Size-fractioned primary production rates from samples collected on R/V Atlantic Explorer cruises AE1102, AE1118, AE1206, AE1219 in the Sargasso Sea Bermuda Atlantic Time-Series Station in 2011-2012 (Trophic BATS project)

Website: https://www.bco-dmo.org/dataset/3912
Data Type: Cruise Results
Version: 1
Version Date: 2013-06-14

Project
» Plankton Community Composition and Trophic Interactions as Modifiers of Carbon Export in the Sargasso Sea (Trophic BATS)

Program
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
Richardson, Tammi	University of South Carolina	Principal Investigator
Condon, Robert	Dauphin Island Sea Lab (DISL)	Co-Principal Investigator
Neuer, Susanne	Arizona State University (ASU)	Co-Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Size-fractioned primary production rates from samples collected on R/V Atlantic Explorer cruises AE1102, AE1118, AE1206, AE1219 in the Sargasso Sea Bermuda Atlantic Time-Series Station in 2011-2012.

Table of Contents

- Coverage
- Dataset Description
  - Methods & Sampling
  - Data Processing Description
- Data Files
- Parameters
- Instruments
- Deployments
- Project Information
- Program Information
- Funding

Coverage

Spatial Extent: **N**:33.5007 **E**:-63.4806 **S**:29.5474 **W**:-65.7996
Temporal Extent: 2011-02-24 - 2012-07-30

Dataset Description

Size-fractioned primary production rates (light and dark) are reported from four cruises in the Sargasso Sea during 2011 and 2012.

Methods & Sampling

Study Site and CTD Casts
Data were collected on four cruises in the Sargasso Sea on board the R/V Atlantic Explorer. On each cruise, sampling was conducted at three stations: the center and edge of a mesoscale eddy and at one station outside of the eddy. Eddies were identified using satellite-derived sea level anomaly (SLA) data provided by Dr. Dennis McGillicuddy and Dr. Valery Kosnyrev of the Woods Hole Oceanographic Institution. Target eddies (one per cruise) were initially identified on the day of departure; the ship's position within the eddy (at the center or the edge, as appropriate) was confirmed by daily checks of SLA data.

At each station, high resolution CTD casts to ~2000 m were performed at noon to measure core physical, chemical and biological parameters of the water column. In addition to the core CTD casts, pre-dawn "Productivity" CTD casts were performed to collect water for measurements of size-fractionated biomass (as chl a) and size-fractionated primary productivity. Samples were obtained using the 24 bottle Niskin rosette from 3-4 depths (20 m, 40-50 m, deep fluorescence maximum (~80 m), and 100 m). Ten-liter polycarbonate collection bottles (covered with black tape) were pre-rinsed with sample water and were filled by draining the Niskin bottles through opaque tubing. All samples were pre-filtered through a 200 um Nitex screen. Further handling of the samples was done in the dark or under red light.

The 200 um pre-screened water from pre-dawn productivity casts was used for measurements of size-fractionated biomass (as chl a) and biomarker photopigments by HPLC and for measurements of size-fractionated primary productivity. HPLC pigments were also used for taxonomic identification of total and size-fractionated phytoplankton groups using ChemTax analyses. Samples for microscopy were also taken from productivity casts as verification of the ChemTax results using methods described above for core CTD casts.

Total phytoplankton biomass was measured directly by filtering triplicate aliquots of 1 to 2 liters of pre-screened water onto GF/F filters. This gave total chl a in the size fraction 0.7 to 200 um. The biomass of three size classes of phytoplankton was quantified by differential filtration: the picophytoplankton (0.7-2 um), the nanophytoplankton (2-20 um) and the microphytoplankton (20-200 um) as follows. Triplicate aliquots of 1 to 2 liters of pre-screened water were filtered through a 2 um Nuclepore filter then onto a GF/F filter (= picophytoplankton, 0.7-2 um). Triplicate aliquots of pre-screened water were also filtered through a 20 um Nitex mesh then onto a GF/F filter (= 0.7-20 um). Biomass of the nanophytoplankton size class was determined by subtracting the picophytoplankton biomass from the 0.7-20 um biomass. Microphytoplankton biomass was determined by subtracting the 0.7-20 um biomass from the total chl a value. Filters were folded and placed in 1.5 ml cryotubes and frozen at -80° C until later analysis at the University of South Carolina (USC) using the methods below.

Primary Prodcutivity Measurements
For size-fractionated primary productivity measurements, 200 um pre-screened water collected from discrete depths were dispensed into Nalgene polycarbonate incubation bottles (7-8 clear bottles plus 1-2 dark bottles per depth; 800-1200 ml each). Bottles were spiked with 14C-labeled sodium bicarbonate (PerkinElmer Health Sciences Inc.) to a final activity 0.04-0.08 uCi ml-1 per bottle. An additional bottle per depth was used as a particulate blank (T0) (Barber et al., 1996). The T0 bottles were immediately filtered onto a GF/F, acidified with 500 ul 0.5 N HCl and left open to fume for 24 hours (Barber et al., 1996). Samples for total counts (Tc; 100 ul) were collected from one bottle per depth and combined with 200 ul of phenylethylamine (PEA) and 5 ml of scintillation cocktail (EcoLume, MPBiomedicals, Solon, Ohio). All bottles were incubated in situ at the depth of collection. Incubations were started before sunrise (usually between 05:00 and 06:00 h) and were terminated 24 h later. The productivity array was tracked using a Telonics, Inc. transponder platform subscribed to the ARGOS satellite tracking system.

Total phytoplankton primary productivity was measured directly by filtering triplicate incubation bottles onto GF/F filters. This gave total primary productivity in the size fraction 0.7 to 200 um. Dark bottle productivity was also measured directly by filtering dark bottles directly onto GF/F filters (= dark productivity; 0.7-200 um). Size-fractionated rates of primary productivity of the picophytoplankton, nanophytoplankton and microphytoplankton were made by differential filtration. Two 1 liter bottles were filtered through a 20 um Nitex mesh then onto a 2 um Nuclepore filter (= nanophytoplankton, 2-20 um). Two or three 1 liter bottles were filtered through a 20 um Nitex mesh then onto a GF/F filter (= 0.7-20 um). Filters were treated with 500 ul of 0.5 N HCl and left under a fumehood for 24 hours, then combined with 10 ml scintillation cocktail. Radioactivity was determined in disintegrations per minute (DPM) by the shipboard liquid scintillation analyzer (Packard Tri-Carb 2000CA).

Rates of primary productivity (PP) were calculated in units of mg C m-3 d-1 using the methods of Barber et al. (1996) with the addition of dark bottles:

PP = (DPM24 – DPM0 – DPMd)/(1.05)(25200 mg C m-2)(DPMtot * time)-1

where DPM24 = activity on filter after 24 hour incubation; DPM0 = activity of (depth-specific) T0 particulate blank; DPMd = average of (depth-specific) dark bottles; DPMtot = total activity DPM of isotope added multiplied by volume of water filtered (DPM ml-1); 1.05 = constant that accounts for preferential uptake of the lighter isotope 12C over 14C; 25,200 = concentration (in mg m-2) of inorganic carbon in seawater.

The rate of primary productivity for the picophytoplankton size class was determined by subtracting the nanophytoplankton productivity from the 0.7-20 um productivity. Primary productivity for the microphytoplankton size class was determined by subtracting the 0.7-20 um productivity from the total primary productivity, 0.7-200 um. Total and size-fractionated rates of primary productivity were integrated to 100 meters using trapezoidal integration (mg C m-2 d-1).

Data Processing Description

BCO-DMO Processing:
- Separated original Date/Time field into the separate date_gmt and time_gmt columns.
- Added date/time formatted to ISO 8601 standard.
- Replaced blanks with 'nd' to indicate 'not determined' (or 'no data').
- Modified paramater names to conform with BCO-DMO naming conventions.

[table of contents | back to top]

Data Files

File	
primary_production.csv	(Comma Separated Values (.csv), 203.03 KB) MD5:e68fd311fb65ca542c3f13b9049d59c5
Primary data file for dataset ID 3912	

[table of contents | back to top]

Parameters

Parameter	Description	Units
cruise_id	Official cruise identifier e.g. AE1102 = R/V Atlantic Explorer cruise number 1102.	dimensionless
date_gmt	Date of sample collection (GMT) in mmddYYYY format.	unitless
cast	CTD cast number.	dimensionless
time_gmt	Time of sample collection (GMT); 24-hour clock.	HHMM
lat	Latitude. Positive values = North.	decimal degrees
lon	Longitude. Positive values = East.	decimal degrees
ISO_DateTime_UTC	Date/Time (UTC) formatted to ISO 8601 standard. T indicates start of time string; Z indicates UTC.	YYYY-mm-ddTHH:MM:SS.ssZ
depth	Sample depth.	meters
sample	Sample identification number.	dimensionless
size_fraction	Size fraction; whole = whole water (not pre-screened).	micrometers
Prod_NPP_light	Raw (light) production.	mg C/m3/d
Prod_NPP_light_dark	Light-dark production.	mg C/m3/d

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	CTD Sea-Bird 9
Generic Instrument Name	CTD Sea-Bird 9
Dataset-specific Description	CTD casts were perfomed using a Sea-Bird Electronics SBE-09 plus (24 bottle Niskin rosette).
Generic Instrument Description	The Sea-Bird SBE 9 is a type of CTD instrument package. The SBE 9 is the Underwater Unit and is most often combined with the SBE 11 Deck Unit (for real-time readout using conductive wire) when deployed from a research vessel. The combination of the SBE 9 and SBE 11 is called a SBE 911. The SBE 9 uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 and SBE 4). The SBE 9 CTD can be configured with auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorometer, altimeter, etc.). Note that in most cases, it is more accurate to specify SBE 911 than SBE 9 since it is likely a SBE 11 deck unit was used. more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Light-Dark Bottle
Generic Instrument Name	Light-Dark Bottle
Dataset-specific Description	Primary productivity was measured using light-dark bottles incubated in situ.
Generic Instrument Description	The light/dark bottle is a way of measuring primary production by comparing before and after concentrations of dissolved oxygen. Bottles containing seawater samples with phytoplankton are incubated for a predetermined period of time under light and dark conditions. Incubation is preferably carried out in situ, at the depth from which the samples were collected. Alternatively, the light and dark bottles are incubated in a water trough on deck, and neutral density filters are used to approximate the light conditions at the collection depth.Rates of net and gross photosynthesis and respiration can be determined from measurements of dissolved oxygen concentration in the sample bottles.

Dataset-specific Instrument Name	Niskin bottle
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Samples were obtained using the 24 bottle Niskin rosette from 3-4 depths.
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.

[table of contents | back to top]

Deployments

AE1102

Website	https://www.bco-dmo.org/deployment/58672
Platform	R/V Atlantic Explorer
Start Date	2011-02-23
End Date	2011-03-07
Description	This cruise was the first in a series of four cruises planned to study the trophic interactions and particle export during the winter season in the Sargasso Sea. The researchers focused on several sampling locations including an anticyclonic eddy, slope waters of the eddy, and repeated visits to the Bermuda Atlantic Time Series (BATS) study site. The research focus for the cruise included phytoplankton production, microzooplankton grazing, mesozooplankton grazing and particle export. This process cruise was designed to quantify stocks and rate processes in the Sargasso Sea food web. Work entailed CTD casts, over the stern deployment of in situ primary production arrays and surface tethered sediment traps. Until 26 November 2012 this cruise was identified by BIOS and R2R as AE-X1101. On 26 November 2012, the cruise ID was corrected to AE1102. Original cruise data are available from the NSF R2R data catalog

AE1118

Website	https://www.bco-dmo.org/deployment/58934
Platform	R/V Atlantic Explorer
Start Date	2011-07-22
End Date	2011-08-04
Description	AE1118 was a process cruise aboard the R/V Atlantic Explorer to quantify stocks and rate processes in the Sargasso Sea food web. This was the second in a series of cruises for the Trophic BATS project. On each cruise, sampling was conducted at three stations: the center and edge of a mesoscale eddy and at one station outside of the eddy. Core CTD casts to ~2000 meters and pre-dawn 'Productivity' CTD casts were made at each station. Original cruise data are available from the NSF R2R data catalog.

AE1206

Website	https://www.bco-dmo.org/deployment/58935
Platform	R/V Atlantic Explorer
Start Date	2012-03-14
End Date	2012-03-23
Description	AE1206 was the third in a series of four cruises for the Trophic BATS project. On each cruise, sampling was conducted at three stations: the center and edge of a mesoscale eddy and at one station outside of the eddy. Core CTD casts to ~2000 meters and pre-dawn 'Productivity' CTD casts were made at each station. Cruise information and original data are available from the NSF R2R data catalog.

AE1219

Website	https://www.bco-dmo.org/deployment/58936
Platform	R/V Atlantic Explorer
Start Date	2012-07-19
End Date	2012-07-31
Description	AE1219 was the final cruise in a series of four for the Trophic BATS project. On each cruise, sampling was conducted at three stations: the center and edge of a mesoscale eddy and at one station outside of the eddy. Core CTD casts to ~2000 meters and pre-dawn 'Productivity' CTD casts were made at each station. Cruise information and original data are available from the NSF R2R data catalog.

[table of contents | back to top]

Project Information

Plankton Community Composition and Trophic Interactions as Modifiers of Carbon Export in the Sargasso Sea (Trophic BATS)

Coverage: Sargasso Sea, BATS site

Fluxes of particulate carbon from the surface ocean are greatly influenced by the size, taxonomic composition and trophic interactions of the resident planktonic community. Large and/or heavily-ballasted phytoplankton such as diatoms and coccolithophores are key contributors to carbon export due to their high sinking rates and direct routes of export through large zooplankton. The potential contributions of small, unballasted phytoplankton, through aggregation and/or trophic re-packaging, have been recognized more recently. This recognition comes as direct observations in the field show unexpected trends. In the Sargasso Sea, for example, shallow carbon export has increased in the last decade but the corresponding shift in phytoplankton community composition during this time has not been towards larger cells like diatoms. Instead, the abundance of the picoplanktonic cyanobacterium, Synechococccus, has increased significantly. The trophic pathways that link the increased abundance of Synechococcus to carbon export have not been characterized. These observations helped to frame the overarching research question, "How do plankton size, community composition and trophic interactions modify carbon export from the euphotic zone". Since small phytoplankton are responsible for the majority of primary production in oligotrophic subtropical gyres, the trophic interactions that include them must be characterized in order to achieve a mechanistic understanding of the function of the biological pump in the oligotrophic regions of the ocean.

This requires a complete characterization of the major organisms and their rates of production and consumption. Accordingly, the research objectives are: 1) to characterize (qualitatively and quantitatively) trophic interactions between major plankton groups in the euphotic zone and rates of, and contributors to, carbon export and 2) to develop a constrained food web model, based on these data, that will allow us to better understand current and predict near-future patterns in export production in the Sargasso Sea.

The investigators will use a combination of field-based process studies and food web modeling to quantify rates of carbon exchange between key components of the ecosystem at the Bermuda Atlantic Time-series Study (BATS) site. Measurements will include a novel DNA-based approach to characterizing and quantifying planktonic contributors to carbon export. The well-documented seasonal variability at BATS and the occurrence of mesoscale eddies will be used as a natural laboratory in which to study ecosystems of different structure. This study is unique in that it aims to characterize multiple food web interactions and carbon export simultaneously and over similar time and space scales. A key strength of the proposed research is also the tight connection and feedback between the data collection and modeling components.

Characterizing the complex interactions between the biological community and export production is critical for predicting changes in phytoplankton species dominance, trophic relationships and export production that might occur under scenarios of climate-related changes in ocean circulation and mixing. The results from this research may also contribute to understanding of the biological mechanisms that drive current regional to basin scale variability in carbon export in oligotrophic gyres.

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1030345

[table of contents | back to top]