Data Documentation for Zooplankton grazing is the largest source of 1 uncertainty for marine carbon cycling in CMIP6 IPCC models

We have provided postprocessed data products to re-create all published figures and analysis. Data is provided and described separately below for 1. The suite CMIP6 model output and 2. The WOMBAT Sensitivity Studies.

1. CMIP6 Model Output

Separate files containing processed month Climatologies for each CMIP6 models included in this study are provided. Within each file is the relevant model grid information and model output. This includes the offline calculations of grazing rates described in the manuscript. Note, we have also included out code (CIMP6_Grazing_Comp.m) which can be further referenced for how offline variables were computed. Note:

- Many variables have been converted into different units than originally downloaded in.
- Not all models include all output listed below
- All 4 dimensional output is depth resolved and organized as (Month, Depth, Lat, Lon)
- All 3 dimensional output is depth integrated (or averaged) and organized as (Month, Lat, Lon)
    - Except in the case of *baccos* which is surface bacteria field.
- In some cases the 'Matrix Name' for each filedoes not always perfectly imply the Variable. However, the 'Variable Name' and 'Long Name' refer exactly to what is described in the manuscript. Please be careful the correct variables is being used.
- In some model phymisc and phypico are differential used for the phytoplankton PFT. Please look through the processing script CIMP6_Grazing_Comp.m for clarity where needed.

Model Output

Matrix name	Variable Name	Long Name	Units
baccos	B	Surface Bacteria Biomass	mmolC/m^3
detoc	D	Detrital Carbon	mmolC/m^3
GSP	G	Bulk Phytoplankton Grazing Mortality	mmolC/m^3/d
graze_spec	g	Zooplankton Specific Grazing	1/d
GSP_ht	GSP	Gross Secondary Production	mmolC/m^3/d
intpp	NPP	Net Primary Productivity	mmolC/m^2/d
o2	O	Disolved Oxygen	mmolC/m^3
phyc	P	Total Phytoplankton Biomass	mmolC/m^3
phydiat	P_{lg}	Diatom Biomass	mmolC/m^3

phydiaz	P_{dz}	Diazatroph Biomass	mmolC/m^3
phypico	P_{sm}	Small Phytoplankton Biomass	mmolC/m^3
phymisc	P_{sm}	Small Phytoplankton Biomass	mmolC/m^3
thetao	T	Ocean Temperature	Degree C
zmeso	Z_{sm}	Mesozooplankton Biomass	mmolC/m^3
zmicro	Z_{lg}	Microzooplankton Biomass	mmolC/m^3
zooc	Z	Total Zooplankton Biomass	mmolC/m^3
Z_loss	M	Bulk Zooplankton Mortality	mmolC/m^3/d
Z_loss_spec	m	Zooplankton Specific Mortality	1/d

Model Grid

Matrix Name	**Variable Name**	**Units**
Lat	Latitude	Degrees E
Lon	Longitude	Degrees N
Cell_Area	Grid Cell area	m^2
Cell_Volume	Grid Cell Volume	m^2
Cell_Thick	Grid Cell Thickness	m^2
depthlev	Grid Cell Depth	m

2. The WOMBAT Sensitivity Studies

All relevant data from the their All relevant data form the WOMBAT sensitivity studies is stored in the file '**WOMBAT_Sensitivity_Exps.mat**'. Within this file are 6 matrices: Model_Output Area Ks Lat Lon gs, descriped below.

Model_Output

This matrix contains the all post-processed data needed to recreate our analysis. It contains global distributions for 14 diagnostic variables computed directly from each simulation and is organized along the following dimensions: (Experiment Suite, Parameter Set, Variable, Lat, Lon) with a corresponding size of: (3, 19, 14, 300, 360). Indexed variables and their units are listed below. The formulation of different Experiment Suites is detailed in Supporting Table 5 and briefly reviewed below. The Parameters Set associated with each index is provided in *Ks* and *gs*, and discussed below

For example, to create the globally integrated mean annual *NPP* from Experiment Suite 1 and Parameter Set 15, you can convolve **Grid_Exp_Data(1, 15, 6, :, :)** the *Area* matrix (see below). To plot the distribution of mean annual *NPP* **Grid_Exp_Data(1, 15, 6, :, :)** can be plotted against *Lat* and *Lon* (see below)**.**

Note, all reported variables not included here can be computed from those included. For example, export efficiency is equal to *EP*/*NPP*. In all cases globally averaged secondary

products were computed from globally averaged primary variables, rather than, for example, first computing *EP*/*NPP* at each grid cell.

Note, variables indexed above 10 are not used in this analysis.

Variable Index	Variable	Unit
Annual Mean Values		
1	Mean Mixed Layer Depth	m
2	Mean Surface Phytoplankton Concentration	$mmolC/m^3$
3	Mean Phytoplankton Inventory (200 m)	mmolC/m2
4	Mean Surface Zooplankton Concentration	$mmolC/m^3$
5	Mean Zooplankton Inventory (1-200 m)	mmolC/m2
6	Mean Net Primary Production	$mmolC/m^2/d$
7	Mean Gross Secondary Production	$mmolC/m^2/d$
8	Mean Export Production (100 m)	$mmolC/m^2/d$
9	Mean Phytoplankton Specific Growth Rate (1-200 m)	d^{-1}
10	Mean Zooplankton Specific Grazing Rate (1-200 m)	d^{-1}

Grid and Experiment Information *(Lat, Lon, Area, Ks, gs)*

These matricies contain information on the model grid and experimental setup. Regarding the model grid, a matrix of the latitude, longitude and area of each grid cell is provided in *Lat*, *Lon*, and *Area*. Regarding the experiment set up, as discussed in the SI, we can three suites of experiments:

1. Type III functional response; Slow Turnover
2. Type II functional response; Slow Turnover
3. Type III functional response; Fast Turnover (i.e. MARBL growth rate)

Within each suite we ran 19 simulations with different $K_{1/2}$ and g_{max} parameters. The same parameter sets were used in each experiment suite. The value of the $K_{1/2}$ and g_{max} parameters are recorded in *Ks* and *gs*. Note, they are repeated but identical for each experiment Suite.

For example, the parameters used in Experiment Suite 1 and Parameter Set 15 can be found in *Ks*(1,15) and gs(1,15) and lead to the simulated mean annual NPP found in **Grid_Exp_Data(1, 15, 6, :, :).**

File	Variable	Units	Size	Dimensions
Lat	Latitude	Degrees E	300 x 360	Model grid
Lon	Longitude	Degrees N	300 x 360	Model grid
Area	Grid cell area	km^2	300 x 360	Model grid
Ks	Half saturation parameter	$mmolC/m^3$	3 x 19	[Experiment Suite, Parameter Set]
gs	Maximum grazing rate parameter	d^{-1}	3 x 19	[Experiment Suite, Parameter Set]