Along track temperature, salinity, backscatter, chlorophyll fluorescence, CDOM fluorescence, Es, Lt and Li, absorption and attenuation from R/V Endeavor cruise EN616 in July 2018

Website: https://www.bco-dmo.org/dataset/843506
Data Type: Cruise Results
Version: 1
Version Date: 2021-03-08

Project
» Coccolithophore Mixotrophy (Cocco-Mix)

Contributors	Affiliation	Role
Balch, William M.	Bigelow Laboratory for Ocean Sciences	Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Along track temperature, salinity, backscatter, chlorophyll fluorescence, CDOM fluorescence, Es, Lt and Li, absorption and attenuation from R/V Endeavor cruise EN616 in July 2018.

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Coverage

Spatial Extent: **N**:43.7728 **E**:-66.2801 **S**:36.9797 **W**:-72.9686
Temporal Extent: 2018-07-03 - 2018-07-14

Dataset Description

.csv file

Acquisition Description

Data were collected while underway on R/V Endeavor cruise EN616 in July 2018. Chlorophyll data is based on inter-calibrating surface discrete Chlorophyll measure with the temporally closest fluorescence measurement and applying the regression results to all fluorescence data. Instruments include a WETLabs WETStar Chlorophyll fluorometer, a WETLabs WETStar CDOM fluorometer, a Wyatt Technology Dawn-EOS multi-angle scattering detector, a Sea-Bird SBE45 MicroTSG and a WETLabs ac9 Absorption and

Attenuation meter. Radiometry was done using a Satlantic Hyperspectral SAS system with Es, Lt and Li sensors.

Processing Description

Data is corrected for biofouling and instrument drift based on weekly pure water calibrations of the system using homegrown software developed in Matlab. Radiometric data is processed using standard Seabird/Satlantic processing software (Prosoft).

BCO-DMO Processing:
- replaced "-9.900e+01" and "-99" with "nd" as the "no data" value;
- saved file in csv format.

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Data Files

File	Version
underway.csv (Comma Separated Values (.csv), 15.55 MB) MD5:cad9c40edfae0435ec867017e48d27bd *EN616 Underway Data (csv file). Contains along track temperature, salinity, backscatter, chlorophyll fluorescence, CDOM fluorescence, Es, Lt and Li, absorption and attenuation from R/V Endeavor cruise EN616 in July 2018. Refer to "Parameters" section of metadata for column definitions and units of measurement.*	1

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Related Publications

Balch, W. M., Drapeau, D. T., Bowler, B. C., Booth, E. S., Windecker, L. A., & Ashe, A. (2007). Space-time variability of carbon standing stocks and fixation rates in the Gulf of Maine, along the GNATS transect between Portland, ME, USA, and Yarmouth, Nova Scotia, Canada. Journal of Plankton Research, 30(2), 119–139. doi:10.1093/plankt/fbm097
Methods

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Parameters

Parameter	Description	Units
date	Date; format: YYYYMMDD	unitless
time	Time; format: hh:mm:ss	unitless
lat	Latitude	degrees North
lon	Longitdue	degrees East
Wt	Water temperature	degrees C
sal	Salinity	psu
bb470	backscatter at 470nm	1/m
bb532	backscatter at 532nm	1/m

bb676	backscatter at 676nm	1/m
chl_stimf	Chl based on fluorometer	mg/m^3
agp412	absorption of gelbstoff and particles at 412nm	1/m
agp440	absorption of gelbstoff and particles at 440nm	1/m
agp488	absorption of gelbstoff and particles at 488nm	1/m
agp510	absorption of gelbstoff and particles at 510nm	1/m
agp555	absorption of gelbstoff and particles at 555nm	1/m
agp630	absorption of gelbstoff and particles at 630nm	1/m
agp650	absorption of gelbstoff and particles at 650nm	1/m
agp676	absorption of gelbstoff and particles at 676nm	1/m
agp715	absorption of gelbstoff and particles at 715nm	1/m
ag412	absorption of gelbstoff at 412nm	1/m
ag440	absorption of gelbstoff at 440nm	1/m
ag488	absorption of gelbstoff at 488nm	1/m
ag510	absorption of gelbstoff at 510nm	1/m
ag555	absorption of gelbstoff at 555nm	1/m
ag630	absorption of gelbstoff at 630nm	1/m
ag650	absorption of gelbstoff at 650nm	1/m
ag676	absorption of gelbstoff at 676nm	1/m
ag715	absorption of gelbstoff at 715nm	1/m
cgp412	attenuation of gelbstoff and particles at 412nm	1/m
cgp440	attenuation of gelbstoff and particles at 440nm	1/m
cgp488	attenuation of gelbstoff and particles at 488nm	1/m
cgp510	attenuation of gelbstoff and particles at 510nm	1/m
cgp555	attenuation of gelbstoff and particles at 555nm	1/m
cgp630	attenuation of gelbstoff and particles at 630nm	1/m
cgp650	attenuation of gelbstoff and particles at 650nm	1/m
cgp676	attenuation of gelbstoff and particles at 676nm	1/m
cgp715	attenuation of gelbstoff and particles at 715nm	1/m
es350	Surface irradiance at 350nm	uW/cm^2/nm
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Isky463	sky radiance at 463nm	uW/cm^2/nm/sr
Isky467	sky radiance at 467nm	uW/cm^2/nm/sr
Isky470	sky radiance at 470nm	uW/cm^2/nm/sr
Isky473	sky radiance at 473nm	uW/cm^2/nm/sr
Isky477	sky radiance at 477nm	uW/cm^2/nm/sr

lsky480	sky radiance at 480nm	uW/cm^2/nm/sr
lsky483	sky radiance at 483nm	uW/cm^2/nm/sr
lsky487	sky radiance at 487nm	uW/cm^2/nm/sr
lsky490	sky radiance at 490nm	uW/cm^2/nm/sr
lsky493	sky radiance at 493nm	uW/cm^2/nm/sr
lsky497	sky radiance at 497nm	uW/cm^2/nm/sr
lsky500	sky radiance at 500nm	uW/cm^2/nm/sr
lsky503	sky radiance at 503nm	uW/cm^2/nm/sr
lsky507	sky radiance at 507nm	uW/cm^2/nm/sr
lsky510	sky radiance at 510nm	uW/cm^2/nm/sr
lsky514	sky radiance at 514nm	uW/cm^2/nm/sr
lsky517	sky radiance at 517nm	uW/cm^2/nm/sr
lsky520	sky radiance at 520nm	uW/cm^2/nm/sr
lsky524	sky radiance at 524nm	uW/cm^2/nm/sr
lsky527	sky radiance at 527nm	uW/cm^2/nm/sr
lsky530	sky radiance at 530nm	uW/cm^2/nm/sr
lsky533	sky radiance at 533nm	uW/cm^2/nm/sr
lsky537	sky radiance at 537nm	uW/cm^2/nm/sr
lsky540	sky radiance at 540nm	uW/cm^2/nm/sr
lsky544	sky radiance at 544nm	uW/cm^2/nm/sr
lsky547	sky radiance at 547nm	uW/cm^2/nm/sr
lsky550	sky radiance at 550nm	uW/cm^2/nm/sr
lsky555	sky radiance at 555nm	uW/cm^2/nm/sr
lsky557	sky radiance at 557nm	uW/cm^2/nm/sr
lsky560	sky radiance at 560nm	uW/cm^2/nm/sr
lsky564	sky radiance at 564nm	uW/cm^2/nm/sr
lsky567	sky radiance at 567nm	uW/cm^2/nm/sr
lsky570	sky radiance at 570nm	uW/cm^2/nm/sr
lsky574	sky radiance at 574nm	uW/cm^2/nm/sr
lsky577	sky radiance at 577nm	uW/cm^2/nm/sr
lsky580	sky radiance at 580nm	uW/cm^2/nm/sr
lsky584	sky radiance at 584nm	uW/cm^2/nm/sr
lsky587	sky radiance at 587nm	uW/cm^2/nm/sr
lsky590	sky radiance at 590nm	uW/cm^2/nm/sr
lsky594	sky radiance at 594nm	uW/cm^2/nm/sr
lsky597	sky radiance at 597nm	uW/cm^2/nm/sr
lsky600	sky radiance at 600nm	uW/cm^2/nm/sr
lsky604	sky radiance at 604nm	uW/cm^2/nm/sr

Isky607	sky radiance at 607nm	uW/cm^2/nm/sr
Isky610	sky radiance at 610nm	uW/cm^2/nm/sr
Isky614	sky radiance at 614nm	uW/cm^2/nm/sr
Isky617	sky radiance at 617nm	uW/cm^2/nm/sr
Isky620	sky radiance at 620nm	uW/cm^2/nm/sr
Isky624	sky radiance at 624nm	uW/cm^2/nm/sr
Isky627	sky radiance at 627nm	uW/cm^2/nm/sr
Isky630	sky radiance at 630nm	uW/cm^2/nm/sr
Isky634	sky radiance at 634nm	uW/cm^2/nm/sr
Isky637	sky radiance at 637nm	uW/cm^2/nm/sr
Isky640	sky radiance at 640nm	uW/cm^2/nm/sr
Isky644	sky radiance at 644nm	uW/cm^2/nm/sr
Isky647	sky radiance at 647nm	uW/cm^2/nm/sr
Isky650	sky radiance at 650nm	uW/cm^2/nm/sr
Isky654	sky radiance at 654nm	uW/cm^2/nm/sr
Isky657	sky radiance at 657nm	uW/cm^2/nm/sr
Isky660	sky radiance at 660nm	uW/cm^2/nm/sr
Isky664	sky radiance at 664nm	uW/cm^2/nm/sr
Isky667	sky radiance at 667nm	uW/cm^2/nm/sr
Isky671	sky radiance at 671nm	uW/cm^2/nm/sr
Isky674	sky radiance at 674nm	uW/cm^2/nm/sr
Isky677	sky radiance at 677nm	uW/cm^2/nm/sr
Isky680	sky radiance at 680nm	uW/cm^2/nm/sr
Isky684	sky radiance at 684nm	uW/cm^2/nm/sr
Isky687	sky radiance at 687nm	uW/cm^2/nm/sr
Isky690	sky radiance at 690nm	uW/cm^2/nm/sr
Isky694	sky radiance at 694nm	uW/cm^2/nm/sr
Isky697	sky radiance at 697nm	uW/cm^2/nm/sr
Isky700	sky radiance at 700nm	uW/cm^2/nm/sr
Isky704	sky radiance at 704nm	uW/cm^2/nm/sr
Isky707	sky radiance at 707nm	uW/cm^2/nm/sr
Isky710	sky radiance at 710nm	uW/cm^2/nm/sr
Isky714	sky radiance at 714nm	uW/cm^2/nm/sr
Isky717	sky radiance at 717nm	uW/cm^2/nm/sr
Isky720	sky radiance at 720nm	uW/cm^2/nm/sr
Isky724	sky radiance at 724nm	uW/cm^2/nm/sr
Isky727	sky radiance at 727nm	uW/cm^2/nm/sr
Isky730	sky radiance at 730nm	uW/cm^2/nm/sr

lsky734	sky radiance at 734nm	uW/cm^2/nm/sr
lsky737	sky radiance at 737nm	uW/cm^2/nm/sr
lsky740	sky radiance at 740nm	uW/cm^2/nm/sr
lsky743	sky radiance at 743nm	uW/cm^2/nm/sr
lsky747	sky radiance at 747nm	uW/cm^2/nm/sr
lsky750	sky radiance at 750nm	uW/cm^2/nm/sr
lsky753	sky radiance at 753nm	uW/cm^2/nm/sr
lsky757	sky radiance at 757nm	uW/cm^2/nm/sr
lsky760	sky radiance at 760nm	uW/cm^2/nm/sr
lsky763	sky radiance at 763nm	uW/cm^2/nm/sr
lsky767	sky radiance at 767nm	uW/cm^2/nm/sr
lsky770	sky radiance at 770nm	uW/cm^2/nm/sr
lsky773	sky radiance at 773nm	uW/cm^2/nm/sr
lsky777	sky radiance at 777nm	uW/cm^2/nm/sr
lsky780	sky radiance at 780nm	uW/cm^2/nm/sr
lsky783	sky radiance at 783nm	uW/cm^2/nm/sr
lsky787	sky radiance at 787nm	uW/cm^2/nm/sr
lsky790	sky radiance at 790nm	uW/cm^2/nm/sr
lsky793	sky radiance at 793nm	uW/cm^2/nm/sr
lsky796	sky radiance at 796nm	uW/cm^2/nm/sr
lsky800	sky radiance at 800nm	uW/cm^2/nm/sr
lsky803	sky radiance at 803nm	uW/cm^2/nm/sr
senz	radiometric zenith angle	degrees
relaz	radiometric relative azimuth angle	degrees
bb470_sd	Standard deviation of the corresponding mean, bb470	1/m
bb532_sd	Standard deviation of the corresponding mean, bb532	1/m
bb676_sd	Standard deviation of the corresponding mean, bb676	1/m
es350_sd	Standard deviation of the corresponding mean, es350	uW/cm^2/nm
es353_sd	Standard deviation of the corresponding mean, es353	uW/cm^2/nm
es357_sd	Standard deviation of the corresponding mean, es357	uW/cm^2/nm
es360_sd	Standard deviation of the corresponding mean, es360	uW/cm^2/nm
es363_sd	Standard deviation of the corresponding mean, es363	uW/cm^2/nm
es367_sd	Standard deviation of the corresponding mean, es367	uW/cm^2/nm
es370_sd	Standard deviation of the corresponding mean, es370	uW/cm^2/nm
es373_sd	Standard deviation of the corresponding mean, es373	uW/cm^2/nm
es377_sd	Standard deviation of the corresponding mean, es377	uW/cm^2/nm
es380_sd	Standard deviation of the corresponding mean, es380	uW/cm^2/nm
es383_sd	Standard deviation of the corresponding mean, es383	uW/cm^2/nm

es387_sd	Standard deviation of the corresponding mean, es387	uW/cm^2/nm
es390_sd	Standard deviation of the corresponding mean, es390	uW/cm^2/nm
es393_sd	Standard deviation of the corresponding mean, es393	uW/cm^2/nm
es397_sd	Standard deviation of the corresponding mean, es397	uW/cm^2/nm
es400_sd	Standard deviation of the corresponding mean, es400	uW/cm^2/nm
es403_sd	Standard deviation of the corresponding mean, es403	uW/cm^2/nm
es407_sd	Standard deviation of the corresponding mean, es407	uW/cm^2/nm
es410_sd	Standard deviation of the corresponding mean, es410	uW/cm^2/nm
es412_sd	Standard deviation of the corresponding mean, es412	uW/cm^2/nm
es417_sd	Standard deviation of the corresponding mean, es417	uW/cm^2/nm
es420_sd	Standard deviation of the corresponding mean, es420	uW/cm^2/nm
es423_sd	Standard deviation of the corresponding mean, es423	uW/cm^2/nm
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es727_sd	Standard deviation of the corresponding mean, es727	uW/cm^2/nm
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es800_sd	Standard deviation of the corresponding mean, es800	uW/cm^2/nm
es803_sd	Standard deviation of the corresponding mean, es803	uW/cm^2/nm
lt350_sd	Standard deviation of the corresponding mean, lt350	uW/cm^2/nm/sr
lt353_sd	Standard deviation of the corresponding mean, lt353	uW/cm^2/nm/sr
lt357_sd	Standard deviation of the corresponding mean, lt357	uW/cm^2/nm/sr
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lt564_sd	Standard deviation of the corresponding mean, lt564	uW/cm^2/nm/sr
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lt584_sd	Standard deviation of the corresponding mean, lt584	uW/cm^2/nm/sr
lt587_sd	Standard deviation of the corresponding mean, lt587	uW/cm^2/nm/sr
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lt620_sd	Standard deviation of the corresponding mean, lt620	uW/cm^2/nm/sr
lt624_sd	Standard deviation of the corresponding mean, lt624	uW/cm^2/nm/sr
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cgp715_sd	Standard deviation of the corresponding mean, cgp715	1/m

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Instruments

Dataset-specific Instrument Name	WETLabs ac9 Absorption and Attenuation meter
Generic Instrument Name	AC 9
Generic Instrument Description	"The WET Labs AC-9 is a type of in-situ spectrophotometer that simultaneously determines the spectral transmittance and spectral absorption of water over nine wavelengths. The unit offers compact size, high precision, and excellent stability in providing a method for determining the absorption (a(l)) and beam attenuation (c(l)) coefficients. The AC-9 employs a 25-cm pathlength for effective measurement of the cleanest natural waters. The unit is also available in a 10-cm pathlength configuration." (more from WET Labs)

Dataset-specific Instrument Name	WETLabs WETStar Chlorophyll fluorometer
Generic Instrument Name	WETLabs WETStar fluorometer
Generic Instrument Description	Submersible fluorometer designed for through-flow or pumped CTD applications manufactured by WetLabs and which can be configured for various types of fluorescence. The probe has a temperature range of 0-30 degrees C and a depth rating of 600m.

Dataset-specific Instrument Name	WETLabs WETStar CDOM fluorometer
Generic Instrument Name	WETLabs WETStar fluorometer
Generic Instrument Description	Submersible fluorometer designed for through-flow or pumped CTD applications manufactured by WetLabs and which can be configured for various types of fluorescence. The probe has a temperature range of 0-30 degrees C and a depth rating of 600m.

Dataset-specific Instrument Name	Sea-Bird SBE45 MicroTSG
Generic Instrument Name	Sea-Bird SBE 45 MicroTSG Thermosalinograph
Generic Instrument Description	A small externally powered, high-accuracy instrument, designed for shipboard determination of sea surface (pumped-water) conductivity and temperature. It is constructed of plastic and titanium to ensure long life with minimum maintenance. It may optionally be interfaced to an external SBE 38 hull temperature sensor. Sea Bird SBE 45 MicroTSG (Thermosalinograph)

Dataset-specific Instrument Name	Wyatt Technology Dawn-EOS multi-angle scattering detector
Generic Instrument Name	Multiangle Light Scattering Detector
Generic Instrument Description	A multiangle light scattering (MALS) detector is a form of static light scattering detector which allows the absolute molecular weight (Mw) and potentially the radius of gyration (Rg) of a sample to be measured. Multiangle light scattering (MALS) describes a technique for determining structure by measuring the change in direction or energy of scattered visible light at a number of different angles, none of which are close to the angle of incidence of the light. It is used for determining both the absolute molar mass and the average size of molecules in solution, by detecting how they scatter light.

Dataset-specific Instrument Name	Satlantic Hyperspectral SAS system with Es, Lt and Li sensors
Generic Instrument Name	Satlantic Hyperspectral Surface Acquisition System Radiometer
Generic Instrument Description	The Satlantic Hyperspectral Surface Acquisition System (HyperSAS) radiometer is an above-water optical sensing system designed to provide continuous ocean color measurements over the spectral range 350-800 nm. The HyperSAS can be mounted on ships and fixed platforms, or on aircrafts for remote sensing surveys. The standard configuration of the system includes one irradiance sensor to measure downwelling irradiance, and two hyperspectral radiance sensors to capture the sea surface signal. The irradiance sensor response is proportional to the cosine of the angle of incidence of the incoming radiation, while each radiance sensor has a 3 deg field of view (FOV). The orientation precision, geo-referencing and time-stamp accuracy may be improved by mounting an optional GPS unit with Satlantic tilt and heading sensor. Moreover, a radiation pyrometer may also be added to measure land or sea surface temperature.

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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

Coccolithophores are unicellular haptophyte algae generally thought of as photoautotrophs. They are covered with scales or "coccoliths" (made of calcium carbonate (particulate inorganic carbon, PIC)). Recent observations suggest that globally, haptophytes contribute more biomass than ubiquitous *Prochlorococcus* and *Synechococcus*. Coccolithophores can affect the draw-down of atmospheric CO2 and are involved in two fundamental "pump paradigms": (1) The alkalinity pump (also known as the carbonate, PIC, or CaCO3 pump) lowers total alkalinity (TA) and dissolved inorganic carbon (DIC) in the euphotic zone during calcification, and increases upper ocean and atmospheric CO2. Coccoliths eventually sink below the ocean's lysocline (the depth where calcium carbonate dissolves), where they release the bicarbonate back into deep water. Thus, they essentially "pump" bicarbonate alkalinity from surface to benthic waters, where it remains isolated in the deep sea for thousands of years. (2) The biological pump in which the ballasting effect of the heavy coccoliths on sinking particulate organic carbon (POC) increases the magnitude of the soft tissue (POC) pump, which ultimately decreases surface CO2. The soft-tissue and alkalinity pumps reinforce each other in maintaining a vertical gradient in DIC but they oppose each other in terms of the air-sea exchange of CO2. Thus, the net effect of coccolithophores on atmospheric CO2 depends on the balance of their CO2-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 the PIC found in coccoliths originates exclusively from DIC, not dissolved organic carbon (DOC). However, there is an increasing body of evidence that coccolithophores are mixotrophic (defined as a combination of growth fueled by autotrophy, uptake of DOC and phagotrophy of small particles (POC). This proposal is to describe the potential uptake and assimilation of an array of DOC compounds in the sea, the kinetics of their uptake and potential incorporation of organic carbon by coccolithophores into PIC coccoliths (which could significantly alter the alkalinity pump paradigm since calcite production in the surface ocean would not be at the expense of bicarbonate).

This work is fundamentally directed at quantifying coccolithophore mixotrophy in lab of technological advances to address this issue, all of which we will apply in this work. We will: (a) screen axenic coccolithophore cultures for the uptake and oxidation of a large array of potential DOC substrates, (b) perform radiolabel-uptake experiments with these molecules using high-specific activity substrates in order to provide the basic kinetic response at environmentally-realistic concentrations, (c) measure radio-labelled carbon fixed into organic tissue, separate from that fixed into PIC, (d) sort 14C-labelled coccolithophores free of the other free-living phytoplankton and bacteria using flow cytometry and e) distinguish the modes of nutrition in these sorted coccolithophore cells. This work will advance the state of knowledge of coccolithophore mixotrophy in the marine environment 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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