Global distribution of phosphate using high sensitivity techniques from data aggregated from many studies between 1988-2017

Website: https://www.bco-dmo.org/dataset/764704
Data Type: Other Field Results
Version: 1
Version Date: 2019-04-17

Project
» Convergence: RAISE: Linking the adaptive dynamics of plankton with emergent global ocean biogeochemistry (Ocean Stoichiometry)

Contributors	Affiliation	Role
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Abstract
Surface ocean phosphate is commonly below the standard analytical detection limit (~100 nM) leading to an incomplete picture of the global variation and biogeochemical role of phosphate. This dataset represents a global compilation of phosphate measured using high-sensitivity methods including magnesium induced precipitation (MAGIC), liquid waveguide cell (LWCC), and solid phase extraction (SPE) methods. We compiled data from 42 major cruises covering all oligotrophic regions using high-sensitivity P measurements. The dataset covered a total of 50591 samples including 41747 samples from the upper 30 m. The compilations revealed several previously unrecognized low-P areas and clear regional biases. Our study demonstrates the importance of accurately quantifying nutrients for understanding the regulation of ocean ecosystems and biogeochemistry now and under future climate conditions.

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Coverage

Spatial Extent: **N**:68 **E**:179.530413 **S**:-40.1672467 **W**:-179.99976
Temporal Extent: 1988 - 2017

Methods & Sampling

For complete methdology, see Martiny et al, (2019).

Data have been aggregated from many studies. Procedures and methodology include the following:
Sampling procedures: Liquid samples taken from the Rosette or Underway System. Samples are either processed fresh or stored frozen until processing. Some samples are pre-filtered.

Methodology: High sensitivity dissolved phosphate measurements done using either Liquid Waveguide Cells, magnesium induced precipitation (MAGIC), or solid phase extraction.

Many instruments were used but the main procedures include: MAGIC (Karl & Tien, 1992), LWCC - Liquid Waveguide cells (Li & Hansell, 2008), and Solid phase extraction (Ma, Yuan, & Yuan, 2017).

Data Processing Description

BCO-DMO Processing:
- removed units from parameter names;
- reformatted month and day to two-digits;
- replaced "-9" as missing data identifier with "nd" in the day column;
- added date field formatted as yyyymmdd.

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Data Files

File
high_sensitivity_DIP.csv (Comma Separated Values (.csv), 2.47 MB) MD5:6f25c7d89b3d1a592009f17a1991edf5 Primary data file for dataset ID 764704

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Related Publications

Karl, D. M., & Tien, G. (1992). MAGIC: A sensitive and precise method for measuring dissolved phosphorus in aquatic environments. Limnology and Oceanography, 37(1), 105–116. doi:10.4319/lo.1992.37.1.0105
Methods

Li, Q. P., & Hansell, D. A. (2008). Intercomparison and coupling of magnesium-induced co-precipitation and long-path liquid-waveguide capillary cell techniques for trace analysis of phosphate in seawater. Analytica Chimica Acta, 611(1), 68–72. doi:10.1016/j.aca.2008.01.074
Methods

Ma, J., Yuan, Y., & Yuan, D. (2017). Underway analysis of nanomolar dissolved reactive phosphorus in oligotrophic seawater with automated on-line solid phase extraction and spectrophotometric system. Analytica Chimica Acta, 950, 80–87. doi:10.1016/j.aca.2016.11.029
Methods

Martiny, Adam C., Michael W Lomas, Weiwei Fu, Philip W Boyd, Yuh-ling L Chen, Gregory A Cutter, Michael J Ellwood, Ken Furuya, Fuminori Hashihama, Jota Kanda, David M Karl, Taketoshi Kodama, Qian P Li, Jian Ma, Thierry Moutin, E Malcolm S Woodward, and J Keith Moore. (2019.) Biogeochemical controls of surface ocean phosphate. Science Advances, Vol. 5, no. 8, eaax0341. DOI: 10.1126/sciadv.aax0341
Results

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Parameters

Parameter	Description	Units
Lat	Latitude	degrees North
Lon	Longitude	degrees East
Depth	Sampling depth	meters (m)
DIP	Dissolved inorganic phophate	micromolar (uM)
Year	4-digit year	unitless
Month	2-digit month	unitless
Day	2-digit day	unitless
Date	Date formatted as yyyymmdd	unitless

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Instruments

Dataset-specific Instrument Name	Liquid Waveguide Cells
Generic Instrument Name	Liquid Waveguide Capillary Cells
Dataset-specific Description	High sensitivity dissolved phosphate measurements done using either Liquid Waveguide Cells, magnesium induced precipitation (MAGIC), or solid phase extraction.
Generic Instrument Description	Liquid Waveguide Capillary Cells (LWCC) are optical sample cells that combine an increased optical pathlength (2-500 cm) with small sample volumes. They can be connected via optical fibers to a spectrophotometer with fiber optic capabilities. Similar to optical fibers, light is confined within the (liquid) core of an LWCC by total internal reflection at the core/wall interface. Ultra-sensitive absorbance measurements can be performed in the ultraviolet (UV), visible (VIS) and near-infrared (NIR) to detect low sample concentrations in a laboratory or process control environment. According to Beer’s Law the absorbance signal is proportional to chemical concentration and light path length.

Dataset-specific Instrument Name	Rosette
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Liquid samples taken from the Rosette or Underway System.
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	Underway System
Generic Instrument Name	Pump - Surface Underway Ship Intake
Dataset-specific Description	Liquid samples taken from the Rosette or Underway System.
Generic Instrument Description	The 'Pump-underway ship intake' system indicates that samples are from the ship's clean water intake pump. This is essentially a surface water sample from a source of uncontaminated near-surface (commonly 3 to 7 m) seawater that can be pumped continuously to shipboard laboratories on research vessels. There is typically a temperature sensor near the intake (known as the hull temperature) to provide measurements that are as close as possible to the ambient water temperature. The flow from the supply is typically directed through continuously logged sensors such as a thermosalinograph and a fluorometer. Water samples are often collected from the underway supply that may also be referred to as the non-toxic supply. Ideally the data contributor has specified the depth in the ship's hull at which the pump is mounted.

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Project Information

Convergence: RAISE: Linking the adaptive dynamics of plankton with emergent global ocean biogeochemistry (Ocean Stoichiometry)

NSF Award Abstract:
Due to their sheer abundance and high activity, microorganisms have the potential to greatly influence how ecosystems are affected by changes in their environment. However, descriptions of microbial physiology and diversity are local and highly complex and thus rarely considered in Earth System Models. Thus, the researchers focus on a convergence research framework that can qualitatively and quantitatively integrate eco-evolutionary changes in microorganisms with global biogeochemistry. Here, the investigators will develop an approach that integrates the knowledge and tools of biologists, mathematicians, engineers, and geoscientists to understand the link between the ocean nutrient and carbon cycles. The integration of data and knowledge from diverse fields will provide a robust, biologically rich, and computationally efficient prediction for the variation in plankton resource requirements and the biogeochemical implications, addressing a fundamental challenge in ocean science. In addition, the project can serve as a road map for many other research groups facing a similar lack of convergence between biology and geoscience.

Traditionally, the cellular elemental ratios of Carbon, Nitrogen, and Phosphorus (C:N:P) of marine communities have been considered static at Redfield proportions but recent studies have demonstrated strong latitudinal variation. Such regional variation may have large - but poorly constrained - implications for marine biodiversity, biogeochemical functioning, and atmospheric carbon dioxide levels. As such, variations in ocean community C:N:P may represent an important biological feedback. Here, the investigators propose a convergence research framework integrating cellular and ecological processes controlling microbial resource allocations with an Earth System model. The approach combines culture experiments and omics measurements to provide a molecular understanding of cellular resource allocations. Using a mathematical framework of increasing complexity describing communicating, moving demes, the team will quantify the extent to which local mixing, environmental heterogeneity and evolution lead to systematic deviations in plankton resource allocations and C:N:P. Optimization tools from engineering science will be used to facilitate the quantitative integration of models and observations across a range of scales and complexity levels. Finally, global ocean modeling will enable understanding of how plankton resource use impacts Earth System processes. By integrating data and knowledge across fields, scales and complexity, the investigators will develop a robust link between variation in plankton C:N:P and global biogeochemical cycles.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1848576

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