

PRODUCT USER MANUAL

For Global Biogeochemical Analysis and Forecast product GLOBAL_ANALYSIS_FORECAST_BIO_001_028

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GLOSSARY AND ABBREVIATIONS

CF	Climate Forecast (convention for NetCDF)
CMEMS	Copernicus Marine Environment Monitoring Service
DGF	Direct Get File (FTP-like CMEMS service tool to download a NetCDF file)
FTP	Protocol to download files
GLO	Global
NetCDF	Network Common Data Form
PUM	Product User Manual
QUID	Quality Information Document
Subsetter	CMEMS service tool to download a NetCDF file of a selected geographical box and time range

I INTRODUCTION

I.1 Summary

This document is the user manual for the CMEMS global analysis and forecast product GLOBAL_ANALYSIS_FORECAST_BIO_001_028.

The GLOBAL_ANALYSIS_FORECAST_BIO_001_028 is produced at Mercator-Ocean (Toulouse, France). It is providing 10 days of 3D global ocean forecasts updated weekly. It provides biogeochemical fields of chlorophyll concentration, nitrate, phosphate, silicate, dissolved oxygen, dissolved iron, primary production, phytoplankton, PH, and surface partial pressure of carbon dioxide.

The global ocean output files are displayed with a 1/4 degree horizontal resolution with regular longitude/latitude equirectangular projection. 50 vertical levels are ranging from 0 to 5500 meters.

This product is based on the PISCES biogeochemical model. It is forced offline at a daily frequency by GLOBAL_ANALYSIS_FORECAST_PHY_001_024 coarsened at 1/4 degree, with SEEK/IAU Data Assimilation of OCEANCOLOUR_GLO_CHL_L4_NRT_OBSERVATIONS_009_033.

The time series is aggregated in time in order to reach a two full year's time series sliding window. This product includes daily and monthly mean files over the global ocean.

It uses PISCES biogeochemical model (available on the NEMO[<https://www.nemo-ocean.eu/>] modelling platform). Outputs mean fields are interpolated on a standard regular grid in NetCDF format.

The product is published on the CMEMS dissemination server after automatic and human quality controls. Product is available on-line and disseminated through the CMEMS Information System. Files downloaded are in NetCDF format and follow CF-1.6 convention.

The analysis and forecasting system is described in the Quality Information Document (QUID): <http://marine.copernicus.eu/documents/QUID/CMEMS-GLO-QUID-001-028.pdf>.

More detailed information can be obtained from the CMEMS Service Desk (servicedesk.cmems@mercator-ocean.eu).

I.2 History of changes

Date	Description of changes and impacted product
17/10/2018	original release

II PRODUCT DESCRIPTION : GLOBAL_ANALYSIS_FORECAST_BIO_001_028

II.1 General Information about products

Product name	GLOBAL_ANALYSIS_FORECAST_BIO_001_028		
Geographical coverage	Global		
Variables	Concentration of chlorophyll Concentration of dissolved iron Concentration of nitrate Net primary production of biomass Concentration of dissolved molecular oxygen PH Concentration of phytoplankton Concentration of phosphate Concentration of silicate Surface partial pressure of carbon dioxide		
	Analysis	Forecast	
Update frequency	Weekly	Weekly	
Available time series	running window with a 2 years length	10-days forecast	
Target delivery time	Thursday at 12pm (noon) UTC	Thursday at 12pm (noon) UTC	
Temporal resolution	daily and monthly means	daily means	
Delivery mechanisms	Subsetter	DGF	FTP
Horizontal resolution	1/4 ° (equirectangular grid)		
Number of vertical levels	50 levels		
Format	NetCDF CF1.6		

II.2 Details of the datasets

GLOBAL_ANALYSIS_FORECAST_BIO_001_028	
global-analysis-forecast-bio-001-028-monthly	Contains output variables.
	chl [mg m-3] Total Chlorophyll mass_concentration_of_chlorophyll_in_sea_water
	fe [mmol m-3] Dissolved Iron mole_concentration_of_dissolved_iron_in_sea_water
	no3 [mmol m-3] Nitrate mole_concentration_of_nitrate_in_sea_water
	nppv [mg m-3 day-1] Total Primary Production of Phyto net_primary_production_of_biomass_expressed_as_carbon_per_unit_volume_in_sea_water
	o2 [mmol m-3] Dissolved Oxygen mole_concentration_of_dissolved_molecular_oxygen_in_sea_water
	ph [1] PH sea_water_ph_reported_on_total_scale
	Phyc [mmol m-3] Total Phytoplankton mole_concentration_of_phytoplankton_expressed_as_carbon_in_sea_water
	po4 [mmol m-3] Phosphate mole_concentration_of_phosphate_in_sea_water
	si [mmol m-3] Dissolved Silicate mole_concentration_of_silicate_in_sea_water
	spco2 [Pa] surface CO2 surface_partial_pressure_of_carbon_dioxide_in_sea_water
global-analysis-forecast-bio-001-	describe the grid.
	longitude [degrees_east] longitude
	latitude [degrees_north] latitude

depth [m] depth
deptho [m] Bathymetry sea_floor_depth_below_geoid
deptho_lev [1] Model level number at sea floor model_level_number_at_sea_floor
mask [1] Land-sea mask : 1 = sea ; 0 = land sea_binary_mask
e1t [m] Cell dimension along X axis cell_width
e2t [m] Cell dimension along Y axis cell_height
e3t [m] Cell dimension along Z axis cell_thickness

II.3 Product System Description

The GLOBAL_ANALYSIS_FORECAST_BIO_001_028 is providing 10 days of 3D global ocean forecasts updated weekly. It provides biogeochemical fields of chlorophyll concentration, nitrate, phosphate, silicate, dissolved oxygen, dissolved iron, primary production, phytoplankton, PH, and surface partial pressure of carbon dioxide. The time series is aggregated in time, in order to reach a two full year's time series sliding window. This product includes daily and monthly mean files over the global ocean.

Domain	Global ocean (180°W-180°E ; 90°S – 90°N)
Resolution and grid	Native grid: ORCA grid at 1/4°; 50 levels.
Geographic coverage	Outputs are then interpolated on a standard collocated equirectangular grid at 1/4 degree (1440 x 681) with 50 vertical levels.
Algorithm	NEMO3.6 - PISCES
Atmospheric forcings	none
Assimilation scheme	SEEK/IAU
Assimilated observations	OCEANCOLOUR_GLO_CHL_L4_NRT_OBSERVATIONS_009_033

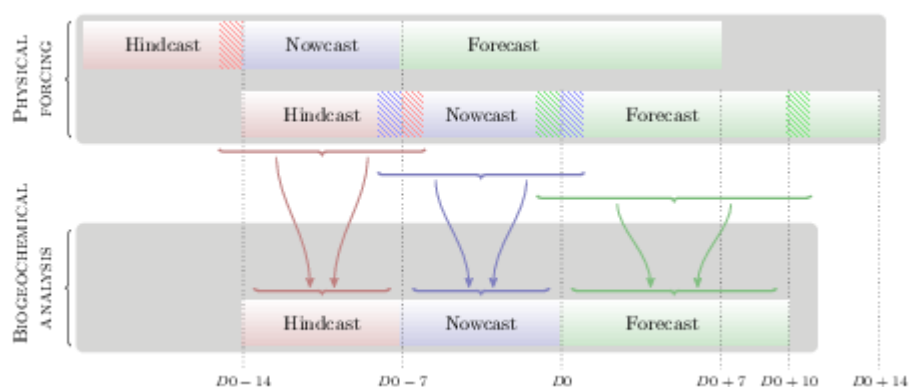
Initial conditions	WOA 2013 for NO ₃ , O ₂ , PO ₄ and Si GLODAP with anthropogenic part for DIC and Alkalinity A 3000-year PISCES run for DOC and Iron
Bathymetry	Merge of ETOPO1 and GEBCO 2014.

II.4 Processing information

II.4.1 Update Time

The daily mean analysis fields are most of the time updated weekly, on Wednesday at 4:00 p.m. However, due to dependencies to physical forcing fields the target time delivery is Thursday at 12:00 a.m.

Production cycle is described in the following schematic:



To run the biogeochemical analysis, along the week D0-14 to D0-7, we need physical forcing fields from D0-15 to D0-6...

II.4.2 Time coverage

2 years of Analysis (running window with a 2 years length)

II.4.3 Time averaging

The fields are daily (monthly) mean from 00h00 to 24h00 (from first day of the month at 00h00 to the last day of the month at 24h00).

III HOW TO DOWNLOAD A PRODUCT

III.1 Download a product through the CMEMS Web Portal Subsetter Service

You first need to register. Please find below the registration steps:
<http://marine.copernicus.eu/web/34-products-and-services-faq.php#1>

Once registered, the CMEMS FAQ <http://marine.copernicus.eu/web/34-products-and-services-faq.php> will guide you on how to download a product through the CMEMS Web Portal Subsetter Service.

III.2 Download a product through the CMEMS Web Portal Ftp Service

You first need to register. Please find below the registration steps:
<http://marine.copernicus.eu/web/34-products-and-services-faq.php#1>

Once registered, the CMEMS FAQ <http://marine.copernicus.eu/web/34-products-and-services-faq.php> will guide you on how to download a product through the CMEMS Web Portal FTP Service.

III.3 Download a product through the CMEMS Web Portal Direct Get File Service

You first need to register. Please find below the registration steps:
<http://marine.copernicus.eu/web/34-products-and-services-faq.php#1>

Once registered, the CMEMS FAQ <http://marine.copernicus.eu/web/34-products-and-services-faq.php> will guide you on how to download a product through the CMEMS Web Portal Direct Get File Service.

IV FILES NOMENCLATURE AND FORMAT

IV.1 Nomenclature of files when downloaded through the Subsetter Service

GLOBAL_ANALYSIS_FORECAST_BIO_001_028 files nomenclature when downloaded through the CMEMS Web Portal Subsetter is based on product dataset name and a numerical reference related to the request date on the portal.

The scheme is: **datasetname_nnnnnnnnnnnnn.nc**

where:

- **datasetname**: as described previously
- **nnnnnnnnnnnnnn**: 13 digit integer corresponding to the current time (download time) in milliseconds since January 1, 1970 midnight UTC.
- **.nc**: standard NetCDF filename extension.

Example: global-analysis-forecast-bio-001-028_1303461772348.nc

IV.2 Nomenclature of files when downloaded through the DGF and CMEMS FTP Services

GLOBAL_ANALYSIS_FORECAST_BIO_001_028 files nomenclature when downloaded through the CMEMS Web Portal DGF or FTP service is based on model name, production date and field date.

The scheme is: **mercatorbiomer4v2r1_global_mean_\${date1}_BIO.nc**

where:

- **date1**: integer corresponding to the field date :
 - format YYYYMMDD for daily mean
 - format YYYYMM for monthly mean

Example: mercatorbiomer4v2r1_global_mean_20161215_BIO.nc

IV.3 File Format: format name

The products are stored using the NetCDF format.

NetCDF (network Common Data Form) is an interface for array-oriented data access and a library that provides an implementation of the interface. The NetCDF library also defines a machine-independent format for representing scientific data. Together, the interface, library, and format support the creation, access, and sharing of scientific data. The NetCDF software was developed at the Unidata Program Center in Boulder, Colorado. The NetCDF libraries define a machine-independent format for representing scientific data.

Please see Unidata NetCDF pages for more information, and to retrieve NetCDF software package.

NetCDF data is:

- * Self-Describing. A netCDF file includes information about the data it contains.
- * Architecture-independent. A NetCDF file is represented in a form that can be accessed by computers with different ways of storing integers, characters, and floating-point numbers.
- * Direct-access. A small subset of a large dataset may be accessed efficiently, without first reading through all the preceding data.
- * Appendable. Data can be appended to a NetCDF dataset along one dimension without copying the dataset or redefining its structure. The structure of a NetCDF dataset can be changed, though this sometimes causes the dataset to be copied.
- * Sharable. One writer and multiple readers may simultaneously access the same NetCDF file.

IV.4 File size

DATASET NAME	FILE NAME	DIMENSION [GB]	
		Compressed	Uncompressed
global-analysis-forecast-bio-001-028	mercatorbiomer4v2r1_global_mean_\$(date 1)_BIO.nc	0.8	2.3

IV.5 Remember: scale_factor & add_offset / missing_value / land mask

Real_Value = (Display_Value X scale_factor) + add_offset

There are no missing values.

Land mask are equal to “_FillValue” (see variable attribute on NetCDF file).

IV.6 Reading Software

NetCDF data can be browsed and used through a number of software, like:

- ✓ ncBrowse: <http://www.epic.noaa.gov/java/ncBrowse/>,
- ✓ NetCDF Operator (NCO): <http://nco.sourceforge.net/>
- ✓ IDL, Matlab, GMT...

Useful information on UNIDATA: <http://www.unidata.ucar.edu/software/netcdf/>

IV.7 Structure and semantic of netCDF maps files

netcdf PHY4v2r1_global_mean_20070103_BIO {

dimensions:

```
longitude = 1440 ;  
latitude = 681 ;  
depth = 50 ;  
time = UNLIMITED ; // (1 currently)
```

variables:

```
float longitude(longitude) ;  
    longitude:valid_min = -180.f ;  
    longitude:valid_max = 179.75f ;  
    longitude:step = 0.25f ;  
    longitude:units = "degrees_east" ;  
    longitude:unit_long = "Degrees East" ;  
    longitude:long_name = "Longitude" ;  
    longitude:standard_name = "longitude" ;  
    longitude:axis = "X" ;  
  
float latitude(latitude) ;  
    latitude:valid_min = -80.f ;  
    latitude:valid_max = 90.f ;  
    latitude:step = 0.25f ;  
    latitude:units = "degrees_north" ;  
    latitude:unit_long = "Degrees North" ;  
    latitude:long_name = "Latitude" ;  
    latitude:standard_name = "latitude" ;  
    latitude:axis = "Y" ;  
  
float depth(depth) ;  
    depth:valid_min = 0.494025f ;  
    depth:valid_max = 5727.917f ;  
    depth:units = "m" ;  
    depth:positive = "down" ;  
    depth:unit_long = "Meters" ;  
    depth:long_name = "Depth" ;
```

```
depth:standard_name = "depth" ;
depth:axis = "Z" ;
float time(time) ;
time:long_name = "Time (hours since 1950-01-01)" ;
time:standard_name = "time" ;
time:calendar = "gregorian" ;
time:units = "hours since 1950-01-01 00:00:00" ;
time:axis = "T" ;
float chl(time, depth, latitude, longitude) ;
chl:long_name = "Total Chlorophyll" ;
chl:standard_name = "mass_concentration_of_chlorophyll_in_sea_water" ;
chl:units = "mg m-3" ;
chl:unit_long = "milligram of Chlorophyll per cubic meter" ;
chl:_FillValue = 9.96921e+36f ;
chl:add_offset = 0.f ;
chl:scale_factor = 1.f ;
chl:valid_min = 0.003345342f ;
chl:valid_max = 0.02141833f ;
float fe(time, depth, latitude, longitude) ;
fe:long_name = "Dissolved Iron" ;
fe:standard_name = "mole_concentration_of_dissolved_iron_in_sea_water" ;
fe:units = "mmol m-3" ;
fe:unit_long = "millimoles per cubic meter" ;
fe:_FillValue = 9.96921e+36f ;
fe:add_offset = 0.f ;
fe:scale_factor = 1.f ;
fe:valid_min = 5.036617e-06f ;
fe:valid_max = 0.009313826f ;
float no3(time, depth, latitude, longitude) ;
no3:long_name = "Nitrate" ;
no3:standard_name = "mole_concentration_of_nitrate_in_sea_water" ;
no3:units = "mmol m-3" ;
no3:unit_long = "millimoles of Nitrate per cubic meter" ;
```

```
no3:_FillValue = 9.96921e+36f ;
no3:add_offset = 0.f ;
no3:scale_factor = 1.f ;
no3:valid_min = 7.870297e-19f ;
no3:valid_max = 55.55519f ;
float nppv(time, depth, latitude, longitude) ;
    nppv:long_name = "Total Primary Production of Phyto" ;
    nppv:standard_name =
"net_primary_production_of_biomass_expressed_as_carbon_per_unit_volume_in_sea_water" ;
    nppv:units = "mg m-3 day-1" ;
    nppv:unit_long = "milligrams of Carbon per cubic meter per day" ;
    nppv:_FillValue = 9.96921e+36f ;
    nppv:add_offset = 0.f ;
    nppv:scale_factor = 1.f ;
    nppv:valid_min = 0.f ;
    nppv:valid_max = 2.482043f ;
float o2(time, depth, latitude, longitude) ;
    o2:long_name = "Dissolved Oxygen" ;
    o2:standard_name =
"mole_concentration_of_dissolved_molecular_oxygen_in_sea_water" ;
    o2:units = "mmol m-3" ;
    o2:unit_long = "millimoles of Oxygen per cubic meter" ;
    o2:_FillValue = 9.96921e+36f ;
    o2:add_offset = 0.f ;
    o2:scale_factor = 1.f ;
    o2:valid_min = 1.491491e-23f ;
    o2:valid_max = 455.7572f ;
float ph(time, depth, latitude, longitude) ;
    ph:long_name = "PH" ;
    ph:standard_name = "sea_water_ph_reported_on_total_scale" ;
    ph:units = "1" ;
    ph:unit_long = "1" ;
    ph:_FillValue = 9.96921e+36f ;
    ph:add_offset = 0.f ;
```



```
ph:scale_factor = 1.f ;
ph:valid_min = 7.029801f ;
ph:valid_max = 8.773923f ;
float phyc(time, depth, latitude, longitude) ;
  phyc:long_name = "Total Phytoplankton" ;
  phyc:standard_name =
"mole_concentration_of_phytoplankton_expressed_as_carbon_in_sea_water" ;
  phyc:units = "mmol m-3" ;
  phyc:unit_long = "millimoles per cubic meter" ;
  phyc:_FillValue = 9.96921e+36f ;
  phyc:add_offset = 0.f ;
  phyc:scale_factor = 1.f ;
  phyc:valid_min = 0.0191551f ;
  phyc:valid_max = 0.07736214f ;
float po4(time, depth, latitude, longitude) ;
  po4:long_name = "Phosphate" ;
  po4:standard_name = "mole_concentration_of_phosphate_in_sea_water" ;
  po4:units = "mmol m-3" ;
  po4:unit_long = "millimoles of Phosphate per cubic meter" ;
  po4:_FillValue = 9.96921e+36f ;
  po4:add_offset = 0.f ;
  po4:scale_factor = 1.f ;
  po4:valid_min = 9.286369e-05f ;
  po4:valid_max = 11.51752f ;
float si(time, depth, latitude, longitude) ;
  si:long_name = "Dissolved Silicate" ;
  si:standard_name = "mole_concentration_of_silicate_in_sea_water" ;
  si:units = "mmol m-3" ;
  si:unit_long = "millimoles of Silicate per cubic meter" ;
  si:_FillValue = 9.96921e+36f ;
  si:add_offset = 0.f ;
  si:scale_factor = 1.f ;
  si:valid_min = 3.326501e-07f ;
  si:valid_max = 247.1501f ;
```

```
float spco2(time, latitude, longitude) ;
    spco2:long_name = "surface CO2" ;
    spco2:standard_name =
"surface_partial_pressure_of_carbon_dioxide_in_sea_water" ;
    spco2:units = "Pa" ;
    spco2:unit_long = "Pascal" ;
    spco2:_FillValue = 9.96921e+36f ;
    spco2:add_offset = 0.f ;
    spco2:scale_factor = 1.f ;
    spco2:valid_min = 7.305039f ;
    spco2:valid_max = 314.2982f ;

// global attributes:
    :product = "GLOBAL_ANALYSIS_FORECAST_BIO_001_028" ;
    :producer = "CMEMS - Global Monitoring and Forecasting Centre" ;
    :title = "daily mean fields from Global Ocean Biogeochemistry Analysis and Forecast"
;

    :area = "GLOBAL" ;
    :quality_information_document =
"http://marine.copernicus.eu/documents/QUID/CMEMS-GLO-QUID-001-028.pdf" ;
    :Conventions = "CF-1.6" ;
    :credit = "E.U. Copernicus Marine Service Information (CMEMS)" ;
    :contact = "servicedesk.cmems@mercator-ocean.eu" ;
    :references = "http://marine.copernicus.eu" ;
    :source = "MERCATOR BIOMER4V2R1" ;
    :licence = "http://marine.copernicus.eu/services-portfolio/service-commitments-
and-licence/" ;
    :dataset = "global-analysis-forecast-bio-001-028-daily" ;
    :institution = "Mercator Ocean" ;
    :product_user_manual = "http://marine.copernicus.eu/documents/PUM/CMEMS-
GLO-PUM-001-028.pdf" ;
    :forecast_type = "hindcast" ;
    :bulletin_date = "2007-01-17 00:00:00" ;
```