Phytoplankton data 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/491098
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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
Hutchins, David A.	University of Southern California (USC)	Co-Principal Investigator
Kinkade, Danie	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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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

Chlorophyll a

Chlorophyll samples (50–250 mL) were filtered onto either a GF/F or a 20µm polycarbonate filter using low vacuum pressure. Samples were extracted for at least 24 h in the dark at −20 deg C in 90% acetone and read on a Turner Designs fluorometer (Welschmeyer, 1994).

Welschmeyer, N.A. 1994. Fluorometric analysis of chlorophyll a in the presence of chlorophyll b and phaeopigments. Limnology and Oceanography 39: 1985-1992.

Nanoplankton Abundance - Flow cytometry

Nanophytoplankton abundance was determined using flow cytometry. Two milliliters of sample were preserved in 1% seawater-buffered, 0.2 um-filtered formalin (final concentration) and frozen at −80 deg C until analysis. Samples were run on a FACSCalibur flow cytometer for 5 min on the high flow rate setting (Campbell, 2001). Nanophytoplankton were identified on two dimensional cytograms based on forward scatter (FSC) and red fluorescence (FL3).

Campbell, L. 2001. Flow cytometric analysis of autotrophic picoplankton. In Methods in Microbiology, 317-341: Academic Press.

Taxon-specific pigments - High Performance Liquid Chromatography

Samples for taxon-specific pigments (600–1000 mL) were filtered under low vacuum onto GF/F filters and frozen in liquid nitrogen until analysis using high performance liquid chromatography (HPLC). An automated Hewlett Packard 1100 HPLC system was used to separate pigments with a reverse-phase Waters Symmetry C-8 column and a solvent gradient containing methanol, aqueous pyridine, acetone, and acetonitrile (DiTullio and Geesey, 2002). A diode array detector was used to record pigment spectra between the wavelengths 350 and 600 nm, as well as continuous chromatograms at 410, 440, and 455 nm every 5 s, and Chl a and c were quantified with an HP 1046A fluorescence detector (excitation 421 nm, emission 666 nm). Unialgal laboratory cultures with the appropriate pigments were used to generate purified pigment standards for system calibration (DiTullio and Geesey, 2002).

DiTullio, G.R., and M.E. Geesey. 2002. Photosynthetic pigments in marine algae and bacteria. In Encyclopedia of Environmental Microbiology, ed. G. Bitton, 2453-2470. NY, NY: J. Wiley and Sons.

Maximum Quantum Yield Efficiency for PSII (Fv/Fm)

Photochemical efficiency of PSII was measured using a MBARI 4th generation bench-top fast repetition rate fluorometer (FRRF) (Kolber et al., 1994). Samples were collected each day from experimental bottles, immediately placed on ice and kept in low light conditions (5– 10 mol photons m−2 s−1) for 30–40 min prior to analysis. The light and cuvette chamber were constantly flushed with dry nitrogen gas to avoid condensation on the exterior of the cuvette due to the temperature difference between the cold seawater and the laboratory air. Minimal (F0) and maximal (Fm) fluorescence and the effective absorption cross section (σPSII) were calculated from each single turnover (ST) saturation curve. The maximum quantum yield efficiency for PSII (Fv/Fm) was calculated (Genty et al., 1989) by normalizing Fm by the difference between the fluorescence at saturation (Fm) and the minimum fluorescence (F0):

Genty, B., J.M. Briantais, and N.R. Baker. 1989. The relationship between the quantum yield of photosynthetic electron transport and quenching of chlorophyll fluorescence. Biochimica et Biophysica Acta 990: 87-92.

Kolber, Z.S., R.T. Barber, K.H. Coale, S.E. Fitzwater, R.M. Greene, K.S. Johnson, S. Lindley, and G.P. Falkowski. 1994. Iron limitation of the phytoplankton photosynthesis in the equatorial Pacific Ocean. Nature 371: 145-149.

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Data Files

File
phyto_all.csv (Comma Separated Values (.csv), 19.23 KB) MD5:309c7f480aa3a49d7e4bea58825579e7 Primary data file for dataset ID 491098

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Parameters

Parameter	Description	Units
experiment	Experimental data type, consisting of chlorophyll a, photosystem efficiency, nanophytoplankton abundance, and taxon specific phytoplankton pigment data.	dimensionless
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: Low temperature, low iron (LTLF); low temperature, high iron (LTHF); high temperature, low iron (HTLF); high temperature, high iron(HTHF)	dimensionless
day	Sampling day during experiment. The experiment was conducted during January, 2006.	dimensionless
bottle	Experimental bottle number.	dimensionless
filter_size	Filter pore size.	micrometers
chlorophyll_a	Chlorophyll a from 0.2 and 20 um size fractions.	ug/L
fucoxanthin	Concentration of fucoxanthin measured by HPLC.	ng/L
hex_19	Concentration of 19-hexanoyloxyfucoxanthin, measured by HPLC.	ng/L
Fv_Fm	Photochemical efficiency of photosystem II (PSII), expressed as a ratio of variable fluorescence (Fv) to maximum fluorescence (Fm).	dimensionless
abund_nanophyto	Nanophytoplankton abundance measured by flow cytometry.	cells/ml

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Instruments

Dataset-specific Instrument Name	FRRF
Generic Instrument Name	Fast Repetition Rate Fluorometer
Dataset-specific Description	Photochemical efficiency of PSII was measured using a MBARI 4th generation bench-top fast repetition rate fluorometer (FRRF).
Generic Instrument Description	An FRRf is used for measuring the fluorescence of a sample of phytoplankton photosynthetic competency (Fv/Fm).

Dataset-specific Instrument Name	Flow Cytometer
Generic Instrument Name	Flow Cytometer
Dataset-specific Description	Samples were run on a FACSCalibur flow cytometer.
Generic Instrument Description	Flow cytometers (FC or FCM) are automated instruments that quantitate properties of single cells, one cell at a time. They can measure cell size, cell granularity, the amounts of cell components such as total DNA, newly synthesized DNA, gene expression as the amount messenger RNA for a particular gene, amounts of specific surface receptors, amounts of intracellular proteins, or transient signalling events in living cells. (from: http://www.bio.umass.edu/micro/immunology/facs542/facswhat.htm)

Dataset-specific Instrument Name	Fluorometer
Generic Instrument Name	Fluorometer
Dataset-specific Description	A Turner Designs fluorometer was used to determine chlorophyll a concentrations.
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	HPLC
Generic Instrument Name	High-Performance Liquid Chromatograph
Dataset-specific Description	An automated Hewlett Packard 1100 HPLC system was used to separate taxon-specific pigments.
Generic Instrument Description	A High-performance liquid chromatograph (HPLC) is a type of liquid chromatography used to separate compounds that are dissolved in solution. HPLC instruments consist of a reservoir of the mobile phase, a pump, an injector, a separation column, and a detector. Compounds are separated by high pressure pumping of the sample mixture onto a column packed with microspheres coated with the stationary phase. The different components in the mixture pass through the column at different rates due to differences in their partitioning behavior between the mobile liquid phase and the stationary phase.

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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 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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