MESMO global model output for future simulations with dynamic C:N:P ratios for years 1750-2500

Website: https://www.bco-dmo.org/dataset/810368
Data Type: model results
Version: 1
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Project
» A power law model of dynamic marine phytoplankton stoichiometry (Power_law_model)

Contributors	Affiliation	Role
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Abstract
MESMO global model output for future simulations with dynamic C:N:P ratios for years 1750-2500. The dataset contains NetCDF files with 3D ocean biogeochemistry model outputs.

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Coverage

Spatial Extent: **N**:90 **E**:180 **S**:-90 **W**:-180
Temporal Extent: 1750 - 2500

Dataset Description

MESMO global model output for future simulations with dynamic C:N:P ratios for years 1750-2500. The dataset contains NetCDF files with 3D ocean biogeochemistry model outputs.

Methods & Sampling

The methodology and model outputs are described in a paper to be submitted shortly: "Modulation of future global export production stoichiometry by Antarctic sea ice" by Katsumi Matsumoto and Tatsuro Tanioka.

Model runs with a power law model of C:N:P. The simulation period for all runs is years 1750-2500
190916a.nc = Control run with flexible C:N:P
190916g.nc = Global warming run with flexible C:N:P
190916k.nc = Global warming run with C:N:P mask
190916l.nc = Global warming run with COM mask
190916e.nc = Control run with fixed C:N:P=117:16:1
190916p.nc = Global warming run with fixed C:N:P=117:16:1

The ocean model used to generate these outputs is MESMO (Matsumoto et al., 2008, 2013). Briefly it is an earth system model of intermediate complexity that consists of a 3D dynamical model of the global ocean, 2D

dynamic-thermodynamic model of sea ice, and 2D energy moisture balanced model of atmosphere. The results archived here are from MESMO experiments under the modern conditions and under a future warming scenario. These experiments are described and their results analyzed in a submitted manuscript: Matsumoto and Tanioka, "Modulation of future global ocean production stoichiometry by Antarctic sea ice."

The equilibrium model run with flexible phytoplankton C:N:P is obtained by running the model for 5000 years under preindustrial boundary conditions until the model reached steady state. The future warming scenario used in this study is the Shared Socioeconomic Pathway 2, a new "middle-of-the road" scenario of future warming. The radiative forcing stabilizes at ~6.5 Wm-2 with pCO2 at ~600 matm by the year 2100. All future runs are 750 years long, start in 1750, and terminate in 2500. There is a Control run for each formulation, where the equilibrium runs were simply continued for the same 750 years.

Data Processing Description

BCO-DMO Data Manager Processing Notes:
* netCDF files in bundled gzip file (.tar.tz) added to Data Files section.

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Data Files

File
3D ocean biogeochemistry model outputs - MESMO future C:N:P filename: matsumoto_mesmo_gw_cnp.tar.tz (GZIP (.gz), 236.36 MB) MD5:7fb165a83eca9e73e94b34c0c40caf09 MESMO, a 3D ocean biogeochemistry model, NetCDF output files containing results of future simulations with dynamic C:N:P. Model runs with a power law model of C:N:P. The simulation period for all runs is years 1750-2500 190916a.nc = Control run with flexible C:N:P 190916g.nc = Global warming run with flexible C:N:P 190916k.nc = Global warming run with C:N:P mask 190916l.nc = Global warming run with COM mask 190916e.nc = Control run with fixed C:N:P=117:16:1 190916p.nc = Global warming run with fixed C:N:P=117:16:1 The bundled and compressed gzip file was created with the command: tar -zcvf matsumoto_mesmo_gw_cnp.tar.tz bcodmo_190916 Files can be extracted with the command: tar -xzvf matsumoto_mesmo_gw_cnp.tar.tz Parameters names, definitions, and units contained in the NetCDF .nc files: ALK,"alkalinity","mol kg-1" A,"ocean surface area","m2" area_oc3,"area_oc3","m2" area_ocn,"ocean srfc grid area","m2" ash_x,"ash (tracer for sediment bioturbation) flux","mol m-2 yr-1" CC_13,"d13C of CaCO3 flux","o/oo"

File

CC_14,"d14C of CaCO3 flux","o/oo"

CC_14_x,"14C flux of CC_","mol m-2 yr-1"

CC2POC," rain ratio (CaCO3 to POC)","ratio"

CC_frac2," cc_frac2","ratio"

CC_x,"calcium carbonate (CaCO3=CC) flux","mol m-2 yr-1"

CFC11,"dissolved CFC-11","mol kg-1"

CFC12,"dissolved CFC-12","mol kg-1"

CO2_aq,"CO2_aq carbonate chemistry","mol kg-1"

CO3,"CO3 carbonate chemistry","mol kg-1"

C_to_N,"C:N uptake ratio","ratio"

C_to_N_diaz,"C:N uptake ratio_diaz","ratio"

C_to_N_lg,"C:N uptake ratio_lg","ratio"

C_to_N_sm,"C:N uptake ratio_sm","ratio"

C_to_P,"C:P uptake ratio","ratio"

C_to_P_diaz,"C:P uptake ratio_diaz","ratio"

C_to_P_lg,"C:P uptake ratio_lg","ratio"

C_to_P_sm,"C:P uptake ratio_sm","ratio"

dCO3_arg,"dCO3_arg carbonate chemistry","mol kg-1"

dCO3_cal,"dCO3_cal carbonate chemistry","mol kg-1"

den_m2,"oceanic denitrification (flux)","molN m-2 yr-1"

det_x,"detrital (refractory) material flux","mol m-2 yr-1"

DIC_13,"d13C of DIC","o/oo"

DIC_14,"D14C of DIC","o/oo"

DIC_14Q,"DIC_14 concentration","mol kg-1"

DIC,"dissolved inorganic carbon","mol kg-1"

DOC_13,"d13C of DOM_C","o/oo"

DOC_14,"D14C of DOM_C","o/oo"

DOC_14Q,"DOC_14 concentration","mol kg-1"

DOC,"dissolved organic carbon","mol kg-1"

DOFe,"dissolved organic iron","mol kg-1"

DOM_frac,"DOM export fraction",""

DON,"dissolved organic nitrogen","mol kg-1"

DOP,"dissolved organic phosphorous","mol kg-1"

dt_Fe_x,"detrital scavenged Fe flux","mol m-2 yr-1"

Fe,"dissolved iron","mol kg-1"

FeL,"ligand-bound Fe","mol kg-1"

fug_CO2,"fug_CO2 carbonate chemistry","atm"

HCO3,"HCO3 carbonate chemistry","mol kg-1"

H,"H carbonate chemistry","mol kg-1"

lat_edges,"latitude of t grid edges","degrees"

lat,"latitude of the t grid","degrees_north"

lat_moc,"latitude of moc grid","degrees_north"

File

Ligand,"iron binding ligand","mol kg-1"

lon_edges,"longitude of t grid edges","degrees"

lon,"longitude of the t grid","degrees_east"

mask_lev,"ocean depth grid level 1=deepest","1"

mask_ocn,"ocean mask 1=ocean, 0=land","1"

mass_oc3,"mass_oc3","kg"

mass_ocn,"ocean srfc grid mass","kg"

MM_diaz,"M-M kinetics index diaz phyto",""

MM_lg,"MM kinetics index lg phyto","1"

MM_sm,"MM kinetics index sm phyto","1"

N2,"dissolved nitrogen","mol kg-1"

Nfix_m2,"N-fixation (flux)","molN m-2 yr-1"

NO3,"dissolved nitrate","mol kg-1"

NPP_m2_diaz,"Net Primary Productivity_Diaz","molC m-2 yr-1"

NPP_m2_lg,"Net Primary Productivity_LG","molC m-2 yr-1"

NPP_m2,"Net Primary Productivity","molC m-2 yr-1"

NPP_m2_sm,"Net Primary Productivity_SM","molC m-2 yr-1"

NPP_P_m2_diaz,"Net Primary Productivity_Diaz in P","molP m-2 yr-1"

NPP_P_m2_lg,"Net Primary Productivity_LG in P","molP m-2 yr-1"

NPP_P_m2,"Net Primary Productivity in P","molP m-2 yr-1"

NPP_P_m2_sm,"Net Primary Productivity_SM in P","molP m-2 yr-1"

N_to_P_diaz,"N:P uptake ratio_diaz","ratio"

N_to_P_lg,"N:P uptake ratio_lg","ratio"

N_to_P,"N:P uptake ratio","ratio"

N_to_P_sm,"N:P uptake ratio_sm","ratio"

O2,"dissolved oxygen","mol kg-1"

O2_to_DOC,"O2:DOC remin ratio","ratio"

O2_to_DOP,"O2:DOP remin ratio","ratio"

O2_to_POC,"O2:POC remin ratio","ratio"

O2_to_POP,"O2:POP remin ratio","ratio"

ohm_arg,"ohm_arg carbonate chemistry","saturation 1=100%"

ohm_cal,"ohm_cal carbonate chemistry","saturation 1=100%"

opal_x,"opal flux","mol m-2 yr-1"

pH,"pH","1"

PO4,"dissolved phosphate","mol kg-1"

POC_13,"d13C of POC flux","o/oo"

POC_14,"D14C of POC flux","o/oo"

POC_14_x,"14C flux of POC","mol m-2 yr-1"

POC_x,"particulate organic carbon flux","mol m-2 yr-1"

POFe_x,"particulate organic iron flux","mol m-2 yr-1"

PON_x,"particulate organic nitrogen flux","mol m-2 yr-1"

POP_x,"particulate organic phosphate flux","mol m-2 yr-1"

PO_sc_Fe_x,"POM scavenged Fe flux","mol m-2 yr-1"

File
res_m2,"oceanic respiration (flux)","molN m-2 yr-1"
sal,"salinity","PSU"
SiO2,"aqueous silicic acid (H4SiO4)","mol kg-1"
si_to_n,"Si:N uptake ratio","ratio"
temp,"temperature","K"
time,"Year","equal month years"
topo_ocn,"ocean depth","m"
Vol,"ocean volume","m3"
xu_edges,"longitude of u grid edges","degrees"
xu,"longitude of the u grid","degrees_east"
year,"year",""
yu_edges,"latitude of u grid edges","degrees"
yu,"latitude of the u grid","degrees_north"
zt_edges,"depth of t grid edges","m"
zt_moc,"depth of moc grid","m"
zt,"z-level mid depth","m"

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Related Publications

Matsumoto, K., Tokos, K. S., Price, A. R., & Cox, S. J. (2008). First description of the Minnesota Earth System Model for Ocean biogeochemistry (MESMO 1.0). Geoscientific Model Development, 1(1), 1–15. doi:10.5194/gmd-1-1-2008
Methods

Matsumoto, K., Tokos, K., Huston, A., & Joy-Warren, H. (2013). MESMO 2: a mechanistic marine silica cycle and coupling to a simple terrestrial scheme. Geoscientific Model Development, 6(2), 477–494. doi:10.5194/gmd-6-477-2013
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Project Information

A power law model of dynamic marine phytoplankton stoichiometry (Power_law_model)

Coverage: Global

NSF Award Abstract:
Almost a century ago, Alfred Redfield observed that the ratios of the elements carbon, nitrogen, and phosphorus in ocean phytoplankton were nearly the same throughout the oceans. This observation came to be called the "Redfield ratio" and is a central idea in biological and chemical oceanography. The Redfield ratio provides a convenient and useful way of relating the uptake of nutrients (nitrogen and phosphorus) and carbon, and of exploring aspects of ocean carbon cycling. Recent work, however, has highlighted the many

ways in which the carbon to nitrogen to phosphorus (C:N:P) ratios can vary, suggesting that the simple assumption that they are unchanging should be revisited. The overall goal of this project is to develop a way of incorporating varying C:N:P ratios into ocean models that will allow researchers to explore the impacts of these variations on carbon cycling. The proposed work will directly support graduate student researchers and include STEM outreach to local schools.

This project will develop a power law model of flexible phytoplankton stoichiometry, an approach that is able to capture the nonlinear behavior of the elemental ratios as a function of multiple environmental drivers. The central feature of the power law model is a coefficient that yields useful insights about phytoplankton biochemistry (i.e., phytoplankton homeostasis) and ocean biogeochemistry (i.e., the buffer capacity of the global carbon export production to environmental changes). Furthermore, the power law model is mathematically robust and thus easily ported to global ocean models. These attributes of the power law model are expected to facilitate widespread studies of dynamic stoichiometry with global ocean models. The investigators will also enable two global ocean models with their new stoichiometry model and quantify the stoichiometry-biogeochemical cycles-climate feedbacks under ongoing global warming and late Pleistocene ice age conditions. This study will thus make a significant contribution to chemical oceanography by developing a new approach to representing stoichiometric diversity in ocean models and by quantifying the global impacts of that diversity under different climate conditions.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1827948

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