PRODUCT USER MANUAL

For Black Sea Physical Analysis and Forecast Product

BLKSEA_ANALYSISFORECAST_PHY_007_001

Issue: 3.2

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RECORD TABLE

Issue	Date	§	Description of Change	Author	Validated By
1.0	01.07.16	all	First version for CMS 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 CMS 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
3.2	30.11.23	all	Quality improvement; Upstream data change; Additional datasets. New template.	R. Lecci, E. Jansen, S. Cretì, D. Azevedo	

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GLOSSARY AND ABBREVIATIONS

BLK	Black Sea
CF	Climate Forecast (convention for NetCDF)
CLS	Collecte Localisation Satellites
CMAP	CPC Merged Analysis of Precipitation
CMS	Copernicus Marine 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

I INTRODUCTION

I.1 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, 15 minutes instantaneous of Sea Surface Height and Zonal and Meridional Surface Velocity and 24 hours mean fields de-tided sea surface height, horizontal de-tided currents.

BLKSEA_ANALYSISFORECAST_PHY_007_001 product is organized in 29 datasets:

5 datasets contain monthly mean fields for the Black Sea: 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**

7 datasets contain daily mean fields for the Black Sea: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height, detided sea surface height, horizontal detided currents, 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**
- **cmems_mod_blk_phy-ssh_anfc_detided_2.5km_P1D-m**
- **cmems_mod_blk_phy-cur_anfc_detided_2.5km_P1D-m**

4 datasets contain daily mean fields for the Marmara Sea: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height, bottom potential temperature information.

- **cmems_mod_mrm_phy-cur_anfc_500m_P1D-m**
- **cmems_mod_mrm_phy-ssh_anfc_500m_P1D-m**

- **cmems_mod_mrm_phy-sal_anfc_500m_P1D-m**
- **cmems_mod_mrm_phy-tem_anfc_500m_P1D-m**

5 datasets contain hourly mean fields for the Black Sea: 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**

4 datasets contain hourly mean fields for the Marmara Sea: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height, bottom potential temperature information.

- **cmems_mod_mrm_phy-cur_anfc_500m_PT1H-i**
- **cmems_mod_mrm_phy-ssh_anfc_500m_PT1H-i**
- **cmems_mod_mrm_phy-sal_anfc_500m_PT1H-i**
- **cmems_mod_mrm_phy-tem_anfc_500m_PT1H-i**

2 datasets contain 15 minutes instantaneous fields for the Black Sea: 2D currents and sea surface height.

- **cmems_mod_blk_phy-cur_anfc_2.5km_PT15M-i**
- **cmems_mod_blk_phy-ssh_anfc_2.5km_PT15M-i**

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

1 dataset contains the static fields for the Marmara Sea system: coordinates, mean sea surface level, mask and bathymetry: **cmems_mod_mrm_phy_anfc_500m_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).

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

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

I.2 History of changes

Date	Description of changes and impacted product
OCTOBER 2016	V1.1 RELATED TO BLK-PHY V2.2 PRODUCTS, INCLUDING REVISIONS AFTER V2.2 ACCEPTANCE
APRIL 2017	V2.0 IS RELATED TO BLK-PHY V3, CONSIDERING SYSTEM EVOLUTION ISSUES AS DESCRIBED IN THE AAP 2017-2018
APRIL 2018	V2.1 IS MOVED TO NEW CMS TEMPLATE AND THE DESCRIPTION OF STATIC FILES IS ADDED
	V2.2 GENERAL REVISION
DECEMBER 2019	V2.3 RELATED TO NOMINAL START OF BLK-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 CMS RECOMMENDATIONS, NEW PUM TEMPLATE
	V2.4 NEW TIMESERIES TEMPORAL COVERAGE
NOVEMBER 2022	QUALITY IMPROVEMENT; UPSTREAM DATA CHANGE; ADDITIONAL DATASET
NOVEMBER 2023	QUALITY IMPROVEMENT, UPSTREAM DATA CHANGE, UPDATED FILE FORMAT, NEW PRODUCTION SYSTEM, ADDITIONAL DATASETS

II DESCRIPTION OF THE PRODUCT SPECIFICATION

II.1 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, cmems_mod_blk_phy-ssh_anfc_detided_2.5km_P1D-m, cmems_mod_blk_phy-cur_anfc_detided_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 1.1: BLK-PHY Real Time product for Black Sea

Product name	BLKSEA_ANALYSISFORECAST_PHY_007_001	
Geographical coverage	25°E - 30°E; 39.5°N - 41.5°N	
Variables	Temperature Salinity Sea Surface Height Sea floor potential temperature	
Update frequency	**Analysis** Daily	**Forecast** Daily
Available time series	last two years up to real-time	8-days forecast
Target delivery time	Daily at 06:00 UTC	Daily at 06:00 UTC
Temporal resolution	cmems_mod_mrm_phy-cur_anfc_500m_PT1H-I, cmems_mod_mrm_phy-ssh_anfc_500m_PT1H-I, cmems_mod_mrm_phy-sal_anfc_500m_PT1H-I, cmems_mod_mrm_phy-tem_anfc_500m_PT1H-i:hourly instantaneous cmems_mod_mrm_phy-cur_anfc_500m_P1D-m, cmems_mod_mrm_phy-ssh_anfc_500m_P1D-m, cmems_mod_mrm_phy-sal_anfc_500m_P1D-m, cmems_mod_mrm_phy-tem_anfc_500m_P1D-m: daily mean	
Horizontal resolution	~0.5km (1/160° in both zonal and meridional directions)	
Number of vertical levels	93	
Format	NetCDF CF1.0	

Delivery mechanisms	Subsetter and FTP

Table 1.2: BLK-PHY Real Time product for Marmara Sea

The runtime schedule:

BLKSEA_ANALYSIS_FORECAST_PHY_007_001

The BLK-PHY NRT for the Black Sea 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.

The BLK-PHY NRT for the Marmara Sea follows only daily cycles producing 2 days of simulation and 8 days of forecast.

II.2 Details of datasets

BLKSEA_ANALYSISFORECAST_PHY_007_001

Black Sea 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**
- **cmems_mod_blk_phy-ssh_anfc_detided_2.5km_P1D-m**
- **cmems_mod_blk_phy-cur_anfc_detided_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, detided sea surface height, detided surface currents

- **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-cur_anfc_2.5km_PT15M-i**
- **cmems_mod_blk_phy-ssh_anfc_2.5km_PT15M-i**

contain 15 minutes instantaneous fields: 2D sea surface height and surface currents

- **cmems_mod_blk_phy_anfc_2.5km_static**

contains the static fields for the system: coordinates, mean sea surface level, mask and bathymetry

Marmara Sea Datasets:

- **cmems_mod_mrm_phy-cur_anfc_500m_PT1H-i**
- **cmems_mod_mrm_phy-ssh_anfc_500m_PT1H-i**
- **cmems_mod_mrm_phy-sal_anfc_500m_PT1H-i**
- **cmems_mod_mrm_phy-tem_anfc_500m_PT1H-i**

contain hourly instantaneous fields: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height

- **cmems_mod_mrm_phy-cur_anfc_500m_P1D-m**
- **cmems_mod_mrm_phy-ssh_anfc_500m_P1D-m**
- **cmems_mod_mrm_phy-sal_anfc_500m_P1D-m**
- **cmems_mod_mrm_phy-tem_anfc_500m_P1D-m**

contain daily mean fields: 3D potential temperature, salinity, and currents information from top to bottom and 2D sea surface height

- **cmems_mod_mrm_phy_anfc_500m_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

zos_detided [m]

Sea surface height assuming no tide

sea_surface_height_above_geoid_assuming_no_tided

uo [m/s]

Eastward Eulerian velocity (Navier-Stokes current)

eastward_sea_water_velocity

uo_detided [m/s] eastward ocean current velocity assuming no tide eastward_sea_water_velocity_assuming_no_tide
vo [m/s] Northward Eulerian velocity (Navier-Stokes current) northward_sea_water_velocity
vo_detided [m/s] northward ocean current velocity assuming no tide northward_sea_water_velocity_assuming_no_tide
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]

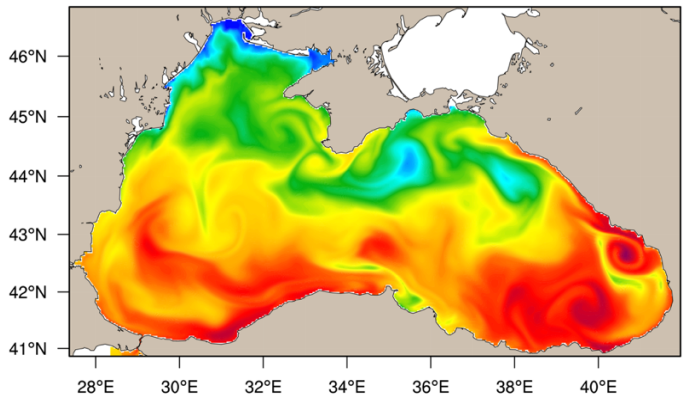
Cell dimension along Z axis
mask [1] Land-sea mask: 1 = sea ; 0 = land sea_binary_mask
deptho [m] Bathymetry sea_floor_depth_below_geoid
deptho_lev [1] Model level number at sea floor model_level_number_at_sea_floor
mdt [m] Mean dynamic topography sea_surface_height_above_geoid

Table 2: list of the datasets and variable names and unit for the BLKSEA_ANALYSISFORECAST_PHY_007_001 product

II.3 Additional Information on parameters

mlotst [m]	ocean_mixed_layer_thickness_defined_by_sigma_theta. It is the depth where the density increases of 0.01 kg.m-3 compared to density at 10 m depth
zos [m]	sea_surface_height_above_geoid. The geoid is a surface of constant geopotential (the mean ocean surface of the Earth if the ocean is 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 was at rest.

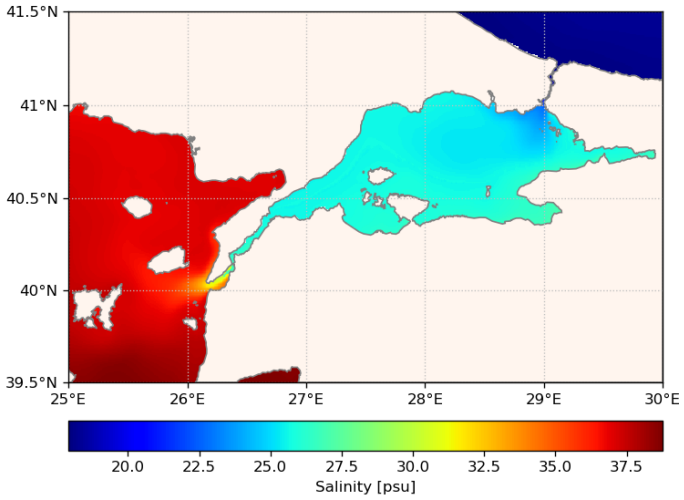
II.4 Production System Description

Domain	BLKSEA (27.25°E - 41.1°E; 40.5°N – 47°N)
Resolution and grid	~2.5km ; regular grid ; 591 x 261
Geographic coverage	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	NEMO v4.2.1
Production unit	CMCC, Italy
Period of validation	01.01.2020–31.12.2022
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 BLK-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; 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 BLK-MFC Phase 1
River run-off	The BLK-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 (BLK-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 BLK-PHY NRT includes in-situ T/S profiles, along-track sea level anomalies SLA and gridded sea surface temperature (SST) provided by Copernicus TACs.

Domain **Resolution and grid** **Geographic coverage**	MRMSEA (25°E - 30°E; 39.5°N - 41.5) ~0.5km ; regular grid ; 320 x 800 This product covers the Marmara basin, the horizontal resolution is approximately 0.5 km, the vertical grid is composed of 93 unevenly spaced vertical levels. 
Model Version **Production unit** **Period of validation**	SHYFEM CMCC, Italy
Vertical grid	The product is delivered at the model native grid, with up to 93 vertical levels: **levels [m]**: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 120, 140, 160, 180, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 1900, 2000, 2100
Atmospheric forcing	ECMWF atmospheric forcing at 1/10 degrees: 3-hourly analysis and forecast
Boundary forcing	Black Sea and Mediterranean MFC products
Initial conditions (spin-up process)	Temperature and salinity fields from Aydogdu et al. 2018
Bathymetry	High resolution bathymetric dataset, same used in Black Sea MFC, provided in the frame of BLK-MFC Phase 1

The Marmara datasets in the Black Sea product are produced using the Unstructured Turkish Straits System (U-TSS) model. The U-TSS model is based on the SHYFEM hydrodynamical model and uses a horizontal grid resolution varying from 50m near the coast up to 500m in the deeper areas. The model uses 93 unevenly spaced vertical levels. U-TSS uses lateral open boundary conditions in the Black Sea and Mediterranean Sea, provided by the respective Copernicus Marine products. The data available in the Marmara Sea datasets have been interpolated onto a regular 1/160° (~500m) horizontal grid, retaining 93 vertical levels.

II.4.1.1 Production Cycle

BLK-PHY NRT processing chain for Black Sea

BLK-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 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.

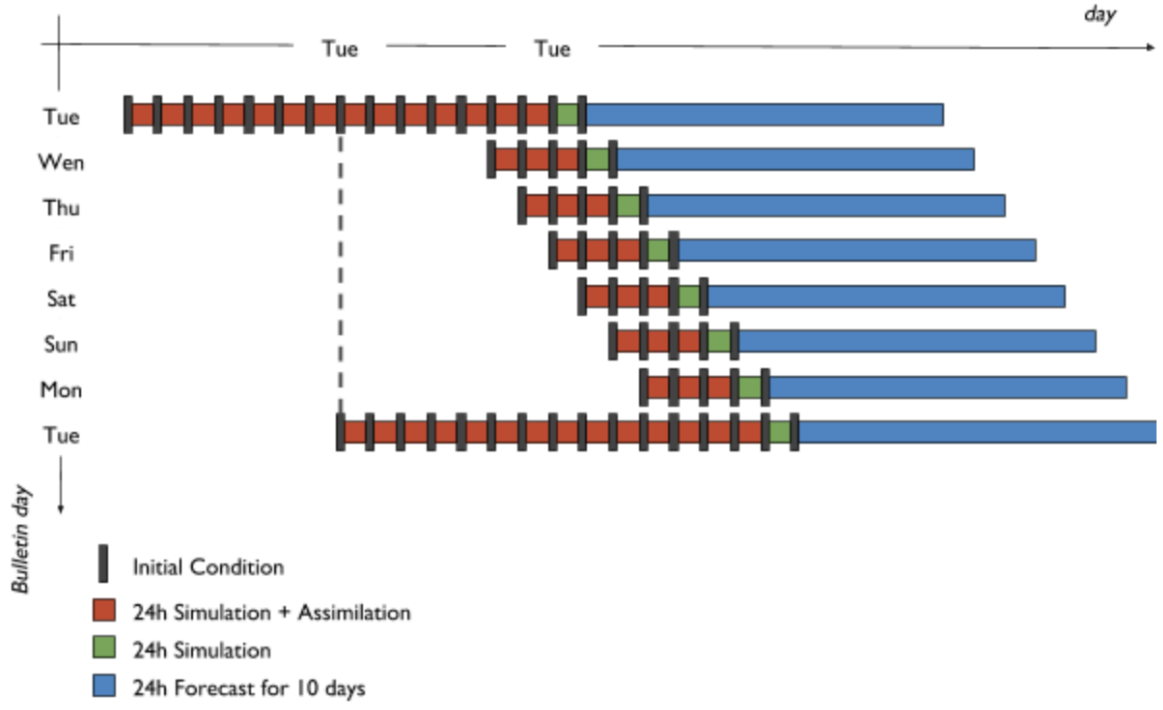


Figure 1 – BLK-PHY NRT processing chain for Black Sea

BLK-PHY NRT processing chain for Marmara Sea

BLK-PHY NRT simulation and forecast are produced using a daily cycle, in which the system produces 1-day simulation and 8-days forecast every day. 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 simulation done for the previous day. A sketch of the processing chain is provided in Figure 2.

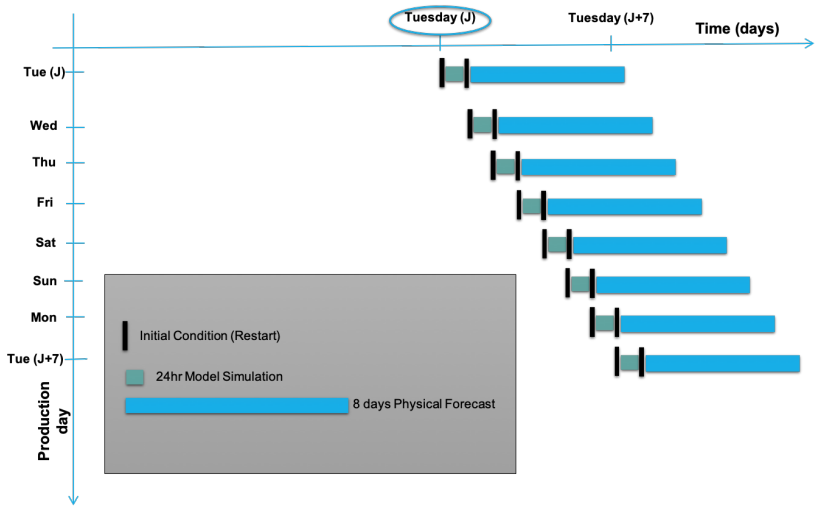


Figure 2 – BLK-PHY NRT processing chain for Marmara Sea

II.4.1.2 Observational Data

BLK-PHY Product System for Black Sea

Observational data are assimilated into the BLK-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 BLK-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]

II.5 Grid

BLK-PHY Product System for Black Sea

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.

BLK-PHY Product System for Marmara Sea

Marmara Sea datasets are interpolated on a regular horizontal grid of 0.5 x 0.5 km resolution.

II.6 Vertical Levels

BLK-PHY for Black Sea

The BLK-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.

BLK-PHY for Marmara Sea

The Marmara Sea datasets are computed on 93 geopotential coordinates vertical levels.

II.7 Processing information

II.7.1 Update Time

The Black Sea datasets are updated daily at 12:00 UTC both for the daily, hourly and 15 minutes datasets. The monthly datasets are updated monthly on the 20th (addition of the monthly mean of the previous month).

The Marmara Sea datasets are updated daily at 06:00 UTC both for the daily and hourly datasets.

II.7.2 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 CMS portal.

II.7.3 Time averaging

For the monthly datasets, the fields are monthly means over the calendar month (first to last day of the month, centered at the mid-day of the month). For the daily datasets, the fields are daily means over a day (midnight to midnight, centered at midday). For the hourly dataset, the fields are hourly means (centered every half-hour). For the 15 minutes datasets the fields are instantaneous.

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

IV.1 Nomenclature of files when downloaded through the CMS 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).

Examples for a file of Salinity for the two areas, on the Black Sea and on the Marmara Sea respectively:

cmems_mod_blk_phy-sal_anfc_2.5km_P1D-m_1303461772348.nc

cmems_mod_mrm_phy-sal_anfc_2.5km_P1D-m_1303461772348.nc

IV.2 Nomenclature of files when downloaded through the CMS Web Portal DirectGetFile or CMS 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

For Black Sea:

valid date	YYYYMMDD
freq flag	m (monthly) d (daily) h (hourly) qi (quarterly instantaneous)
producer	CMCC
config	BSeas6
region	BLK
parameter	TEMP PSAL ASLV RFVL AMXL
field	mask_bathy mdt coordinates
bul date	bYYYYMMDD
product type	fc (forecast) an (analysis) sm (simulation)
file version	12.00

Example for a forecast file of Salinity:

20231102_d-CMCC--PSAL-BSeas6-BLK-b20231101_fc-sv12.00.nc

This is the forecasted mean field of salinity centered at 12:00 UTC of the 2th November 2023, and the time coverage is from 00:00 UTC to 23:59 UTC of the 2th November 2023 (see section IV.8).

20231102_h-CMCC--PSAL-BSeas6-BLK-b20231101_fc-sv12.00.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 2th November 2023 (see section IV.9).

For Marmara Sea:

valid date	YYYYMMDD
freq flag	d (daily) h (hourly)
producer	CMCC
config	MSeas1
region	MRM
parameter	TEMP PSAL ASLV RFVL
field	mask_bathy mdt coordinates
bul date	bYYYYMMDD
product type	fc (forecast) an (analysis) sm (simulation)
file version	1.00

Example for a forecast file of Salinity:

20231102_d-CMCC--PSAL-MSeas1-MRM-b20231101_fc-sv1.00.nc

This is the forecasted mean field of salinity centered at 12:00 UTC of the 2th November 2023, and the time coverage is from 00:00 UTC to 23:59 UTC of the 2th November 2023 (see section IV.8).

20231102_h-CMCC--PSAL-MSeas1-MRM-b20231101_fc-sv1.00.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 2th November 2023 (see section IV.9).

IV.3 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: 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 CMS online system data from the latest 2 years (running window) are available via these download interfaces: Subsetter and FTP download

IV.4 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, mesh mask 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***

BLACK SEA DATASETS		
DATASET NAME	**FILE NAME**	**DIMENSION [MB]**
cmems_mod_blk_phy-ssh_anfc_2.5km_P1M-m	{date1}_m-CMCC--ASLV-BSeas6-BLK-b{date2}_an-sv12.00.nc	0.204
cmems_mod_blk_phy-sal_anfc_2.5km_P1M-m	{date1}_m-CMCC--PSAL-BSeas6-BLK-b{date2}_an-sv12.00.nc	13
cmems_mod_blk_phy-tem_anfc_2.5km_P1M-m	{date1}_m-CMCC--TEMP-BSeas6-BLK-b{date2}_an-sv12.00.nc	15
cmems_mod_blk_phy-cur_anfc_2.5km_P1M-m	{date1}_m-CMCC--RFVL-BSeas6-BLK-b{date2}_an-sv12.00.nc	80
cmems_mod_blk_phy-mld_anfc_2.5km_P1M-m	{date1}_m-CMCC--AMXL-BSeas6-BLK-b{date2}_an-sv12.00.nc	0.224
cmems_mod_blk_phy-ssh_anfc_2.5km_P1D-m	{date1}_d-CMCC--ASLV-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_d-CMCC--ASLV-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_d-CMCC--ASLV-BSeas6-BLK-b{date2}_an-sv12.00.nc	0.208/2.92/5.2
cmems_mod_blk_phy-sal_anfc_2.5km_P1D-m	{date1}_d-CMCC--PSAL-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_d-CMCC--PSAL-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_d-CMCC--PSAL-BSeas6-BLK-b{date2}_an-sv12.00.nc	14/196/350

cmems_mod_blk_phy-tem_anfc_2.5km_P1D-m	{date1}_d-CMCC--TEMP-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_d-CMCC--TEMP-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_d-CMCC--TEMP-BSeas6-BLK-b{date2}_an-sv12.00.nc	15/210/375
cmems_mod_blk_phy-cur_anfc_2.5km_P1D-m	{date1}_d-CMCC--RFVL-BSeas6-BLK-b{date2}_fc-sv11.nc {date1}_d-CMCC--RFVL-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_d-CMCC--RFVL-BSeas6-BLK-b{date2}_an-sv12.00.nc	81/1134/2025
cmems_mod_blk_phy-mld_anfc_2.5km_P1D-m	{date1}_d-CMCC--AMXL-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_d-CMCC--AMXL-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_d-CMCC--AMXL-BSeas6-BLK-b{date2}_an-sv12.00.nc	0.228/3.192/5.7
cmems_mod_blk_phy-ssh_anfc_detided_2.5km_P1D-m	{date1}_d-CMCC--SHNT-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_d-CMCC--SHNT-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_d-CMCC--SHNT-BSeas6-BLK-b{date2}_an-sv12.00.nc	0.208/2.92/5.2
cmems_mod_blk_phy-cur_anfc_detided_2.5km_P1D-m	{date1}_d-CMCC--HCNT-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_d-CMCC--HCNT-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_d-CMCC--HCNT-BSeas6-BLK-b{date2}_an-sv12.00.nc	0.416/5.84/10.4
cmems_mod_blk_phy-sal_anfc_2.5km_PT1H-m	{date1}_h-CMCC--PSAL-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_h-CMCC--PSAL-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_h-CMCC--PSAL-BSeas6-BLK-b{date2}_an-sv12.00.nc	327/2943/6540

cmems_mod_blk_phy-tem_anfc_2.5km_PT1H-m	{date1}_h-CMCC--TEMP-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_h-CMCC--TEMP-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_h-CMCC--TEMP-BSeas6-BLK-b{date2}_an-sv12.00.nc	359/3231/7180
cmems_mod_blk_phy-cur_anfc_2.5km_PT1H-m	{date1}_h-CMCC--RFVL-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_h-CMCC--RFVL-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_h-CMCC--RFVL-BSeas6-BLK-b{date2}_an-sv12.00.nc	1200/10900/24000
cmems_mod_blk_phy-cur_anfc_2.5km_PT15M-i	{date1}_qi-CMCC--RFVL-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_qi-CMCC--RFVL-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_qi-CMCC--RFVL-BSeas6-BLK-b{date2}_an-sv12.00.nc	34.4/309.6/688
cmems_mod_blk_phy-ssh_anfc_2.5km_PT1H-m	{date1}_h-CMCC--ASLV-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_h-CMCC--ASLV-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_h-CMCC--ASLV-BSeas6-BLK-b{date2}_an-sv12.00.nc	4.3/38.7/86
cmems_mod_blk_phy-ssh_anfc_2.5km_PT15M-i	{date1}_qi-CMCC--ASLV-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_qi-CMCC--ASLV-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_qi-CMCC--ASLV-BSeas6-BLK-b{date2}_an-sv12.00.nc	17.2/154.8/344
cmems_mod_blk_phy-mld_anfc_2.5km_PT1H-m	{date1}_h-CMCC--AMXL-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_h-CMCC--AMXL-BSeas6-BLK-b{date2}_sm-sv12.00.nc {date1}_h-CMCC--AMXL-BSeas6-BLK-b{date2}_an-sv12.00.nc	3.9/35.1/78

cmems_mod_blk_phy_anfc_2.5km_static	BLK-MFC_007_001_${field}.nc	180
MARMARA SEA DATASETS		
DATASET NAME	**FILE NAME**	**DIMENSION [MB]**
cmems_mod_blk_phy-ssh_anfc_2.5km_P1D-m	{date1}_d-CMCC--ASLV-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_d-CMCC--ASLV-BSeas6-BLK-b{date2}_sm-sv12.00.nc	0.623/5.6/5.6
cmems_mod_blk_phy-sal_anfc_2.5km_P1D-m	{date1}_d-CMCC--PSAL-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_d-CMCC--PSAL-BSeas6-BLK-b{date2}_sm-sv12.00.nc	31/279/279
cmems_mod_blk_phy-tem_anfc_2.5km_P1D-m	{date1}_d-CMCC--TEMP-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_d-CMCC--TEMP-BSeas6-BLK-b{date2}_sm-sv12.00.nc	31/279/279
cmems_mod_blk_phy-cur_anfc_2.5km_P1D-m	{date1}_d-CMCC--RFVL-BSeas6-BLK-b{date2}_fc-sv11.nc {date1}_d-CMCC--RFVL-BSeas6-BLK-b{date2}_sm-sv12.00.nc	62/558/558
cmems_mod_blk_phy-sal_anfc_2.5km_PT1H-m	{date1}_h-CMCC--PSAL-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_h-CMCC--PSAL-BSeas6-BLK-b{date2}_sm-sv12.00.nc	744/6696/6696
cmems_mod_blk_phy-tem_anfc_2.5km_PT1H-m	{date1}_h-CMCC--TEMP-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_h-CMCC--TEMP-BSeas6-BLK-b{date2}_sm-sv12.00.nc	1488/13392/13392
cmems_mod_blk_phy-cur_anfc_2.5km_PT1H-m	{date1}_h-CMCC--RFVL-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_h-CMCC--RFVL-BSeas6-BLK-b{date2}_sm-sv12.00.nc	744/6696/6696

cmems_mod_blk_phy-ssh_anfc_2.5km_PT1H-m	{date1}_h-CMCC--ASLV-BSeas6-BLK-b{date2}_fc-sv12.00.nc {date1}_h-CMCC--ASLV-BSeas6-BLK-b{date2}_sm-sv12.00.nc	15/134.6/134.6
cmems_mod_mrm_phy_anfc_2.5km_static	MRM-MFC_007_001_mask_bathy.nc	210

V FILE FORMAT

V.1 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 (http://www.unidata.ucar.edu/software/netcdf/) for more information, and to retrieve netCDF software package.

NetCDF data format 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.

The products are compliant with the NetCDF Climate and Forecast Convention CF-1.4 (see http://cf-pcmdi.llnl.gov/).

The BLKSEA_ANALYSISFORECAST_PHY_007_001 product is distributed in netCDF4 format.

V.2 Reader Software

NetCDF data can be browsed and used through a number of software packages, including:

- ✓ ncBrowse: http://www.epic.noaa.gov/java/ncBrowse/,
- ✓ NetCDF Operator (NCO): http://nco.sourceforge.net/
- ✓ IDL, Matlab, Panoply, GMT…

V.3 Structure and semantic of netCDF maps files

The model output files contain some additional fields in addition to the variables mentioned earlier. An example output NetCDF file header for cmems_mod_blk_phy-cur_anfc_2.5km_P1D-m is inserted below, with the additional fields in italic fonts.

netcdf \20230612_d-CMCC--RFVL-BSeas6-BLK-b20230614_an-sv12.00 {

dimensions:

time = UNLIMITED ; // (1 currently)

depth = 121 ;

lat = 261 ;

lon = 591 ;

variables:

VI REFERENCES

Quality Information Document (QUID) : https://catalogue.marine.copernicus.eu/documents/QUID/CMEMS-BLK-QUID-007_001.pdf

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