



PRODUCT USER MANUAL

for Mediterranean Sea Biogeochemical Reanalysis Product

MEDSEA_REANALYSIS_BIO_006_008

Issue: 2.3

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Approval Date: 10.09.2019

Issue	Date	§	Description of Change	Author	Validated By
1.0	26.01.16	all	First version of document	R. Lecci, G. Cossarini, S. Salon, G. Bolzon	
1.1	01.04.16	all	Change of file nomenclature, general revision.	R. Lecci, S. Salon	
2.0	18.01.17	all	General revision for CMEMS EIS V3.0	R. Lecci, S. Salon, G. Bolzon, G. Cossarini	
2.1	16.02.18	all	General revision for CMEMS EIS V4.1	R. Lecci, G. Bolzon, G. Cossarini	
2.2	21.01.19	all	Addition of 2017 year	R. Lecci, G. Bolzon, S. Salon	
2.3	10.09.19	all	Addition of 2018 year New template and general revision	R. Lecci, G. Cossarini, S. Salon, G. Bolzon	

TABLE OF CONTENTS

<i>GLOSSARY AND ABBREVIATIONS</i>	4
<i>INTRODUCTION</i>	6
I.1 Summary	6
I.2 History of changes	6
<i>II Description of the product specification</i>	8
II.1 General Information about product	8
II.2 Details of the datasets	9
II.3 Product System Description	10
II.4 Processing information	11
<i>III HOW TO DOWNLOAD A PRODUCT</i>	12
III.1 Download a product through the CMEMS Web Portal Subsetter Service	12
III.2 Download a product through the CMEMS Web Portal Ftp Service	12
III.3 Download a product through the CMEMS Web Portal Direct Get File Service	12
<i>IV FILES NOMENCLATURE and FORMAT</i>	13
IV.1 Nomenclature of files when downloaded through the Subsetter Service	13
IV.2 Nomenclature of files when downloaded through the DGF and CMEMS FTP Services	13
IV.3 File Format: format name	15
IV.4 File size	16
IV.5 Remember: scale_factor & add_offset / missing_value / land mask	17
IV.6 Reading Software	17
IV.7 Structure and semantic of netCDF maps files	17

GLOSSARY AND ABBREVIATIONS

ALK	Alkalinity
Analysis (Numerical)	<p>a detailed study of the state of the ocean done in Near real Time based on observations and numerical model. The operational prediction centre produces 3D time-space analysis systems.</p> <p>A long series of analyses is of great utility for studying the behavior of the ocean system.</p>
BCs	Boundary Conditions
BFM	Biogeochemical Flux Model
BODC	British Oceanographic Data Centre
CF	Climate Forecast (convention for NetCDF)
CHL	Chlorophyll
CIS	CMEMS Information System
CMEMS	Copernicus Marine Environment Monitoring Service
CNR	Centro Nazionale delle Ricerche
DGF	DirectGetFile
DIC	Dissolved Inorganic Carbon
DirectGetFile	CMEMS service tool (FTP like) to download a NetCDF file
EOF	Empirical Orthogonal Function
ESA-CCI	European Space Agency - Climate Change Initiative
FAQ	Frequently Asked Question
Forecast (Numerical)	<p>a computer forecast or prediction based on equations governing the motions and the forces affecting motion of fluids. The equations are based, or initialized, on specified ocean conditions at a certain place and time (NOAA Glossary).</p>
FTP	File Transfer Protocol
GOS	Global Ocean Satellite

ISAC	Institute of Atmospheric Sciences and Climate
Med/MED	Mediterranean
MEDAR	Mediterranean Data Archaeology and Rescue
MFC	Monitoring and Forecasting Centre
MFSTEP	Mediterranean Forecasting System Toward Environmental Predictions
MyOcean2	Prototype Operational Continuity for GMES Ocean Monitoring and Forecasting System FP7 R&D project
NetCDF	Network Common Data Form
NOAA	National Oceanic and Atmospheric Administration
OCMIP	Ocean Carbon-Cycle Model Intercomparison Project
OCTAC	Ocean Color Thematic Assembly Centre
OGS	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale
OPA	Océan PARallélisé
OpenDAP	Open-Source Project for a Network Data Access Protocol. Protocol to download subset of data from a n-dimensional gridded dataset (ie: 4 dimensions: lon-lat,depth,time)
pCO2	partial pressure of carbon dioxide
PFT	Plankton Functional Types
pH	potential of Hydrogen
PU	Production Unit
Subsetter	CMEMS service tool to download a NetCDF file of a selected geographical box using values of longitude and latitude, and time range
Vb	Covariance among biogeochemical variables
Vh	Horizontal Covariance
Vv	Vertical Covariance
3DVAR	Three-Dimensional Variational

INTRODUCTION

I.1 Summary

This document is the user manual for the CMEMS reanalysis product for Mediterranean Sea biogeochemistry **MEDSEA_REANALYSIS_BIO_006_008**. An archive of reanalysis since 01/01/1999 is available on the CMEMS server.

The product is composed by 3D, monthly mean concentration of chlorophyll, nitrate, phosphate, primary production, dissolved oxygen and phytoplankton carbon biomass, ocean pCO₂ and ocean pH.

MEDSEA_REANALYSIS_BIO_006_008 product is organized in 5 datasets:

- 4 contain the 3D monthly mean fields for all the variables
 - **sv03-med-ogs-bio-rean-m**
 - **sv03-med-ogs-car-rean-m**
 - **sv03-med-ogs-nut-rean-m**
 - **sv03-med-ogs-pft-rean-m**
- 1 contains the static fields for the system (coordinates, mask and bathymetry):
MEDSEA_REANALYSIS_BIO_006_008-statics

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.

The reanalysis system is described in the Quality Information Document (QUID) CMEMS-MED-QUID-006-008 (<http://cmems-resources.cls.fr/documents/QUID/CMEMS-MED-QUID-006-008.pdf>).

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

Disclaimer: The quality of the product may vary during the proposed time series depending on the possible update of the system.

I.2 History of changes

Apr 2017	Upgrade of the data assimilation module: surface chlorophyll concentration over the entire domain (included coastal areas) is now integrated in assimilation Improved qualification of the variables including coastal areas.
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Sep 2019

New template and general revision

II DESCRIPTION OF THE PRODUCT SPECIFICATION

II.1 General Information about product

Product Specification	MEDSEA_REANALYSIS_BIO_006_008
Geographical coverage	5.5625°W → 36.25°E; 30.1875°N → 45.9375°N
Variables	Chlorophyll Phosphate Nitrate Primary Production Dissolved Oxygen Phytoplankton Carbon Biomass Ocean pCO ₂ Ocean pH
	Reanalysis
Available time series	From 1999 Regularly updated (see product improvements pages http://marine.copernicus.eu/services-portfolio/product-improvements/)
Temporal resolution	sv03-med-ogs-nut-rean-m, sv03-med-ogs-pft-rean-m, sv03-med-ogs-bio-rean-m, sv03-med-ogs-car-rean-m: monthly mean
Target delivery time	N/A
Delivery mechanism	CMEMS Information System (Subsetter, CMEMS FTP, DGF)
Horizontal resolution	1/16°
Number of vertical levels	72
Format	NetCDF CF1.0

Detailed information on the systems and products are on CMEMS web site: <http://marine.copernicus.eu/>.

II.2 Details of the datasets

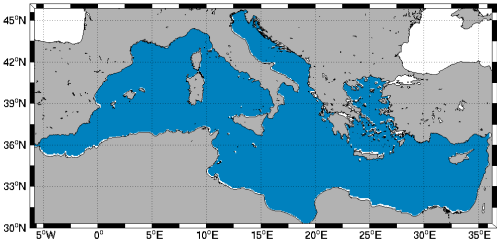
MEDSEA_REANALYSIS_BIO_006_008	
sv03-med-ogs-nut-rean-m	contains the 3D <u>monthly mean fields</u> : 3D mole concentration of Nitrate and Phosphate information from top to bottom
	nit [mmol m-3] Nitrate mole_concentration_of_nitrate_in_sea_water
	pho [mmol m-3] Phosphate mole_concentration_of_phosphate_in_sea_water
sv03-med-ogs-pft-rean-m	contains the 3D <u>monthly mean fields</u> : 3D mole concentration of Phytoplankton expressed as carbon and mass concentration of Chlorophyll information from top to bottom.
	pcb [mmol m-3] Phytoplankton Carbon Biomass mole_concentration_of_phytoplankton_expressed_as_carbon_in_sea_water
	chl [mg m-3] Chlorophyll mass_concentration_of_chlorophyll_a_in_sea_water
sv03-med-ogs-bio-rean-m	contains the 3D <u>monthly mean fields</u> : 3D net Primary Productivity of Carbon Per Unit Volume and mole concentration of Dissolved Oxygen information from top to bottom.
	npp [mol/ m ³ /s] Primary Production net_primary_production_of_biomass_expressed_as_carbon_per_unit_volume_in_sea_water
	dox [mmol m-3] Dissolved Oxygen mole_concentration_of_dissolved_molecular_oxygen_in_sea_water
sv03-med-ogs-car-rean-m	contains the 3D <u>monthly mean fields</u> : 3D on ocean pCO ₂ , ocean pH and dissolved inorganic carbon information from top to bottom
	pco [Pa] Ocean pCO ₂ partial_pressure_of_carbon_dioxide_in_sea_water
	ph [1] Ocean pH sea_water_ph_reported_on_total_scale

MEDSEA_REANALYSIS_BIO_006_008-statics	contains the static fields for the system: coordinates, mask and bathymetry.
	e1t [m] Cell dimension along X axis
	e2t [m] Cell dimension along Y axis
	e3t [m] Cell dimension along Z axis cell_thickness
	mask [1] Land-sea mask: 1 = sea ; 0 = land sea_binary_mask
	deptho [m] Bathymetry sea_floor_depth_below_geoid
	deptho_lev [1] Model level number at sea floor model_level_number_at_sea_floor

II.3 Product System Description

A reanalysis of Mediterranean Sea biogeochemistry at 1/16 degree was carried out starting from 1999 using the MedBFM1 model system (which includes the transport model OGSTMv2.0 coupled with the biogeochemical model BFMv2.1 and the data assimilation module 3DVAR-BIOv2.1). The data assimilation module has been upgraded with respect to previous version in order to assimilate surface chlorophyll concentration also from coastal areas. In this reanalysis, OGSTMv2.0 was driven by physical forcing fields produced as output by the Med-MFC-Currents model managed by the CMCC Production Unit. The ESA-CCI database of surface chlorophyll concentration estimated by satellite and delivered within CMEMS-OCTAC managed by GOS-ISAC-CNR was used for data assimilation. This reanalysis provides monthly means of 3D fields of chlorophyll, phosphate, nitrate, dissolved oxygen concentrations, net primary production, phytoplankton carbon biomass, ocean pH and ocean pCO₂.

Domain	MEDSEA (5.5625°W-36.25°E; 30.1875°N – 45.9375°N)
Resolution and grid	1/16 ; regular grid; 670 x 253
Geographic coverage	This product is over the Mediterranean Area, the horizontal resolution is 1/16 (approx 6 km), the vertical grid is composed of 72 unevenly spaced vertical.

	
Algorithm	MedBFM1
Atmospheric forcings	ECMWF atmospheric forcings at 1/8 degree: 6-hourly analysis and 3-hourly for the first 3 days of forecast
Assimilation scheme	3DVarBio (3DVAR)
Assimilated observations	ESA-CCI database of surface chlorophyll from multisensor satellite (SeaWiFS, MODIS, VIIRS) data provided by CMEMS OCTAC
Initial conditions	Climatology from: nutrients, oxygen and carbonate system data from ECHO-OGS datasets
Bathymetry	GEBCO 30sec interpolated on the model grid

II.4 Processing information

The reanalysis has been initialized with a gridded climatology for nutrients, dissolved inorganic carbon and alkalinity computed from MEDAR MEDATLAS database. The model has been initialized at the 1st January 1995. The assimilation of the available satellite data is done since January 1st 1999. Four year of spin-up are considered, thus the available data starts in 1999.

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

MEDSEA_REANALYSIS_BIO_006_008 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 CIS.

The scheme is: **datasetname_nnnnnnnnnnnnn.nc**

where:

.datasetname is a character string within one of the following :

- sv03-med-ogs-nut-rean-m
- sv03-med-ogs-pft-rean-m
- sv03-med-ogs-bio-rean-m
- sv03-med-ogs-car-rean-m

. nnnnnnnnnnnnn: 13-digit integer corresponding to the current time (download time) in milliseconds since January 1, 1970 midnight UTC.

.nc: standard NetCDF filename extension.

The fields **nut/pft/bio/car** are respectively for the variables of Nitrate and Phosphate (nit and pho) / Phytoplankton Carbon Biomass and Chlorophyll (pcb and chl) / Primary Production and Dissolved Oxygen (npp and dox) / Ocean pCO₂ and Ocean pH (pco and ph).

Example:

sv03-med-ogs-bio-rean-m_1303461772348.nc

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

MEDSEA_REANALYSIS_BIO_006_008 files nomenclature when downloaded through CMEMS FTP is based as follows:

{valid date}_{freq flag}{average flag}-{producer}-{parameter}-{config}-{region}-{bul date}_{product type}-sv{file version}.nc

where

- **valid date** YYYYMMDD is the validity day of the data in the file
- **freq flag** is the frequency of data values in the file (m = monthly)
- **average flag** is m=mean
- **producer** is a short version of the CMEMS production unit
- **config** identifies the producing system and configuration
- **region** is a three-letter code for the region
- **parameter** is a four-letter code for the parameter or parameter set from Standard BODC
- **bul date** bYYYYMMDD is the bulletin date the product was produced

- **product type** is a two-letter code for the product type, for example fc for forecast, an for analysis and re for reanalysis
- **file version** is xx.yy where xx is the CMEMS version and yy is an incremental version number

The description of the nomenclature for the MEDSEA_REANALYSIS_BIO_006_008 products is shown below:

valid date	YYYYMMDD
freq flag	m (monthly)
average flag	m (mean)
producer	OGS
config	MedBFM1
region	MED
parameter	NUTR PFTC BIOL CARB
bul date	bYYYYYMMDD
product type	re (reanalysis)
file version	03.00 (from 1999 to 2015) 04.10 (2016-2017) 05.00 (2018)

Example for a reanalysis file:

19990101_mm-OGS--NUTR-MedBFM1-MED-b20161201_re-sv03.00.nc

This is the mean field of biogeochemistry for the month of January 1999. The mean is computed from midnight (00:00 UTC) of the 1st January 1999 to midnight (23:59 UTC) of the 31st January 1999 (see section IV.8).

20160101_m-OGS--NUTR-MedBFM1-MED-b20171201_re-sv04.10.nc

This is the mean field of biogeochemistry for the month of January 2016. The mean is computed from midnight (00:00 UTC) of the 1st January 2016 to midnight (23:59 UTC) of the 31st January 2016 (see section IV.8).

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	NAME OF FILE	DIMENSION unzipped (zipped) [MB]
sv03-med-ogs-nut-rean-m	{date1}_mm-OGS--NUTR- MedBFM1-MED-b{date2}_re- sv03.00.nc {date1}_m-OGS--NUTR- MedBFM1-MED-b{date2}_re- sv04.10.nc {date1}_m-OGS--NUTR- MedBFM1-MED-b{date2}_re- sv05.00.nc	94 (23)
sv03-med-ogs-pft-rean-m	{date1}_mm-OGS--PFTC- MedBFM1-MED-b{date2}_re- sv03.00.nc {date1}_m-OGS--PFTC- MedBFM1-MED-b{date2}_re- sv04.10.nc {date1}_m-OGS--PFTC- MedBFM1-MED-b{date2}_re- sv05.00.nc	94 (23)
sv03-med-ogs-bio-rean-m	{date1}_mm-OGS--BIOL- MedBFM1-MED-b{date2}_re- sv03.00.nc {date1}_m-OGS--BIOL- MedBFM1-MED-b{date2}_re- sv04.10.nc {date1}_m-OGS--BIOL- MedBFM1-MED-b{date2}_re- sv05.00.nc	94 (23)
sv03-med-ogs-car-rean-m	{date1}_mm-OGS--CARB- MedBFM1-MED-b{date2}_re- sv03.00.nc {date1}_m-OGS--CARB- MedBFM1-MED-b{date2}_re- sv04.10.nc {date1}_m-OGS--CARB- MedBFM1-MED-b{date2}_re- sv05.00.nc	94 (23)
MEDSEA_REANALYSIS_BIO_006_008-statics	MED-MFC_006_008_\${field}.nc	1.9

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

The missing value for this product is: 1.e+20

Land mask is 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

DIMENSIONS	VARIABLES		
	NAME	DIMENSIONS	TYPE
longitude=670 latitude=253 depth=72 time=1	longitude	longitude	float
	latitude	latitude	float
	depth	depth	float
	time	time	double
	nit	time,depth,latitude,longitude	float
	pho	time,depth,latitude,longitude	float
	pcb	time,depth,latitude,longitude	float
	chl	time,depth,latitude,longitude	float
	npp	time,depth,latitude,longitude	float
	dox	time,depth,latitude,longitude	float
	pco	time,depth,latitude,longitude	float
	ph	time,depth,latitude,longitude	float

For 19990101_mm-OGS--NUTR-MedBFM1-MED-b20161201_re-sv03.00.nc

```
netcdf \19990101_mm-OGS--NUTR-MedBFM1-MED-b20161201_re-sv03.00 {
```

dimensions:

```
    longitude = 670 ;
```

```
    latitude = 253 ;
```

```
    depth = 72 ;
```

time = 1 ;

variables:

float longitude(longitude) ;

longitude:valid_min = -5.5625f ;

longitude:long_name = "longitude" ;

longitude:standard_name = "longitude" ;

longitude:units = "degrees_east" ;

longitude:valid_max = 36.25f ;

longitude:axis = "X" ;

float latitude(latitude) ;

latitude:valid_min = 30.1875f ;

latitude:long_name = "latitude" ;

latitude:standard_name = "latitude" ;

latitude:units = "degrees_north" ;

latitude:valid_max = 45.9375f ;

latitude:axis = "Y" ;

float depth(depth) ;

depth:positive = "down" ;

depth:valid_min = 1.4721f ;

depth:long_name = "depth" ;

depth:standard_name = "depth" ;

depth:units = "m" ;

depth:valid_max = 5334.648f ;

depth:axis = "Z" ;

float pho(time, depth, latitude, longitude) ;

pho:_FillValue = 1.e+20f ;

pho:coordinates = "time depth latitude longitude" ;

pho:long_name = "Mole concentration of Phosphate in sea water" ;

pho:standard_name = "mole_concentration_of_phosphate_in_sea_water" ;

pho:units = "millimol m-3" ;

pho:missing_value = 1.e+20f ;

float nit(time, depth, latitude, longitude) ;

nit:_FillValue = 1.e+20f ;

```
nit:coordinates = "time depth latitude longitude" ;
nit:long_name = "Mole concentration of Nitrate in sea water" ;
nit:standard_name = "mole_concentration_of_nitrate_in_sea_water" ;
nit:units = "millimol m-3" ;
nit:missing_value = 1.e+20f ;

double time(time) ;

time:units = "seconds since 1970-01-01 00:00:00" ;
time:long_name = "time" ;
time:standard_name = "time" ;
time:calendar = "standard" ;
time:axis = "T" ;

// global attributes:
:comment = "Please check in CMEMS catalogue the INFO section for product
MEDSEA_REANALYSIS_BIO_006_008 - http://marine.copernicus.eu/" ;
:field_type = "monthly_mean_beginning_at_time_field" ;
:bulletin_date = "2016-12-01" ;
:title = "Nitrate and Phosphate (3D) - Monthly Mean" ;
:Conventions = "CF-1.0" ;
:source = "MedBFM1" ;
:contact = "servicedesk.cmems@mercator-ocean.eu" ;
:references = "Please check in CMEMS catalogue the INFO section for product
MEDSEA_REANALYSIS_BIO_006_008 - http://marine.copernicus.eu/" ;
:bulletin_type = "reanalysis" ;
:institution = "OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale) ,
Sgonico (Trieste) - Italy" ;
}
```