Moorings temperature and pH from multiple sites in the California Current System starting 2008 (OMEGAS-MaS project, ACIDIC project)

Website: https://www.bco-dmo.org/dataset/3650
Data Type: Other Field Results
Version: 28 May 2015
Version Date: 2015-05-28

Project
» OCEAN ACIDIFICATION - Category 1: COLLABORATIVE RESEARCH: Acclimation and adaptation to ocean acidification of key ecosystem components in the California Current System (OMEGAS-MaS)
» Collaborative Research: The role of calcifying algae as a determinant of rocky intertidal macrophyte community structure at a meta-ecosystem scale (ACIDIC)

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)

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- Funding

Coverage

Spatial Extent: **N**:44.84 **E**:-120.61 **S**:34.72 **W**:-124.57
Temporal Extent: 2011-04-19 - 2014-06-16

Dataset Description

High frequency in-situ pH time series from Durafet-based sensors deployed in the intertidal zone.

pH records are derived from a Durafet-based sensor, custom designed and fabricated for intertidal deployment by Gernot Friederich (MBARI) for the OMEGAS project.

ISO_DateTime_GMT, GMT_Date, GMT_Time, Sensor Temperature (degrees C), pH (total scale)

Methods & Sampling

pH records are derived from a Durafet-based sensor, custom designed and fabricated for intertidal deployment by Gernot Friederich (MBARI) for the OMEGAS project.

Data Processing Description

Records from multiple deployments are merged into an annual file.
The data have been initially controlled to exclude out of deployment records and clear instance of sensor fouling.

BCO-DMO Processing Notes
Generated from original .csv files contributed by Francis Chan, Kristen Milligan and Ann Russell
- Date reformatted to BCO-DMO standard of YYYYMMDD
- Time reformatted to BCO-DMO standard of HHMMSS
- "nd" (no data) inserted into blank fields
- 20-Feb-2015: ISO_DateTime_UTC column added using the original date and time values provided by PI.
- Updated with 28May2015 final data

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Data Files

File
Moorings_Temp_pH.csv (Comma Separated Values (.csv), 46.57 MB) MD5:cd64fdd0f00e828c6d34c182d220984a Primary data file for dataset ID 3650

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Parameters

Parameter	Description	Units
Year	Year of Data	YYYY
Site	Mooring site text identifier	text
Latitude	Latitude of Station (South is Negative)	decimal degrees
Longitude	Longitude of Station (West is Negative)	decimal degrees
GMT_Date	Date of data (GMT)	YYYYMMDD
GMT_Time	Time of Data (GMT)	HHMMSS
GIFET_T	Temperature	degrees Celsius
GIFET_pH	pH	Total scale
Mooring_DataSet_Id	Mooring Dataset Id	text
ISO_DateTime_UTC	Date and time (UTC) formatted to ISO 8601:2004(E) standard. The standard takes on the form: YYYY-MM-DDTHH:MM:SS[.xx]Z where the T indicates the start of the time string and Z indicates UTC (example: 2009-08-30T14:05:00.00Z)	YYYY-MM-DDTHH:MM:SS[.xx]Z

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Instruments

Dataset-specific Instrument Name	DURAFET pH Sensor
Generic Instrument Name	pH Sensor
Dataset-specific Description	pH records are derived from a Durafet-based sensor, custom designed and fabricated for intertidal deployment by Gernot Friederich (MBARI) for the OMEGAS project
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	SAMI-pH
Generic Instrument Name	pH Sensor
Dataset-specific Description	SAMI-pH
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	Seafet-pH
Generic Instrument Name	SeapHOx/SeaFET
Dataset-specific Description	Seafet-pH
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	Water Temperature Sensor
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).

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Deployments

OMEGAS-FCKX00-GIFET

Website	https://www.bco-dmo.org/deployment/58808
Platform	PISCO Fogarty Creek Intertidal Long-Term Ecological Research Site
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2011-04-17
End Date	2020-01-01
Description	Intertidal (surf-zone) station See also: OMEGAS moorings site page

OMEGAS-IBODXX-GIFET

Website	https://www.bco-dmo.org/deployment/58893
Platform	Bodega Head State Marine Reserve Intertidal Long-Term Ecological Research Site
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2011-05-20
End Date	2020-01-01
Description	Intertidal (surf-zone) station See also: OMEGAS moorings site page

OMEGAS-ILOLXX-GIFET

Website	https://www.bco-dmo.org/deployment/58894
Platform	PISCO Lompoc Landing Intertidal Long-Term Ecological Research Site
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2011-05-05
End Date	2020-01-01
Description	Intertidal (surf-zone) station See also: OMEGAS moorings site page

OMEGAS-ITRPXX-GIFET

Website	https://www.bco-dmo.org/deployment/58895
Platform	PISCO Terrace Point Intertidal Long-Term Ecological Research Site
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2011-05-05
End Date	2020-01-01
Description	Intertidal (surf-zone) station See also: OMEGAS moorings site page

OMEGAS-IVDPXX-GIFET

Website	https://www.bco-dmo.org/deployment/58896
Platform	Van Damme State Park Intertidal Long-Term Ecological Research Site
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2011-05-09
End Date	2020-01-01
Description	Intertidal (surf-zone) station See also: OMEGAS moorings site page

OMEGAS-SHLX00-GIFET

Website	https://www.bco-dmo.org/deployment/58807
Platform	PISCO Strawberry Hill Intertidal Long-Term Ecological Research Site
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2011-04-17
End Date	2020-01-01
Description	Intertidal (surf-zone) station See also: OMEGAS moorings site page

OMEGAS-IHOPXX-GIFET

Website	https://www.bco-dmo.org/deployment/472472
Platform	PISCO-OMEGAS Hopkins Ecological Research Site
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2012-04-24
End Date	2020-01-01
Description	Intertidal (surf-zone) station See also: OMEGAS moorings site page

OMEGAS-ICMDXX-GIFET

Website	https://www.bco-dmo.org/deployment/511596
Platform	PISCO Cape Mendocino Ecological Time-Series Station
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2011-05-22
End Date	2020-01-01
Description	Intertidal (surf-zone) station See also: OMEGAS moorings site page

OMEGAS-CARX00-GIFET

Website	https://www.bco-dmo.org/deployment/58809
Platform	PISCO Cape Arago Ecological Time-Series Station
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2008-04-01
End Date	2020-01-01
Description	surf-zone PAR, chlorophyll fluorescence, and temperature sensors

OMEGAS-ISOPXX-GIFET

Website	https://www.bco-dmo.org/deployment/559904
Platform	PISCO Soberanes Ecological Time-Series Station
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2013-04-01
End Date	2020-01-01
Description	surf-zone PAR, chlorophyll fluorescence, and temperature sensors

OMEGAS-CBLX00-GIFET

Website	https://www.bco-dmo.org/deployment/511592
Platform	PISCO Cape Blanco Ecological Time-Series Station
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2012-08-21
End Date	2020-01-01
Description	Intertidal (surf-zone) station See also: OMEGAS moorings site page NOTE: This platform/deployment is shared with the ACIDIC Project as well.

OMEGAS-KHLX00-GIFET

Website	https://www.bco-dmo.org/deployment/511600
Platform	Kibesillah Hill Ecological Time-Series Station
Report	http://omegas.science.oregonstate.edu/?q=sites
Start Date	2012-04-11
End Date	2020-01-01
Description	Intertidal (surf-zone) station See also: OMEGAS moorings site page

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Project Information

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.

Collaborative Research: The role of calcifying algae as a determinant of rocky intertidal macrophyte community structure at a meta-ecosystem scale (ACIDIC)

Coverage: US West Coast; North bounding latitude: 45.00N, South bounding latitude: 38.00N

Algal Communities in Distress: Impacts and Consequences (ACIDIC)

Environmental stress models have recently been modified to incorporate the influence of facilitation to join negative effects such as predation, competition, and abiotic stress as determinants of community structure. Nevertheless, our empirical understanding of the processes that regulate the expression of facilitation effects

across systems and the potential for facilitation to amplify or dampen the ecological consequences of climate change remains limited. This project focuses on facilitation dynamics in the broader meta-ecosystem concept, which hypothesizes that variation among communities depends not only on locally-varying species interactions and impacts of abiotic factors such as environmental stress and physical disturbance but also on regionally- and globally-varying ecosystem processes such as dispersal and flows of materials such as nutrients and carbon. The investigators will study the influence of a potentially critical facilitative interaction between coralline algal turfs and canopy-forming macrophytes including kelps and surfgrass in a rocky intertidal meta-ecosystem. The research will be conducted in a climate change context, with a focus on how the macrophyte-coralline interaction is influenced by ocean conditions, including factors driven by variable upwelling (temperature, nutrients, phytoplankton abundance, and light) and increases in ocean acidification, which vary in a mosaic pattern along the coast of the northern California Current (NCC) in Oregon and northern California.

The goal of the project is to test the hypothesis that the coralline turf-macrophyte canopy interaction is a cardinal interaction in the determination of low rocky intertidal community structure, and that disruption of this interaction would dramatically alter the structure and function of this kelp- and surfgrass-dominated assemblage. The project will take advantage of, and enhance, a research platform established across 17 sites spanning ~800 km in the NCC coastal meta-ecosystem with prior NSF funding that will at each site: (1) quantify ocean conditions, including temperature, nutrients, phytoplankton, light (PAR), and carbonate chemistry to document the response of community structure oceanographic variation across a meta ecosystem mosaic; (2) carry out field experiments testing the nature of the interaction between coralline algal turfs (primarily Corallina vancouveriensis) and dominant canopy species, the kelp Saccharina sessile and the surfgrass Phyllospadix scouleri; and (3) carry out laboratory experiments focusing on the mechanism of the interaction, specifically testing the effects of carbonate chemistry, light, temperature, and nutrients. Component (1) will employ both remote sensors deployed in the intertidal (fluorometers, thermal sensors, PAR sensors, and a recently developed pH sensor) and direct sampling (nutrients, phytoplankton, pCO2, and pH) to quantify the in situ exposure regime of benthic primary producers to resources, energy, and environmental stress across spatial scales. These metrics will be combined with a newly developed index for quantifying local-scale variation in upwelling intensity to characterize the linkages between climate forcing and ecosystem state. Coupling oceanography with our field and laboratory experiments will provide unique and valuable insights into how the current state of rocky intertidal ecosystems is likely to be altered in the future.

Intellectual Merit. The project will contribute one of the first studies to test the community consequences of varying upwelling and CO2 across an ecosystem scale. How these factors alter the direct and indirect interactions of key species is of fundamental importance in our efforts to learn how field ecosystems will respond to climate change. Such knowledge is crucial to our efforts to manage and conserve marine communities facing human-induced variation in climate.

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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-1041260
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041222
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041089
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041240
NSF Division of Ocean Sciences (NSF OCE)	OCE-1061233
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041244
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041229
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041075
NSF Division of Ocean Sciences (NSF OCE)	OCE-1220372
NSF Division of Ocean Sciences (NSF OCE)	OCE-1220363
NSF Division of Ocean Sciences (NSF OCE)	OCE-1220412
NSF Division of Ocean Sciences (NSF OCE)	OCE-1220338
NSF Division of Ocean Sciences (NSF OCE)	OCE-1519401

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