PRODUCT USER MANUAL

For Black Sea Physical Analysis and Forecast Product BLKSEA_ANALYSISFORECAST_PHY_007_001

Issue: 3.1

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Approval Date : November 2022

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RECORD TABLE

Issue	Date	§	Description of Change	Author	Validated By
1.0	01.07.16	all	First version for CMEMS V2.2	S. Ciliberti, A. Storto, S. Creti', F. Macchia	
1.1	02.10.16	all	Update version after PIT v1.2 acceptance: correction in $IV.1	S. Ciliberti, S. Creti'	
2.0	20.11.16	all	First version for CMEMS V3	S. Ciliberti	
2.1	22.10.18	all	Preparing for the new template and adding the static files description	S. Ciliberti	
2.2	21.01.19	all	General revision	R. Lecci, S. Ciliberti	C. Derval
2.3	10.09.19	all	Inclusion of new dataset centered at 12Z	R.Lecci, S. Ciliberti, S. Cretì	
2.4	03.04.20	all	Revision of time series coverage	R.Lecci	C. Derval
3.0	15.01.21	all	New higher resolution product	R.Lecci, S. Ciliberti	C. Derval
3.1	29.11.22	all	Quality improvement; Upstream data change; Additional dataset	R. Lecci, E. Jansen, L. Stefanizzi, D. Azevedo	Copernicus Marine Product management

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GLOSSARY AND ABBREVIATIONS

BS	Black Sea
CF	Climate Forecast (convention for NetCDF)
CLS	Collecte Localisation Satellites
CMAP	CPC Merged Analysis of Precipitation
CMEMS	Copernicus Marine Environment Monitoring Service
CTD	Conductivity Temperature Depth
DAC	Dynamic Atmospheric Correction
ECMWF	European Centre for Medium-Range Weather Forecasts
EOF	Empirical Orthogonal Function
FAQ	Frequently Asked Question
FTP	File Transfer Protocol
Hereon	Helmholtz-Zentrum Hereon (former HZG)
HZG	Helmholtz-Zentrum Geesthacht
Meridional Velocity	South to North component of the horizontal velocity vector
MFC	Monitoring and Forecasting Centre
NEMO	Nucleus 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
Subsetter	Copernicus Marine 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
WAM	Wave Model
Zonal Velocity	West to East component of the horizontal velocity vector

DOWNLOAD A PRODUCT

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1) INTRODUCTION

a) Summary

This document is the user manual for the Copernicus Marine analysis and forecast product BLKSEA_ANALYSISFORECAST_PHY_007_001. A rolling archive of analysis over the last two years up to real-time is available on the Copernicus Marine server.
It contains 3D, monthly mean fields, 24 hours mean fields and hourly mean fields of Potential Temperature, Bottom Temperature, Salinity, Zonal and Meridional Velocity, and by 2D, monthly mean fields, 24 hours mean fields and hourly mean fields of Sea Surface Height, Mixed Layer Depth and Bottom Potential Temperature, monthly mean fields and 24 hours mean fields of Vertical Velocity.

BLKSEA_ANALYSISFORECAST_PHY_007_001 product is organized in 16 datasets:
5 datasets contain monthly mean fields: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height, bottom potential temperature, mixed layer thickness information.

- cmems_mod_blk_phy-cur_anfc_2.5km_P1M-m
- cmems_mod_blk_phy-ssh_anfc_2.5km_P1M-m
- cmems_mod_blk_phy-mld_anfc_2.5km_P1M-m
- cmems_mod_blk_phy-sal_anfc_2.5km_P1M-m
- cmems_mod_blk_phy-tem_anfc_2.5km_P1M-m

5 datasets contain daily mean fields: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height, bottom potential temperature, mixed layer thickness information.

- cmems_mod_blk_phy-cur_anfc_2.5km_P1D-m
- cmems_mod_blk_phy-ssh_anfc_2.5km_P1D-m
- cmems_mod_blk_phy-mld_anfc_2.5km_P1D-m
- cmems_mod_blk_phy-sal_anfc_2.5km_P1D-m
- cmems_mod_blk_phy-tem_anfc_2.5km_P1D-m

5 datasets contain hourly mean fields: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height, bottom potential temperature, mixed layer thickness information.

- cmems_mod_blk_phy-cur_anfc_2.5km_PT1H-m
- cmems_mod_blk_phy-ssh_anfc_2.5km_PT1H-m
- cmems_mod_blk_phy-mld_anfc_2.5km_PT1H-m
- cmems_mod_blk_phy-sal_anfc_2.5km_PT1H-m
- cmems_mod_blk_phy-tem_anfc_2.5km_PT1H-m

1 dataset contains the static fields for the system: coordinates, mean sea surface level, mask and bathymetry: cmems_mod_blk_phy_anfc_2.5km_static

The product is published on the Copernicus Marine dissemination server after automatic and human quality controls. Product is available on-line and disseminated through the Copernicus Marine Information System. Files downloaded are in NetCDF format.

The analysis and forecasting system is described in the Quality Information Document (QUID – see link in REFERENCES).

Disclaimer: The quality of the product may vary during the proposed time series depending on the possible update of the system.

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b) History of changes

Date	Description of changes and impacted product
October 2016	V1.1 related to BS-PHY V2.2 products, including revisions after V2.2 acceptance
April 2017	V2.0 is related to BS-PHY V3, considering system evolution issues as described in the AAP 2017-2018
April 2018	V2.1 is moved to new CMEMS template and the description of static files is added
	V2.2 general revision
December 2019	V2.3 related to nominal start of BS-PHY products from 12:00 of J to 00:00 of J, change from NetCDF3 to NetCDF4, revision of the semantic of files to account CMEMS recommendations, new PUM template
	V2.4 new timeseries temporal coverage
November 2022	Quality improvement; Upstream data change; Additional dataset

2) DESCRIPTION OF THE PRODUCT SPECIFICATION

a) General Information

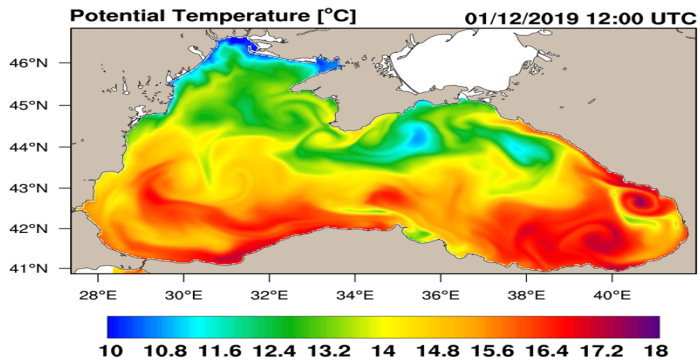
Product name	BLKSEA_ANALYSISFORECAST_PHY_007_001	
Geographical coverage	27.25°E - 41.1°E; 40.5°N - 47.0°N	
Variables	Temperature Salinity Sea Surface Height Horizontal velocity (eastward and northward components) Vertical velocity (upward component) Ocean mixed layer thickness Sea floor potential temperature	
Update frequency	**Analysis** Daily/Weekly	**Forecast** Daily
Available time series	last two years up to real-time	10-days forecast
Target delivery time	Daily at 12 UTC /On Tuesday at 12:00 UTC	Daily at 12:00 UTC
Temporal resolution	cmems_mod_blk_phy-cur_anfc_2.5km_PT1H-m, cmems_mod_blk_phy-ssh_anfc_2.5km_PT1H-m, cmems_mod_blk_phy-mld_anfc_2.5km_PT1H-m, cmems_mod_blk_phy-sal_anfc_2.5km_PT1H-m, cmems_mod_blk_phy-tem_anfc_2.5km_PT1H-m: hourly mean cmems_mod_blk_phy-cur_anfc_2.5km_P1D-m, cmems_mod_blk_phy-ssh_anfc_2.5km_P1D-m, cmems_mod_blk_phy-mld_anfc_2.5km_P1D-m, cmems_mod_blk_phy-sal_anfc_2.5km_P1D-m, cmems_mod_blk_phy-tem_anfc_2.5km_P1D-m: daily mean cmems_mod_blk_phy-cur_anfc_2.5km_P1M-m, cmems_mod_blk_phy-ssh_anfc_2.5km_P1M-m, cmems_mod_blk_phy-mld_anfc_2.5km_P1M-m, cmems_mod_blk_phy-sal_anfc_2.5km_P1M-m, cmems_mod_blk_phy-tem_anfc_2.5km_P1M-m: monthly mean	
Horizontal resolution	~2.5km (1/40° in both zonal and meridional directions)	
Number of vertical levels	121	
Format	NetCDF CF1.0	
Delivery mechanisms	Subsetter and FTP	

Table 1: BS-MFC Real Time products

<u>The runtime schedule:</u>
BLKSEA_ANALYSIS_FORECAST_PHY_007_001

The BS-PHY NRT production follows daily and weekly cycles.
In the daily cycle the system produces 3 days of analysis, 1 day of simulation and 10 days of forecast. While on the weekly cycle, each Tuesday the system produces 14 days of analysis, 1 day of simulation and 10 days of forecast to assimilate a larger number of in-situ and satellite observations.

b) Production System Description

Domain Resolution and grid Geographic coverage	BLKSEA (27.25°E □ 41.1°E; 40.5°N □ 47) ~2.5km ; regular grid ; 591 x 261 This product covers the Black Sea basin, the horizontal resolution is approx 2.5 km, the vertical grid is composed of 121 unevenly spaced vertical z-levels. 
Model Version Production unit Period of validation	▪ NEMO v4.0 ▪ CMCC, Italy ▪ 01.01.2020–31.12.2020
Vertical grid	The product is delivered at the model native grid, with up to 121 vertical levels: ▪ levels [m]: 0.5001728, 1.501598, 2.504562, 3.509193, 4.515629, 5.524022, 6.534534, 7.547341, 8.562635, 9.580623, 10.60153, 11.62559, 12.65308, 13.68428, 14.7195, 15.75907, 16.80335, 17.85274, 18.90767, 19.96858, 21.03599, 22.11043, 23.19248, 24.28278, 25.38202, 26.49095, 27.61035, 28.74112, 29.88418, 31.04057, 32.2114, 33.39785, 34.60124, 35.82297, 37.06456, 38.32767, 39.61407, 40.92572, 42.26469, 43.63326, 45.03389, 46.46922, 47.94216, 49.4558, 51.01352, 52.61897, 54.27611, 55.98921, 57.7629, 59.60218, 61.51247, 63.49964, 65.57002, 67.73048, 69.98843, 72.35188, 74.82951, 77.43068, 80.16553, 83.04501, 86.08092, 89.28606, 92.67419, 96.26022, 100.0602, 104.0915, 108.3727, 112.9241, 117.7673, 122.9258, 128.4248, 134.2913, 140.5545, 147.2458, 154.3988, 162.0498, 170.2374, 179.0034, 188.3921, 198.4513, 209.232, 220.7884, 233.1786, 246.4644, 260.7114, 275.9896, 292.3729, 309.9397, 328.7727, 348.9593, 370.5913, 393.7652, 418.5819, 445.1469, 473.5699, 503.965, 536.45, 571.1462, 608.1785, 647.674, 689.7625, 734.575, 782.2433, 832.8996, 886.6748, 943.6982, 1004.096, 1067.991, 1135.502, 1206.738, 1281.805, 1360.798, 1443.804, 1530.9, 1622.15, 1717.607, 1817.312, 1921.292, 2029.56, 2142.117, 2258.949
Tides	8 components : M2, S2, N2, K2, K1, O1, P1, Q1
Atmospheric forcing	ECMWF atmospheric forcing at 1/10 degrees: 6-hourly analysis; 1 hour for the first 3 days of forecast, 3 hours for the following 3 days of forecast and 6 hours for the last 4 days of forecast
Boundary forcing	The BS-NRT system has 3 open boundaries at the Marmara Sea. The ocean model NEMO is forced with data from the Unstructured Turkish Strait System model (U-TSS).

Assimilation scheme	OceanVar (3DVAR)
Assimilated observations	Insitu vertical profiles of Temperature and Salinity from ARGO; Sea Level Anomaly (SLA) from available satellites Jason 2 & 3, Saral-Altika, Cryosat, Sentinel-3A & 3B; Sea Surface Temperature (SST)
Initial conditions (spin-up process)	SeaDataNet v1.1 January Climatology (initial date: 2014/01/01)
Bathymetry	GEBCO 30 sec interpolated on the model grid for the overall basin + high resolution bathymetric dataset for the Marmara box – Bosporus Strait – Bosporus exit provided in the frame of BS-MFC Phase 1
River run-off	The BS-NRT system has 72 rivers forced at a daily frequency. For the Danube we use observations provided by NIHWM including a forecast data for the production of the Black Sea forecasting system. For all the other rivers the runoff is given by a monthly means from SESAME project, to which we applied the Killworth correction.

The physical component of the Black Sea Forecasting System (BS-PHY NRT) is a hydrodynamic model implemented over the whole Black Sea basin, including the Bosporus Strait and a portion of the Marmara Sea for the optimal interface with the Mediterranean Sea through lateral open boundary conditions. The model horizontal grid resolution is 1/40° in zonal and 1/40° in meridional direction (ca. 121 km) and has 121 unevenly spaced vertical levels.

The hydrodynamics are supplied by the Nucleus for European Modeling of the Ocean (NEMO, v4.0). The model solutions are corrected by the OceanVar variational assimilation (based on a 3DVAR scheme), developed by CMCC. The observations assimilated in the BS-PHY NRT includes in-situ T/S profiles, along-track sea level anomalies SLA and gridded sea surface temperature (SST) provided by Copernicus TACs.

c) Observations

Observational data are assimilated into the BS-NRT system in the both the daily and the weekly cycles. Apart from the period that is processed, the assimilation scheme in the two cycles is the same. As the weekly cycle reaches further in the past, it allows the system to ingest (post-processed) observations that are not available in time for the daily cycle.
Data from the following products are assimilated into the BS-NRT system:

Temperature and salinity from ARGO profiling floats
[INSITU_BS_NRT_OBSERVATIONS_013_034]
Sea level anomaly (SLA) observations
[SEALEVEL_EUR_PHY_L3_NRT_OBSERVATIONS_008_059]
Satellite sea surface temperature (SST) observations
[SST_BS_SST_L4_NRT_OBSERVATIONS_010_006]

d) Grid

NEMO uses a staggered Arakawa C grid but all variables are defined at the center of the output grid cell after interpolation. All products are interpolated onto the same geographical mesh on the sphere with regular grid-spacing.

e) Vertical levels

The BS-PHY NRT products are computed on 121 unevenly spaced vertical levels, using z-star time varying vertical coordinates. The final output is interpolated onto a common set of fixed z-levels, as described in Section II.4.

3)PROCESSING INFORMATION

BS-PHY NRT analysis and forecast are produced using two different cycles. One cycle is daily, in which the system produces 3-day analysis, 1-day simulation and 10-days forecast every day. The second cycle is weekly, in which on Tuesday the system produces 14-day analysis, 1-day simulation and 10-days of forecast in order to assimilate a larger number of in-situ and satellite observations for providing the best initial condition for the forecasting cycle. Irrespective of the cycle, the starting fields for the initialization of each forecast are taken as the instantaneous field at 00:00:00 UTC of day J resulting from the chain of daily analyses done for the previous 3 (or 14) days and 1-day simulation. A sketch of the processing chain is provided in Figure 1.

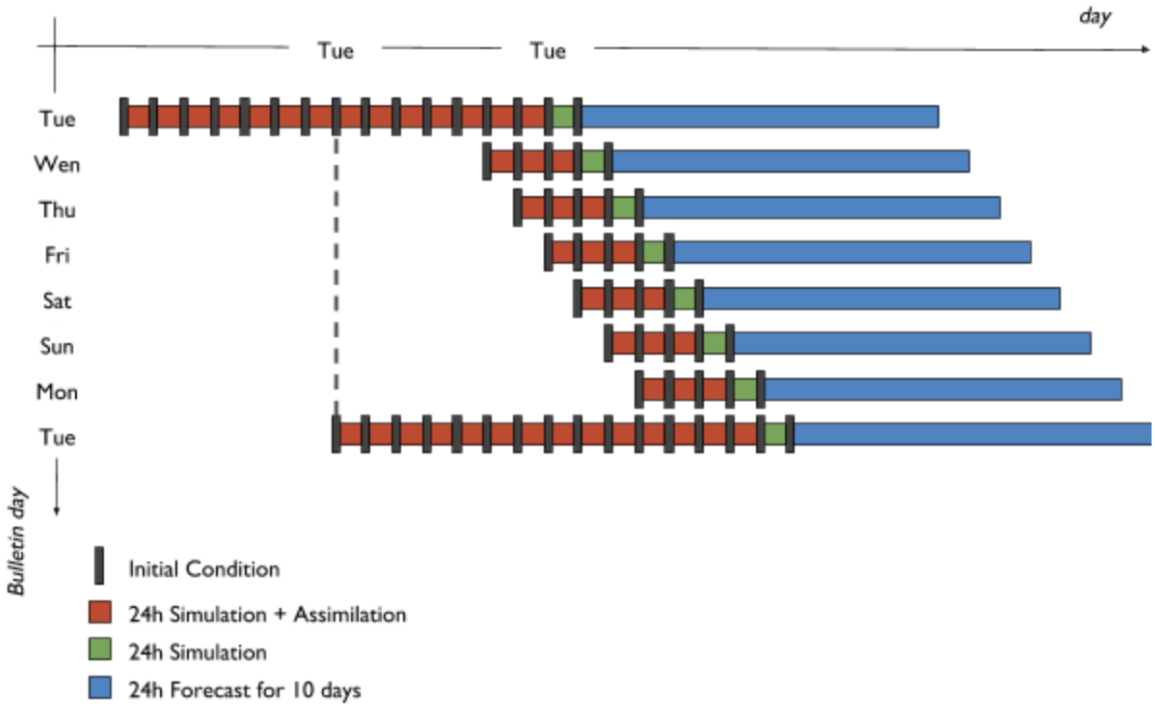


Figure 1 – BS-PHY NRT processing chain

1. Update Time

The product is updated daily at 12:00 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).

2. Temporal extent of analysis and forecast stored on delivery mechanism

A rolling archive of analysis over the last two years up to real-time is available on CMEMS portal.

3. Time averaging

For the monthly datasets, the fields are monthly means over the calendar month (first to last day of the month, centred at the mid-day of the month). For the daily datasets, the fields are daily means over a day (midnight to midnight, centred at midday). For the hourly dataset, the fields are hourly means (centred every half-hour)..

4)DETAILS OF DATASETS

BLKSEA_ANALYSISFORECAST_PHY_007_001
Datasets: • cmems_mod_blk_phy-cur_anfc_2.5km_P1M-m • cmems_mod_blk_phy-ssh_anfc_2.5km_P1M-m • cmems_mod_blk_phy-mld_anfc_2.5km_P1M-m • cmems_mod_blk_phy-sal_anfc_2.5km_P1M-m • cmems_mod_blk_phy-tem_anfc_2.5km_P1M-m contain monthly mean fields: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height, bottom potential temperature, mixed layer thickness • cmems_mod_blk_phy-cur_anfc_2.5km_P1D-m • cmems_mod_blk_phy-ssh_anfc_2.5km_P1D-m • cmems_mod_blk_phy-mld_anfc_2.5km_P1D-m • cmems_mod_blk_phy-sal_anfc_2.5km_P1D-m • cmems_mod_blk_phy-tem_anfc_2.5km_P1D-m contain daily mean fields: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height, bottom potential temperature, mixed layer thickness • cmems_mod_blk_phy-cur_anfc_2.5km_PT1H-m • cmems_mod_blk_phy-ssh_anfc_2.5km_PT1H-m • cmems_mod_blk_phy-mld_anfc_2.5km_PT1H-m • cmems_mod_blk_phy-sal_anfc_2.5km_PT1H-m • cmems_mod_blk_phy-tem_anfc_2.5km_PT1H-m contain hourly mean fields: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height, bottom potential temperature, mixed layer thickness cmems_mod_blk_phy_anfc_2.5km_static contains the static fields for the system: coordinates, mean sea surface level, mask and bathymetry Variables name in the NetCDF file and Unit: Long_name & Standard_name
zos [m] Sea surface height sea_surface_height_above_geoid
uo [m/s] Eastward Eulerian velocity (Navier-Stokes current) eastward_sea_water_velocity
vo [m/s] Northward Eulerian velocity (Navier-Stokes current) northward_sea_water_velocity
wo [m/s] Quasi geostrophic vertical velocity upward_sea_water_velocity
so [psu] Salinity sea_water_salinity
thetao [°C] Sea Temperature sea_water_potential_temperature
bottomT [°C] Sea floor potential temperature sea_water_potential_temperature_at_sea_floor
mlotst [m]

Mixed layer thickness ocean_mixed_layer_thickness_defined_by_sigma_theta
e1t [m] Cell dimension along X axis
e2t [m] Cell dimension along Y axis
e3t [m] Cell dimension along Z axis
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 the datasets and variable names and unit for the BLKSEA_ANALYSISFORECAST_PHY_007_001 product

5)FILES NOMENCLATURE

a) Nomenclature of files when downloaded through the Copernicus Marine Web Portal Subsetter Service

Files nomenclature when downloaded through the Copernicus Marine Service 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 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.
-

The fields tem/sal/ssh/cur/mld are respectively for the variable of Potential Temperature (thetao), Bottom Temperature (bottomT) Salinity (so), Sea Surface Height (zos), Velocity (uo, vo, wo) and Mixed Layer Depth (mlotst).
Example for a file of Salinity:

cmems_mod_blk_phy-sal_anfc_2.5km_P1D-m_1303461772348.nc

b) Nomenclature of files when downloaded through the Copernicus Marine Web Portal FTP Service

When downloading through the Copernicus Marine Service FTP service is based as follows:
{valid date}_{freq flag}-{producer}--{parameter}-{config}-{region}-{bul date}_{product type}-sv{file version}.nc
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 (h = hourly)
- producer is a short version of the Copernicus Marine production unit
- parameter is a four-letter code for the parameter or parameter set from Standard BODC
- config identifies the producing system and configuration
- region is a six-letter code for the region
- 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.
- **file version** is xx.yy where xx is the Copernicus Marine version and yy is an incremental version number

Table 2 shows the nomenclature for the BLKSEA_ANALYSISFORECAST_PHY_007_001 product.
Table 2 - Description of the nomenclature for BLKSEA_ANALYSISFORECAST_PHY_007_001

valid date	YYYYMMDD
freq flag	m (monthly) d (daily) h (hourly)
producer	CMCC
config	BSeas5
region	BS
parameter	TEMP PSAL ASLV RFVL AMXL
field	mask_bathy mdt coordinates
bul date	bYYYYYMMDD

product type	fc (forecast) an (analysis) sm (simulation)
file version	11.00

Example for a forecast file of Salinity:
20210105_d-CMCC--PSAL-BSeas5-BS-b20210101_fc-sv11.00.nc
This is the forecasted mean field of salinity centered at 12:00 UTC of the 5th January 2021, and the time coverage is from 00:00 UTC to 23:59 UTC of the 5th January 2021 (see section IV.8).
20210105_h-CMCC--PSAL-BSeas5-BS-b20210101_fc-sv11.00.nc
This file contains the forecasted 24 hourly mean fields of salinity, each one centered at 30' of every hour from 00:00 UTC to 23:59 UTC of the 5th January 2021 (see section IV.9).

c) Other information: land mask value, compression

Real_Value = (Display_Value X scale_factor) + add_offset
The missing value for this product is: 1e+20
Land and sea-ice masks are equal to "_FillValue" (see variable attribute on NetCDF file).

The PHY forecasts are using the NetCDF4 format without offset nor scale factors.
In the MDS online system data from the latest 2 years (running window) are available via these download interfaces: Subsetter and FTP download

d) File size

Table 3 reports synthetic information for dataset, associated files and total dimensions in MB as given by a complete production cycle. For daily and hourly datasets, we provide the estimation of 1 day of one of the files as reference unit (in Italic) and the estimation of total file dimensions for both cycle described in Figure 1 (daily in **blue**, weekly in **green**). Static datasets include basically bathymetry, meshmask and mean dynamic topography and they are uploaded once.

*Table 3 – File dimensions within each dataset: reference dimension of one file corresponding to 1 day or 1 month in **bold Italic**; total dimension for 1 daily production cycle in **blue**; total dimension for 1 weekly production cycle in **green***

DATASET NAME	FILE NAME	DIMENSION [MB]
cmems_mod_blk_phy-ssh_anfc_2.5km_P1M-m	{date1}_m-CMCC--ASLV-BSeas5-BS-b{date2}_an-sv11.00.nc	*0.204*
cmems_mod_blk_phy-sal_anfc_2.5km_P1M-m	{date1}_m-CMCC--PSAL-BSeas5-BS-b{date2}_an-sv11.00.nc	*13*
cmems_mod_blk_phy-tem_anfc_2.5km_P1M-m	{date1}_m-CMCC--TEMP-BSeas5-BS-b{date2}_an-sv11.00.nc	*15*
cmems_mod_blk_phy-cur_anfc_2.5km_P1M-m	{date1}_m-CMCC--RFVL-BSeas5-BS-b{date2}_an-sv11.00.nc	*80*
cmems_mod_blk_phy-mld_anfc_2.5km_P1M-m	{date1}_m-CMCC--AMXL-BSeas5-BS-b{date2}_an-sv11.00.nc	*0.224*
cmems_mod_blk_phy-ssh_anfc_2.5km_P1D-m	{date1}_d-CMCC--ASLV-BSeas5-BS-b{date2}_fc-sv11.00.nc {date1}_d-CMCC--ASLV-BSeas5-BS-b{date2}_sm-sv11.00.nc {date1}_d-CMCC--ASLV-BSeas5-BS-b{date2}_an-sv11.00.nc	*0.208/2.92/5.2*
cmems_mod_blk_phy-sal_anfc_2.5km_P1D-m	{date1}_d-CMCC--PSAL-BSeas5-BS-b{date2}_fc-sv11.00.nc {date1}_d-CMCC--PSAL-BSeas5-BS-b{date2}_sm-sv11.00.nc {date1}_d-CMCC--PSAL-BSeas5-BS-b{date2}_an-sv11.00.nc	*14/196/350*
cmems_mod_blk_phy-tem_anfc_2.5km_P1D-m	{date1}_d-CMCC--TEMP-BSeas5-BS-b{date2}_fc-sv11.00.nc {date1}_d-CMCC--TEMP-BSeas5-BS-b{date2}_sm-sv11.00.nc {date1}_d-CMCC--TEMP-BSeas5-BS-b{date2}_an-sv11.00.nc	*15/210/375*

cmems_mod_blk_phy-cur_anfc_2.5km_P1D-m	{date1}_d-CMCC--RFVL-BSeas5-BS-b{date2}_fc-sv11.nc {date1}_d-CMCC--RFVL-BSeas5-BS-b{date2}_sm-sv11.00.nc {date1}_d-CMCC--RFVL-BSeas5-BS-b{date2}_an-sv11.00.nc	*81/1134/2025*
cmems_mod_blk_phy-mld_anfc_2.5km_P1D-m	{date1}_d-CMCC--AMXL-BSeas5-BS-b{date2}_fc-sv11.00.nc {date1}_d-CMCC--AMXL-BSeas5-BS-b{date2}_sm-sv11.00.nc {date1}_d-CMCC--AMXL-BSeas5-BS-b{date2}_an-sv11.00.nc	*0.228/3.192/5.7*
cmems_mod_blk_phy-sal_anfc_2.5km_PT1H-m	{date1}_h-CMCC--PSAL-BSeas5-BS-b{date2}_fc-sv11.00.nc {date1}_h-CMCC--PSAL-BSeas5-BS-b{date2}_sm-sv11.00.nc {date1}_h-CMCC--PSAL-BSeas5-BS-b{date2}_an-sv11.00.nc	*327/2943/6540*
cmems_mod_blk_phy-tem_anfc_2.5km_PT1H-m	{date1}_h-CMCC--TEMP-BSeas5-BS-b{date2}_fc-sv11.00.nc {date1}_h-CMCC--TEMP-BSeas5-BS-b{date2}_sm-sv11.00.nc {date1}_h-CMCC--TEMP-BSeas5-BS-b{date2}_an-sv11.00.nc	*359/3231/7180*
cmems_mod_blk_phy-cur_anfc_2.5km_PT1H-m	{date1}_h-CMCC--RFVL-BSeas5-BS-b{date2}_fc-sv11.00.nc {date1}_h-CMCC--RFVL-BSeas5-BS-b{date2}_sm-sv11.00.nc {date1}_h-CMCC--RFVL-BSeas5-BS-b{date2}_an-sv11.00.nc	*1200/10900/24 000*
cmems_mod_blk_phy-ssh_anfc_2.5km_PT1H-m	{date1}_h-CMCC--ASLV-BSeas5-BS-b{date2}_fc-sv11.00.nc {date1}_h-CMCC--ASLV-BSeas5-BS-b{date2}_sm-sv11.00.nc {date1}_h-CMCC--ASLV-BSeas5-BS-b{date2}_an-sv11.00.nc	*4.3/38.7/86*
cmems_mod_blk_phy-mld_anfc_2.5km_PT1H-m	{date1}_h-CMCC--AMXL-BSeas5-BS-b{date2}_fc-sv11.00.nc {date1}_h-CMCC--AMXL-BSeas5-BS-b{date2}_sm-sv11.00.nc {date1}_h-CMCC--AMXL-BSeas5-BS-b{date2}_an-sv11.00.nc	*3.9/35.1/78*
cmems_mod_blk_phy_anfc_2.5km_static	BS-MFC_007_001_${field}.nc	180

6) FILE FORMAT

a) NetCDF

The product is stored using the NetCDF-4 format.

To know more about the NetCDF format, please follow this link:
What is the format of Copernicus Marine products ? NetCDF

The products are compliant with the NetCDF Climate and Forecast Convention CF-1.7 (see http://cf-pcmdi.llnl.gov/). However, standard name for zooplankton and micronekton variables may be still under validation. As variables of the second dataset (lmtl-Fphy) are very specific, they were not proposed to the CF convention.

b) Reader Software

- NetCDF data can be browsed and used through several software packages, including:
- ncBrowse: https://www.epic.noaa.gov/java/ncBrowse/,
- NetCDF Operator (NCO): https://nco.sourceforge.net/
- IDL, Matlab, Panoply, GMT…

Useful information on UNIDATA: https://www.unidata.ucar.edu/software/netcdf/

c) Structure and semantic of NetCDF maps files

Examples of the header of output NetCDF files are inserted in ANNEX, for each dataset.

7) REFERENCES

Quality Information Document (QUID) :
https://catalogue.marine.copernicus.eu/documents/QUID/CMEMS-BS-QUID-007-001.pdf

Jansen, E., Martins, D., Stefanizzi, L., Ciliberti, S. A., Gunduz, M., Ilicak, M., Lecci, R., Cretí, S., Causio, S., Aydoğdu, A., Lima, L., Palermo, F., Peneva, E. L., Coppini, G., Masina, S., Pinardi, N., Palazov, A., & Valchev, N. (2022). Black Sea Physical Analysis and Forecast (CMEMS BS-Currents, EAS5 system) (Version 1) [Data set]. Copernicus Monitoring Environment Marine Service (CMEMS).
https://doi.org/10.25423/CMCC/BLKSEA_ANALYSISFORECAST_PHY_007_001_EAS5

ANNEX

Structure and semantic of NetCDF maps files

An example output NetCDF file header for cmems_mod_blk_phy-cur_anfc_2.5km_P1D-m is inserted below

```
netcdf \20221101_d-CMCC--RFVL-BSeas4-BS-b20221115_an-sv10.00 {
dimensions:
      depth = 121 ;
      lat = 261 ;
      lon = 591 ;
      time = UNLIMITED ; // (1 currently)
variables:
      float lon(lon) ;
            lon:units = "degrees_east" ;
            lon:long_name = "longitude" ;
            lon:standard_name = "longitude" ;
            lon:axis = "X" ;
      float uo(time, depth, lat, lon) ;
            uo:_FillValue = 1.e+20f ;
            uo:valid_min = -2.f ;
            uo:coordinates = "time depth lat lon" ;
            uo:long_name = "zonal current" ;
            uo:standard_name = "eastward_sea_water_velocity" ;
            uo:units = "m/s" ;
            uo:missing_value = 1.e+20f ;
            uo:valid_max = 2.f ;
      float vo(time, depth, lat, lon) ;
            vo:_FillValue = 1.e+20f ;
            vo:valid_min = -2.f ;
            vo:coordinates = "time depth lat lon" ;
            vo:long_name = "meridional current" ;
            vo:standard_name = "northward_sea_water_velocity" ;
            vo:units = "m/s" ;
            vo:missing_value = 1.e+20f ;
            vo:valid_max = 2.f ;
      float depth(depth) ;
            depth:units = "m" ;
            depth:long_name = "depth" ;
            depth:standard_name = "depth" ;
            depth:positive = "down" ;
            depth:axis = "Z" ;
      double time(time) ;
            time:units = "seconds since 1970-01-01 00:00:00" ;
            time:long_name = "time" ;
            time:standard_name = "time" ;
            time:calendar = "standard" ;
            time:axis = "T" ;
      float lat(lat) ;
            lat:units = "degrees_north" ;
            lat:long_name = "latitude" ;
            lat:standard_name = "latitude" ;
            lat:axis = "Y" ;
// global attributes:
```

```
            :_NCProperties =
"version=1|netcdflibversion=4.6.1|hdf5libversion=1.10.4" ;
            :comment = "Please check in CMEMS catalogue the INFO section
for product BLKSEA_ANALYSISFORECAST_PHY_007_001 -
http://marine.copernicus.eu/" ;
            :Conventions = "CF-1.0" ;
            :source = "BS EAS4" ;
            :contact = "servicedesk.cmems@mercator-ocean.eu" ;
            :references = "Please check in CMEMS catalogue the INFO
section for product BLKSEA_ANALYSISFORECAST_PHY_007_001 -
http://marine.copernicus.eu/" ;
            :institution = "Centro Euro-Mediterraneo sui Cambiamenti
Climatici - CMCC, Italy" ;
            :bulletin_date = "20221115" ;
            :bulletin_type = "analysis" ;
            :field_type = "daily_mean_centered_at_time_field" ;
            :title = "Horizontal Velocity (3D) - Daily Mean" ;
}
```