MESMO global model output for glacial simulations with dynamic C:N:P ratios

Website: https://www.bco-dmo.org/dataset/784634
Data Type: model results
Version: 1
Version Date: 2019-12-18

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

Contributors	Affiliation	Role
Matsumoto, Katsumi	University of Minnesota Twin Cities (UMTC)	Principal Investigator
Biddle, Mathew	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Model outputs archived have a complete suite of biogeochemical state variables in the 3D global ocean domain. They include temperature, salinity, nutrients (PO4, NO3, Fe, Si), carbon pools and their isotopes (DIC, DOC, POC, 13C and 14C) oxygen, and alkalinity. Stoichiometric ratios of phytoplankton functional types (C:P, C:N, N:P) are also included. Rates and fluxes archived include production (NPP, export) by phytoplankton types and nitrogen fixation and denitrification. After 5000 years, almost all properties reach steady state, with the except nitrogen fixation and denitrification in some runs

Table of Contents

Coverage

Spatial Extent: **N**:90 **E**:180 **S**:-90 **W**:-180

Dataset Description

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 glacial conditions. These experiments are described and their results analyzed in a submitted manuscript: Matsumoto, Rickaby, and Tanioka, "Carbon export buffering and CO2 drawdown by flexible phytoplankton C:N:P under glacial conditions." The experiments are all 5000 year runs.

Model outputs archived have a complete suite of biogeochemical state variables in the 3D global ocean domain. They include temperature, salinity, nutrients (PO4, NO3, Fe, Si), carbon pools and their isotopes (DIC, DOC, POC, 13C and 14C) oxygen, and alkalinity. Stoichiometric ratios of phytoplankton functional types (C:P, C:N, N:P) are also included. Rates and fluxes archived include production (NPP, export) by phytoplankton types and nitrogen fixation and denitrification. After 5000 years, almost all properties reach steady state, with the except nitrogen fixation and denitrification in some runs

Data Processing Description

BCO-DMO Processing Notes:
- linked to the provided tar.tz compressed package.

[table of contents | back to top]

Data Files

File
3D ocean biogeochemistry model outputs - MESMO glacial C:N:P filename: matsumoto_mesmo_glacial_cnp.tar.tz (Octet Stream, 347.77 MB) MD5:2fa54ffeb72d5ebd8abf4b16c4da0511 package was compressed using: tar -zcvf matsumoto_mesmo_glacial_cnp.tar.tz bcodmo_190917/   File descriptions: Model runs with a power law model of C:N:P 190917a.nc = Modern/control run 190917g.nc = Full glacial run 190917h.nc = Glacial land ice run 190917i.nc = Glacial greenhouse gas run 190917j.nc = Glacial winds run 190917k.nc = Glacial dust run 190917x.nc = Glacial orbital run 190917q.nc = Full glacial run with C:N:P mask 190917r.nc = Full glacial run with community composition mask   Model runs with fixed C:N:P 190917e.nc = Control 190917o.nc = Full glacial run   Model runs with linear model of C:P 190917f.nc = Control 190917p.nc = Full glacial run   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" 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"

File

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

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"

File

```
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"
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"
```

File
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"

[table of contents | back to top]

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

[table of contents | back to top]

Parameters

Parameters for this dataset have not yet been identified

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

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

[table of contents | back to top]