

Phytoplankton (Prochlorococcus, Synechococcus, and PEuKs) determined by flow cytometry of samples collected on R/V Thomas G. Thompson and R/V Kilo Moana cruises TN277, KM1301, KM1312 in the Eastern North Pacific Ocean from 2012-2013 (POWOW project)

Website: <https://www.bco-dmo.org/dataset/3901>

Data Type: Cruise Results

Version: 4

Version Date: 2014-09-10

Project

» [Seasonal and decadal changes in temperature drive Prochlorococcus ecotype distribution patterns](#)
(POWOW)

Contributors	Affiliation	Role
Johnson, Zackary I.	Duke University	Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract

This dataset quantifies phytoplankton (Prochlorococcus, Synechococcus, and PEuKs), determined by flow cytometry of samples collected on R/V Thomas G. Thompson and R/V Kilo Moana cruises TN277, KM1301, KM1312 in the Eastern North Pacific Ocean from 2012-2013.

Table of Contents

- [Coverage](#)
- [Dataset Description](#)
 - [Acquisition Description](#)
 - [Processing Description](#)
- [Related Publications](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Funding](#)

Coverage

Spatial Extent: N:46.6888 E:-118.316 S:21.3428 W:-160.6166

Temporal Extent: 2012-03-01 - 2013-07-27

Dataset Description

Phytoplankton concentrations from POWOW1 (TN277), POWOW2 (KM1301), and POWOW3 (KM1312) cruises including Prochlorococcus, Synechococcus and pico-photosynthetic eukaryotes (PEuKs) determined by flow cytometry.

Acquisition Description

Phytoplankton were enumerated using a FACSCalibur flow cytometer (Becton Dickinson) and populations characterized as previously described (Johnson et al., 2010). Briefly, cells were excited with a 488 nm laser (15 mW Ar) and inelastic forward ($<15^\circ$) scatter, inelastic side (90°) scatter (SSC), green (530 ± 30 nm) fluorescence, orange fluorescence (585 ± 42 nm), and red fluorescence (> 670 nm) emissions were measured. Populations were deemed 'phytoplankton' if they contained red-fluorescence, i.e. had a chlorophyll signal and were subsequently assigned to specific taxa (i.e. Prochlorococcus, Synechococcus or Pico-photosynthetic eukaryotes) based on previous classification schemes (Johnson et al., 2010).

References:

Johnson, Z.I., Shyam, R., Ritchie, A.E., Lin, Y., Mioni, C., Lance, V.P. et al. (2010) The effects of iron- and light-limitation on phytoplankton communities of deep chlorophyll maxima of the Western Pacific Ocean. *Journal of Marine Research* 68: 1-26. doi: [10.1357/002224010793721433](https://doi.org/10.1357/002224010793721433)

Processing Description

Cells counts were normalized to volume sampled to determined cells per mL.

BCO-DMO edits made:

- Parameter names have been changed to conform to BCO-DMO conventions.
- month_utc, day_utc, and year were added, based on the original date field.
- Original version of POWOW1 data (dated 25 March 2013) replaced with updated version 28 May 2013; POWOW2 added 14 May 2013.
- Replaced 'NaN' with 'nd' to indicate 'no data'.

[[table of contents](#) | [back to top](#)]

Related Publications

Johnson, Z. I., Shyam, R., Ritchie, A. E., Mioni, C., Lance, V. P., Murray, J. W., & Zinser, E. R. (2010). The effect of iron- and light-limitation on phytoplankton communities of deep chlorophyll maxima of the western Pacific Ocean. *Journal of Marine Research*, 68(2), 283–308. doi:[10.1357/002224010793721433](https://doi.org/10.1357/002224010793721433)
Methods

[[table of contents](#) | [back to top](#)]

Parameters

Parameter	Description	Units
cruise_name	Cruise identifier (POWOW1 = TN277 = R/V Thomas G. Thompson cruise 277; POWOW2 = KM1301 = R/V Kilo Moana cruise 1301).	text
cast	CTD cast number.	unitless
lat	Latitude in decimal degrees. Positive = North.	decimal degrees
lon	Longitude in decimal degrees. Positive = East.	decimal degrees
month_utc	2-digit month of year, UTC.	mm (01 to 12)
day_utc	2-digit day of month, UTC.	dd (01 to 31)
year	4-digit year.	YYYY
depth	Sample depth.	meters
bot	Rosette position of the bottle.	unitless
prochlorococcus	Concentration of Prochlorococcus (cells/mL).	cells per milliliter
synechococcus	Concentration of Synechococcus (cells/mL).	cells per milliliter
pico_euks	Concentration of pico-photosynthetic eukaryotes, or PEuks (cells/mL).	cells per milliliter
depth_w	Depth of the water (bottom depth).	meters
time_utc	Time, in hours and minutes, UTC; 24-hour clock.	HHMM

[[table of contents](#) | [back to top](#)]

Instruments

Dataset-specific Instrument Name	Flow Cytometer
Generic Instrument Name	Flow Cytometer
Dataset-specific Description	A FACSCalibur flow cytometer (Becton Dickinson) was used to enumerate phytoplankton.
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)

[[table of contents](#) | [back to top](#)]

Deployments

TN277

Website	https://www.bco-dmo.org/deployment/58867
Platform	R/V Thomas G. Thompson
Report	http://dmoserv3.whoi.edu/data_docs/POWOW/POWOW1-cruise_report.pdf
Start Date	2012-02-29
End Date	2012-03-11
Description	<p>The POWOW#1 cruise was a trip of opportunity to sample along temperature gradients and test out new protocols. The primary goal of this cruise was to measure the abundance, diversity and activity of Prochlorococcus and associated bacterial and viral communities across temperature (and other environmental) gradients to understand how climate change may impact ocean ecology and biogeochemistry. There are many additional scientific and broader impact goals including characterizing oxidative stress and investigating nitrogen uptake/utilization molecular diversity. Cruise information and original data are available from the NSF R2R data catalog.</p>

KM1301

Website	https://www.bco-dmo.org/deployment/505095
Platform	R/V Kilo Moana
Report	http://dmoserv3.whoi.edu/data_docs/POWOW/POWOW2-cruise_report.pdf
Start Date	2013-01-10
End Date	2013-02-08
Description	<p>From the cruise report: The POWOW#2 cruise was the second in a series of cruises to study the influence of temperature and other environmental variables on Prochlorococcus, its viruses and other members of the microbial community. The primary goal of this cruise was to measure the abundance, diversity and activity of Prochlorococcus and associated bacterial and viral communities across temperature (and other environmental) gradients to understand how climate change may impact ocean ecology and biogeochemistry. Cruise information and original data are available from the NSF R2R data catalog.</p>

KM1312

Website	https://www.bco-dmo.org/deployment/515629
Platform	R/V Kilo Moana
Report	http://dmoserv3.whoi.edu/data_docs/POWOW/POWOW3-cruise_report.pdf
Start Date	2013-07-01
End Date	2013-07-28
Description	From the cruise report: The POWOW#3 cruise was the third in a series of cruises to study the influence of temperature and other environmental variables on Prochlorococcus, its viruses and other members of the microbial community in the Northern Pacific Ocean. The primary goal of this cruise was to measure the abundance, diversity and activity of Prochlorococcus and associated bacterial and viral communities across temperature (and other environmental) gradients to understand how climate change may impact ocean ecology and biogeochemistry. There are many additional scientific and broader impact goals including characterizing oxidative stress and investigating nitrogen uptake/utilization molecular diversity. The official title of the project is "Collaborative Research: Seasonal and decadal changes in temperature drive Prochlorococcus ecotype distribution patterns" and it is part of NSF #1031064 (Duke) and 1030518 (UTK). Cruise information and original data are available from the NSF R2R data catalog.

[[table of contents](#) | [back to top](#)]

Project Information

Seasonal and decadal changes in temperature drive Prochlorococcus ecotype distribution patterns (POWOW)

Website: <http://oceanography.ml.duke.edu/johnson/research/powow/>

Coverage: Eastern North Pacific Ocean

Project also known as '*Prochlorococcus* Of Warming Ocean Waters' (POWOW).

The two numerically-dominant ecotypes of the marine cyanobacterium *Prochlorococcus* partition the surface ocean niche latitudinally, with ecotype eMIT9312 dominant in the 30 degree N to 30 degree S region and eMED4 dominant at higher latitudes. These ecotypes may account for 25-50% of primary production in open ocean ecosystems, but this percentage is dependent on which ecotype dominates. The relative abundance of the two ecotypes follows a log-linear relationship with temperature, with the transition from eMIT9312 to eMED4 occurring at approx. 18 degrees C. From these descriptive data, it has been hypothesized that temperature is the primary driver of relative abundance. Their contribution to net primary production, however, appears to be independent of temperature, suggesting temperature regulates ecotype dominance through photosynthesis-independent mechanisms.

To test these hypotheses, the PIs are undertaking a series of field and lab studies to investigate the effect of temperature change on the distribution of these ecotypes. Two cruises in the North Pacific will trace the transitions from eMIT9312- to eMED4-dominated regions, with one cruise during the winter and the other during summer. They have hypothesized that the ratio of ecotype abundance will move latitudinally with the seasonal shift in temperature gradient: migration of the 18 degrees C isotherm northward in the summer will be matched by a similar migration of the 1:1 ecotype transition point. Multiple crossings of the 18 degrees C isotherm are proposed, and the summer cruise will also follow the isotherm to the Western US coast to gain insight on physical and geochemical influences. Environmental variables such as nutrient concentrations, light/mixing depths, and virus /grazing based mortality, which may impinge on

the relationship between temperature and ecotype ratio, will be assessed through a series of multivariate analyses of the collected suite of physical, chemical and biological data. Seasonal comparisons will be complemented with on-deck incubations and lab competition assays (using existing and new isolates) that will establish, for the first time, how fitness coefficients of these ecotypes relate to temperature. As latitudinal shifts in temperature gradient and migration of ecotypes during seasonal warming likely share common features with high latitude warming as a consequence of climate change, the investigator's analyses will contribute important biological parameters (e.g., abundances, production rates, temperature change coefficients) for modeling biological and biogeochemical responses to climate change. This research will be integrated with that of committed collaborators, generating data sufficient for ecosystem-scale characterizations of the contributions of temperature (relative to other forcing factors) in constraining the range and seasonal migration of these numerically dominant marine phototrophs.

Publications produced as result of this research:

Rowe, J.M., DeBruyn, J.M., Poorvin, L., LeCleir, G.R., Johnson, Z.I., Zinser, E.R., and Wilhelm, S.W. 2012. Viral and bacterial abundance and production in the Western Pacific Ocean and the relation to other oceanic realms. *FEMS Microbiology Ecology*, 72, p. 359. DOI: [10.1111/j.1574-6941.2011.01223.x](https://doi.org/10.1111/j.1574-6941.2011.01223.x)

Morris, J.J., Lenski, R.E. and E.R. Zinser. 2012. The Black Queen Hypothesis: Evolution of Dependencies through Adaptive Gene Loss. *mBio*, 3, p. e00036-12. DOI: [10.1128/mBio.00036-12](https://doi.org/10.1128/mBio.00036-12)

Morris, J.J., Johnson, Z.I., Szul, M.J., Keller, M., and Zinser, E.R. 2011. Dependence of the cyanobacterium *Prochlorococcus* on hydrogen peroxide scavenging microbes for growth at the ocean's surface. *PLoS One*, 6(2), p. 16805. DOI: [10.1371/journal.pone.0016805](https://doi.org/10.1371/journal.pone.0016805)

Ringuet, S., Sassano, L., and Johnson, Z.I. 2011. A suite of microplate reader-based colorimetric methods to quantify ammonium, nitrate, orthophosphate and silicate concentrations for aquatic nutrient monitoring. *Journal of Environmental Monitoring*. DOI: [10.1039/COEM00290A](https://doi.org/10.1039/COEM00290A)

Ritchie, A.E. and Johnson, Z.I. 2012. Abundance and genetic diversity of aerobic anoxygenic phototrophic bacteria of coastal regions of the Pacific Ocean. *Applied and Environmental Microbiology*, 78, p. 2858. DOI: [10.1128/AEM.06268-11](https://doi.org/10.1128/AEM.06268-11)

[[table of contents](#) | [back to top](#)]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1031064

[[table of contents](#) | [back to top](#)]