dmo.org/dataset/626102
Version: 05 November 2015
Version Date: 2015-11-05

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

Program
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
Andersson, Andreas	University of California-San Diego (UCSD-SIO)	Principal Investigator, Contact
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Gegg, Stephen R.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Dataset Description

Surface seawater carbonate chemistry parameters from the Bermuda coral reef platform (2007 - 2012). Bermuda reef data cover four spatial sites (Bouy 33 (B33), Tyne's Bay (TB), Mid Platform (MP) and North Channel (NC)). The dataset contains measurements of surface seawater temperature, salinity, total dissolved inorganic carbon (DIC) and total alkalinity (TA) data.

Sampling:Locations:

Reef Site Name	Latitude	Longitude
Bouy 33 (B33)	32.32957	-64.81760
Tyne's Bay (TB)	32.30966	-64.78230
Mid Platform (MP)	32.37342	-64.78169
North Channel (NC)	32.41597	-64.74285

Related files and references:

Andersson AJ, Yeakel KL, Bates NR, de Putron SJ (2014) Partial offsets in ocean acidification from changing coral reef biogeochemistry. Nat Clim Chang 4, 56-61.

Dickson AG, Sabine CL, Christian JR (2007) Guide to best practises for ocean CO_2 measurements. PICES Special Publication, IOCCP Report no. 8.

Yeakel KL, Andersson AJ, Bates NR, Noyes TJ, Collins A, Garley R (2015) Shifts in coral reef biogeochemistry

and resulting acidification linked to offshore productivity. Proc Natl Acad Sci USA, doi:10.1073/pnas.1507021112

Methods & Sampling

Sampling and Analytical Methodology:

From 2007 to 2012, surface seawater samples from the Bermuda coral reef platform were collected once a month at 0.5–1-m depth using a 5-L Niskin bottle. TA and DIC samples were collected according to standard protocols (Dickson et al., 2007) using 250-mL Kimax brand glass sample bottles. Samples were immediately poisoned with 100 µL saturated solution of $HgCl_2$. Temperature was measured in the Niskin bottle while samples for salinity were collected in glass bottles and later analyzed using an autosalinometer (Guildline Instruments). DIC was analyzed coulometrically using a UIC CM5011 CO_2 coulometer combined with a VINDTA3C (Marianda Inc) or SOMMA system, alternatively based on infrared absorption using an AIRICA (Marianda, Inc) and a Li-Cor 7000 as the detector. TA was analyzed based on potentiometric acid titrations (~0.1 N HCl) using a VINDTA3S (Marianda Inc). Performance and precision of the instruments were regularly verified using certified reference material (CRM) prepared by A. Dickson at Scripps In- stitution of Oceanography (SIO). The accuracy and precision of repli- cate CRMs on any given day of analyses were typically in the range of ±2–4 µmol kg^{-1} for both TA and DIC.

Data Processing Description

Sampling and Analytical Methodology:

From 2007 to 2012, surface seawater samples from the Bermuda coral reef platform were collected once a month at 0.5–1-m depth using a 5-L Niskin bottle. TA and DIC samples were collected according to standard protocols (Dickson et al., 2007) using 250-mL Kimax brand glass sample bottles. Samples were immediately poisoned with 100 µL saturated solution of $HgCl_2$. Temperature was measured in the Niskin bottle while samples for salinity were collected in glass bottles and later analyzed using an autosalinometer (Guildline Instruments). DIC was analyzed coulometrically using a UIC CM5011 CO_2 coulometer combined with a VINDTA3C (Marianda Inc) or SOMMA system, alternatively based on infrared absorption using an AIRICA (Marianda, Inc) and a Li-Cor 7000 as the detector. TA was analyzed based on potentiometric acid titrations (~0.1 N HCl) using a VINDTA3S (Marianda Inc). Performance and precision of the instruments were regularly verified using certified reference material (CRM) prepared by A. Dickson at Scripps In- stitution of Oceanography (SIO). The accuracy and precision of repli- cate CRMs on any given day of analyses were typically in the range of ±2–4 µmol kg^{-1} for both TA and DIC.

BCO-DMO Processing Notes
- Generated from original file "BDA_reef_timeseries_2007-2012" contributed by Andreas Andersson
- Parameter names edited to conform to BCO-DMO naming convention found at Choosing Parameter Name
- Date reformatted to YYYYMMDD

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Data Files

File
BDA_Reef_TimeSeries.csv (Comma Separated Values (.csv), 18.03 KB) MD5:c81c35205b53f60ab45613a9ff12e5dd Primary data file for dataset ID 626102

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Parameters

Parameter	Description	Units
Date	Date of Sample Collection	YYYYMMDD
DecimalDate	Decimal Date of Sample Location	YYYY.xxxxxxxxxx
ReefSiteName	ReefSiteName (site abbrev) Reef sites: Bouy 33 (B33); TyneΓÇÖs Bay (TB); Mid Platform (MP); North Channel (NC)	text
Latitude	Latitude of Sample Location (South is negative)	decimal degrees
Longitude	Longitude of Sample Location (West is negative)	decimal degrees
Temperature	Temperature (Celsius)	degrees Celsius
Salinity	Salinity (psu)	psu
TA	Total Alkalinity (TA; micromol/kg seawater)	micromol/kgSW
DIC	Total Dissolved Inorganic Carbon (DIC; micromol/kg seawater	micromol/kgSW

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Instruments

Dataset-specific Instrument Name	autosalinometer
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	UIC CM5011 CO2 coulometer
Generic Instrument Name	CO2 Coulometer
Dataset-specific Description	DIC was analyzed coulometrically using a UIC CM5011 CO2 coulometer combined with a VINDTA3C (Marianda Inc) or SOMMA system, alternatively based on infrared absorption using an AIRICA (Marianda, Inc) and a Li-Cor 7000 as the detector.
Generic Instrument Description	A CO2 coulometer semi-automatically controls the sample handling and extraction of CO2 from seawater samples. Samples are acidified and the CO2 gas is bubbled into a titration cell where CO2 is converted to hydroxyethylcarbonic acid which is then automatically titrated with a coulometrically-generated base to a colorimetric endpoint.

Dataset-specific Instrument Name	Li-Cor 7000
Generic Instrument Name	LI-COR LI-7000 Gas Analyzer
Dataset-specific Description	DIC was analyzed coulometrically using a UIC CM5011 CO2 coulometer combined with a VINDTA3C (Marianda Inc) or SOMMA system, alternatively based on infrared absorption using an AIRICA (Marianda, Inc) and a Li-Cor 7000 as the detector.
Generic Instrument Description	The LI-7000 CO2/H2O Gas Analyzer is a high performance, dual cell, differential gas analyzer. It was designed to expand on the capabilities of the LI-6262 CO2/ H2O Gas Analyzer. A dichroic beam splitter at the end of the optical path provides radiation to two separate detectors, one filtered to detect radiation absorption of CO2 and the other to detect absorption by H2O. The two separate detectors measure infrared absorption by CO2 and H2O in the same gas stream. The LI-7000 CO2/ H2O Gas Analyzer is a differential analyzer, in which a known concentration (which can be zero) gas is put in the reference cell, and an unknown gas is put in the sample cell.

Dataset-specific Instrument Name	VINDTA3C (Marianda Inc)
Generic Instrument Name	MARIANDA VINDTA 3C total inorganic carbon and titration alkalinity analyser
Dataset-specific Description	DIC was analyzed coulometrically using a UIC CM5011 CO2 coulometer combined with a VINDTA3C (Marianda Inc) or SOMMA system, alternatively based on infrared absorption using an AIRICA (Marianda, Inc) and a Li-Cor 7000 as the detector.
Generic Instrument Description	The Versatile INstrument for the Determination of Total inorganic carbon and titration Alkalinity (VINDTA) 3C is a laboratory alkalinity titration system combined with an extraction unit for coulometric titration, which simultaneously determines the alkalinity and dissolved inorganic carbon content of a sample. The sample transport is performed with peristaltic pumps and acid is added to the sample using a membrane pump. No pressurizing system is required and only one gas supply (nitrogen or dry and CO2-free air) is necessary. The system uses a Metrohm Titrino 719S, an ORION-Ross pH electrode and a Metrohm reference electrode. The burette, the pipette and the analysis cell have a water jacket around them. Precision is typically +/- 1 umol/kg for TA and/or DIC in open ocean water.

Dataset-specific Instrument Name	SOMMA system
Generic Instrument Name	MARIANDA VINDTA 3C total inorganic carbon and titration alkalinity analyser
Dataset-specific Description	DIC was analyzed coulometrically using a UIC CM5011 CO2 coulometer combined with a VINDTA3C (Marianda Inc) or SOMMA system, alternatively based on infrared absorption using an AIRICA (Marianda, Inc) and a Li-Cor 7000 as the detector.
Generic Instrument Description	The Versatile INstrument for the Determination of Total inorganic carbon and titration Alkalinity (VINDTA) 3C is a laboratory alkalinity titration system combined with an extraction unit for coulometric titration, which simultaneously determines the alkalinity and dissolved inorganic carbon content of a sample. The sample transport is performed with peristaltic pumps and acid is added to the sample using a membrane pump. No pressurizing system is required and only one gas supply (nitrogen or dry and CO2-free air) is necessary. The system uses a Metrohm Titrino 719S, an ORION-Ross pH electrode and a Metrohm reference electrode. The burette, the pipette and the analysis cell have a water jacket around them. Precision is typically +/- 1 umol/kg for TA and/or DIC in open ocean water.

Dataset-specific Instrument Name	Niskin Bottle
Generic Instrument Name	Niskin bottle
Dataset-specific Description	From 2007 to 2012, surface seawater samples from the Bermuda coral reef platform were collected once a month at 0.5–1-m depth using a 5-L Niskin bottle.
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

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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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