Particulate nutrients from phyto and microzooplankton experiments from the RVIB Nathaniel B. Palmer NBP0601 cruise in the Ross Sea, Southern Ocean from 2005-2006 (CORSACS project, Antarctic microzooplankton project)

Website: https://www.bco-dmo.org/dataset/505004
Version: 2014-03-06

Project
» Controls of Ross Sea Algal Community Structure (CORSACS)
» Rising climatic temperatures impact on antarctic microzooplankton growth and grazing (Antarctic microzooplankton)

Program
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
Rose, Julie	National Oceanic and Atmospheric Administration (NOAA-Milford)	Principal Investigator
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Dataset Description

Experimental Design

Experiments were conducted during the CORSACS (Controls On Ross Sea Algal Community Structure) expedition in January 2006 to the Ross Sea, Antarctica, onboard the RVIB Nathaniel B. Palmer (cruise NBP-0601). Water was collected at 75.00S, 177.36E using a trace metal clean towed-intake surface water Teflon diaphragm pumping system (Bruland et al., 2005). Water was prescreened through acid-washed 200µm Nitex mesh to eliminate large zooplankton and collected into a 50-L mixing carboy. Collected water was gently mixed and dispensed into 12 4.5-L and 12 2.7-L acid washed trace metal clean clear polycarbonate bottles for incubation. Half of the bottles were spiked with 1.0nM FeCl3 (final concentration) at the beginning of the experiment. Bottles were incubated in two temperature controlled deck-board incubators (Feng et al., 2009; Hare et al., 2007). Incubators were screened to 18% of Io using two layers of neutral density filter. One incubator was kept at ambient temperature (0 deg C), while the temperature in the other was gradually increased to 4 deg C over the course of 24 h. Bottles were incubated for seven days. The 4.5-L bottles were sampled daily and the 2.7-L bottles were only sampled on the final day of the experiment. All sampling occurred under a laminar flow hood using trace metal clean techniques.

References

Bruland, K.W., E.L. Rue, G.J. Smith, and G.R. DiTullio. 2005. Iron, macronutrients and diatom blooms in the Peru upwelling regime: brown and blue waters of Peru. Marine Chemistry 93: 81-103.

Feng, Y., C.E. Hare, K. Leblanc, G.R. DiTullio, P.A. Lee, S.W. Wilhelm, J. Sun, J.M. Rose, N. Nemcek, I. Benner, and D.A. Hutchins. 2009. The effects of increased pCO2 and temperature on the North Atlantic Spring Bloom: I. The phytoplankton community and biogeochemical response. Marine Ecology Progress Series 388: 13-25.

Hare, C.E., K. Leblanc, G.R. DiTullio, R.M. Kudela, Y. Zhang, P.A. Lee, S.F. Riseman, and D.A. Hutchins. 2007. Consequences of increased temperature and CO2 for phytoplankton community structure in the Bering Sea. Marine Ecology Progress Series 352: 9-16.

Methods & Sampling

Particulate nutrient Sampling:

Total particulate carbon and nitrogen samples (150–250 mL) were filtered at low vacuum onto GF/F filters that had been precombusted at 450oC for 2 h. Filters were then dried at 60oC. Samples were analyzed with a Finnigan Delta Plus mass spectrometer and a Carlo Erba NA1500 elemental analyzer/Conflo II. Elemental compositions were measured using the mass 44 beam intensity (V) on the Delta Plus and calibrated against the mass 44 beam intensity of at least five standards also analyzed during each run of 40 samples. Total particulate phosphorus samples (100–200 mL) were gently filtered onto precombusted GF/F filters and rinsed with 2 ml 0.12 mol L−1 Na2SO4. Filters were placed overnight in precombusted (450oC, overnight) 20mL borosilicate glass scintillation vials with 2mL 0.017 mol L−1 MnSO4. Vials were covered with aluminum foil, dried at 95oC and stored dessicated until analysis. Total particulate phosphorus content was determined as follows: vials and filters were combusted at 450oC for 2 h, cooled, and 5mL 0.2 mol L−1 HCl was added to each vial. Vials were capped and heated to 80oC for 30 min to digest particulate organic phosphorus into inorganic phosphate, and digested samples were analyzed using the standard molybdate colorimetric method (Solorzano and Sharp, 1980). Biogenic silica samples (100–250 mL) were gently filtered onto 0.6µm polycarbonate filters, dried at 60oC and stored at room temperature until analysis. Samples were analyzed according to Brzezinski and Nelson (1995).

References:

Bruland, K.W., E.L. Rue, G.J. Smith, and G.R. DiTullio. 2005. Iron, macronutrients and diatom blooms in the Peru upwelling regime: brown and blue waters of Peru. Marine Chemistry 93: 81-103.
Brzezinski, M.A., and D.M. Nelson. 1995. The annual silica cycle in the Sargasso Sea near Bermuda. Deep-Sea Research I 42: 1215-1237.
Buck, K.N., M.C. Lohan, C.J.M. Berger, and K.W. Bruland. 2007. Dissolved iron speciation in two distinct river plumes and an estuary: implications for riverine iron supply. Limnology and Oceanography 52: 843-855.
Donat, J.R., and K.W. Bruland. 1988. Direct determination of dissolved cobalt and nickel in seawater by differential pulse cathodic stripping voltammetry preceded by adsorptive collection of cyclohexane-1,2,-dione dioxime complexes. Analytical Chemistry 60.
Ellwood, M., and C.M.G. Van den Berg. 2000. Zinc speciation in the Northeastern Atlantic Ocean. Marine Chemistry 68: 295-306.
Solorzano, L., and J.H. Sharp. 1980. Determination of total dissolved phosphorus and particulate phosphorus in natural waters. Limnology and Oceanography 25: 756-760.

Data Processing Description

BCO-DMO Processing Notes:

- File was sorted by treatment
- Added lat,lon values of original water sampling location to file
- Added BCO-DMO header lines
- Parameter names were edited to conform with BCO-DMO convention

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Data Files

File
nuts_partic_ant1.csv (Comma Separated Values (.csv), 2.69 KB) MD5:28e0d2885d0683c0229c66d766ce2575 Primary data file for dataset ID 505004

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Parameters

Parameter	Description	Units
lat	Latitude component of geographic position where water was sampled.	decimal degrees
lon	Longitude component of geographic position where water was sampled.	decimal degrees
treatment	Experimental conditions varied during the experiment. Four treatments were used: High temperature, high iron (HTHF); High temperature, low iron (HTLF); Low temperature, high iron (LTHF); Low temperature, low iron (LTLF)	dimensionless
day	Sampling day during experiment. The experiment was conducted during January, 2006.	dimensionless
bottle	Experimental bottle number.	dimensionless
carbon_partic	Total particulate carbon.	micromolar
silica_biogenic	Biogenic silica.	micromolar
nitrogen_partic	Total particulate nitrogen.	micromolar
phosphorus_partic	Total particulate phosphorus.	micromolar

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Instruments

Dataset-specific Instrument Name	CHN_EA
Generic Instrument Name	CHN Elemental Analyzer
Dataset-specific Description	A Carlo Erba NA1500 elemental analyzer/Conflo II was used for analysis.
Generic Instrument Description	A CHN Elemental Analyzer is used for the determination of carbon, hydrogen, and nitrogen content in organic and other types of materials, including solids, liquids, volatile, and viscous samples.

Dataset-specific Instrument Name	Mass Spec
Generic Instrument Name	Mass Spectrometer
Dataset-specific Description	A Finnigan Delta Plus mass spectrometer was used for analysis.
Generic Instrument Description	General term for instruments used to measure the mass-to-charge ratio of ions; generally used to find the composition of a sample by generating a mass spectrum representing the masses of sample components.

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Deployments

NBP0601

Website	https://www.bco-dmo.org/deployment/57985
Platform	RVIB Nathaniel B. Palmer
Report	http://data.bco-dmo.org/CORSACS/cruises/Dunbar_Hydrography_report_NBP0601.pdf
Start Date	2005-12-17
End Date	2006-01-30
Description	This was the first of two Controls of Ross Sea Algal Community Structure (CORSACS) project cruises and was funded by the NSF Office of Polar Programs. The NBP0601 cruise was conducted in the Ross Sea in December 2005 and January 2006, Ross Sea, ca. 65.21°S-78.65°S, 164.98°E-164.70°W, and supported by NSF research grant, OPP-0338097. The 'Science Pan and Project Description' document includes details of the cruise sampling strategy. Related Files: Science Plan and Project Descriptions (PDF file)Cruise track map (PDF file)Photo of Ice Breaker Nathaniel B. Palmer on station near Beaufort Island (JPG image) Related Sites: MGDS catalog: http://www.marine-geo.org/tools/search/entry.php?id=NBP0601

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Project Information

Controls of Ross Sea Algal Community Structure (CORSACS)

Website: http://www.whoi.edu/sites/corsacs

Coverage: Ross Sea Southern Ocean

Project summary

The Controls of Ross Sea Algal Community Structure (CORSACS) project was funded by the NSF Office of Polar Programs as "Collaborative Research: Interactive Effects of Iron, Light and Carbon Dioxide on Phytoplankton Community Dynamics in the Ross Sea". Two cruises were completed in 2006 to investigate the interactions between the primary productivity of the Ross Sea and pCO2, iron and other trace elements. Data sets of carbon, nutrient, metal, and biological measurements will be reported.

The main objective in the proposed research was to investigate the relative importance and potential interactive

effects of iron, light and CO2 levels in structuring algal assemblages and growth rates in the Ross Sea. The investigators hypothesized that the interaction of these three variables largely determines the bottom-up control on these two dominant Southern Ocean phytoplankton taxa. While grazing and other loss processes are important variables in determining the relative dominance of these two taxa, the CORSACS research project was designed to focus on the bottom-up control mechanisms. It is important to understand such environmentally-driven taxonomic shifts in primary production, since they are expected to impact the fixation and export of carbon and nutrients, and the production of DMS, thus potentially providing both positive and negative feedbacks on climate.

The CORSACS investigators considered a range of ambient iron, light and pCO2 levels that span those typically observed in the Ross Sea during the growing season. That is, dissolved iron ranging from ~0.1 nM (low iron) to greater than 1 nM (high iron) (Fitzwater et al. 2000; Sedwick et al. 2000); mean irradiance (resulting from vertical mixing/self shading) ranging from less than 10% Io (low light) to greater than 40% (high light) (Arrigo et al., 1998, 1999), possibly adjusted based on field observations during the CORSACS cruises; and pCO2 ranging (Sweeney et al. 2001) from ~150 ppm (low CO2) to the probable higher levels of pCO2 - 750 ppm as a conservative estimate - that are likely to be attained later this century due to anthropogenic perturbation of the global carbon cycle (IPCC, 2001).

From the information previously available from both field observations and experiments, the investigators formulated the following specific hypotheses regarding the interactive role of iron, light and CO2 in regulating algal composition in the Ross Sea: diatoms bloom in the southern Ross Sea only under optimum conditions of high iron, light and pCO2; colonial Phaeocystis dominate under conditions of high iron with either (or both) low light or low pCO2; and solitary Phaeocystis are predominant under conditions of low iron with either (or both) low light or low pCO2.

References:

Fitzwater, S.E., K.S. Johnson, R.M. Gordon, K.H. Coale, and W.O. Smith, Jr. (2000). Trace metal concentrations in the Ross Sea and their relationship with nutrients and growth. Deep-Sea Research II, 47: 3159-3179.

Martin JH, Gordon RM, Fitzwater SE. Iron in Antarctic waters. Nature 1990 ;345(6271):156-158. Martin JH. 1990. Glacial-interglacial CO2 change: The iron hypothesis. Paleoceanography 5(1):1-13

P. N. Sedwick, G. R. DiTullio, and D. J. Mackey, Iron and manganese in the Ross Sea, Antarctica: Seasonal iron limitation in Antarctic shelf waters, Journal of Geophysical Research, 105 (C5), 11,321-11,336, 2000.

Sweeney, C. K. Arrigo, and G. van Gijken (2001). Prediction of seasonal changes in surface pCO2 in the Ross Sea, Antarctica using ocean color satellite data. 2001 Annual AGU meeting, San Fransisco, CA Dec. 10-15.

IPCC, 2001: Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of theIntegovernmental Panel on Climate Change [Watson, R.T. and the Core Writing Team (eds.)]. Cambridge University Press, Cambridge,United Kingdom, and New York, NY, USA, 398 pp.

Publications

Saito, M. A., Goepfert, T. J., Noble, A. E., Bertrand, E. M., Sedwick, P. N., and DiTullio, G. R.: A seasonal study of dissolved cobalt in the Ross Sea, Antarctica: micronutrient behavior, absence of scavenging, and relationships with Zn, Cd, and P, Biogeosciences, 7, 4059-4082, doi:10.5194/bg-7-4059-2010, 2010 (http://www.biogeosciences.net/7/4059/2010/bg-7-4059-2010.html)

Bertrand EM, Saito MA, Lee PA, Dunbar RB, Sedwick PN and DiTullio GR (2011) Iron limitation of a springtime bacterial and phytoplankton community in the Ross Sea: implications for vitamin B12 nutrition. Front. Microbio. 2:160. doi: 10.3389/fmicb.2011.00160 (http://www.frontiersin.org/Aquatic_Microbiology/10.3389/fmicb.2011.00160/abstract)

Rising climatic temperatures impact on antarctic microzooplankton growth and grazing (Antarctic microzooplankton)

Coverage: Ross Sea

The investigator will examine to what extent rising climatic temperatures impact antarctic microzooplankton

The investigator will examine to what extent rising climatic temperatures impact antarctic microzooplankton growth and grazing, and to what extent such an impact would modulate top-down control of phytoplankton growth in cold waters. The experimental part of the proposed work would take place in the Ross Sea, a permanently cold ecosystem, and the location of annual large-scale blooms of both diatoms and Phaeocystis antarctica. Changing climate regimes may alter current microzooplankton grazing rates on these blooms either directly through temperature increases or indirectly through algal community shifts. Complementary laboratory experiments on cultures of Antarctic microzooplankton will be conducted to determine the individual and combined effects of temperature and carbon dioxide levels on growth and grazing.

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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 Antarctic Sciences (NSF ANT)	PLR-0528715

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