PRODUCT USER MANUAL

For North-West Shelf Physical Forecast Product

NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_001_b

Issue: 3.4

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CMEMS version scope : Version 3.0

Approval Date :

CHANGE RECORD

Issue	Date	§	Description of Change	Author	Validated By
1.0	31 October 2011	All	Creation of the document based on the V1.1 doc	John Siddorn	John Siddorn
2.0	14 January 2013	II.3 IV.2	Updates for V3.	Niall McConnell	
2.1	14 February 2013		Updates following acceptance review	Adrian Hines	
2.2	02 September 2013		Inclusion of new full-depth hourly dataset	Ed Blockley	L. Crosnier
2.3	09 January 2014		Updating for V4 and some minor fixes	Ed Blockley	L. Crosnier
3.0	December 2014		Updates for V5 and Follow On project	Ed Blockley	L. Crosnier
3.1	Feb2015		Add history of changes	Ed Blockley	L. Crosnier
3.2	May 1 2015	all	Change format to fit CMEMS graphical rules		L. Crosnier
3.3	Jan 2016		Add new variables and substitution of MyOcean with CMEMS	Niall McConnell	M. Tonani
3.4	Jan 2017 Feb 2017	All	Updated for CMEMS V3 service release Updated with suggested	Ray Mahdon	M. Tonani

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GLOSSARY AND ABBREVIATIONS

MFC	Monitoring and Forecasting Centre
NWS	North-West Shelf
NetCDF	Network Common Data Form
CF	Climate Forecast (convention for NetCDF)
SSS	Sea surface salinity.
SSC	Sea surface currents
SSH	Sea surface height
RMS	Root mean square
PC	Production Centre
PU	Production Unit
Meridional Velocity	West to East component of the horizontal velocity vector
Zonal Velocity	South to North component of the horizontal velocity vector
TMB	Top, Middle, Bottom. Refers to terrain following water column levels for certain fields
ftp	Protocol to download files
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)
Subsetter	CMEMS service tool to download a NetCDF file of a selected geographical box using values of longitude an latitude, and time range
DirectGetFile - DGF	CMEMS service tool (FTP like) to download a NetCDF file

I INTRODUCTION

This guide describes the physical forecast product files from the Met Office Dissemination Unit of the NWS MFC (NWS-METOFFICE-EXETER-UK), what data services are available to access them, and how to use the files and services. NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_001_b is the analysis and forecast physical product of the NWS MFC from the UK Met Office, and includes:

- 3D daily mean fields of temperature, salinity, zonal velocity, meridional velocity, Mixed Layer Depth and Temperature at the sea floor
- 3D hourly fields of temperature, salinity, zonal velocity and meridional velocity
- hourly surface, middle and bottom fields of temperature, salinity, zonal velocity and meridional velocity, sea surface height (surface only)

II DESCRIPTION OF THE PRODUCT SPECIFICATION

II.1 General Information

Product Lines	NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_001_b
Geographical coverage	20°W → 13°E ; 40°N → 65°N
Variables	Long_name (variable name in the file) Sea Water Potential Temperature (votemper) **: 3D-daily & 3D-hourly & 3-level (TMB) hourly** Sea Water Salinity (vosaline) **: 3D-daily & 3D-hourly &3-level (TMB) hourly** Eastward Current Velocity in the Water Column (vozocrtx): **3D-daily & 3D-hourly & 3-level (TMB) hourly** Northward Current Velocity in the Water Column (vomecrty): **3D-daily & 3D-hourly & 3-level (TMB) hourly** Ocean mixed layer thickness defined by density (karamld) **: Daily-mean** Sea floor potential temperature (sotemper) **: Daily-mean** Sea surface height above geoid (sossheig) : **surface-level hourly**
Analysis	Yes
Forecast	Yes 6 day-forecast
Available time series	01/04/2014– present
Temporal resolution	• Daily mean for the 2D and 3D above variables • 3D-hourly mean for Temperature, Salinity and Horizontal velocity (meridional and zonal component) • 3-level hourly mean for Temperature, Salinity, SSH (surface only) and Horizontal velocity (meridional and zonal component)
Target delivery time	Daily 0900 UTC
Delivery mechanism	Subsetter, FTP, DGF
Horizontal resolution	~7km (1/9^{o} lon x 1/15^{o} lat) – Regular grid

Number of vertical levels	• 3D Daily and hourly mean:24 levels -5000m to 0 • 3 level hourly mean: 3 (surface, mid-water and near-bottom) except SSH which has no depth dimension
Format	Netcdf CF1.0

Table 1: *NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_001_b Product Specification of 3D-daily , 3D-hourly and 3-level hourly fields*

Detailed information on the systems and products are on CMEMS web site: marine.copernicus.eu .

II.2 Details of datasets

NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_001_b	
• 3D daily mean fields of temperature, salinity, zonal velocity, meridional velocity, Mixed Layer Depth and Temperature at the sea floor • 3D hourly fields of temperature, salinity, zonal velocity and meridional velocity • hourly surface, middle and bottom fields of temperature, salinity, zonal velocity and meridional velocity, sea surface height (surface only)	
DATASETS	Variables name in the NetCDF file and Unit Long_name Standard_name
MetO-NWS-PHYS-dm-CUR	**vomecrty** [ms^{-1}] Northward Current Velocity in the Water Column northward_sea_water_velocity
MetO-NWS-PHYS-dm-CUR	**vozocrtx** [ms^{-1}] Eastward Current Velocity in the Water Column eastward_sea_water_velocity
MetO-NWS-PHYS-dm-TEM	**votemper** [C] Sea Water Potential Temperature sea_water_potential_temperature
MetO-NWS-PHYS-dm-SAL	**vosaline** [1e-3] Sea Water Salinity sea_water_salinity
MetO-NWS-PHYS-dm-BED	**sotemper** [C] Sea floor potential temperature sea_water_potential_temperature_at_sea_floor
MetO-NWS-PHYS-dm-MLD	**karamld** [m] Ocean mixed layer thickness defined by density ocean_mixed_layer_thickness_defined_by_density
MetO-NWS-PHYS-hi-TMB-CUR	**vomecrty** [ms^{-1}] Northward Current Velocity in the Water Column northward_sea_water_velocity

MetO-NWS-PHYS-hi-TMB-CUR	**vozocrtx** [ms^{-1}] Eastward Current Velocity in the Water Column eastward_sea_water_velocity
MetO-NWS-PHYS-hi-TMB-TEM	**votemper** [C] Sea Water Potential Temperature sea_water_potential_temperature
MetO-NWS-PHYS-hi-TMB-SAL	**vosaline** [1e-3] Sea Water Salinity sea_water_salinity
MetO-NWS-PHYS-hi-SSH	**sossheig** [m] Sea surface height above geoid sea_surface_height_above_geoid
MetO-NWS-PHYS-hi-CUR	**vomecrty** [ms^{-1}] Northward Current Velocity in the Water Column northward_sea_water_velocity
MetO-NWS-PHYS-hi-CUR	**vozocrtx** [ms^{-1}] Eastward Current Velocity in the Water Column eastward_sea_water_velocity
MetO-NWS-PHYS-hi-TEM	**votemper** [C] Sea Water Potential Temperature sea_water_potential_temperature
MetO-NWS-PHYS-hi-SAL	**vosaline** [1e-3] Sea Water Salinity sea_water_salinity

Table 2: List of the datasets (column 1), of variables name (column 2) in the NetCDF file, unit, Long_name and standard_name for the NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_001_b

karamld [m]	Ocean mixed layer thickness defined by density (as in Kara, 2000, with the reference depth at 3m instead of 10m)
sossheig (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 SSH 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.
sotemper (C)	sea_water_potential_temperature_at_sea_floor

Table 3**:** *A description of the calculation method for derived variables for the NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_001_b product.*

II.3 Production System Description

<table>
<tr><td>Domain
Resolution and grid

Geographic coverage</td><td>REGIONAL(20°W → 13°E ; 40°N → 65°N)
~7km (1/9° x 1/15°) and 24 vertical levels (-5000m to 0)
Regular grid
<table>
<tr><td colspan="9">NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_002</td></tr>
<tr><td>VARIABLE</td><td>LON MIN</td><td>LON MAX</td><td>LAT MIN</td><td>LAT MAX</td><td>LON SIZE</td><td>LAT SIZE</td><td>XPOINT</td><td>YPOINT</td></tr>
<tr><td>All</td><td>19.888°W</td><td>13.000°E</td><td>40.066°N</td><td>65.000°N</td><td>0.111°</td><td>0.066°</td><td>297</td><td>375</td></tr>
</table>
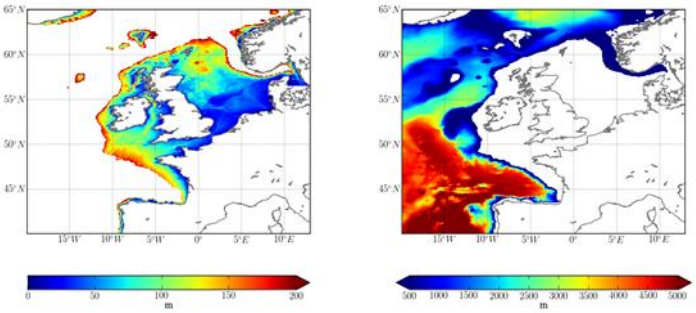
Figure 2: NWS V5 bathymetry (m) showing (left) the domain on the European NorthWest Shelf (defined here as total depth less than 200m) and (right) the domain off the shelf.</td></tr>
<tr><td>Vertical grid</td><td>The NWS models use terrain-following coordinates in the vertical stretched in deeper waters to give increased resolution near the surface and sea bed. This is normally referred to as hybrid S-σ coordinates. In the case of the nominal forecast model some coordinate intersection through the sea bed is also used (for improved numerics), so the model can be considered hybrid S-σ-z-coordinates. These grids, although the best solution for the modelling, are difficult to visualise and to manipulate and so the NWS MFC products are interpolated from the terrain-following coordinate system onto standard depths where appropriate. All daily and hourly mean parameters where depth is relevant (i.e. not sea surface height) are all interpolated in the vertical to a standard set of depths based upon ICES standard depths: , 3, 10, 15, 20, 30, 50, 75, 100, 125, 150, 200, 250,300, 400, 500, 600, 750, 1000, 1500, 2000, 3000, 4000, 5000.</td></tr>
<tr><td>Model Version</td><td>The Forecasting Ocean Assimilation Model 7km Atlantic Margin model (FOAM AMM7) (see section II.3.2 & II.3.3 http://cmems-resources.cls.fr/documents/QUID/CMEMS-NWS-QUID-004-001.pdf)</td></tr>
<tr><td>Assimilation scheme</td><td>NEMOVAR 3D-Var FGAT (see http://cmems-resources.cls.fr/documents/QUID/CMEMS-NWS-QUID-004-001-002.pdf section II.3.4)</td></tr>
</table>

Assimilated observations	• SLA:CMEMS SEALEVEL_EUR_SLA_ASSIM_L3_NRT_OBSERVATIONS_008_037 • SST: GHRSST • IN SITU: GTS see http://cmems-resources.cls.fr/documents/QUID/CMEMS-NWS-QUID-004-001-002.pdf section II.3.4)
Initial conditions	• PHY: from the CMEMS NWS reanalysis product for 1 January 2015
Boundary conditions	• NWP forcing: Met Office Global-NWP at 3-hourly frequency; 1-hourly for wind speed and surface pressure • Atlantic: from Met Office FOAM NAT12(6hr) • Baltic: from CMEMS-BAL-MFC(hourly) • River data: Climatological river inputs
Bathymetry	Bathymetry was supplied by North-West Shelf Operational Oceanographic System (NOOS) partners, who have processed GEBCO 1 arc-minute data together with a variety of other local data sources. The bathymetry was further interpolated in-house to fit with the model grid.

II.4 Processing Information

II.4.1 Update Time

The forecast products are updated daily at 0900 UTC with a new analysis "best guess" valid for T-48 [1] to T0 and six day forecast valid for T0 to T144 being provided. T0 is defined as 0000 UTC on the day of the model run. All forecast models are run with updated atmospheric forcing, with the "best guess" ocean being forced by the latest analysis NWP forcing, and the T0 to T144 being forced by the equivalent NWP forcing. This means the ocean forecast is being forced by the most recent possible NWP forecast fields.

II.4.2 Temporal extent of analysis and forecast stored on delivery mechanism

Six days of forecast are available with the first days forecast being the forecast for the day of production. The 6 day-forecast is updated daily. An archive of analysis since April 1st 2014 is available.

II.4.3 Time averaging

For the forecast products hourly instantaneous and daily mean values are available. Hourly instantaneous values are the output from the model at the model time step closest to the hour in UTC. There is no temporal averaging or interpolation performed, and thus the sum of the hourly

[1] The nomenclature used here takes T0 to be the time (in hours) at the start of the first forecast day. T24 is therefore the 24th hour of forecast, T-24 is 24 hours prior to the forecast starting (i.e. within the analysis period).

instantaneous values will not exactly match the time averaged properties. Daily mean values are calculated as means of 25 hourly instantaneous values, starting at midnight (UTC) and finishing on the following midnight to remove both diurnal and tidal cycles.

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 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

The ftp site is accessed using your CMEMS user name and password and the files are located in the directory called NORTHWESTSHELF_FORECAST_PHYS_004_001.

III.3 Download a product through the CMEMS DGF (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#3 will guide you on How to download a product through the CMEMS Web Portal DGF Service.

IV FILES NOMENCLATURE AND FORMAT

The nomenclature of the downloaded files differs on the basis of the chosen download mechanism **Subsetter** or **CMEMS FTP** and **DGF** service.

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

The NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_001_b 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 MIS.

The scheme is: **datasetname-nnnnnnnnnnnnn.nc**

where :

- **datasetname:** as described in table 2
- **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:

```
MetO-NWS-PHYS-dm-CUR -1303461772348.nc
```

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

The NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_001_b 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 MIS.

The scheme is: **datasetname-nnnnnnnnnnnnn.zip**

where :

- **datasetname:** as described in table 2
- **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:

```
MetO-NWS-PHYS-dm-CUR -1303461772348.zip
```

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

The below describes the near-real time forecast products:

- NORTHWESTSHELF_ANALYSIS_FORECAST_PHYS_004_001_b

The files are delivered containing data for:

* the full spatial coverage of the model domain

* one variable or variable group

* a single day data

For example an analysis and five-day forecast is distributed in six daily files, each of which contain a single daily mean or multiple higher-frequency values. The filenames contain fields that identify the model, domain, variable and time of the contents:

metoffice_foam1_amm7_NWS_XXXX_b20091025_dm20091024.nc

* metoffice: production centre that produced the file

* foam1: model system and version

* amm7: model configuration

* NWS: region

* XXXX: variable or variable group, see table 4 below

* b20091025: bulletin (production) date YYYYMMDD

* dm20091024: dm = daily mean or hi = hourly instantaneous, then data validity date YYYYMMDD

TEM	Potential temperature (including SST)
SAL	Salinity
CUR	Water velocities
SSH	Sea surface height
MLD	Mixed layer depth
BED	Temperature at the sea floor

***Table 4**: Variable naming convention for the filenames*

IV.4 File Format : NetCDF CF1.0

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.

All variables are packed, and the netcdf metadata fully describes the scale factors and offsets required to interpret the packing. Most visualization and data handling software will automatically interpret the packing metadata to convert to real-world values.

IV.5 File size

DATASET NAME	NAME OF FILE	DIMENSION [MB]
		Uncompressed
MetO-NWS-PHYS-dm-CUR	metoffice_foam1_amm7_NWS_CUR_b{{yyyymmdd}}_dm{{yyyymmdd}}.nc	2.4
MetO-NWS-PHYS-dm-TEM	metoffice_foam1_amm7_NWS_TEM_b{{yyyymmdd}}_dm{{yyyymmdd}}.nc	1.5
MetO-NWS-PHYS-dm-SAL	metoffice_foam1_amm7_NWS_SAL_b{{yyyymmdd}}_dm{{yyyymmdd}}.nc	1.1
MetO-NWS-PHYS-dm-BED	metoffice_foam1_amm7_NWS_BED_b{{yyyymmdd}}_dm{{yyyymmdd}}.nc	0.1
MetO-NWS-PHYS-dm-MLD	metoffice_foam1_amm7_NWS_MLD_b{{yyyymmdd}}_dm{{yyyymmdd}}.nc	0.1
MetO-NWS-PHYS-hi-TMB-CUR	metoffice_foam1_amm7_NWS_TMB_CUR_b{{yyyymmdd}}_hi{{yyyymmdd}}.nc	12
MetO-NWS-PHYS-hi-TMB-TEM	metoffice_foam1_amm7_NWS_TMB_TEM_b{{yyyymmdd}}_hi{{yyyymmdd}}.nc	6.7
MetO-NWS-PHYS-hi-TMB-SAL	metoffice_foam1_amm7_NWS_SAL_CUR_b{{yyyymmdd}}_hi{{yyyymmdd}}.nc	5.4
MetO-NWS-PHYS-hi-SSH	metoffice_foam1_amm7_NWS_SSH_b{{yyyymmdd}}_hi{{yyyymmdd}}.nc	1.8
MetO-NWS-PHYS-hi-CUR	metoffice_foam1_amm7_NWS_CUR_b{{yyyymmdd}}_hi{{yyyymmdd}}.nc	55
MetO-NWS-PHYS-hi-SAL	metoffice_foam1_amm7_NWS_SAL_b{{yyyymmdd}}_hi{{yyyymmdd}}.nc	21
MetO-NWS-PHYS-hi-TEM	metoffice_foam1_amm7_NWS_TEM_b{{yyyymmdd}}_hi{{yyyymmdd}}.nc	31

Table 5 Compressed and uncompressed file sizes for each product.

IV.6 Remember : scale_factor & add_offset / missing-value /land mask

Real_Value = (Display_Value X scale_factor) + add_offset

Land mask are equal to "_FillValue" (see variable attribute on NetCDF file).

missing_value = -32768s

IV.7 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…
- PANOPLY (NASA): https://www.giss.nasa.gov/tools/panoply/