Hydrography and environmental conditions measured with CTD at nine stations during R/V Endeavor cruise EN616 in July 2018

Website: https://www.bco-dmo.org/dataset/887800
Data Type: Cruise Results
Version: 1
Version Date: 2023-02-24

Project
» Coccolithophore Mixotrophy (Cocco-Mix)

Contributors	Affiliation	Role
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Abstract
Hydrography and environmental conditions were measured with CTD at nine stations during R/V Endeavor cruise EN616 in July 2018. The stations ranged from the New England Continental Shelf, New England Continental Slope, to the Sargasso Sea ocean regions.

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Coverage

Spatial Extent: **N**:43.71835 **E**:-66.51748 **S**:36.98572 **W**:-72.92708
Temporal Extent: 2018-07-05 - 2018-07-13

Methods & Sampling

Discrete water sampling, depth profiles and CTD/Rosette Casts
Hydrography and environmental conditions were measured with CTD at nine stations during R/V Endeavor cruise EN616 in July 2018. Casts at each station included a CTD/rosette profile of temperature, salinity, dissolved oxygen and beam attenuation.

At eight depths, three 10L Niskin samples were taken for discrete measurements of:

1. Chlorophyll, nutrients including nitrate, nitrite, ammonium, phosphate, and silicate
2. Particulate organic carbon (POC) plus particulate organic nitrogen (PON)
3. Particulate inorganic carbon (PIC)

4. Biogenic silica
5. Birefringence counts of coccolithophores (done ashore)
6. Shipboard Yokogawa Fluid Imaging Technologies FlowCam imaging cytometer, in order to enumerate the major microalgal classes and estimate the particle size distribution function

Measurements 1 to 4 are part of BCO-DMO dataset 837074 (See https://www.bco-dmo.org/dataset/837074, and the Related Datasets section below).
Measurement 5 of birefringence counts data is BCO-DMO dataset 887863 (See https://www.bco-dmo.org/dataset/887863, and the Related Datasets section below).
Measurement 6 is BCO-DMO dataset 887787. (See https://www.bco-dmo.org/dataset/887787, and the Related Datasets section below)

Data Processing Description

SeaBird Data Processing was performed using Seasave Ver, 7.26.7.107; SBE Data Processing, Ver 7.26.7.

BCO-DMO processing
- Data is from columns AU through BK on the original source file titled "EN616_master_datasheet_bottle_and_discrete_organics_updated_ccc_BCODMO.csv"
- CTD data extracted from combined "master datasheet" into a separate file called "CTD_EN616.csv"
- Modified parameter (column) names to conform with BCO-DMO naming conventions.
- Converted date format to ISO Date 8601 format
- Removed columns for Primary and Seconday Density since no measurements or values

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Data Files

File	
ctd_en616.csv	(Comma Separated Values (.csv), 11.75 KB) MD5:b9d30b2aecfbdd1c271592c176594d88
CTD hydrography and environmental conditions from cruise EN616	

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Related Publications

Balch, W. M., Drapeau, D. T., Poulton, N., Archer, S. D., Cartisano, C., Burnell, C., & Godrijan, J. (2023). Osmotrophy of dissolved organic compounds by coccolithophore populations: Fixation into particulate organic and inorganic carbon. Science Advances, 9(21). https://doi.org/10.1126/sciadv.adf6973
Results

SeaBird Electronics (2017) Seasave V7 from SEASOFT V2 software suite. Accessed from https://www.ssc-ras.ru/eg/Equipment/SBE_19plusV2/website/software/SeasaveV7.htm
Software

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Related Datasets

IsSupplementedBy

Balch, W. M. (2021) **Measurements of Chlorophyll, NO2, NO3, PO4, Silicate, NH4, PIC, POC, PON, BSi from CTD casts on R/V Endeavor cruise EN616 in July 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-03-08 doi:10.26008/1912/bco-dmo.837074.1 [view at BCO-DMO]

IsSupplementTo

Balch, W. M., Archer, S. D., Drapeau, D. T., Godrijan, J. (2023) **Ambient concentrations of acetate, glycerol, and mannitol measured from samples collected during R/V Endeavor cruise EN616 in the northwest Atlantic in July 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-02-26 doi:10.26008/1912/bco-dmo.887851.1 [view at BCO-DMO]

Balch, W. M., Archer, S. D., Drapeau, D. T., Godrijan, J. (2023) **FlowCAM enumeration of phytoplankton classes from samples taken during R/V Endeavor cruise EN616 in July 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-01-27 doi:10.26008/1912/bco-dmo.887787.1 [view at BCO-DMO]

Balch, W. M., Godrijan, J., Drapeau, D. T., Archer, S. D. (2023) **DOC uptake rates by coccolithophores and scintillation counts from field experiments in the North Atlantic during R/V Endeavor cruise EN616 in July 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-22 doi:10.26008/1912/bco-dmo.887562.1 [view at BCO-DMO]

IsRelatedTo

Balch, W. M., Archer, S. D., Drapeau, D. T., Godrijan, J. (2023) **Coccolithophore counts from polarized microscopy birefringence measurements of samples collected in the Northwest Atlantic during R/V Endeavor cruise EN616 in July 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-02-05 doi:10.26008/1912/bco-dmo.887863.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Cruise	Cruise identification	unitless
Station	Station number for EN616 cruise for water sample collection	unitless
Type	Type of sample; B = discrete bottle sample	unitless
Longitude	Longitude of water sample collection	decimal degrees
Latitude	Latitude of water sample collection	decimal degrees
Depth	Depth of water sample	meters
ISO_DateTime_UTC	Date and time of sample collection	unitless
Gear	Gear used to collect the water and coccolithophore samples	unitless

Balch_Sample_num	Consecutive unique numbers assigned to each water sample for all analyses done for a given station	unitless
Conductivity_Primary	CTD Primary Conductivity for depth where Niskin bottle tripped	milliSiemens per centimeter (mS/cm)
Conductivity_Secondary	CTD Secondary Conductivity for depth where Niskin bottle tripped	milliSiemens per centimeter (mS/cm)
Temperature_Primary	CTD Primary Temperature for depth where Niskin bottle tripped	degrees Celsius
Temperature_Secondary	CTD Secondary Temperature for depth where Niskin bottle tripped	degrees Celsius
Salinity_Primary	CTD Primary Salinity for depth where Niskin bottle tripped	psu
Salinity_Secondary	CTD Secondary Salinity for depth where Niskin bottle tripped	psu
Oxygen	CTD dissolved Oxygen for depth where Niskin bottle tripped	milliliters per liter (mL/L)
Pressure	CTD Pressure measured with Digiquartz for depth where Niskin bottle tripped measured	decibars (dB)
Beam_C_Attenuation	CTD Beam C Attenuation at 660 nm measured with WET Labs C-star for depth where Niskin bottle tripped	per meter
Fluorescence	CTD Chlorophyll Fluorescence measured with WET Labs ECO-AFL/FL fluorometer for depth where Niskin bottle tripped	volts
PAR	CTD Photosynthetically Available Radiation (PAR) measured with Biospherical/Licor for depth where Niskin bottle tripped	micromole photons per square meter per second (umol photons/m^2/sec)
Sigma_Primary	CTD Primary Sigma is the primary density anomaly (sigma theta) for depth where Niskin bottle tripped	units

Sigma_Secondary	CTD Secondary Sigma is the secondary density anomaly (sigma theta) for depth where Niskin bottle tripped	units
Transmittance	CTD Transmittance at 660 nm wavelength for depth where Niskin bottle tripped	percent
SPAR	CTD Surface Photosynthetically Available Radiation (SPAR; 400-700 nm) measured at surface when Niskin bottle tripped	micromole photons per square meter per second (umol photons/m^2/sec)

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Instruments

Dataset-specific Instrument Name	SeaBird Electronics SBE 911plus CTD
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	SeaBird Electronics; SBE 911plusCTD
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Biospherical/Licor
Generic Instrument Name	LI-COR Biospherical PAR Sensor
Dataset-specific Description	Photosynthetically Available Radiation (PAR) was measured using Biospherical/Licor) for depth where Niskin bottle was tripped
Generic Instrument Description	The LI-COR Biospherical PAR Sensor is used to measure Photosynthetically Available Radiation (PAR) in the water column. This instrument designation is used when specific make and model are not known.

Dataset-specific Instrument Name	WET Labs ECO-AFL/FL fluorometer
Generic Instrument Name	Wet Labs ECO-AFL/FL Fluorometer
Dataset-specific Description	Chlorophyll fluorescence was measured (in Volts [relative scale]) using WET Labs ECO-AFL/FL fluorometer for depth where Niskin bottle was tripped.
Generic Instrument Description	The Environmental Characterization Optics (ECO) series of single channel fluorometers delivers both high resolution and wide ranges across the entire line of parameters using 14 bit digital processing. The ECO series excels in biological monitoring and dye trace studies. The potted optics block results in long term stability of the instrument and the optional anti-biofouling technology delivers truly long term field measurements. more information from Wet Labs

Dataset-specific Instrument Name	WET Labs C-Star
Generic Instrument Name	WET Labs {Sea-Bird WETLabs} C-Star transmissometer
Dataset-specific Description	Beam attenuation and beam transmittance were measured using WET Labs C-Star. The instrument had a 25 cm pathlength and measured beam attenuation at a wavelength of 660 nm.
Generic Instrument Description	The C-Star transmissometer has a novel monolithic housing with a highly intgrated opto-electronic design to provide a low cost, compact solution for underwater measurements of beam transmittance. The C-Star is capable of free space measurements or flow-through sampling when used with a pump and optical flow tubes. The sensor can be used in profiling, moored, or underway applications. Available with a 6000 m depth rating. More information on Sea-Bird website: https://www.seabird.com/c-star-transmissometer/product?id=60762467717

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Deployments

EN616

Website	https://www.bco-dmo.org/deployment/837075
Platform	R/V Endeavor
Start Date	2018-07-03
End Date	2018-07-15
Description	See additional cruise information from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/EN616

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Project Information

Coccolithophore Mixotrophy (Cocco-Mix)

Coverage: Partially lab-based, with field sites in Gulf of Maine and NW Atlantic between the Gulf of Maine and

Bermuda

NSF Award Abstract
Coccolithophores are single-cell algae that are covered with limestone (calcite) plates called coccoliths. They may make up most of the phytoplankton biomass in the oceans. Coccolithophores are generally considered to be autotrophs, meaning that they use photosynthesis to fix carbon into both soft plant tissue and hard minerogenic calcite, using sunlight as an energy source ("autotrophic"). However, there is an increasing body of evidence that coccolithophores are "mixotrophic", meaning that they can fix carbon from photosynthesis as well as grow in darkness by engulfing small organic particles plus taking up other simple carbon molecules from seawater. The extent to which Coccolithophores engage in mixotrophy can influence the transfer of carbon into the deep sea. This work is fundamentally directed at quantifying coccolithophore mixotrophy -- the ability to use dissolved and reduce carbon compounds for energy -- using lab and field experiments plus clarifying its relevance to ocean biology and chemistry. This work will generate broader impacts in three areas: 1) Undergraduate training: Two REU undergraduates will be trained during the project. The student in the second year will participate in the research cruise. 2) Café Scientifique program: This work will be presented in Bigelow Laboratory's Café Scientifique program. These are free public gatherings where the public is invited to join in a conversation about the latest ideas and issues in ocean science and technology. 3) Digital E-Book: We propose to make a digital E-book to specifically highlight and explain mixotrophy within coccolithophores. Images of mixotrophic coccolithophores would be the primary visual elements of the book. The E-book will be publicly available and distributed to our educational affiliate, Colby College. The goal of the book is to further communicate the intricacies of the microbial world, food web dynamics, plus their relationship to the global carbon cycle, to inspire interest, education, and curiosity about these amazing life forms.

Coccolithophores can significantly affect the draw-down of atmospheric CO2 and they can transfer CO2 from the surface ocean and sequester it in the deep sea via two carbon pump mechanisms: (1) The "alkalinity pump" (also known as the calcium carbonate pump), where coccolithophores in the surface ocean take up dissolved inorganic carbon (DIC; primarily a form called bicarbonate, a major constituent of ocean alkalinity). They convert half to CO2, which is either fixed as plant biomass or released as the gas, and half is synthesized into their mineral coccoliths. Thus, coccolithophore calcification can actually increase surface CO2 on short time scales (i.e. weeks). However, over months to years, coccoliths sink below thousands of meters, where they dissolve and release bicarbonate back into deep water. Thus, sinking coccoliths essentially "pump" bicarbonate alkalinity from surface to deep waters, where that carbon remains isolated in the abyssal depths for thousands of years. (2) The "biological pump", where the ballasting effect of the dense limestone coccoliths speeds the sinking of organic, soft-tissue debris (particulate organic carbon or POC), essentially "pumping" this soft carbon tissue to depth. The biological pump ultimately decreases surface CO_2. The soft-tissue and alkalinity pumps reinforce each other in maintaining a vertical gradient in DIC (more down deep than at the surface) but they oppose each other in terms of the air-sea exchange of CO_2. Thus, the net effect of coccolithophores on atmospheric CO2 depends on the balance of their CO_2-raising effect associated with the alkalinity pump and their CO2-lowering effect associated with the soft-tissue biological pump. It is virtually always assumed that coccolith particulate inorganic carbon (PIC) originates exclusively from dissolved inorganic carbon (DIC, as bicarbonate), not dissolved organic carbon (DOC). The goal of this proposal is to describe a) the potential uptake and assimilation of an array of DOC compounds by coccolithophores, b) the rates of uptake, and potential incorporation of DOC by coccolithophores into PIC coccoliths, which, if true, would represent a major shift in the alkalinity pump paradigm. This work is fundamentally directed at quantifying coccolithophore mixotrophy using lab and field experiments plus clarifying its relevance to ocean biology and chemistry. There have been a number of technological advances to address this issue, all of which will be applied in this work. The investigators will: (a) screen coccolithophore cultures for the uptake and assimilation of a large array of DOC molecules, (b) perform tracer experiments with specific DOC molecules in order to examine uptake at environmentally-realistic concentrations, (c) measure fixation of DOC into organic tissue, separately from that fixed into PIC coccoliths, (d) separate coccolithophores from other phytoplankton and bacteria using flow cytometry and e) distinguish the modes of nutrition in these sorted coccolithophore cells. This work will fundamentally advance the state of knowledge of coccolithophore mixotrophy in the sea and address the balance of carbon that coccolithophores derived from autotrophic versus heterotrophic sources.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1635748

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