Seawater carbonate chemistry from experiment on brooded coral larval, March 2011, Taiwan (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects)

Website: https://www.bco-dmo.org/dataset/535163
Data Type: experimental
Version: 1
Version Date: 2014-10-07

Project
» Moorea Coral Reef Long-Term Ecological Research site (MCR LTER)
» The ecophysiological basis of the response of coral larvae and early life history stages to global climate change (Climate_Coral_Larvae)

Program
» Long Term Ecological Research network (LTER)

Contributors	Affiliation	Role
Edmunds, Peter J.	California State University Northridge (CSUN)	Principal Investigator
Cumbo, Vivian R	California State University Northridge (CSUN)	Co-Principal Investigator
Fan, Tung-Yung	National Museum of Marine Biology and Aquarium (NMMBA)	Co-Principal Investigator
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
The physiological development of brooded larvae from the pocilloporid corals Pocillopora damicornis in southern Taiwan under elevated temperature and pCO2 was examined. These data include seawater carbonate chemistry from experiments on the physiological development of brooded coral larvae conducted in March 2011. Reported parameters include temperature, salinity, pH, total alkalinity, pCO2, bicarbonate and carbonate concentration, and the saturation state (omega) for aragonite. These data were published in Cumbo et al, JEMBE, 2013.

Table of Contents

Coverage

Spatial Extent: **Lat**:21.93817 **Lon**:120.74602
Temporal Extent: 2011-03-02 - 2011-03-18

Methods & Sampling

Treatments were created in eight 150 L tanks, each filled with 120 L of filtered (1 um) seawater that was changed partially (20%) every day (at ~17:00 h). Tanks were individually heated (300 Wheaters, Taikong Corporation) and chilled (Aquatech Ac11 or Shyeh Duwai Enterprise), with the temperature regulated using programmable, digital controllers (±0.1 °C, AquaControllers, Neptune Systems). Illumination was provided by metal halide (Phillips 150 W 10,000 k) and fluorescent (39 W, Phillips T5 460 nm) bulbs to create a mean light intensity of 268± 17 µmol quanta m-2 s-1 (±SE, n=64). The light intensity was selected to approximate that found at the collection depth of the parent colonies in March.

Treatments were created by blending CO2 with air, and continually assessing the mixture through an Infra Red gas analyzer (S151, Qubit Systems), which dynamically adjusted the flow of CO2 to maintain desired levels. The gas mixture was supplied through an air stone to four of the eight tanks, with others supplied with compressed air (i.e., ambient pCO2). The conditions in the tanks were analyzed for pH, salinity, temperature, and total alkalinity (TA) using standard operating procedures (Dickson et al., 2007), and the program CO2SYS (Lewis and Wallace, 1998) to calculate DIC parameters. The gas mixing technology and the methods for seawater analyses essentially are identical to those we have used before (see Dufault et al., 2012; Edmunds, 2011). In the present analysis, the calculated TA values of certified reference materials supplied by Dr. Andrew Dickson, Scripps Institute of Oceanography (batch no. 98 and 107), were determined within a mean of 1% of the certified value.

The incubation system created target temperatures of ~24.00 °C versus 30.50 °C, and target pCO2 values of ambient versus 86.1 Pa, and an irradiance of ~268 µmol quanta m-2 s-1. Conditions in the tanks were measured at least daily using a certified digital thermometer (Model 15-077-8, Fisher Scientific,±0.05 °C), a cosine-corrected quantum light meter (Li-Cor LI-192 attached to an LI-1400), and a sample ofwater withdrawn from each tank for pH, salinity, and TA analysis.

The 'ambient' and 'high' pCO2 levels: 49.4 Pa versus 86.2 Pa
The 'ambient' and 'high' temperatures: 24.00 °C [ambient] versus 30.49 °C

Data also available from PANGAEA: doi:10.1594/PANGAEA.823582

Data Processing Description

BCO-DMO processing notes:

- added conventional header with dataset name, PI name, version date, reference information
- renamed parameters to BCO-DMO standard
- added lab, lat, lon columns
- columns not served: temp out, press out, pH out, fugacity, CO2 out, B Alk out, OH out, P Alk out Si Alk out, Revelle, Omega-Ca, xCO2 out.
- reformatted date from m.d.yyyy to yyyy-mm-dd
- removed "Tank " from data in tank column

[table of contents | back to top]

Data Files

File
brood3_chem.csv (Comma Separated Values (.csv), 3.41 KB) MD5:1a91974447bd440798d22ba04dc2a513 Primary data file for dataset ID 535163

[table of contents | back to top]

Supplemental Files

File
Biological data for "brooded coral larvae expt. 3" datasets filename: Cumbo_etal_2012_JEMBE_data1_BCODMO.xls (Octet Stream, 154.50 KB) MD5:e6c5e6012df9bfc581b9f769f7e52a98 Original biological data for Cumbo et al 2013 including respiration raw data, respiration by mg protein, symbiont densities, protein content, % mortality
Tank physical data filename: Cumbo_etal_2012_JEMBE_Tank_Parameters_BCODMO.xlsx (Octet Stream, 57.05 KB) MD5:0170402805d7c1fe4784a51d2b26fb66 Tank physical data for "brooded coral larvae 3" experiment including seawater chemistry, light and temperature data.

[table of contents | back to top]

Related Publications

Cumbo, V. R., Fan, T. Y., & Edmunds, P. J. (2013). Effects of exposure duration on the response of Pocillopora damicornis larvae to elevated temperature and high pCO2. Journal of Experimental Marine Biology and Ecology, 439, 100–107. doi:10.1016/j.jembe.2012.10.019
Results

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
https://isbnsearch.org/isbn/1-897176-07-4
Methods

Dufault, A. M., Cumbo, V. R., Fan, T.-Y., & Edmunds, P. J. (2012). Effects of diurnally oscillating pCO2 on the calcification and survival of coral recruits. Proceedings of the Royal Society B: Biological Sciences, 279(1740), 2951–2958. doi:10.1098/rspb.2011.2545
Results

Edmunds, P. J. (2011). Zooplanktivory ameliorates the effects of ocean acidification on the reef coral Porites spp. Limnology and Oceanography, 56(6), 2402–2410. doi:10.4319/lo.2011.56.6.2402
Methods

Pierrot, D. E. Lewis,and D. W. R. Wallace. 2006. MS Excel Program Developed for CO2 System Calculations. ORNL/CDIAC-105a. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee. doi: 10.3334/CDIAC/otg.CO2SYS_XLS_CDIAC105a.
Methods

[table of contents | back to top]

Related Datasets

IsRelatedTo

Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Light data in tanks from experiment on brooded coral larval, Taiwan, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 http://lod.bco-dmo.org/id/dataset/535219 [view at BCO-DMO]

Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Protein content of brooded coral larvae at high and ambient temperature and pCO2, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 http://lod.bco-dmo.org/id/dataset/535425 [view at BCO-DMO]

Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Respiration and protein content of brooded coral larvae at high and ambient temperature and pCO2, Taiwan, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 http://lod.bco-dmo.org/id/dataset/535328 [view at BCO-DMO]

Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Respiration of brooded coral larvae at high and ambient temperature and pCO2, Taiwan, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 http://lod.bco-dmo.org/id/dataset/535266 [view at BCO-DMO]

Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Symbiont Symbiodinium density in brooded coral larvae at high and ambient temperature and pCO2, Taiwan, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 http://lod.bco-dmo.org/id/dataset/535358 [view at BCO-DMO]

Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Temperature data from tanks from experiment on brooded coral larval, Taiwan, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 http://lod.bco-dmo.org/id/dataset/535244 [view at BCO-DMO]

Edmunds, P. J., Cumbo, V. R., Fan, T. (2021) **Settling and mortality measurements of brooded coral larvae at high and ambient temperature and pCO2, Taiwan, March 2011 (MCR LTER project, Climate_Coral_Larvae project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 doi:10.26008/1912/bco-dmo.535462.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
lab	laboratory	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
date	local date	yyyy-mm-dd
tank	tank id number	tank
treatment	temperature: AT=ambient (24 C) or HT=high (30.49 C); pCO2 treatment: AC=ambient (419-470 uatm) or HC=high (604-742 uatm)	unitless
sal	salinity	PSU scale
treatment_temp	target temperature	degrees Celsius
temp_tank	temperature reading in the tank	degrees Celsius
TA	total alkalinity	umol/kg
pH	pH: The measure of the acidity or basicity of an aqueous solution	pH scale
pCO2	partial pressure of carbon dioxide by computation from pH and alkalinity	uatm
bicarbonate	concentration of bicarbonate ion ([HCO3]-) in seawater	umol/kg seawater
carbonate	concentration of carbonate ion ([CO3]2-)	umol/kg seawater
omega_Ara	the saturation state of seawater with respect to aragonite	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Aquarium chiller
Generic Instrument Name	Aquarium chiller
Dataset-specific Description	Aquatech Ac11 or Shyeh Duwai Enterprise
Generic Instrument Description	Immersible or in-line liquid cooling device, usually with temperature control.

Dataset-specific Instrument Name	Gas Analyzer
Generic Instrument Name	Gas Analyzer
Dataset-specific Description	Infra Red gas analyzer (S151, Qubit Systems)
Generic Instrument Description	Gas Analyzers - Instruments for determining the qualitative and quantitative composition of gas mixtures.

Dataset-specific Instrument Name	Immersion heater
Generic Instrument Name	Immersion heater
Dataset-specific Description	300 Wheaters, Taikong Corporation
Generic Instrument Description	Submersible heating element for water tanks and aquaria.

Dataset-specific Instrument Name	LI-COR LI-192 light sensor
Generic Instrument Name	LI-COR LI-192 PAR Sensor
Dataset-specific Description	cosine-corrected quantum light meter (Li-Cor LI-192 attached to an LI-1400)
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	Water Temp Sensor
Generic Instrument Name	Water Temperature Sensor
Dataset-specific Description	certified digital thermometer (Model 15-077-8, Fisher Scientific,±0.05 °C)
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

[table of contents | back to top]

Deployments

lab_Edmunds_NMMBA

Website	https://www.bco-dmo.org/deployment/58892
Platform	Natl Museum Mar. Bio. and Aquar. Taiwan
Start Date	2010-03-18
End Date	2010-03-24
Description	Experiments related to the research project: 'RUI- The ecophysiological basis of the response of coral larvae and early life history stages to global climate change' were conducted at the laboratories of the National Museum of Marine Biology and Aquarium in Southern Taiwan.

[table of contents | back to top]

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.

This project is supported by continuing grants with slight name variations:
LTER: Long-Term Dynamics of a Coral Reef Ecosystem
LTER: MCR II - Long-Term Dynamics of a Coral Reef Ecosystem
LTER: MCR IIB: Long-Term Dynamics of a Coral Reef Ecosystem
LTER: MCR III: Long-Term Dynamics of a Coral Reef Ecosystem
LTER: MCR IV: Long-Term Dynamics of a Coral Reef Ecosystem

The ecophysiological basis of the response of coral larvae and early life history stages to global climate change (Climate_Coral_Larvae)

Coverage: Moorea, French Polynesia; Southern Taiwan; California State University Northridge

Tropical coral reefs face a suite of environmental assaults ranging from anchor damage to the effects of global climate change (GCC). The consequences are evident throughout the tropics, where many coral reefs have lost a substantial fraction of their coral cover in a few decades. Notwithstanding the importance of reducing the impacts of environmental stresses, the only means by which these ecosystems can recover (or simply persist) is through the recruitment of scleractinians, which is a function of successful larval development, delivery, settlement, metamorphosis, and post-settlement events. Despite wide recognition of the importance of these processes, there are few pertinent empirical data, and virtually none that address the mechanisms mediating the success of early coral life stages in a physical environmental varying at multiple spatio-temporal scales.

The objective of this research is to complete one of the first comprehensive ecophysiological analyses of the early life stages of corals through a description of: (1) their functionality under 'normal' conditions, and (2) their response to the main drivers of GCC. These analyses will be completed for 2 species representative of a brooding life history strategy, and the experiments will be completed in two locations, one (Taiwan) that provides unrivalled experience in coral reproductive biology, and superb microcosm facilities, and the other (Moorea), with access to a relatively pristine environment, a well described ecological and oceanographic context (through the MCR-LTER), and the capacity to bring a strong biogeographic contrast to the project. The results of the study will be integrated through modeling to explore the effects of GCC on coral community structure over the next century.

The following publications and data resulted from this project:

2013 Wall CB, Fan TY, Edmunds PJ. Ocean acidification has no effect on thermal bleaching in the coral *Seriatopora caliendrum*. Coral Reefs 33: 119-130.
Symbiodinium_Seriatopora photosynthesis
Symbiodinium_Seriatopora PI curve
Symbiodinium_Seriatopora temp-salinity-light
Symbiodinium_Seriatopora water chemistry
- Download complete data for this publication (Excel file)

2013 Wall CB, Edmunds PJ. *In situ* effects of low pH and elevated HCO3- on juvenile *Porites* spp. in Moorea, French Polynesia. Biological Bulletin 225:92-101.
Data at MCR and PANGEA: doi.pangaea.de/10.1594/PANGAEA.833913
- Download complete data for this publication (Excel file)

2013 Vivian R Cumbo, Peter J Edmunds, Christopher B Wall, Tung-Yung Fan. Brooded coral larvae differ in their response to high temperature and elevated pCO2 depending on the day of release. Marine Biology DOI 10.1007/s00227-013-2280-y.
Data also at PANGEA: doi.pangaea.de/10.1594/PANGAEA.831612
brooded coral larvae 2 - carbonate chemistry
brooded coral larvae 2 - larval release March 2003-2008
brooded coral larvae 2 - respiration_photosyth_mortality
- Download complete data for this publication (Excel file)

2013 Edmunds PJ, Cumbo VR, Fan TY. Metabolic costs of larval settlement and metamorphosis in the coral *Seriatopora caliendrum* under ambient and elevated pCO2. Journal Experimental Marine Biology and Ecology 443: 33-38 Data also at PANGEA: doi:10.1594/PANGAEA.821644
Coral post-settlement physiology
- Download complete data for this publication (Excel file)

2013 Aaron M Dufault, Aaron Ninokawa, Lorenzo Bramanti, Vivian R Cumbo, Tung-Yung Fan, Peter J Edmunds. The role of light in mediating the effects of ocean acidification on coral calcification. Journal of Experimental Biology 216: 1570-1577.
coral-light expt.- PAR
coral-light expt.- carbonate chemistry
coral-light expt.- temp_salinity
coral-light expt.- growth
coral-light expt.- protein
coral-light expt.- survival
- Download complete data for this publication (Excel file)

2012 Cumbo, VR, Fan TY, Edmunds PJ. Effects of exposure duration on the response of *Pocillopora damicornis* larvae to elevated temperature and high pCO2. J Exp Mar Biol Ecol 439: 100-107.
Data is also at PANGEA: doi:10.1594/PANGAEA.823582
brooded coral larvae 3 - carbonate chemistry
brooded coral larvae 3 - light
brooded coral larvae 3 - mortality
brooded coral larvae 3 - protein
brooded coral larvae 3 - respiration and protein
brooded coral larvae 3 - respiration raw data
brooded coral larvae 3 - symbiont density
brooded coral larvae 3 - tank temperature
- Download part 1 of data for this publication (Excel file)
- Download tank parameters data for this publication (Excel file)

2012 Cumbo, VR, Fan TY, Edmunds PJ. Physiological development of brooded larvae from two pocilloporid corals in Taiwan. Marine Biology 159: 2853-2866.
brooded coral - carbonate chemistry
brooded coral - release
brooded coral - respiration
brooded coral - settlement competency
brooded coral - size_July
brooded coral - size_protein_symbionts_photosynth
- Download complete data for this publication (Excel file)

2012 Dufault, Aaron M; Vivian R Cumbo; Tung-Yung Fan; Peter J Edmunds. Effects of diurnally oscillating pCO2 on the calcification and survival of coral recruits. Royal Society of London (B) 279: 2951-2958. doi:10.1098/rspb.2011.2545
Data is also at PANGEA: doi:10.1594/PANGAEA.830185
recruit_growth_area
recruit_growth_weight
recruit_seawater_chemistry
recruit_survival
- Download complete data for this publication (Excel file)

2011 Edmunds PJ, Cumbo V, Fan TY. Effects of temperature on the respiration of brooded larvae from tropical reef corals. Journal of Experimental Biology 214: 2783-2790.
CoralLarvae_comparison_respir
CoralLarvae_release
CoralLarvae_respir
CoralLarvae_size
- Download complete data for this publication (Excel file)

[table of contents | back to top]

Program Information

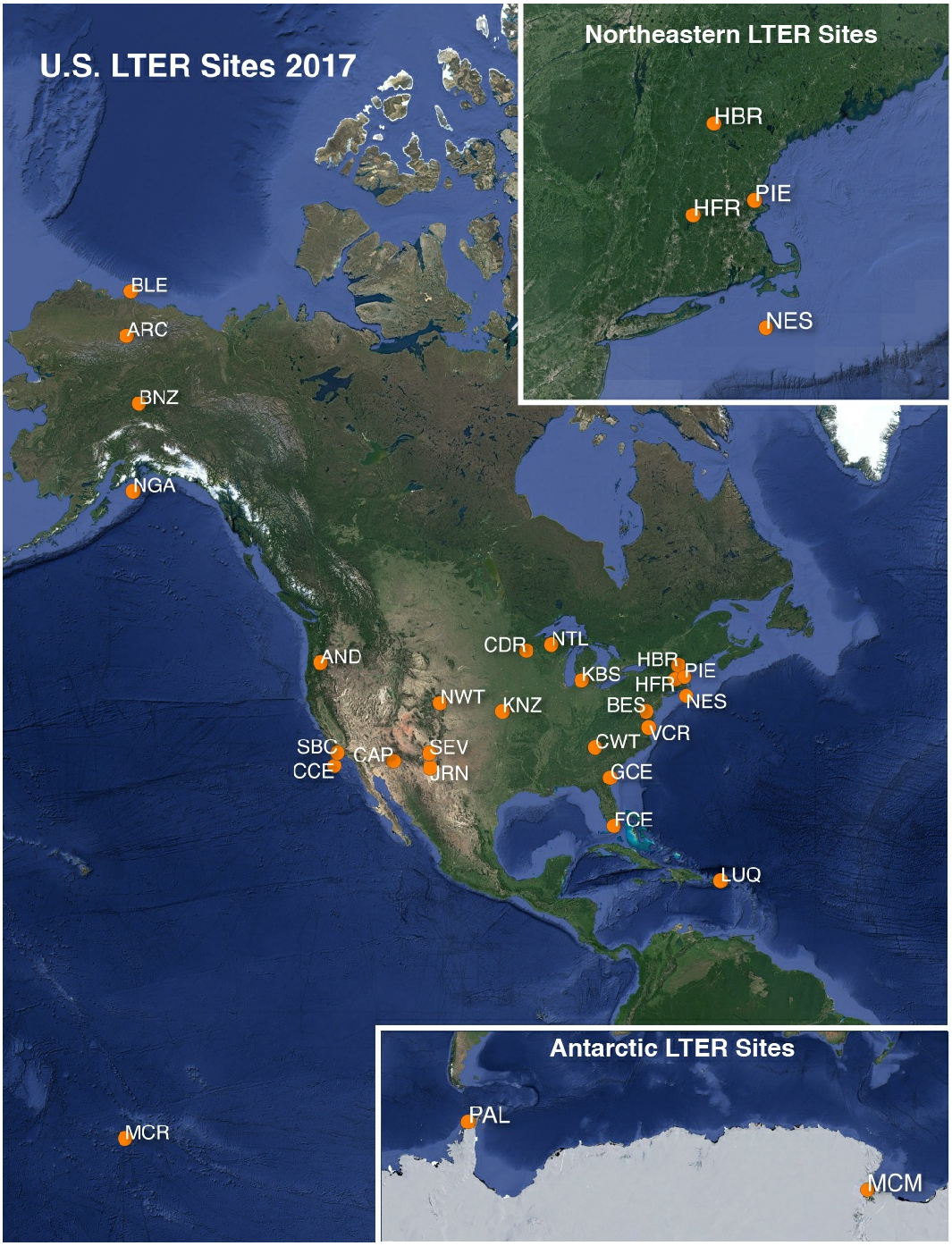
Long Term Ecological Research network (LTER)

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.



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

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

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0844785

[table of contents | back to top]