Calcification rates of Porites corals collected from a naturally high-Ωar reef and a naturally low-Ωar reef in Palau incubated at three experimental Ωar conditions

Website: https://www.bco-dmo.org/dataset/706075
Data Type: Other Field Results
Version: 1
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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
Calcification rates of Porites corals collected from a naturally high-Ωar reef and a naturally low-Ωar reef in Palau incubated at three experimental Ωar conditions.

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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

Calcification rates of Porites corals collected from a naturally high-Ωar reef and a naturally low-Ωar reef incubated at three Ωar conditions.

These data were originally published in figure 2 of:
H.C. Barkley, A.L. Cohen, D.C. McCorkle, Y. Golbuu. Mechanisms and thresholds for pH tolerance in Palau corals. Journal of Experimental Marine Biology and Ecology, 489, 7-14 (2017). doi:10.1016/j.jembe.2017.01.003

Methods & Sampling

Coral collection: Coral plugs were collected in December 2012 from massive *Porites* colonies at a naturally low-Ω_{ar} reef site (7.324 N, 134.493 E; mean Ω_{ar} = 2.3; n = 78) and a naturally high-Ω_{ar} reef site (7.268 N, 134.522 E; mean Ω_{ar} = 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.

CO_2 manipulation experiment: Corals from two reefs were cultured at three CO_2 levels for eight weeks in March to May 2013 (n = 10 corals per treatment, n = 60 corals total). The corals were individually incubated in independently manipulated plastic cups (volume = 750 ml) to increase statistical power. Cups were placed within a large, temperature-controlled water bath. The corals were maintained at mean (± SD) temperatures of 29.4C ± 0.1C. Light was provided by LED aquarium lights (Coralife) at average levels of 334 ± 48 umol photons m^{-2} s^{-1} (measured by an underwater quantum sensor, LI-COR) on a 12h:12h light:dark schedule. Corals were fed live *Artemia* brine shrimp larvae every other evening by pipetting 1 ml of concentrated brine shrimp in filtered seawater into each cup. Coral cups were cleaned weekly to prevent algae overgrowth.

Mean pH (total scale)/Ω_{ar} levels for the three treatment conditions were 7.98/3.0, 7.83/2.3, and 7.60/1.5. In each coral cup, carbon system chemistry was regulated using a combination of flow-through pre-equilibrated water and bubbling of mixed air/CO_2 gas. Incoming seawater (filtered to 0.35 um) from the reef was aerated and split into three header tanks. In the low-CO_2 header tank, water was bubbled with air. In the mid-CO_2 and high-CO_2 header tanks, CO_2 levels were regulated by a pH controller (Drs. Foster and Smith) connected to a solenoid valve that introduced CO_2 gas into the header tank through a column diffuser. Water was siphoned from the three header tanks into each coral cup at a rate of approximately 375 ml per hour. Each coral cup was also bubbled with either compressed air (low CO_2 treatment) or mixed compressed air and CO_2 gas (mid and high CO_2 treatment) controlled by pairs of mass flow controllers (Aalborg Instruments) at approximately 200 ml per minute. Low alkalinity levels in the source water to the Palau International Coral Reef Center (drawn from within the lower-alkalinity Rock Islands) prevented Ω_{ar} in the low-CO_2 condition (Ω_{ar} = 3.0) from reaching values that were as high as those measured on the barrier reef site (Ω_{ar} = 3.7).

To characterize the carbonate chemistry in each cup, total alkalinity (TA), pH, temperature, and salinity were measured weekly. Spectrophotometric pH measurements were made with 2 mM *m*-Cresol purple indicator dye using a spectrometer with a 100 mm flow cell (Ocean Optics, mean precision = 0.005) following procedures in Clayton and Byrne (1993) and Dickson et al. (2007) and using the equation of Liu et al. (2011). Samples for TA were collected in 20 ml glass vials and poisoned with saturated mercuric chloride. Automated gran titrations for TA were run on duplicate 1 ml samples using a Metrohm Titrando 808 and 730 Sample Changer (mean precision = 4 umol/kg), and TA values were standardized to certified reference materials obtained from Andrew Dickson [Scripps Institution of Oceanography (Dickson, 2001)]. Salinity was measured in each cup using an YSI salinity probe, and temperatures were measured using an Omega thermocouple (accuracy = 0.1 degree C). Full CO_2 system parameters were calculated from temperature, salinity, TA, and pH using CO2SYS (Lewis and Wallace, 1998) with the constants of Mehrbach et al. (1973) as refit by Dickson and Millero (1987).

Coral calcification analysis: Calcification rates were measured using both buoyant weight (Davies, 1989) and alkalinity anomaly (Chisholm and Gattuso, 1991) techniques. Buoyant weights for each coral were collected at the beginning of the experiment, after three weeks in experimental CO_2 conditions, and then weekly during weeks four to eight. Corals were weighed using a balance with a weigh-below hook (Sartorius GC803S), which allows for beneath-balance weighing of coral plugs that remain entirely submerged in experimental cups maintained at treatment Ω_{ar} levels. Wet weight data were converted to dry weights using an aragonite density of 2.93 grams per cubic centimeter and the density of seawater determined using a standard of known weight and density. Repeated buoyant weight measurements on the same coral yielded mean precision estimates of ± 0.03 g.

Day/night alkalinity depletion experiments were conducted at the end of the eight-week experiment. Water flow to each coral cup was stopped during this time but gas bubbling was continued in order to maintain pH levels.

Samples for TA were collected for each coral cup at the beginning and end of two four-hour periods (one four-hour period during the day and one at night). Alkalinity depletion incubations were simultaneously run in control cups containing only filtered seawater (n=3 per experiment). Because the net change in TA values in control cups was within analytical precision (mean = 3 umol per kilogram), coral calcification was assumed to be the only process impacting the alkalinity in the cups, where two moles of alkalinity were consumed for every one mole of calcium carbonate produced. TA pre and post incubation was determined following the titration procedure described in section *2.2* with samples run in triplicate.

Calcification rates for both buoyant weight and alkalinity anomaly measurements were normalized to coral tissue surface areas. Surface areas were measured following the general procedure for aluminum foil wrapping, in which the weight of aluminum foil needed to cover the entire surface of the coral skeleton is converted to area using a calibration curve (Marsh 1970). However, skeletons were wrapped with electrical tape instead of aluminum foil because the use of electric tape provided tighter control and minimization of tape overlap, which can significantly overestimate surface area. The area of each coral skeleton occupied by living tissue was wrapped in electrical tape that was subsequently carefully trimmed to eliminate any overlay. The weight of tape used to cover the coral tissue for each skeleton were converted to surface areas using a weight-to-area calibration, where ten pieces of electrical tape of known area were weighed to build a weight-per-unit area curve. Replicated electrical tape surface area estimates on ten coral skeletons produced a mean precision of 0.43 square cm, or ~1% of calculated surface areas.

Data Processing Description

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

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Data Files

File
calcification_rates.csv (Comma Separated Values (.csv), 1.67 KB) MD5:2303bacc91a73fd6fd636df6c34bc12f Primary data file for dataset ID 706075

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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
General

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
Results

,
Methods

Chisholm, J. R. M., & Gattuso, J.-P. (1991). Validation of the alkalinity anomaly technique for investigating calcification of photosynthesis in coral reef communities. Limnology and Oceanography, 36(6), 1232–1239. doi:10.4319/lo.1991.36.6.1232
Methods

Clayton, T. D., & Byrne, R. H. (1993). Spectrophotometric seawater pH measurements: total hydrogen ion concentration scale calibration of m-cresol purple and at-sea results. Deep Sea Research Part I: Oceanographic Research Papers, 40(10), 2115–2129. doi:10.1016/0967-0637(93)90048-8
Methods

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

Dickson, A. G., & Millero, F. J. (1987). A comparison of the equilibrium constants for the dissociation of carbonic acid in seawater media. Deep Sea Research Part A. Oceanographic Research Papers, 34(10), 1733–1743. doi:10.1016/0198-0149(87)90021-5
Methods

Dickson, A.G. (2001). Reference materials for oceanic measurements. Oceanography, 14(4), 21-22.
Methods

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO2 measurements. PICES Special Publication 3, 191 pp. ISBN: 1-897176-07-4. URL: https://www.nodc.noaa.gov/ocads/oceans/Handbook_2007.html https://hdl.handle.net/11329/249
Methods

Lewis, E., Wallace, D., & Allison, L. J. (1998). Program developed for CO2 system calculations (No. ORNL/CDIAC-105). Brookhaven National Lab., Dept. of Applied Science, Upton, NY (United States); Oak Ridge National Lab., Carbon Dioxide Information Analysis Center, TN (United States). doi: 10.2172/639712
Methods

Liu, X., Patsavas, M. C., & Byrne, R. H. (2011). Purification and Characterization of meta-Cresol Purple for Spectrophotometric Seawater pH Measurements. Environmental Science & Technology, 45(11), 4862–4868. doi:10.1021/es200665d
Methods

Marsh, J. A. (1970). Primary Productivity of Reef-Building Calcareous Red Algae. Ecology, 51(2), 255–263. doi:10.2307/1933661
Methods

Mehrbach, C., Culberson, C. H., Hawley, J. E., & Pytkowicx, R. M. (1973). Measurement of the apparent dissociation constants of carbonic acid in seawater at atmospheric pressure. Limnology and Oceanography, 18(6), 897–907. doi:10.4319/lo.1973.18.6.0897
Methods

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 https://doi.org/10.1002/2013GL058489
General

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Parameters

Parameter	Description	Units
coral_id	Unique identification number for each coral	unitless
origin_reef_omega_AR	Saturation state of aragonite of the reef where each coral was collected	unitless
CO2_treatment	Experimental carbon dioxide level (low, medium, high)	unitless
experiment_omega_AR	Saturation state of aragonite in experimental conditions	unitless
calc_rate_buoyant_weight	Calcification rate of corals determined by difference between final and initial buoyant weight measurements	milligrams per square centimeter per week (mg/cm2/wk)
calc_rate_alk_anomaly	Calcification rate of corals determined by alkalinity anomaly at end of experiment	milligrams per sqare centimeter per hour (mg/cm2/hr)

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Instruments

Dataset-specific Instrument Name	Metrohm Titrando 808 and 730 Sample Changer
Generic Instrument Name	Automatic titrator
Dataset-specific Description	Automated gran titrations for TA were run on duplicate 1 ml samples using a Metrohm Titrando 808 and 730 Sample Changer.
Generic Instrument Description	Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

Dataset-specific Instrument Name	LI-COR underwater quantum sensor LI-192
Generic Instrument Name	LI-COR LI-192 PAR Sensor
Dataset-specific Description	A LI-COR underwater quantum sensor measured light on a 12h:12h light:dark schedule.
Generic Instrument Description	The LI-192 Underwater Quantum Sensor (UWQ) measures underwater or atmospheric Photon Flux Density (PPFD) (Photosynthetically Available Radiation from 360 degrees) using a Silicon Photodiode and glass filters encased in a waterproof housing. The LI-192 is cosine corrected and features corrosion resistant, rugged construction for use in freshwater or saltwater and pressures up to 800 psi (5500 kPa, 560 meters depth). Typical output is in um s-1 m-2. The LI-192 uses computer-tailored filter glass to achieve the desired quantum response. Calibration is traceable to NIST. The LI-192 serial numbers begin with UWQ-XXXXX. LI-COR has been producing Underwater Quantum Sensors since 1973. These LI-192 sensors are typically listed as LI-192SA to designate the 2-pin connector on the base of the housing and require an Underwater Cable (LI-COR part number 2222UWB) to connect to the pins on the Sensor and connect to a data recording device. The LI-192 differs from the LI-193 primarily in sensitivity and angular response. 193: Sensitivity: Typically 7 uA per 1000 umol s-1 m-2 in water. Azimuth: < ± 3% error over 360° at 90° from normal axis. Angular Response: < ± 4% error up to ± 90° from normal axis. 192: Sensitivity: Typically 4 uA per 1000 umol s-1 m-2 in water. Azimuth: < ± 1% error over 360° at 45° elevation. Cosine Correction: Optimized for underwater and atmospheric use. (www.licor.com)

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. This term could also refer to a simple tool like a hammer, saw, or other hand-held tool.

Dataset-specific Instrument Name	Aalborg Instruments mass flow controllers GFCS-010554 and GFCS-011067
Generic Instrument Name	Mass Flow Controller
Dataset-specific Description	Each coral cup was also bubbled with either compressed air or mixed compressed air and CO2 gas controlled by pairs of mass flow controllers (Aalborg Instruments).
Generic Instrument Description	Mass Flow Controller (MFC) - A device used to measure and control the flow of fluids and gases

Dataset-specific Instrument Name	Sartorius GC803S scale
Generic Instrument Name	scale
Dataset-specific Description	Corals were weighed using a balance with a weigh-below hook (Sartorius GC803S).
Generic Instrument Description	An instrument used to measure weight or mass.

Dataset-specific Instrument Name	Ocean Optics pH spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	Spectrophotometric pH measurements were made with 2 mM m-Cresol purple indicator dye using a spectrometer with a 100 mm flow cell (Ocean Optics, mean precision = 0.005).
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

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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: 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)

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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