Sediment trap gel images of settled particles that were collected from the Sargasso Sea between 2013 and 2014.

Website: https://www.bco-dmo.org/dataset/728395
Data Type: Other Field Results
Version: 1
Version Date: 2018-04-17

Project
» Rapid, Autonomous Particle Flux Observations in the Oligotrophic Ocean (RapAutParticleFlux)

Program
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
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Abstract
Sinking particle sizes span many orders of magnitude and the relative influence of small particles on carbon export compared to large particles has not been resolved. To determine the influence of particle size on carbon export, the flux of both small (11–64 µm) and large (>64 µm) particles in the upper mesopelagic was examined during five cruises of the Bermuda Atlantic Time Series (BATS) in the Sargasso Sea using neutrally buoyant sediment traps mounted with tubes containing polyacrylamide gel layers to preserve sizes and shapes of sinking particles. Microphotographic images of gels were collected and used to determine particle size distributions.

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Coverage

Spatial Extent: **N**:34.7787 **E**:-61.1357 **S**:28.3441 **W**:-69.1118
Temporal Extent: 2013 - 2014

Dataset Description

Sediment trap gel images of settled particles.

Methods & Sampling

Particle flux measurements and images of settled particles were obtained from neutrally-buoyant sediment trap (NBST) deployments during a series of five short cruises in conjunction with the Bermuda Atlantic Time-series Study (BATS) in the Sargasso Sea from July 2013 to March 2014. The NBST platforms were constructed around Sounding Oceanographic Lagrangian Observer (SOLO) profiling floats and carried four sediment trap tubes with areas of 0.0113 m2 (see http://www.bco-dmo.org/instrument/632). NBSTs were programmed to descend to a single measurement depth (150, 200, 300 or 500 m), sample for a 2–3 d period, and then ascend to the surface for recovery. Details are described fully in Durkin et al. (2015) and Estapa et al. (2017).

One tube on each NBST was loaded with a polyacrylamide gel insert to preserve sizes and shapes of settling particles for imaging. Polyacrylamide gel layers were prepared in 11-cm diameter polycarbonate jars using methods described in previous studies (Ebersbach and Trull, 2008; Lundsgaard, 1995; McDonnell and Buesseler, 2010) with slight modifications. To prepare 12% polyacrylamide gel, 7.5 g of sea salts was dissolved into 400 mL of surface seawater from Vineyard Sound, MA, USA and filtered through a 0.2-µm polycarbonate filter. The filtered brine was boiled for 15 min to reduce the oxygen content and reduce the brine volume to 350 mL. The solution was bubbled with nitrogen gas through glass pipet tips attached to a pressurized tank while the solution cooled to room temperature. The container of brine was then placed in an ice bath on a stir plate and 150 mL of 40% acrylamide solution and 1 g of ammonium persulfate was added to the solution while stirring. After the ammonium persulfate dissolved, 1 mL of tetramethylethylenediamine was added to catalyze polymerization. Gels were stored at 4°C until use. Prior to deployment, a jar containing a layer of polyacrylamide gel was fitted to the bottom of the trap tube and the tube was filled with filtered seawater. Upon recovery and a settling period of >1 h, the overlying seawater was pumped down to the top of the gel jar and the gel insert was removed and stored at 4°C until analysis. One additional gel trap tube was identically prepared and processed, but was kept covered in the ship's lab during the deployment period to serve as a process blank.

A series of photomicrographs was taken of each gel trap at 7×, 16×, and 63× magnifications using an Olympus SZX12 stereomicroscope with an Olympus Qcolor 5 camera attachment and QCapture imaging software. At a magnification of 7×, 49–67% of the gel surface area was imaged in 16–22 fields of view (0.1 pixels per µm) in a single focal plane. At 16×, 17–38% of the gel surface area was imaged in randomly distributed fields of view (0.236 pixels per µm) across the entire gel surface. At this magnification, a single focal plane could not capture every particle within one field of view; large particles typically accumulated toward the bottom of the gel layer and relatively small particles were distributed in more focal planes throughout the gel layer. To reduce the underestimation of small particle abundance, two images were taken from different focal planes in each field of view (27–60 fields, 54–120 images). At 63×, 0.5–0.8% of the total gel surface area was imaged (12–20 fields of view). Images were taken in cross-sections spanning the diameter of the gel. The purpose of imaging a small percentage of the gel at high magnification was to accurately quantify the abundance of small particles. Between 11 and 15 focal planes were imaged in each field of view (0.746 pixels per µm), depending on the depth of the gel and how many distinct focal planes contained particles. Imaging the same particle twice within one field of view was avoided by ensuring that focal planes did not include overlapping particles. Between 132 and 220 images were captured of each gel at 63× magnification. By imaging at three magnifications, between 240 and 360 images were captured of each gel. Image files are named as ‘month_trapdepth_magnification_fieldofview_focalplane.tiff’, with field of view represented as sequential integers and focal plane represented as sequential letters. Recognizable zooplankton, presumed to have actively entered the gel traps, were also counted manually in 40 fields of view per gel at 32× magnification.

Flux measurements and images are not available at 200 m for the July 5, 2013 deployment due to failure of the lid closure mechanisms on all tubes.

Data Processing Description

BCO-DMO Processing Description

-Created table to include download links for zip files.

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Data Files

File
gel_images.csv (Comma Separated Values (.csv), 881 bytes) MD5:1fb5e344179719b5534fde999cd55b44 Primary data file for dataset ID 728395

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Related Publications

Durkin, C. A., Estapa, M. L., & Buesseler, K. O. (2015). Observations of carbon export by small sinking particles in the upper mesopelagic. Marine Chemistry, 175, 72–81. doi:10.1016/j.marchem.2015.02.011
Results
,
Methods

Ebersbach, F., & Trull, T. W. (2008). Sinking particle properties from polyacrylamide gels during the KErguelen Ocean and Plateau compared Study (KEOPS): Zooplankton control of carbon export in an area of persistent natural iron inputs in the Southern Ocean. Limnology and Oceanography, 53(1), 212–224. doi:10.4319/lo.2008.53.1.0212
Methods

Estapa, M., Durkin, C., Buesseler, K., Johnson, R., & Feen, M. (2017). Carbon flux from bio-optical profiling floats: Calibrating transmissometers for use as optical sediment traps. Deep Sea Research Part I: Oceanographic Research Papers, 120, 100–111. doi:10.1016/j.dsr.2016.12.003
Results
,
Methods

Jackson, G. A., Maffione, R., Costello, D. K., Alldredge, A. L., Logan, B. E., & Dam, H. G. (1997). Particle size spectra between 1 µm and 1 cm at Monterey Bay determined using multiple instruments. Deep Sea Research Part I: Oceanographic Research Papers, 44(11), 1739–1767. doi:10.1016/s0967-0637(97)00029-0
Methods

Lamborg, C. H., Buesseler, K. O., Valdes, J., Bertrand, C. H., Bidigare, R., Manganini, S., Pike, S., Steinberg. D., Trull, T.,& Wilson, S. (2008). The flux of bio- and lithogenic material associated with sinking particles in the mesopelagic "twilight zone" of the northwest and North Central Pacific Ocean. Deep Sea Research Part II: Topical Studies in Oceanography, 55(14-15), 1540–1563. doi:10.1016/j.dsr2.2008.04.011
General

Lundsgaard, C. (1995) Use of a high viscosity medium in studies of aggregates.In S. Floderus, A.-S. Heisakanen, M. Oleson and P. Wassman, [eds.], Proceedings of the Symposium on Seasonal Dynamics of Planktonic Ecosystems and Sedimentation in Coastal Nordic Waters. Finnish Environment Agency. 211 p.
Methods

McDonnell, A. M. P., & Buesseler, K. O. (2010). Variability in the average sinking velocity of marine particles. Limnology and Oceanography, 55(5), 2085–2096. doi:10.4319/lo.2010.55.5.2085
Methods

S.A., O., K.O., B., C.H., L., J., V., M.W., L., R.J., J., … D.A, S. (2013). A new time series of particle export from neutrally buoyant sediments traps at the Bermuda Atlantic Time-series Study site. Deep Sea Research Part I: Oceanographic Research Papers, 72, 34–47. doi:10.1016/j.dsr.2012.10.011
General

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Parameters

Parameter	Description	Units
Year	Year images were collected; yyyy	unitless
Month	Month images were collected	unitless
Image_zip_download_link	Download link to the zip file of images from the respective year and month	unitless
Zip_size	Zip file size	unitless

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Instruments

Dataset-specific Instrument Name	Olympus SZX12 stereomicroscope with an Olympus Qcolor 5 camera attachment
Generic Instrument Name	Microscope - Optical
Dataset-specific Description	Used to take photomicrographs
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

Dataset-specific Instrument Name	NBST
Generic Instrument Name	Neutrally Buoyant Sediment Trap
Dataset-specific Description	Used to measure particles
Generic Instrument Description	In general, 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. The Neutrally Buoyant Sediment Trap (NBST) was designed by researchers at Woods Hole Oceanographic Institution. The central cylinder of the NBST controls buoyancy and houses a satellite transmitter. The other tubes collect sediment as the trap drifts in currents at a predetermined depth. The samples are collected when the tubes snap shut before the trap returns to the surface. (more: http://www.whoi.edu/instruments/viewInstrument.do?id=10286)

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Deployments

AE1315

Website	https://www.bco-dmo.org/deployment/729072
Platform	R/V Atlantic Explorer
Report	http://ezid.cdlib.org/id/doi:10.7284/903354
Start Date	2013-07-06
End Date	2013-07-12
Description	BATS cruise

AE1318

Website	https://www.bco-dmo.org/deployment/729047
Platform	R/V Atlantic Explorer
Report	http://ezid.cdlib.org/id/doi:10.7284/903360
Start Date	2013-08-01
End Date	2013-08-10
Description	BATS cruise

AE1320

Website	https://www.bco-dmo.org/deployment/729045
Platform	R/V Atlantic Explorer
Report	http://ezid.cdlib.org/id/doi:10.7284/903281
Start Date	2013-09-15
End Date	2013-09-21
Description	BATS cruise

AE1323

Website	https://www.bco-dmo.org/deployment/729043
Platform	R/V Atlantic Explorer
Report	http://ezid.cdlib.org/id/doi:10.7284/903370
Start Date	2013-10-18
End Date	2013-10-23
Description	BATs cruise

AE1402

Website	https://www.bco-dmo.org/deployment/729041
Platform	R/V Atlantic Explorer
Report	http://ezid.cdlib.org/id/doi:10.7284/903364
Start Date	2014-03-04
End Date	2014-03-08
Description	BATS cruise

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Project Information

Rapid, Autonomous Particle Flux Observations in the Oligotrophic Ocean (RapAutParticleFlux)

Coverage: Sargasso Sea

Particles settling into the deep ocean remove carbon and biologically-important trace elements from sunlit, productive surface waters and from contact with the atmosphere over short timescales. A shifting balance among physical, chemical, and biological processes determines the ultimate fate of most particles at depths between 100 and 1,000 m, where fluxes are hardest to measure. Our challenge is to expand the number of particle flux observations in the critical "twilight zone", something that has proven elusive with ship-based “snapshots” that have lengths of, at most, a few weeks. Here, we propose an optical, transmissometer-based method to make particle flux observations from autonomous, biogeochemical profiling floats. Novel developments in data interpretation, sensor operation, and platform control now allow flux measurements at hourly resolution and give us observational access to the water-column processes driving particle flux over short timescales. The sensors and float platforms that we propose to use are simple, robust, and commercially-available, making them immediately compatible with community-scale efforts to implement other float-based biogeochemical measurements.

We have two main goals: First, we will *quantify particulate organic carbon (POC) flux using float-based optical measurements* by validating our observations against fluxes measured directly with neutrally-buoyant, drifting sediment traps. Second, we will *evaluate the contribution of rapid export events to total POC fluxes in the oligotrophic ocean* by using a biogeochemical profiling float to collect nearly-continuous, depth-resolved flux measurements and coupled, water-column bio-optical profiles.

To achieve these goals, we will implement a work plan consisting of 1) a set of laboratory-based sensor calibration experiments to determine detection limits and evaluate sensitivity to particle size; 2) a series of four sediment trap and biogeochemical float co-deployments during which we will collect POC flux and field calibration data; and 3) a long-term sampling and analysis period (approximately 1 year) during which data will be returned by satellite from the biogeochemical float. We will conduct calibration fieldwork in conjunction with monthly Bermuda Atlantic Time-series Study (BATS) cruises, taking advantage of the timeseries measurements and the context provided by the 25-year record of POC flux at that site. The data returned by the float will comprise the first quantitative particle flux observations made at high-enough temporal resolution to interpret in the context of short-term, upper-ocean production events.

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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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1406552

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