Coral area from a study of year-long effects of high pCO2 on the community structure of a tropical fore reef assembled in outdoor flumes in Moorea, French Polynesia from 2017 to 2018

Website: https://www.bco-dmo.org/dataset/924650
Data Type: Other Field Results, experimental
Version: 1
Version Date: 2024-04-09

Project
» RUI: Ocean Acidification- Category 1- The effects of ocean acidification on the organismic biology and community ecology of corals, calcified algae, and coral reefs (OA_Corals)

Program
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Contributors	Affiliation	Role
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Abstract
This coral calcification dataset includes the areas of corals as they changed over a year-long experiment. Flume physical and chemical conditions are provided as a supplemental file. These data are part of a study of year-long effects of high pCO2 on the community structure of a tropical fore reef assembled in outdoor flumes in Moorea, French Polynesia from 2017 to 2018. These coral calcification data support publication (Edmunds et al., 2020; doi:10.1093/icesjms/fsaa015) with the following abstract: In this study, fore reef coral communities were exposed to high pCO2 for a year to explore the relationship between net accretion (Gnet) and community structure (planar area growth). Coral reef communities simulating the fore reef at 17-m depth on Mo'orea, French Polynesia, were assembled in three outdoor flumes (each 500 l) that were maintained at ambient (396 matm), 782 matm, and 1434 matm pCO2, supplied with seawater at 300 l h 1, and exposed to light simulating 17-m depth. The communities were constructed using corals from the fore reef, and the responses of massive Porites spp., Acropora spp., and Pocillopora verrucosa were assessed through monthly measurements of Gnet and planar area. High pCO2 depressed Gnet but did not affect colony area by taxon, although the areas of Acropora spp. and P. verrucosa summed to cause multivariate community structure to differ among treatments. These results suggest that skeletal plasticity modulates the effects of reduced Gnet at high pCO2 on planar growth, at least over a year. The low sensitivity of the planar growth of fore reef corals to the effects of ocean acidification.

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Coverage

Location: Moorea, French Polynesia
Spatial Extent: **N**:-17.47495 **E**:-149.80817 **S**:-17.48437 **W**:-149.84705
Temporal Extent: 2017-01-01 - 2018-01-01

Dataset Description

See "Related Datasets" and "Supplemental Files" sections for access to related data published as part of these pCO2 flume experiments published in Edmunds et al., (2020, doi:10.1093/icesjms/fsaa015).

Related metabolism data was published in Edmunds et al. (2024, doi:10.1002/lno.12504).

Methods & Sampling

Fore reef communities were assembled in three outdoor flumes in Mo'orea, which were assigned randomly to a pCO_2 treatment targeting ambient (400 µatm), 700 µatm, and 1300 µatm pCO_2. The elevated pCO_2 treatments approximated atmospheric conditions projected for about the year 2140 under representative concentration pathways (RCP) 2.6, 4.5, and 8.5. Treatments were maintained for one year beginning in late Austral spring (November 2017), and actual pCO_2 treatments over the year differed from target values (described below). In brief, each flume consisted of a working section that was 5.0-m long, 30-cm wide and filled to ~ 30-cm depth with ~ 500 L of seawater. The fixed and unfixed communities within each fume occupied a 4.7 × 0.3 m portion of the floor of the working section of each flume. Seawater was circulated continually through a return section, and was supplied with fresh seawater at ~ 5 L min^{-1}. Seawater was pumped from Cook's Bay (14-m depth) and filtered through sand (pore size ~ 450–550 µm) before entering the flumes. With this pore size, small particulates passed through the filter and were added to the flumes where they were available as food for heterotrophic organisms.

Fore reef communities:

The reef communities were assembled to correspond to the mean percent cover of the major benthic space holders recorded in 2006 at 17-m depth on the fore reef of the north shore of Mo'orea. A historic community structure (rather than present day) was used because 2006 represented the long-term community structure on this reef, and it created the capacity to compare aspects of the present experiment with a previous experiment. Based on six sites sampled around Mo'orea in 2006, the community structure in the flumes was targeted to ~ 11% cover of *Pocillopora* spp., ~ 8% massive *Porites* spp., 8% *Acropora* spp., and ~ 53% reef rock. This construct created a community with ~ 27% coral cover, which was slightly lower than the actual mean coral cover in 2006 (32%), because the remaining 14 genera of scleractinians and *Millepora* contributed 5% coral cover. The *Pocillopora* conformed to the classic morphology of *P. verrucosa*, but it is likely that other *Pocillopora* spp. were present in the flumes. Likewise, *Acropora* spp. were selected to represent *A. hyacinthus* and *A. retusa*, which were common on the fore reef when the experiment was completed, and colonies of these species were scattered haphazardly among the flumes. Given the morphological complexity of *Acropora* spp., it is possible that other species were placed into the flumes. Pieces of coral rubble (~ 11.5-cm diameter) were added to achieve ~ 29% cover. Coral and rubble were haphazardly scattered along the working section of each flume to approach the targets for percentage cover, and this resulted in portions of the flumes having slightly different covers of coral. This was important for the central 2.4-m portion of the flume, where community members were fixed to allow the community structure to be quantified monthly using planar photographs. In the adjacent portions of the flumes, community members were unfixed (and rested on the floor of the flumes) so that they could be removed monthly for buoyant weighing (described below).

Corals and rubble were collected from ~ 17-m depth on the north shore fore reef, epoxied (Z-Spar A788, Pettit Marine Paint, Rockaway, NJ, USA) to plastic bases, and placed in a seawater table for at least 2 d before being added to the flumes. This time allowed the epoxy to cure and for the corals to recover from collection. Fore reef communities were assembled in the flumes on 27 October 2017, where they were maintained under ambient seawater conditions until 3 November. At this time, treatment pCO_2 levels were initiated in two flumes (one remained at ambient pCO_2), with pCO_2 gradually increased to target values over 24 h.

Physical and chemical parameters (see "Supplemental Files" for data access)**:**

Seawater was circulated in the flumes at ~ 0.1 m s^{-1} using a pump (Wave II 373 J s^{-1}, W. Lim Co., El Monte, CA, USA), and flow speeds were measured across the working sections using a Nortek Vectrino Acoustic Doppler Velocimeter. This flow speed was ecologically relevant for 15-m depth on the fore reef of Mo'orea (14-y mean = 0.065 m s^{-1}). The flumes were exposed to natural sunlight that was reduced with a blue filter (LEE #183, Lee Filters, Andover, England) to photon flux densities (PFD) in the range of photosynthetically active radiation (400–700 nm) that approximated those at 17-m depth. Light in the flumes was measured continuously (at 0.0006 Hz) using cosine-corrected sensors (Odyssey, Dataflow Systems Ltd, Christchurch, New Zealand) that recoded PAR. Odyssey sensors were calibrated with a Li-COR meter [LI-1400, Li-COR Biosciences, Lincoln, NE, USA] attached to a 2p sensor [LI 192A]). Temperatures in the flumes were regulated with chillers (heaters were not required) and were maintained close to the mean monthly seawater temperature at 17-m depth on the fore reef.

Seawater carbonate chemistry was uncontrolled in one flume (ambient, ~ 400 µatm pCO_2), and controlled in two others to simulate conditions arising from seawater pCO_2 targeted at 700 µatm and 1300 µatm. Seawater pH was not altered in the ambient flume, but was controlled in the treatment flumes by bubbling CO_2 into the seawater to alter pH relative to a set-point (regulated using an Aquacontroller, Neptune Systems, Morgan Hill, CA, USA) that operated a solenoid supplying pure CO_2 gas to a diffuser stone submerged in each flume. A diurnal upward pH adjustment of ~ 0.1 unit was applied to the two treatment flumes to simulate natural diurnal variation in seawater pCO_2 on the reef of Mo'orea. The ambient flume also maintained a diurnal variation in pCO_2 with a night time pH ~ 0.1 unit lower than in the daytime. Ambient air was bubbled continuously into all flumes. Periodic measurements of pCO_2 in the flumes confirmed that nocturnal pCO_2 met, or exceeded day-time target values (described in results).

Throughout the experiment, logging sensors (described above) recorded PAR, and temperature (Hobo Pro v2 [± 0.2 °C], Onset Computer Corp., Bourne, MA, USA). pH was measured daily on the total hydrogen ion scale (pH_T) using a handheld meter (see below). The values from the temperature and pH measurements were used to adjust the thermostat and pH-set points to achieve target pCO_2 values. Seawater carbonate chemistry (pH and A_T) and salinity were measured during the day (14:00 hrs) and night (20:00 hrs) and were obtained weekly. A bench-top conductivity meter (Thermo Scientific, Orionstar A212, Waltham, MA, USA) was used to measure salinity. The remaining parameters of the seawater carbonate system were calculated from temperature, salinity, pH_T, and A_T, using the R package Seacarb.

pH_T was measured using a DG 115-SC electrode (Mettler Toledo, Columbus, OH, USA) that was calibrated with a TRIS buffer. A_T was measured using open-cell, acidimetric titration using a certified titrant with an automatic titrator (T50, Mettler Toledo) fitted with a DG 115-SC electrode (Mettler Toledo). The accuracy and precision of measurements were determined by processing certified reference materials (CRMs batch numbers 158 and 172; from A. Dickson Laboratory, Scripps Institution of Oceanography, CA, USA), against which measured values of A_T maintained an accuracy of 1.7 ± 0.3 µmol kg^{-1} (n = 15) and precision of 1.8 ± 0.1 µmol kg^{-1} (n = 475).

Response variables:

See more details about coral weight and Gnet calculation in the related dataset "Edmunds et al. 2020 ICES: pCO2 flume - Coral weight" https://www.bco-dmo.org/dataset/924603.

Community structure:
* This section describes the methodology of the "percent_area" column in this dataset.
* The images of each flume (1-3) are in the "Supplemental Files" section of this dataset.

The effects of the treatments on the community structure were described using photographs recorded monthly in planar view. The image-based technique strengthened the ability to address the effects of OA on the community ecology of coral reefs, which frequently is recorded using planar photographs (including in Mo'orea). Photographs were recorded in ambient light using a GoPro Hero 4 camera (12 MP, 3-mm focal length) that was fitted to a stand and positioned on the upper edge of the flumes to record the benthic community through the air-water interface. At each sampling, the camera was sequentially moved along the flume to record the community in the middle 2.4 m of the working section using ~ 15 contiguous photographs.

Photographs were analyzed using ImageJ software after they were stitched together to make a single image for each sampling. This image covered the ~ 2.4-m length of the central portion of the flume where the corals were secured to a plastic-coated metal grid with a mesh size of 5 × 5 cm. The stitching of photographs sometimes was imperfect due to parallax errors, and in such cases, separate pictures were evaluated to assess organism size. The planar area of living tissue on corals was quantified by outlining organisms in ImageJ, after scaling the image using the metal grid as a size reference. Organism size (cm^2) was expressed as a percentage of the area (7200 cm^2) occupied by the fixed portion of the community. The summed area of community members was used to determine cover of the benthic community, and the areas of each organism were used to quantify growth (and shrinkage). Where organisms died, their area was set to zero.

Organism identifiers (Taxon, LifeSciences Identifier (LSID), name as appears in Species column):

Acropora hyacinthus, urn:lsid:marinespecies.org:taxname:207044, A. hyacinthus
Acropora retusa, urn:lsid:marinespecies.org:taxname:430653, A. retusa
Porites, urn:lsid:marinespecies.org:taxname:206485, Massive Porites
Pocillopora damicornis, urn:lsid:marinespecies.org:taxname:206953,
Pocillopora verrucosa, urn:lsid:marinespecies.org:taxname:206954,

Data Processing Description

SEACARB for the analysis of seawater chemistry: Lavigne, H. and Gattuso, J. P. 2013. Seacarb, seawater carbonate
chemistry with, R. R package version 2.4.10. Available at: http://CRAN.R-project.org/package=seacarb (last accessed 11 July 2014).

BCO-DMO Processing Description

* Sheet 2 of submitted file "Areas.xlsx" was imported into the BCO-DMO data system for this dataset. Values "nd" imported as missing data values. Sheet 1 contained metadata added to Parameters section.
** Missing data values are displayed differently based on the file format you download. They are blank in csv files, "NaN" in MatLab files, etc.
* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]
* dataset Lon bounds corrected from deg 149... to -149...
* quote characters removed from some species values so entire column is consistent.
* Year and month reformatted for consistency within the dataset and between related coral weight datast. Variable full month and abbreviated month in month column, and separate column for year converted to one Year_Month column formatted to match related datasets.
* Sheet 2 of "Physical _and_Chemical_conditions.xlsx" exported as a supplemental file. Column names adjusted to BCO-DMO conventions. Column values with micron (greek mu character) changed to -> u replaced in the flume identifier column and – replaced with standard hyphen character -.
* Site list added for LTER sites from the existing table included for datasets "Edmunds et al. 2024 Oecologia..."

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Data Files

File
924650_v1_pco2flume-coral-area.csv (Comma Separated Values (.csv), 89.53 KB) MD5:793132967343b0d49e4443e0d6c04b5a Primary data file for dataset ID 924650, version 1

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Supplemental Files

File	
Flume 1_1300 uatm.jpg	(JPEG Image (.jpg), 2.23 MB) MD5:7e2c135399b1243366ff5e501954cc7d
Image of flume 1 (1300 uatm). See methodology section "Community structure" for details of how this image was used for percent_area calculations in this dataset. See supplemental file "Flume physical and chemical properties" for more information about conditions in each flume.	
Flume 2_700 uatm.jpg	(JPEG Image (.jpg), 424.38 KB) MD5:429bcf4b2691d961de85c41fde3df141
Image of flume 2 (700 uatm). See methodology section "Community structure" for details of how this image was used for percent_area calculations in this dataset. See supplemental file "Flume physical and chemical properties" for more information about conditions in each flume.	
Flume 3 400 uatm.jpg	(JPEG Image (.jpg), 1.43 MB) MD5:4ede7fa42cedfc21cf41337282994dbf
Image of flume 3 (400 uatm). See methodology section "Community structure" for details of how this image was used for percent_area calculations in this dataset. See supplemental file "Flume physical and chemical properties" for more information about conditions in each flume.	
Flume physical and chemical properties filename: flume_physical_and_chemical_properties.csv	(Comma Separated Values (.csv), 91.17 KB) MD5:6d8aa82397eebbb08652080511fa6e2b
Physical and chemical properties of flumes during the experiment. Parameter information (Column name, description, and units) with blanks as the missing data identifier: Flume_Target_pCO2,Flume number (1-3) and target treatment pCO2 (400, 700, 1300 µatm) Month,"Month of experiment (format 'mmm',%b)" Year,"Year of experiment (format 'YYYY',%Y)" Temp,seawater temperature over the 24 h period on the day photographs were taken. Unit = °C MMT,mean daily seawater temperature on a 1 month period prior to photographic sampling. Unit = °C,,,"mean, daily pCO2 over the month prior to photographic sampling. Unit = µatm" SMDT,slope by least squares linear regression of daily seawater temperature against time (days) over the month prior to photographic sampling. Unit = °C d-1 pCO2,"mean, daily pCO2 over the month prior to photographic sampling. Unit = µatm" AT,mean daily total alkalinity over the month prior to photographic sampling. Unit = µmol kg-1 pH,daily mean pH over the month prior to photographic sampling MLI,maximum daily PFD on the day of photographic sampling. Unit = µmol photons m-2 s-1 MeLI,mean PFD over the day of photographic sampling. Unit = µmol photons m-2 s-1 ILI,PPFD integrated over the day of photographic sampling. Units = mol photons m-2 d-1 MeLIM,mean PFD over the month prior to photographic sampling. Unit = µmol photons m-2 s-1 SMLI,slope by least squares linear regression of maximum daily PFD over the month prior to photographic sampling. Units = µmol m-2 s-1 d-1 SILI,slope by least squares linear regression of PPFD integrated by day over the month prior to photographic sampling. Units = mol photons m-2 d-2	
Moorea LTER site list filename: site_locations.csv	(Comma Separated Values (.csv), 247 bytes) MD5:a591f465e8d2ceb50d389785b7562996
Site location list in Moorea (LTER0,LTER1,LTER2,LTER4) for datasets related to Edmunds et al. (2024, doi:10.1007/s00442-024-05517-y) and Edmunds et al. (2020, doi:10.1093/icesjms/fsaa015). Columns: location, geolocation name site, site identifier lat_dd, site latitude, decimal degrees lon_dd, site longitude, decimal degrees lat_deg_decmin, site latitude, degrees decimal minutes lon_deg_decmin, site longitude, degrees decimal minutes	

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Related Publications

Edmunds, P. J., Doo, S. S., & Carpenter, R. C. (2020). Year-long effects of high pCO2 on the community structure of a tropical fore reef assembled in outdoor flumes. ICES Journal of Marine Science, 77(3), 1055–1065. https://doi.org/10.1093/icesjms/fsaa015
Results

Edmunds, P. J., Doo, S. S., & Carpenter, R. C. (2024). Effects of year-long exposure to elevated pCO2 on the metabolism of back reef and fore reef communities. Limnology and Oceanography, 69(3), 533–547. Portico. https://doi.org/10.1002/lno.12504

Related Research

Lavigne H, Gattuso J (2013) Seacarb: seawater carbonate chemistry with R. R package version 2.4.10. Available from http://CRAN.R-project.org/package=seacarb
Software

Schneider, C. A., Rasband, W. S., ... (n.d.). ImageJ. US National Institutes of Health, Bethesda, MD, USA. Available from https://imagej.nih.gov/ij/
Software

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Parameters

Parameter	Description	Units
Flume	Flume number (1-3) and target treatment pCO2 (400, 700, 1300 uatm)	unitless
Year_Month	Year and month of experiment	unitless
Sample	Reference tag for each corals	unitless
Type	Specimen type that either were mobile and taken out every month for weighing, or permanent and not disturbed for weighing	unitless
Species	Species used	unitless
percent_area	size of the coral as a % of the area of the flume floor	percent (%)

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Instruments

Dataset-specific Instrument Name	Nortek Vectrino Acoustic Doppler Velocimeter
Generic Instrument Name	Acoustic Doppler Velocimeter
Generic Instrument Description	ADV is the acronym for acoustic doppler velocimeter. The ADV is a remote-sensing, three-dimensional velocity sensor. Its operation is based on the Doppler shift effect. The sensor can be deployed either as a moored instrument or attached to a still structure near the seabed. Reference: G. Voulgaris and J. H. Trowbridge, 1998. Evaluation of the Acoustic Doppler Velocimeter (ADV) for Turbulence Measurements. J. Atmos. Oceanic Technol., 15, 272–289. doi: http://dx.doi.org/10.1175/1520-0426(1998)0152.0.CO;2

Dataset-specific Instrument Name	A bench-top conductivity meter (Thermo Scientific, Orionstar A212, Waltham, MA, USA)
Generic Instrument Name	Conductivity Meter
Generic Instrument Description	Conductivity Meter - An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. Commonly used in hydroponics, aquaculture and freshwater systems to monitor the amount of nutrients, salts or impurities in the water.

Dataset-specific Instrument Name	Hobo Pro v2
Generic Instrument Name	Onset HOBO Pro v2 temperature logger
Dataset-specific Description	Throughout the experiment, logging sensors (described above) recorded PAR, and temperature (Hobo Pro v2 [± 0.2 °C], Onset Computer Corp., Bourne, MA, USA).
Generic Instrument Description	The HOBO Water Temp Pro v2 temperature logger, manufactured by Onset Computer Corporation, has 12-bit resolution and a precision sensor for ±0.2°C accuracy over a wide temperature range. It is designed for extended deployment in fresh or salt water. Operation range: -40° to 70°C (-40° to 158°F) in air; maximum sustained temperature of 50°C (122°F) in water Accuracy: 0.2°C over 0° to 50°C (0.36°F over 32° to 122°F) Resolution: 0.02°C at 25°C (0.04°F at 77°F) Response time: (90%) 5 minutes in water; 12 minutes in air moving 2 m/sec (typical) Stability (drift): 0.1°C (0.18°F) per year Real-time clock: ± 1 minute per month 0° to 50°C (32° to 122°F) Additional information (http://www.onsetcomp.com/) Onset Computer Corporation 470 MacArthur Blvd Bourne, MA 02532

Dataset-specific Instrument Name	
Generic Instrument Name	pH Sensor
Dataset-specific Description	pHT was measured using a DG 115-SC electrode (Mettler Toledo, Columbus, OH, USA) that was calibrated with a TRIS buffer
Generic Instrument Description	An instrument that measures the hydrogen ion activity in solutions. The overall concentration of hydrogen ions is inversely related to its pH. The pH scale ranges from 0 to 14 and indicates whether acidic (more H+) or basic (less H+).

Dataset-specific Instrument Name	
Generic Instrument Name	Photosynthetically Available Radiation Sensor
Dataset-specific Description	Light in the flumes was measured continuously (at 0.0006 Hz) using cosine-corrected sensors (Odyssey, Dataflow Systems Ltd, Christchurch, New Zealand) that recoded PAR. Odyssey sensors were calibrated with a Li-COR meter [LI-1400, Li-COR Biosciences, Lincoln, NE, USA] attached to a 2p sensor [LI 192A])
Generic Instrument Description	A PAR sensor measures photosynthetically available (or active) radiation. The sensor measures photon flux density (photons per second per square meter) within the visible wavelength range (typically 400 to 700 nanometers). PAR gives an indication of the total energy available to plants for photosynthesis. This instrument name is used when specific type, make and model are not known.

Dataset-specific Instrument Name	Wave II 373 J s-1, W. Lim Co., El Monte, CA, USA
Generic Instrument Name	Pump
Generic Instrument Description	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

Dataset-specific Instrument Name	GoPro Hero 4
Generic Instrument Name	Underwater Camera
Dataset-specific Description	Photographs were recorded in ambient light using a GoPro Hero 4 camera (12 MP, 3-mm focal length) that was fitted to a stand and positioned on the upper edge of the flumes to record the benthic community through the air-water interface.
Generic Instrument Description	All types of photographic equipment that may be deployed underwater including stills, video, film and digital systems.

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Project Information

RUI: Ocean Acidification- Category 1- The effects of ocean acidification on the organismic biology and community ecology of corals, calcified algae, and coral reefs (OA_Corals)

Coverage: Moorea, French Polynesia

While coral reefs have undergone unprecedented changes in community structure in the past 50 y, they now may be exposed to their gravest threat since the Triassic. This threat is increasing atmospheric CO2, which equilibrates with seawater and causes ocean acidification (OA). In the marine environment, the resulting decline in carbonate saturation state (Omega) makes it energetically less feasible for calcifying taxa to mineralize; this is a major concern for coral reefs. It is possible that the scleractinian architects of reefs will cease to exist as a mineralized taxon within a century, and that calcifying algae will be severely impaired. While there is a rush to understand these effects and make recommendations leading to their mitigation, these efforts are influenced strongly by the notion that the impacts of pCO2 (which causes Omega to change) on calcifying taxa, and the mechanisms that drive them, are well-known. The investigators believe that many of the key processes of mineralization on reefs that are potentially affected by OA are only poorly known and that current knowledge is inadequate to support the scaling of OA effects to the community level. It is vital to measure organismal-scale calcification of key taxa, elucidate the mechanistic bases of these responses, evaluate community scale calcification, and finally, to conduct focused experiments to describe the functional relationships between these scales of mineralization.

This project is a 4-y effort focused on the effects of Ocean Acidification (OA) on coral reefs at multiple spatial and functional scales. The project focuses on the corals, calcified algae, and coral reefs of Moorea, French Polynesia, establishes baseline community-wide calcification data for the detection of OA effects on a decadal-scale, and builds on the research context and climate change focus of the Moorea Coral Reef LTER.

This project is a hypothesis-driven approach to compare the effects of OA on reef taxa and coral reefs in Moorea. The PIs will utilize microcosms to address the impacts and mechanisms of OA on biological processes, as well as the ecological processes shaping community structure. Additionally, studies of reef-wide metabolism will be used to evaluate the impacts of OA on intact reef ecosystems, to provide a context within which the experimental investigations can be scaled to the real world, and critically, to provide a much needed reference against which future changes can be gauged.

Datasets listed in the "Dataset Collection" section include references to results journal publications published as part of this project.

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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)

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041270
NSF Division of Ocean Sciences (NSF OCE)	OCE-1415268

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