Nitrous oxide concentrations (depths of 5-175 m) at Station ALOHA collected during Hawaii Ocean Time-Series cruises between 2008 and 2016 (HOT project)

Website: https://www.bco-dmo.org/dataset/713977 Data Type: Cruise Results Version: 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

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

Contributors	Affiliation	Role
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Coverage

Spatial Extent: Lat:22.75 Lon:-158 Temporal Extent: 2008-12-01 - 2016-11-27

Dataset Description

Nitrous oxide concentrations (depths of 5-175 m) at Station ALOHA (2008-2016). This dataset includes pressure, temperature, salinity, density, dissolved oxygen, N2O (atmospheric), N2O (equilibrium), and N2O (measured).

Related dataset: Methane concentrations at Station ALOHA

Methods & Sampling

The following describes the methodology for both this (N2O) dataset as well as the CH4 dataset since the analysis was done together. CH4 results can be found on the page: <u>Methane concentrations at Station ALOHA</u>

Calibration of the analytical system was conducted using gaseous standards purchased from Scott-Marin (CH4: 20.15 \pm 1% ppmv; N2O: 4.81 \pm 2% ppmv in a balance of N2) and NOAA (CH4: 1965.32 ppbv; N2O: 357.56 ppbv in a balance of air). From March 2016 onwards, the calibration for CH4 and N2O 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 CH4 calibration values and a polynomial curve was fitted to the N2O calibration values. The precision of CH4 measurements for surface seawater with concentrations of 2.57 \pm 0.07 (SD) nmol kg-1 (n=14), as calculated by the coefficient of variation was 3%. The accuracy of CH4 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 \pm 0.9% of predicted values. The precision of N2O measurements in surface seawater, with concentrations of 6.47 \pm 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 CH4, the accuracy of N2O measurements was 2.6 \pm 1.9% of predicted values.

Instruments:

For quantifying the dissolved gases, the analytical column (30 m x 0.32 mm GS-CarbonPLOT capillary column; J&W Scientific) was housed within a gas chromatograph (GC) 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 CH4 and N2O from a single sample.

Reference:

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, 9885–9892. https://doi.org/10.1002/2017GL074458

Data Processing Description

BCO-DMO Data Manager Processing Notes:

* 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)

- * blank values replaced with no data value 'nd'
- * changed name "Logitude" -> "Longitude"
- * changed lat lon (22.75 N, 158 W) to (28.45, -158)
- * added ISO_DateTime_UTC from HST date, time

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Data Files

File N2O.csv(Comma Separated Values (.csv), 72.05 KB) MD5:0a312c3ddab6fc029e3a1ae38d23b77d

Primary data file for dataset ID 713977

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Parameters

Parameter	Description	Units
Cruise_ID	Cruise identifier	unitless
HOT_cruise	Hawaiian Ocean Time-Series cruise identifier	unitless
Latitude	Latitude	unitless
Longitude	Longitude	unitless
Station	Station number	unitless
Cast	Cast number	unitless
Bottle	Bottle number	unitless
Press	Sample pressure	decibars
Date_HST	Local date (HST) in format yyyy-mm-dd	unitless
Time_HST	Local time (HST) in format HH:MM	unitless
ISO_DateTime_UTC	ISO timestamp based on the ISO 8601:2004(E) standard in format YYYY-mm-ddTHH:MMZ (UTC)	unitless
Temp	Temperature from CTD	degrees Celsius
Salinity	Salinity	Practical Salinity Units (PSU)
Density	Density	kilograms per meter cubed (kg/m3)
02	Dissolved oxygen	micromoles per kilogram (umol/kg)
Atmos_N2O	Nitrous oxide (N2O) (atmospheric) MLO flask	mole fraction (ppb)
N2O_equilib	Nitrous oxide (N2O) (equilibrium)	nanomoles per kilogram (nmol/kg)
N2O_measured	Nitrous oxide (N2O) (measured)	nanomoles per kilogram (nmol/kg)

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Instruments

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	gas chromatograph (GC) Agilent 7890A
Generic Instrument Name	Gas Chromatograph
Dataset- specific Description	For quantifying the dissolved gases, the analytical column (30 m x 0.32 mm GS-CarbonPLOT capillary column; J&W Scientific) was housed within a gas chromatograph (GC) 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 CH4 and N2O from a single sample.
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)

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Deployments

HOT_cruises

Website	https://www.bco-dmo.org/deployment/58879
Platform	Multiple Vessels
Report	http://hahana.soest.hawaii.edu/hot/
Start Date	1988-10-31
Description	Since October 1988, the Hawaii Ocean Time-series (HOT) program has investigated temporal dynamics in biology, physics, and chemistry at Stn. ALOHA (22°45' N, 158°W), a deep ocean field site in the oligotrophic North Pacific Subtropical Gyre (NPSG). HOT conducts near monthly ship-based sampling and makes continuous observations from moored instruments to document and study NPSG climate and ecosystem variability over semi-diurnal to decadal time scales.

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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 nearcontinuous 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 multidecadal 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.

Program Information

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.

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

Website: <u>http://usjgofs.whoi.edu/</u>

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: <u>http://www.whoi.edu/website/TS-workshop/home</u>

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; <u>http://usjgofs.whoi.edu</u>) 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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1260164

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