# Trichodesmium species in the North Atlantic from R/V Oceanus OC471-01 in the NW Atlantic: Woods Hole to Barbados from April 2011 (Trichodesmium project)

**Website**: https://www.bco-dmo.org/dataset/505567
**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 |
|---|---|---|
| McGillicuddy, Dennis J. | Woods Hole Oceanographic Institution (WHOI) | Chief Scientist, Principal Investigator |
| Davis, Cabell S. | Woods Hole Oceanographic Institution (WHOI) | Co-Principal Investigator |
| Dyhrman, Sonya T. | Woods Hole Oceanographic Institution (WHOI) | Co-Principal Investigator |
| Waterbury, John | Woods Hole Oceanographic Institution (WHOI) | Co-Principal Investigator |
| Kosnyrev, Olga | Woods Hole Oceanographic Institution (WHOI) | Data Manager |
| Copley, Nancy | Woods Hole Oceanographic Institution (WHOI BCO-DMO) | BCO-DMO Data Manager |

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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 - OC469: http://www.bco-dmo.org/dataset/472813

**Data Processing Description**

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

See Experimental Treatment Codes (OC471) (pdf)

See Readme 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_oc471_8apr2014.csv** (Comma Separated Values (.csv), 126.49 KB) MD5:5af994f3a3449df7a43e7fbb722ae8b1 Primary data file for dataset ID 505567 |

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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 |
| lat | CTD latitude (degN) | decimal degrees |
| lon | CTD longitude (degW) | decimal degrees |
| depth_n | Nominal depth (m) | meters |
| press | pressure | decibars |
| num_BTL | # of .BTL values used to compute average CTD press;Temp;Sal 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 phosphorus 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 | kilgrams/meter^3 |
| density2 | sigma-theta density from secondary sensor | kilgrams/meter^3 |
| O2_umol_kg | dissolved oxygen concentration | micromoles/kilogram |
| O2_sat_pcent | Saturation of oxygen | percent |
| 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/centimeter^2/second |
| spar | SPAR/Surface Irradiance | microEinsteins/centimeter^2/second |
| turbidity | turbidity | Nephelometric Turbidity Units (NTU) |
| O2_v | oxygen voltage | volts |

| | | |
|---|---|---|
| AP_activity | Water column alkaline phosphatase activity | nanomoles Phosphate/hour/liter |
| AP_activity_sig | significance note for Trichodesmium AP Activity - Mixed | unitless |
| chl_a | chlorophyll | micrograms/liter |
| inst_Tricho | Trichodesmium sampling instrument (MOCNESS or net) | unitless |
| cast2 | MOCNESS cast number | unitless |
| date_cast2 | MOCNESS date | yyyymmdd |
| time_cast2 | MOCNESS time | hhmm |
| lat_cast2 | MOCNESS station latitude; north is positive | decimal degrees |
| lon_cast2 | MOCNESS station longitude; east is positive | decimal degrees |
| Trich_AP_mix | Trichodesmium AP Activity - Mixed | 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_avg | average N fixation rate - colonies | nanomoles Nitrogen/hour/colony |
| Nfix_colony_avg_sig | significance code: see codes in Processing section | unitless |
| Nfix_colony_avg_sd | standard deviation N fixation rate - colonies | nanomoles Nitrogen/hour/colony |
| Nfix_colony_sd_sig | significance code: see codes in Processing section | unitless |
| 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 |
| C_colony_1 | carbon content per colony - replicate 1 | micromoles Carbon |
| C_colony_2 | carbon content per colony - replicate 2 | micromoles Carbon |
| C_colony_3 | carbon content per colony - replicate 3 | micromoles Carbon |
| Nfix_C_1 | nitrogen fixation rate - replicate 1 | micromoles Nitrogen/hour/mole Carbon |
| Nfix_C_2 | nitrogen fixation rate - replicate 2 | micromoles Nitrogen/hour/mole Carbon |
| Nfix_C_3 | nitrogen fixation rate - replicate 3 | micromoles Nitrogen/hour/mole Carbon |

| | | |
|---|---|---|
| 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_1_sig | significance note: see codes in Processing section | unitless |
| Nfix_exp_colony_2 | experimental nitrogen fixation rate - colony 2 | nanomoles Nitrogen/hour/colony |
| Nfix_exp_colony_2_sig | significance note: see codes in Processing section | unitless |
| 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 |
| 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 |
| C_exp_colony_1 | carbon content per colony in experimental treatment - replicate 1 | micromoles Carbon per colony |
| C_exp_colony_2 | carbon content per colony in experimental treatment - replicate 2 | micromoles Carbon per 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_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_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 |

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## Instruments

| | |
|---|---|
| **Dataset-specific Instrument Name** | CTD |
| **Generic Instrument Name** | CTD - profiler |
| **Dataset-specific 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. |
| **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** | MOC.25 |
| **Generic Instrument Name** | MOCNESS.25 |
| **Dataset-specific Description** | MOCNESS-1/4 nets had 150 micron mesh. |
| **Generic Instrument Description** | The Multiple Opening/Closing Net and Environmental Sensing System or MOCNESS is a family of net systems based on the Tucker Trawl principle. The MOCNESS-1/4 carries nine 1/4-m2 nets usually of 64 micrometer mesh and is used to sample the larger micro-zooplankton. |

| | |
|---|---|
| **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** | SBE-43 DO |
| **Generic Instrument Name** | Sea-Bird SBE 43 Dissolved Oxygen Sensor |
| **Dataset-specific Description** | WS = 2 |
| **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** | Chelsea/Seatech/Wetlab Cstar |
| **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

**OC471-01**

| | |
|---|---|
| **Website** | https://www.bco-dmo.org/deployment/473010 |
| **Platform** | R/V Oceanus |
| **Start Date** | 2011-04-23 |
| **End Date** | 2011-05-13 |
| **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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