Methane concentrations from depths of 5 to 175 meters at Station ALOHA collected during Hawaii Ocean Time-Series cruises between 2008 and 2016

Website: https://www.bco-dmo.org/dataset/713965
Data Type: Cruise Results
Version: 1
Version Date: 2017-08-28

Project
» [Current] Hawaii Ocean Time-series (HOT): 2023-2028; [Previous] Hawaii Ocean Time-series (HOT): Sustaining ocean ecosystem and climate observations in the North Pacific Subtropical Gyre (HOT)

Programs
» U.S. Joint Global Ocean Flux Study (U.S. JGOFS)
» Ocean Time-series Sites (Ocean Time-series)
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
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Abstract
Discrete seawater samples for methane (CH4) and nitrous oxide (N2O) analyses were collected at Station ALOHA as part of the near-monthly Hawaii Ocean Time-series (HOT) cruises from December 2008 to November 2016. For the majority of this observational period, single samples were collected from eight depths (5, 25, 45, 75, 100, 125, 150, and 175 meters) with collection of replicate samples on discrete occasions and periodically extending the vertical profiles to a depth of 1000 meters.

Table of Contents

Coverage

Location: Station ALOHA (circle of 6 mile radius in the Pacific Ocean north of Hawaii)
Spatial Extent: **Lat**:22.75 **Lon**:-158
Temporal Extent: 2008-12-01 - 2016-11-27

Dataset Description

Methane concentrations (depths of 5-175 m) at Station ALOHA (2008-2016). This dataset includes temperature, salinity, depth, density, atmospheric methane, theoretical methane concentration, and measured methane concentration.

Methods & Sampling

The following describes the methodology for both this dataset (methane) as well as the nitrous oxide dataset because the analyses were completed concurrently. Please see Related Datasets section below for N2O results.

Water sampling
Samples were collected using specially-designed 12L Niskin® bottles connected to a rosette with a Sea-Bird SBE 911Plus CTD package integrated into the system. The bottles were designed by John Bullister (NOAA Pacific Marine Environmental Laboratory (PMEL)) to specifically minimize contamination for trace gases, in particular chlorofluorocarbons and sulfur hexafluoride (Bullister and Wisegarver, 2008). Seawater was dispensed using Tygon® tubing from the bottles into the bottom of 240 mL borosilicate bottles to at least two times overflowing ensuring the absence of bubbles.

Sample preservation
The samples were preserved using 200 microliters of saturated mercuric chloride solution, crimp-sealed and stored in the dark at room temperature until analysis.

Analysis
Analysis of methane (CH_4) and nitrous oxide (N_2O) was conducted simultaneously using a gas chromatography method (del Valle & Karl, 2014; Wilson et al., 2014), typically 1 to 6 months after sample collection. Briefly, the water sample was transferred under positive pressure (supplied by helium gas) from the glass vials to a purge chamber fitted with a porous frit. The sample was then purged with ultra-high purity helium and the gas stream passed through a Nafion® dryer (Perma Pure LLC) and a Drierite® trap (VWR) to remove water vapor and then passed through an Ascarite trap to remove CO_2, before being trapped on a packed sample loop (Porapak Q 80/100; Sigma-Aldrich) immersed in liquid nitrogen. After sparging for 10 minutes, the sample loop was heated and injected onto an analytical column (30 m x 0.32 mm GS-CarbonPLOT capillary column; J&W Scientific) within a gas chromatograph (Agilent 7890A) equipped with a flame ionization detector (FID) and an electron capture detector (ECD). The carrier flow was alternated from the FID to the ECD using a Dean's switch® (Agilent Technologies) which allowed the quantification of both CH_4 and N_2O from a single sample. The oven temperature was typically maintained at 38°C, although this subsequently was decreased to 30°C in August 2016 to better resolve the CH_4 peak when partial overlap with an O_2 peak occurred.

Calibration
Calibration of the analytical system was conducted using gaseous standards purchased from Scott-Marin (CH_4: 20.15 ± 1% ppmv; N_2O: 4.81 ± 2% ppmv in a balance of N2) and NOAA (CH_4: 1965.32 ppbv; N2O: 357.56 ppbv in a balance of air). From March 2016 onwards, the calibration for CH_4 and N_2O was compared against reference standards prepared by John Bullister at NOAA PMEL on behalf of SCOR Working Group #143. In all instances, standards were injected prior to the purge and trap set-up and therefore passed through the purge chamber and gas drying apparatus. A linear curve was applied to the CH_4 calibration values and a polynomial curve was fitted to the N_2O calibration values.

Precision and Accuracy
The precision of CH_4 measurements for surface seawater with concentrations of 2.57 ± 0.07 (SD) nmol kg^{-1} (n=14), as calculated by the coefficient of variation, was 3%. The accuracy of CH_4 measurements was evaluated by analyzing filtered (0.2 µm) seawater samples that had been equilibrated with atmospheric air at a range of set temperatures between 19–27°C which were maintained using a water bath. The measured values agreed to within 2.4 ± 0.9% of predicted values. The precision of N_2O measurements in surface seawater, with concentrations of 6.47 ± 0.14 (SD) nmol kg^{-1} (n=14), as calculated by the coefficient of variation was 2%. Using the same air-equilibrated seawater set-up, as described for CH_4, the accuracy of N_2O measurements was 2.6 ± 1.9% of predicted values.

Calculation

The sea-air flux (F, µmol m^{-2} d^{-1}) of CH_4 and N_2O was calculated as :

$$F = k\,(Cw - Ceq)$$

where k is the gas transfer velocity (m d^{-1}), Cw is the ambient concentration of the gas dissolved in water (µmol m^{-3}), and Ceq is the concentration of the gas at equilibrium with the atmosphere. Ceq was determined from the solubility equations for N_2O (Weiss and Price, 1980) and for CH_4 (Wiesenburg & Guinasso, 1979), and using the atmospheric concentrations measured at the NOAA Mauna Loa Observatory and available online from NOAA's Global Monitoring Laboratory (Lan & Keeling, 2025; Dlugokencky et al., 2016). The wind speed data, used to calculate k, for January 2009 to May 2016 were taken from the Woods Hole Oceanographic Institution-Hawaii Ocean Time-series Site (WHOTS) mooring (Upper Ocean Processes Group, 2024) and normalized to a height of 10 meters above sea surface (Smith, 1988). The wind data from July–December 2016 derive from the Blended Sea Winds data product for the coordinates 22°45' N and 158°00' W (Zhang et al., 2006). k was determined for each gas using the wind speed parameterization of Wanninkhof (2014) and the Schmidt numbers for each gas, calculated using the updated empirical temperature dependence formulations (Wanninkhof, 2014). To calculate the sea-air fluxes, the mean k value for the week prior to sample collection was used.

BCO-DMO Processing Description

* processing completed 2017-08-28 by Amber York. Updated in 2025 by Dana Gerlach.
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions (e.g. no spaces, slashes, special characters)
* converted latitude and longitude values to decimal degree values
* added column for ISO_DateTime_UTC converted from local date and time (HST time zone)
* removed extra decimal point for the salinity value in row 390

[table of contents | back to top]

Related Publications

Smith, S. D. (1988). Coefficients for sea surface wind stress, heat flux, and wind profiles as a function of wind speed and temperature. Journal of Geophysical Research: Oceans, 93(C12), 15467–15472. Portico. https://doi.org/10.1029/jc093ic12p15467 https://doi.org/10.1029/JC093iC12p15467
Methods

Wanninkhof, R. (2014). Relationship between wind speed and gas exchange over the ocean revisited. Limnology and Oceanography: Methods, 12(6), 351–362. doi:10.4319/lom.2014.12.351
Methods

Wiesenburg, D. A., & Guinasso, N. L. (1979). Equilibrium solubilities of methane, carbon monoxide, and hydrogen in water and sea water. Journal of Chemical & Engineering Data, 24(4), 356–360. https://doi.org/10.1021/je60083a006
Methods

Wilson, S. T., Ferrón, S., & Karl, D. M. (2017). Interannual Variability of Methane and Nitrous Oxide in the North Pacific Subtropical Gyre. Geophysical Research Letters, 44(19), 9885–9892. Portico. https://doi.org/10.1002/2017gl074458 https://doi.org/10.1002/2017GL074458
Results

Zhang, H.-M., Bates, J. J., & Reynolds, R. W. (2006). Assessment of composite global sampling: Sea surface wind speed. Geophysical Research Letters, 33(17). doi:10.1029/2006gl027086 https://doi.org/10.1029/2006GL027086
Methods

del Valle, D., & Karl, D. (2014). Aerobic production of methane from dissolved water-column methylphosphonate and sinking particles in the North Pacific Subtropical Gyre. Aquatic Microbial Ecology, 73(2), 93–105. https://doi.org/10.3354/ame01714
Methods

[table of contents | back to top]

Related Datasets

IsRelatedTo

Wilson, S. T., Karl, D. M., White, A. E. (2017) **Nitrous oxide concentrations from depths of 5 to 175 meters at Station ALOHA collected during Hawaii Ocean Time-Series cruises between 2008 and 2016.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2017-08-28 http://lod.bco-dmo.org/id/dataset/713977 [view at BCO-DMO]

Related Research

Dlugokencky, E. J., Lang, P. M., Crotwell, A. M., Mund, J. W., Crotwell, M. J., & Thoning, K. W. (2016). Atmospheric methane dry air mole fractions from the NOAA ESRL Carbon Cycle Cooperative Global Air Sampling Network, 1983–2015, Version: 2017–01-09, Path: ftp://aftp.cmdl.noaa.gov/data/trace_gases/ch4/flask/surface https://hdl.handle.net/10013/epic.51033

Lan, X., & Keeling, R. (2025, January 3). Trends in atmospheric carbon dioxide (CO_2). NOAA Global Monitoring Laboratory. Retrieved August 5, 2025, from https://gml.noaa.gov/ccgg/trends/data.html

Upper Ocean Processes Group. (2024, December 5). Project WHOTS – WHOI Hawaii Ocean Time-series Station: WHOTS Data (Real-time meteorological data). Woods Hole Oceanographic Institution. http://uop.whoi.edu/currentprojects/WHOTS/whotsdata.html

Zhang, H.-M., Bates, J. J., & Reynolds, R. W. (2006). NOAA/NCEI Blended Global Sea Surface Winds [Subset with coordinates 22°45' N and 158°00' W]. NOAA National Centers for Environmental Information. Retrieved from https://www.ncei.noaa.gov/products/blended-sea-winds

[table of contents | back to top]

Parameters

Parameter	Description	Units
Cruise_ID	Cruise identifier	unitless
HOT_cruise_ID	Hawai'i Ocean Time-Series cruise identifier	unitless
Latitude	Latitude of sampling location	decimal degrees
Longitude	Longitude of sampling location	decimal degrees
Station	Station number	unitless
Cast	Cast number	unitless
Bottle	Bottle number	unitless
Depth	Sample depth	meters (m)

ISO_DateTime_UTC	Datetime of sampling in ISO8601 standard format	unitless
Temperature	Temperature from CTD at the time the bottle was tripped	degrees Celsius
Salinity	Salinity from CTD at time the bottle was tripped	Practical Salinity Units (PSU)
Density	Potential Density calculated using the CTD temperature and salinities	kilograms per meter cubed (kg/m3)
Oxygen	Dissolved oxygen from CTD at time bottle was tripped	micromoles per kilogram (umol/kg)
Atmos_CH4_MLO_flask	Atmospheric methane (CH4) concentration from MLO flask (data from the Mauna Loa Keeling Observatory).	mole fraction (ppb)
Atmos_CH4_KUM_flask	Atmospheric methane (CH4) from KUM flask (sea-level samples from Cape Kumukahi, Pahoa)	mole fraction (ppb)
Theoretical_CH4_conc_MLO	Theoretical (or expected equilibrium) methane (CH4) concentration in water determined using the solubility equations of Wiesenburg & Guinasso (1979) and the atmospheric concentrations measured at the NOAA Mauna Loa Observatory (Dlugokencky et al., 2016)	nanomoles per kilogram (nmol/kg)
Measured_CH4_conc	Measured methane (CH4) concentration using gas chromatography	nanomoles per kilogram (nmol/kg)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Ascarite trap
Generic Instrument Name	Ascarite trap
Dataset-specific Description	The sample was purged with ultra-high purity helium and the gas stream passed through an Ascarite trap to remove CO2.
Generic Instrument Description	An Ascarite trap is a gas purification device used to remove carbon dioxide (CO_2) from gas streams. It contains Ascarite®, a solid chemical absorbent—typically sodium hydroxide (NaOH) coated on a solid support like silica—that chemically reacts with CO_2 and traps it.

Dataset-specific Instrument Name	water sampling bottles to reduce trace gas contamination
Generic Instrument Name	Bottle
Dataset-specific Description	These Niskin-like bottles were designed by John Bullister (NOAA Pacific Marine Environmental Laboratory (PMEL)) to specifically minimize contamination for trace gases, in particular chlorofluorocarbons and sulfur hexafluoride (Bullister and Wisegarver, 2008).
Generic Instrument Description	A container, typically made of glass or plastic and with a narrow neck, used for storing drinks or other liquids.

Dataset-specific Instrument Name	water bath
Generic Instrument Name	circulating water bath
Dataset-specific Description	The seawater samples were maintained at temperatures between 19 and 27 degrees Celsius using a water bath.
Generic Instrument Description	A device designed to regulate the temperature of a vessel by bathing it in water held at the desired temperature. [Definition Source: NCI]

Dataset-specific Instrument Name	Sea-Bird SBE 911Plus
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Dean’s switch® (Agilent Technologies)
Generic Instrument Name	Dean's switch
Dataset-specific Description	The carrier flow was alternated from the FID to the ECD using a Dean’s switch® (Agilent Technologies) which allowed the quantification of both CH4 and N2O from a single sample.
Generic Instrument Description	A Dean's switch is a type of flow-switching device used in gas chromatography (GC) to divert or direct carrier gas and analyte streams between different paths—typically toward different detectors or traps. The Dean's switch is named after James R. Dean, a researcher who described a method for thermally controlled flow switching in gas chromatography during the 1960s and 70s.

Dataset-specific Instrument Name	Drierite® trap (VWR)Drierite® trap (VWR)
Generic Instrument Name	Drierite trap
Dataset-specific Description	The gas stream was passed through a Drierite® trap (VWR) to remove water vapor
Generic Instrument Description	A Drierite trap is a laboratory gas drying device that uses a trademarked desiccant (Drierite®) designed to remove moisture (water vapor) from gas streams, ensuring that sensitive instruments and processes receive dry, purified gases. These traps are particularly useful in applications like gas chromatography, environmental monitoring, and gas sampling.

Dataset-specific Instrument Name	flame ionization detector (FID) on gas chromatograph
Generic Instrument Name	Flame Ionization Detector
Dataset-specific Description	A gas chromatograph (GC) Agilent 7890A was equipped with a flame ionization detector (FID) and an electron capture detector (ECD). The carrier flow was alternated from the FID to the ECD using a Dean’s switch® (Agilent Technologies) which allowed the quantification of both CH4 and N2O from a single sample.
Generic Instrument Description	A flame ionization detector (FID) is a scientific instrument that measures the concentration of organic species in a gas stream. It is frequently used as a detector in gas chromatography. Standalone FIDs can also be used in applications such as landfill gas monitoring, fugitive emissions monitoring and internal combustion engine emissions measurement in stationary or portable instruments.

Dataset-specific Instrument Name	gas chromatograph (GC) Agilent 7890A
Generic Instrument Name	Gas Chromatograph
Generic Instrument Description	Instrument separating gases, volatile substances, or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay. (from SeaDataNet, BODC)

Dataset-specific Instrument Name	Nafion® dryer (Perma Pure LLC) trap
Generic Instrument Name	Nafion dryer
Dataset-specific Description	The gas stream was passed through a Nafion® dryer (Perma Pure LLC) to remove water vapor.
Generic Instrument Description	A Nafion dryer is a type of gas or vapor drying device that uses a special perfluorosulfonic acid polymer membrane—known as Nafion®—to remove water vapor (humidity) from gas streams. It is commonly used in laboratories and industrial processes to dry gases like air, hydrogen, nitrogen, and carbon dioxide without altering their chemical composition. See also: https://www.chromservis.eu/en/nafion-dryers

[table of contents | back to top]

Deployments

KM0822

Website	https://www.bco-dmo.org/deployment/59007
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2008-11-29
End Date	2008-12-03
Description	HOT - Cruise Schedules, Chief Scientist Reports and Cast Sheets Cruise information and original data are available from the NSF R2R data catalog.

KN195-07

Website	https://www.bco-dmo.org/deployment/59010
Platform	R/V Knorr
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2009-04-27
End Date	2009-05-01
Description	HOT - Cruise Schedules, Chief Scientist Reports and Cast Sheets

KOK0909

Website	https://www.bco-dmo.org/deployment/59011
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2009-05-26
End Date	2009-05-30
Description	HOT - Cruise Schedules, Chief Scientist Reports and Cast Sheets Cruise information and original data are available from the NSF R2R data catalog.

KM0915

Website	https://www.bco-dmo.org/deployment/59012
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2009-07-02
End Date	2009-07-06
Description	HOT - Cruise Schedules, Chief Scientist Reports and Cast Sheets Cruise information and original data are available from the NSF R2R data catalog.

KM0918

Website	https://www.bco-dmo.org/deployment/59013
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2009-07-23
End Date	2009-07-27
Description	HOT - Cruise Schedules, Chief Scientist Reports and Cast Sheets Cruise information and original data are available from the NSF R2R data catalog.

KM0920

Website	https://www.bco-dmo.org/deployment/59014
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2009-08-17
End Date	2009-08-21
Description	HOT - Cruise Schedules, Chief Scientist Reports and Cast Sheets Cruise information and original data are available from the NSF R2R data catalog.

KOK0916

Website	https://www.bco-dmo.org/deployment/59015
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2009-09-23
End Date	2009-09-27
Description	HOT - Cruise Schedules, Chief Scientist Reports and Cast Sheets Cruise information and original data are available from the NSF R2R data catalog.

KOK0917

Website	https://www.bco-dmo.org/deployment/59016
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2009-11-02
End Date	2009-11-06
Description	HOT - Cruise Schedules, Chief Scientist Reports and Cast Sheets Cruise information and original data are available from the NSF R2R data catalog.

KOK0920

Website	https://www.bco-dmo.org/deployment/59017
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2009-12-08
End Date	2009-12-12
Description	HOT - Cruise Schedules, Chief Scientist Reports and Cast Sheets Cruise information and original data are available from the NSF R2R data catalog.

KM1015

Website	https://www.bco-dmo.org/deployment/731500
Platform	R/V Kilo Moana
Start Date	2010-08-06
End Date	2010-08-10

KM1017

Website	https://www.bco-dmo.org/deployment/731815
Platform	R/V Kilo Moana
Start Date	2010-09-02
End Date	2010-09-02

KM1019

Website	https://www.bco-dmo.org/deployment/731862
Platform	R/V Kilo Moana
Start Date	2010-10-02
End Date	2010-10-06

TN258

Website	https://www.bco-dmo.org/deployment/947844
Platform	R/V Thomas G. Thompson
Start Date	2010-11-20
End Date	2010-11-22
Description	Project: Hawaii Ocean Timeseries (HOT), Cruise 227 Original cruise data are available from the NSF R2R data catalog: https://www.rvdata.us/search/cruise/TN258

KM1108

Website	https://www.bco-dmo.org/deployment/731928
Platform	R/V Kilo Moana
Start Date	2011-02-27
End Date	2011-03-03
Description	Project: Hawaii Ocean Timeseries (HOT), Cruise 230

KM1113

Website	https://www.bco-dmo.org/deployment/731963
Platform	R/V Kilo Moana
Start Date	2011-04-10
End Date	2011-04-14

KOK1107

Website	https://www.bco-dmo.org/deployment/947840
Platform	R/V Ka`imikai-O-Kanaloa
Start Date	2011-05-08
End Date	2011-05-12
Description	HOT-232 Cruise report found at https://hahana.soest.hawaii.edu/hot

KOK1205

Website	https://www.bco-dmo.org/deployment/59098
Platform	R/V Ka`imikai-O-Kanaloa
Start Date	2012-05-29
End Date	2012-06-02
Description	In the summer of 2012, C-MORE conducted a "continuous" long-term field experiment at Station ALOHA to observe and interpret temporal variability in microbial processes, and the consequences for ecological dynamics and biogeochemical cycling. Special focus was given to time-space coupling because proper scale sampling of the marine environment is an imperative, but generally neglected aspect of marine microbiology. Hawaii Ocean Experiment - Dynamics of Light and Nutrients (HOE-DYLAN)

KM1213

Website	https://www.bco-dmo.org/deployment/59100
Platform	R/V Kilo Moana
Start Date	2012-06-25
End Date	2012-06-29
Description	In the summer of 2012, C-MORE conducted a "continuous" long-term field experiment at Station ALOHA to observe and interpret temporal variability in microbial processes, and the consequences for ecological dynamics and biogeochemical cycling. Special focus was given to time-space coupling because proper scale sampling of the marine environment is an imperative, but generally neglected aspect of marine microbiology. Hawaii Ocean Experiment - Dynamics of Light and Nutrients (HOE-DYLAN)

KM1216

Website	https://www.bco-dmo.org/deployment/59102
Platform	R/V Kilo Moana
Start Date	2012-07-30
End Date	2012-08-03
Description	In the summer of 2012, C-MORE conducted a "continuous" long-term field experiment at Station ALOHA to observe and interpret temporal variability in microbial processes, and the consequences for ecological dynamics and biogeochemical cycling. Special focus was given to time-space coupling because proper scale sampling of the marine environment is an imperative, but generally neglected aspect of marine microbiology. Hawaii Ocean Experiment - Dynamics of Light and Nutrients (HOE-DYLAN)

KM1218

Website	https://www.bco-dmo.org/deployment/59104
Platform	R/V Kilo Moana
Start Date	2012-08-16
End Date	2012-08-20
Description	In the summer of 2012, C-MORE conducted a "continuous" long-term field experiment at Station ALOHA to observe and interpret temporal variability in microbial processes, and the consequences for ecological dynamics and biogeochemical cycling. Special focus was given to time-space coupling because proper scale sampling of the marine environment is an imperative, but generally neglected aspect of marine microbiology. Hawaii Ocean Experiment - Dynamics of Light and Nutrients (HOE-DYLAN)

KM1220

Website	https://www.bco-dmo.org/deployment/59106
Platform	R/V Kilo Moana
Start Date	2012-09-13
End Date	2012-09-17
Description	In the summer of 2012, C-MORE conducted a "continuous" long-term field experiment at Station ALOHA to observe and interpret temporal variability in microbial processes, and the consequences for ecological dynamics and biogeochemical cycling. Special focus was given to time-space coupling because proper scale sampling of the marine environment is an imperative, but generally neglected aspect of marine microbiology. Hawaii Ocean Experiment - Dynamics of Light and Nutrients (HOE-DYLAN)

KM1419

Website	https://www.bco-dmo.org/deployment/949113
Platform	R/V Kilo Moana
Start Date	2014-09-13
End Date	2014-09-17
Description	Project: Hawaii Ocean Timeseries (HOT), Cruise 265

SKQ201615S

Website	https://www.bco-dmo.org/deployment/700776
Platform	R/V Sikuliaq
Report	http://dmoserv3.whoi.edu/data_docs/ProEco/cs288.pdf
Start Date	2016-11-25
End Date	2016-11-29

KOK1005

Website	https://www.bco-dmo.org/deployment/965818
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2010-03-08
End Date	2010-03-12

KOK1007

Website	https://www.bco-dmo.org/deployment/965824
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2010-04-05
End Date	2010-04-09

KOK1011

Website	https://www.bco-dmo.org/deployment/965832
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2010-05-17
End Date	2010-05-21

KOK1013

Website	https://www.bco-dmo.org/deployment/965840
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2010-06-07
End Date	2010-06-11

KM1012

Website	https://www.bco-dmo.org/deployment/965848
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2010-07-07
End Date	2010-07-11

KM1102A

Website	https://www.bco-dmo.org/deployment/965856
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2011-01-27
End Date	2011-01-31

KM1120

Website	https://www.bco-dmo.org/deployment/965864
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2011-07-18
End Date	2011-07-22

KM1124

Website	https://www.bco-dmo.org/deployment/965872
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2011-08-29
End Date	2011-09-01

KM1127

Website	https://www.bco-dmo.org/deployment/965879
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2011-09-25
End Date	2011-09-28

KOK1113

Website	https://www.bco-dmo.org/deployment/965886
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2011-11-03
End Date	2011-11-07

KOK1114

Website	https://www.bco-dmo.org/deployment/965894
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2011-11-27
End Date	2011-12-01

KM1131

Website	https://www.bco-dmo.org/deployment/965901
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2011-12-18
End Date	2011-12-22

KOK1201

Website	https://www.bco-dmo.org/deployment/965907
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2012-01-17
End Date	2012-01-21

KM1205

Website	https://www.bco-dmo.org/deployment/965915
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2012-03-23
End Date	2012-03-27

KOK1202

Website	https://www.bco-dmo.org/deployment/965922
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2012-04-30
End Date	2012-05-04

KM1223

Website	https://www.bco-dmo.org/deployment/965930
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2012-10-06
End Date	2012-10-10

KM1227

Website	https://www.bco-dmo.org/deployment/965938
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2012-12-02
End Date	2012-12-06

KM1302

Website	https://www.bco-dmo.org/deployment/965946
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2013-02-11
End Date	2013-02-15

KM1305

Website	https://www.bco-dmo.org/deployment/965954
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2013-03-05
End Date	2013-03-09

TN294

Website	https://www.bco-dmo.org/deployment/965962
Platform	R/V Thomas G. Thompson
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2013-04-04
End Date	2013-04-08

KM1308

Website	https://www.bco-dmo.org/deployment/965970
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2013-05-16
End Date	2013-05-20

KM1311

Website	https://www.bco-dmo.org/deployment/965978
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2013-06-24
End Date	2013-06-28

KM1315

Website	https://www.bco-dmo.org/deployment/965986
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2013-09-10
End Date	2013-09-14

KM1317

Website	https://www.bco-dmo.org/deployment/965994
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2013-09-30
End Date	2013-10-04

KM1319

Website	https://www.bco-dmo.org/deployment/966002
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2013-10-26
End Date	2013-10-30

KM1321

Website	https://www.bco-dmo.org/deployment/966010
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2013-11-25
End Date	2013-11-29

KM1323

Website	https://www.bco-dmo.org/deployment/966018
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2013-12-19
End Date	2013-12-23

KM1402

Website	https://www.bco-dmo.org/deployment/966026
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2014-01-14
End Date	2014-01-18

KM1406

Website	https://www.bco-dmo.org/deployment/966034
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2014-02-13
End Date	2014-02-17

KM1408

Website	https://www.bco-dmo.org/deployment/966042
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2014-03-04
End Date	2014-03-08

KM1410

Website	https://www.bco-dmo.org/deployment/966050
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2014-04-09
End Date	2014-04-13

KOK1404

Website	https://www.bco-dmo.org/deployment/966058
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2014-05-30
End Date	2014-06-03

KM1414

Website	https://www.bco-dmo.org/deployment/966066
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2014-06-29
End Date	2014-07-03

KM1421

Website	https://www.bco-dmo.org/deployment/966074
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2014-10-12
End Date	2014-10-16

KM1425

Website	https://www.bco-dmo.org/deployment/966082
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2014-11-20
End Date	2014-11-24

KM1428

Website	https://www.bco-dmo.org/deployment/966090
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2014-12-15
End Date	2014-12-19

KOK1502

Website	https://www.bco-dmo.org/deployment/966098
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2015-02-23
End Date	2015-02-27

KOK1503

Website	https://www.bco-dmo.org/deployment/966106
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2015-03-27
End Date	2015-03-31

KM1504

Website	https://www.bco-dmo.org/deployment/966114
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2015-04-20
End Date	2015-04-24

KM1508

Website	https://www.bco-dmo.org/deployment/966122
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2015-05-22
End Date	2015-05-26

KM1510

Website	https://www.bco-dmo.org/deployment/966130
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2015-06-18
End Date	2015-06-22

KM1512

Website	https://www.bco-dmo.org/deployment/966138
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2015-07-18
End Date	2015-07-22

KOK1508

Website	https://www.bco-dmo.org/deployment/966146
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2015-08-11
End Date	2015-08-15

KOK1515

Website	https://www.bco-dmo.org/deployment/966154
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2015-10-12
End Date	2015-10-16

KM1518

Website	https://www.bco-dmo.org/deployment/966162
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2015-11-12
End Date	2015-11-16

KOK1516

Website	https://www.bco-dmo.org/deployment/966168
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2015-12-07
End Date	2015-12-11

KM1601

Website	https://www.bco-dmo.org/deployment/966175
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2016-01-11
End Date	2016-01-15

KM1602

Website	https://www.bco-dmo.org/deployment/966182
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2016-02-08
End Date	2016-02-12

KM1603

Website	https://www.bco-dmo.org/deployment/966190
Platform	R/V Kilo Moana
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2016-03-07
End Date	2016-03-11

KOK1605

Website	https://www.bco-dmo.org/deployment/700778
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://dmoserv3.whoi.edu/data_docs/ProEco/cs283.pdf
Start Date	2016-04-13
End Date	2016-04-17
Description	Note the cruise report identifies this cruise as KOK16-04. KOK16-04 was the intial cruise ID but it was changed to KOK16-05 after completion of the cruise do to changes in the ship's schedule.

OC1605B

Website	https://www.bco-dmo.org/deployment/966203
Platform	R/V Oceanus
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2016-05-27
End Date	2016-05-31

KOK1608

Website	https://www.bco-dmo.org/deployment/966211
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2016-07-10
End Date	2016-07-14

KOK1611

Website	https://www.bco-dmo.org/deployment/966219
Platform	R/V Ka`imikai-O-Kanaloa
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2016-08-08
End Date	2016-08-12

OC1610A

Website	https://www.bco-dmo.org/deployment/966227
Platform	R/V Oceanus
Report	http://hahana.soest.hawaii.edu/hot/cruises.html
Start Date	2016-10-14
End Date	2016-10-18

[table of contents | back to top]

Project Information

[Current] Hawaii Ocean Time-series (HOT): 2023-2028; [Previous] Hawaii Ocean Time-series (HOT): Sustaining ocean ecosystem and climate observations in the North Pacific Subtropical Gyre (HOT)

Website: https://hahana.soest.hawaii.edu/hot/

Coverage: North Pacific Subtropical Gyre; 22 deg 45 min N, 158 deg W

Hawai'i Ocean Time-Series Project Summary
This continuing award for the HOT research program sustains the open-ocean climatology of biological, chemical, and physical observations into a 4th decade.

Intellectual Merit
The scientific mission of HOT continues to be monitoring of temporal dynamics in the cycling of carbon and associated bioelements, and observations of the variability of hydrological and ecological properties, heat fluxes, and circulation of the North Pacific Subtropical Gyre (NPSG). The proposed research will rely on shipboard observations and experiments conducted on 10 separate 5-day expeditions per annum along with near-continuous moored platform measurements of air-sea interactions, ocean mixing, and physical characteristics of the deep sea. The HOT program maintains the high-quality suite of biogeochemical and physical measurements required for continued assessment of dynamics in ocean carbon and nutrient pools and fluxes, plankton community structure, ecosystem productivity, and inherent optical properties of the water column. Continuity of these observations improves the value of the dataset for deciphering how low-frequency natural and anthropogenic climate signals influence ecosystem structure in the NPSG as well as providing up-to-date measurements to place current signals in the longer-term context. Such efforts will continue to aid on-going modeling efforts required for predicting how future habitat perturbations may influence ecosystem dynamics in the NPSG. All HOT program data are publicly available and are frequently used by researchers and policy makers around the world. HOT data provide reference baselines for essential ocean variables, allow for characterization of natural patterns of ocean system variability and associated links to regional climate indices, and support calibration/validation of autonomous in situ and remote (satellite, airborne) sensors.

Broader Impacts
The long-term, continuous HOT data are critical to assess variability on seasonal to decadal time-scales and thus are essential to determine the emergence of anthropogenic signals in the oligotrophic North Pacific. Further sustaining HOT measurements will strengthen our capacity to test hypotheses about poorly understood interactions between ocean dynamics, climate, and biogeochemistry and increase the value of HOT data for understanding the response of ocean ecosystems to both natural and anthropogenic climate perturbations. Over the next 5 years, we will continue to promote the value of HOT research through high quality, high visibility peer-reviewed journal and book articles, newspaper and newsletter articles, and community outreach. With partners BCO-DMO and OceanSITES we will also continue to strive for a FAIR data model (see data management plan) as metadata standards and conventions evolve in the community. We will continue working with an Earthcube Research Coordination Network for Marine Ecological Time Series (METS) to support efforts that bring together different cross-sections of METS data producers, data users, data scientists, and data managers in large- and small-group formats to foster the necessary dialog to develop FAIR data solutions across multiple time-series. In addition, HOT is a community resource that helps support the research of numerous ocean scientists who rely on the program's infrastructure (ship time, staff, laboratories,

equipment) to conduct their research, education, and outreach activities. Moreover, HOT PIs maintain a strong commitment to mentoring and training of undergraduate and graduate students, and will continue these activities as well as facilitates access to the sea by a number of ancillary students and scientists.

NSF Award Abstract:

Long-term observations of ocean physics, biology, and chemistry across decades provide a powerful lens for understanding the response of the oceans to environmental change. This award will continue the Hawaii Ocean Time-series (HOT) research program, which began in 1988, for an additional five years. Continuity of these observations will improve the value of the dataset for deciphering how natural and human-influenced climate signals affect ecosystem structure in the Pacific Ocean. All HOT program data are publicly available and are frequently used by researchers and policy makers around the world. HOT also serves as (1) a testbed for the development of new sensors and methodologies, (2) a calibration/validation site, (3) an invaluable training ground that attracts students and researchers from around the globe, and (4) a forum for international collaboration and capacity building.

The proposed research will rely on shipboard observations and experiments conducted on ten separate five-day expeditions per year along with near-continuous moored platform measurements of air-sea interactions, ocean mixing, and physical characteristics of the deep sea. Observations include biogeochemical and physical measurements required for continued assessment of dynamics in ocean carbon and nutrient pools and fluxes, plankton community structure, ecosystem productivity, and inherent optical properties of the water column. The major program goals and objectives over the next 5 years remain as in prior years and include: (1) sustain high quality, time-resolved oceanographic measurements on the interactions between ocean-climate and ecosystem variability in the North Pacific Subtropical Gyre (NPSG), (2) quantify time-varying (seasonal to decadal) changes in reservoirs and fluxes of carbon and associated bioelements (nitrogen, phosphorus, and silicon), (3) constrain processes controlling air-sea carbon exchange, rates of carbon transformation through the planktonic food web, and fluxes of carbon into the ocean's interior, (4) extend to 40 years a climatology of hydrographic and biogeochemical dynamics from which to gauge anomalous or extreme changes to the NPSG habitat, forming a multi-decadal baseline from which to decipher natural and anthropogenic influences on the NPSG ecosystem, (5) continue to provide scientific and logistical support to ancillary programs that benefit from the temporal context, interdisciplinary science, and regular access to the open sea afforded by HOT program occupation of Station ALOHA, including projects implementing, testing, and validating new methodologies and transformative ocean sampling technologies, and (6) provide unique training and educational opportunities for the next generation of ocean scientists.

[table of contents | back to top]

Program Information

U.S. Joint Global Ocean Flux Study (U.S. JGOFS)

Website: http://usjgofs.whoi.edu/

Coverage: Global

The United States Joint Global Ocean Flux Study was a national component of international JGOFS and an integral part of global climate change research.

The U.S. launched the Joint Global Ocean Flux Study (JGOFS) in the late 1980s to study the ocean carbon cycle. An ambitious goal was set to understand the controls on the concentrations and fluxes of carbon and associated nutrients in the ocean. A new field of ocean biogeochemistry emerged with an emphasis on quality measurements of carbon system parameters and interdisciplinary field studies of the biological, chemical and physical process which control the ocean carbon cycle. As we studied ocean biogeochemistry, we learned that our simple views of carbon uptake and transport were severely limited, and a new "wave" of ocean science was born. U.S. JGOFS has been supported primarily by the U.S. National Science Foundation in collaboration with the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, the Department of Energy and the Office of Naval Research. U.S. JGOFS, ended in 2005 with the conclusion of the Synthesis and Modeling Project (SMP).

Ocean Time-series Sites (Ocean Time-series)

Coverage: Bermuda, Cariaco Basin, Hawaii

Program description text taken from Chapter 1: Introduction from the **Global Intercomparability in a Changing Ocean: An International Time-Series Methods Workshop** report published following the workshop held November 28-30, 2012 at the Bermuda Institute of Ocean Sciences. The full report is available from the workshop Web site hosted by US OCB: http://www.whoi.edu/website/TS-workshop/home

Decades of research have demonstrated that the ocean varies across a range of time scales, with anthropogenic forcing contributing an added layer of complexity. In a growing effort to distinguish between natural and human-induced earth system variability, sustained ocean time-series measurements have taken on a renewed importance. Shipboard biogeochemical time-series represent one of the most valuable tools scientists have to characterize and quantify ocean carbon fluxes and biogeochemical processes and their links to changing climate (Karl, 2010; Chavez et al., 2011; Church et al., 2013). They provide the oceanographic community with the long, temporally resolved datasets needed to characterize ocean climate, biogeochemistry, and ecosystem change.

The temporal scale of shifts in marine ecosystem variations in response to climate change are on the order of several decades. The long-term, consistent and comprehensive monitoring programs conducted by time-series sites are essential to understand large-scale atmosphere-ocean interactions that occur on interannual to decadal time scales. Ocean time-series represent one of the most valuable tools scientists have to characterize and quantify ocean carbon fluxes and biogeochemical processes and their links to changing climate.

Launched in the late 1980s, the US JGOFS (Joint Global Ocean Flux Study; http://usjgofs.whoi.edu) research program initiated two time-series measurement programs at Hawaii and Bermuda (HOT and BATS, respectively) to measure key oceanographic measurements in oligotrophic waters. Begun in 1995 as part of the US JGOFS Synthesis and Modeling Project, the CARIACO Ocean Time-Series (formerly known as the CArbon Retention In A Colored Ocean) Program has studied the relationship between surface primary production, physical forcing variables like the wind, and the settling flux of particulate carbon in the Cariaco Basin.

The objective of these time-series effort is to provide well-sampled seasonal resolution of biogeochemical variability at a limited number of ocean observatories, provide support and background measurements for process-oriented research, as well as test and validate observations for biogeochemical models. Since their creation, the BATS, CARIACO and HOT time-series site data have been available for use by a large community of researchers.

Data from those three US funded, ship-based, time-series sites can be accessed at each site directly or by selecting the site name from the Projects section below.

Ocean Carbon and Biogeochemistry (OCB)

Website: http://us-ocb.org/

Coverage: Global

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF.

The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems.

The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO2 and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two.

The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen conditions in the coastal and open oceans.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Biological Infrastructure (NSF DBI)	DBI-0424599
NSF Division of Ocean Sciences (NSF OCE)	OCE-1260164
Simons Foundation (Simons)	SCOPE 329108
Gordon and Betty Moore Foundation (GBMF)	GMBF3794

[table of contents | back to top]