Prochlorococcus, Synechococcus, and picoeukaryotic phytoplankton yearly mean global abundance for four CMIP5 climate scenarios using an ensemble of five circulation models

Website: https://www.bco-dmo.org/dataset/793690
Data Type: model results
Version: 1
Version Date: 2020-02-18

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

Contributors	Affiliation	Role
Martiny, Adam	University of California-Irvine (UC Irvine)	Principal Investigator
Flombaum, Pedro	Universidad de Buenos Aires	Co-Principal Investigator, Contact
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Coverage

Spatial Extent: **N**:89.5 **E**:180 **S**:-89.5 **W**:-180
Temporal Extent: 1901 - 2100

Dataset Description

Prochlorococcus, Synechococcus, and picoeukaryotic phytoplankton yearly mean global abundance for four CMIP5 climate scenarios using an ensemble of five circulation models from 1900 to 2100.

Acquisition Description

We estimated *Prochlorococcus, Synechococcus*, and picoeukaryotic phytoplankton global cell abundance (cell) using quantitative niche models (Flombaum et al. 2013, 2020). Inputs for the niche models were temperature and nitrate from Earth System Models, and light from Ocean Color (oceancolor.gsfc.nasa.gov) which identical across simulations. Mean was estimated for *Prochlorococcus* and *Synechococcus* from a 10.000 iteration bootstrap on a yearly basis, and for picoeukaryotic phytoplankton as 100 iterations for each unique geographic and depth location.

Data columns containing mean global cell abundance are labeled after lineage, scenario, and Earth System Model.
Lineages: Prochlorococcus, Synechococcus, and picoeukaryotic phytoplankton.
Scenarios: Historic, RCP2.6, RCP4.5, RCP8.5.
Earth System Models: GFDL-ESM2G, HadGEM2-ES, IPSL-CM5A-MR, MPI-ESM-LR, NorESM1-ME (Taylor et al 2012).

Processing Description

BCO-DMO Processing:
- renamed columns to conform with BCO-DMO naming convetions;
- replaced NaN with nd ("no data").

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Related Publications

Flombaum, P., Gallegos, J. L., Gordillo, R. A., Rincon, J., Zabala, L. L., Jiao, N., … Martiny, A. C. (2013). Present and future global distributions of the marine Cyanobacteria Prochlorococcus and Synechococcus. Proceedings of the National Academy of Sciences, 110(24), 9824–9829. doi:10.1073/pnas.1307701110
Related Research

Flombaum, P., Wang, W.-L., Primeau, F. W., & Martiny, A. C. (2020). Global picophytoplankton niche partitioning predicts overall positive response to ocean warming. Nature Geoscience, 13(2), 116–120. doi:10.1038/s41561-019-0524-2
Related Research

Taylor, K. E., Stouffer, R. J., & Meehl, G. A. (2012). An Overview of CMIP5 and the Experiment Design. Bulletin of the American Meteorological Society, 93(4), 485–498. doi:10.1175/bams-d-11-00094.1
https://doi.org/10.1175/BAMS-D-11-00094.1
Related Research

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Parameters

Parameter	Description	Units
Years_for_Historic_scenario	Four-digit year; format: YYYY	unitless
Years_for_scenarios_RCP2_6_RCP4_5_RCP8_5	Four-digit year; format: YYYY	unitless
Prochlorococccus_for_HISTORIC_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus Historic GFDL-ESM2G	number of cells

Prochlorococcus_for_HISTORIC_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus Historic HadGEM2-ES	number of cells
Prochlorococcus_for_HISTORIC_scenario_IPSLCM5AMR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus Historic IPSL-CM5A-MR	number of cells
Prochlorococcus_for_HISTORIC_scenario_MPIESMLR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus Historic MPI-ESM-LR	number of cells
Prochlorococcus_for_HISTORIC_scenario_NorESM1ME_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus Historic NorESM1-ME	number of cells
Prochlorococcus_for_RCP2_6_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP2.6 GFDL-ESM2G	number of cells
Prochlorococcus_for_RCP2_6_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP2.6 HadGEM2-ES	number of cells
Prochlorococcus_for_RCP2_6_scenario_IPSLCM5AMR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP2.6 IPSL-CM5A-MR	number of cells
Prochlorococcus_for_RCP2_6_scenario_MPIESMLR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP2.6 MPI-ESM-LR	number of cells

Prochlorococccus_for_RCP2_6_scenario_NorESM1ME_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP2.6 NorESM1-ME	number of cells
Prochlorococccus_for_RCP4_5_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP4.5 GFDL-ESM2G	number of cells
Prochlorococccus_for_RCP4_5_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP4.5 HadGEM2-ES	number of cells
Prochlorococccus_for_RCP4_5_scenario_IPSLCM5AMR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP4.5 IPSL-CM5A-MR	number of cells
Prochlorococccus_for_RCP4_5_scenario_MPIESMLR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP4.5 MPI-ESM-LR	number of cells
Prochlorococccus_for_RCP4_5_scenario_NorESM1ME_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP4.5 NorESM1-ME	number of cells
Prochlorococccus_for_RCP8_5_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP8.5 GFDL-ESM2G	number of cells
Prochlorococccus_for_RCP8_5_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP8.5 HadGEM2-ES	number of cells

Prochlorococccus_for_RCP8_5_scenario_IPSLCM5AMR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP8.5 IPSL-CM5A-MR	number of cells
Prochlorococccus_for_RCP8_5_scenario_MPIESMLR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP8.5 MPI-ESM-LR	number of cells
Prochlorococccus_for_RCP8_5_scenario_NorESM1ME_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Prochlorococcus RCP8.5 NorESM1-ME	number of cells
Synechococcus_for_HISTORIC_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus Historic GFDL-ESM2G	number of cells
Synechococcus_for_HISTORIC_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus Historic HadGEM2-ES	number of cells
Synechococcus_for_HISTORIC_scenario_IPSLCM5AMR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus Historic IPSL-CM5A-MR	number of cells
Synechococcus_for_HISTORIC_scenario_MPIESMLR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus Historic MPI-ESM-LR	number of cells
Synechococcus_for_HISTORIC_scenario_NorESM1ME_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus Historic NorESM1-ME	number of cells

Synechococcus_for_RCP2_6_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP2.6 GFDL-ESM2G	number of cells
Synechococcus_for_RCP2_6_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP2.6 HadGEM2-ES	number of cells
Synechococcus_for_RCP2_6_scenario_IPSLCM5AMR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP2.6 IPSL-CM5A-MR	number of cells
Synechococcus_for_RCP2_6_scenario_MPIESMLR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP2.6 MPI-ESM-LR	number of cells
Synechococcus_for_RCP2_6_scenario_NorESM1ME_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP2.6 NorESM1-ME	number of cells
Synechococcus_for_RCP4_5_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP4.5 GFDL-ESM2G	number of cells
Synechococcus_for_RCP4_5_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP4.5 HadGEM2-ES	number of cells
Synechococcus_for_RCP4_5_scenario_IPSLCM5AMR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP4.5 IPSL-CM5A-MR	number of cells

Synechococcus_for_RCP4_5_scenario_MPIESMLR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP4.5 MPI-ESM-LR	number of cells
Synechococcus_for_RCP4_5_scenario_NorESM1ME_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP4.5 NorESM1-ME	number of cells
Synechococcus_for_RCP8_5_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP8.5 GFDL-ESM2G	number of cells
Synechococcus_for_RCP8_5_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP8.5 HadGEM2-ES	number of cells
Synechococcus_for_RCP8_5_scenario_IPSLCM5AMR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP8.5 IPSL-CM5A-MR	number of cells
Synechococcus_for_RCP8_5_scenario_MPIESMLR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP8.5 MPI-ESM-LR	number of cells
Synechococcus_for_RCP8_5_scenario_NorESM1ME_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Synechococcus RCP8.5 NorESM1-ME	number of cells
Eukaryotic_phytoplankton_for_HISTORIC_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton Historic GFDL-ESM2G	number of cells

Eukaryotic_phytoplankton_for_HISTORIC_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton Historic HadGEM2-ES	number of cells
Eukaryotic_phytoplankton_for_HISTORIC_scenario_IPSLCM5AMR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton Historic IPSL-CM5A-MR	number of cells
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Eukaryotic_phytoplankton_for_HISTORIC_scenario_NorESM1ME_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton Historic NorESM1-ME	number of cells
Eukaryotic_phytoplankton_for_RCP2_6_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton RCP2.6 GFDL-ESM2G	number of cells
Eukaryotic_phytoplankton_for_RCP2_6_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton RCP2.6 HadGEM2-ES	number of cells
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Eukaryotic_phytoplankton_for_RCP4_5_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton RCP4.5 GFDL-ESM2G	number of cells
Eukaryotic_phytoplankton_for_RCP4_5_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton RCP4.5 HadGEM2-ES	number of cells
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Eukaryotic_phytoplankton_for_RCP8_5_scenario_GFDLESM2G_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton RCP8.5 GFDL-ESM2G	number of cells
Eukaryotic_phytoplankton_for_RCP8_5_scenario_HadGEM2ES_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton RCP8.5 HadGEM2-ES	number of cells
Eukaryotic_phytoplankton_for_RCP8_5_scenario_IPSLCM5AMR_Model	Mean global cell abundance; labeled after lineage, scenario, and Earth System Model: Picoeukaryotic phytoplankton RCP8.5 IPSL-CM5A-MR	number of cells
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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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