PRODUCT USER MANUAL

For Black Sea Waves Analysis and Forecast Product BLKSEA_ANALYSISFORECAST_WAV_007_003

Issue: 3.1

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RECORD TABLE

Issue	Date	§	Description of Change	Author	Validated By
1.0	20.11.16	all	First version of PUM doc for Waves prod.	S. Ciliberti, A. Behrens, J. Staneva	C. Derval
1.1	21.01.19	all	General revision in the framework of Q2/2019 and addition of static files description	R. Lecci, A. Behrens, J. Staneva	C. Derval
1.2	03.04.20	all	Change of target delivery time from 00UTC to 12UTC New template and new timeseries temporal coverage	R. Lecci, A. Behrens, J. Staneva	C. Derval
2.0	10.09.20	all	New product name including new dataset	J. Staneva, A. Behrens, M. Ricker, R. Lecci	C. Derval
3.0	10.09.21	all	New product	R. Lecci, J. Staneva, M. Ricker, A. Behrens	C. Derval
3.1	29.11.22	all	Addition of data assimilation	R. Lecci, J. Staneva, M. Ricker, A. Behrens	Copernicus 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

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.

1) INTRODUCTION

a) Summary

This document is the user manual for the Copernicus Marine analysis and forecast product BLKSEA_ANALYSISFORECAST_WAV_007_003. It provides aggregated simulations updated daily with 10-day forecast. A rolling archive of simulations over the last two years up to real-time is available on the Copernicus Marine server.

The wave products are the integrated parameters computed from the total wave spectrum (significant wave height, period, direction, Stokes drift,...etc), as well as the following partitions: the wind wave, the primary swell wave and the secondary swell wave.

The product is organised in 2 datasets:

- cmems_mod_blk_wav_anfc_2.5km_PT1H-i containing hourly instantaneous values for all the variables;
- cmems_mod_blk_wav_anfc_2.5km_static containing the coordinates, mask and bathymetry

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 simulation and forecasting system is described in the Quality Information Document (QUID – see link in **Error! Reference source not found.**).

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b) History of changes

Date	Description of changes and impacted product
Jan 2019	adding the description of static files
Apr 2020	new template and new timeseries temporal coverage, change of target delivery time from 00UTC to 12UTC
Dec 2020	new product name and new dataset
Dec 2021	new product including new dataset
Nov 2022	product quality improvement (addition of data assimilation)

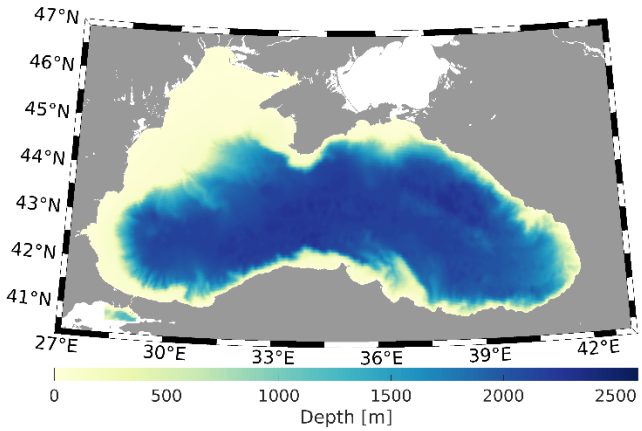
2) DESCRIPTION OF THE PRODUCT SPECIFICATION

a) General Information

Product Line	BLKSEA_ANALYSISFORECAST_WAV_007_003	
Geographical coverage	27.25°E → 42.00°E ; 40.50°N → 47.00°N	
Product Type	Analysis and Forecast	
Variables	Spectral significant wave height (Hm0) Spectral moments (-1,0) wave period (Tm-10) Spectral moments (0,2) wave period (Tm02) Wave period at spectral peak / peak period (Tp) Mean wave direction from (Mdir) Wave principal direction at spectral peak Stokes drift U Stokes drift V Spectral significant wind wave height Spectral moments (0,1) wind wave period Mean wind wave direction from Spectral significant primary swell wave height Spectral moments (0,1) primary swell wave period Mean primary swell wave direction from Spectral significant secondary swell wave height Spectral moments (0,1) secondary swell wave period Mean secondary swell wave direction from Maximum zero crossing wave height (Hmax) Maximum wave period (Tmax)	
Update frequency	Hindcast daily	Forecast daily
Available time series	last two years up to real-time	10-days forecast
Target delivery time	Daily at 12:00 UTC of the day+1 from the nominal start of the forecast	Daily at 12:00 UTC of the day+1 from the nominal start of the forecast
Temporal resolution	1-hourly instantaneous	1-hourly instantaneous
Delivery mechanisms	Subsetter and FTP	
Horizontal resolution	About 2.5 km (1/40° zonal resolution, 1/40° meridional resolution)	
Number of vertical levels	Surface only	
Format	Netcdf CF1.6	
Reference DOI	Staneva et al. (2022) 10.25423/CMCC/BLKSEA_ANALYSISFORECAST_WAV_007_003_EAS5	

b) Production System Description

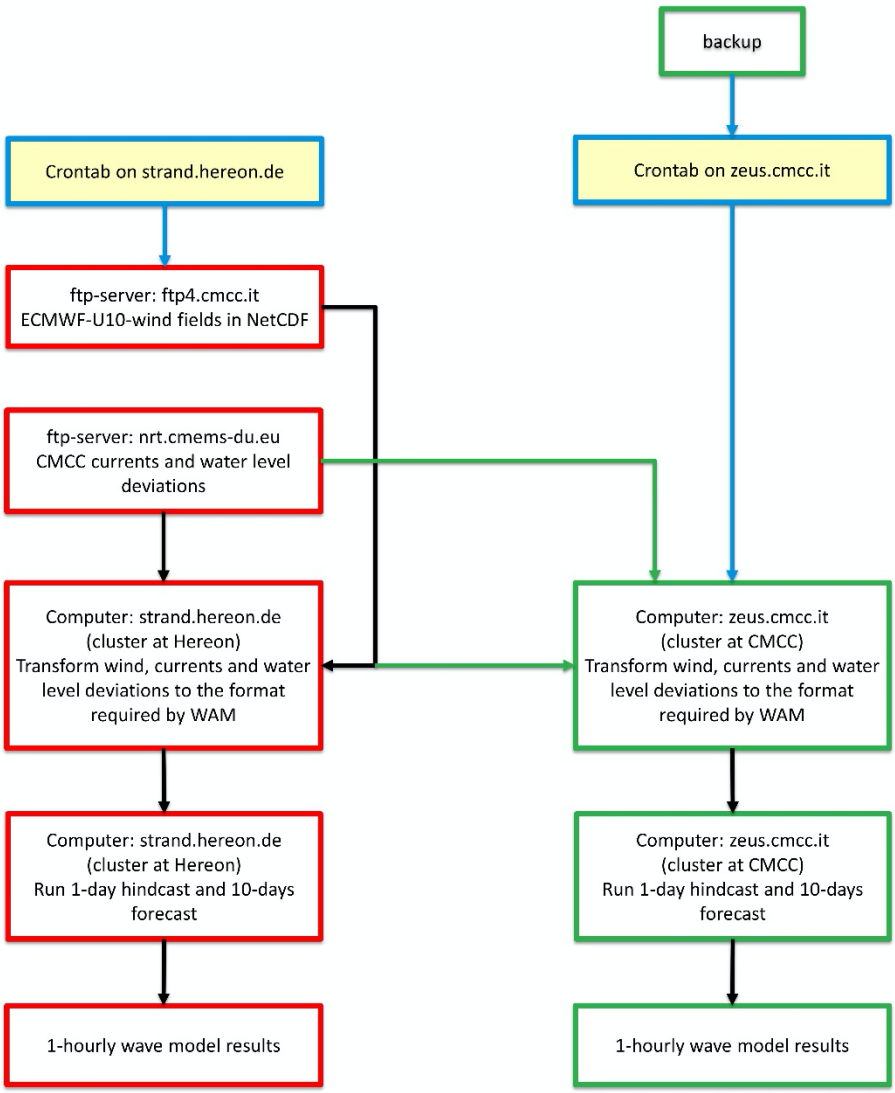
The third-generation spectral wave model WAM Cycle 6 has been adapted to the Black Sea area und runs successfully on the cluster at Hereon. The shallow water version is implemented on a spherical grid with a spatial resolution of about 2.5 km (1/40 x 1/40°) with 24 directional and 30 frequency bins. The number of active wave model grid points is 74518. The model considers depth refraction and wave breaking and provides currently a one-day hindcast, followed by ten-days forecast with one-hourly output once a day. The atmospheric forcing is taken from server ecmwf.cmcc-opa.eu in NetCDF and locally (on strand.hereon.de) transformed into a corresponding format required by the wave model WAM. Surface currents and sea surface height from BLKSEA_ANALYSISFORECAST_PHY_007_001 are used for additional forcing and considered in WAM.

Domain Resolution and grid Geographic coverage	BLKSEA (27.25°E → 42.00°E; 40.50°N → 47.00°N) 1/40°; regular grid ; 591 x 261 This product covers the Black Sea area; the horizontal resolution is approx. 2.5 km 
Algorithm	WAM Cycle 6
Atmospheric forcing	ECMWF atmospheric forcing at 1/10 degree: 6-hourly analysis and 1-hourly for the first 3 days of forecast, 3-hourly for the next 3 days, and 6-hourly for the last 4 days.
Assimilation scheme	Sequential optimal interpolation

Assimilated observations	Significant wave height and wind speed
Initial conditions	Initial 2-d-wave spectrum generated via fetch law from local wind field
Bathymetry	GEBCO 30 sec interpolated on the model grid for the overall basin

c) Processing information

The daily prediction system runs once per day. A schematic of the flow of data in the prediction system is shown below. In the forecast part of the cycle, the system is forced by the ECMWF 10 m forecast winds at 1/10° resolution, at 1-hourly intervals for the first 72 hours of the forecast, 3-hourly for next 72 hours, and at 6-hourly intervals from hour 168 to 240 of forecast and the 1-hourly currents and water level deviations from the hydrodynamic CMCC model.



BLKSEA_ANALYSISFORECAST_WAV_007_003 products temporal coverage: for the hourly instantaneous fields, every day J a time series is available starting over the last two years to the day J+10. Every day, the time series is updated 1-day of simulation and 10-days of forecast.

1. *Update Time*

The product is updated daily at 12:00 UTC of the day+1 from the nominal start of the forecast

2. *Time coverage*

T A rolling archive of simulation over the last two years up to real-time is available.

3)Details of datasets

BLKSEA_ANALYSISFORECAST_WAV_007_003
cmems_mod_blk_wav_anfc_2.5km_PT1H-i
contains all the variables.
VHM0 [m] Spectral significant wave height (Hm0) sea_surface_wave_significant_height
VTM10 [s] Spectral moments (-1,0) wave period (Tm-10) sea_surface_wave_mean_period_from_variance_spectral_density_inverse_frequency_moment
VTM02 [s] Spectral moments (0,2) wave period (Tm02) sea_surface_wave_mean_period_from_variance_spectral_density_second_frequency_moment
VTPK [s] Wave period at spectral peak / peak period (Tp) sea_surface_wave_period_at_variance_spectral_density_maximum
VMDR [degree] Mean wave direction from (Mdir) sea_surface_wave_from_direction
VPED [degree] Wave principal direction at spectral peak sea_surface_wave_from_direction_at_variance_spectral_density_maximum
VSDX [m s-1] Stokes drift U sea_surface_wave_stokes_drift_x_velocity
VSDY [m s-1] Stokes drift V sea_surface_wave_stokes_drift_y_velocity
VHM0_WW [m] Spectral significant wind wave height sea_surface_wind_wave_significant_height
VTM01_WW [s] Spectral moments (0,1) wind wave period sea_surface_wind_wave_mean_period
VMDR_WW [degree] Mean wind wave direction from sea_surface_wind_wave_from_direction
VHM0_SW1 [m] Spectral significant primary swell wave height sea_surface_primary_swell_wave_significant_height
VTM01_SW1 [s] Spectral moments (0,1) primary swell wave period sea_surface_primary_swell_wave_mean_period
VMDR_SW1 [degree] Mean primary swell wave direction from sea_surface_primary_swell_wave_from_direction

VHM0_SW2 [m] Spectral significant secondary swell wave height sea_surface_secondary_swell_wave_significant_height
VTM01_SW2 [s] Spectral moments (0,1) secondary swell wave period sea_surface_secondary_swell_wave_mean_period
VMDR_SW2 [degree] Mean secondary swell wave direction from sea_surface_secondary_swell_wave_from_direction
VZMX [m] Maximum zero crossing wave height (Hmax) sea_surface_wave_maximum_height
VTMX [s] Maximum wave period (Tmax) sea_surface_wave_maximum_period
contains the static fields for the system: coordinates, mask, and bathymetry.
e1t [m] Cell dimension along X axis
e2t [m] Cell dimension along Y axis
mask [1] Land-sea mask: 1 = sea ; 0 = land sea_binary_mask
deptho [m] Bathymetry sea_floor_depth_below_geoid

4)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.

Example: **cmems_mod_blk_wav_anfc_2.5km_PT1H-i**_1303461772348.nc

b) Nomenclature of files when downloaded through the Copernicus Marine 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 1 shows the nomenclature for the BLKSEA_ANALYSISFORECAST_WAV_007_003 product.

Table 1 Description of the nomenclature for BLKSEA_ANALYSISFORECAST_WAV_007_003

valid date	YYYYMMDD
freq flag	h (hourly)
producer	Hereon

config	BSeas4
region	BS
parameter	WAVES
bul date	bYYYYYMMDD
product type	sm (hindcast) fc (forecast)
file version	08.00

Example for a forecast file:

20220428_h-Hereon--WAVES- BSeas4-BS-b20220428_fc-sv08.00.nc
This file contains the hourly instantaneous fields of the wave parameters of every hour from noon (12:00 UTC) of the 27th April 2022 to 11:00 UTC of the 28th April 2022.

c) Other information: land mask value, compression

The NetCDF4 format is used with short integer coding for best compression, using an offset and scale factor as shown below:

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).

d) File size

DATASET NAME	NAME OF FILE	DIMENSION [MB]
cmems_mod_blk_wav_anfc_2.5km_PT1H-i	{date1}_h-Hereon--WAVES –Bseas5-BS-b{date2}_sm-sv09.00.nc {date1}_h-Hereon--WAVES-BSeas5-BS-b{date2}_fc-sv09.00.nc	281
cmems_mod_blk_wav_anfc_2.5km_static	BS-MFC_007_003_${field}.nc	2

5) 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.

6) REFERENCES

QUID – Quality Information Document : https://catalogue.marine.copernicus.eu/documents/QUID/CMEMS-BS-QUID-007-003.pdf

Staneva, J., Ricker, M., & Behrens, A. (2022). Black Sea Waves Analysis and Forecast (CMEMS BS-Waves, EAS5 system) (Version 1) [Data set]. Copernicus Monitoring Environment Marine Service (CMEMS). https://doi.org/10.25423/CMCC/BLKSEA_ANALYSISFORECAST_WAV_007_003_EAS5

ANNEX

Structure and semantic of NetCDF maps files

DIMENSIONS	VARIABLES		
lon=591 lat=261 time=24	NAME	DIMENSIONS	TYPE
	lon	lon	float
	lat	lat	float
	time	time	int
	VHM0	time,lat,lon	float
	VTM10	time,lat,lon	float
	VTM02	time,lat,lon	float
	VTPK	time,lat,lon	float
	VMDR	time,lat,lon	float
	VPED	time,lat,lon	float
	VSDX	time,lat,lon	float
	VSDY	time,lat,lon	float
	VHM0_WW	time,lat,lon	float
	VTM01_WW	time,lat,lon	float
	VMDR_WW	time,lat,lon	float
	VHM0_SW1	time,lat,lon	float
	VTM01_SW1	time,lat,lon	float
	VMDR_SW1	time,lat,lon	float
	VHM0_SW2	time,lat,lon	float
	VTM01_SW2	time,lat,lon	float
	VMDR_SW2	time,lat,lon	float
	VZMX	time,lat,lon	float
	VTMX	time,lat,lon	float

In the following, an example output NetCDF file header for cmems_mod_blk_wav_anfc_2.5km_PT1H-i is inserted:

```
netcdf \20220428_h-Hereon--WAVES-BSeas5-BS-b20220428_sm-sv09.00 {
dimensions:
	time = UNLIMITED ; // (24 currently)
	lon = 591 ;
	lat = 261 ;
variables:
	float lon(lon) ;
		lon:standard_name = "longitude" ;
		lon:long_name = "longitude" ;
		lon:units = "degrees_east" ;
		lon:axis = "X" ;
		lon:valid_max = 42.f ;
		lon:valid_min = 27.25f ;
	float lat(lat) ;
		lat:standard_name = "latitude" ;
		lat:long_name = "latitude" ;
		lat:units = "degrees_north" ;
```

```
            lat:axis = "Y" ;
            lat:valid_max = 47.f ;
            lat:valid_min = 40.5f ;
        double time(time) ;
            time:standard_name = "time" ;
            time:long_name = "time" ;
            time:units = "seconds since 1950-01-01 00:00:00" ;
            time:calendar = "standard" ;
            time:axis = "T" ;
        float VHM0(time, lat, lon) ;
            VHM0:standard_name = "sea_surface_wave_significant_height" ;
            VHM0:long_name = "Spectral significant wave height (Hm0)" ;
            VHM0:units = "m" ;
            VHM0:_FillValue = 1.e+20f ;
            VHM0:valid_min = 0.f ;
            VHM0:valid_max = 20.f ;
            VHM0:missing_value = 1.e+20f ;
            VHM0:Coordinates = "time lat lon" ;
        float VTPK(time, lat, lon) ;
            VTPK:standard_name =
"sea_surface_wave_period_at_variance_spectral_density_maximum" ;
            VTPK:long_name = "Wave period at spectral peak / peak period (Tp)" ;
            VTPK:units = "s" ;
            VTPK:_FillValue = 1.e+20f ;
            VTPK:valid_min = 1.f ;
            VTPK:valid_max = 30.f ;
            VTPK:missing_value = 1.e+20f ;
            VTPK:Coordinates = "time lat lon" ;
        float VTM10(time, lat, lon) ;
            VTM10:standard_name =
"sea_surface_wave_mean_period_from_variance_spectral_density_inverse_frequency_mome
nt" ;
            VTM10:long_name = "Spectral moments (-1,0) wave period (Tm-10)" ;
            VTM10:units = "s" ;
            VTM10:_FillValue = 1.e+20f ;
            VTM10:valid_min = 1.f ;
            VTM10:valid_max = 20.f ;
            VTM10:missing_value = 1.e+20f ;
            VTM10:Coordinates = "time lat lon" ;
        float VTM02(time, lat, lon) ;
            VTM02:standard_name =
"sea_surface_wave_mean_period_from_variance_spectral_density_second_frequency_mome
nt" ;
            VTM02:long_name = "Spectral moments (0,2) wave period (Tm02)" ;
            VTM02:units = "s" ;
            VTM02:_FillValue = 1.e+20f ;
            VTM02:valid_min = 1.f ;
            VTM02:valid_max = 20.f ;
            VTM02:missing_value = 1.e+20f ;
            VTM02:Coordinates = "time lat lon" ;
        float VMDR(time, lat, lon) ;
            VMDR:standard_name = "sea_surface_wave_from_direction" ;
            VMDR:long_name = "Mean wave direction from (Mdir)" ;
```

```
            VMDR:units = "degree" ;
            VMDR:_FillValue = 1.e+20f ;
            VMDR:valid_min = 0.f ;
            VMDR:valid_max = 360.f ;
            VMDR:missing_value = 1.e+20f ;
            VMDR:Coordinates = "time lat lon" ;
        float VHM0_WW(time, lat, lon) ;
            VHM0_WW:standard_name = "sea_surface_wind_wave_significant_height" ;
            VHM0_WW:long_name = "Spectral significant wind wave height" ;
            VHM0_WW:units = "m" ;
            VHM0_WW:_FillValue = 1.e+20f ;
            VHM0_WW:valid_min = 0.f ;
            VHM0_WW:valid_max = 20.f ;
            VHM0_WW:missing_value = 1.e+20f ;
            VHM0_WW:Coordinates = "time lat lon" ;
        float VTM01_WW(time, lat, lon) ;
            VTM01_WW:standard_name = "sea_surface_wind_wave_mean_period" ;
            VTM01_WW:long_name = "Spectral moments (0,1) wind wave period" ;
            VTM01_WW:units = "s" ;
            VTM01_WW:_FillValue = 1.e+20f ;
            VTM01_WW:valid_min = 1.f ;
            VTM01_WW:valid_max = 20.f ;
            VTM01_WW:missing_value = 1.e+20f ;
            VTM01_WW:Coordinates = "time lat lon" ;
        float VMDR_WW(time, lat, lon) ;
            VMDR_WW:standard_name = "sea_surface_wind_wave_from_direction" ;
            VMDR_WW:long_name = "Mean wind wave direction from" ;
            VMDR_WW:units = "degree" ;
            VMDR_WW:_FillValue = 1.e+20f ;
            VMDR_WW:valid_min = 0.f ;
            VMDR_WW:valid_max = 360.f ;
            VMDR_WW:missing_value = 1.e+20f ;
            VMDR_WW:Coordinates = "time lat lon" ;
    float VZMX(time, lat, lon) ;
            VZMX:standard_name = "sea_surface_wave_maximum_height" ;
            VZMX:long_name = "Maximum zero crossing wave height (Hmax)" ;
            VZMX:units = "m" ;
            VZMX:_FillValue = 1.e+20f ;
            VZMX:valid_min = 0.f ;
            VZMX:valid_max = 40.f ;
            VZMX:missing_value = 1.e+20f ;
            VZMX:Coordinates = "time lat lon" ;
        float VTMX(time, lat, lon) ;
            VTMX:standard_name = "sea_surface_wave_maximum_period" ;
            VTMX:long_name = "Maximum wave period (Tmax)" ;
            VTMX:units = "s" ;
            VTMX:_FillValue = 1.e+20f ;
            VTMX:valid_min = 1.f ;
            VTMX:valid_max = 30.f ;
            VTMX:missing_value = 1.e+20f ;
            VTMX:Coordinates = "time lat lon" ;
        float VPED(time, lat, lon) ;
```

```
            VPED:standard_name =
"sea_surface_wave_from_direction_at_variance_spectral_density_maximum" ;
            VPED:long_name = "Wave principal direction at spectral peak" ;
            VPED:units = "degree" ;
            VPED:_FillValue = 1.e+20f ;
            VPED:valid_min = 0.f ;
            VPED:valid_max = 360.f ;
            VPED:missing_value = 1.e+20f ;
            VPED:Coordinates = "time lat lon" ;
      float VHM0_SW1(time, lat, lon) ;
            VHM0_SW1:standard_name =
"sea_surface_primary_swell_wave_significant_height" ;
            VHM0_SW1:long_name = "Spectral significant primary swell wave height" ;
            VHM0_SW1:units = "m" ;
            VHM0_SW1:_FillValue = 1.e+20f ;
            VHM0_SW1:valid_min = 0.f ;
            VHM0_SW1:valid_max = 20.f ;
            VHM0_SW1:missing_value = 1.e+20f ;
            VHM0_SW1:Coordinates = "time lat lon" ;
      float VTM01_SW1(time, lat, lon) ;
            VTM01_SW1:standard_name = "sea_surface_primary_swell_wave_mean_period" ;
            VTM01_SW1:long_name = "Spectral moments (0,1) primary swell wave period" ;
            VTM01_SW1:units = "s" ;
            VTM01_SW1:_FillValue = 1.e+20f ;
            VTM01_SW1:valid_min = 0.f ;
            VTM01_SW1:valid_max = 30.f ;
            VTM01_SW1:missing_value = 1.e+20f ;
            VTM01_SW1:Coordinates = "time lat lon" ;
      float VMDR_SW1(time, lat, lon) ;
            VMDR_SW1:standard_name = "sea_surface_primary_swell_wave_from_direction" ;
            VMDR_SW1:long_name = "Mean primary swell wave direction from" ;
            VMDR_SW1:units = "degree" ;
            VMDR_SW1:_FillValue = 1.e+20f ;
            VMDR_SW1:valid_min = 0.f ;
            VMDR_SW1:valid_max = 360.f ;
            VMDR_SW1:missing_value = 1.e+20f ;
            VMDR_SW1:Coordinates = "time lat lon" ;
      float VHM0_SW2(time, lat, lon) ;
            VHM0_SW2:standard_name =
"sea_surface_secondary_swell_wave_significant_height" ;
            VHM0_SW2:long_name = "Spectral significant secondary swell wave height" ;
            VHM0_SW2:units = "m" ;
            VHM0_SW2:_FillValue = 1.e+20f ;
            VHM0_SW2:valid_min = 0.f ;
            VHM0_SW2:valid_max = 20.f ;
            VHM0_SW2:missing_value = 1.e+20f ;
            VHM0_SW2:Coordinates = "time lat lon" ;
      float VTM01_SW2(time, lat, lon) ;
            VTM01_SW2:standard_name =
"sea_surface_secondary_swell_wave_mean_period" ;
            VTM01_SW2:long_name = "Spectral moments (0,1) secondary swell wave period" ;
            VTM01_SW2:units = "s" ;
            VTM01_SW2:_FillValue = 1.e+20f ;
```

```
            VTM01_SW2:valid_min = 0.f ;
            VTM01_SW2:valid_max = 30.f ;
            VTM01_SW2:missing_value = 1.e+20f ;
            VTM01_SW2:Coordinates = "time lat lon" ;
      float VMDR_SW2(time, lat, lon) ;
            VMDR_SW2:standard_name =
"sea_surface_secondary_swell_wave_from_direction" ;
            VMDR_SW2:long_name = "Mean secondary swell wave direction from" ;
            VMDR_SW2:units = "degree" ;
            VMDR_SW2:_FillValue = 1.e+20f ;
            VMDR_SW2:valid_min = 0.f ;
            VMDR_SW2:valid_max = 360.f ;
            VMDR_SW2:missing_value = 1.e+20f ;
            VMDR_SW2:Coordinates = "time lat lon" ;
      float VSDX(time, lat, lon) ;
            VSDX:standard_name = "sea_surface_wave_stokes_drift_x_velocity" ;
            VSDX:long_name = "Stokes drift U" ;
            VSDX:units = "m/s" ;
            VSDX:_FillValue = 1.e+20f ;
            VSDX:valid_min = -1.f ;
            VSDX:valid_max = 1.f ;
            VSDX:missing_value = 1.e+20f ;
            VSDX:Coordinates = "time lat lon" ;
      float VSDY(time, lat, lon) ;
            VSDY:standard_name = "sea_surface_wave_stokes_drift_y_velocity" ;
            VSDY:long_name = "Stokes drift V" ;
            VSDY:units = "m/s" ;
            VSDY:_FillValue = 1.e+20f ;
            VSDY:valid_min = -1.f ;
            VSDY:valid_max = 1.f ;
            VSDY:missing_value = 1.e+20f ;
            VSDY:Coordinates = "time lat lon" ;

// global attributes:
            :bulletim_type = "simulation" ;
            :institution = "Helmholtz-Zentrum Hereon, Germany" ;
            :source = "WAM Cycle 6" ;
            :contact = "servicedesk.cmems@mercator-ocean.eu" ;
            :references = "Please check in CMEMS catalogue the INFO section for product
BLKSEA_ANALYSISFORECAST_WAV_007_003 - http://marine.copernicus.eu" ;
            :comment = "Please check in CMEMS catalogue the INFO section for product
BLKSEA_ANALYSISFORECAST_WAV_007_003 - http://marine.copernicus.eu" ;
            :conventions = "CF-1.0" ;
            :bulletin_date = "20220428" ;
            :field_type = "hourly_instantaneous_at_time_field" ;
            :title = "Wave Products (2D) - Instantaneous Field" ;
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