Sediment trap flux measurements for the Hawaii Ocean Time-Series (HOT) project from December 1988 to December 2023 at Station ALOHA

Website: https://www.bco-dmo.org/dataset/737393
Data Type: Cruise Results
Version: 3
Version Date: 2025-02-19

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)
» Ocean Time-series Sites (Ocean Time-series)

Contributors	Affiliation	Role
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Abstract
This dataset presents 35 years of particle flux measurements from Hawaii Ocean Time-Series (HOT) cruises during December 1988 to December 2023 at Station ALOHA in the Pacific Ocean north of Hawaii. Particle flux was measured at a standard reference depth using multiple cylindrical particle interceptor traps deployed on a free-floating array for approximately 60 hours during each cruise. Sediment trap design and collection methods are described in Winn et al. (1991). Passively sinking particulate matter was collected, prescreened (335 µm) to remove zooplankton and micronekton carcasses, then the sample materials analyzed for particulate carbon, nitrogen, phosphorus, silica, and mass flux.

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Coverage

Location: Station ALOHA in the Pacific Ocean north of Hawai'i
Spatial Extent: **Lat**:22.75 **Lon**:-158
Temporal Extent: 1988-12-01 - 2023-12-31

Dataset Description

Monthly measurements of particle flux were collected at Station ALOHA as part of the HOT program. Passively sinking particulate matter is intercepted using a free-floating sediment trap array. After screening the collected materials to remove zooplankton and micronekton carcasses, portions of the remaining sample are analyzed for C, N, P and biogenic-Si flux.

Methods & Sampling

Particle flux was measured at a standard reference depth of 150 meters using multiple cylindrical particle interceptor traps deployed on a free-floating array for approximately 60 hours during each cruise. Sediment trap design and collection methods are described in Winn et al. (1991). Passively sinking particulate matter is collected, prescreened (335 µm) to remove zooplankton and micronekton carcasses, then the sample materials are analyzed for C, N, P and mass flux (mg m-2 d-1). Samples were analyzed for particulate carbon (PC), nitrogen (PN), phosphorus (PP), and silica (PSi). Typically six traps are analyzed for PC and PN, three for PP, and another three traps for PSi.

A summary of methodology is listed below. Full details can be found at the HOT Field & Laboratory Protocols page or below in Related Publications section (Karl et al., and HOT Program Sediment Trap Protocols: Chapter 18)

1. Principle
Although most of the particulate matter both on the seafloor and in suspension in seawater is very fine, evidence suggests that most of the material deposited on the benthos arrives via relatively rare, rapidly sinking large particles (McCave, 1975). Therefore, in order to describe adequately the ambient particle field and to understand the rates and mechanisms of biogeochemical cycling in the marine environment, it is imperative to employ sampling methods that enable the investigator to distinguish between the suspended and sinking pools of particulate matter. This universal requirement for a careful and comprehensive analysis of sedimenting particles has resulted in the development, evaluation and calibration of a variety of *in situ* particle collectors or sediment traps. The results, after nearly a decade of intensive field experiments, have contributed significantly to our general understanding of: (1) the relationship between the rate of primary production and downward flux of particulate organic matter, (2) mesopelagic zone oxygen consumption and nutrient regeneration, (3) biological control of the removal of abiogenic particles from the surface ocean and (4) seasonal and interannual variations in particle flux to the deep-sea. Future sediment trap studies will, most likely, continue to provide novel and useful data on the rates and mechanisms of important biogeochemical processes.

At Station ALOHA, we initially deployed a free-drifting sediment trap array with 12 individual collectors positioned at 150, 300 and 500 meters. The deployment period was approximately 72 hours. The passively sinking particles were subsequently analyzed for a variety of chemical properties, including C, N, P, biogenic-Si and total mass. From HOT-64 to present, the traps were deployed at a single reference depth (150 meters) for a period of approximately 48-60 hours. Routine mass-flux measurements were discontinued at HOT-68.

We presently deploy a free-drifting sediment trap array with 12 individual collectors positioned at 150, 300 and 500 m. The deployment period is generally 72 hours. The passively sinking particles are subsequently analyzed for a variety of chemical properties, including: total mass, C, N and P.

2. Precautions
Because particle fluxes in oligotrophic habitats are expected to be low, special attention must be paid to the preparation of individual sediment trap collector tubes so that they are clean and free of dust and other potentially contaminating particles. Traps should be capped immediately after filling and immediately after retrieval. Attention should be paid to airborne and/or shipboard particulate contamination sources. In addition, the time interval between trap retrieval and subsample filtration should be minimized in order to limit the inclusion of extraneous abiotic particles and the post-collection solubilization of particles.

3. Field Operations
Hardware
The HOT program free-floating sediment trap array is patterned after the MULTITRAP system (Knauer et al., 1979) and used extensively in the decade-long VERTEX program. Twelve individual sediment trap collectors (0.0039 m2 mouth opening) are deployed at 150 meters depth. The traps are affixed to a PVC cross that is attached to 1/2" Spectra line. The traps are tracked using XEOS and Argos satellite transmitters, VHF radio, and strobe lights. Since HOT-71 (April 1996) both the trap array configuration and the deployment period were

altered to conserve ship time.

Trap solutions
Prior to deployment, each trap is cleaned with 1 M HCl, rinsed thoroughly with deionized water then filled with a high-density solution to prevent advective-diffusive loss of extractants and preservatives during the deployment period and to eliminate flushing of the traps during recovery (Knauer et al., 1979). The trap solution is prepared by adding 50 g of NaCl to each liter of surface seawater. This brine solution is gravity filtered through a 0.2 µm filter cartridge after the addition of 10 ml per liter 100% formalin solution. Individual traps are filled and at least 10 liters of the trap solution is saved for analysis of solution blanks.

Post-recovery processing
Upon recovery, individual traps are capped and transported to the shipboard portable laboratory for analysis. Care is taken not to mix the higher density trap solutions with the overlying seawater. Trap samples are processed from deep to shallow in order to minimize potential contamination. The depth of the interface between the high density solution and overlying seawater is marked on each trap and a second mark is made 5 cm above the interface. The overlying seawater is then aspirated with a plastic tube attached to a vacuum system to the upper mark in order to avoid disturbing the high density solution below. Because some sinking particulate material collects near the interface between the high density solution and the overlying seawater, the overlying seawater is removed only to a depth that is 5 cm above the previously identified interface.

After the overlying seawater has been removed from all the traps at a given depth, the contents of each trap is gently mixed to disrupt large amorphous particles and then passed through an acid rinsed 335 µm NitexR screen to remove contaminating zooplankton and micronekton which entered the traps in a living state and are not truly part of the passive flux. The traps are rinsed with a portion of the <335 µm sample in order to recover all particulate matter, and the 335 µm NitexR screen is examined to determine whether residual material, in addition to the so-called "swimmers", is present. If so, the screens are rinsed again with a portion of the 335 µm filtrate. After all traps from the same depth have been processed, the 335 µm screen is removed and placed into a vial containing 20 ml of formalin-seawater solution, and stored at 4°C for subsequent microscopic examination and organism identification and enumeration.

4. Determination of C, N, P and biogenic-Si Flux
The quantities of particulate C, N, P and biogenic silica in the screened trap solutions are determined using methods described in the chapters for Particulate Carbon and Nitrogen, Particulate Phosphorus, and Particulate Biogenic Silica in the HOT protocols document (*see Related Publications section below*). Six replicate traps are used for C/N determinations and three additional traps for P. Typically, 1.5 to 2 liters are used for a single C/N or P measurement, and a subsample of 250 mL for Si. An equivalent volume of the time-zero sediment trap solution, filtered through the appropriate filters is used as a C, N or P blank

Addendum - PPO4 protocol (April 7, 2015)
The method used for the analysis of particulate phosphate (PPO4) has been modified and applied to samples analyzed from November 2011 (HOT 236) to the present. The previous protocol was in use over at least the previous 10-year period. The modified procedure included vortexing of the sample prior to a longer leaching time (1 hour versus 30 min) of the GFF filter in 0.15 N HCl at room temperature.

Both the previous and modified procedures were tested in paired analyses on samples collected over one year (12 cruises). The modified procedure resulted in higher yields by approximately 50% for water column samples (integrated 0-100 m: old method 1.00±0.27 mmol P m-2, versus 1.56±0.14 mmol P m-2) and approximately 30% for P-flux estimated from sediment trap samples (old method: 0.31±0.07 mg P m-2 d-1 versus 0.40±0.09 mg P m-2 d-1).

Key to Treatment indicator:

- C = Solutions from individual traps combined and replicate subsamples drawn from this solution;
- I = Individual traps sampled as replicates;
- W = Swimmers picked out before analysis;
- O = Some other (special) treatment.

Data Processing Description

Calculations

C, N, P and biogenic-Si flux is calculated as follows:

$$\text{mg C (or N, P) m-2 d-1} = \frac{[(Cs-Cb)] * Vt}{Vf * 0.0039 * t}$$

where:

- Cs = carbon (mg) in sample
- Cb = carbon (mg) in blank
- Vt = volume of trap (liters)
- Vf = volume filtered (liters)
- 0.0039 = cross-sectional area of trap (m2)
- t = deployment period (d)

BCO-DMO Processing Description

- Imported data from source files "hot335-339.flux" and "hot334-339.flux" file into the BCO-DMO data system.
- Missing data identifiers of -9, -9.0 replaced with blank cells
- Concatenated the new data files to the version 2 data and ordered by cruise/date
- Added column for original datafile name
- Added columns for latitude and longitude of Station ALOHA.
- Combined separate Date and Time columns into single ISO8601 datetime format for local (HST) and UTC time zones

Problem Description

Please note that particle flux data was not collected on every cruise. Deployment of the sediment trap did not occur in bad weather or if there were safety concerns. The following cruises do NOT have particle flux data: HOT-12, 21, 25, 42, 43, 48, 59, 61, 87, 88, 133, 138, 144, 151, 161, 177, 190, 204, 207, 218, 219, 227, 234, 235, 237, 238, 276, 278, 279, 280, 283, 288, 290, 293, 299, 300, 301, 303, 308, 317, 318, and HOT-334.

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Data Files

File
737393_v3_hot_particle_flux.csv (Comma Separated Values (.csv), 95.03 KB) MD5:bebc626ca7bd4b33e4d1ce16da441c60 Primary data file for dataset ID 737393, version 3

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Related Publications

Fujieki, L., F. Santiago-Mandujano, C. Fumar, R. Lukas and M. Church. (2015) Hawaii Ocean Time-series Program Data Report 24: 2012.
Results
,
Methods

Hawai'i Ocean Time-Series (HOT) Program Field and Laboratory Protocols. Chapter 18: Sediment Trap Protocols Free-Floating Array. https://hahana.soest.hawaii.edu/hot/protocols/protocols.html?Chapter=18#

Methods

Karl, D., Winn, C., Hebel, D., and Letelier, R. Hawai'i Ocean Time-Series Program Field and Laboratory Protocols. https://hahana.soest.hawaii.edu/hot/protocols/protocols.html#
Methods

Knauer, G. A., Martin, J. H., & Bruland, K. W. (1979). Fluxes of particulate carbon, nitrogen, and phosphorus in the upper water column of the northeast Pacific. Deep Sea Research Part A. Oceanographic Research Papers, 26(1), 97–108. doi:10.1016/0198-0149(79)90089-x https://doi.org/10.1016/0198-0149(79)90089-X
Methods

McCave, I. N. (1975). Vertical flux of particles in the ocean. Deep Sea Research and Oceanographic Abstracts, 22(7), 491–502. doi:10.1016/0011-7471(75)90022-4
Methods

Nielsen, E. S. (1952). The Use of Radio-active Carbon (C14) for Measuring Organic Production in the Sea. ICES Journal of Marine Science, 18(2), 117–140. doi:10.1093/icesjms/18.2.117
Methods

Scharek, R., Tupas, L., & Karl, D. (1999). Diatom fluxes to the deep sea in the oligotrophic North Pacific gyre at Station ALOHA. Marine Ecology Progress Series, 182, 55–67. https://doi.org/10.3354/meps182055
Methods

Winn, C., C. Sabine, D. Hebel, F. Mackenzie and D. M. Karl. (1991) Inorganic carbon system dynamics in the central Pacific Ocean: Results of the Hawaii Ocean Time-series program. EOS, Transactions of the American Geophysical Union 72, 70.
Results

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Parameters

Parameter	Description	Units
Cruise	Cruise ID (HOT ID) for Hawaii Ocean Timeseries program	unitless
Latitude	Latitude	decimal degrees
Longitude	Longitude	decimal degrees
Start_ISO_DateTime_UTC	Start datetime in ISO 8601 format in UTC	unitless
End_ISO_DateTime_UTC	End datetime in ISO 8601 format in UTC	unitless
Depth	Depth	meters
Treatment	Treatment of the sample (C=Solutions from individual traps combined and replicate subsamples drawn from this solution; I=Individual traps sampled as replicates; W=Swimmers picked out before analysis; O=Some other treatment)	unitless
Carbon_flux	Carbon flux	milligrams per square meter per day (mg/m^2/d)

Carbon_sd_diff	Either standard deviation or difference. If num replicates >= 3, then std dev. If num reps = 2, then difference	milligrams per square meter per day (mg/m^2/d)
Carbon_numreps	Number of replicate carbon samples collected for replicate analysis	unitless
Nitrogen_flux	Nitrogen flux	milligrams per square meter per day (mg/m^2/d)
Nitrogen_sd_diff	Either standard deviation or difference. If num replicates >= 3, then std dev. If num reps = 2, then difference	milligrams per square meter per day (mg/m^2/d)
Nitrogen_numreps	Number of replicate nitrogen samples collected for replicate analysis	unitless
Phosphorus_flux	Phosphorus flux	milligrams per square meter per day (mg/m^2/d)
Phosphorus_sd_diff	Either standard deviation or difference. If num replicates >= 3, then std dev. If num reps = 2, then difference	milligrams per square meter per day (mg/m^2/d)
Phosphorus_numreps	Number of replicate phosphorus samples collected for replicate analysis	unitless
Mass_flux	Mass flux	milligrams per square meter per day (mg/m^2/d)
Mass_sd_diff	Either standard deviation or difference. If num replicates >= 3, then std dev. If num reps = 2, then difference	milligrams per square meter per day (mg/m^2/d)
Mass_numreps	Number of replicate mass samples collected for replicate analysis	unitless
Silica_flux	Silica flux	milligrams per square meter per day (mg/m^2/d)
Silica_sd_diff	Either standard deviation or difference. If num replicates >= 3, then std dev. If num reps = 2, then difference	milligrams per square meter per day (mg/m^2/d)
Silica_numreps	Number of replicate silica samples collected for replicate analysis	unitless
Delta_15N	Delta-15N of particulate nitrogen (permil vs air-N2)	permil vs. air-N2

Delta_15N_sd_diff	Either standard deviation or difference. If num replicates >= 3, then std dev. If num reps = 2, then difference	permil vs. air-N2
Delta_15N_numreps	Number of replicate nitrogen isotope samples for replicate analysis	unitless
Delta_13C	Delta-13C of particulate carbon (permil vs. VPDB)	permil vs. VPDB
Delta_13C_sd_diff	Either standard deviation or difference. If num replicates >= 3, then std dev. If num reps = 2, then difference	permil vs. VPDB
Delta_13C_numreps	Number of replicate carbon isotope samples for replicate analysis	unitless
PIC_flux	Particulate Inorganic Carbon flux	milligrams per square meter per day (mg/m^2/d)
PIC_sd_diff	Either standard deviation or difference. If num replicates >= 3, then std dev. If num reps = 2, then difference	milligrams per square meter per day (mg/m^2/d)
PIC_numreps	Number of replicate PIC samples collected for replicate analysis	unitless
filename	Original filename of particle flux data from HOT	unitless
StartTime_local_HST	Start datetime in local time zone (HST, GMT-10)	unitless
EndTime_local_HST	End datetime in local time zone (HST, GMT-10)	unitless
Cruise_num	Cruise number (same as Cruise ID, but numerical)	unitless

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Instruments

Dataset-specific Instrument Name	PE-2400 Carbon/Nitrogen analyzer with integrator
Generic Instrument Name	Particulate Organic Carbon/Nitrogen Analyzer
Dataset-specific Description	PE-2400 Carbon/Nitrogen analyzer with integrator
Generic Instrument Description	A unit that accurately determines the carbon and nitrogen concentrations of organic compounds typically by detecting and measuring their combustion products (CO_2 and NO).

Dataset-specific Instrument Name	Cahn electronic microbalance
Generic Instrument Name	scale or balance
Dataset-specific Description	Cahn electronic microbalance
Generic Instrument Description	Devices that determine the mass or weight of a sample.

Dataset-specific Instrument Name	sediment trap array
Generic Instrument Name	Sediment Trap
Dataset-specific Description	sediment trap array (spar buoy, radiotransmitter, strobe light, floats, trap supports, collector tubes)
Generic Instrument Description	Sediment traps are specially designed containers deployed in the water column for periods of time to collect particles from the water column falling toward the sea floor. In general a sediment trap has a jar at the bottom to collect the sample and a broad funnel-shaped opening at the top with baffles to keep out very large objects and help prevent the funnel from clogging. This designation is used when the specific type of sediment trap was not specified by the contributing investigator.

Dataset-specific Instrument Name	spectrophotometer and 1-cm cuvette
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	spectrophotometer (Perkin-Elmer Lambda 3B) and 1-cm cuvette
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

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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.

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

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

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

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

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

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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 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.

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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: 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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0926766
NSF Division of Ocean Sciences (NSF OCE)	OCE-1260164
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756517
NSF Division of Ocean Sciences (NSF OCE)	OCE-2241005
NSF Division of Ocean Sciences (NSF OCE)	OCE-0752606
NSF Division of Ocean Sciences (NSF OCE)	OCE-0327513
NSF Division of Ocean Sciences (NSF OCE)	OCE-0326616
NSF Division of Ocean Sciences (NSF OCE)	OCE-9617409

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