National Aeronautics and Space Administration Goddard Earth Science Data Information and Services Center (GES DISC)

README Document for NASA Ocean Biogeochemical Model

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Revision History

Revision Date	*Changes*	*Author*
2008	Original version	Gregg W.W.
March 2012	See “1.4. What’s New?”	Gregg W.W. and Rousseaux C.S.

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1.0 Introduction

This document provides basic information for using NASA Ocean Biogeochemical Model products.

The NASA Ocean Biogeochemical Model is a three dimensional representation of coupled circulation/biogeochemical/radiative processes in the global oceans. It spans the domain from -84° to 72° latitude in increments of 1.25° longitude by 2/3° latitude, including only open ocean areas where bottom depth >200m. The biogeochemical processes model contains 4 phytoplankton groups, 4 nutrient groups, a single herbivore group, and 3 detrital pools.

1.1 Dataset Description

The NASA Ocean Biogeochemical Model (NOBM) is a fully coupled general circulation/ biogeochemical/radiative model of the global oceans [*Gregg and Casey*, 2007]. The model has been extensively validated [*Gregg and Casey*, 2007; *Gregg, et al.*, 2003], involving a comparison of 9 of the 14 model state variables against in situ and/or satellite data sets (only herbivores, the 3 detrital components, and dissolved organic carbon have not been validated). The model contains 4 explicit phytoplankton taxonomic groups: diatoms, cyanobacteria, chlorophytes, and coccolithophores. As with nutrients and total chlorophyll, the phytoplankton groups in the model have been validated against in situ data [*Gregg and Casey*, 2007, publicly available at the GMAO web site].

Total chlorophyll fields (sum of all phytoplankton components) in NOBM are assimilated using Sea-viewing Wide Field-of-view Sensor (SeaWiFS) data from 1998-2007. Phytoplankton relative abundances are not directly affected by the data assimilation, but they can be affected indirectly via changes in concentration gradients, light availability, and nutrient availability that are derived from changes in total chlorophyll.

1.3 Data Disclaimer

Please refer to the 'Reference' section of this document for further technical details on the NOBM or contact us directly.

1.3.1 Acknowledgement

Please acknowledge the NOBM and the data source (i.e. Giovanni).

1.3.2 Contact Information

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1.4 What's New?

The R2012.3 version (released in March 2012) of the NOBM uses a multi-variate assimilation methodology where the imbalances derived from the assimilation of satellite chlorophyll are corrected using a mechanistic approach involving the nutrient-to chlorophyll ratios embedded in the model (Rousseaux & Gregg, submitted). The difference between the chlorophyll assimilation results and the prior chlorophyll produced by the model (the analysis increments) are used to adjust the nutrient concentrations. The multi-variate assimilation is applied to silica and dissolved iron, as well as nitrate.

In the model, all biological processes are assumed to cease in the presence of sea ice. We provide a variable called 'ice' (either 'moniceYYYYMM' or dayICEYYYYMMDD') that represents the distribution of sea ice cover. The variables chlorophytes, diatoms, coccolithophores, cyanobacteria and total chlorophyll have been normalized to the fraction of ice (data=data(100-ice/100)).

The multi-variate assimilation of nutrients begins with the assimilation of satellite chlorophyll

$\Delta C_T = C_T(\text{ana}) - C_T(\text{model})$ (1)

$C_T(\text{model}) = \sum_i C_i$ (2)

$\Delta N = b_n \Delta C_T$ (3)

where ΔC_T (Eq. 1) is the difference between the analyzed total chlorophyll, $C_T(\text{ana})$, and the model, $C_T(\text{model})$. $C_T(\text{model})$ is the total chlorophyll (sum of all 4 phytoplankton components, Eq. 2), C_i is the i^{th} phytoplankton chlorophyll component, and f_i is the fraction of the i^{th} phytoplankton component of the total chlorophyll. The change in nitrate ΔN is simply a function of the analysis increment of total chlorophyll ΔC_T modified by the nitrate-to-chlorophyll ratio b_n (Eq. 3). We only allow the assimilation to change nitrate by a maximum of one-half in each assimilation event to reduce model instability resulting from outliers in the satellite chlorophyll data

$N(\text{assim}) = N(\text{model}) + \min[\Delta N, 0.5N(\text{model})]$ (4)

where N(assim) is the new assimilated nitrate.

We extend this multi-variate approach to silica, except that silica is related strictly to the analysis increment of diatoms

$\Delta Si = b_s f_i \Delta C_T$ (5)

$f_i = C_i(\text{model})/C_T(\text{model})$ (6)

where b_s is the silica-to-chlorophyll ratio, and f_i is the fraction of the i^{th} phytoplankton group to the total (in this case it is the diatom component). Like nitrate, Si(assim) is not allowed to change model prior Si by more than half.

$Si(\text{assim}) = Si(\text{model}) + \min[\Delta Si, 0.5Si(\text{model})]$ (7)

For dissolved iron, the approach is the same as for to nitrate and silica, as expressed in Eqs. 1-7. However, under conditions of persistent negative ΔC_T and low atmospheric deposition, which occurs in the South Pacific, the assimilated dissolved iron concentrations can approach zero. To rectify this problem, we apply a special case for iron assimilation that only applies for $\Delta Fe<0$ (and therefore $\Delta C_T<0$):

$$Fe(assim) = Fe(model) + \min[w\Delta Fe, 0.5Fe(model)] \quad (8)$$

where Eq. 8 is the same as Eqs. 4 and 7 for nitrate and silica, respectively, except for a weighting factor w. This weighting factor is a function of the prior concentration of Fe.

$$w = 33.3Fe - 5.0 \quad (9)$$

The weighting is applied globally and provides a smooth transition of the analysis increment to prevent iron concentrations from becoming so low as to prohibit all phytoplankton growth.

2.0 Data Organization

The dataset can either be downloaded as monthly (http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=ocean_model) or daily (http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=ocean_model_day) gridded data set.

The NASA Ocean Biogeochemical Model is a three dimensional representation of coupled circulation/biogeochemical/radiative processes in the global oceans. It spans the domain from -84° to 72° latitude in increments of 1.25° longitude by 2/3° latitude.

In the model, all biological processes are assumed to cease in the presence of sea ice. We provide a variable called 'ice' (either 'moniceYYYYMM' or dayICEYYYYMMDD') that represents the distribution of sea ice cover. The variables chlorophytes, diatoms, coccolithophores, cyanobacteria and total chlorophyll have been normalized to the fraction of ice (data=data(100-ice/100)).

2.1 File Naming Convention

Depending on the data set downloaded the file names will either start by 'mon' for monthly dataset or 'day' for daily data set:

monVARyyyymm**.hdf** **(for monthly data set)**

dayVARyyyymmdd**.hdf** **(for daily data set)**

where:

o VAR = the variable being downloaded [total chlorophyll ('tot'), diatoms ('dia'), chlorophytes ('chl'), cyanobacteria ('cya'), coccolithophores ('coc'), nitrate('rno'), iron ('irn'), mixed layer depth ('h'), ice cover ('ice')].
o yyyy = 4 digit year number [2002 -].
o mm = 2 digit month number [01-12]
o dd = day of month [01-31]

Filename example: irn199805.hdf

2.2 File Format and Structure

NOBM Data set files are in HDF-4 format. The NASA Ocean Biogeochemical Model is a three dimensional representation of coupled circulation/biogeochemical/radiative processes in the global oceans. It spans the domain from -84° to 72° latitude in increments of 1.25° longitude by 2/3° latitude.

3.0 Data Contents

3.1 Global Attributes

In addition to SDS arrays containing variables and dimension scales, global metadata is also stored in the files. Some metadata are required by standard conventions, some are present to meet data provenance requirements and others as a convenience to users of NOBM products. A summary of global attributes present in all files is shown in Table 1.

Global Attribute	**Description**
Map_Projection	Equidistant Cylindrical
Latitude_Units	degrees North
Longitude_Units	degrees East
Northernmost_Latitude	72.0
Southernmost_Latitude	-84.0
Westernmost_Latitude	-180.0
Eaternmost_Latitude	180.0
Latitude_Step	0.66666698
Longitude_Step	1.25
First_Point_Latitude	-84.0
First_Point_Longitude	-180.0

Table 1. Global metadata attributes associated with each SDS.

A floating point value of 9.99e+11 is used to identify missing data.

3.2 Products/Parameters

The following NOBM products are available through the Giovanni website:

Variables	Description	Units
tot	Total chlorophyll *a* concentration	µg chl *a*/L
chl	Chlorophyte concentration	µg chl *a*/L
dia	Diatom concentration	µg chl *a*/L
coc	Coccolithophores concentration	µg chl *a*/L
cya	Cyanobacteria concentration	µg chl *a*/L
irn	Iron concentration	Nano mole/L
rno	Nitrate concentration	Micro mole/L
h	Mixed layer depth	m

4.0 Data Services

If you need assistance or wish to report a problem:
Email: gsfc-help-disc@lists.nasa.gov
Voice: 301-614-5224
Fax: 301-614-5268
Address:
Goddard Earth Sciences Data and Information Services Center NASA Goddard Space Flight Center Code 610.2 Greenbelt, MD 20771 USA

5.0 More Information

The NOBM is provided by the Global Modeling and Assimilation Office at NASA Goddard Space Flight Center http://gmao.gsfc.nasa.gov/research/oceanbiology/

6.0 Acknowledgements

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