234Th flux in epipelagic waters at Station ALOHA and the Equatorial Pacific from R/V Kilo Moana cruises KM1407, KM1418, & KM1515 during 2014-2015

Website: https://www.bco-dmo.org/dataset/806471
Data Type: Cruise Results
Version: 1
Version Date: 2020-03-19

Project
» Evaluating the relative importance of suspended and sinking particles to the meso and bathypelagic food web in the central North Pacific (SuspendSinkPart)
» Collaborative Research: Isotopic insights to mercury in marine food webs and how it varies with ocean biogeochemistry (Hg_Biogeochemistry)

Contributors	Affiliation	Role
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Abstract
234Th flux in epipelagic waters at Station ALOHA and the Equatorial Pacific from R/V Kilo Moana cruises KM1407, KM1418, & KM1515 during 2014-2015.

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Coverage

Spatial Extent: **N**:22 **E**:-155 **S**:5 **W**:-158
Temporal Extent: 2014-02-19 - 2015-09-08

Methods & Sampling

Total ^{234}Th was measured in samples of seawater collected at discrete depths using Niskin bottles as described in Umhau et al. (2019). Briefly, 2 L of seawater was collected at each selected depth. Samples were spiked with ^{230}Th as a yield tracer and acidified to pH ~ 1 using concentrated nitric acid. After equilibration, ~ 6 hours later, $KMnO_4$ and $MnCl_2$ were added and the pH adjusted to ~ 9 with concentrated NH_4OH in order to co-precipitate Th via the formation of MnO_2. After eight hours, total ^{234}Th samples were filtered onto 25 mm QMA filters, air dried, and frozen.

The ^{234}Th flux (dpm m^{-2} d^{-1}) was calculated from the ^{234}Th:^{238}U disequilibrium and assuming a steady state

(Umhau et al. 2019). The ^{234}Th flux at each depth was obtained by integrating the flux for the overlying depths using trapezoidal integration.

Thorium counts were made using a low level RISO beta counter within 2 weeks of sample collection.

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Data Files

File
234Th_flux.csv (Comma Separated Values (.csv), 1.80 KB) MD5:64485290821b63ad3923220b6d4522c8 Primary data file for dataset ID 806471

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Related Publications

Umhau, B. P., Benitez-Nelson, C. R., Close, H. G., Hannides, C. C. S., Motta, L., Popp, B. N., ... Drazen, J. C. (2019). Seasonal and spatial changes in carbon and nitrogen fluxes estimated using 234Th:238U disequilibria in the North Pacific tropical and subtropical gyre. Marine Chemistry, 217, 103705. doi:10.1016/j.marchem.2019.103705
Results

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Parameters

Parameter	Description	Units
Cruise	Cruise identifier	unitless
Date_initial	Sampling initial date (UTC); format: yyyy-mm-dd	unitless
Date_final	Sampling final date (UTC); format: yyyy-mm-dd	unitless
Site	Site identifier	unitless
Latitude	Latitude	degrees N
Longitude	Longitude	degrees W
Season	Season	unitless
Depth	Sampling depth	meters (m)
Th_flux	Integrated 234Th flux; BD = below detection	dpm m-2 d-1
Th_flux_error	Integrated 234Th flux error	dpm m-2 d-1

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Instruments

Dataset-specific Instrument Name	Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Total 234Th was measured in samples of seawater collected at discrete depths using Niskin bottles.
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	RISO beta counter
Generic Instrument Name	Riso Laboratory Anti-coincidence Beta Counter
Dataset-specific Description	Thorium counts were made using a low level RISO beta counter within 2 weeks of sample collection.
Generic Instrument Description	Low-level beta detectors manufactured by Riso (now Nutech) in Denmark. These instruments accept samples that can be mounted on a 25mm filter holder. These detectors have very low backgrounds, 0.17 counts per minute, and can have counting efficiencies as high as 55%. Typically used in laboratory analyses. Designed to measure low levels of beta particle emission. The systems work on the principle of anticoincidence.

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Deployments

KM1407

Website	https://www.bco-dmo.org/deployment/635932
Platform	R/V Kilo Moana
Start Date	2014-02-19
End Date	2014-02-28
Description	Original cruise data are available from the NSF R2R data catalog

KM1418

Website	https://www.bco-dmo.org/deployment/636002
Platform	R/V Kilo Moana
Start Date	2014-08-29
End Date	2014-09-11
Description	Original cruise data are available from the NSF R2R data catalog

KM1515

Website	https://www.bco-dmo.org/deployment/657964
Platform	R/V Kilo Moana
Start Date	2015-08-15
End Date	2015-09-12

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Project Information

Evaluating the relative importance of suspended and sinking particles to the meso and bathypelagic food web in the central North Pacific (SuspendSinkPart)

Coverage: Subtropical waters north of Hawaii; Station Aloha (22° 45'N, 158° 00'W)

Description from NSF award abstract:
The ocean's midwaters are the largest living space on the planet. The mesopelagic food web plays key roles in the biological carbon pump and the production of food for commercially harvested species, but its functioning is understudied because it is remote and technologically challenging to sample. Recent estimates indicate respiratory demand outstrips measured sinking particle supply by up to 2-3 orders of magnitude suggesting that some food inputs to the mesopelagic food web have been underestimated or missed. Suspended particles frequently are not sampled effectively and may be an overlooked food source. Because identifying the principal inputs of organic matter to the deep-sea food web is critical to understanding its function, the investigators propose to evaluate the relative importance of suspended and sinking particles to the meso- and bathypelagic food web in the central North Pacific. They will characterize the isotopic compositions of specific groups of mesopelagic and bathypelagic zooplankton and micronekton, and identify the extent to which they consume suspended or sinking particles using mass balance approaches. The investigators recently have recognized differences in delta 15N and delta 13C values of amino acids (AA) of sinking and suspended particles; these patterns diverge with depth, providing a means to distinguish between food web pathways. The research will define the source-specific isotopic values of suspended and sinking particles at several depths from the surface to the bathypelagic and test proposed microbial mechanisms driving these depth patterns. At corresponding depths, MOCNESS trawls will sample diverse metazoa: zooplankton size fractions, plus targeted resident, migrating and likely suspension-feeding taxa of zooplankton and micronekton. Preliminary data suggest that suspended particles are a secondary food source, containing less labile organic matter than sinking particles that exhibit a seasonal cycle in flux in the central North Pacific. This study will determine if suspended particles become more important to zooplankton and micronekton during a time of year when sinking particle flux is low (Jan/Feb) in comparison to when it is high (Aug), allowing an evaluation of how temporal change in surface ocean productivity affects the functioning of mesopelagic food webs.

Recent research has called for additional study of the ocean's deep midwaters. This study will provide new insights into the functioning of the meso- and bathypelagic food web and its coupling with surface ocean processes in the central North Pacific. The recently-demonstrated ecological tool of amino acid-specific isotopic analysis will provide a novel and comprehensive approach with which to address our hypotheses, and the project will develop the first AA isotopic dataset spanning particles to fish. Results will help identify the ecological underpinnings of increasing delta 15N values with depth in zooplankton -- apparently a common pattern. Zooplankton consumption of suspended particles also could constitute a mechanistic link between the microbial loop and higher trophic levels. The processes controlling the enormous attenuation of particle flux by mesopelagic consumers -- and thereby the strength of carbon sequestration to the deep ocean -- are not understood. Seasonal sampling will help us relate mesopelagic food web processes to changes in surface ocean productivity, furthering our understanding of future climate change impacts on deep-sea food webs and carbon flux. With regard to fisheries, many oceanic top predators such as tuna and swordfish feed on mesopelagic micronekton. A clearer understanding of the structure of mesopelagic food webs will help inform ecosystem models which are used to understand variation in fisheries production.

Collaborative Research: Isotopic insights to mercury in marine food webs and how it varies with ocean biogeochemistry (Hg_Biogeochemistry)

Coverage: Pacific Subtropical Gyre, Station ALOHA 22.75N 158W; equatorial Pacific (10N 155W, 5N 155W)

NSF award abstract:
Mercury is a pervasive trace element that exists in several states in the marine environment, including monomethylmercury (MMHg), a neurotoxin that bioaccumulates in marine organisms and poses a human health threat. Understanding the fate of mercury in the ocean and resulting impacts on ocean food webs requires understanding the mechanisms controlling the depths at which mercury chemical transformations occur. Preliminary mercury analyses on nine species of marine fish from the North Pacific Ocean indicated that intermediate waters are an important entry point for MMHg into open ocean food webs. To elucidate the process controlling this, researchers will examine mercury dynamics in regions with differing vertical dissolved oxygen profiles, which should influence depths of mercury transformation. Results of the study will aid in a better understanding of the pathways by which mercury enters the marine food chain and can ultimately impact humans. This project will provide training for graduate and undergraduate students, and spread

awareness on oceanic mercury through public outreach and informal science programs.

Mercury isotopic variations can provide insight into a wide variety of environmental processes. Isotopic compositions of mercury display mass-dependent fractionation (MDF) during most biotic and abiotic chemical reactions and mass-independent fractionation (MIF) during photochemical radical pair reactions. The unusual combination of MDF and MIF can provide information on reaction pathways and the biogeochemical history of mercury. Results from preliminary research provide strong evidence that net MMHg formation occurred below the surface mixed layer in the pycnocline and suggested that MMHg in low oxygen intermediate waters is an important entry point for mercury into open ocean food webs. These findings highlight the critical need to understand how MMHg levels in marine biota will respond to changes in atmospheric mercury emissions, deposition of inorganic mercury to the surface ocean, and hypothesized future expansion of oxygen minimum zones. Using field collections across ecosystems with contrasting biogeochemistry and mercury isotope fractionation experiments researchers will fill key knowledge gaps in mercury biogeochemistry. Results of the proposed research will enable scientists to assess the biogeochemical controls on where in the water column mercury methylation and demethylation likely occur.

Related background publication with supplemental data section:
Joel D. Blum, Brian N. Popp, Jeffrey C. Drazen, C. Anela Choy & Marcus W. Johnson. 2013. Methylmercury production below the mixed layer in the North Pacific Ocean. Nature Geoscience 6, 879–884. doi:10.1038/ngeo1918

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Funding

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NSF Division of Ocean Sciences (NSF OCE)	OCE-1333734
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