Temperature, pH, and salinity collected by SAMI sensors at the Bodega Marine Lab mooring in the nearshore surface waters off the central California coast from 2011-2012 (BOAR and OMEGAS-MaS projects)

Website: https://www.bco-dmo.org/dataset/3536
Data Type: Other Field Results
Version: 1
Version Date: 2015-03-31

Project
» Bodega Ocean Acidification Research (BOAR)
» OCEAN ACIDIFICATION - Category 1: COLLABORATIVE RESEARCH: Acclimation and adaptation to ocean acidification of key ecosystem components in the California Current System (OMEGAS-MaS)

Programs
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)
» Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)

Contributors	Affiliation	Role
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Abstract
Temperature, pH, and salinity collected by SAMI sensors at the Bodega Marine Lab mooring in the nearshore surface waters off the central California coast from 2011-2012.

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Coverage

Spatial Extent: **Lat**:38.312 **Lon**:-123.083
Temporal Extent: 2011-01-01 - 2014-12-31

Dataset Description

Near-surface pH time series at BML mooring, offshore of Bodega Marine Laboratory, central California coast.
Dataset was updated on 21 October 2013 with data from 2012.

Dataset was updated on 31 March 2015 with data from 2013 and 2014.

(Note: This dataset was supported by funding to both the BOAR and OMEGAS projects.)

Methods & Sampling

01 Jan 2011 to 22 Feb 2011:
Time series collected continuously at a depth of ~1m below surface. Instrumentation includes Sunburst SAMI-pH, Durafet SeaFET, and Durafet SeapHOx. In some cases records from multiple instruments overlap in time. Quality control is still underway; accuracy and precision are yet to be verified.

25 May 2011 to 30 June 2011:
Hourly pH data from 5/25/2011 to 6/30/2011 using near-surface (~1 m) Sunburst Sensors SAMI pH. QA/QC not performed, these are raw data. Date stamp displayed in data has been corrected due to a glitch between SAMI and Excel.

13 April 2012 to 18 Nov 2012:
Hourly pH data from 4/13/2012 to 11/18/2012 using Sunburst Sensors SAMI pH (spectrophotometric) instruments and a SeapHox (FET) instrument, as well as temperature data from both sensor types.

08 May 2013 to 26 Nov 2013:
Hourly pH data from 06/11/2013 to 09/23/2013 using SepHOx sensor, and from 10/22/2013 to 11/26/2013 using the SAMI80 sensor.

08 Jan 2014 to 31 Dec 2014:
Hourly pH data from 01/08/2014 to 12/31/2014 using SepHOx sensor, and from 01/30/2014 to 03/19/2014 using the SAMI80 sensor.

Data Processing Description

QA/QC not performed. These are raw data. Data originally submitted to BCO-DMO as Excel files, "BML_moor_pH_Jan_1_2011-Feb_22_2011.xls" contributed by Brian Gaylord and "SAMI_pH_for_BCO_DMO.xlsx", "pH_2012_for_BCODMO.xlsx", "2013_BML_data_for_BCODMO.xlsx", and "2014_BML_data_for_BCODMO.xlsx" contributed by Tessa Hill.

Data notes:
bottle data provided here were analyzed on a SAMI pH, corrected for any offsets utilizing Dickson Standard.
2013 Data:
(1) before 6/11/2013 6:00:01 AM seapHOx was not working correctly, data questionable, EXT-INT very unstable.
(2) before 9/12/2013 9:00:00 PM and after 9/23/2013 8:00:00 PM seapHOx was not working correctly, data questionable, EXT-INT very unstable, also small gap inbetween removed.
(3) seaphox sent back to martz lab 10/15/2013, The controller board was a very old version and the durafet and ISE were both three years old.
(4) there is no 1m bottle data before 7/22/2013.
(5)

2014 Data:
(1) 5/13/2014 6:00:01 PM to 7/17/2014 7:00:00 PM salinity data for seapHOx >0.3 PSU off, microcat 4956 salinity used instead (last calibrated 20130109)
(2) 1/8/2014 10:00:00 PM to 5/13/2014 4:00:00 PM seapHOx standardization done with 2/5/2014 6:30 SAMI pH + OFFSET 1 meter bottle value
(3) 5/13/2014 6:00:01 PM to 7/17/2014 7:00:00 PM seapHOx standardization done with 5/21/2014 18:00 SAMI pH + OFFSET 1 meter bottle value
(4) 7/17/2014 8:00:00 PM to 12/31/2014 11:00:00 PM seapHOx standardization done with 7/17/2014 19:00 SAMI pH + OFFSET 1 meter bottle value with seapHOx 7/17/2014 20:00 values

BCO-DMO Edits
- Parameter names modified to conform to BCO-DMO convention
- Date reformatted to YYYYMMDD

- Time reformatted to HHMM.mm
- 'nd' (no data) inserted in blank cells
- 31 March 2015: removed restricted-only access to the dataset, added data from 2013 and 2014, added ISO_DateTime field.

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Data Files

File
BML_pH.csv (Comma Separated Values (.csv), 2.31 MB) MD5:b8b31fb8e92b3ad1eecfb2ce0b1043dd Primary data file for dataset ID 3536

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Parameters

Parameter	Description	Units
date_gmt	Date, GMT.	YYYYMMDD
time_gmt	Time, 24-hour clock, GMT.	HHMM.mm
pH	pH (instrumentation includes Sunburst SAMI-pH, Durafet SeaFET, and Durafet SeapHOx).	sea water scale
temp	Temperature, in degrees C. (Instrumentation includes Sunburst SAMI-pH, Durafet SeaFET, and Durafet SeapHOx.)	degrees Celsius
lat	Latitude of the mooring, North = positive.	decimal degrees
lon	Longitude of the mooring, East = positive.	decimal degrees
mooring	Name of the mooring.	text
month_gmt	2-digit month of year. e.g. 05 = May.	mm (01 to 12)
day_gmt	2-digit day of month, GMT.	dd (01 to 31)
year	Four-digit year.	YYYY
start_date	Sampling start date (GMT).	YYYYmmdd

end_date	Sampling end date (GMT).	YYYYmmdd
pH_SAMI80	pH as measured by SAMI80 instrument.	sea water scale
temp_SAMI80	Temperature, in degrees C, as measured by SAMI80 instrument.	degrees Celsius
pH_SAMI83	pH as measured by SAMI83 instrument.	sea water scale
temp_SAMI83	Temperature, in degrees C, as measured by SAMI83 instrument.	degrees Celsius
pH_SeapHOx	pH as measured by SeapHOx instrument.	sea water scale
temp_SeapHOx	Temperature, in degrees C, as measured by SeapHOx instrument.	degrees Celsius
sal_SeapHOx	Salinity as measured by SeapHOx instrument.	PSU (practical salinity units)
pH_SAMI_bot_0m	Bottle data (pH) from 0 meters depth analyzed on a SAMI pH, corrected for any offsets utilizing Dickson Standard.	sea water scale
pH_SAMI_bot_1m	Bottle data (pH) from 1 meter depth analyzed on a SAMI pH, corrected for any offsets utilizing Dickson Standard.	sea water scale
ISO_DateTime_UTC	Date and time formatted to ISO 8601 standard. This standard is based on ISO 8601:2004(E) and takes on the following format: YYYY-mm-ddTHH:MM:SS[.xx]Z (where T represent the start of the time string and Z indicates UTC) examples: 2009-08-30T09:05:00[.xx] (local time) 2009-08-30T14:05:00[.xx]Z (UTC time) 2009-08-30T14:05:00[.xx]-05:00 The dashes and the colons can be dropped. The T can also be dropped "by mutual agreement", but one needs the trailing Z if the time is UTC.	YYYY-MM-DDTHH:MM:SS[.xx]Z

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Instruments

Dataset-specific Instrument Name	SeapHOx/SeaFET
Generic Instrument Name	SeapHOx/SeaFET
Dataset-specific Description	A SeapHox (FET) instrument was used to measure pH and temperature hourly.
Generic Instrument Description	The SeapHOx and SeaFET are autonomous sensors originally designed and developed by the Todd Martz Lab at Scripps Institution of Oceanography. The SeaFET was designed to measure pH and temperature. The SeapHOx, designed later, combined the SeaFET with additional integrated sensors for dissolved oxygen and conductivity. Refer to Martz et al. 2010 (doi:10.4319/lom.2010.8.172). The SeapHOx package is now produced by Sea-Bird Scientific and allows for integrated data collection of pH, temperature, salinity, and oxygen. Refer to Sea-Bird for specific model information.

Dataset-specific Instrument Name	Submersible Autonomous Moored Instrument
Generic Instrument Name	Submersible Autonomous Moored Instrument
Dataset-specific Description	Sunburst Systems Submersible Autonomous Moored Instrument for pH (SAMI-pH). Range: 7-9 Salinity Range: 30-36 Acc: +/- 0.003 pH units Prec: From http://bml.ucdavis.edu/boon/bml_buoy.html
Generic Instrument Description	The Submersible Autonomous Moored Instrument (SAMI) measures and logs levels of dissolved chemicals in sea and fresh water. It is a plastic cylinder about 6 inches wide and 2 feet long that is self-powered and capable of hourly measurements for up to one year. All data collected are logged to an internal memory chip to be downloaded later. SAMI sensors usually are placed a few feet underwater on permanent moorings, while others on floating drifters sample the water wherever the wind and currents carry them. The instruments have been used by researchers around the globe in a variety of studies since 1999. Dr. Mike DeGrandpre, University of Montana, developed the SAMI between 1990 and 1993 during his postdoctoral work at the Woods Hole Oceanographic Institution (Woods Hole, MA, USA). For additional information, see URL: http://www.sunburstsensors.com/ from the manufacturer, Sunburst Sensors, LLC, 1226 West Broadway, Missoula, MT 59802.

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Deployments

BML_Mooring

Website	https://www.bco-dmo.org/deployment/58721
Platform	Bodega Marine Laboratory Mooring
Start Date	2011-01-01
End Date	2012-11-18
Description	Offshore of Bodega Marine Laboratory; nearshore surface waters off the coast of central California (1 km from shore at 47 m isobath) 38.312N, 123.083W.

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Project Information

Bodega Ocean Acidification Research (BOAR)

Website: http://bml.ucdavis.edu/research/research-programs/climate-change/oceanacidification/

Coverage: Central California coast (northeast Pacific)

The absorption of human-produced CO2 into the world's oceans is decreasing seawater pH and causing marked declines in the saturation state for calcium carbonate, a major building block for shells, skeletons, and tests of many marine species. Such changes (collectively termed "ocean acidification") have the potential to devastate a broad array of organisms, both at the level of individuals and at population and ecosystem scales. Although awareness of these issues is rapidly growing, most of what is known is based on studies of coral reef organisms and plankton.

The proposed work will enhance understanding of impacts from ocean acidification by providing rigorous data on several new fronts applicable to temperate systems. The project will operate within one of the strongest upwelling centers of the eastern Pacific, where global trends in acidification are amplified by the presence of cold water characterized by already-high levels of aqueous CO2. Using an integrated, comparative approach that exploits the expertise of oceanographers, marine chemists, and biologists, the project will explicitly couple moored and shipboard measurements of seawater chemistry to controlled laboratory and field studies of biological responses.

Two vital foundation species (the California mussel, *Mytilus californianus*, and the Olympia oyster, *Ostrea conchaphila*) will be targeted. These two species play disproportionately important roles in open-coast and estuarine systems, respectively. Larvae (which are often the most vulnerable stages) of mussels and oysters will be cultured under elevated-CO2 conditions through the full pelagic period and into juvenile life. Growth and survivorship will be quantified, and water temperature and salinity will be varied to test for interactive effects of multiple factors. Intraspecific variation in response of larvae from different parental lineages will be examined. "Carry-over" effects that originate from exposure during the larval stage, but influence subsequent juvenile growth and survival, will be determined both in the laboratory and using field outplants. Because larval and juvenile stages play important roles as demographic age-structure bottlenecks, overall population consequences will be estimated through comparison of observed impacts on early life stages to other recognized sources of recruitment variation.

Data Status: Data will be reported from the BML offshore oceanographic moorings and from moorings within nearby Tomales Bay. The moorings will be outfitted with autonomously recording pH and pCO2 sensors, and these measurements will be supplemented with discrete water samples collected monthly along two associated transects.

Live Data: For live-streaming data from Tomales Bay, visit http://www.ipacoa.org/Explorer and click on the icon in Tomales Bay.

OCEAN ACIDIFICATION - Category 1: COLLABORATIVE RESEARCH: Acclimation and adaptation to ocean acidification of key ecosystem components in the California Current System (OMEGAS-MaS)

Website: http://omegas.science.oregonstate.edu

Coverage: California Current Large Marine Ecosystem, Oregon, California

In 2010-2012/13, the OMEGAS consortium is investigating the impact of ocean acidification (OA) on two ecologically important, calcification-dependent marine invertebrates (sea urchins *Strongylocentrotus purpuratus* and mussels *Mytilus californianus*) in relation to local-to-coastal variation in carbonate chemistry in the California Current Large Marine Ecosystem (CCLME). An interdisciplinary team of investigators with expertise in physical and chemical oceanography, marine ecology, biochemistry, molecular physiology, and molecular genetics carry out integrated, lab and field, multi-site investigations of the ecological, physiological,

and evolutionary responses of sea urchins and mussels to spatial and temporal variation in OA.

The research takes place in the context of a mosaic of variable oceanography, including recently documented latitudinal variation in carbonate chemistry along the upwelling-dominated US west coast. Variation in upwelling regimes from Washington to southern California generates spatial and temporal gradients in concentration of CO2 that shoal to surface waters during upwelling events, extending shoreward into the inner shelf region. Because calcifiers in the upwelling-dominated CCLME probably have historically experienced wide fluctuation in pH, many likely are adapted to a variable carbonate chemistry environment. The new challenge to these organisms is that they may have limited ability to respond to additional increases in CO2. It is this challenge, the mechanistic ability of calcifying invertebrates to acclimate or adapt to increasing CO2 and aragonite saturation states < 1.0, that is addressed in this program.

Our research includes several integrated elements that span our three project areas (Moorings and sensors; Genomics, physiology, and larval rearing; and Field transplants and growth experiments):

(1) Document the oceanographic context in which the study organisms operate in four regions of the CCLME with contrasting upwelling regimes.

(2) Examine physiological, genomic, and genetic mechanisms underlying acclimatization and adaptation to OA conditions with coordinated and integrated studies of adults and larvae of sea urchins and mussels collected from each of two sites within each of the four regions. In common-garden experiments culture sea urchins and mussels, respectively, under different CO2 and temperature regimes, and use genomics techniques to determine the tolerance of larvae to present and future OA conditions.

(3) Determine evolutionary responses and adaptational potential to OA using genetic surveys of urchins and mussels across the 8 sites and relate detected variability to the oceanographic conditions.

(4) Examine ecological responses to OA with transplants of mussels and urchins in the field and monitor growth rates and shell accretion rates in relation to oceanographic and physical conditions.

The team will investigate the impact of ocean acidification (OA) on two ecological important, calcification-dependent marine invertebrates (sea urchins *Strongylocentrotus purpuratus* and mussels *Mytilus californianus*) in relation to local-to-coastal variation in carbonate chemistry in the California Current Large Marine Ecosystem (CCLME). An interdisciplinary team of investigators with expertise in physical and chemical oceanography, marine ecology, biochemistry, molecular physiology, and molecular genetics will carry out an integrated, lab and field, multi-site investigation of the ecological, physiological, and evolutionary responses of sea urchins and mussels to spatial and temporal variation in OA. The research will take place in the context of a mosaic of variable oceanography, including recently documented latitudinal variation in carbonate chemistry along the upwelling-dominated US west coast. Variation in upwelling regimes from Washington to southern California generates spatial and temporal gradients in concentration of CO2 that shoal to surface waters during upwelling events, extending shoreward into the inner shelf region. Because calcifiers in the upwelling-dominated CCLME probably have historically experienced wide fluctuation in pH, many likely are adapted to a variable carbonate chemistry environment. The new challenge to these organisms is that they may have limited ability to respond to additional increases in CO2. It is this challenge, the mechanistic ability of calcifying invertebrates to acclimate or adapt to increasing CO2 and decreasing carbonate mineral saturation state, that is addressed in this project.

The OMEGAS Moorings and Sensors team will document the oceanographic context in which the study organisms operate in four regions of the CCLME with contrasting upwelling regimesThis project also coordinates closely with other OMEGAS projects [(i) Genetics, physiology, larval rearing and (ii) Field transplants] to achieve goals of the project to determine acclimatization and adaptational capacity to present and future OA conditions .

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH

Gaylord, B., T. M. Hill, E. Sanford, E. A. Lenz, L. A. Jacobs, K. N. Sato, A. D. Russell, and A. Hettinger. "Functional impacts of ocean acidification in an ecologically critical foundation species", *Journal of Experimental Biology*, v.214, 2011, p. 2586.

Howarth, R., F. Chan, D. J. Conley, S. C. Doney, R. Marino, and G. Billen. "Coupled biogeochemical cycles: eutrophication and hypoxia in temperate estuaries and coastal marine ecosystems", *Frontiers in Ecology and the Environment*, v.9, 2011, p. 18.

Yu, P. D., P. G. Matson, T. R. Martz, and G. E. Hofmann. "The ocean acidification seascape and its relationship to theperformance of calcifying marine invertebrates: laboratory experiments on the development of urchin

larvae framed by environmentally-relevant pCO2/pH", *Journal of Experimental Marine Biology and Ecology*, v.400, 2011, p. 288.

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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)

Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)

Website: http://www.piscoweb.org/

Coverage: West coast of North America from Mexico to Alaska

The Partnership for Interdisciplinary Studies of Coastal Oceans is a long-term ecosystem research and monitoring program established with the goals of:

- understanding dynamics of the coastal ocean ecosystem along the U.S. west coast
- sharing that knowledge so ocean managers and policy makers can make science based decisions regarding coastal and marine stewardship
- producing a new generation of scientists trained in interdisciplinary collaborative approaches

Over the last 10 years, PISCO has successfully built a unique research program that combines complementary disciplines to answer critical environmental questions and inform management and policy. Activities are conducted at the latitudinal scale of the California Current Large Marine Ecosystem along the west coast of North America, but anchored around the dynamics of coastal, hardbottom habitats and the oceanography of the nearshore ocean – among the most productive and diverse components of this ecosystem. The program integrates studies of changes in the ocean environment through ecological monitoring and experiments. Scientists examine the causes and consequences of ecosystem changes over spatial scales that are the most relevant to marine species and management, but largely unstudied elsewhere.

Findings are linked to solutions through a growing portfolio of tools for policy and management decisions. The time from scientific discovery to policy change is greatly reduced by coordinated, efficient links between scientists and key decision makers.

Core elements of PISCO are:

- Interdisciplinary ecosystem science
- Data archiving and sharing
- Outreach to public and decision-making user groups
- Interdisciplinary training
- Coordination of distributed research team

Established in 1999 with funding from The David and Lucile Packard Foundation, PISCO is led by scientists from core campuses Oregon State University (OSU); Stanford University's Hopkins Marine Station; University of California, Santa Cruz (UCSC); and University of California, Santa Barbara (UCSB). Collaborators from other institutions also contribute to leadership and development of PISCO programs. As of 2005, core PISCO activities are funded by collaborative grants from The David and Lucile Packard Foundation and the Gordon and Betty Moore Foundation. Core support, along with additional funding from diverse public and private sources, make this unique partnership possible.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0927255

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