PRODUCT USER MANUAL

For Mediterranean Sea Waves Reanalysis Product
MEDSEA_MULTIYEAR_WAV_006_012

Issue: 2.3

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RECORD TABLE

Issue	Date	§	Description of Change	Author	Validated By
1.0	25.09.17	all	First version of document	G. Korres, M. Ravdas, A. Zacharioudaki, A. Chalkiopoulos, D. Denaxa, A. Konstantinidou, R. Lecci	
1.1	16.02.18	all	Changes for CMEMS EISv4.1. Inclusion to the time series of additional year (2016)	R. Lecci, G. Korres, M. Ravdas, A. Zacharioudaki, A. Chalkiopoulos, D. Denaxa,	
1.2	21.01.19	all	Inclusion to the time series of additional year (2017)	R. Lecci, D. Denaxa	
1.3	10.09.19	all	New template and general revision	R. Lecci	C. Derval
2.0	15.01.21	all	New product	R. Lecci, D. Denaxa	C. Derval
2.1	10.09.21	all	Addition of interim dataset	R. Lecci, D. Denaxa	C. Derval
2.2	29.11.22	all	Additional dataset	R. Lecci, D. Denaxa	Copernicus Marine Product Management
2.3	30.11.23	all	Additional dataset	R. Lecci, D. Denaxa	Copernicus Marine Product Management

	Copernicus Marine Product User Manual for **MEDSEA_MULTIYEAR_WAV_006_012**	Issue: 2.3 2023/11

Table of Contents

GLOSSARY AND ABBREVIATIONS

Analysis (Numerical)	A detailed study of the state of the ocean done in Near real Time based on observations and numerical model. The operational prediction centre produces 3D time-space analysis systems. A long series of analyses is of great utility for studying the behaviour of the ocean system.
CF	Climate Forecast (convention for NetCDF)
CMEMS	Copernicus Marine Environment Monitoring Service
ECMWF	European Centre for Medium-Range Weather Forecasts
FAQ	Frequently Asked Question
Forecast (Numerical)	A computer forecast or prediction based on equations governing the motions and the forces affecting motion of fluids. The equations are based, or initialized, on specified ocean conditions at a certain place and time (NOAA Glossary).
FTP	File Transfer Protocol
Med/MED	Mediterranean
MFC	Monitoring and Forecasting Centre
MFS	Mediterranean Forecasting System
NetCDF	Network Common Data Form
NOAA	National Oceanic and Atmospheric Administration
NWP	Numerical Weather Prediction
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)
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
SWH	Significant Wave Height
TAC	Thematic Assembly Centre
WAM	Third generation Wave Prediction Model

I   INTRODUCTION

I.1 Summary

This document is the user manual for the Copernicus Marine multi-year reanalysis product **MEDSEA_MULTIYEAR_WAV_006_012**. An archive of reanalysis since 01/01/1993 is available on the Marine Data Store.

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 4 datasets:

- **med-hcmr-wav-rean-h** containing 1-hourly instantaneous values for all the variables

- **cmems_mod_med_wav_myint_4.2km_PT1H-i** containing interim 1-hourly instantaneous values for all the variables

- **cmems_mod_med_wav_my_4.2km-climatology_P1M-m** containing the monthly climatology fields for significant wave height and zero-crossing wave period

- **cmems_mod_med_wav_my_4.2km_static** containing the coordinates, mask and bathymetry

The product is published on the Copernicus Marine dissemination server after automatic and human quality controls. Files downloaded are in NetCDF format.

The reanalysis system is described in the Quality Information Document (see in Annex).

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
Sep 2019	New template and general revision
Jan 2021	New product, with new nomenclature, including data assimilation, upgraded modelling system and new forcing. New dataset. New template.
Sep 2021	Addition of interim dataset
Nov 2022	Additional dataset
Nov 2023	Additional dataset

II DESCRIPTION OF THE PRODUCT SPECIFICATION

II.1 General Information

Product name	MEDSEA_MULTIYEAR_WAV_006_012
Geographical coverage	18.125°W → 36.2917°E; 30.1875°N → 45.9792°N
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

	Reanalysis	Interim
Update frequency	Twice a year	Every month
Available time series	Since 1993 up to the previous year	Since the last day of Reanalysis up to the previous month
Target delivery time	NA	20th of each month at 16UTC
Temporal resolution	med-hcmr-wav-rean-h: 1-hourly instantaneous cmems_mod_med_wav_myint_4.2km_PT1H-i: interim 1-hourly instantaneous cmems_mod_med_wav_my_4.2km-climatology_P1M-m: monthly climatology (reference period 1993-2016)	
Horizontal resolution	1/24 °	
Number of vertical levels	Surface only	
Format	NetCDF CF1.6	
Delivery mechanisms	Subsetter and FTP	

Table 1: MED-MFC MultiYear products

II.2 Details of datasets

MEDSEA_MULTIYEAR_WAV_006_012
Datasets:
•   med-hcmr-wav-rean-h
contains 1-hourly instantaneous values for all the variables
•   cmems_mod_med_wav_myint_4.2km_PT1H-i
contains the interim monthly mean fields for all the variables
•   cmems_mod_med_wav_my_4.2km-climatology_P1M-m
contains the monthly climatology fields and standard deviations for all the variables
•   cmems_mod_med_wav_my_4.2km_static
contains the static fields for the system: coordinates, mask and bathymetry
Variables name in the NetCDF file and Unit: Long_name & Standard_name
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 [ms-1]

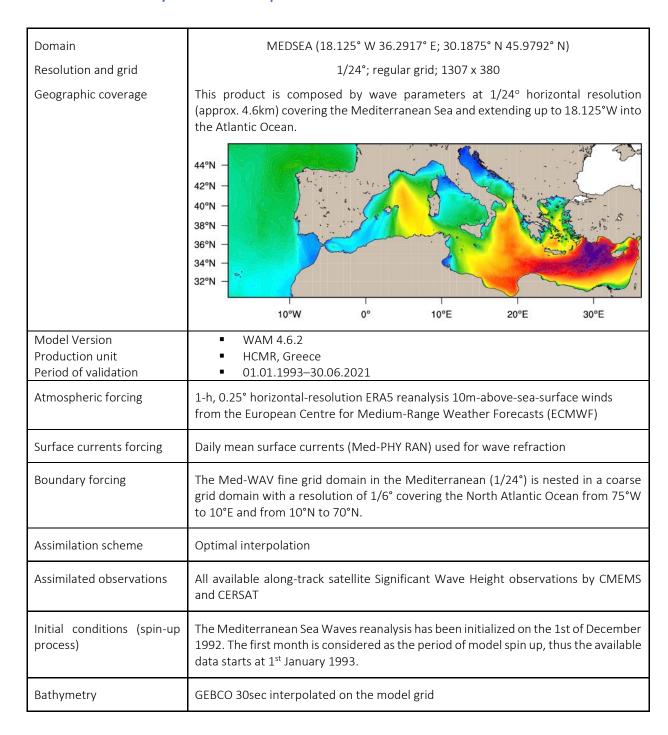| |
|---|
| Stokes drift U

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 |
| **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

Table 2: list of the datasets and variable names and unit for the MEDSEA_MULTIYEAR_WAV_006_012 product

II.3 Production System Description

Domain	MEDSEA (18.125° W 36.2917° E; 30.1875° N 45.9792° N)
Resolution and grid	1/24°; regular grid; 1307 x 380
Geographic coverage	This product is composed by wave parameters at 1/24° horizontal resolution (approx. 4.6km) covering the Mediterranean Sea and extending up to 18.125°W into the Atlantic Ocean.
Model Version Production unit Period of validation	▪ WAM 4.6.2 ▪ HCMR, Greece ▪ 01.01.1993–30.06.2021
Atmospheric forcing	1-h, 0.25° horizontal-resolution ERA5 reanalysis 10m-above-sea-surface winds from the European Centre for Medium-Range Weather Forecasts (ECMWF)
Surface currents forcing	Daily mean surface currents (Med-PHY RAN) used for wave refraction
Boundary forcing	The Med-WAV fine grid domain in the Mediterranean (1/24°) is nested in a coarse grid domain with a resolution of 1/6° covering the North Atlantic Ocean from 75°W to 10°E and from 10°N to 70°N.
Assimilation scheme	Optimal interpolation
Assimilated observations	All available along-track satellite Significant Wave Height observations by CMEMS and CERSAT
Initial conditions (spin-up process)	The Mediterranean Sea Waves reanalysis has been initialized on the 1st of December 1992. The first month is considered as the period of model spin up, thus the available data starts at 1st January 1993.
Bathymetry	GEBCO 30sec interpolated on the model grid

MEDSEA_MULTIYEAR_WAV_006_012 is the reanalysis product of the Mediterranean Sea Waves forecasting system based on WAM 4.6.2 with an optimal interpolation assimilation scheme, and is composed by hourly wave parameters at 1/24° horizontal resolution covering the Mediterranean Sea and extending up to 18.125W into the Atlantic Ocean.

II.3.1.1   Observations

The assimilation system uses satellite along-track SWH observations available from CERSAT-IFREMER and Copernicus Marine WAVE Thematic Assembly Centre. The assimilation step adopted equals to 3 hours.

Assimilated Data : all available CERSAT–IFREMER inter-calibrated along-track SWH observations from ERS1, ERS2, ENVISAT, TOPEX/Poseidon, JASON-1, JASON-2, GEOSAT FO, CRYOSAT-2 and SARAL/Altika over the period 1993-2017; all available WAVE_GLO_WAV_L3_SWH_NRT_OBSERVATIONS_014_001 inter-calibrated along-track SWH observations from JASON-3, SENTINEL-3A, SENTINEL-3B, SARAL/Altika, CRYOSAT-2, CFOSAT and HAIYANG-2B satellite missions, distributed by the CMEMS WAV TAC, over the period 2017-present.

II.4 Grid

Med-WAV Reanalysis is delivered on a regular grid (model native grid) covering the whole Mediterranean Sea and extending up to 18.125°W into the Atlantic Ocean at 1/24°. The model grid covers the area 18.125°W to 36.2917°E and from 30.1875°N to 45.9792°N and its size is 1307 x 380. All wave variables are provided at the same horizontal resolution (1/24°, approx. 4.6km)

II.5 Processing information

II.5.1   Update Time

The Mediterranean Sea Waves reanalysis has been initialized on the 1st of December 1992. The first month is considered as the period of model spin up, thus the available data starts at 1st January 1993.

The Mediterranean Sea Waves interim dataset is updated monthly on the 20th (addition of the previous month).

II.5.2   Temporal extent of reanalysis stored on delivery mechanism

The product is available from 01/01/1993.

II.5.3   Time averaging

The fields are 1-hourly instantaneous at 00, 01, 02, …, 23 UTC.

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 Web Portal Subsetter Service

MEDSEA_MULTIYEAR_WAV_006_012 files nomenclature when downloaded through the Copernicus Marine Web Portal Subsetter is based on product dataset name and a numerical reference related to the request date on the CIS.

The scheme is: **datasetname_nnnnnnnnnnnnn.nc**

where :

       .datasetname is the following character string:

                med-hcmr-wav-rean-h

       . 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 for a file:

med-hcmr-wav-rean-h_1303461772348.nc

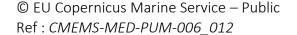## IV.2 Nomenclature of files when downloaded through the FTP Service

MEDSEA_MULTIYEAR_WAV_006_012 files nomenclature when downloaded through the Copernicus Marine FTP service is based as follows:

{valid date}_{freq flag}-{producer}--{parameter}-{config}-{region}-{bul date}_{product type}-sv{file version}.nc.gz

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 CMEMS 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, sm for hindcast.
- **file version** is xx.yy where xx is the CMEMS version and yy is an incremental version number

valid date	YYYYMMDD (reanalysis/interim)

	19930101-20161231 (clim dataset)
freq flag	h (hourly) (reanalysis/interim) m (monthly) (clim dataset)
producer	HCMR
config	MEDWAM3 (reanalysis/clim dataset) MEDWAM3i (interim)
region	MEDATL
parameter	WAVE (reanalysis/interim) CLIM (clim dataset)
bul date	bYYYYMMDD
product type	re (reanalysis/clim dataset) in (interim)
file version	01.00

Example for a reanalysis file:

20181220_h-HCMR--WAVE-MEDWAM3-MEDATL-b20200601_re-sv01.00.nc

This file contains the hourly instantaneous fields of the wave parameters listed analytically in Section II.2, from **00:00** UTC of the 20th of December 2018 to **23:00** UTC of the 20th of December 2018.

Example for a file of Interim:

20200301_h- HCMR--WAVE-MEDWAM3i-MEDATL-b20210101_in-sv01.00.nc

This file contains the hourly instantaneous fields of the wave parameters listed analytically in Section II.2, from **00:00** UTC of the 1st of March 2020 to **23:00** UTC of the 1st of March 2020.

Filename of the climatological dataset:

19930101-20161231_m-HCMR--CLIM-MEDWAM3-MEDATL-b{date2}_re-sv01.00.nc

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: -32767s

Land and sea-ice masks are equal to "_FillValue" (see variable attribute on NetCDF file).

In the CMEMS online system data from the latest 2 years (running window) are available via these download interfaces: Subsetter and FTP download

IV.4 File size

DATASET NAME	FILE NAME	DIMENSION [MB]
med-hcmr-wav-rean-h	{date1}_h-HCMR--WAVE-MEDWAM3-MEDATL-b{date2}_re-sv01.00.nc	145
cmems_mod_med_wav_myint_4.2km_PT1H-i	{date1}_h-HCMR--WAVE-MEDWAM3i-MEDATL-b{date2}_in-sv01.00.nc	145
cmems_mod_med_wav_my_4.2km-climatology_P1M-m	19930101-20161231_m-HCMR--CLIM-MEDWAM3-MEDATL-b{date2}_re-sv01.00.nc	25
cmems_mod_med_wav_my_4.2km_static	MED-MFC_006_012_${field}.nc	1

V   FILE FORMAT

V.1 NetCDF

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

The MEDSEA_MULTIYEAR_WAV_006_012 product is distributed in netCDF4 format.

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

V.2 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 a file of the dataset med-hcmr-wav-rean-h is inserted below, with the additional fields in italic fonts.:

netcdf \20191201_h-HCMR--WAVE-MEDWAM3-MEDATL-b20200601_re-sv01.00 {

dimensions:

> *time = UNLIMITED ; // (24 currently)*

> *latitude = 380 ;*

> *longitude = 1307 ;*

variables:

VI REFERENCES

Korres, G., Ravdas, M., Zacharioudaki, A., Denaxa, D., & Sotiropoulou, M. (2021). Mediterranean Sea Waves Reanalysis (CMEMS Med-Waves, MedWAM3 system) (Version 1) [Data set]. Copernicus Monitoring Environment Marine Service (CMEMS).
https://doi.org/10.25423/CMCC/MEDSEA_MULTIYEAR_WAV_006_012

Korres, G., Ravdas, M., Denaxa, D., & Sotiropoulou, M. (2021). Mediterranean Sea Waves Reanalysis INTERIM (CMEMS Med-Waves, MEDWAM3i system) (Version 1) [Data set]. Copernicus Monitoring Environment Marine Service (CMEMS).
https://doi.org/10.25423/CMCC/MEDSEA_MULTIYEAR_WAV_006_012_MEDWAM3I

Korres, G., Oikonomou, C., Denaxa, D., & Sotiropoulou, M. (2023). Mediterranean Sea Waves Monthly Climatology (CMS Med-Waves, MedWAM3 system) (Version 1) [Data set]. Copernicus Marine Service (CMS). https://doi.org/10.25423/CMCC/MEDSEA_MULTIYEAR_WAV_006_012_CLIM

Quality Information Document (QUID): CMEMS-MED-QUID-006-013.pdf (copernicus.eu)