

Sediment trap flux measurements from the Hawaii Ocean Time-Series (HOT) project at station ALOHA.

Website: <https://www.bco-dmo.org/dataset/737393>

Data Type: Cruise Results

Version: 1

Version Date: 2018-04-25

Project

» [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)

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Abstract

Particle flux measurements from the Hawaii Ocean Time-Series (HOT). Particle flux was measured at a standard reference depth of 150 m using multiple cylindrical particle interceptor traps deployed on a free-floating array for approximately 60 h during each cruise. Sediment trap design and collection methods are described in Winn et al. (1991). Samples were analyzed for particulate C, N, P & Si. Typically six traps are analyzed for PC and PN, three for PP, and another three traps for PSi.

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Coverage

Spatial Extent: Lat:22.75 Lon:-158

Dataset Description

Monthly measurements of particle flux were collected at station ALOHA as part of the HOT program.

Acquisition Description

Particle flux was measured at a standard reference depth of 150 m using multiple cylindrical particle interceptor traps deployed on a free-floating array for approximately 60 h during each cruise. Sediment trap design and collection methods are described in Winn et al. (1991). Samples were analyzed for particulate C, N, P & Si. Typically six traps are analyzed for PC and PN, three for PP, and another three traps for PSi.

The information below has been copied from the HOT Field & Laboratory Protocols page, found at <http://hahana.soest.hawaii.edu/hot/protocols/protocols.html#> (last visited on 2018-05-23).

SUMMARY: Passively sinking particulate matter is collected using a free-floating sediment array and, after prescreening (335 μm) to remove zooplankton and micronekton carcasses, the sample materials are analyzed for C, N, P and mass flux ($\text{mg m}^{-2} \text{d}^{-1}$).

1. Principle

Although most of the particulate matter both on the seafloor and in suspension in seawater is very fine, recent 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 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. Pay particular attention 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

3.1.

Hardware

Our free-floating sediment trap array is patterned after the MULTITRAP system pioneered by Knauer et al. (1979) and used extensively in the decade-long VERTEX program. Twelve individual sediment trap collectors (0.0039 m²) are typically deployed at three depths (150, 300 and 500 m). The traps are affixed to a PVC cross attached to 1/2" polypropylene line. The traps are tracked using VHF radio and Argos satellite transmitters and strobelights. Typically we deploy our traps for a period of 72 hours each cruise.

3.2.

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 pressure filtered sequentially through a 1.0 and 0.5 µm filter cartridge prior to the addition of 10 ml 100% formalin I-1. Individual traps are filled and at least 10 l of the trap solution is saved for analysis of solution blanks (see sections 4.1

and 5.1).

3.3.

Post-recovery processing

3.3.1.

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.

3.3.2.

The depth of the interface between the high density solution and overlying seawater is marked on each trap. The overlying seawater is then aspirated with a plastic tube attached to a vacuum system in order to avoid disturbing the high density solution. 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.

3.3.3.

After the overlying seawater has been removed from all the traps at a given depth, the contents of each trap is 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. Immediately before this sieving process, the contents of each trap are mixed to disrupt large amorphous particles. The traps are rinsed with a portion of the $<335 \mu\text{m}$ 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 a given 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 Mass Flux

4.1.

Three of the 12 traps deployed at each water depth are used for the determination of mass flux. At our shore-based laboratory, triplicate 250 ml subsamples of the time-zero high density trap solution (blank) and equivalent volumes individual traps (start with the deepest depth and work up), are vacuum filtered through tared 25 mm 0.2 μm Nuclepore membrane filters (see Chapter 18, sections 4.1.4 to 4.1.3). The tared filters are prepared as follows:

4.1.1.

Rinse filters three times with distilled water. Place rinsed filter on a 2.5 cm² foil square (to reduce static electricity) in a plastic 47 mm petri dish.

4.1.2.

Fold the foil in half over the filter and place the petri dish in a drying oven with the lid ajar for 2 hours at 55 °C. Remove and cool in dessicator for 30 minutes.

4.1.3.

Weigh filter to constant weight (i.e., repeat oven drying, cooling and weighing until a relative standard deviation of $<0.005\%$ is achieved), on a microbalance capable of $0.1\ \mu\text{g}$ resolution. Record weights (to the nearest $0.1\ \mu\text{g}$) on label tape placed on top of the petri dish.

4.2.

After the last of the sample has passed through the filter, the walls of the filter funnel are washed with three consecutive 5 ml rinses of an isotonic (1 M) ammonium formate solution to remove seawater salts. During each rinse, allow the ammonium formate solution to completely cover the filter.

4.3.

Return the processed filter to its petri dish, record sample number (on the dish and data sheet), and place in a drying oven at $55\ ^\circ\text{C}$ for 8 hours. Alternately, store in a dessicator, if an oven is not immediately available. Dry to constant weight (as in Chapter 18, section 4.1.3).

5. Determination of C, N and P Flux

5.1.

The quantities of particulate C, N and P in the prescreened trap solutions are determined using methods described in Chapters 10 and 11. Six replicate traps are used for C/N determinations and three additional traps for P. Typically, 1.5-2 liters are used for a single C/N or P measurement. 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 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).

Please see the HOT Data Report 2012 for more detail

Processing Description

Mass flux is calculated as follows:

$$\text{mg (dry wt.) m}^{-2} \text{ d}^{-1} = \frac{[(W_a - W_b) - W_{bl}] * V_t}{V_f * 0.0039 * 1000 * t}$$

where:

W_a = filter weight after filtration (μg)

W_b = filter weight before filtration (μg)

W_{bl} = net weight of blank solution (μg)

V_t = volume of trap (l)

V_f = volume filtered (l)

0.0039 = cross-sectional area of trap (m²)

1000 = conversion factor (μg mg⁻¹)

t = deployment period (d)

C, N and P flux is calculated as follows:

$$\text{mg C (or N, P) m}^{-2} \text{ d}^{-1} = \frac{[(C_s - C_b)] * V_t}{V_f * 0.0039 * t}$$

where:

C_s = carbon (mg) in sample

C_b = carbon (mg) in blank

V_t = volume of trap (liters)

V_f = volume filtered (liters)

0.0039 = cross-sectional area of trap (m²)

t = deployment period (d)

Please see HOT's ["Particle Flux Data Format Document"](#) for detailed description of original HOT data formatting, original parameter names and Quality Word definitions.

BCO-DMO Processing Notes:

- transferred the data from the University of Hawaii ftp site to the BCO-DMO servers.
- reformatted the data into csv.
- updated the version date in the served data to the date the data was updated.
- created ISO8601 start_date_time and end_date_time fields which were extracted from the Date and Start_time, End_time fields, respectively.
- appended latitude, longitude values as provided by University of Hawaii.

Related Publications

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

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)

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](https://doi.org/10.1016/0011-7471(75)90022-4)

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.

Parameters

Parameter	Description	Units
Carbon	Carbon	milligrams per square meter per day (mg/m ² /d)
Carbon_n	Number of replicate samples collected for replicate analysis.	unitless
Carbon_sd_diff	Standard Deviation presented where Carbon_n=3; Difference between replicate presented where Carbon_n=2	milligrams per square meter per day (mg/m ² /d)
Cruise	Cruise Number	unitless
Delta_13C	Delta-13C of PC (permil vs. VPDB)	permil vs. VPDB

Delta_13C_n	Number of replicate samples collected for replicate analysis.	unitless
Delta_13C_sd_diff	Standard Deviation presented where Delta_13C_n=3; Difference between replicate presented where Delta_13C_n=2	milligrams per square meter per day (mg/m2/d)
Delta_15N	Delta-15N of PN (permil vs. air-N2)	permil vs. air-N2
Delta_15N_n	Number of replicate samples collected for replicate analysis.	unitless
Delta_15N_sd_diff	Standard Deviation presented where Delta_15N_n=3; Difference between replicate presented where Delta_15N_n=2	milligrams per square meter per day (mg/m2/d)
Depth	Depth	meters (m)
lat	Latitude with South negative	decimal degrees
lon	Longitude with East negative	decimal degrees
Mass	Mass	milligrams per square meter per day (mg/m2/d)
Mass_n	Number of replicate samples collected for replicate analysis.	unitless
Mass_sd_diff	Standard Deviation presented where Mass_n=3; Difference between replicate presented where Mass_n=2	milligrams per square meter per day (mg/m2/d)

Nitrogen	Nitrogen	milligrams per square meter per day (mg/m ² /d)
Nitrogen_n	Number of replicate samples collected for replicate analysis.	unitless
Nitrogen_sd_diff	Standard Deviation presented where Nitrogen_n=3; Difference between replicate presented where Nitrogen_n=2	milligrams per square meter per day (mg/m ² /d)
P_flux_filename	Original filename of the particle flux data from HOT	unitless
Phosphorus_n	Number of replicate samples collected for replicate analysis.	unitless
Phosphorus	Phosphorus Addendum - PPO ₄ protocol (April 7 2015) The method used for the analysis of particulate phosphate (PPO ₄) has been modified and applied to samples analyzed 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). Please see the HOT Data Report 2012 for more detail.	milligrams per square meter per day (mg/m ² /d)
Phosphorus_sd_diff	Standard Deviation presented where Phosphorus_n=3; Difference between replicate presented where Phosphorus_n=2	milligrams per square meter per day (mg/m ² /d)

PIC_n	Number of replicate samples collected for replicate analysis.	unitless
PIC	Particulate Inorganic Carbon	milligrams per square meter per day (mg/m ² /d)
PIC_sd_diff	Standard Deviation presented where PIC_n=3; Difference between replicate presented where PIC_n=2	milligrams per square meter per day (mg/m ² /d)
Silica_n	Number of replicate samples collected for replicate analysis.	unitless
Silica_sd_diff	Standard Deviation presented where Silica_n=3; Difference between replicate presented where Silica_n=2	milligrams per square meter per day (mg/m ² /d)
Silica	Silica	milligrams per square meter per day (mg/m ² /d)
Treatment	C-Solutions from individual traps combined and replicate subsamples drawn from this solution. I-Individual traps sampled as replicates. W-Swimmers picked out before analyzed.O-Some other (special?) treatment.	unitless

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Instruments

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	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	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.

Dataset-specific Instrument Name	Cahn electronic microbalance
Generic Instrument Name	Scale
Dataset-specific Description	Cahn electronic microbalance
Generic Instrument Description	An instrument used to measure weight or mass.

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Deployments

HOT_cruises

Website	https://www.bco-dmo.org/deployment/58879
Platform	Unknown Platform
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

Hawaii Ocean Time-series (HOT): Sustaining ocean ecosystem and climate observations in the North Pacific Subtropical Gyre (HOT)

Website: http://hahana.soest.hawaii.edu/hot/hot_jgofs.html

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

Systematic, long-term observations are essential for evaluating natural variability of Earth's climate and ecosystems and their responses to anthropogenic disturbances. 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. HOT was founded to understand the processes controlling the time-varying fluxes of carbon and associated biogenic elements in the ocean and to document changes in the physical structure of the water column. To achieve these broad objectives, the program has several specific goals: Quantify time-varying (seasonal to decadal) changes in reservoirs and fluxes of carbon (C) and associated bioelements (nitrogen, oxygen, phosphorus, and silicon). Identify processes controlling air-sea C exchange, rates of C transformation through the planktonic

food web, and fluxes of C into the ocean's interior. Develop a climatology of hydrographic and biogeochemical dynamics from which to form a multi-decadal baseline from which to decipher natural and anthropogenic influences on the NPSG ecosystem. 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 Sta. ALOHA, including projects implementing, testing, and validating new methodologies, models, and transformative ocean sampling technologies. Over the past 24+ years, time-series research at Station ALOHA has provided an unprecedented view of temporal variability in NPSG climate and ecosystem processes. Foremost among HOT accomplishments are an increased understanding of the sensitivity of bioelemental cycling to large scale ocean-climate interactions, improved quantification of reservoirs and time varying fluxes of carbon, identification of the importance of the hydrological cycle and its influence on upper ocean biogeochemistry, and the creation of long-term data sets from which the oceanic response to anthropogenic perturbation of elemental cycles may be gauged. A defining characteristic of the NPSG is the perennially oligotrophic nature of the upper ocean waters. This biogeochemically reactive layer of the ocean is where air-sea exchange of climate reactive gases occurs, solar radiation fuels rapid biological transformation of nutrient elements, and diverse assemblages of planktonic organisms comprise the majority of living biomass and sustain productivity. The prevailing Ekman convergence and weak seasonality in surface light flux, combined with relatively mild subtropical weather and persistent stratification, result in a nutrient depleted upper ocean habitat. The resulting dearth of bioessential nutrients limits plankton standing stocks and maintains a deep (175 m) euphotic zone. Despite the oligotrophic state of the NPSG, estimates of net organic matter production at Sta. ALOHA are estimated to range ~1.4 and 4.2 mol C m² yr⁻¹. Such respectable rates of productivity have highlighted the need to identify processes supplying growth limiting nutrients to the upper ocean. Over the lifetime of HOT numerous ancillary science projects have leveraged HOT science and infrastructure to examine possible sources of nutrients supporting plankton productivity. Both physical (mixing, upwelling) and biotic (N₂ fixation, vertical migration) processes supply nutrients to the upper ocean in this region, and HOT has been instrumental in demonstrating that these processes are sensitive to variability in ocean climate. Station ALOHA - site selection and infrastructure

Station ALOHA is a deep water (~4800 m) location approximately 100 km north of the Hawaiian Island of Oahu. Thus, the region is far enough from land to be free of coastal ocean dynamics and terrestrial inputs, but close enough to a major port (Honolulu) to make relatively short duration (45 m depth), below depths of detection by Earth-orbiting satellites. The emerging data emphasize the value of in situ measurements for validating remote and autonomous detection of plankton biomass and productivity and demonstrate that detection of potential secular-scale changes in productivity against the backdrop of significant interannual and decadal fluctuations demands a sustained sampling effort. Careful long-term measurements at Stn. ALOHA also highlight a well-resolved, though relatively weak, seasonal climatology in upper ocean primary productivity. Measurements of ¹⁴C-primary production

document a ~3-fold increase during the summer months (Karl et al., 2012) that coincides with increases in plankton biomass (Landry et al., 2001; Sheridan and Landry, 2004). Moreover, phytoplankton blooms, often large enough to be detected by ocean color satellites, are a recurrent summertime feature of these waters (White et al., 2007; Dore et al., 2008; Fong et al., 2008). Analyses of ~13-years (1992-2004) of particulate C, N, P, and biogenic Si fluxes collected from bottom-moored deep-ocean (2800 m and 4000 m) sediment traps provide clues to processes underlying these seasonal changes. Unlike the gradual summertime increase in sinking particle flux observed in the upper ocean (150 m) traps, the deep sea particle flux record depicts a sharply defined summer maximum that accounts for ~20% of the annual POC flux to the deep sea, and appears driven by rapidly sinking diatom biomass (Karl et al., 2012). Analyses of the ¹⁵N isotopic signatures associated with sinking particles at Sta. ALOHA, together with genetic analyses of N₂ fixing microorganisms, implicates upper ocean N₂ fixation as a major control on the magnitude and efficiency of the biological carbon pump in this ecosystem (Dore et al., 2002; Church et al., 2009; Karl et al., 2012).

Motivating Questions

Science results from HOT continue to raise new, important questions about linkages between ocean climate and biogeochemistry that remain at the core of contemporary oceanography. Answers have begun to emerge from the existing suite of core program measurements; however, sustained sampling is needed to improve our understanding of contemporary ecosystem behavior and our ability to make informed projections of future changes to this ecosystem. HOT continues to focus on providing answers to some of the questions below: How sensitive are rates of primary production and organic matter export to short- and long-term climate variability? What processes regulate nutrient supply to the upper ocean and how sensitive are these processes to climate forcing? What processes control the magnitude of air-sea carbon exchange and over what time scales do these processes vary? Is the strength of the NPSG CO₂ sink changing in time? To what extent does advection (including eddies) contribute to the mixed layer salinity budget over annual to decadal time scales and what are the implications for upper ocean biogeochemistry? How do variations in plankton community structure influence productivity and material export? What processes trigger the formation and demise of phytoplankton blooms in a persistently stratified ocean ecosystem?

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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

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