Carbonate chemistry from outdoor flume experiments with coral Acropora hyacinthus at the UCB Gump Research Station Moorea, French Polynesia in September and October of 2012

Website: https://www.bco-dmo.org/dataset/754736
Data Type: Other Field Results
Version: 1
Version Date: 2020-11-17

Project
» Moorea Coral Reef Long-Term Ecological Research site (MCR LTER)
» The effects of ocean acidification on the organismic biology and community ecology of corals, calcified algae, and coral reefs (OA_Corals)
» Collaborative Research: Ocean Acidification and Coral Reefs: Scale Dependence and Adaptive Capacity (OA coral adaptation)

Programs
» Long Term Ecological Research network (LTER)
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Contributors	Affiliation	Role
Carpenter, Robert	California State University Northridge (CSU-Northridge)	Principal Investigator
Edmunds, Peter J.	California State University Northridge (CSU-Northridge)	Co-Principal Investigator
Srednick, Griffin	California State University Northridge (CSU-Northridge)	Technician
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Carbonate chemistry from outdoor flumes at the UCB Gump Research Station Moorea, French Polynesia in September and October of 2012. These data were collected as part of a study of investigating how diel pCO2 oscillations modulate the response of the coral Acropora hyacinthus to ocean acidification. See Comeau et al. (2014) for details of this study.

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Coverage

Spatial Extent: **Lat**:-17.490483 **Lon**:-149.826367
Temporal Extent: 2012-09-01 - 2012-10-10

Acquisition Description

Seawater pH was measured at 07:00 h and 19:00 h in each tank, using a pH meter (Orion, 3-stars mobile coupled with a Mettler DG 115-SC pH electrode) calibrated every 2 d on the total scale using Tris/HCl buffers (Dickson).

Parameters of the carbonate system were calculated from salinity, temperature, AT, and pHT using the R package seacarb (Lavigne and Gattuso 2011).

Refer to publication Comeau et al. (2014) for more details.

Processing Description

BCO-DMO Data Manager Processing Notes:
* Data submitted as sheet "Carbonate chemistry" in original excel file "Calcifcation_data_MEPS_2014.xlsx" exported as csv with the formatting that was set in Excel.
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions: only A-Za-z0-9 and underscore allowed. Can not start with a number. (spaces, +, and - changed to underscores).
* Date converted to ISO 8601 format yyyy-mm-dd

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Related Publications

Comeau, S., Edmunds, P., Spindel, N., & Carpenter, R. (2014). Diel pCO2 oscillations modulate the response of the coral Acropora hyacinthus to ocean acidification. Marine Ecology Progress Series, 501, 99–111. doi:10.3354/meps10690
Results

Lavigne H, Gattuso J-P. (2011). seacarb: seawater carbonate chemistry with R. R package version 2.4.1. http://CRAN.Rproject.org/package=seacarb
Software

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Related Datasets

References

Carpenter, R., Edmunds, P. J. (2020) **Calcification data from outdoor flume experiments with coral Acropora hyacinthus at the UCB Gump Research Station Moorea, French Polynesia in September and October of 2012.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2020-11-17 http://lod.bco-dmo.org/id/dataset/754703 [view at BCO-DMO]
Relationship Description: Calcification data from the same study.

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Parameters

Parameter	Description	Units
Date	Date	unitless
Tank	Mesocosm tank	unitless
S	salinity. Calculated using seacarb (Lavigne & Gattuso 2011)	PSU
T	temperature. Calculated using seacarb (Lavigne & Gattuso 2011)	C
pH	pH. Calculated using seacarb (Lavigne & Gattuso 2011)	total scale
CO2	Carbon dioxide. Calculated using seacarb (Lavigne & Gattuso 2011)	umol/kg
pCO2	Partial pressure of carbon dioxide (water) at sea surface temperature (wet air). Calculated using seacarb (Lavigne & Gattuso 2011)	uatm
fCO2	Fugacity of carbon dioxide (water) at sea surface temperature (wet air). Calculated using seacarb (Lavigne & Gattuso 2011)	uatm
HCO3	Bicarbonate ion [HCO3]-. Calculated using seacarb (Lavigne & Gattuso 2011)	umol/kg
CO3	Carbonate ion [CO3]2-. Calculated using seacarb (Lavigne & Gattuso 2011)	umol/kg
DIC	Carbon, inorganic, dissolved. Calculated using seacarb (Lavigne & Gattuso 2011)	umol/kg
ALK	Alkalinity, total. Calculated using seacarb (Lavigne & Gattuso 2011)	umol/kg
OmegaAragonite	Aragonite saturation state. Calculated using seacarb (Lavigne & Gattuso 2011)	omega aragonite (Ω aragonite)
OmegaCalcite	Calcite saturation state. Calculated using seacarb (Lavigne & Gattuso 2011)	omega calcite (Ω calcite)

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Instruments

Dataset-specific Instrument Name	ThermoFisher Traceable
Generic Instrument Name	Water Temperature Sensor
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

Dataset-specific Instrument Name	Mettler Toledo T50
Generic Instrument Name	Automatic titrator
Dataset-specific Description	TA: Mettler Toledo T50
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	YSI 63
Generic Instrument Name	Salinity Sensor
Generic Instrument Description	Category of instrument that simultaneously measures electrical conductivity and temperature in the water column to provide temperature and salinity data.

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Project Information

Moorea Coral Reef Long-Term Ecological Research site (MCR LTER)

Website: http://mcr.lternet.edu/

Coverage: Island of Moorea, French Polynesia

From http://www.lternet.edu/sites/mcr/ and http://mcr.lternet.edu/:
The Moorea Coral Reef LTER site encompasses the coral reef complex that surrounds the island of Moorea, French Polynesia (17°30'S, 149°50'W). Moorea is a small, triangular volcanic island 20 km west of Tahiti in the Society Islands of French Polynesia. An offshore barrier reef forms a system of shallow (mean depth ~ 5-7 m), narrow (~0.8-1.5 km wide) lagoons around the 60 km perimeter of Moorea. All major coral reef types (e.g., fringing reef, lagoon patch reefs, back reef, barrier reef and fore reef) are present and accessible by small boat.

The MCR LTER was established in 2004 by the US National Science Foundation (NSF) and is a partnership between the University of California Santa Barbara and California State University, Northridge. MCR researchers include marine scientists from the UC Santa Barbara, CSU Northridge, UC Davis, UC Santa Cruz, UC San Diego, CSU San Marcos, Duke University and the University of Hawaii. Field operations are conducted from the UC Berkeley Richard B. Gump South Pacific Research Station on the island of Moorea, French Polynesia.

MCR LTER Data: The Moorea Coral Reef (MCR) LTER data are managed by and available directly from the MCR project data site URL shown above. The datasets listed below were collected at or near the MCR LTER sampling locations, and funded by NSF OCE as ancillary projects related to the MCR LTER core research themes.

The following publications and data resulted from this project:

2012 Edmunds PJ. Effect of pCO2 on the growth, respiration, and photophysiology of massive Porites spp. in Moorea, French Polynesia. Marine Biology 159: 2149-2160. doi:10.1594/PANGAEA.820375
Porites growth_respiration_photophys
Download complete data for this publication (Excel file)

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.

The following publications and data resulted from this project:

2016 Edmunds P.J. and 15 others. Integrating the effects of ocean acidification across functional scales on tropical coral reefs. Bioscience (in press Feb 2016) **not yet available**

2016 Comeau S, Carpenter RC, Lantz CA, Edmunds PJ. Parameterization of the response of calcification to temperature and pCO $_2$ in the coral *Acropora pulchra* and the alga *Lithophyllum kotschyanum*. Coral Reefs (in press Feb 2016)

2016 Brown D., Edmunds P.J. Differences in the responses of three scleractinians and the hydrocoral *Millepora platyphylla* to ocean acidification. Marine Biology (in press Feb 2016) **available soon**
MarBio. 2016: calcification and biomass
MarBio. 2016: tank conditions

2016 Comeau, S., Carpenter, R.C., Edmunds, P.J. Effects of pCO $_2$ on photosynthesis and respiration of tropical scleractinian corals and calcified algae. ICES Journal of Marine Science doi:10.1093/icesjms/fsv267

2015 Evensen NR, Edmunds PJ, Sakai K. Effects of pCO $_2$ on the capacity for spatial competition by the corals *Montipora aequituberculata* and massive *Porites* spp. Marine Ecology Progress Series 541: 123–134. doi: 10.3354/meps11512
MEPS 2015: chemistry
MEPS 2015: field survey
MEPS 2015: linear extension
Download data for this publication (Excel file)

2015 Comeau S., Lantz C. A., Edmunds P. J., Carpenter R. C. Framework of barrier reefs threatened by ocean acidification. Global Change Biology doi: 10.1111/gcb.13023

2015 Comeau, S., Carpenter, R. C., Lantz, C. A., and Edmunds, P. J. Ocean acidification accelerates dissolution of experimental coral reef communities, Biogeosciences, 12, 365-372, doi:10.5194/bg-12-365-2015.
calcification rates - flume expt
carbonate chemistry - flume expt
External data repository: http://doi.pangaea.de/10.1594/PANGAEA.847986

2014 Comeau S, Carpenter RC, Edmunds PJ. Effects of irradiance on the response of the coral *Acropora pulchra* and the calcifying alga *Hydrolithon reinboldii* to temperature elevation and ocean acidification. Journal of Experimental Marine Biology and Ecology (in press)

2014 Comeau S, Carpenter RC, Nojiri Y, Putnam HM, Sakai K, Edmunds PJ · Pacific-wide contrast highlights resistance of reef calcifiers to ocean acidification. Royal Society of London (B) 281: doi.org/10.1098/rspb.2014.1339
External data repository: http://doi.pangaea.de/10.1594/PANGAEA.832834

2014 Comeau, S., Edmunds, P. J., Lantz, C. A., & Carpenter, R. C. Water flow modulates the response of coral reef communities to ocean acidification. Scientific Reports, 4. doi:10.1038/srep06681
calcification rates - flume expt
carbonate chemistry - flume expt

2014 Comeau, S., Edmunds, P. J., Spindel, N. B., & Carpenter, R. C. Fast coral reef calcifiers are more sensitive to ocean acidification in short-term laboratory incubations. Limnology and Oceanography, 59(3), 1081–1091. doi:10.4319/lo.2014.59.3.1081
algae_calcification
coral_calcification
External data repository: http://doi.pangaea.de/10.1594/PANGAEA.832584

2014 Comeau S, Edmunds PJ, Spindel NB, Carpenter RC. Diel pCO $_2$ oscillations modulate the response of the coral Acropora hyacinthus to ocean acidification. Marine Ecology Progress Series 453: 28-35

2013 Comeau, S, Carpenter, RC, Edmunds PJ. Response to coral reef calcification: carbonate, bicarbonate and proton flux under conditions of increasing ocean acidification. Proceedings of the Royal Society of London 280: doi.org/10.1098/rspb.2013.1153

2013 Comeau S, Carpenter RC. Edmunds PJ. Effects of feeding and light intensity on the response of the coral *Porites rus* to ocean acidification. Marine Biology 160: 1127-1134
External data repository: http://doi.pangaea.de/10.1594/PANGAEA.829815

2013 Comeau, S., Edmunds, P. J., Spindel, N. B., Carpenter, R. C. The responses of eight coral reef calcifiers to increasing partial pressure of CO2 do not exhibit a tipping

point. Limnol. Oceanogr. 58, 388–398.
algae_calcification
coral_calcification
External data repository: http://doi.pangaea.de/10.1594/PANGAEA.833687

2012 Comeau, S., Carpenter, R. C., & Edmunds, P. J. Coral reef calcifiers buffer their response to ocean acidification using both bicarbonate and carbonate. Proceedings of the Royal Society B: Biological Sciences, 280(1753), 20122374. doi:10.1098/rspb.2012.2374
carbonate_chemistry
light_dark_calcification
mean_calcification
External data repository: http://doi.pangaea.de/10.1594/PANGAEA.832834

Collaborative Research: Ocean Acidification and Coral Reefs: Scale Dependence and Adaptive Capacity (OA coral adaptation)

Website: http://mcr.lternet.edu

Coverage: Moorea, French Polynesia

Extracted from the NSF award abstract:

This project focuses on the most serious threat to marine ecosystems, Ocean Acidification (OA), and addresses the problem in the most diverse and beautiful ecosystem on the planet, coral reefs. The research utilizes Moorea, French Polynesia as a model system, and builds from the NSF investment in the Moorea Coral Reef Long Term Ecological Research Site (LTER) to exploit physical and biological monitoring of coral reefs as a context for a program of studies focused on the ways in which OA will affect corals, calcified algae, and coral reef ecosystems. The project builds on a four-year NSF award with research in five new directions: (1) experiments of year-long duration, (2) studies of coral reefs to 20-m depth, (3) experiments in which carbon dioxide will be administered to plots of coral reef underwater, (4) measurements of the capacity of coral reef organisms to change through evolutionary and induced responses to improve their resistance to OA, and (5) application of emerging theories to couple studies of individual organisms to studies of whole coral reefs. Broader impacts will accrue through a better understanding of the ways in which OA will affect coral reefs that are the poster child for demonstrating climate change effects in the marine environment, and which provide income, food, and coastal protection to millions of people living in coastal areas, including in the United States.

This project focuses on the effects of Ocean Acidification on tropical coral reefs and builds on a program of research results from an existing 4-year award, and closely interfaces with the technical, hardware, and information infrastructure provided through the Moorea Coral Reef (MCR) LTER. The MCR-LTER, provides an unparalleled opportunity to partner with a study of OA effects on a coral reef with a location that arguably is better instrumented and studied in more ecological detail than any other coral reef in the world. Therefore, the results can be both contextualized by a high degree of ecological and physical relevance, and readily integrated into emerging theory seeking to predict the structure and function of coral reefs in warmer and more acidic future oceans. The existing award has involved a program of study in Moorea that has focused mostly on short-term organismic and ecological responses of corals and calcified algae, experiments conducted in mesocosms and flumes, and measurements of reef-scale calcification. This new award involves three new technical advances: for the first time, experiments will be conducted of year-long duration in replicate outdoor flumes; CO2 treatments will be administered to fully intact reef ecosystems in situ using replicated underwater flumes; and replicated common garden cultivation techniques will be used to explore within-species genetic variation in the response to OA conditions. Together, these tools will be used to support research on corals and calcified algae in three thematic areas: (1) tests for long-term (1 year) effects of OA on growth, performance, and fitness, (2) tests for depth-dependent effects of OA on reef communities at 20-m depth where light regimes are attenuated compared to shallow water, and (3) tests for beneficial responses to OA through intrinsic, within-species genetic variability and phenotypic plasticity. Some of the key experiments in these thematic areas will be designed to exploit integral projection models (IPMs) to couple organism with community responses, and to support the use of the metabolic theory of ecology (MTE) to address scale-dependence of OA effects on coral reef organisms and the function of the communities they build.

The following publications and data resulted from this project:

Comeau S, Carpenter RC, Lantz CA, Edmunds PJ. (2016) Parameterization of the response of calcification to temperature and pCO2 in the coral Acropora pulchra and the alga Lithophyllum kotschyanum. Coral Reefs 2016. DOI 10.1007/s00338-016-1425-0.
calcification rates (2014)
calcification rates (2010)

Comeau, S., Carpenter, R.C., Edmunds, P.J. (2016) Effects of pCO2 on photosynthesis and respiration of tropical scleractinian corals and calcified algae. ICES Journal of Marine Science doi:10.1093/icesjms/fsv267.
respiration and photosynthesis I
respiration and photosynthesis II

Evensen, N.R. & Edmunds P. J. (2016) Interactive effects of ocean acidification and neighboring corals on the growth of Pocillopora verrucosa. Marine Biology, 163:148. doi: 10.1007/s00227-016-2921-z
coral growth
seawater chemistry
coral colony interactions

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Program Information

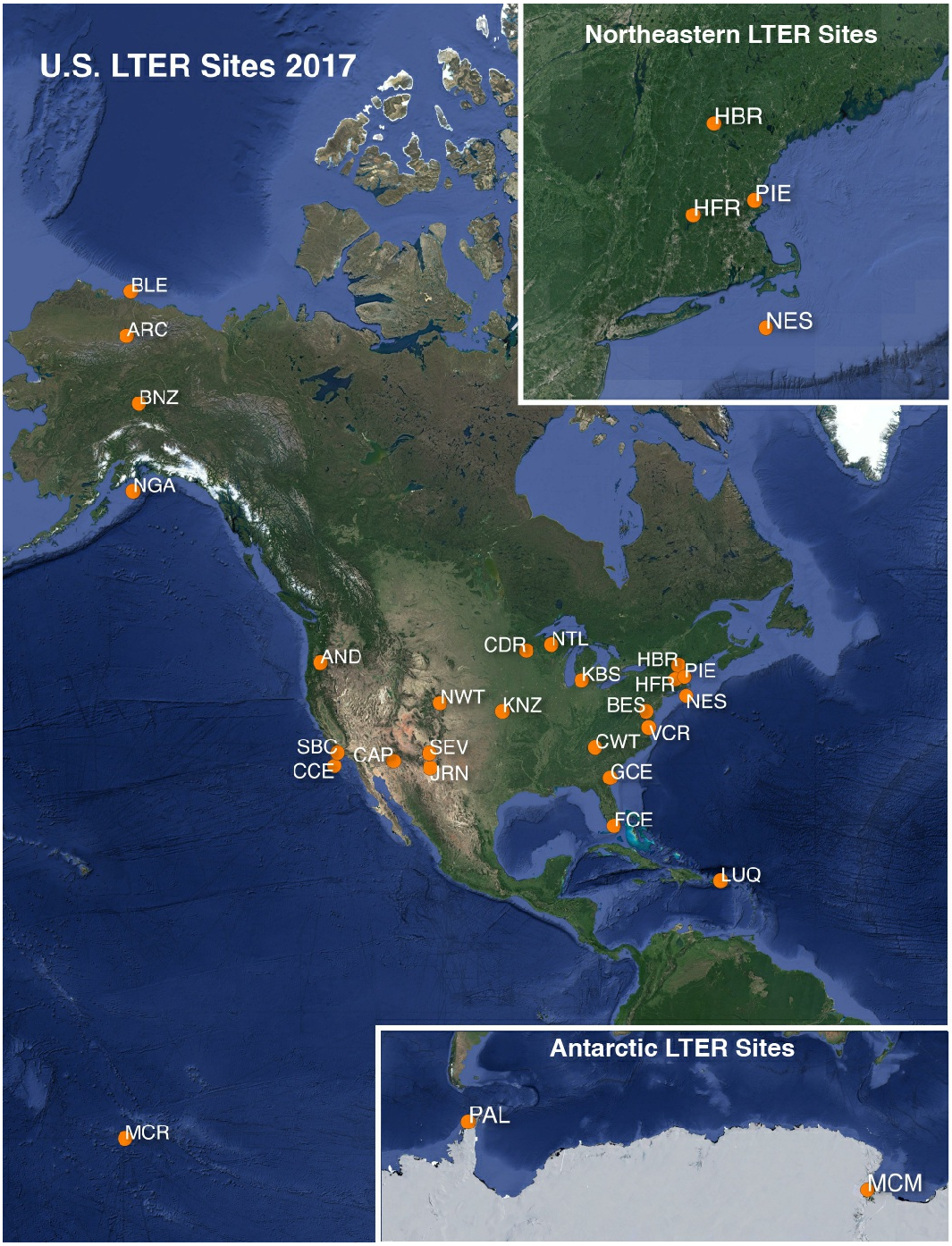
Long Term Ecological Research network (LTER)

Website: http://www.lternet.edu/

Coverage: United States

adapted from http://www.lternet.edu/

The National Science Foundation established the LTER program in 1980 to support research on long-term ecological phenomena in the United States. The Long Term Ecological Research (LTER) Network is a collaborative effort involving more than 1800 scientists and students investigating ecological processes over long temporal and broad spatial scales. The LTER Network promotes synthesis and comparative research across sites and ecosystems and among other related national and international research programs. The LTER research sites represent diverse ecosystems with emphasis on different research themes, and cross-site communication, network publications, and research-planning activities are coordinated through the LTER Network Office.



Site Codes

AND	Andrews Forest LTER
ARC	Arctic LTER
BES	Baltimore Ecosystem Stu
BLE	Beaufort Lagoon Ecosystems LTER
BNZ	Bonanza Creek LTER
CCE	California Current Ecosystem LTER
CDR	Cedar Creek Ecosystem Science Reserve
CAP	Central Arizona-Phoenix LTER
CWT	Coweeta LTER
FCE	Florida Coastal Everglades LTER
GCE	Georgia Coastal Ecosystems LTER
HFR	Harvard Forest LTER
HBR	Hubbard Brook LTER
JRN	Jornada Basin LTER
KBS	Kellogg Biological Station LTER
KNZ	Konza Prairie LTER
LUQ	Luquillo LTER
MCM	McMurdo Dry Valleys LT
MCR	Moorea Coral Reef LTEF
NWT	Niwot Ridge LTER
NTL	North Temperate Lakes I
NES	Northeast U.S. Shelf LTE
NGA	Northern Gulf of Alaska I
PAL	Palmer Antarctica LTER
PIE	Plum Island Ecosystems LTER
SBC	Santa Barbara Coastal L
SEV	Sevilleta LTER
VCR	Virginia Coast Reserve L

2017 LTER research site map obtained from https://lternet.edu/site/lter-network/

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

Website: http://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 (http://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)

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

Website: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503477

Coverage: global

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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-0417412
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041270
NSF Division of Ocean Sciences (NSF OCE)	OCE-1026851
NSF Division of Ocean Sciences (NSF OCE)	OCE-1415268

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