Temperature on Dongsha Atoll measured from June 2013 to August 2015

Website: https://www.bco-dmo.org/dataset/560618
Data Type: Other Field Results
Version: 18 April 2017
Version Date: 2017-04-18

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)
» Can Coral Reefs in the Central Pacific Survive Ocean Warming? A 2015 El Nino Test (Coral Reef Resilience)

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
Cohen, Anne L.	Woods Hole Oceanographic Institution (WHOI)	Principal Investigator
DeCarlo, Thomas	Woods Hole Oceanographic Institution (WHOI)	Contact
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Coverage

Spatial Extent: **N**:20.77595 **E**:116.9228 **S**:20.699 **W**:116.7503
Temporal Extent: 2013-06-20 - 2015-08-03

Dataset Description

Temperature on Dongsha Atoll measured from June 2013 to August 2015.

Related publications:

DeCarlo T.M., Karnauskas K.B., Davis K.A., & G.T.F. Wong. 2015. Climate modulates internal wave activity in the Northern South China Sea. Geophysical Research Letters 42, 831-838.doi:10.1002/2014GL062522 (PDF)

DeCarlo T.M., Cohen A.L., Wong G.T.F., Davis K.A., Lohmann P., & K. Soong. 2017. Mass coral mortality under local amplification of 2 °C ocean warming. Scientific Reports 7, 44586. doi:10.1038/srep44586

Methods & Sampling

Temperature was measured with an Onset Corp. HOBO U22 temperature logger, calibrated in an isothermal bath before deployment to achieve accuracy of 0.1 degree C. The temperature logger was deployed at 1-10 meters water depth (see data) on a buoy 1 meter above the seafloor.

Data Processing Description

BCO-DMO processing:
- Modified format of date/time UTC field; created separate columns for month, day, year, and time.
- Add location name, latitude, and longitude from PI-provided metadata form.
- 18 April 2017: Dataset was updated to included data from 4 additional sites. Original dataset (version date 22-June-2015) included data from only 1 site. Water depth column was also added to the data.

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Data Files

File
Dongsha_temp.csv (Comma Separated Values (.csv), 19.39 MB) MD5:7f7b313b61448c549559845ee2dd3463 Primary data file for dataset ID 560618

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Parameters

Parameter	Description	Units
location	Name of study site.	text
lat	Latitude of study site.	decimal degrees
lon	Longitude of study site.	decimal degrees
ISO_DateTime_UTC	Date and time formatted to ISO 8601 standard, where T represents the start of the time string and Z indicates UTC.	YYYY-mm-ddTHH:MM:SS.ssZ
temp	Water temperature.	degrees Celsius (C)
time	Time (UTC), in hours and minutes; 24-hour clock.	HHMM
day	2-digit day of month.	dd (01 to 31)
mon	2-digit month of year.	mm (01 to 12)
year	4-digit year.	YYYY
depth	Water depth at which the temperature logger was located.	meters (m)

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Instruments

Dataset-specific Instrument Name	Onset Corp. HOBO U22 temperature logger
Generic Instrument Name	Water Temperature Sensor
Dataset-specific Description	Temperature was measured with an Onset Corp. HOBO U22 temperature logger, calibrated in an isothermal bath before deployment to achieve accuracy of 0.1 degree C.
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

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Deployments

Cohen_2013-15

Website	https://www.bco-dmo.org/deployment/560664
Platform	Dongsha_Atoll
Start Date	2013-06-20
End Date	2015-08-03
Description	Various coral reef studies conducted at Dongsha Atoll during 2013-2015.

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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).

Can Coral Reefs in the Central Pacific Survive Ocean Warming? A 2015 El Nino Test (Coral Reef Resilience)

Coverage: Central Tropical Pacific

This project supports a 7 day expedition to the heart of the central tropical Pacific during a particularly strong El Niño event, arguably one of the strongest on record. The target is Jarvis Island, located in the path of the cool, nutrient-rich Equatorial Under-Current (EUC). As a consequence of its location, Jarvis, a pristine, uninhabited coral reef ecosystem, is characterized by enhanced productivity, high densities of large predatory fish, turtles, corals and other sea life. However, sea surface temperatures on Jarvis are currently 3.9 degrees Celsius higher than normal for this time of year, due to El Niño. This provides investigators with a unique opportunity to examine how a highly productive reef ecosystem responds to ocean warming, and the mechanisms and timescales for recovery. Information will be collected by deploying state-of-the-art instrumentation on the reef, and sampling seawater, particulates, plankton and corals from surface to 150 meters depth. This will be the first expedition to Jarvis Island during a bleaching event. The US Pacific Remote Island Marine National Monument (PRIMNM) was recently expanded as part of a multi-national commitment to protect and preserve vast areas of our ocean and ocean resources for future generations. However, these protections do not shield ocean ecosystems from the impacts of 21st century climate change. The project investigates the potential for simultaneous changes in equatorial ocean circulation to lessen the impacts of the global warming for equatorial reefs. It tests hypotheses that improve understanding of fundamental mechanisms of coral reef resilience to climate change, and the ability to identify such reef systems for inclusion in Protected Area Networks. The cruise supports the training of four PhD students, three of whom are National Science Foundation / National Defense Science and Engineering graduate research fellows, and provide material in support of six PhD theses. Results will be shared at international meetings and workshops, and published in peer-reviewed journals. All data collected and generated from the cruise will be made publicly available via the Biological and Chemical Oceanography Data Management Office.

Global climate models project enhanced warming of the central tropical Pacific over this century. By implication, waters bathing five out of the seven coral reef ecosystems protected within the recently expanded PRIMNM, will warm by more than 3 degrees Celsius. This rate of warming far exceeds the known thermal tolerances of

reef-building corals, fueling concerns that these reefs may not survive 21st century climate change. However the same models project a concurrent strengthening of the EUC, a projection supported by observations. The EUC carries cool, nutrient-rich waters that upwell on the west sides of the equatorial islands, cooling the reefs and enhancing productivity locally. If the GCM projections are realized, a strengthening EUC could modulate the impact of ocean warming for these reefs by reducing the rate of warming and supporting energetically replete coral communities that survive bleaching. This proposal exploits the current El Niño state of the tropical Pacific to test the following hypotheses: (1) Coral communities bathed in the nutrient-rich, productive waters of the central equatorial Pacific bleach during every El Niño, but mortality is low and as a result, percent live cover remains high. (2) Localized EUC-enhanced productivity supports nutritionally replete coral communities, which metabolize existing lipid reserves to support energetic requirements during bleaching. (3) In addition, equatorial corals adopt a flexible feeding strategy, switching from direct nitrate uptake during nitrogen-rich (greater than 5 micromolar nitrate) La Niña conditions to heterotrophic feeding during nitrogen-"poor" (less than 3 micromolar nitrate) El Niño conditions. We propose that, fueled by exogenous sources, equatorial Pacific coral communities survive bleaching with limited mortality, coral cover remains high and coral growth rates quickly recover. If data generated under this project support our hypotheses, then the combination of oceanographic and political protections could maximize the potential for coral reef survival through the 21st century.

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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
NSF Division of Ocean Sciences (NSF OCE)	OCE-1605365

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