Trichodesmium species in the North Atlantic from R/V Oceanus OC469-01 in the NW Atlantic, Woods Hole to Barbados from October 2010 (Trichodesmium project)

Website: https://www.bco-dmo.org/dataset/472813
Version: 2014-04-08

Project
» Quantification of Trichodesmium spp. vertical and horizontal abundance patterns and nitrogen fixation in the western North Atlantic (Trichodesmium)

Program
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
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Dataset Description

At each station, CTD casts measured temperature, salinity and PAR. Water samples collected at depths of 700, 500, 300, 200, 100, 80, 60, 40, 20 m, and the surface were filtered and preserved for nutrient analysis. In the upper 80 m, water samples were gravity filtered and preserved for microscopic enumeration of both Trichodesmium colonies and free trichomes. For each nitrogen fixation sample, the number of puffs, number of rafts, and amount of carbon was measured. Individual carbon per colony values were estimated by regressing carbon content with number of puffs and number of rafts. Bowtie carbon content per colony was assumed the same as puff carbon per colony.

The sampling program included daily stations with associated nitrogen fixation experiments beginning at approximately 10:00 a.m. local time. Trichodesmium colonies for on-board incubation experiments and genetic assays were picked individually with pipettes from water collected at the surface (5-15 m) and at depth (20-70 m). Surface and deep samples were collected by pumping water through a 150 µm sieve on OC469 and by MOCNESS with 150 µm nets on OC471. Additional surface samples were taken by net tow (150 µm) on both cruises. After initial collection, the largest and most intact individual colonies were isolated using eyedroppers and transferred to filtered seawater for incubation experiments in order to assemble sufficient biomass to produce measurable rates. Nitrogen fixation was measured by acetylene reduction assay (Capone and Montoya, 2001).

Related References:

Capone, D. G. and J. P. Montoya, 2001: Nitrogen fixation and denitrification. Marine Microbiology, J. H. Paul, Ed., Academic Press, Methods in Microbiology, Vol. 30, 501-515, doi: http://dx.doi.org/10.1016/S0580-9517(01)30060-0, URL: http://www.sciencedirect.com/science/article/pii/S0580951701300600.

Related Dataset:

Tricho N Atlantic - OC471: http://www.bco-dmo.org/dataset/505567

Data Processing Description

See Nutrients Detection Limit (DL) and Quality Limit (QL): OC469 and OC471 (pdf)

See Experimental Treatment Codes (OC469) (pdf)

See OC469 CN Molar CN ID codes (pdf)

See Readme file (pdf)

See data corrections file (pdf)

Significance code descriptions:

1 - Values that were not statistically significant (e.g. slopes were not statistically greater than zero as determined using Prism software) - these cells were formatted bold, italic in the original data file.

2 - Values that were not statistically significant (e.g. slopes were not statistically greater than zero as determined using Prism software) - these cells were formatted bold, italic in the original data file. DEAD? (oc471, st15, 6 points)

3 - Monica Ruoco: not considered. They might be almost dead (oc469, st13)

nd - no notes

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Data Files

File
tricho_oc469_8apr2014.csv (Comma Separated Values (.csv), 189.61 KB) MD5:ec68e1623fda7b730bda0ecb22fad591 Primary data file for dataset ID 472813

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Parameters

Parameter	Description	Units
station	station number	unitless
cast	CTD cast number	unitless
date	CTD date	yyyymmdd
time	CTD time	hhmm
year	year	unitless
month	month	unitless
day	day	unitless

yrday_gmt	GMT day and decimal time; as 326.5 for the 326th day of the year or November 22 at 1200 hours (noon)	unitless
inst_Tricho	Trichodesmium sampling instrument (pump or net)	unitless
cast2	pump cast number	unitless
date_cast2	pump date	yyyymmdd
time_cast2	pump time	hhmm
lat_cast2	pump station latitude; north is positive	decimal degrees
lon_cast2	pump station longitude; east is positive	decimal degrees
lat	CTD latitude	decimal degrees
lon	CTD longitude	decimal degrees
depth_n	nominal depth	meters
press	pressure	decibars
num_BTL	# of .BTL values used to compute average CTD pressure temperature salinity etc reported for that depth entry in the bottle file. [.BTL files are created by SeaBird CTD processing with average values for the time each bottle was tripped.]	unitless
NH4	ammonium concentration	microMolar
NO3_NO2	nitrate and nitrite concentration	microMolar
DIN	dissolved inorganic nitrogen concentration	microMolar
TDN	total dissolved nitrogen concentration	microMolar
DON	dissolved organic nitrogen concentration	microMolar
TDP	total dissolved phosphorus concentration	microMolar
PO4	Phosphate concentration	microMolar
DOP	dissolved organic phosphorous concentration	microMolar
Si	silicate concentration	microMolar
PO4_P_flag	PO4-P low level dissolved inorganic phosphate (LLDIP) assay marker: 1 = LLDIP was used (typically in upper ocean samples); 0 = the standard method was used (typically deeper samples where DIP is higher). See nutrient detection limit note (pdf) in Processing section.	unitless
O2_ml_L	dissolved oxygen concentration	milliliters/liter
sal	salinity from primary sensor	practical salinity units
sal2	salinity from secondary sensor	practical salinity units
density	sigma-theta density from primary sensor	kilograms/meter^3
density2	sigma-theta density from secondary sensor	kilograms/meter^3
temp	temperature from primary sensor	degrees Celsius
temp2	temperature from secondary sensor	degrees Celsius
cond	conductivity from primary sensor	Siemens/meter
cond2	conductivity from secondary sensor	Siemens/meter
fluor	fluorescence	milligrams/m^3
trans	beam transmission	percent
alt	altitude	meters

par	PAR/Irradiance	microEinsteins/*cm*^2/second
spar	SPAR/Surface Irradiance	microEinsteins/*cm*^2/second
turbidity	turbidity	Nephelometric Turbidity Units (NTU)
O2_v	oxygen voltage	volts
AP_activity	Water column alkaline phosphatase activity	nanomoles Phosphate/hour/liter
chl_a	chlorophyll	micrograms/liter
Trich_AP_mix	Trichodesmium AP Activity - Mixed	nanomoles Phosphorus/hour/colony
Trich_AP_puff	Trichodesmium AP Activity - Puffs	nanomoles Phosphorus/hour/colony
Trich_AP_raft	Trichodesmium AP Activity - Rafts	nanomoles Phosphorus/hour/colony
light_insitu	in situ light level	microEinsteins
light_incub	incubation light level	microEinsteins
temp_incub	incubation temperature	degrees Celsius
Nfix_colony_1	N fixation rate - colony 1	nanomoles Nitrogen/hour/colony
Nfix_colony_1_sig	significance code: see codes in Processing section	unitless
Nfix_colony_2	N fixation rate - colony 2	nanomoles Nitrogen/hour/colony
Nfix_colony_2_sig	significance code: see codes in Processing section	unitless
Nfix_colony_3	N fixation rate - colony 3	nanomoles Nitrogen/hour/colony
Nfix_colony_3_sig	significance code: see codes in Processing section	unitless
Nfix_colony_avg	average colony nitrogen fixation rate	nanomoles Nitrogen/hour/colony
Nfix_colony_avg_sd	standard deviation of colony average nitrogen fixation rate	nanomoles Nitrogen/hour/colony
num_rafts_1	number rafts - replicate 1	rafts
num_rafts_2	number rafts - replicate 2	rafts
num_rafts_3	number rafts - replicate 3	rafts
num_puffs_1	number puffs - replicate 1	puffs
num_puffs_2	number puffs - replicate 2	puffs
num_puffs_3	number puffs - replicate 3	puffs
Nfix_C_1	nitrogen fixation rate - replicate 1	micromoles Nitrogen/hour/mole Carbon
Nfix_C_1_sig	significance code: see codes in Processing section	unitless
Nfix_C_2	nitrogen fixation rate - replicate 2	micromoles Nitrogen/hour/mole Carbon
Nfix_C_2_sig	significance code: see codes in Processing section	unitless
Nfix_C_3	nitrogen fixation rate - replicate 3	micromoles Nitrogen/hour/mole Carbon
Nfix_C_3_sig	significance code: see codes in Processing section	unitless

Nfix_C_avg	average nitrogen fixation rate	micromoles Nitrogen/hour/mole Carbon
Nfix_C_sd	standard deviation of nitrogen fixation rate	micromoles Nitrogen/hour/mole Carbon
expt_code	experimental treatment code. See notes (pdf) in Processing section	unitless
Nfix_exp_colony_1	experimental nitrogen fixation rate - colony 1	nanomoles Nitrogen/hour/colony
Nfix_exp_colony_2	experimental nitrogen fixation rate - colony 2	nanomoles Nitrogen/hour/colony
Nfix_exp_colony_3	experimental nitrogen fixation rate - colony 3	nanomoles Nitrogen/hour/colony
Nfix_exp_colony_avg	average colony experimental nitrogen fixation rate	nanomoles Nitrogen/hour/colony
Nfix_exp_colony_sd	standard deviation of colony experimental nitrogen fixation rate	nanomoles Nitrogen/hour/colony
Nfix_exp_C_1	experimental nitrogen fixation rate - replicate 1	micromoles Nitrogen/hour/mole Carbon
Nfix_exp_C_2	experimental nitrogen fixation rate - replicate 2	micromoles Nitrogen/hour/mole Carbon
Nfix_exp_C_2_sig	significance note: see codes in Processing section	unitless
Nfix_exp_C_3	experimental nitrogen fixation rate - replicate 3	micromoles Nitrogen/hour/mole Carbon
Nfix_exp_C_avg	average experimental nitrogen fixation rate	micromoles Nitrogen/hour/mole Carbon
Nfix_exp_C_sd	standard deviation of experimental nitrogen fixation rate	micromoles Nitrogen/hour/mole Carbon
num_rafts_exp_1	number of rafts in experimental treatment - replicate 1	rafts
num_rafts_exp_2	number of rafts in experimental treatment - replicate 2	rafts
num_rafts_exp_3	number of rafts in experimental treatment - replicate 3	rafts
num_puffs_exp_1	number of puffs in experimental treatment - replicate 1	puffs
num_puffs_exp_2	number of puffs in experimental treatment - replicate 2	puffs
num_puffs_exp_3	number of puffs in experimental treatment - replicate 3	puffs
CNMolarC_N_id	molar carbon to nitrogen ratio identification codes???	unitless
C_exp_colony	carbon content per colony in experimental treatment	micromoles Carbon
N_exp_colony	nitrogen content per colony in experimental treatment	micromoles Nitrogen
C_to_N_exp_colony	carbon to nitrogen ratio per colony in experimental treatment	unitless
num_colony_puff	number of puff colony forms	colonies
num_colony_raft	number of raft colony forms	colonies
num_colong_bow	number of bowtie colony forms	colonies
num_colony_totl	number of total colony forms	colonies
filament_free	number of free filaments	filaments
vol_filt_colony_filamt	volume filtered for colonies and filaments	liters

ISODateTime_UTC	Date/Time (UTC) ISO formatted. E.g., 2009-08-30T14:05:00[.xx]Z (UTC time)	YYYY-MM-DDTHH:MM:SS[.xx]Z

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Instruments

Dataset-specific Instrument Name	CTD
Generic Instrument Name	CTD - profiler
Dataset-specific Description	SeaBird 911+ Rosette 24-position, 10-liter bottle Rosette with dual T/C sensors At each station, CTD casts measured temperature, salinity and PAR. Water samples collected at depths of 700, 500, 300, 200, 100, 80, 60, 40, 20 m, and the surface were filtered and preserved for nutrient analysis.
Generic Instrument Description	The Conductivity, Temperature, Depth (CTD) unit is an integrated instrument package designed to measure the conductivity, temperature, and pressure (depth) of the water column. The instrument is lowered via cable through the water column. It permits scientists to observe the physical properties in real-time via a conducting cable, which is typically connected to a CTD to a deck unit and computer on a ship. The CTD is often configured with additional optional sensors including fluorometers, transmissometers and/or radiometers. It is often combined with a Rosette of water sampling bottles (e.g. Niskin, GO-FLO) for collecting discrete water samples during the cast. This term applies to profiling CTDs. For fixed CTDs, see https://www.bco-dmo.org/instrument/869934.

Dataset-specific Instrument Name	LI-COR Biospherical PAR
Generic Instrument Name	LI-COR Biospherical PAR Sensor
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	PAR sensor
Generic Instrument Name	Photosynthetically Available Radiation Sensor
Dataset-specific Description	Biospherical underwater PAR (1000m depth limit) with reference Surface PAR
Generic Instrument Description	A PAR sensor measures photosynthetically available (or active) radiation. The sensor measures photon flux density (photons per second per square meter) within the visible wavelength range (typically 400 to 700 nanometers). PAR gives an indication of the total energy available to plants for photosynthesis. This instrument name is used when specific type, make and model are not known.

Dataset-specific Instrument Name	Plankton Net
Generic Instrument Name	Plankton Net
Dataset-specific Description	150 micron mesh on a 1-meter ring net
Generic Instrument Description	A Plankton Net is a generic term for a sampling net that is used to collect plankton. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	Pressure Sensor
Generic Instrument Name	Pressure Sensor
Dataset-specific Description	Digiquartz
Generic Instrument Description	A pressure sensor is a device used to measure absolute, differential, or gauge pressures. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	
Generic Instrument Name	Pump
Dataset-specific Description	On OC-469-01, seawater from surface and deep samples were pumped through a 150 micron sieve.
Generic Instrument Description	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

Dataset-specific Instrument Name	SBE-43 DO
Generic Instrument Name	Sea-Bird SBE 43 Dissolved Oxygen Sensor
Generic Instrument Description	The Sea-Bird SBE 43 dissolved oxygen sensor is a redesign of the Clark polarographic membrane type of dissolved oxygen sensors. more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Seapoint Turbidity
Generic Instrument Name	Seapoint Turbidity Meter
Generic Instrument Description	The Seapoint Turbidity Meter detects light scattered by particles suspended in water, generating an output voltage proportional to turbidity or suspended solids.

Dataset-specific Instrument Name	Transmissometer
Generic Instrument Name	Transmissometer
Dataset-specific Description	Wet Labs C*Star transmissometer (660nm wavelength)
Generic Instrument Description	A transmissometer measures the beam attenuation coefficient of the lightsource over the instrument's path-length. This instrument designation is used when specific manufacturer, make and model are not known.

Dataset-specific Instrument Name	ECO AFL/FL
Generic Instrument Name	Wet Labs ECO-AFL/FL Fluorometer
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

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Deployments

OC469-01

Website	https://www.bco-dmo.org/deployment/473009
Platform	R/V Oceanus
Start Date	2010-10-02
End Date	2010-10-22
Description	Project: Trichodesmium spp. Abundance Patterns and Nitrogen Fixation Cruise information and original data are available from the NSF R2R data catalog.

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Project Information

Quantification of Trichodesmium spp. vertical and horizontal abundance patterns and nitrogen fixation in the western North Atlantic (Trichodesmium)

The diazotroph Trichodesmium spp. constitutes a major pathway of nitrogen flow into marine planktonic ecosystems, but estimates of its impact on global nitrogen budgets vary widely. Sampling is made difficult by the fragility of the organism with the consequence that Trichodesmium spp. are difficult to manipulate in both field and laboratory experiments. Optical methods that sample the organism nondestructively are thus appealing. A recent transatlantic survey using the Video Plankton Recorder (VPR) revealed unexpectedly high

abundance of Trichodesmium spp. at depth, suggesting the vertical distribution of the organism within the euphotic zone may be more uniform than previously thought (Davis, C.S. and McGillicuddy, D.J., 2006. Transatlantic Abundance of the N2-Fixing Colonial Cyanobacterium Trichodesmium. Science, 312: 1517-1520). Application of a simple bio-optical model of productivity to the observed profile of abundance suggests the depth-integrated nitrogen fixation rate could be three to five times higher than that based on the canonical profile of exponential decrease in abundance with depth. However, the observations described in Davis and McGillicuddy (2006) come from a latitude range where Trichodesmium spp. are not especially abundant. This raises a key question: is there a similar vertical distribution in waters further to the south, where Trichodesmium spp. are an order of magnitude more abundant overall? If so, are the deep populations actively fixing nitrogen? If so, the implications for the global nitrogen budget would be substantial.

To answer these questions, we propose two cruises to survey the waters of the southern Sargasso Sea and tropical Atlantic, where Trichodesmium spp. are commonly found in high abundance. Along-track VPR measurements will document the abundance and distribution of the organism on the scale of meters to thousands of kilometers. Standard hydrographic station work will provide for comparison of VPR-based estimates with microscope counts, as well as some additional in situ optical methods. A combination of nifH gene expression assays and direct determinations of N2-fixation rates will be made to assess whether or not the deep populations are actively fixing nitrogen. These observations will be synthesized in the context of an eddy-resolving numerical model. This will permit investigation of the mechanisms controlling the vertical and horizontal distribution and abundance of Trichodesmium spp. at multiple scales, including the enigmatic association of relative maxima in abundance with anticyclonic eddies (also described in Davis and McGillicuddy, 2006). Moreover, integration of these observations into the numerical model will facilitate revised estimates of nitrogen fixation by Trichodesmium spp. in the North Atlantic. The intellectual merit of this effort stems from our interdisciplinary approach (physics and biology), advanced observational techniques (optical imaging, molecular methods) and integrated analysis in the context of state-of-the-art coupled physical-biogeochemical models.

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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-0925284

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