COPERNICUS MARINE ENVIRONMENT MONITORING SERVICE

MED MFC

CMEMS ELEMENT

PRODUCT USER MANUAL

For Mediterranean Sea Physical Reanalysis Product MEDSEA_REANALYSIS_PHYS_006_004

Reference: CMEMS-MED-PUM-006-004

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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.
CF	Climate Forecast (convention for NetCDF)
CLS	Collecte Localisation Satellites
CMAP	CPC Merged Analysis of Precipitation
CMCC	Centro Euro-Mediterraneo sui Cambiamenti Climatici
CMEMS	Copernicus Marine Environment Monitoring Service
CNR-ISAC	Istituto di Scienze dell'Atmosfera e del Clima
CTD	Conductivity Temperature Depth
DAC	Dynamic Atmospheric Correction
DGF	DirectGetFile
DirectGetFile	CMEMS service tool (FTP like) to download a NetCDF file
ECMWF	European Centre for Medium-Range Weather Forecasts
EOF	Empirical Orthogonal Function
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
MDT	Mean Dynamic Topography
Med/MED	Mediterranean
Meridional Velocity	West to East component of the horizontal velocity vector
MFC	Monitoring and Forecasting Centre
MFS	Mediterranean Forecasting System
NEMO	Nucleous for European Modelling of the Ocean

NetCDF	Network Common Data Form
NOAA	National Oceanic and Atmospheric Administration
OA	Objective Analyses
OCEANVAR	Oceanographic variational data assimilation scheme developed at INGV/CMCC.
OGCM	Ocean General Circulation Model
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)
OSI	Ocean and Sea Ice
PU	Production Unit
SL	Sea Level
SLA	Sea Level Anomaly
SSH	Sea Surface Height
SST	Sea Surface Temperature
Subsetter	CMEMS service tool to download a NetCDF file of a selected geographical box using values of longitude and latitude, and time range
TAC	Thematic Assembly Centre
XBT	eXpandable BathyThermograph
WW3	WaveWatch-III
Zonal Velocity	South to North component of the horizontal velocity vector
3DVAR	Three-Dimensional Variational

I INTRODUCTION

I.1 Summary

This guide describes the Med-MFC (Mediterranean Monitoring and Forecasting Centre) products giving details about the content and about the accessing services.

MEDSEA_REANALYSIS_006_004 is one of the two products for the reanalysis of the physical state of the Mediterranean Sea which includes 3D, daily and monthly mean fields of Temperature, Salinity, Zonal and Meridional Velocity, and by 2D, daily and monthly mean fields of Sea Surface Height.

I.2 History of changes

On April 2016, this product has been improved with:

- Change from NEMO version 3.2 to NEMO version 3.4;

II HOW TO DOWNLOAD A PRODUCT

II.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

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.

II.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

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.

II.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

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 DGF Service.

III DESCRIPTION OF THE PRODUCT SPECIFICATION

III.1 General Information

Table 1 provides information about reanalysis products.

Table 1 MEDSEA_REANALYSIS_PHYS_006_004 Product Specification

Product Specification	MEDSEA_REANALYSIS_PHYS_006_004
Geographical coverage	6°W → 36.25°E ; 30.1875°N → 45.9375°N
Variables	Potential Temperature Salinity Sea Surface Height Horizontal Velocity (meridional and zonal component)
Available time series	29 years (1987-2015)
Temporal resolution	Daily/Monthly mean
Target delivery time	Once
Delivery mechanism	CMEMS Information System (Subsetter, CMEMS FTP, DirectGetFile)
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/ .

III.2 Production subsystem description

III.2.1 Brief overview

The Mediterranean Forecasting System, physical reanalysis component, is a hydrodynamic model, supplied by the Nucleous for European Modelling of the Ocean (NEMO), with a variational data assimilation scheme (OceanVAR) for temperature and salinity vertical profiles and satellite Sea Level Anomaly along track data. The model horizontal grid resolution is 1/16˚ (ca. 6-7 km) and the unevenly spaced vertical levels are 72.

III.2.2 Detailed description

The OGCM (Ocean General Circulation Model) code are NEMO-OPA (Nucleus for European Modelling of the Ocean-Ocean Parallelise) version 3.2 and version 3.4 (Madec et al 1998). The code is developed and maintained by the NEMO-consortium. The model is primitive equation in spherical coordinates. NEMO has been implemented in the Mediterranean at 1/16° x 1/16° horizontal resolution and 72 unevenly spaced vertical levels (Oddo et al., 2009). The model is located in the Mediterranean Basin and also extends into the Atlantic in order to better resolve the exchanges with the Atlantic Ocean at the Strait of Gibraltar.

The NEMO model is nested, in the Atlantic, within the monthly mean climatological fields computed from the daily output of the 1/4×1/4 degrees GLO_MFC model, hereafter called MERCATOR-1/4 (Drevillon et al., 2008), spanning from 2001 to 2005. Details on the nesting technique and major impacts on the model results are in *Oddo et al., 2009*. The model uses vertical partial cells to fit the bottom depth shape.

The model is forced by momentum, water and heat fluxes interactively computed by bulk formulae using the 6-h, 0.75° horizontal-resolution **ERAInterim reanalysis fields** (*Dee et al. 2011*) from the European Centre for Medium-Range Weather Forecasts (ECMWF) and the model predicted surface temperatures (details of the air-sea physics are in *Tonani et al., 2008*). Atmospheric variables used are: air temperature at 2m, dew point temperature at 2m, mean sea level pressure, total cloud cover, 10m wind u and v components. Satellite SST is used to correct interactively the computed heat flux at air-sea interface with a relaxation constant of 60 W/m^2K.

Water balance is computed as Evaporation minus Precipitation and Runoff. The evaporation is derived from the latent heat flux. Runoff is provided by monthly mean datasets: the Global Runoff Data Centre dataset (*Fekete et al., 1999*) for the Ebro, Nile and Rhone and the dataset from Raicich (*Raicich, 1996*) for the Adriatic rivers (Po, Vjosë, Seman and Bojana). The Dardanelles inflow is parameterized as a river and the climatological net inflow rates are taken from *Kourafalou and Barbopoulos (2003)*. Precipitations are from ERAInterim reanalysis (6-h, 0.75° horizontal-resolution).

The **data assimilation** system is the OceanVar scheme developed by *Dobricic and Pinardi (2008).* The background error correlation matrix is estimated from the temporal variability of parameters in a historical model simulation. Background error correlation matrices vary seasonally in 13 regions of the Mediterranean Sea, which have different physical characteristics (*Dobricic et al 2006*). The mean dynamic topography, used for Sea Level Anomaly (SLA) data assimilation has been computed by *Dobricic et al. (2005)*.

The assimilated data include:

1. Sea Level Anomaly;
2. In situ Temperature and Salinity profiles.

The SLA dataset **SEALEVEL-MED-SLA-L3-REP-OBSERVATIONS-008-020** was updated at the latest version released on June 2016 completing the time series till the end of 2015. The data set is composed of mono altimeter satellite along-track sea surface heights computed with respect to a seven-year mean. All the missions are homogenized with respect to a reference mission, which is currently Jason-2. This product is computed with an optimal and centred computation time window (6 weeks before and after the date). The available processing series corresponds to up-to-date datasets with up to four satellites at a given time, which means a non-homogenous series but better quality sampling. The time coverage depends on the duration of the missions and starts from 1992. We did not take into consideration GEOSAT data.

The **in situ temperature and salinity** profiles considered for the MED REA production belong from different instrumental data type: CTDs, XBTs, MBTs, bottles, ARGO floats. In situ data sets have been collected from European Marine databases and have been archived in a specific format to be assimilated. They were downloaded from different sources: 1) SeaDataNet European infrastructure (DG-Research-FP6); 2) MEDAR-MEDATLAS dataset covering the period 1985-1999 (*Maillard et al. 2005*); 3) MFS (Mediterranean Forecasting System) operational observation infrastructure based on Enea and Coriolis data centers and 4) MyOcean In situ TAC (Thematic Assembly Centre). Potential duplicates were thus identified and excluded from successive usage and analysis. The decrease of the number of observations for the recent years due to a time lag between the sampling and the insertion of the data inside the SDN infrastructure is a common characteristic of historical databases. This required the use of MFS and MyOcean in situ TAC operational observations to integrate the SDN data set in the recent period. We intend for MFS operational observations, near real time (NRT) observations collected in the Mediterranean Sea within different precursor projects spanning a time period from 1999 to April 2009 when MyOcean Project started:

MFSPP (Mediterranean ocean Forecasting System Pilot Project) 1998-2001 EU-MAST project MA 53-CT98-0171

MFSTEP (Mediterranean ocean Forecasting System Towards Environmental Prediction) 2003-2005 DG-Research – FP5 EU Contract Number EVK3-CT-2002-00075;

The SST dataset, used to correct interactively the computed heat flux at air-sea interface, is a time concatenation of SST products characterized by horizontal maps already optimally interpolated:

1. SST reprocessed data (1985-July 2008) at 1/16° of the recent AVHRR Pathfinder SST (*Marullo et al., 2008*)
2. SST Reconstruction DT data at 1/16° from 2008 to August 2010 (*Marullo et al. 2007*)
3. SST_MED_SST_L4_HR: Level 4 (L4) products covering Mediterranean corresponds to daily (night-time) gridded super-collated (multi-sensor) and optimally interpolated satellite SST estimates at High spatial Resolution (HR), i.e. at 1/16° (*Buongiorno Nardelli et al. 2013*).

Table 2 summarizes the external products used in MED REA System for different data type.

MED REA has been initialized by a temperature and salinity monthly climatology (named SDN_V2aa) produced within the framework of SeaDataNet FP6 Project. It has been calculated utilizing the extensive historical in situ data set from 1900 to 1987. We considered only observations before 1987 to compute the initial condition because we did not want the climatology to be affected by the Eastern Mediterranean Transient (EMT). Mediterranean observations have been blended to the World Ocean Atlas climatology (WOA) in the Atlantic Box. The climatology has been computed with DIVA software tool (Data-Interpolating Variational Analysis, which allows to spatially interpolate observations onto a regular grid in an optimal way (*modb.oce.ulg.ac.be/mediawiki/index.php/DIVA*).

MED REA has been initialized on the 1st of January 1985 and run till the 31st of December 2015. The first two years of integration are not delivered since they are considered the period of model spin up.

Table 2 External Products associated with the MED REA system

DATA TYPE	EXTERNAL PRODUCTS
ATMOSPHERIC FORCING	ECMWF ERAInterim Atmospheric Reanalysis
SLA	SEALEVEL-MED-SLA-L3-REP-OBSERVATIONS-008-020 SEALEVEL_MED_SLA_L3_NRT_OBSERVATIONS_008_019
ARGO	Coriolis and INSITU TAC dataset INSITU_MED_NRT_OBSERVATIONS_013_035 INSITU_GLO_NRT_OBSERVATIONS_013_030
CTD	SeaDataNet, MEDATLAS, MFS (Enea), INSITU-TAC dataset in-situ SeaDataNet product (FREE access temperature Salinity Observations) in-situ SeaDataNet product (RESTRICTED access temperature Salinity Observations) MEDAR MEDATLAS (Historical data)
SST	GOS-CNR-SST-HR-RAN-MEDITERRANEAN GOS-CNR-SST-HR-DT-MEDITERRANEAN SST_MED_SST_L4_NRT_OBSERVATIONS_010_004
XBT	MEDATLAS, MFS (Enea), INSITU_MED_NRT_OBSERVATION_013_035

III.2.3 Processing information

The Mediterranean Sea Physical reanalysis has been initialized by a temperature and salinity monthly climatology on the 1st of January 1985 and run till the 31st of December 2015. The first two years are considered the period of model spin up

III.3 Details of datasets

Table 3 List of the variables for each dataset and their names in the NetCDF

MEDSEA_REANALYSIS_PHYS_006_004		
DATASETS	VARIABLES AND UNITS	NAME OF VARIABLES IN THE NETCDF FILE
sv03-med-ingv-cur-rean-d	Zonal Velocity [m/s] Meridional Velocity [m/s]	vozocrtx vomecrty
sv03-med-ingv-ssh-rean-d	Sea Surface Height [m]	sossheig
sv03-med-ingv-tem-rean-d	Potential Temperature [degC]	votemper
sv03-med-ingv-sal-rean-d	Salinity [PSU]	vosaline
sv03-med-ingv-cur-rean-m	Zonal Velocity [m/s] Meridional Velocity [m/s]	vozocrtx vomecrty
sv03-med-ingv-ssh-rean-m	Sea Surface Height [m]	sossheig
sv03-med-ingv-tem-rean-dm	Potential Temperature [degC]	votemper
sv03-med-ingv-sal-rean-dm	Salinity [PSU]	vosaline

IV NOMENCLATURE OF FILES

The nomenclature of the downloaded files differs on the basis of the chosen download mechanism **Subsetter** , **MFTP** or **DGF** service.

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

MEDSEA_REANALYSIS_PHYS_006_004 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-ingv-tem-rean-d
- sv03-med-ingv-sal-rean-d
- sv03-med-ingv-cur-rean-d
- sv03-med-ingv-ssh-rean-d
- sv03-med-ingv-tem-rean-m
- sv03-med-ingv-sal-rean-m
- sv03-med-ingv-cur-rean-m
- sv03-med-ingv-ssh-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 **tem/sal/ssh/cur** are respectively for the variable of Potential Temperature (**votemper**), Salinity (**vosaline**), Sea Surface Height (**sossheig**), and Velocity (**vozocrtx**, **vomecrty).**

Example for a file of Salinity:

`sv03-med-ingv-sal-rean-d_1303461772348.nc`

IV.2 Nomenclature of files when downloaded through the CMEMS FTP Service

MEDSEA_REANALYSIS_PHYS_006_004 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}-fv{file version}.nc.gz

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 (d = daily, 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

Table 4 shows the nomenclature for the MEDSEA_REANALYSIS_PHYS_006_004 products.

Table 4 Description of the nomenclature for MEDSEA_REANALYSIS_PHYS_006_004

valid date	YYYYMMDD
freq flag	d (daily) m (monthly)
average flag	m (mean)
producer	INGV
config	MFSs4b3 (1987-2013) MFSe1r1 (2014-2015)
region	MED
parameter	TEMP PSAL ASLV RFVL
bul date	bYYYYMMDD
product type	re (reanalysis)
file version	04.00 (from 1987 to 2003) 05.00 (from 2004 to 2013) 06.00 (2014) 07.00 (2015)

Example for a reanalysis file of Salinity:

`20000401_mm-INGV--PSAL-MFSs4b3-MED-b20130712_re-fv04.00.nc.gz`

This is the monthly mean field of salinity for the month of April 2000. The mean is computed from noon (12:00 UTC) of the 31st March 2000 to noon (12:00 UTC) of the 30th April 2000 (see section IV.8).

`20150401_mm-INGV--PSAL-MFSe1r1-MED-b20160501_re-fv07.00.nc.gz`

This is the monthly mean field of salinity for the month of April 2015. The mean is computed from noon (12:00 UTC) of the 31st March 2015 to noon (12:00 UTC) of the 30th April 2015 (see section IV.8).

`20110409_dm-INGV--PSAL-MFSs4b3-MED-b20130712_re-fv05.00.nc.gz`

This is the mean field of salinity centered at 00:00 UTC of the 9th April 2011, and the time coverage is from noon (12:00 UTC) of the 8th April 2011 to noon (12:00 UTC) of the 9th April 2011 (see section IV.8).

IV.3 Nomenclature of files when downloaded through the CMEMS DGF Service

MEDSEA_REANALYSIS_PHYS_006_004 files nomenclature when downloaded through the CMEMS Web Portal DGF is based on product dataset name and a numerical reference related to the request date on the CIS.

The scheme is:

http---purl.org-myocean-ontology-product-database-**datasetname_nnnnnnnnnnnn.zip**

where :

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

- sv03-med-ingv-tem-rean-d
- sv03-med-ingv-sal-rean-d
- sv03-med-ingv-cur-rean-d
- sv03-med-ingv-ssh-rean-d
- sv03-med-ingv-tem-rean-m
- sv03-med-ingv-sal-rean-m
- sv03-med-ingv-cur-rean-m
- sv03-med-ingv-ssh-rean-m

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

The fields **tem/sal/ssh/cur** are respectively for the variable of Potential Temperature (**votemper**), Salinity (**vosaline**), Sea Surface Height (**sossheig**), and Velocity (**vozocrtx**, **vomecrty).**

Example:

`http---purl.org-myocean-ontology-product-database-sv03-med-ingv-tem-rean-d_1303461772348.zip`

The zip file contains one or more files, depending on the number of selected days, whose name is

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

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 (d = daily, 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

Table 5 shows the nomenclature for the MEDSEA_REANALYSIS_PHYS_006_004 products.

Table 5 Description of the nomenclature for MEDSEA_REANALYSIS_PHYS_006_004

valid date	YYYYMMDD
freq flag	d (daily) m (monthly)
average flag	m (mean)
producer	INGV
config	MFSs4b3 (1987-2013) MFSe1r1 (2014-2015)
region	MED
parameter	TEMP PSAL ASLV RFVL
bul date	bYYYYMMDD
product type	re (reanalysis)
file version	04.00 (from 1987 to 2003) 05.00 (from 2004 to 2013) 06.00 (2014) 07.00 (2015)

Example for a reanalysis file of Salinity:

`20000401_mm-INGV--PSAL-MFSs4b3-MED-b20130712_re-fv04.00.nc.gz`

This is the monthly mean field of salinity for the month of April 2000. The mean is computed from noon (12:00 UTC) of the 31st March 2000 to noon (12:00 UTC) of the 30th April 2000 (see section IV.8).

`20150401_mm-INGV--PSAL-MFSe1r1-MED-b20160501_re-fv07.00.nc.gz`

This is the monthly mean field of salinity for the month of April 2015. The mean is computed from noon (12:00 UTC) of the 31st March 2015 to noon (12:00 UTC) of the 30th April 2015 (see section IV.8).

`20110409_dm-INGV--PSAL-MFSs4b3-MED-b20130712_re-fv05.00.nc.gz`

This is the mean field of salinity centered at 00:00 UTC of the 9th April 2011, and the time coverage is from noon (12:00 UTC) of the 8th April 2011 to noon (12:00 UTC) of the 9th April 2011 (see section IV.8).

IV.4 Grid

The horizontal grid step is regular in latitude and longitude with a resolution of 1/16°x1/16° of degree (~6.5 Km). The vertical grid is composed of 72 unevenly spaced vertical levels (see §IV.5).

In Table 6 there is the description of the grid and the spatial coverage for each variable for the MEDSEA_REANALYSIS_PHYS_006_004 products.

Table 6 Description of grid and spatial coverage

MEDSEA_REANALYSIS_PHYS_006_004 *							
VARIABLE	LON MIN	LON MAX	LAT MIN	LAT MAX	XPOINT	YPOINT	ZPOINT
Potential Temperature	6°W	36.25°E	30.1875°N	45.9375°N	677	253	72
Salinity	6°W	36.25°E	30.1875°N	45.9375°N	677	253	72
Sea Surface Height	6°W	36.25°E	30.1875°N	45.9375°N	677	253	1
Horizontal Current	6°W	36.25°E	30.1875°N	45.9375°N	677	253	72

* The Gulf of Biscay is excluded.

IV.5 Domain coverage

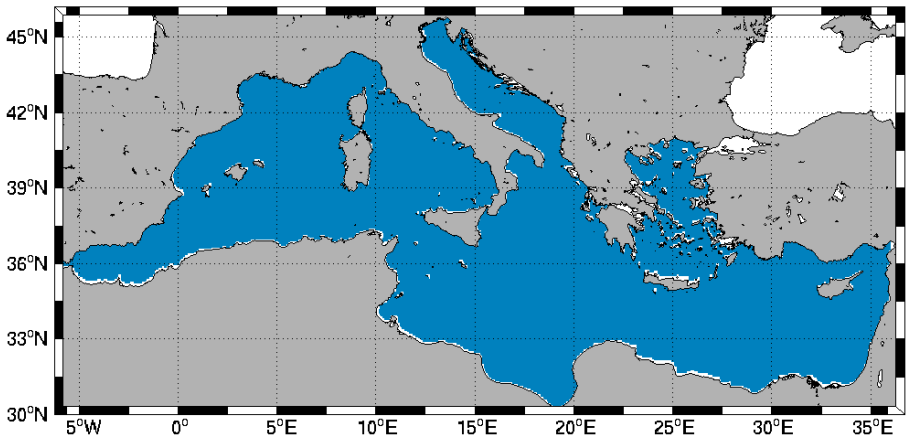

Figure 1 Spatial coverage of the MEDSEA_REANALYSIS_PHYS_006_004 products (blue zone).

The blue area in Figure 1 represents the spatial coverage of the MEDSEA_REANALYSIS_PHYS_006_004 products.

Grid type is the following standard projection:

Regular projection: longitude and latitude step is constant	

IV.6 Vertical Levels

MEDSEA_REANALYSIS_PHYS_006_004 product is computed on 72 unevenly spaced vertical levels: the thickness of the layer at the surface is about 3 meters, and increases up to 300 meters at the bottom. All the 72 levels are released. The depths are (in meters): 1.5, 4.6, 7.9, 11.6, 15.4, 19.6333, 24.1, 28.9, 34.1, 39.7, 45.7, 52.1, 59.0, 66.4, 74.3, 82.8, 92, 101.7, 112.2, 123.4, 135.4, 148.3, 162.1, 176.8, 192.6, 209.4, 227.5, 246.8, 267.5, 289.6, 313.3, 338.6, 365.6, 394.5, 425.4, 458.5, 493.8, 531.6, 571.9, 615.1, 661.1, 710.3, 762.8, 818.9, 878.9, 942.8, 1011.2, 1084.1, 1161.9, 1245, 1333.6, 1428.2, 1529.1, 1636.6, 1751.3, 1873.5, 2003.8, 2142.7, 2290.6, 2448.2, 2615.9, 2794.6, 2984.7, 3186.9, 3402.1, 3630.7, 3873.8, 4132.1, 4406.5, 4697.7, 5006.8, 5334.648.

MEDSEA_REANALYSIS_PHYS_006_004 has a vertical grid with partial steps (See NEMO_book_v3_3.pdf, pag 90). The depth of the last level depends therefore from point to point from the bathymetry depth. The vertical grids are described in the file: MEDmeshmask_SYS4b3_T.nc. This file is freely available via HTTP at this link. http://cmems-med-mfc.eu/masks/MEDmeshmask_SYS4b3_T.nc.gz. The relevant variables described in MEDmeshmask_SYS4b3_T.nc file are:

- tmask (3D land/sea mask);
- Depthlevt (3D matrix with the depth of each grid point taking into account the partial steps)
- e3t (3D matrix with the Δz of each grid point, taking into account the partial steps)

netcdf MEDmeshmask_SYS4b3_T {

dimensions:

x = 677 ;

y = 253 ;

z = 72 ;

t = UNLIMITED ; // (1 currently)

variables:

float nav_lon(y, x) ;

```
        float nav_lat(y, x) ;
        float nav_lev(z) ;
        double time_counter(t) ;
        byte tmask(t, z, y, x) ;
        float glamt(t, y, x) ;
        float gphit(t, y, x) ;
        double e1t(t, y, x) ;
        double e2t(t, y, x) ;
        double ff(t, y, x) ;
        short mbathy(t, y, x) ;
        double hdept(t, y, x) ;
        double e3t(t, z, y, x) ;
        double gdept_0(t, z) ;
        double e3t_0(t, z) ;
        double Depthlevt(t, z, y, x) ;

    // global attributes:
                :DOMAIN_number_total = 1 ;
                :DOMAIN_number = 0 ;
                :DOMAIN_dimensions_ids = 1, 2 ;
                :DOMAIN_size_global = 677, 253 ;
                :DOMAIN_size_local = 677, 253 ;
                :DOMAIN_position_first = 1, 1 ;
                :DOMAIN_position_last = 677, 253 ;
                :DOMAIN_halo_size_start = 0, 0 ;
                :DOMAIN_halo_size_end = 0, 0 ;
                :DOMAIN_type = "BOX" ;
    }
```

IV.7 Temporal extend of analysis and forecast stored on delivery mechanism

MEDSEA_REANALYSIS_PHYS_006_004 temporal coverage is 28 years, from 1987 to 2015. The reanalysis has been produced using the sys4b3 (1987-2013) and the syse1r1 (2014-2015).

IV.8 Other information: mean centre of Products, missing value, production chain and file dimension

IV.8.1 Mean Centre of Products

MEDSEA_REANALYSIS_PHYS_006_004 product reanalysis is available as daily mean and as monthly mean fields.

In the case of daily mean, the reanalysis is 24hr mean fields centered at midnight, 00:00 UTC (Figure 2).

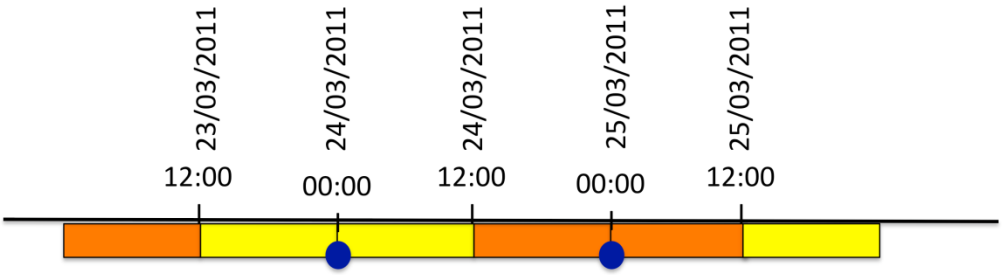

Figure 2 Example of time coverage of the products for MEDSEA_REANALYSIS_PHYS_006_004. The products are 24hr mean centered at midnight

IV.8.2 Missing Value

The **missing value** for the MEDSEA_REANALYSIS_PHYS_006_004 products is 1e+20.

IV.8.3 Production Chain

MEDSEA_REANALYSIS_PHYS_006_004 production chain is as follows:

In the V6 products, the model is forced to the surface by 0.75° horizontal-resolution ERA-Interim reanalysis fields from the European Centre for Medium-Range Weather Forecasts (ECMWF). Model solution is corrected every 24hr by the OCEANVAR assimilation scheme of the available satellite (SLA) and in situ data (XBT, CTD and ARGO). Satellite OA-SST data are used for the surface heat fluxes correction.

IV.8.4 File Dimension

Table 7 describes the dimensions of the files for reanalysis for one day and for one month.

Table 7 Names and dimensions of the files (*Dimensions for one day and for one month of reanalysis)

DATASET NAME	NAME OF FILE	DIMENSION [MB]*	
		Compressed	Uncompressed
sv03-med-ingv-ssh-rean-d	{date1}_dm-INGV--ASLV-MFSs4b3-MED-b{date2}_re-fv{04|5.00}.nc {date1}_dm-INGV--ASLV-MFSe1r1-MED-b{date2}_re-fv{06|7.00}.nc	0.24	0.7

sv03-med-ingv-sal-rean-d	{date1}_dm-INGV--PSAL-MFSs4b3-MED-b{date2}_re-fv{04|5.00}.nc {date1}_dm-INGV--PSAL-MFSe1r1-MED-b{date2}_re-fv{06|7.00}.nc	9	50
sv03-med-ingv-tem-rean-d	{date1}_dm-INGV--TEMP-MFSs4b3-MED-b{date2}_re-fv{04|5.00}.nc {date1}_dm-INGV--TEMP-MFSe1r1-MED-b{date2}_re-fv{06|7.00}..nc	10	50
sv03-med-ingv-cur-rean-d	{date1}_dm-INGV--RFVL-MFSs4b3-MED-b{date2}_re-fv{04|5.00}.nc {date1}_dm-INGV--RFVL-MFSe1r1-MED-b{date2}_re-fv{06|7.00}..nc	23	101
sv03-med-ingv-ssh-rean-m	{date1}_mm-INGV--ASLV-MFSs4b3-MED-b{date2}_re-fv{04|5.00}.nc {date1}_mm-INGV--ASLV-MFSe1r1-MED-b{date2}_re- fv{06|7.00}..nc	0.24	0.7
sv03-med-ingv-sal-rean-m	{date1}_mm-INGV--PSAL-MFSs4b3-MED-b{date2}_re-fv{04|5.00}.nc {date1}_mm-INGV--PSAL-MFSe1r1-MED-b{date2}_re- fv{06|7.00}..nc	9	50
sv03-med-ingv-tem-rean-m	{date1}_mm-INGV--TEMP-MFSs4b3-MED-b{date2}_re-fv{04|5.00}.nc {date1}_mm-INGV--TEMP-MFSe1r1-MED-b{date2}_re- fv{06|7.00}..nc	10	50
sv03-med-ingv-cur-rean-m	{date1}_dm-INGV--RFVL-MFSs4b3-MED-b{date2}_re-fv{04|5.00}.nc {date1}_dm-INGV--RFVL-MFSe1r1-MED-b{date2}_re-fv{06|7.00}..nc	23	101

Table 8 describes the dimensions of the entire time series for each dataset.

Table 8 Names and dimensions of the entire datasets

DATASET NAME	DIMENSION [MB]**	
	Compressed	Uncompressed
sv03-med-ingv-ssh-rean-d	2365.2	6898.5
sv03-med-ingv-sal-rean-d	88695	492750
sv03-med-ingv-tem-rean-d	98550	492750
sv03-med-ingv-cur-rean-d	226665	995355
sv03-med-ingv-ssh-rean-m	77.76	226.8

sv03-med-ingv-sal-rean-m	2916	16200
sv03-med-ingv-tem-rean-m	3240	16200
sv03-med-ingv-cur-rean-m	7452	32724

**Dimension for daily dataset and for monthly dataset of reanalysis

V FILE FORMAT

V.1 Netcdf

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.

V.2 Structure and semantic of NetCDF maps files

Table 9 Dimensions and variables included in the files NetCDF of MEDSEA_REANALYSIS_PHYS_006_004.

DIMENSIONS	VARIABLES		
	NAME	DIMENSIONS	TYPE
lon=677 lat=253 depth=72 time=1	lon	lon	float
	lat	lat	float
	depth	depth	float
	time	time	int
	sossheig	time,lat,lon	float
	votemper	time,depth,lat,lon	float
	vosaline	time,depth,lat,lon	float
	vozocrtx	time,depth,lat,lon	float
	vomecrty	time,depth,lat,lon	float

For 20121223_dm-INGV--PSAL-MFSs4b3-MED-b20130712_re-fv05.00.nc

```
netcdf \20121223_dm-INGV--PSAL-MFSs4b3-MED-b20130712_re-fv05.00 {
dimensions:
        depth = 72 ;
        lat = 253 ;
        lon = 677 ;
        time = UNLIMITED ; // (1 currently)
variables:
        float depth(depth) ;
                depth:units = "m" ;
                depth:positive = "down" ;
                depth:valid_min = 1.472102f ;
                depth:valid_max = 5334.648f ;
                depth:long_name = "depth" ;
                depth:axis = "Z" ;
                depth:standard_name = "depth" ;
        float lat(lat) ;
                lat:units = "degrees_north" ;
                lat:valid_min = 30.1875f ;
                lat:valid_max = 45.9375f ;
                lat:long_name = "latitude" ;
                lat:standard_name = "latitude" ;
                lat:axis = "Y" ;
        float lon(lon) ;
                lon:units = "degrees_east" ;
                lon:valid_min = -6.f ;
                lon:valid_max = 36.25f ;
                lon:long_name = "longitude" ;
                lon:standard_name = "longitude" ;
                lon:axis = "X" ;
        int time(time) ;
                time:units = "seconds since 1970-01-01 00:00:00" ;
                time:calendar = "standard" ;
                time:long_name = "time" ;
                time:standard_name = "time" ;
                time:axis = "T" ;
        float vosaline(time, depth, lat, lon) ;
                vosaline:units = "1e-3" ;
```

vosaline:missing_value = 1.e+20f ;

vosaline:valid_min = 15.f ;

vosaline:valid_max = 42.f ;

vosaline:long_name = "Salinity" ;

vosaline:_FillValue = 1.e+20f ;

vosaline:coordinates = "time depth lat lon" ;

vosaline:standard_name = "sea_water_salinity" ;

// global attributes:

:bulletin_type = " reanalysis " ;

:institution = "Istituto Nazionale di Geofisica e Vulcanologia - Bologna, Italy" ;

:source = " MFS SYS4b3" ;

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

:references = "Please check in CMEMS catalogue the INFO section for product MEDSEA_REANALYSIS_PHYS_006_004 - http://marine.copernicus.eu/" ;

:comment = "Please check in CMEMS catalogue the INFO section for product MEDSEA_REANALYSIS_PHYS_006_004 - http://marine.copernicus.eu/" ;

:Conventions = "CF-1.0" ;

:field_type = "daily_mean_centered_at_time_field" ;

:title = "Salinity (3D) - Daily Mean" ;

}

V.3 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/
- ✓ Net CDF Climata Data Operators (CDO): https://code.zmaw.de/projects/cdo
- ✓ IDL, Matlab, GMT…