MESMO global ocean model results for glacial and freshwater hosing simulations with calibrated, semilabile and refractory dissolved organic matter

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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 ocean model results for glacial and freshwater hosing simulations with calibrated, semilabile and refractory dissolved organic matter (DOM). 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

Acquisition Description

The ocean model used to generate these outputs is MESMO 3 (Matsumoto et al., 2021). 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 3 experiments under the modern conditions with freshwater hosing and under glacial conditions. The "c" in the dataset name "MESMO 3c DOM" indicates the calibrated version of MESMO 3 was used. These experiments are described and their results analyzed in a submitted manuscript: "Modeling marine dissolved organic carbon response to climate change" by Maya D. Gilchrist and Katsumi Matsumoto.

Model outputs archived have a complete suite of biogeochemical state variables in the 3D global ocean domain. The main variables are related to the dissolved organic matter. The complete set of variables 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.

MESMO 3c model runs with semilabile and refractory DOM. 220407 experiments are transient freshwater

hosing experiments. 220408 experiments are steady state glacial model runs.

ee "Data Files" section for a file bundle containing the following NetCDF files.
220407v.nc = Control run for the freshwater hosing experiments
220407w.nc = 0.4 Sv freshwater hosing experiment
220407x.nc = 0.3 Sv freshwater hosing experiment
220407y.nc = 0.2 Sv freshwater hosing experiment
220407z.nc = 0.1 Sv freshwater hosing experiment

220408b.nc = Control run for the glacial experiments
220408c.nc = Full glacial experiment
220408d.nc = Glacial land ice experiment
220408e.nc = Glacial greenhouse gas experiments
220408f.nc = Glacial dust experiment
220408g.nc = Glacial orbital parameters experiment
220408h.nc = Glacial winds experiment

Temporal range for 220408 glacial experiments: Steady state after 20,000 years of model run.
Temporal range for 220407 hosing experiments: Transient state with 1000 years of freshwater perturbation and 1500 years of continued run.

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Data Files

File	Version
MESMO 3c DOM: glacial and freshwater hosing simulation output filename: MESMO_3c_model_runs.zip (ZIP Archive (ZIP), 397.59 MB) MD5:7ee7b6a7ca0bcac3d83506013e228742 *This file bundle contains netCDF files with the results of MESMO 3c model runs with semilabile and refractory DOM. "220407" experiments are transient freshwater hosing experiments. "220408" experiments are steady state glacial model runs.* *220407v.nc = Control run for the freshwater hosing experiments* *220407w.nc = 0.4 Sv freshwater hosing experiment* *220407x.nc = 0.3 Sv freshwater hosing experiment* *220407y.nc = 0.2 Sv freshwater hosing experiment* *220407z.nc = 0.1 Sv freshwater hosing experiment* *220408b.nc = Control run for the glacial experiments* *220408c.nc = Full glacial experiment* *220408d.nc = Glacial land ice experiment* *220408e.nc = Glacial greenhouse gas experiments* *220408f.nc = Glacial dust experiment* *220408g.nc = Glacial orbital parameters experiment* *220408h.nc = Glacial winds experiment* *These netCDF files contain the parameters:* *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"* *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"*	1

File	Version
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_deg,"DOC microbial degradation","molC kg-1 yr-1" DOC,"dissolved organic carbon","mol kg-1" DOC_prod_split1,"DOCt production from NPP","molC kg-1 yr-1" DOCr_13,"d13C of DOCr","o/oo" DOCr_14,"D14C of DOCr","o/oo" DOCr_14Q,"DOCr_14 concentration","mol kg-1" DOCr_bk_deg,"DOCr background degradation in vent boxes","molC kg-1 yr-1" DOCr_bkg_deg,"DOCr background degradation","molC kg-1 yr-1" DOCr_photodeg,"DOCr photodegradation","molC kg-1 yr-1" DOCr_prod_split2,"DOCr production deep POC split","molC m-2 yr-1" DOCr,"refractory DOC","mol kg-1" DOCr_vent_deg,"DOCr vent degradation","molC kg-1 yr-1" DOCsl_prod_split2,"DOCsl production deep POC split","molC m-2 yr-1" DOFe,"dissolved organic iron","mol kg-1" DOM_frac,"DOM export fraction","" DON,"dissolved organic nitrogen","mol kg-1" DONr,"refractory DON","mol kg-1" DOP,"dissolved organic phosphorous","mol kg-1" DOPr,"refractory DOP","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" 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" topo_ocn,"ocean depth","m"	

File	Version
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., Tanioka, T., & Zahn, J. (2021). MESMO 3: Flexible phytoplankton stoichiometry and refractory dissolved organic matter. Geoscientific Model Development, 14(4), 2265–2288. https://doi.org/10.5194/gmd-14-2265-2021
Methods

Matsumoto, K., and Gilchrist, M (submitted). "Modeling marine dissolved organic carbon response to climate change" submitted to Paleoceanography and Paleoclimatology.
Results

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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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