Phaeocystis colony counts from raw Digital Holographic Microscope images from casts on RVIB Nathaniel B. Palmer NBP1302, March 2013 (TRACERS project)

Website: https://www.bco-dmo.org/dataset/683038
Data Type: Cruise Results
Version: 1
Version Date: 2017-02-28

Project
» TRacing the fate of Algal Carbon Export in the Ross Sea (TRACERS)

Contributors	Affiliation	Role
Bochdansky, Alexander B.	Old Dominion University (ODU)	Principal Investigator
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Abstract
This dataset reports Phaeocystis colony counts from raw (unreconstructed) Digital Inline Holographic Microscope (DIHM) images collected in the Ross Sea on RV\N.B. Palmer cruise NBP-1302 in February and March 2013.

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Coverage

Spatial Extent: **N**:-66.66096 **E**:-135 **S**:-78.59056 **W**:164
Temporal Extent: 2013-03-01

Methods & Sampling

Digital inline holographic microscopy (DIHM): (from Bochdansky,et al (2017) JMS)

Details of the DIHM were published in Bochdansky et al. (2013). Briefly, a laser beam is focused on a 9 um single-mode optical fiber that serves as a small but intense point source of light. The expanding beam intercepts particles that create interfering shadow images on the adjacent screen of a high-resolution (4.2 megapixel) charge-coupled device (CCD) camera without a lens. The camera was connected to an eBOX530-820-FL1.6G-RC computer (Axiomtek) with a Gb LAN cable; images were recorded on a 750 GB hard disk at a frame rate of ~7-12 images per second. When the laser beam intercepts a structure, a portion of the image beam scatters and interferes with the light of the primary beam in a predictable pattern. This raw image represents a hologram that can then be reconstructed by applying the Kirchhoff–Helmholtz transform (Xu et

al., 2001) in commercially available reconstruction software (Octopus, 4-Deep Inwater Imaging, formerly Resolution Optics). Being lens-less, the advantage of this method is that anything in the 7-cm long image beam can be reconstructed without having to adjust the focus on the object. The entirety of the image beam volume (i.e., 1.8 ml in this configuration) can be reconstructed in this fashion, and thus explores orders of magnitude more volume than any lens-based system would at the same resolution. Reconstruction of the images and analysis (particle quantities, sizes, and type) were performed manually as no reliable image reconstruction and analysis system currently exists for this custom-built DIHM. The DIHM is well suited to detect hard structures (e.g., silica, chitin, calcium carbonate, strontium sulfate) to a resolution as small as 5 um, and reliably images particles of any composition from 50 um to ~8 um in the image volume (Bochdansky et al., 2013). The DIHM does not "see" transparent exopolymers (TEP), which can only be inferred from the distribution of finer particles suspended in that matrix. Even at speeds of 1.5 m s-1 through the water, our instrument yields sharp images (Bochdansky et al., 2013, 2017).

NOTE: Phaeocystis colonies, because of their dense structure, did not reconstruct well (Fig. 3); however, they have a very characteristic shape and texture even in the unreconstructed holograms (Fig. 1) that we were able to verify in tests with laboratory cultures of P. antarctica. Consequently, we were able to perform a detailed analysis on Phaeocystis colonies on all casts through all depths (including the surface mixed layer).

Fig. 1. Four Phaeocystis antarctica colonies in a single unreconstructed hologram (a), and after reconstruction of one colony (b). The image volume of an individual hologram is 1.8 ml, but the reconstruction can only visualize a specific image plane within that volume. We concluded that Phaeocystis colonies were sufficiently distinguishable and unique that unreconstructed images could be used for quantification. Poor reconstruction of Phaeocystis colonies makes exact size determination unreliable but colony diameters in field collections in the Ross Sea range from approximately 10 to 400 um (Mathot et al., 2000). DOI: 10.4319/lom.2013.11.28

Data Processing Description

The field of view of each image represents 1.8 ml. The number of observed colonies in each meter bin was divided by the number of images and by 1.8 to yield the number of Phaeocystis colonies per liter for each meter.

BCO-DMO Processing notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- reduced number of digits to right of decimal of cell counts from 7 to 1 due to sampling precision methods

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Data Files

File
Phaeocystis_counts.csv (Comma Separated Values (.csv), 1.65 MB) MD5:f85ff5663d5c65ccbc5485eaaa1f16ec Primary data file for dataset ID 683038

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Supplemental Files

File
Fig.1 Phaeocystis holograms filename: Fig1_hologram_phaeocystis_colonies.jpg (JPEG Image (.jpg), 63.47 KB) MD5:24291384059bd62e853c59da257a473e Four Phaeocystis antarctica colonies in a single unreconstructed hologram (a), and after reconstruction of one colony (b). The image volume of an individual hologram is 1.8 ml, but the reconstruction can only visualize a specific image plane within that volume. We concluded that Phaeocystis colonies were sufficiently distinguishable and unique that unreconstructed images could be used for quantification. Poor reconstruction of Phaeocystis colonies makes exact size determination unreliable but colony diameters in field collections in the Ross Sea range from approximately 10 to 400 µm (Mathot et al., 2000).

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Related Publications

Bochdansky, A. B., Clouse, M. A., & Hansell, D. A. (2017). Mesoscale and high-frequency variability of macroscopic particles (> 100 µm) in the Ross Sea and its relevance for late-season particulate carbon export. Journal of Marine Systems, 166, 120–131. doi:10.1016/j.jmarsys.2016.08.010
Methods

Bochdansky, A. B., Jericho, M. H., & Herndl, G. J. (2013). Development and deployment of a point-source digital inline holographic microscope for the study of plankton and particles to a depth of 6000 m. Limnology and Oceanography: Methods, 11(1), 28–40. doi:10.4319/lom.2013.11.28
Methods

Hansell, D. (2014). Ship-based Trackline Geophysical Data (MGD77) from the Southern Ocean acquired during the Nathaniel B. Palmer expedition NBP1302 (2013) (Version 1) [Data set]. Interdisciplinary Earth Data Alliance (IEDA). https://doi.org/10.1594/ieda/320064 https://doi.org/10.1594/IEDA/320064
Related Research

Hansell, D. (2014). Underway Hydrographic, Weather and Ship-state Data (JGOFS) from Nathaniel B. Palmer expedition NBP1302 (2013) (Version 1) [Data set]. Interdisciplinary Earth Data Alliance (IEDA). https://doi.org/10.1594/ieda/320062 https://doi.org/10.1594/IEDA/320062
Related Research

Hansell, D. (2015). Calibrated Hydrographic Data from the Southern Ocean acquired with a CTD during the Nathaniel B. Palmer expedition NBP1302 (2013) (Version 1) [Data set]. Interdisciplinary Earth Data Alliance (IEDA). https://doi.org/10.1594/ieda/320068 https://doi.org/10.1594/IEDA/320068
Related Research

Hansell, D. (2015). Raw XBT Expendable Probe Data from the Southern Ocean acquired during the Nathaniel B. Palmer expedition NBP1302 (2013) (Version 1) [Data set]. Interdisciplinary Earth Data Alliance (IEDA). https://doi.org/10.1594/ieda/320066 https://doi.org/10.1594/IEDA/320066
Related Research

Mathot, S., Smith, W. O., Carlson, C. A., Garrison, D. L., Gowing, M. M., & Vickers, C. L. (2000). CARBON PARTITIONING WITHIN PHAEOCYSTIS ANTARCTICA (PRYMNESIOPHYCEAE) COLONIES IN THE ROSS SEA, ANTARCTICA. Journal of Phycology, 36(6), 1049–1056. doi:10.1046/j.1529-8817.2000.99078.x
Related Research

Xu, W., Jericho, M. H., Meinertzhagen, I. A., & Kreuzer, H. J. (2001). Digital in-line holography for biological applications. Proceedings of the National Academy of Sciences, 98(20), 11301–11305. doi:10.1073/pnas.191361398
Methods

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Related Datasets

IsRelatedTo

Bochdansky, A. B. (2021) **Particle abundances and characteristics from the video plankton profiler with matching CTD data, from casts on RVIB Nathaniel B. Palmer NBP1302, Feb/Mar 2013 (TRACERS project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1)

Version Date 2017-02-28 doi:10.26008/1912/bco-dmo.683064.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
station	station number	unitless
julian_day	Julian Day in 2013	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
press	pressure	decibars
depth	depth	meters
Phaeocystis_L	Phaeocystis colonies	colonies/liter

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Instruments

Dataset-specific Instrument Name	DIHM
Generic Instrument Name	Digital inline holographic microscope
Dataset-specific Description	Used to count Phaeocystis colonies in situ.
Generic Instrument Description	A Digital Inline Holographic Microscope (DIHM) uses coherent (laser) light and a digital camera to image objects with micrometer scale resolution. A portion of the light scattered by illuminated objects interferes with incident light in a predictable manner. The resulting interference patterns projected onto a two-dimensional plane (i.e. digital camera sensor) are recorded as holograms. These digital holograms are then numerically reconstructed to produce an in-focus image at a given distance from the recording plane. A relatively large illuminated volume (>100 mL) can be reconstructed in this manner to produce a single image with an extended depth of field.

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Deployments

NBP1302

Website	https://www.bco-dmo.org/deployment/547873
Platform	RVIB Nathaniel B. Palmer
Report	http://dmoserv3.whoi.edu/data_docs/TRACERS/NBP1302_data_report.pdf
Start Date	2013-02-12
End Date	2013-04-05
Description	Ross Sea, Antarctica (53 days) RVIB Nathaniel B. Palmer : February-April 2013 McMurdo Station, Antarctica - Punta Arenas, Chile Project Title: “TRacing the fate of Algal Carbon Export in the Ross Sea” (TRACERS) Chief Scientist: Dennis Hansell, UM-RSMAS Project Description: The research focus of this cruise was to investigate the biogeochemistry associated after a phytoplankton bloom at the end of the Antarctic Austral Summer. I helped analyze and coordinate analyses of nutrients (silicic acid, phosphate, and nitrate) and collect samples for dissolved organic carbon (DOC). Note R2R Link takes user to Marine Geoscience Data System (MGDS): NBP1302 Nathaniel B. Palmer Systems and Specifications

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Project Information

TRacing the fate of Algal Carbon Export in the Ross Sea (TRACERS)

Coverage: Ross Sea

Sinking particles are a major element of the biological pump and they are commonly assigned to two fates: mineralization in the water column and accumulation at the seafloor. However, there is another fate of export hidden within the vertical decline of carbon, the transformation of sinking organic matter to fine suspended and/or dissolved organic fractions. This process has been suggested but has rarely been observed or quantified. As a result, it is presumed that the solubilized fraction is largely mineralized over short time scales. However, global ocean surveys of dissolved organic carbon are demonstrating a significant water column accumulation of organic matter under high productivity environments. This proposal will investigate the transformation of organic particles from sinking to solubilized phases of the export flux in the Ross Sea. The Ross Sea experiences high export particle production, low dissolved organic carbon export with overturning circulation, and the area has a predictable succession of production and export events. In addition, the basin is shallow (< 1000 m) so the products the PIs will target are relatively concentrated. To address the proposed hypothesis, the PIs will use both well-established and novel biochemical and optical measures of export production and its fate. The outcomes of this work will help researchers close the carbon budget in the Ross Sea.

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Funding

Funding Source	Award
NSF Division of Polar Programs (NSF PLR)	PLR-1142097

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