PRODUCT USER MANUAL

For the Global Ocean Physical Reanalysis product

GLOBAL_REANALYSIS_ PHY_001_030

Issue: 1.1

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CMEMS version scope : Version 4

Approval Date : 17 April 2018

CHANGE RECORD

Issue	Date	§	Description of Change	Author	Validated By
1.1	16/02/2018	All	initial version	E. Fernandez, J.M. Lellouche	C. Derval

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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)
ECMWF	European Centre for Medium Range Weather forecast
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

This document is the user manual for the CMEMS global reanalysis product **GLOBAL_REANALYSIS_ PHY_001_030**. The reanalysis is built to be as close as possible to the observations (i.e. realistic) and in agreement with the model physics. It covers the period 1992 to 2016.

The goal of this CMEMS global ocean reanalysis is to provide an eddy resolving (1/12°) global ocean simulation, covering the recent period during which altimeter data are available (period starting with the launch of TOPEX POSEIDON and ERS-1 satellites early in the nineties), constrained by assimilation of observations and describing the space-time evolution of 3D thermodynamic variables (T, S), 3D dynamic variables (U, V), sea surface height and sea-ice features (concentration, thickness and horizontal velocity).

This product is defined on a standard regular grid at 1/12 degree (approx. 8km) and on 50 standard levels. It is interpolated from the 1/12 degree and 50 vertical levels Arakawa C native grid. All variables are on the same regular grid points.

GLOBAL_REANALYSIS_ PHY_001_030 product is organised in three datasets:

- **global-reanalysis-phy-001-030-daily** which contains the 3D daily mean fields: 3D potential temperature, salinity and currents information from top to bottom and 2D sea surface level, bottom potential temperature, mixed layer thickness, sea ice thickness, sea ice fraction and sea ice velocities information.

- **global-reanalysis-phy-001-030-monthly** which contains the monthly mean fields: 3D potential temperature, salinity and currents information from top to bottom and 2D sea surface level, bottom potential temperature, mixed layer thickness, sea ice thickness, sea ice fraction and sea ice velocities information.

- **global-reanalysis-phy-001-030-statics** which contains the static fields for the system: coordinates, mean sea surface level, mask and bathymetry.

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-1.4 convention.

The reanalysis system is described in the Quality Information Document (QUID) CMEMS_GLO_QUID_001_030 (http://marine.copernicus.eu/documents/QUID/CMEMS-GLO-QUID-001-030.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.

II   DESCRIPTION OF THE PRODUCT SPECIFICATION

II.1 General Information about product

Product Specification	GLOBAL_REANALYSIS_ PHY_001_030		
Geographical coverage	Global (180°E to 180°E ; 89°S to 90°N)		
Variables	Potential temperature Salinity Sea surface height Horizontal velocity (eastward and northward components) Sea ice concentration Sea ice velocity (eastward and northward components) Sea ice thickness Sea floor potential temperature Density ocean mixed layer thickness		
	Reanalysis		
Update frequency	Yearly		
Available time series	04/12/1991 to 27/12/2016		
Target delivery time	N/A		
Temporal resolution	- global-reanalysis-phy-001-030-daily: daily mean - global-reanalysis-phy-001-030-monthly: monthly mean		
Delivery mechanism	Subsetter	DGF	FTP
Horizontal resolution	1/12 ° (equirectangular grid)		
Number of vertical levels	50 levels		
Format	NetCDF CF1.4		

II.2 Details of the datasets

<table>
<tr><td colspan="2" align="center">GLOBAL_REANALYSIS_ PHY_001_030</td></tr>
<tr>
<td rowspan="11">global-reanalysis-phy-001-030-daily</td>
<td>contains the <u>daily mean fields</u>: 3D potential temperature, salinity and currents information from top to bottom and 2D sea surface level, bottom potential temperature, mixed layer thickness, sea ice thickness, sea ice fraction and sea ice velocities information.</td>
</tr>
<tr><td>thetao [°C]
Potential temperature
sea_water_potential_temperature</td></tr>
<tr><td>so [psu]
Salinity
sea_water_salinity</td></tr>
<tr><td>uo [m/s]
Eastward ocean current velocity
eastward_sea_water_velocity</td></tr>
<tr><td>vo [m/s]
Northward ocean current velocity
northward_sea_water_velocity</td></tr>
<tr><td>zos [m]
Sea surface height
sea_surface_height_above_geoid</td></tr>
<tr><td>mlotst [m]
Mixed layer thickness
ocean_mixed_layer_thickness_defined_by_sigma_theta</td></tr>
<tr><td>bottomT [°C]
Sea floor potential temperature
sea_water_potential_temperature_at_sea_floor</td></tr>
<tr><td>siconc [1]
Sea ice concentration
sea_ice_area_fraction</td></tr>
<tr><td>sithick [m]
Sea ice thickness
sea_ice_thickness</td></tr>
<tr><td>usi [m/s]
Eastward sea ice velocity
eastward_sea_ice_velocity</td></tr>
<tr><td>vsi [m/s]
Northward sea ice velocity
northward_sea_ice_velocity</td></tr>
</table>

global-reanalysis-phy-001-030-monthly	contains the <u>monthly mean fields</u>: 3D potential temperature, salinity and currents information from top to bottom and 2D sea surface level, bottom potential temperature, mixed layer thickness, sea ice thickness, sea ice fraction and sea ice velocities information.
	thetao [°C] Potential temperature sea_water_potential_temperature
	so [psu] Salinity sea_water_salinity
	uo [m/s] Eastward ocean current velocity eastward_sea_water_velocity
	vo [m/s] Northward ocean current velocity northward_sea_water_velocity
	zos [m] Sea surface height sea_surface_height_above_geoid
	mlotst [m] Mixed layer thickness ocean_mixed_layer_thickness_defined_by_sigma_theta
	bottomT [°C] Sea floor potential temperature sea_water_potential_temperature_at_sea_floor
	siconc [1] Sea ice concentration sea_ice_area_fraction
	sithick [m] Sea ice thickness sea_ice_thickness
	usi [m/s] Eastward sea ice velocity eastward_sea_ice_velocity
	vsi [m/s] Northward sea ice velocity northward_sea_ice_velocity
global-reanalysis-	contains the static fields for the system: coordinates, mean sea surface level, mask and bathymetry.
	e1t [m] Cell dimension along X axis
	e2t [m] Cell dimension along Y axis

| |
|---|
| **e3t** [m/s]
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 |
| **mdt** [m]
Mean dynamic topography
sea_surface_height_above_geoid |

II.3 Details on some parameters

mlotst [m]	ocean_mixed_layer_thickness_defined_by_sigma_theta. It is the depth where the density increase compared to density at 10 m depth corresponds to a temperature decrease of 0.2°C in local surface conditions (θ10m, S10m, P0= 0 db, surface pressure)
zos [m]	sea_surface_height_above_geoid. The geoid is a surface of constant geopotential with which mean sea level would coincide if the ocean were at rest. The parameter "zos" is the difference between the actual sea surface height at any given time and place, and that which it would have if the ocean were at rest.

- The altimeter measures **the SSH referenced to the ellipsoid of reference** (Earth + Ocean contributions) = Geoid + ADT
- The NEMO Ocean General Circulation Model represents **the SSH referenced to the geoid** (Ocean only contribution) = ADT
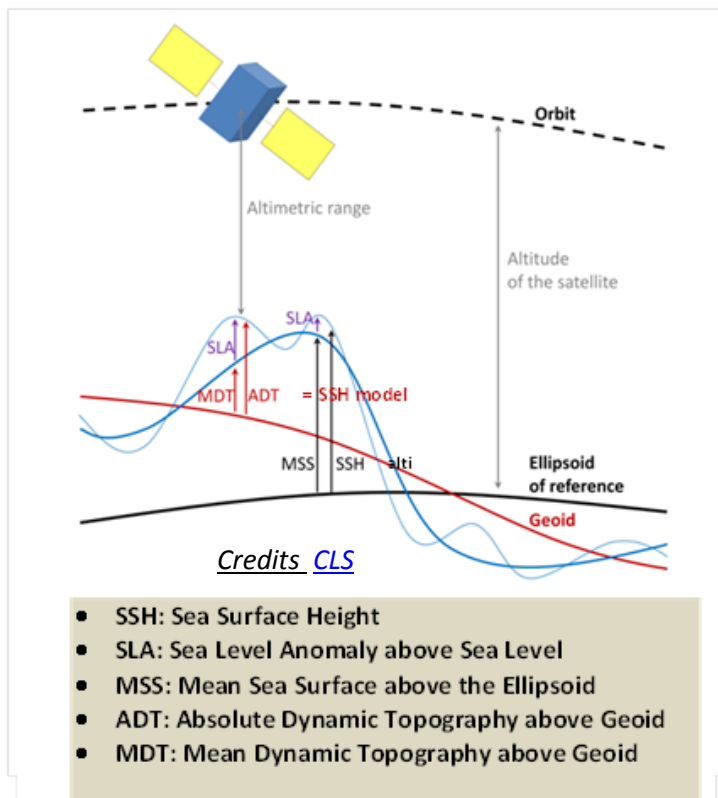
SSH_altimeter = Geoid + ADT obs

SSH_model = ADT obs

SSH_model = SSH_altimeter-Geoid

Sea Level Anomaly
SLA_altimeter ~ SSH_model – MDT

Absolute Dynamical Topography
ADT_aviso ~ SSH_model

Credits *CLS*

- **SSH:** Sea Surface Height
- **SLA:** Sea Level Anomaly above Sea Level
- **MSS:** Mean Sea Surface above the Ellipsoid
- **ADT:** Absolute Dynamic Topography above Geoid
- **MDT:** Mean Dynamic Topography above Geoid
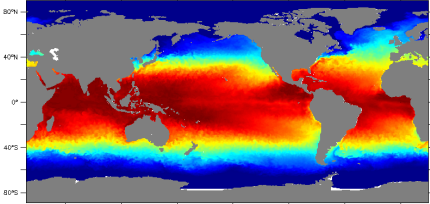
- **SSH model:** Sea Surface Height above the Geoid
- **SSH altimeter:** Sea Surface Height above the Ellipsoid of reference

The Offset to apply is notified as arguments for the SSH_model variable in the NetCDF file

II.4 Product System Description

The Operational Mercator global ocean reanalysis system at 1/12 degree is providing a 25-years time series starting on December 4th, 1991 and ending on December 27th, 2016. This product includes daily and monthly mean files of temperature, salinity, currents, sea level, mixed layer depth and ice parameters from the top to the bottom over the global ocean.

Domain Resolution and grid Geographic coverage	GLOBAL (180°W-180°E ; 80°S – 90°N) 1/12º ; regular grid ; 4320 x 2041 This product is global with dedicated projection and spatial resolution. It is defined on a standard collocated grid at 1/12 degree (approx. 8 km). The parameters are interpolated from the native grid model, the 1/12 degree and 50 vertical levels Arakawa C native grid.
Model Version	LIM2 EVP NEMO 3.1
Atmospheric forcing	3-h and 24-h atmospheric forcing from ERA-Interim, including precipitation and radiative fluxes (SW+LW) corrections
Assimilation scheme	SAM2 (SEEK Kernel) + FGAT + IAU and 3D-VAR T/S bias correction
Assimilated observations	Reynolds 0.25° AVHRR-only SST, Delayed Time SLA from all altimetric satellites, in situ T/S profiles from CMEMS CORAv4.1 database, CERSAT Sea Ice Concentration
Initial conditions	December 1991 T/S regressed from EN.4.2.0
Bathymetry	ETOPO1 for deep ocean and GEBCO8 on coast and continental shelf.

II.5 Processing information

II.5.1 Time coverage

The time series covers the following period: 04/12/1991 to 27/12/2016.

II.5.2 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 (midnight to midnight, centered at noon).

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 Authenticated 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_REANALYSIS_ PHY_001_030 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: global-reanalysis-phy-001-030-daily_1303461772348.nc

IV.2 Nomenclature of files when downloaded through the CMEMS Web Portal Directgetfile and FTP Service

When downloading product via Directgetfile, you get data in ZIP archive format with a specific nomenclature. When ZIP archive is uncompressed, files are provided with the native nomenclature. When downloading via FTP, the files are provided with the native nomenclature.

- ZIP nomenclature:

datasetname_nnnnnnnnnnnnn.**zip**

Where:

> *.datasetname* is a character string containing the dataset name as described previously

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

> **.zip**: ZIP Archive filename extension.

- Native nomenclature:

For the daily dataset, the scheme is:

mercatorglorys12v1_gl12_mean_*yyyymmdd*_R*YYYYMMDD*.nc

Where:

- yyyymmdd: field daily mean central date, on YYYYMMDD format

- YYYYMMDD: creation date of the file

- **.nc**: standard NetCDF filename extension.

For the monthly dataset, the scheme is:

mercatorglorys12v1_gl12_mean_*yyyymm*.nc

Where:

- yyyymm: field monthly mean central date, on YYYYMM format

- **.nc**: standard NetCDF filename extension.

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 [GB]
global-reanalysis -phy-001-030-daily	mercatorglorys12v1_gl12_mean_${date1}_R${date2}.nc	3.4

global-reanalysis-phy-001-030-monthly	mercatorglorys12v1_gl12_mean_${yyyymm}.nc	3.4

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

Real_Value = (Display_Value X scale_factor) + add_offset

The missing value for this product is: -32767s

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/