PRODUCT USER MANUAL

For Mediterranean Sea Biogeochemical Analysis and Forecasting Product

MEDSEA_ANALYSIS_FORECAST_BIO_006_014

Issue: 1.3

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Issue	Date	§	Description of Change	Author	Validated By
1.0	25/09/2017	all	Initial version	R. Lecci, G. Bolzon, S. Salon, G. Cossarini	
1.1	30/04/2018	all	Update after v4.1	R. Lecci, G. Bolzon, S. Salon, G. Cossarini	
1.2	31/05/2018	all	Update of section III	R. Lecci	
1.3	21/01/2019	all	New template and inclusion of new datasets	R. Lecci, G. Bolzon, S. Salon, G. Cossarini	

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GLOSSARY AND ABBREVIATIONS

Analysis (Numerical)	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. A long series of analyses is of great utility for studying the behavior of the ocean system.
BFM	Biogeochemical Flux Model
CF	Climate Forecast (convention for NetCDF)
CHL	Chlorophyll
CMEMS	Copernicus Marine Environment Monitoring Service
DGF	DirectGetFile
DIC	Dissolved Inorganic Carbon
DirectGetFile	CMEMS service tool (FTP like) to download a NetCDF file
FAQ	Frequently Asked Question
Forecast (Numerical)	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).
FTP	File Transfer Protocol
Med/MED	Mediterranean
MFC	Monitoring and Forecasting Centre
NetCDF	Network Common Data Form
NOAA	National Oceanic and Atmospheric Administration
OCTAC	Ocean Color Thematic Assembly Centre
OGS	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale
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
3DVAR	Three-Dimensional Variational

I INTRODUCTION

I.1 Summary

This document is the user manual for the CMEMS analysis and forecast product **MEDSEA_ANALYSIS_FORECAST_BIO_006_014**. An archive of analysis since 01/01/2017 up to real-time is available on the CMEMS server.

The product is composed by 3D, 24 hours mean concentration of chlorophyll, nitrate, phosphate, primary production, dissolved oxygen, phytoplankton carbon biomass, ocean pCO2, ocean pH, dissolved inorganic carbon, and 2D 24 hours mean of surface flux of CO2.

MEDSEA_ANALYSIS_FORECAST_BIO_006_014 product is organised in 11 datasets:

- 5 contain the 3D monthly mean fields for all the variables
  - **med-ogs-bio-an-fc-m**
  - **med-ogs-car-an-fc-m**
  - **med-ogs-co2-an-fc-m**
  - **med-ogs-nut-an-fc-m**
  - **med-ogs-pft-an-fc-m**
- 5 contain the 3D daily mean fields for all the variables
  - **med-ogs-bio-an-fc-d**
  - **med-ogs-car-an-fc-d**
  - **med-ogs-co2-an-fc-d**
  - **med-ogs-nut-an-fc-d**
  - **med-ogs-pft-an-fc-d**
- **1** contains the static fields for the system: coordinates, mask and bathymetry: **MEDSEA_ANALYSIS_FORECAST_BIO_006_014-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 analysis and forecasting system is described in the Quality Information Document (QUID) CMEMS-MED-QUID-006-014 (http://cmems-resources.cls.fr/documents/QUID/CMEMS-MED-QUID-006-014.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

21.01.2019	New template and inclusion of new datasets

II PRODUCT DESCRIPTION

II.1 General Information about products

Product name	MEDSEA_ANALYSIS_FORECAST_BIO_006_014		
Geographical coverage	5.541667°W → 36.29167°E ; 30.1875°N → 45.97917°N		
Variables	Chlorophyll concentration Phosphate Nitrate Primary Production Dissolved Oxygen Phytoplankton Carbon Biomass Ocean pCO2 Ocean pH Dissolved Inorganic Carbon Surface CO2 flux		
	Analysis	**Forecast**	
Update frequency	Weekly	Twice weekly	
Available time series	01/01/2017 up to real-time	10-days forecast	
Target delivery time	On Wednesdays at 05pm UTC	On Wednesdays and Saturdays at 05pm UTC	
Temporal resolution	• med-ogs-bio-an-fc-d, med-ogs-car-an-fc-d, med-ogs-co2-an-fc-d, med-ogs-nut-an-fc-d, med-ogs-pft-an-fc-d: daily mean • med-ogs-bio-an-fc-m, med-ogs-car-an-fc-m, med-ogs-co2-an-fc-m, med-ogs-nut-an-fc-m, med-ogs-pft-an-fc-m: monthly mean		
Delivery mechanisms	Subsetter	DGF	FTP
Horizontal resolution	1/24 °		
Number of vertical levels	125		

Format	NetCDF CF1.0

II.2 Details of the datasets

MEDSEA_ANALYSIS_FORECAST_BIO_006_014	
med-ogs-nut-an-fc-m	contains the 3D monthly mean fields: 3D mole concentration of Nitrate and Phosphate information from top to bottom
	no3 [mmol m-3] Nitrate mole_concentration_of_nitrate_in_sea_water
	po4 [mmol m-3] Phosphate mole_concentration_of_phosphate_in_sea_water
med-ogs-pft-an-fc-m	contains the 3D monthly mean fields: 3D mole concentration of Phytoplankton expressed as carbon and mass concentration of Chlorophyll information from top to bottom.
	phyc [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
med-ogs-bio-an-fc-m	contains the 3D monthly mean fields: 3D net Primary Productivity of Carbon Per Unit Volume and mole concentration of Dissolved Oxygen information from top to bottom.
	nppv [mg m-3 day-1] Primary Production 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
med-ogs-car-an-fc-m	contains the 3D monthly mean fields: 3D on ocean pCO2, ocean pH and dissolved inorganic carbon information from top to bottom
	pco [uatm] Ocean pCO2 partial_pressure_of_carbon_dioxide_in_sea_water
	ph [1] Ocean pH sea_water_ph_reported_on_total_scale
	dic [umol kg-1] Dissolved Inorganic Carbon dissolved_inorganic_carbon

med-ogs-co2-an-fc-m	contains the 2D monthly mean fields: 2D surface flux of CO2 information.
	co2airflux [mmol m-2 day-1] Surface CO2 flux carbon_dioxide_flux_at_air_sea_interface
med-ogs-nut-an-fc-d	contains the 3D daily mean fields: 3D mole concentration of Nitrate and Phosphate information from top to bottom
	no3 [mmol m-3] Nitrate mole_concentration_of_nitrate_in_sea_water
	po4 [mmol m-3] Phosphate mole_concentration_of_phosphate_in_sea_water
med-ogs-pft-an-fc-d	contains the 3D daily mean fields: 3D mole concentration of Phytoplankton expressed as carbon and mass concentration of Chlorophyll information from top to bottom.
	phyc [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
med-ogs-bio-an-fc-d	contains the 3D daily mean fields: 3D net Primary Productivity of Carbon Per Unit Volume and mole concentration of Dissolved Oxygen information from top to bottom.
	nppv [mg m-3 day-1] Primary Production 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
med-ogs-car-an-fc-d	contains the 3D daily mean fields: 3D on ocean pCO2, ocean pH and dissolved inorganic carbon from top to bottom
	pco [uatm] Ocean pCO2 partial_pressure_of_carbon_dioxide_in_sea_water
	ph [1] Ocean pH sea_water_ph_reported_on_total_scale
	dic [umol kg-1] Dissolved Inorganic Carbon dissolved_inorganic_carbon

med-ogs-co2-an-fc-d	contains the 2D daily mean fields: 2D surface flux of CO2 information.
	co2airflux [mmol m-2 day-1] Surface CO2 flux carbon_dioxide_flux_at_air_sea_interface
MEDSEA_ANALYSIS_FORECAST_BIO_006_014-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

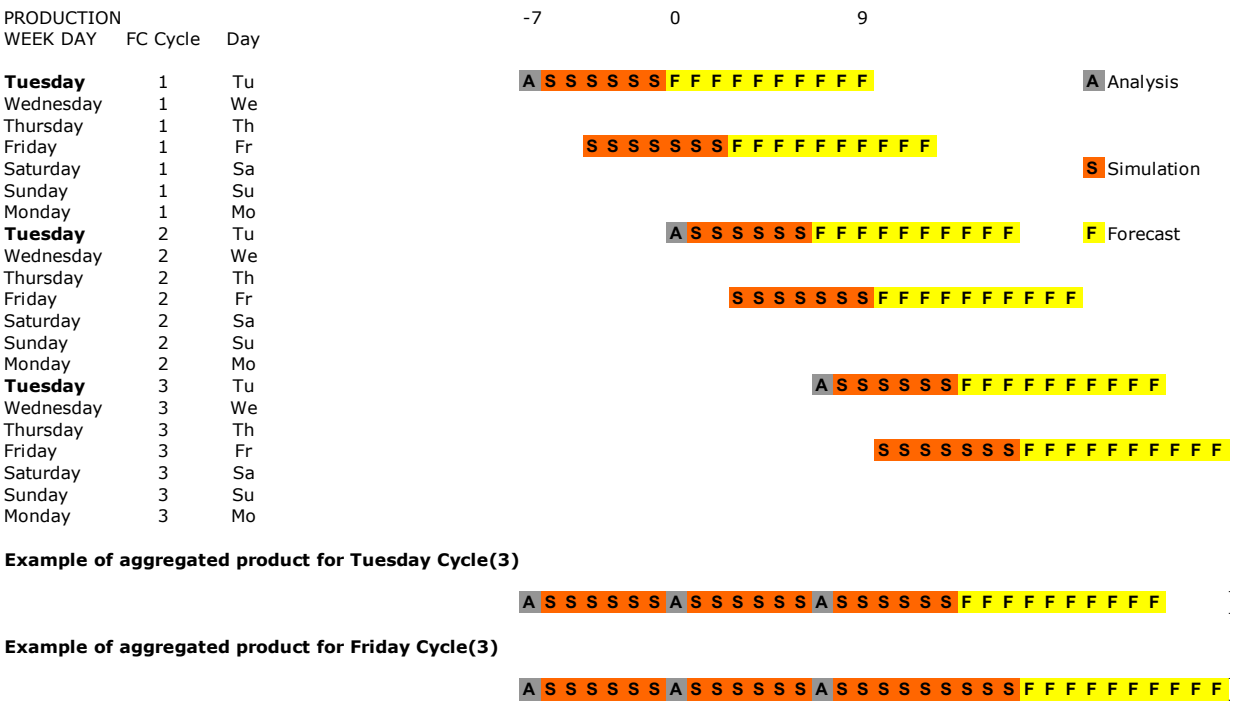
II.3 Product System Description

The biogeochemical analysis and forecasts for the Mediterranean Sea at 1/24 degree are produced by means of the MedBFM model system (i.e. the physical-biogeochemical OGSTM-BFM model coupled with the 3DVarBio assimilation scheme). MedBFM model is run by OGS and uses as physical forcing the outputs of the Med-PHY products (managed by CMCC). Seven days of analysis/hindcast and ten days of forecast are bi-weekly produced on Wednesday and on Saturday, with the assimilation of surface chlorophyll concentration from satellite observations (provided by the CMEMS-OCTAC).

Domain Resolution and grid Geographic coverage	MEDSEA (5.54°W-36.30°E ; 30.18°N – 45.98°N) 1/24º ; regular grid ; 1005 x 380 This product is over the Mediterranean Area, the horizontal resolution is 1/24 (approx 4 km), the vertical grid is composed of 125 unevenly spaced vertical.
Algorithm	MedBFM3
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	Surface chlorophyll from multisensor satellite (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

MEDSEA_ANALYSIS_FORECAST_BIO_006_014 analysis and forecast products are updated on Wednesday and Saturday within 17 UTC. The production is composed by: 1 day of analysis (A, with data assimilation), 6 days of hindcast (also referred to as simulation, S) and 10 days of forecast (F) for the Wednesday run; 7 days of hindcast (S) and 10 days of forecast (F) for the Saturday run. An example of aggregated product is shown in the Figure below.



II.4.1 Update Time

Daily datasets are updated on Wednesdays and Saturdays at 17:00 UTC.

The monthly dataset is updated monthly on the 20th (addition of the monthly mean of the previous month).

II.4.2 Time coverage

An archive of analysis since 01/01/2017 up to real-time is available.

II.4.3 Time averaging

For the monthly dataset, the fields are monthly means over the calendar month (first to last day of the month). For the daily dataset, the fields are daily means over a day (midday to midday, centered at midnight). For the hourly dataset, the fields are hourly means (centered every half-hour).

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_ANALYSIS_FORECAST_BIO_006_014 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
- **nnnnnnnnnnnnn**: 13 digit integer corresponding to the current time (download time) in milliseconds since January 1, 1970 midnight UTC.
- **.nc**: standard NetCDF filename extension.

Example: med-ogs-bio-an-fc-d_1303461772348.nc

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

MEDSEA_ANALYSIS_FORECAST_BIO_006_014 files nomenclature when downloaded through the CMEMS Web Portal DGF or FTP service is based as follows:

{valid date}_{freq 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 (h = hourly, hts = hourly time series, d = daily, m=monthly)
- **producer** is a short version of the CMEMS production unit
- **config** identifies the producing system and configuration
- **region** is a maximum six 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 sm for hindcast.
- **file version** is xx.yy where xx is the CMEMS version (03, 04 or 05) and yy is an incremental version number

Table 1 shows the nomenclature for the MEDSEA_ANALYSIS_FORECAST_BIO_006_014 products.

Table 1 Description of the nomenclature for MEDSEA_ANALYSIS_FORECAST_BIO_006_014

valid date	YYYYMMDD
freq flag	m (monthly) d (daily)
producer	OGS
config	MedBFM3
region	MED
parameter	NUTR PFTC BIOL CARB CO2F
bul date	bYYYYYMMDD
product type	fc (forecast) an (analysis) sm (hindcast)
file version	05.00

Example for a forecast file:

`20170410_d-OGS--NUTR-MedBMF3-MED-b20170405_fc-sv05.00.nc`

This is the mean field of biogeochemistry centered at 12:00 UTC of the 10th April 2017, and the time coverage is from midnight (00:00 UTC) of the 10th April 2017 to midnight (00:00 UTC) of the 11th April 2017 (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	FILE NAME	DIMENSION [MB]
med-ogs-nut-an-fc-d	{date1}_d-OGS--NUTR-MedBFM3-MED-b{date2}_fc-sv05.00.nc {date1}_d-OGS--NUTR-MedBFM3-MED-b{date2}_sm-sv05.00.nc {date1}_d-OGS--NUTR-MedBFM3-MED-b{date2}_an-sv05.00.nc	59
med-ogs-pft-an-fc-d	{date1}_d-OGS--PFTC-MedBFM3-MED-b{date2}_fc-sv05.00.nc {date1}_d-OGS-- PFTC-MedBFM3-MED-b{date2}_sm-sv05.00.nc {date1}_d-OGS--PFTC-MedBFM3-MED-b{date2}_an-sv05.00.nc	69
med-ogs-bio-an-fc-d	{date1}_d-OGS--BIOL-MedBFM3-MED-b{date2}_fc-sv05.00.nc {date1}_d-OGS--BIOL-MedBFM3-MED-b{date2}_sm-sv05.00.nc {date1}_d-OGS--BIOL-MedBFM3-MED-b{date2}_an-sv05.00.nc	61
med-ogs-car-an-fc-d	{date1}_d-OGS--CARB-MedBFM3-MED-b{date2}_fc-sv05.00.nc {date1}_d-OGS--CARB-MedBFM3-MED-b{date2}_sm-sv05.00.nc {date1}_d-OGS--CARB-MedBFM3-MED-b{date2}_an-sv05.00.nc	67

med-ogs-co2-an-fc-d	{date1}_d-OGS--CO2F-MedBFM3-MED-b{date2}_fc-sv05.00.nc {date1}_d-OGS--CO2F-MedBFM3-MED-b{date2}_sm-sv05.00.nc {date1}_d-OGS--CO2F-MedBFM3-MED-b{date2}_an-sv05.00.nc	0.5
med-ogs-nut-an-fc-m	{date1}_m-OGS--NUTR-MedBFM3-MED-b{date2}_an-sv05.00.nc	59
med-ogs-pft-an-fc-m	{date1}_m-OGS--PFTC-MedBFM3-MED-b{date2}_an-sv05.00.nc	69
med-ogs-bio-an-fc-m	{date1}_m-OGS--BIOL-MedBFM3-MED-b{date2}_an-sv05.00.nc	61
med-ogs-car-an-fc-m	{date1}_m-OGS--CARB-MedBFM3-MED-b{date2}_an-sv05.00.nc	67
med-ogs-co2-an-fc-m	{date1}_m-OGS--CO2F-MedBFM3-MED-b{date2}_an-sv05.00.nc	0.5
MEDSEA_ANALYSIS_FORECAST_BIO_006_014-statics	MED-MFC_006_014_${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

Table 8 Dimensions and variables included in the files NetCDF of MEDSEA_ANALYSIS_FORECAST_BIO_006_014.

DIMENSIONS	VARIABLES		
	NAME	DIMENSIONS	TYPE
longitude=1005 latitude=380 depth=125 time=1	longitude	longitude	float
	latitude	latitude	float
	depth	depth	float
	time	time	int
	no3	time,depth,latitude,longitude	float
	po4	time,depth, latitude,longitude	float
	phyc	time,depth, latitude,longitude	float
	chl	time,depth, latitude,longitude	float
	nppv	time,depth, latitude,longitude	float
	o2	time,depth, latitude,longitude	float
	pco	time,depth, latitude,longitude	float
	ph	time,depth, latitude,longitude	float
	dic	time,depth, latitude,longitude	float
	co2airflux	time, latitude,longitude	float

For 20170101_d-OGS--PFTC-MedBFM3-MED-b20190115_sm-sv05.00.nc:

```
netcdf \20170101_d-OGS--PFTC-MedBFM3-MED-b20191015_sm-sv05.00 {
dimensions:
      longitude = 1005 ;
      latitude = 380 ;
      depth = 125 ;
      time = 1 ;
variables:
      double time(time) ;
            time:units = "seconds since 1970-01-01 00:00:00" ;
            time:long_name = "time" ;
            time:standard_name = "time" ;
            time:axis = "T" ;
            time:calendar = "standard" ;
      float depth(depth) ;
            depth:units = "m" ;
            depth:long_name = "depth" ;
            depth:standard_name = "depth" ;
            depth:positive = "down" ;
            depth:axis = "Z" ;
            depth:valid_min = 1.018237f ;
```

```
            depth:valid_max = 4152.896f ;
      float latitude(latitude) ;
            latitude:units = "degrees_north" ;
            latitude:long_name = "latitude" ;
            latitude:standard_name = "latitude" ;
            latitude:axis = "Y" ;
            latitude:valid_min = 30.1875f ;
            latitude:valid_max = 45.97917f ;
      float longitude(longitude) ;
            longitude:units = "degrees_east" ;
            longitude:long_name = "longitude" ;
            longitude:standard_name = "longitude" ;
            longitude:axis = "X" ;
            longitude:valid_min = -5.541667f ;
            longitude:valid_max = 36.29167f ;
      float phyc(time, depth, latitude, longitude) ;
            phyc:_FillValue = 1.e+20f ;
            phyc:missing_value = 1.e+20f ;
            phyc:units = "mmol m-3" ;
            phyc:long_name = "Concentration of Phytoplankton Biomass in sea
water" ;
            phyc:standard_name                                              =
"mole_concentration_of_phytoplankton_expressed_as_carbon_in_sea_water" ;
            phyc:coordinates = "time depth latitude longitude" ;
      float chl(time, depth, latitude, longitude) ;
            chl:_FillValue = 1.e+20f ;
            chl:missing_value = 1.e+20f ;
            chl:units = "mg m-3" ;
            chl:long_name = "Concentration of Chlorophyll in sea water" ;
            chl:standard_name                                               =
"mass_concentration_of_chlorophyll_in_sea_water" ;
            chl:coordinates = "time depth latitude longitude" ;


// global attributes:
            :Conventions = "CF-1.0" ;
            :references = "Please check in CMEMS catalogue the INFO section
for          product          MEDSEA_ANALYSIS_FORECAST_BIO_006_014          -
http://marine.copernicus.eu/" ;
            :institution = "OGS (Istituto Nazionale di Oceanografia e di
Geofisica Sperimentale) , Sgonico (Trieste) - Italy" ;
```

```
            :source = "3DVAR-OGSTM-BFM" ;

            :comment = "Please check in CMEMS catalogue the INFO section
for         product         MEDSEA_ANALYSIS_FORECAST_BIO_006_014         -
http://marine.copernicus.eu/" ;

            :contact = "servicedesk.cmems@mercator-ocean.eu" ;

            :bulletin_date = "2019-10-15" ;

            :bulletin_type = "simulation" ;

            :field_type = "daily_mean_centered_at_time_field" ;

            :title = "Carbon and Chlorophyll content of phytoplankton
functional type (3D) - Daily Mean" ;

}
```