Underway Data from R/V Melville, R/V Roger Revelle cruises MV1101, RR1202 in the Southern Ocean (30-60S); 2011-2012 (Great Calcite Belt project)

Website: https://www.bco-dmo.org/dataset/560142
Version: 08 June 2015
Version Date: 2015-06-08

Project
» The Great Southern Coccolithophore Belt (Great Calcite Belt)

Contributors	Affiliation	Role
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Gegg, Stephen R.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Dataset Description

Along track temperature, Salinity, backscatter, Chlorophyll Fluoresence, and normalized water leaving radiance (nLw).

On the bow of the vessel was a Satlantic SeaWiFS Aircraft Simulator (MicroSAS) system, used to estimate water-leaving radiance from the ship, analogous to to the nLw derived by the SeaWiFS and MODIS satellite sensors, but free from atmospheric error (hence, it can provide data below clouds).

The system consisted of a down-looking radiance sensor and a sky-viewing radiance sensor, both mounted on a steerable holder on the bow. A downwelling irradiance sensor was mounted at the top of the ship's meterological mast, on the bow, far from any potentially shading structures. These data were used to estimate normalized water-leaving radiance as a function of wavelength. The radiance detector was set to view the water at 40deg from nadir as recommended by Mueller et al. [2003b]. The water radiance sensor was able to view over an azimuth range of ~180deg across the ship's heading with no viewing of the ship's wake. The direction of the sensor was adjusted to view the water 90-120deg from the sun's azimuth, to minimize sun glint. This was continually adjusted as the time and ship's gyro heading were used to calculate the sun's position using an astronomical solar position subroutine interfaced with a stepping motor which was attached to the radiometer mount (designed and fabricated at Bigelow Laboratory for Ocean Sciences). Protocols for operation and calibration were performed according to Mueller [Mueller et al., 2003a; Mueller et al., 2003b; Mueller et al., 2003c]. Before 1000h and after 1400h, data quality was poorer as the solar zenith angle was too low. Post-cruise, the 10Hz data were filtered to remove as much residual white cap and glint as possible (we accept the lowest 5% of the data). Reflectance plaque measurements were made several times at local apparent noon on sunny days to verify the radiometer calibrations.

Within an hour of local apparent noon each day, a Satlantic OCP sensor was deployed off the stern of the vessel after the ship oriented so that the sun was off the stern. The ship would secure the starboard Z-drive, and use port Z-drive and bow thruster to move the ship ahead at about 25cm s-1. The OCP was then trailed aft and brought to the surface ~100m aft of the ship, then allowed to sink to 100m as downwelling spectral irradiance and upwelling spectral radiance were recorded continuously along with temperature and salinity. This procedure ensured there were no ship shadow effects in the radiometry.

Instruments include a WETLabs wetstar fluorometer, a WETLabs ECOTriplet and a SeaBird microTSG.
Radiometry was done using a Satlantic 7 channel microSAS system with Es, Lt and Li sensors.

Chl 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.

Data have been corrected for instrument biofouling and drift based on weekly purewater calibrations of the system. Radiometric data has been processed using standard Satlantic processing software and has been checked with periodic plaque measurements using a 2% spectralon standard.

Lw is calculated from Lt and Lsky and is "what Lt would be if the
sensor were looking straight down". Since our sensors are mounted at
40o, based on various NASA protocols, we need to do that conversion.

Lwn adds Es to the mix. Es is used to normalize Lw. Nlw is related to Rrs, Remote Sensing Reflectance

Techniques used are as described in:
Balch WM, Drapeau DT, Bowler BC, Booth ES, Windecker LA, Ashe A (2008) 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.
J Plankton Res 30:119–139

Methods & Sampling

Instruments include a WETLabs wetstar fluorometer, a WETLabs ECOTriplet and a SeaBird microTSG. Radiometry was done using a Satlantic 7 channel microSAS system with Es, Lt and Li sensors.

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Data Processing Description

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BCO-DMO Processing Notes
- Generated from original files "mv1101-merged-SAS-flow.out" and "rr1202-merged-SAS-flow.out" contributed by Bruce Bowler

- Date reformatted to YYYYMMDD
- Time reformatted to HHMMSS
- Parameter names edited to conform to BCO-DMO naming convention found at Choosing Parameter Name

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Data Files

File
Underway_Data.csv (Comma Separated Values (.csv), 3.45 MB) MD5:b84cb63ea471f21eecbfac9e8f93f942 Primary data file for dataset ID 560142

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Parameters

Parameter	Description	Units
CruiseId	Official UNOLS cruise id	text
Measurement_Depth	Measurement Depth	meters
ISO_DateTime_UTC	ISO DateTime UTC	YYYY-MM-DDTHH:MM:SS[.xx]Z
date	Date (UTC)	YYYYMMDD
time	Time (UTC)	HHMMSS
lat	Latitude Position (South is negative)	decimal degrees
lon	Longitude Position (West is negative)	decimal degrees
Wt	Water temperature	degreesC
sal	Salinity	PSU
chl	Chlorophyll Fluoresence	mg/m^3
bbp532	Backscatter@532nm	1/m
es412	irradiance at 412nm	uW/cm^2/nm
es443	irradiance at 443nm	uW/cm^2/nm
es490	irradiance at 490nm	uW/cm^2/nm
es510	irradiance at 510nm	uW/cm^2/nm
es531	irradiance at 531nm	uW/cm^2/nm
es555	irradiance at 555nm	uW/cm^2/nm
es670	irradiance at 670nm	uW/cm^2/nm
Lt412	water radiance at 412nm	uW/cm^2/nm/sr
Lt443	water radiance at 443nm	uW/cm^2/nm/sr
Lt490	water radiance at 490nm	uW/cm^2/nm/sr
Lt510	water radiance at 510nm	uW/cm^2/nm/sr
Lt531	water radiance at 531nm	uW/cm^2/nm/sr
Lt555	water radiance at 555nm	uW/cm^2/nm/sr
Lt670	water radiance at 670nm	uW/cm^2/nm/sr
Lsky412	sky radiance at 412nm	uW/cm^2/nm/sr
Lsky443	sky radiance at 443nm	uW/cm^2/nm/sr
Lsky490	sky radiance at 490nm	uW/cm^2/nm/sr
Lsky510	sky radiance at 510nm	uW/cm^2/nm/sr
Lsky531	sky radiance at 531nm	uW/cm^2/nm/sr
Lsky555	sky radiance at 555nm	uW/cm^2/nm/sr
Lsky670	sky radiance at 670nm	uW/cm^2/nm/sr
Lw412	water leaving radiance at 412nm	uW/cm^2/nm/sr
Lw443	water leaving radiance at 443nm	uW/cm^2/nm/sr
Lw490	water leaving radiance at 490nm	uW/cm^2/nm/sr
Lw510	water leaving radiance at 510nm	uW/cm^2/nm/sr
Lw531	water leaving radiance at 531nm	uW/cm^2/nm/sr
Lw555	water leaving radiance at 555nm	uW/cm^2/nm/sr
Lw670	water leaving radiance at 670nm	uW/cm^2/nm/sr
Lwn412	normalized water leaving radiance at 412nm	uW/cm^2/nm/sr
Lwn443	normalized water leaving radiance at 443nm	uW/cm^2/nm/sr
Lwn490	normalized water leaving radiance at 490nm	uW/cm^2/nm/sr
Lwn510	normalized water leaving radiance at 510nm	uW/cm^2/nm/sr
Lwn531	normalized water leaving radiance at 531nm	uW/cm^2/nm/sr
Lwn555	normalized water leaving radiance at 555nm	uW/cm^2/nm/sr
Lwn670	normalized water leaving radiance at 670nm	uW/cm^2/nm/sr
relaz	relative azimuth	degrees

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Instruments

Dataset-specific Instrument Name	Fluorometer
Generic Instrument Name	Fluorometer
Dataset-specific Description	WETLabs wetstar fluorometerProduct Brochure
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	MicroTSG Thermosalinograph
Generic Instrument Name	MicroTSG Thermosalinograph
Dataset-specific Description	SBE 45 MicroTSG ThermosalinographProduct Brochure
Generic Instrument Description	An externally powered, high-accuracy instrument, designed for shipboard determination of sea surface (pumped-water) conductivity and temperature. Salinity and sound velocity can also be computed.

Dataset-specific Instrument Name	Radiometer
Generic Instrument Name	Radiometer
Dataset-specific Description	Radiometry was done using a Satlantic 7 channel microSAS system with Es, Lt and Li sensorsProduct Brochure
Generic Instrument Description	Radiometer is a generic term for a range of instruments used to measure electromagnetic radiation (radiance and irradiance) in the atmosphere or the water column. For example, this instrument category includes free-fall spectral radiometer (SPMR/SMSR System, Satlantic, Inc), profiling or deck cosine PAR units (PUV-500 and 510, Biospherical Instruments, Inc). This is a generic term used when specific type, make and model were not specified.

Dataset-specific Instrument Name	Triplet
Generic Instrument Name	Wet Labs ECO Triplet
Dataset-specific Description	WETLabs ECOTripletProduct Brochure
Generic Instrument Description	The Wet Labs ECO Triplet is a special-order, three-optical-sensor instrument available from WET Labs (wetlabs.com) in a user-defined configuration. The Triplet addresses the need for multiple simultaneous scattering and fluorescence sensors for autonomous vehicles and unattended measurement platforms. For example, possible configurations include any combination of three of the following: Blue scattering, Green scattering, Red scattering, Chlorophyll fluorescence, CDOM fluorescence, Phycoerythrin fluorescence, Phycocyanin fluorescence, Rhodamine fluorescence, or Uranine (fluorescein) fluorescence.

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Deployments

MV1101

Website	https://www.bco-dmo.org/deployment/473222
Platform	R/V Melville
Start Date	2011-01-11
End Date	2011-02-16
Description	Original data are available from the NSF R2R data catalog **Methods & Sampling** Data header from original file: /begin_header /affiliations=Bigelow_Laboratory_for_Ocean_Sciences /investigators=William_Balch /contact=bbalch@bigelow.org /experimer /fields=date,time,lat,lon,Wt,sal,chl,bbp532,es412,es443,es490,es510,es531,es555,es670,Lt412,Lt443,Lt490,Lt510,Lt531,Lt555,Lt670,Lsky412,Lsky443,Lsky490,Lsky5 /units=yyyymmdd,hh:mm:ss,degrees,degrees,degreesC,PSU,mg/m^3,1/m,uW/cm^2/nm,uW/cm^2/nm,uW/cm^2/nm,uW/cm^2/nm,uW/cm^2/nm,uW/cm^2/nm,uW/c /delimiter=tab /documents=readme.txt /data_file_name=mv1101.xls /data_status=preliminary /measurement_depth=5 /missing=-999 /water_depth=NA /wind_speed=N

RR1202

Website	https://www.bco-dmo.org/deployment/473230
Platform	R/V Roger Revelle
Start Date	2012-02-18
End Date	2012-03-23
Description	Original data are available from the NSF R2R data catalog **Methods & Sampling** Data header from original file: /begin_header /affiliations=Bigelow_Laboratory_for_Ocean_Sciences /investigators=William_Balch /contact=bbalch@bigelow.org /experimer /fields=date,time,lat,lon,Wt,sal,chl,bbp532,es412,es443,es490,es510,es531,es555,es670,Lt412,Lt443,Lt490,Lt510,Lt531,Lt555,Lt670,Lsky412,Lsky443,Lsky490,Lsky5 /units=yyyymmdd,hh:mm:ss,degrees,degrees,degreesC,PSU,mg/m^3,1/m,uW/cm^2/nm,uW/cm^2/nm,uW/cm^2/nm,uW/cm^2/nm,uW/cm^2/nm,uW/cm^2/nm,uW/c /delimiter=tab /documents=readme.txt /data_file_name=AMTrr1202.xls /data_status=preliminary /measurement_depth=5 /missing=-999 /water_depth=NA /wind_speed

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Project Information

The Great Southern Coccolithophore Belt (Great Calcite Belt)

Website: http://greatbeltresearchcruise.com/gbr11/

Coverage: Southern Ocean. 60W to 120E; 30S to 60S;

Collaborative Research: The Great Southern Coccolithophore Belt

Intellectual merit: Recent advances in satellite remote sensing enable estimation of suspended calcium carbonate (particulate inorganic carbon or 'PIC') from space. This radiative approach is operationally specific to marine coccolithophores (Haptophyceae) and sensitive enough to quantify PIC concentrations in oligotrophic gyres. Global images of suspended PIC taken over the seven years of the MODIS Aqua mission show a 'Great Belt' of PIC near the sub-Antarctic front of the Southern Ocean that circles the globe. This feature occurs every year during austral summer and appears to be within the high-nutrient, low chlorophyll region of the Southern Ocean. The area of the Great Belt is ~88 million km2, 26% of the global ocean. Evidence from several cruises into the Great Belt region of the Atlantic, Indian and Pacific sectors has verified elevated concentrations of coccolithophores; previous work in the Atlantic sector verified high optical scattering from PIC. The few ship observations we have are entirely consistent with the satellite views. In this project, the investigators will systematically study the coccolithophores of the Great Belt guided by the following science goals: (a) identify the coccolithophore species within this belt; (b) measure the abundance of coccolithophores and associated PIC; (c) measure coccolithopore calcification rates; (d) elucidate factors that may limit coccolithophore latitudinal range (e.g. stratification, temperature, macronutrients, trace metals, grazing); (e) demonstrate whether the variability in PIC relates to shallow export flux; (f) define how variability in PIC production relates to the pCO2, total alkalinity and dissolved inorganic carbon budgets; and (g) examine the impact of short-term ocean acidification on coccolithophore growth and calcite dissolution.

The research will involve cruises along the 50 S parallel to sample the Great Belt, during the austral summer. The investigators will use a combination of underway surface sampling (primarily optical and hydrographic) and vertical station profiles (using CTD/rosette and large volume submersible pumps) to address hypotheses related to the above goals. The cruise track will elucidate both zonal and meridional variability in the Great Belt. Controlled carboy incubation experiments will examine the impact of ocean acidification at various future scenarios on coccolithophore growth and dissolution. Dilution experiments will address grazing-related mortality and dissolution questions. Controlled metal-addition incubations will focus on potential iron, zinc and cobalt limitation of the coccolithophores or competition from diatoms related to silica availability. The proposed field observations and metal-addition experiments will provide important information on the current status of the Great Belt in the context of global biogeochemistry. The ocean acidification experiments to be undertaken are more forward-looking in terms of the fate of the Southern Ocean coccolithophores in a future acidified ocean.

Broader impacts: The globally significant size of the Great Belt indicates that it likely plays a major role in global biogeochemistry and climate change feedbacks. Thus, the investigators expect this work to have broad, transformative impacts in biological and chemical oceanography. Ocean acidification from the burning of fossil fuels is predicted to lower the pH of the surface ocean by 0.3 units in the next century and up to 0.7 units - a 5-fold increase in the proton concentration by the year 2300. A major goal of this study is to examine the effects of ocean acidification on coccolithophores in a region of low calcite saturation (i.e., one of the first regions expected to become sub-saturating for calcite). The results of these experiments will therefore be highly relevant to our basic understanding of the marine carbon cycle. Related to career development and Criterion II activities, the project includes field experience on two cruises for NSF REU undergraduates from Maine universities or colleges, providing funds for them to attend a scientific meeting. Participation of undergraduate students from Maine colleges builds capacity in our rural coastal state and helps thwart the serious issue of 'brain drain', in which the best students are leaving Maine to seek opportunity in wealthier, more populated states. A teacher will also participate on the cruises (via the NSF-sponsored ARMADA program). This teacher will develop learning modules for students about such topics as coccolithophores, calcification, export production, metal-plankton interactions, ocean acidification and climate change.

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH

Balch, WM; Drapeau, DT; Bowler, BC; Lyczskowski, E; Booth, ES; Alley, D. "The contribution of coccolithophores to the optical and inorganic carbon budgets during the Southern Ocean Gas Exchange Experiment: New evidence in support of the "Great Calcite Belt" hypothesis," *JOURNAL OF GEOPHYSICAL RESEARCH-OCEANS*, v.116, 2011. View record at Web of Science

Poulton, AJ; Young, JR; Bates, NR; Balch, WM. "Biometry of detached Emiliania huxleyi coccoliths along the Patagonian Shelf," *MARINE ECOLOGY-PROGRESS SERIES*, v.443, 2011, p. 1. View record at Web of Science

BOOKS/ONE TIME PROCEEDING

Brown, Michael S, W. Balch, S. Craig, B. Bowler, D. Drapeau, J. Grant. "Optical closure within a Patagonian Shelf coccolithhophore bloom", 06/01/2011-05/31/2012, 2012, "ACCESS'12. Atlantic Canada Coastal & Estuarine Science Society. Dalhousie University, Halifax, Nova Scotia. 10-13 May, 2012.".

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0961660

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