



PRODUCT USER MANUAL

For the GLOBAL Ocean Sea Physical Analysis and Forecasting Products

GLOBAL_ANALYSIS_FORECAST_PHY_001_024

Issue: 1.3

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CHANGE RECORD

Issue	Date	§	Description of Change	Author	Validated By
1.1	21/09/2016	All	initial version	L.NOUEL	Y Drillet
1.2	19/09/2017	All	Addition of static and monthly datasets – Reformatting to follow new template	E. Fernandez	L. Nouel
4.1	26/04/2018	II.3	Addition of Information on SSH	C. Derval	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 analysis and forecast product **GLOBAL_ANALYSIS_FORECAST_PHY_001_024**: it provides with aggregated analyses updated weekly with 10-day forecast (updated daily). An archive of analysis since 26/12/2006 up to real-time is available on the CMEMS server.

It contains 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. This product is global. It is defined on a standard 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 grid points.

GLOBAL_ANALYSIS_FORECAST_PHY_001_024 product is organised in four datasets:

- **global-analysis-forecast-phy-001-024** 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-analysis-forecast-phy-001-024-hourly-t-u-v-ssh** which contains the hourly mean surface fields: potential temperature, currents and sea surface level information.
- **global-analysis-forecast-phy-001-024-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-analysis-forecast-phy-001-024-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 analysis and forecasting system is described in the Quality Information Document (QUID) CMEMS_GLO_QUID_001_024 (<http://marine.copernicus.eu/documents/PUM/CMEMS-GLO-QUID-001-024.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_ANALYSIS_FORECAST_PHY_001_024		
Geographical coverage	Global		
Variables	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		
	Analysis	Forecast	
Update frequency	Weekly	Daily	
Available time series	26/12/2006 up to real-time	10-days forecast	
Target delivery time	On Thursdays at 12pm (noon) UTC	Daily at 12pm (noon) UTC	
Temporal resolution	- global-analysis-forecast-phy-001-024-hourly-t-u-v-ssh: hourly mean - global-analysis-forecast-phy-001-024: daily mean - global-analysis-forecast-phy-001-024-monthly: monthly mean		
Delivery mechanism	Subsetter	DGF	FTP
Horizontal resolution	1/12 ° (equirectangular grid)		
Number of vertical levels	50		
Format	NetCDF CF1.4		

II.2 Details of the datasets

GLOBAL_ANALYSIS_FORECAST_PHY_001_024	
global-analysis-forecast-phy-001-024	contains the <u>3D 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.
	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
	m1otst [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-analysis-forecast-phy-001-024-hourly-t-u-v-ssh	contains the <u>hourly mean surface fields</u> : potential temperature, currents and surface sea surface level information.
	thetao [°C] Potential temperature sea_water_potential_temperature
	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
global-analysis-forecast-phy-001-024-monthly	contains the <u>3D 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
	mldtst [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

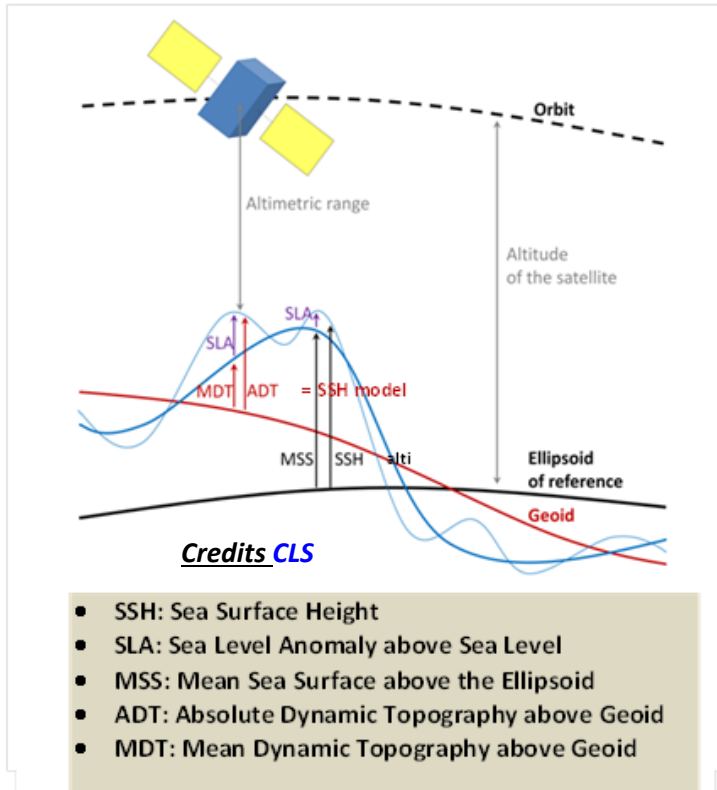
PUM for GLOBAL Sea Physical Analysis and Forecasting Product GLOBAL_ANALYSIS_FORECAST_PHY_001_024	Ref: CMEMS-GLO-PUM-001-024 Date : 10 April 2018 Issue : 1.3
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global-analysis-forecast-phy-001-024-statics	usi [m/s] Eastward sea ice velocity eastward_sea_ice_velocity
	vsi [m/s] Northward sea ice velocity northward_sea_ice_velocity
	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 (θ_{10m} , S_{10m} , $P_0 = 0$ 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



$$\text{SSH}_{\text{altimeter}} = \text{Geoid} + \text{ADT obs}$$

$$\text{SSH}_{\text{model}} = \text{ADT obs}$$

$$\text{SSH}_{\text{model}} = \text{SSH}_{\text{altimeter}} - \text{Geoid}$$

Sea Level Anomaly

$$\text{SLA}_{\text{altimeter}} \sim \text{SSH}_{\text{model}} - \text{MDT}$$

Absolute Dynamical Topography

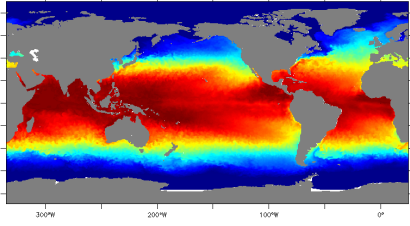
$$\text{ADT}_{\text{aviso}} \sim \text{SSH}_{\text{model}}$$

- 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

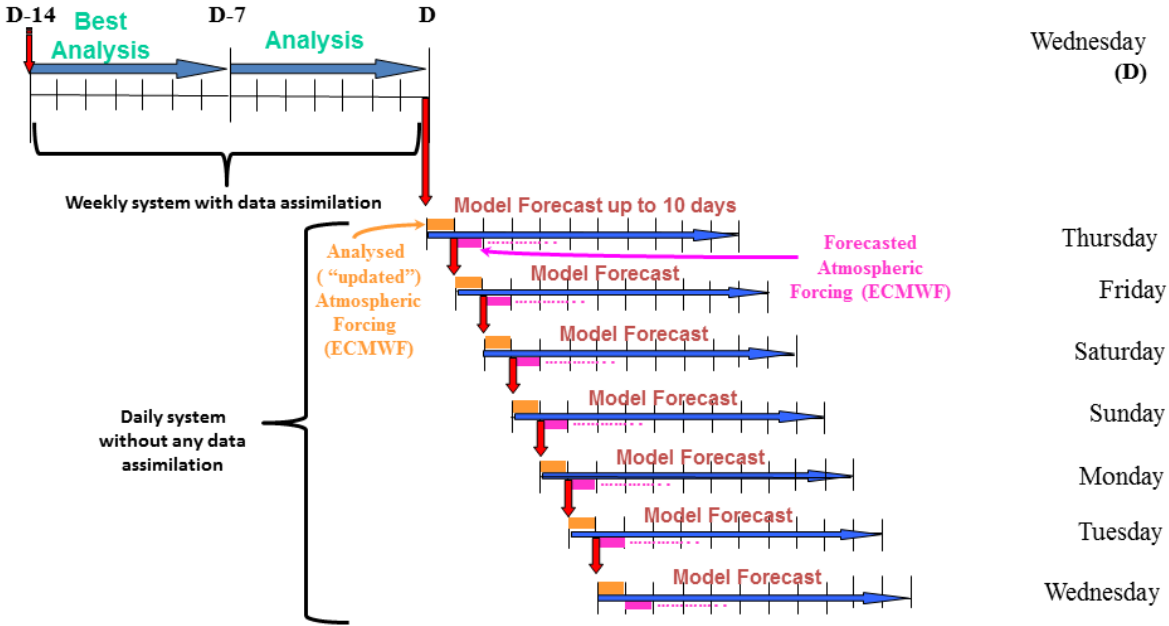
The Operational Mercator global ocean analysis and forecast system at 1/12 degree is providing 10 days of 3D global ocean forecasts updated daily. The time series starts on December 26, 2006 until real time. This product includes daily and monthly mean files of temperature, salinity, currents, sea level, mixed layer depth and ice parameters from the top to the bottom over the global ocean. It also includes hourly mean surface fields for sea level height, temperature and currents.

Domain Resolution and grid Geographic coverage	<p>GLOBAL (180°W-180°E ; 89°S – 90°N) 1/12° ; regular grid ; 4320 x 2041</p> <p>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.</p> 
Model Version	NEMO 3.1
Atmospheric forcings	3-hourly from ECMWF
Assimilation scheme	SAM2 (SEEK Kernel)
Assimilated observations	<p>CMEMS OSTIA SST + CMEMS Sea Ice Concentration + CMEMS SLA + in situ profile from CMEMS database + MDT adjusted based on CNES-CLS13, Rio et al., 2014 + WOA 2013 climatology (temperature and salinity) below 2000 m (assimilation using a non-Gaussian error at depth)</p>
Initial conditions	<p>Levitus (2009 T and S) for the ocean Ifremer/Cersat data for ice concentration and GLORYS2V1 for ice thickness</p>
Bathymetry	ETOPO1 for the deep ocean and GEBCO8 close to the cost and slope

II.5 Processing information

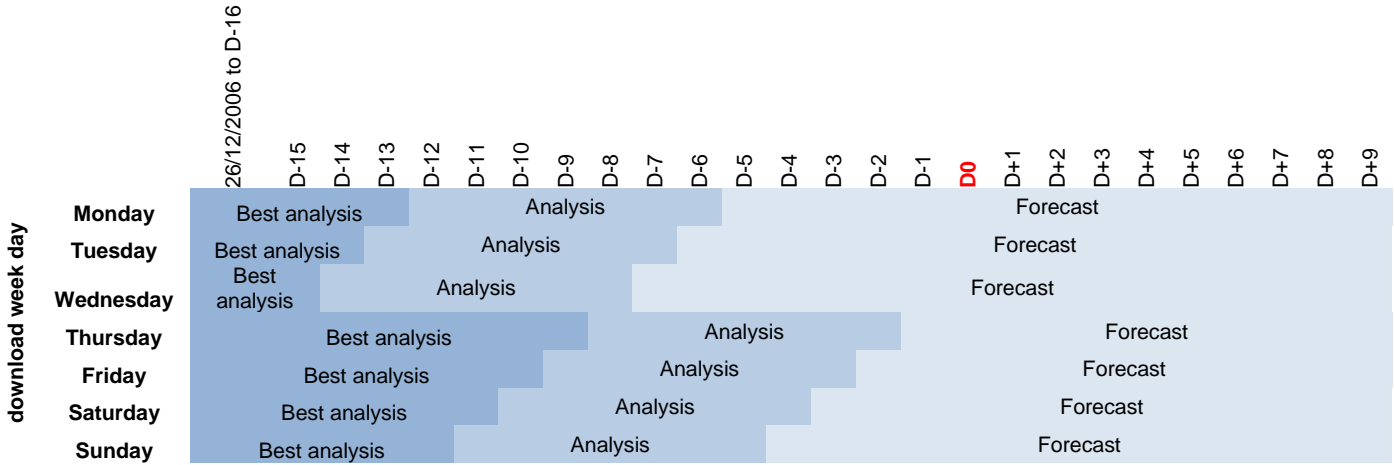
II.5.1 Update Time

The product is updated as follows:



Everyday, the daily configuration is run with updated atmospheric forcings, without assimilation, for days D-1 to D+9. The daily runs are initialized with the previous day's run, except on Thursdays, when they start from the weekly analysis run. Every week, on Wednesdays, the weekly configuration is run with assimilation for days D-14 to D-1. This run is separated in two parts: a best analysis for days D-14 to D-8 and an analysis for days D-7 to D-1

Every day, the time series is updated with new forecasts for days D-1 to D+9, erasing the previously available data for D-1 to D+8. In addition, on Thursdays, the analysis is also provided, replacing previously available files for days D-14 to D-1. So depending on the download weekday, one will have a time series from different runs with or without assimilation. The following table explains what time series to expect depending on when one downloads data.



For example, on Friday 15th September 2017, if one downloads data for a month, from 20th August to 20th September, the time series obtained will be as follows:

- 20th August to 5th September (D-10) will be from the best analysis
- 6th September (D-9) to 12th September (D-3) will be from the analysis
- 13th September (D-2) will be from the forecast run on Thursday 14th September
- 14th September (D-1) to 20th September (D+5) will be from the latest forecast, run on Friday 15th September

The product is updated daily at 1200 UTC for the daily and hourly datasets.

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

II.5.2 Time coverage

An archive of analysis since 26/12/2006 up to real-time is available.

II.5.3 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 (midnight to midnight, centered at noon). 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.

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IV FILES NOMENCLATURE AND FORMAT

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

GLOBAL_ANALYSIS_FORECAST_PHY_001_024 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
- **nnnnnnnnnnnnnn:** 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-analysis-forecast-phy-001-024_1303461772348.nc

IV.2 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.3 File size

DATASET NAME	NAME OF FILE	DIMENSION [GB]
global-analysis-forecast-phy-001-024	mercatorpsy4v3r1_gl12_mean_\${date1}_R\${date2}.nc	3.4
global-analysis-forecast-phy-001-024-hourly-t-u-v-ssh	mercatorpsy4v3r1_gl12_hrly_\${date1}_R\${date2}.nc	1.6
global-analysis-forecast-phy-001-024-monthly	mercatorpsy4v3r1_gl12_mean_\${YYYYMM}.nc	3.4
global-analysis-forecast-phy-001-024-statics	GLO-MFC_001_024_\${field}.nc	2.3

IV.4 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.5 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/>