PRODUCT USER MANUAL

For the Global Ocean Physical Multi Year product

GLOBAL_MULTIYEAR_PHY_001_030

Issue: 1.3

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RECORD TABLE

Issue	Date	§	Description of Change	Author	Validated By
1.1	2018/02/16	All	initial version	E. Fernandez, J.M. Lellouche	C. Derval
1.2	2021/01/13	all	Addition of climatology dataset	M Drevillon	C. Derval
1.3	2021/11/15	All	Update nomenclature product and dataset	C. Derval	C. Derval

Table OF CONTENTS

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

I.1 Summary

This document is the user manual for the CMEMS global reanalysis product **GLOBAL_MULTIYEAR_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 from 1992 to Year-1

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_MULTIYEAR_PHY_001_030 product is organised in three datasets:

- **cmems_mod_glo_phy_my_0.083_P1D-m** 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.
- **cmems_mod_glo_phy_my_0.083_P1M-m** 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.
- **cmems_mod_glo_phy_my_0.083-climatology_P1M-m** which contains the monthly climatology mean fields: for each month of the year, the 1993-2016 average of 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.
- **cmems_mod_glo_phy_my_0.083_static** 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 analysis and forecasting system is described in the Quality Information Document (QUID) CMEMS_GLO_QUID_001_030 (https://catalogue.marine.copernicus.eu/documents/QUID/CMEMS-GLO-QUID-001-030.pdf).

Information on operational issues on products and services can be found on our User Notification Service. If you have any questions, please contact us.

II DESCRIPTION OF THE PRODUCT SPECIFICATION

II.1 General Information

Product line	GLOBAL_MULTIYEAR_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 year - 1		
Target delivery time	N/A		
Temporal resolution	- **cmems_mod_glo_phy_my_0.083_P1D-m**: daily mean - **cmems_mod_glo_phy_my_0.083_P1M-m**: monthly mean - **cmems_mod_glo_phy_my_0.083-climatology_P1M-m**		
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 datasets

GLOBAL_MULTIYEAR_PHY_001_030
cmems_mod_glo_phy_my_0.083_P1D-m contains the 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
cmems_mod_glo_phy_my_0.083_P1M-m 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.
cmems_mod_glo_phy_my_0.083-climatology_P1M-m contains the monthly climatology mean fields: for each month of the year, the 1993-2016 average of 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.
These 3 datasets contained all the variables described below:
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
cmems_mod_glo_phy_my_0.083_static 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

Table 2: List of variables in datasets and their names and units in the NetCDF output files for the GLOBAL_MULTIYEAR_PHY_001_030 product

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

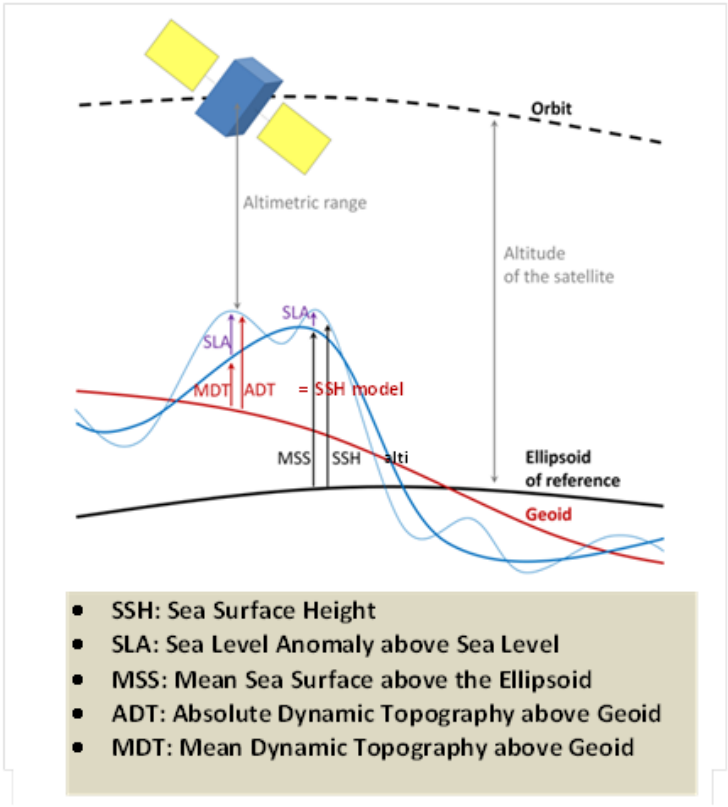
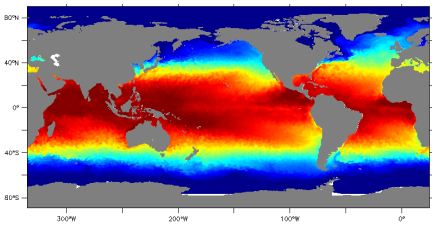


Figure 1 Altimetry principle https://catalogue.marine.copernicus.eu/documents/PUM/CMEMS-SL-PUM-008-063-066-067.pdf

II.4 Production System Description

The Operational Mercator global ocean reanalysis system at 1/12 degree is providing a 28-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. Hourly ERA5 forcing from January 1st 2019
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 27/12/2019. (with periodic temporal extensions)

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 DOWNLOAD A PRODUCT

After registration, you will be able to download our data. To assist you, our HelpCenter is available, and more specifically its section about download.

Information on operational issues on products and services can be found on our User Notification Service. If you have any questions, please contact us.

IV FILES NOMENCLATURE AND FORMAT

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

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 or CMEMS 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: 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.

IV.4 File size

DATASET NAME	NAME OF FILE	DIMENSION [GB]
cmems_mod_glo_phy_my_0.083_P1D-m	mercatorglorys12v1_gl12_mean_${date1}_R${date2}.nc	3.4
cmems_mod_glo_phy_my_0.083_P1M-m	mercatorglorys12v1_gl12_mean_${yyyymm}.nc	3.4

IV.5 Other information: mean centre of Products, land mask value, missing value

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).

I.1 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.6 Structure and semantic of NetCDF files

```
netcdf mercatorglorys12v1_gl12_mean_20191230_R20200101 {
dimensions:
   longitude = 4320 ;
   latitude = 2041 ;
   depth = 50 ;
   time = UNLIMITED ; // (1 currently)
variables:
   float longitude(longitude) ;
      longitude:valid_min = -180.f ;
      longitude:valid_max = 179.9167f ;
      longitude:step = 0.08332825f ;
      longitude:units = "degrees_east" ;
      longitude:unit_long = "Degrees East" ;
      longitude:long_name = "Longitude" ;
      longitude:standard_name = "longitude" ;
      longitude:axis = "X" ;
   float latitude(latitude) ;
```

latitude:valid_min = -80.f ;
latitude:valid_max = 90.f ;
latitude:step = 0.08333588f ;
latitude:units = "degrees_north" ;
latitude:unit_long = "Degrees North" ;
latitude:long_name = "Latitude" ;
latitude:standard_name = "latitude" ;
latitude:axis = "Y" ;
float depth(depth) ;
depth:valid_min = 0.494025f ;
depth:valid_max = 5727.917f ;
depth:units = "m" ;
depth:positive = "down" ;
depth:unit_long = "Meters" ;
depth:long_name = "Depth" ;
depth:standard_name = "depth" ;
depth:axis = "Z" ;
float time(time) ;
time:long_name = "Time (hours since 1950-01-01)" ;
time:standard_name = "time" ;
time:calendar = "gregorian" ;
time:units = "hours since 1950-01-01 00:00:00" ;
time:axis = "T" ;
short mlotst(time, latitude, longitude) ;
mlotst:long_name = "Density ocean mixed layer thickness" ;
mlotst:standard_name = "ocean_mixed_layer_thickness_defined_by_sigma_theta" ;
mlotst:units = "m" ;
mlotst:unit_long = "Meters" ;
mlotst:add_offset = -0.152592554688454 ;
mlotst:scale_factor = 0.152592554688454 ;
mlotst:_FillValue = -32767s ;
mlotst:valid_min = 1s ;
mlotst:valid_max = 4406s ;
mlotst:cell_methods = "area: mean" ;

short zos(time, latitude, longitude) ;
zos:long_name = "Sea surface height" ;
zos:standard_name = "sea_surface_height_above_geoid" ;
zos:units = "m" ;
zos:unit_long = "Meters" ;
zos:add_offset = 0. ;
zos:scale_factor = 0.000305185094475746 ;
zos:_FillValue = -32767s ;
zos:valid_min = -6148s ;
zos:valid_max = 5409s ;
zos:cell_methods = "area: mean" ;
short bottomT(time, latitude, longitude) ;
bottomT:long_name = "Sea floor potential temperature" ;
bottomT:standard_name = "sea_water_potential_temperature_at_sea_floor" ;
bottomT:units = "degrees_C" ;
bottomT:unit_long = "Degrees Celsius" ;
bottomT:_FillValue = -32767s ;
bottomT:add_offset = 21. ;
bottomT:scale_factor = 0.000732444226741791 ;
bottomT:valid_min = -32738s ;
bottomT:valid_max = 20750s ;
bottomT:cell_methods = "area: mean" ;
short sithick(time, latitude, longitude) ;
sithick:long_name = "Sea ice thickness" ;
sithick:standard_name = "sea_ice_thickness" ;
sithick:units = "m" ;
sithick:unit_long = "Meters" ;
sithick:add_offset = -0.000762962736189365 ;
sithick:scale_factor = 0.000762962736189365 ;
sithick:_FillValue = -32767s ;
sithick:valid_min = 1s ;
sithick:valid_max = 5095s ;
sithick:cell_methods = "area: mean where sea_ice" ;
short siconc(time, latitude, longitude) ;

siconc:long_name = "Ice concentration" ;
siconc:standard_name = "sea_ice_area_fraction" ;
siconc:units = "1" ;
siconc:unit_long = "Fraction" ;
siconc:add_offset = -3.81481368094683e-05 ;
siconc:scale_factor = 3.81481368094683e-05 ;
siconc:_FillValue = -32767s ;
siconc:valid_min = 1s ;
siconc:valid_max = 28007s ;
siconc:cell_methods = "area: mean where sea_ice" ;
short usi(time, latitude, longitude) ;
usi:long_name = "Sea ice eastward velocity" ;
usi:standard_name = "eastward_sea_ice_velocity" ;
usi:units = "m s-1" ;
usi:unit_long = "Meters per second" ;
usi:add_offset = 0. ;
usi:scale_factor = 3.05185094475746e-05 ;
usi:_FillValue = -32767s ;
usi:valid_min = -27495s ;
usi:valid_max = 32731s ;
usi:cell_methods = "area: mean where sea_ice" ;
short vsi(time, latitude, longitude) ;
vsi:long_name = "Sea ice northward velocity" ;
vsi:standard_name = "northward_sea_ice_velocity" ;
vsi:units = "m s-1" ;
vsi:unit_long = "Meters per second" ;
vsi:add_offset = 0. ;
vsi:scale_factor = 3.05185094475746e-05 ;
vsi:_FillValue = -32767s ;
vsi:valid_min = -31993s ;
vsi:valid_max = 32343s ;
vsi:cell_methods = "area: mean where sea_ice" ;
short thetao(time, depth, latitude, longitude) ;
thetao:long_name = "Temperature" ;

thetao:standard_name = "sea_water_potential_temperature" ;
thetao:units = "degrees_C" ;
thetao:unit_long = "Degrees Celsius" ;
thetao:_FillValue = -32767s ;
thetao:add_offset = 21. ;
thetao:scale_factor = 0.000732444226741791 ;
thetao:valid_min = -32738s ;
thetao:valid_max = 20726s ;
thetao:cell_methods = "area: mean" ;
short so(time, depth, latitude, longitude) ;
so:long_name = "Salinity" ;
so:standard_name = "sea_water_salinity" ;
so:units = "1e-3" ;
so:unit_long = "Practical Salinity Unit" ;
so:_FillValue = -32767s ;
so:add_offset = -0.00152592547237873 ;
so:scale_factor = 0.00152592547237873 ;
so:valid_min = 2s ;
so:valid_max = 28677s ;
so:cell_methods = "area: mean" ;
short uo(time, depth, latitude, longitude) ;
uo:long_name = "Eastward velocity" ;
uo:standard_name = "eastward_sea_water_velocity" ;
uo:units = "m s-1" ;
uo:unit_long = "Meters per second" ;
uo:_FillValue = -32767s ;
uo:add_offset = 0. ;
uo:scale_factor = 0.000610370188951492 ;
uo:valid_min = -2921s ;
uo:valid_max = 4580s ;
uo:cell_methods = "area: mean" ;
short vo(time, depth, latitude, longitude) ;
vo:long_name = "Northward velocity" ;
vo:standard_name = "northward_sea_water_velocity" ;

vo:units = "m s-1" ;

vo:unit_long = "Meters per second" ;

vo:_FillValue = -32767s ;

vo:add_offset = 0. ;

vo:scale_factor = 0.000610370188951492 ;

vo:valid_min = -3322s ;

vo:valid_max = 3045s ;

vo:cell_methods = "area: mean" ;

// global attributes:

:title = "daily mean fields from Global Ocean Physics Analysis and Forecast updated Daily" ;

:easting = "longitude" ;

:northing = "latitude" ;

:history = "2020/11/28 14:31:11 MERCATOR OCEAN Netcdf creation" ;

:source = "MERCATOR GLORYS12V1" ;

:institution = "MERCATOR OCEAN" ;

:references = "http://www.mercator-ocean.fr" ;

:comment = "CMEMS product" ;

:Conventions = "CF-1.4" ;

:domain_name = "GL12" ;

:field_type = "mean" ;

:field_date = "2019-12-30 00:00:00" ;

:field_julian_date = 25565.f ;

:julian_day_unit = "days since 1950-01-01 00:00:00" ;

:forecast_range = "" ;

:forecast_type = "" ;

:bulletin_date = "2020-01-01 00:00:00" ;

:bulletin_type = "operational" ;

:longitude_min = -180.f ;

:longitude_max = 179.9167f ;

:latitude_min = -80.f ;

:latitude_max = 90.f ;

:z_min = 0.494025f ;

:z_max = 5727.917f ;