

Επιχειρησιακές προγνώσεις ανεμογενών κυματισμών και κυμάτων καταιγίδας (storm surges) στα πλαίσια του συστήματος ΠΟΣΕΙΔΩΝ και της υπηρεσίας Copernicus – CMEMS

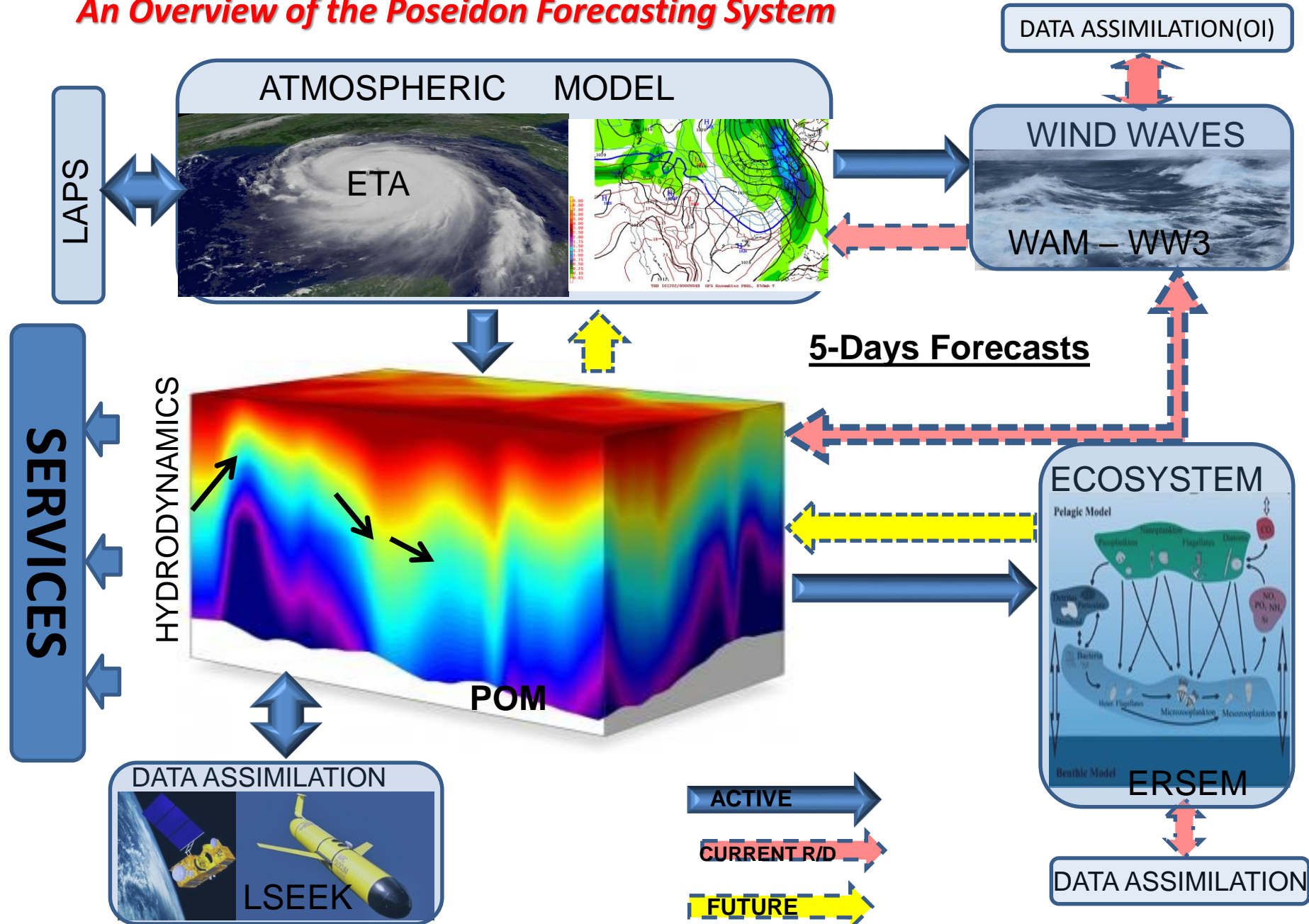
**Γ. Κορρές & Επιστημονική Ομάδα Συστήματος ΠΟΣΕΙΔΩΝ
Ινστιτούτο Ωκεανογραφίας - ΕΛΚΕΘΕ**

Συμβολή των Ερευνητικών Κέντρων στην αντιμετώπιση των φυσικών καταστροφών
29.11.2019 - Εθνικό Ίδρυμα Ερευνών






Overview

- The POSEIDON System in brief
- The wind Wave Forecasting component
- The Storm Surge Forecasting component
- The Copernicus CMEMS wave analysis and forecasting for the Mediterranean Sea
- Future perspectives

An Overview of the Poseidon Forecasting System

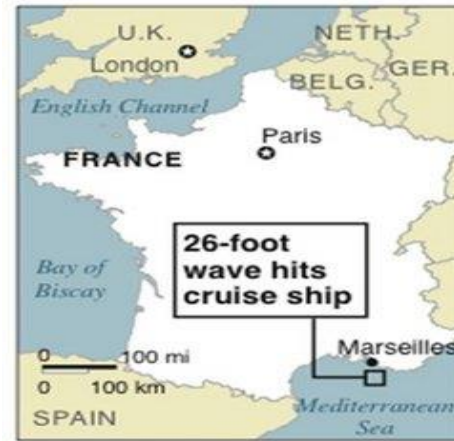


How do we use POSEIDON products (5 days forecasts)

- | | | |
|---|---|---|
| • Maps of SST (Sea Surface Temperature) |  | • Estimation of survival times at sea(NMS) |
| • Maps of SSH (Sea Surface Height) |  | • poseidon.hcmr.gr : coastal flooding (civil protection) |
| • Maps of Significant Wave Height and direction |  | • poseidon.hcmr.gr : maritime transport, civil protection |
| • Surface currents & 10m winds |  | • S&R application (SARISA application- Greek Air Forces) |
| • Surface currents, stokes drift velocity & 10m winds |  | • Oil spill forecasting web application (@Evi Bourma) |

Usefulness of wind waves forecasting

- Maritime transport
- Marine Safety (SAR, Oil Spill, Port Operations)
- Coast Guard
- Civil protection
- General public
- Oil and Gas industry
- Aquaculture sector
- Renewable Energy
- Engineers
- Maritime sports & Tourism industry
- Research community



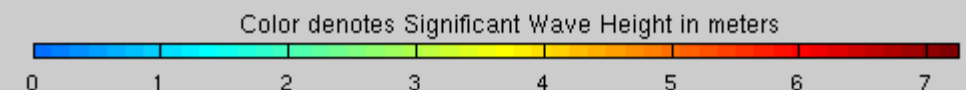
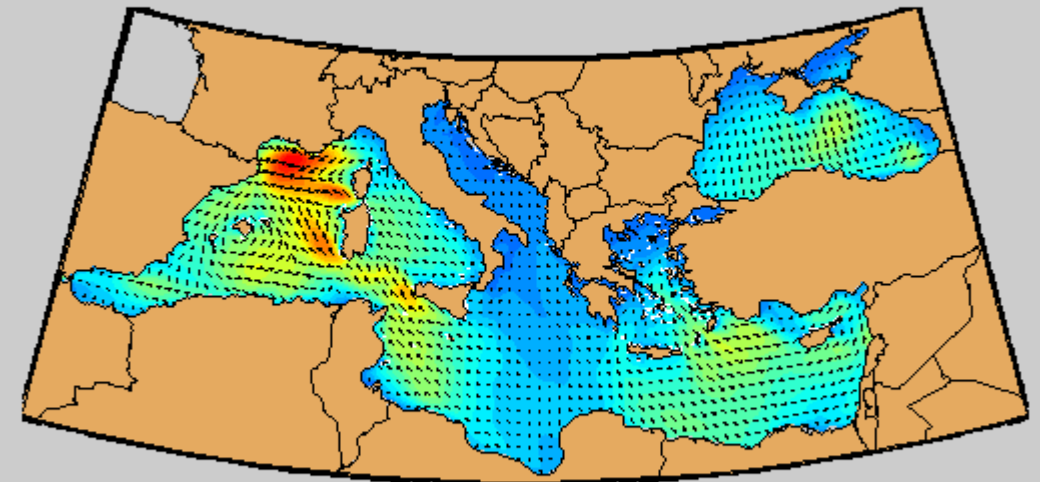
3 March 2010: Huge wave kills 2 passengers on a cruise ship sailing from Barcelona to Genoa

POSEIDON Wave Forecast issued on 2 March 2010



Hellenic Center for Marine Research, GR-19013, Anavissos, GREECE
POSEIDON System - <http://www.poseidon.hcmr.gr>

Mediterranean and Black sea
Significant Wave Height on Wednesday (03/03/10) 12:00UTC



The wind waves forecasting component

poseidon.hcmr.gr: 5-day wind waves forecasts on a daily basis



~5km resolution - WaveWatch III

Previous Next

February 2015

S	M	T	W	T	F	S
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

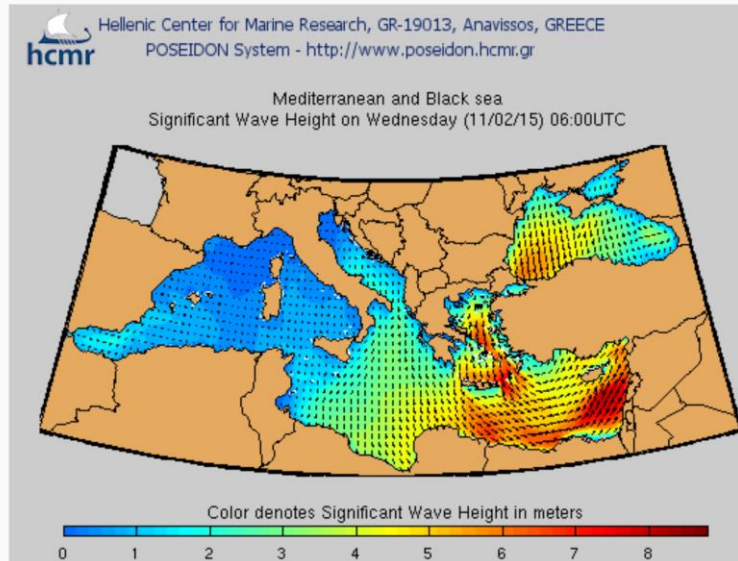
forecast you want to display and then the relevant area.

Select Forecast
Sea State Forecast

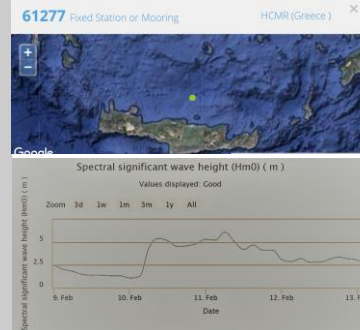
Select Region
Mediterranean

Select Parameter
Wave Height & Direction

Select Date
11.02.15 Hour:06:00 UTC



Cretan Sea buoy - 11 Feb 2015 06:00 UTC: 6,093m



~3km resolution - WAM 4.6.2

January 2018

S	M	T	W	T	F	S
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			

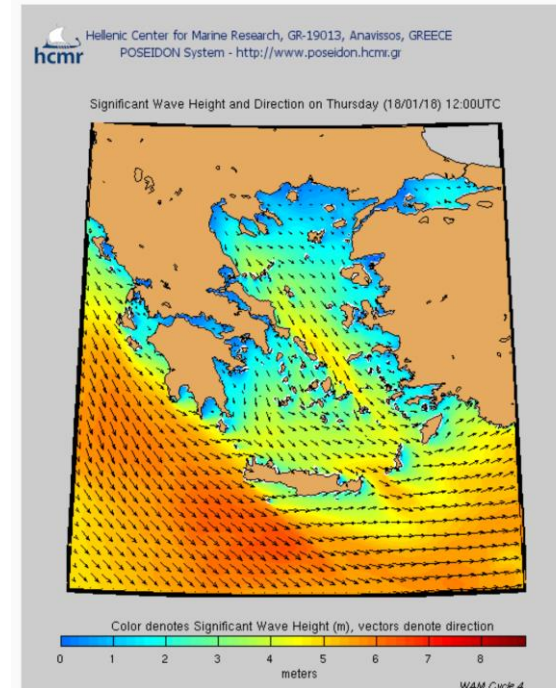
forecast you want to display and then the relevant area.

Select Forecast
Sea State Forecast

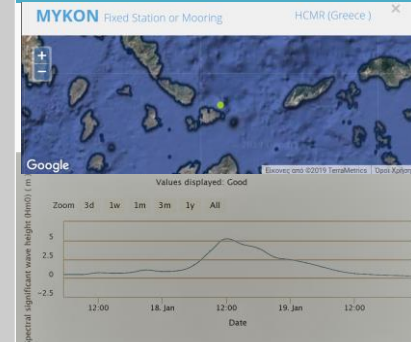
Select Region
Aegean

Select Parameter
Wave Height & Direction

Select Date
18.01.18 Hour:12:00 UTC



Mykonos buoy - 18 Jan 2018 12:00 UTC: 5,22m

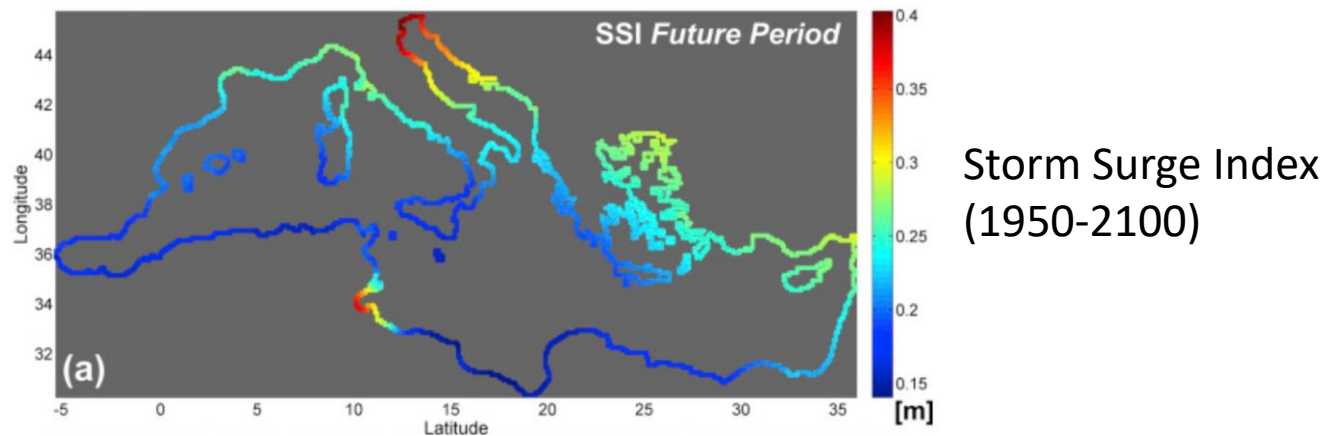


The POSEIDON storm surge forecasting component

Latest Intergovernmental Panel on Climate Change (IPCC) Special Report (**Special Report on the Ocean and Cryosphere in a Changing Climate – Sept 2019**):

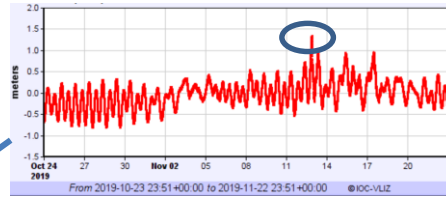
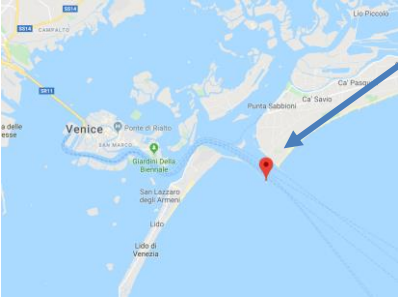
More frequent extreme sea level events

Sea level rise will increase the frequency of extreme sea level events, which occur for example during high tides and intense storms. **Indications are that with any degree of additional warming, events that occurred once per century in the past will occur every year by mid-century in many regions, increasing risks for many low-lying coastal cities and small islands.**



Androulidakis et al., 2015: SSI is defined as the average of the three (3) highest independent storm surge maxima per year. It is calculated over a 150 yrs period (1951 – 2100)

The storm surges forecasting component

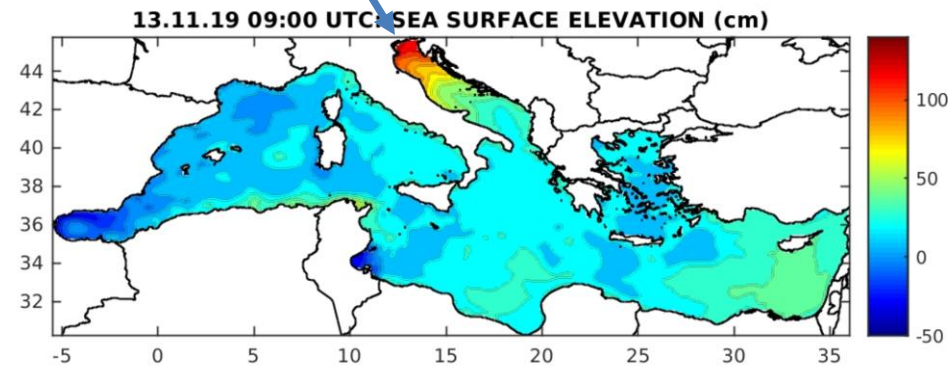
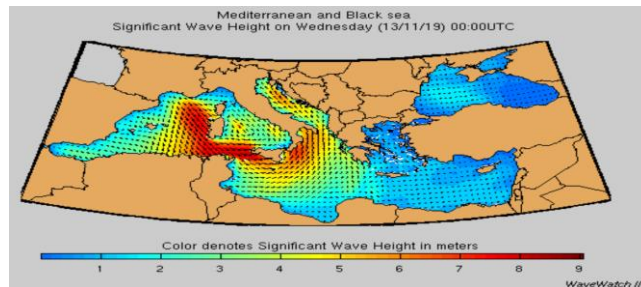


Tide gauge recording

140 cm

Storm surge in the north Adriatic produces extreme flooding in Venice: 13 Nov 2019

Wind waves few hours before the event



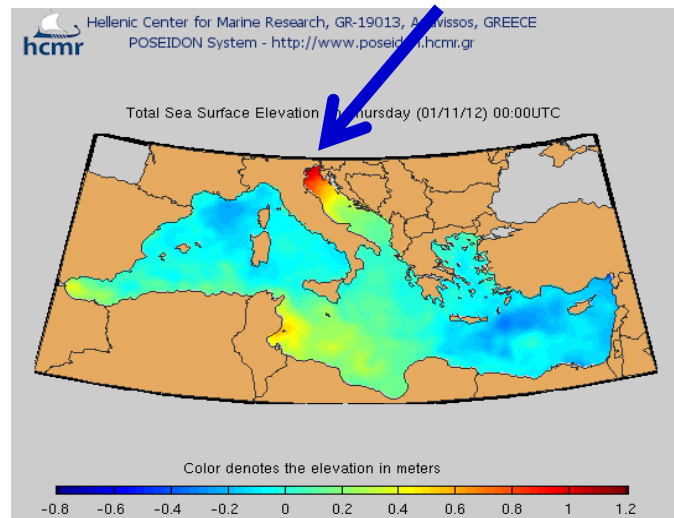
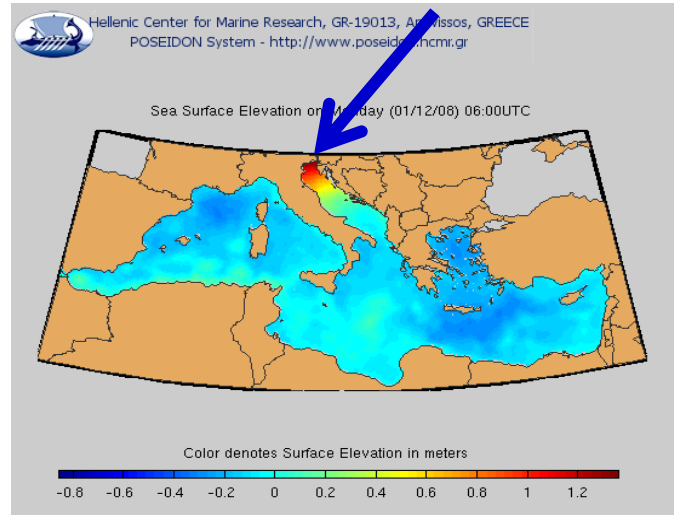
13.11.19 09:00 UTC: POSEIDON SSH FORECAST

"The city is on its knees,"
Venice's Mayor Luigi
Brugnaro said in an
interview with national
broadcaster RAI.

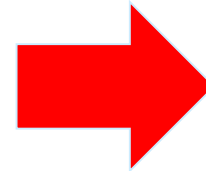


North Adriatic storm surges predicted by the POSEIDON system

POSEIDON SEA LEVEL FORECASTS



Storm surge induces flooding in Venice



1 Dec 2008: 1.56m



1 Nov 2012: 1.4m

Nov 1, 2012 - 17:29

Venice hit by worst flooding in two years



VENICE (Reuters) - Tourists in Venice put plastic bags over their legs and residents wore rubber boots as water rose to knee-high levels in many parts of the lagoon city on Thursday.

The median level of the Adriatic Sea swelled to about 1.4 metres (1.5 yards) above normal - the highest in nearly two years - sending water from the lagoon into St. Mark's Square and many narrow alleyways.

Wooden catwalks which are usually used to allow pedestrian passage over flooded areas were removed after the water rose above them, rendering them useless.

In some places, it was impossible to distinguish where canals ended and sidewalks began.

Much of Italy has been hit by heavy rain and strong winds over the past week.

(Reporting By Philip Pullella; editing by Paul Casciato)

Reuters

C M E M S : M o n i t o r i n g a n d f o r e c a s t i n g t h e o c e a n

MULTI-YEAR
10 to 45 years

REAL-TIME
Daily, hourly

FORECAST
2 to 10 days

ESSENTIAL MARINE VARIABLES

Blue
(Physics)

White
(Sea Ice)

Green
(Biogeochemistry)

OBSERVATIONS
In-situ & Satellites

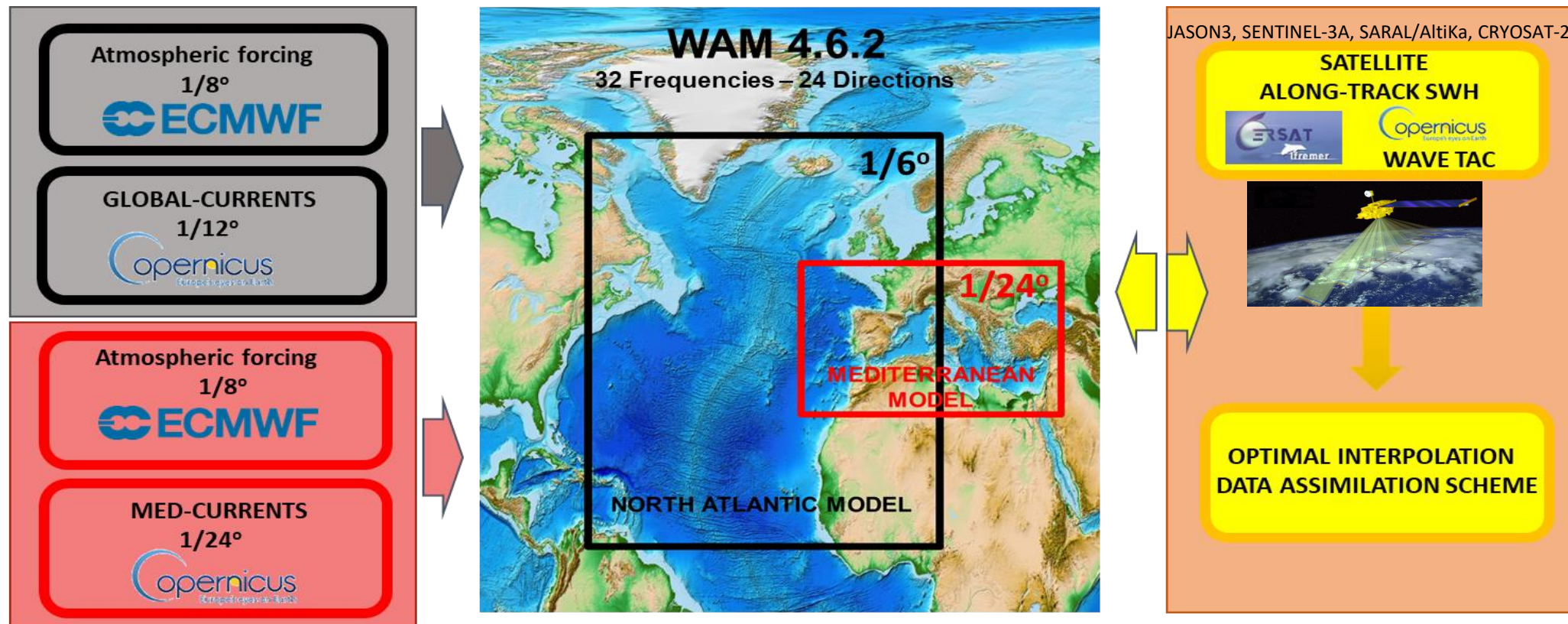
**NUMERICAL MODELS &
data assimilation**

MED MFC: Med-waves
by HCMR

- | | |
|----------|-------------|
| 1 Global | 5 IBI |
| 2 Arctic | 6 Med Sea |
| 3 Baltic | 7 Black Sea |
| 4 NWS | |

Open and Free access





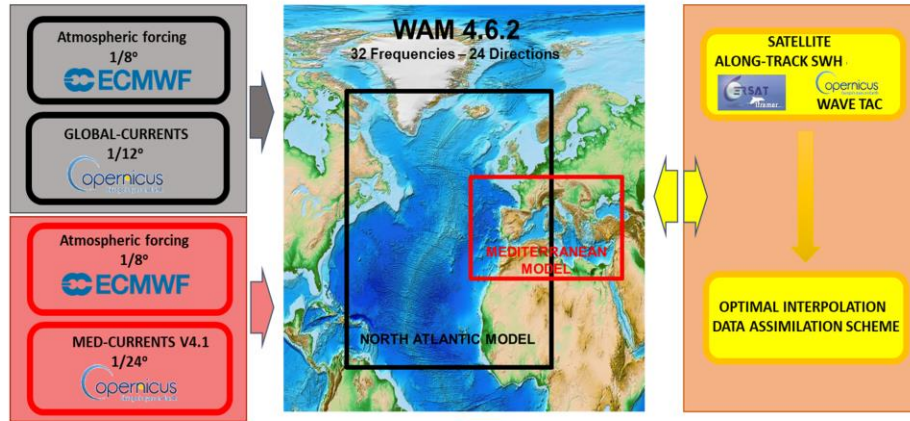
Analysis & 10-days Forecast Products : 2D Instantaneous hourly for

MED-WAVES

- spectral significant wave height (H_{m0}),
- spectral moments (0,2) wave period (T_{m02}),
- spectral moments (-1,0) wave period (T_{m-10}),
- wave period at spectral peak/peak period (T_p),
- mean wave direction from (M_{dir}),
- 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.

Cal/Val module
In-situ and Satellite observations

Continuous check of Med-waves product quality



Quality check using InSitu and Satellite wave products:

- INSITU MED NRT OBSERVATIONS
- SATELLITE WAVE PRODUCTS from CMEMS & CERSAT - IFREMER

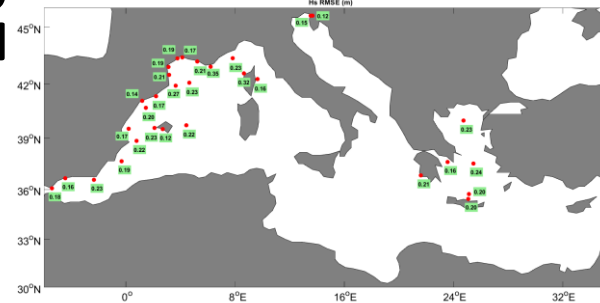
System Performance for year 2018

	RMSE (sat/ buoys)	BIAS (sat/ buoys)
SWH	0.214m / 0.202m	-0.031m / -0.004m
Tm	0.693s	-0.488s

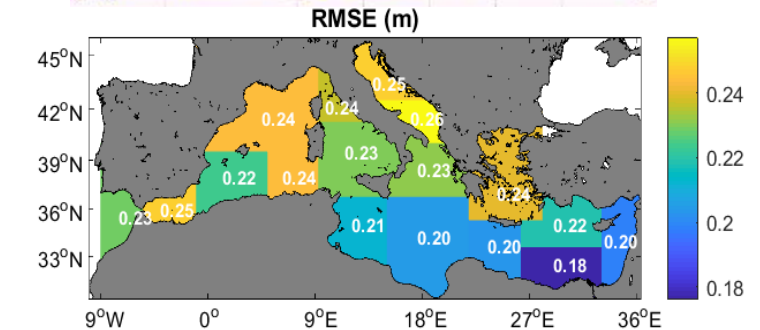
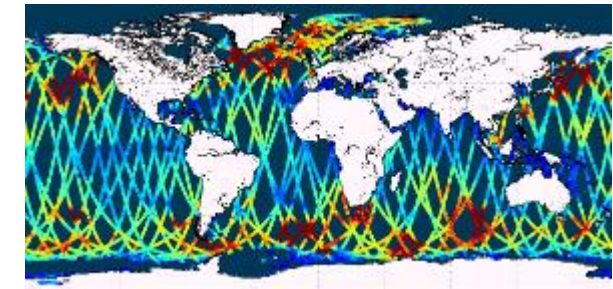
Locations of wave buoys



2018



Satellite SWH along track observations



Intercomparison with other operational centers (2014)

	WESTERN MEDITERRANEAN				CENTRAL AND EASTERN MEDITERRANEAN				
	ECMWF	Met Office	Meteo France	DMI	CMEMS MED MFC	ECMWF	Meteo France	DMI	CMEMS MED MFC
RMSE (m)	0.234	0.281	0.279	0.292	0.227	0.22	0.244	0.268	0.201
SI	0.204	0.231	0.23	0.256	0.211	0.248	0.282	0.298	0.242
BIAS (m)	-0.056	-0.114	-0.112	-0.064	-0.03	-0.07	-0.057	-0.094	-0.044
CORR	0.96	0.947	0.951	0.938	0.954	0.951	0.935	0.926	0.949

Med-waves validation web site (URL): <http://med-mfc-wav.hcmr.gr/>
Contains quarterly statistics with respect to insitu and satellite data

<http://marine.copernicus.eu/>



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OCEAN PRODUCTS
Ocean product catalogue, to download or visualize data across nearly 15 variables, including hindcast, current and forecast data.

OCEAN MONITORING INDICATORS
Essential variables monitoring the health of the ocean

OCEAN STATE REPORT
Extensive annual analysis on the state of the ocean over nearly 20 years and severe/notable annual events

LATEST NEWS FLASH
CMEMS 9737
WIND_GLO_WIND_L4_NRT_OB! delayed on 2019-05-10
RESOLVED

OCEANPREDICT'19 -COPERNICUS MARINE TRAININGS & PRESENTATIONS
The GODAE OceanView Symposium OceanPredict '19 is May 6th through the 10th, 2019 in Halifax, Nova Scotia.

CMEMS Med-Waves: a 24/7/365 service

MEDITERRANEAN SEA WAVES ANALYSIS AND FORECAST

Metadata provided by CMEMS
Credits: E.U. Copernicus Marine Service Information

Spectral Significant Wave Height [m] 15/01/2019 12:00 UTC

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PRODUCT IDENTIFIER MEDSEA_ANALYSIS_FORECAST_WAV_006_017

OVERVIEW

Short description:
MEDSEA_ANALYSIS_FORECAST_WAV_006_017 is the nominal product of the Mediterranean Sea Waves Forecasting system, composed by hourly wave parameters at 1/24° horizontal resolution covering the Mediterranean Sea and extending up to -18.125W into the Atlantic Ocean. The waves forecast component (Med-Waves system) is a wave model based on the upgraded WAM Cycle 4.6.2. In the wave model the continuous wave spectrum is approximated by means of step functions which are constant in a frequency-direction bin. The Med-Waves modelling system resolves the prognostic part of the wave spectrum with 24 directional and 32 logarithmically distributed frequency bins and the model solutions are corrected by an optimal interpolation data assimilation scheme of all available along track satellite significant wave height observations. The Med-Waves set up includes a coarse grid domain with a resolution of 1/6° covering the North Atlantic Ocean from 75° W to 10° E and from 70° N to 10° S and a nested fine grid domain with a resolution of 1/24° covering the Mediterranean Sea from 18.125° W to 36.2917° E and from 30.1875° N to 45.9792° N. The system provides a Mediterranean wave analysis and 10 days Mediterranean wave forecasts updated daily.

Product Citation: Please refer to our Technical FAQ for citing products. <http://marine.copernicus.eu/faq/cite-cmEMS-products-cmEMS-credit/?dpage=169>

REFERENCES

DOI (Product): https://doi.org/10.25423/CMCC/MEDSEA_ANALYSIS_FORECAST_WAV_006_017

Korres, G., Ravidas, M., & Zacharioudaki, A. (2019). Mediterranean Sea Waves Analysis and Forecast (CMEMS Med-Waves 2017-2019) (Version 1) [Data set]. Copernicus Monitoring Environment Marine Service (CMEMS). https://doi.org/10.25423/CMCC/MEDSEA_ANALYSIS_FORECAST_WAV_006_017

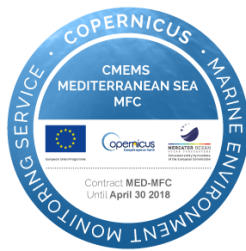
GEOGRAPHICAL COVERAGE

Areas:
mediterranean-sea

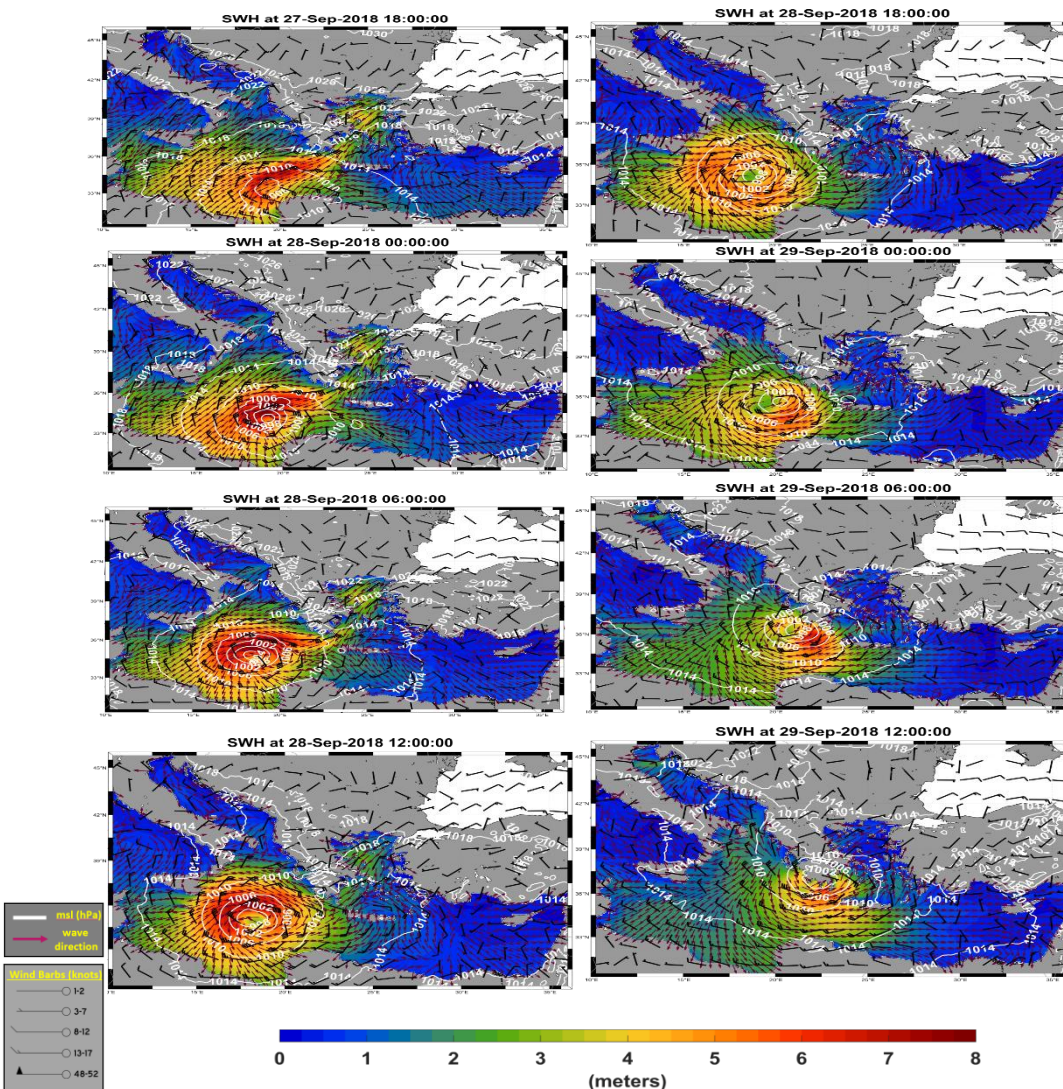
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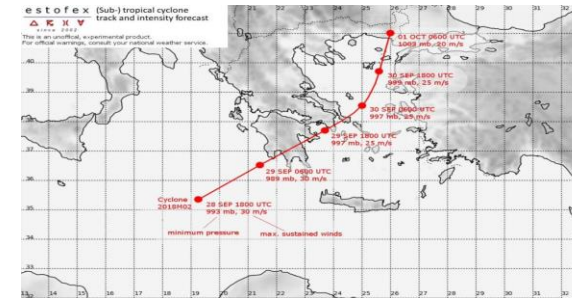
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20191103_h-HCMR--WAVE-MEDWAM3-MEDATL-b20191030_fc-sv05.00.nc	134 MB	31/10/2019, 05:00:00
20191104_h-HCMR--WAVE-MEDWAM3-MEDATL-b20191030_fc-sv05.00.nc	134 MB	31/10/2019, 05:01:00
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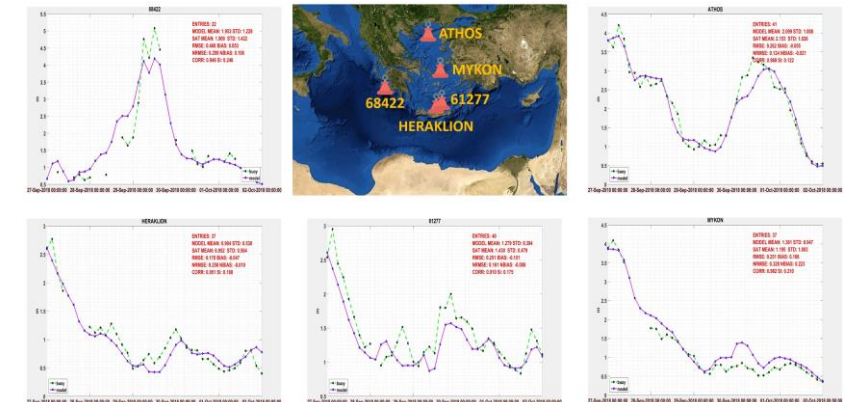
Medicane Zorba (27 Sep 18 – 01 Oct 18) as seen by Med-waves system



Med-waves analyses (27.09.18
18:00 UTC -> 29.09.18 12:00 UTC)



Zorba's track



Med-wave SWH analyses vs **buoy** observations for the period 27 Sep – 01 Oct 2018

- Increase horizontal resolution and geographical coverage (i.e. Corinth Gulf, Evoikos) of the POSEIDON forecasting system for the Aegean and Ionian Seas (HIMIOFOTS Research Infrastructure)
- Deal with wave forecast uncertainty: setup and operate a wave ensemble forecasting system for the Mediterranean Sea (Copernicus CMEMS Phase 3 - 2021-2023)
- Use directional wave spectrum and theoretical statistical models for wave extremes to accurately infer the expected shape and probability of the largest waves (CMEMS Phase 3)
- Produce long (1993 – today; 1960 – today) wind waves and storm surges re-analyses time series for the Mediterranean Sea