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

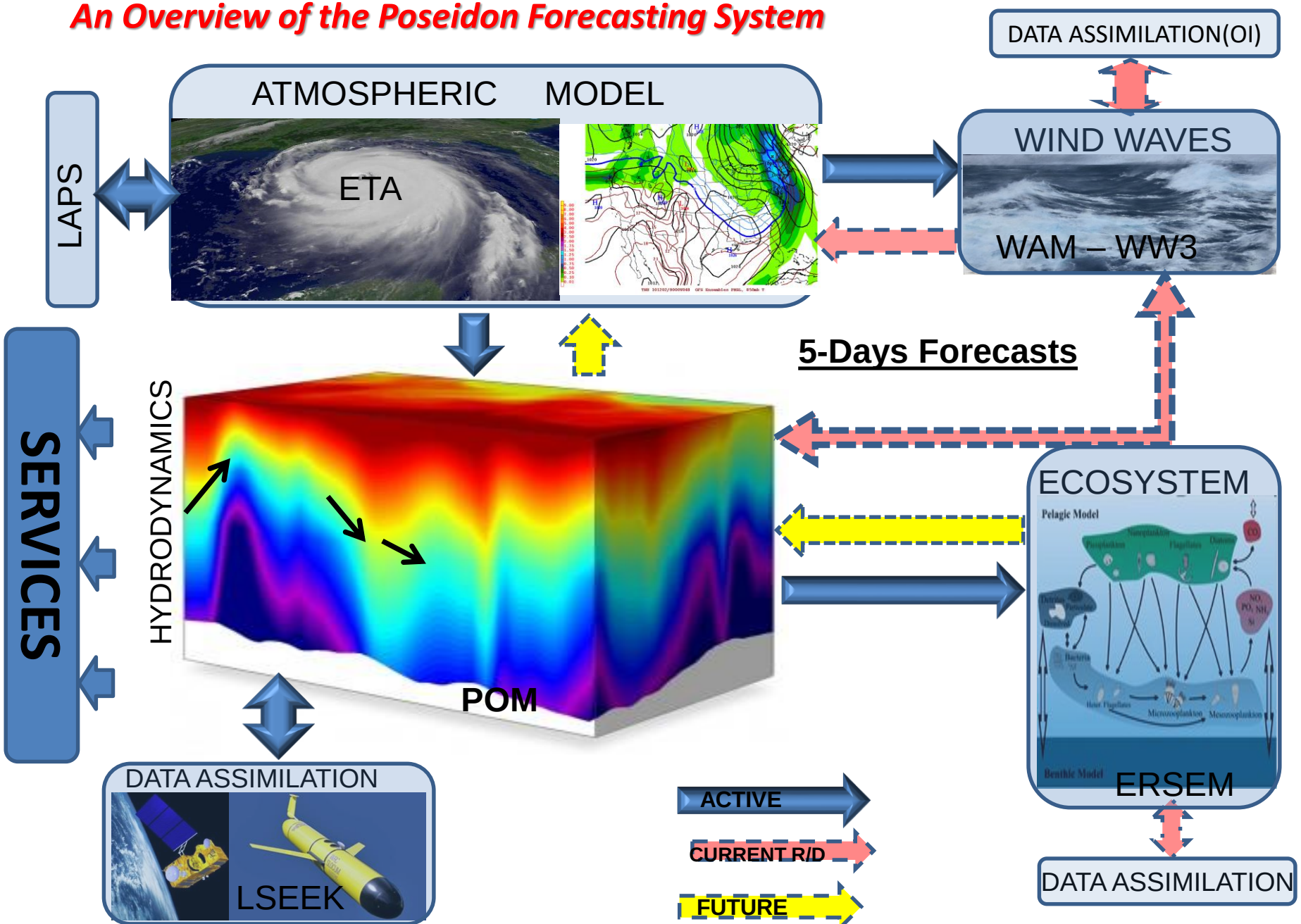
Γ. Κορρές & Επιστημονική Ομάδα Συστήματος ΠΟΣΕΙΔΩΝ
Ινστιτούτο Ωκεανογραφίας - ΕΛΚΕΘΕ

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)
- Maps of SSH (Sea Surface Height)
- Maps of Significant Wave Height and direction
- Surface currents & 10m winds
- Surface currents, stokes drift velocity & 10m winds





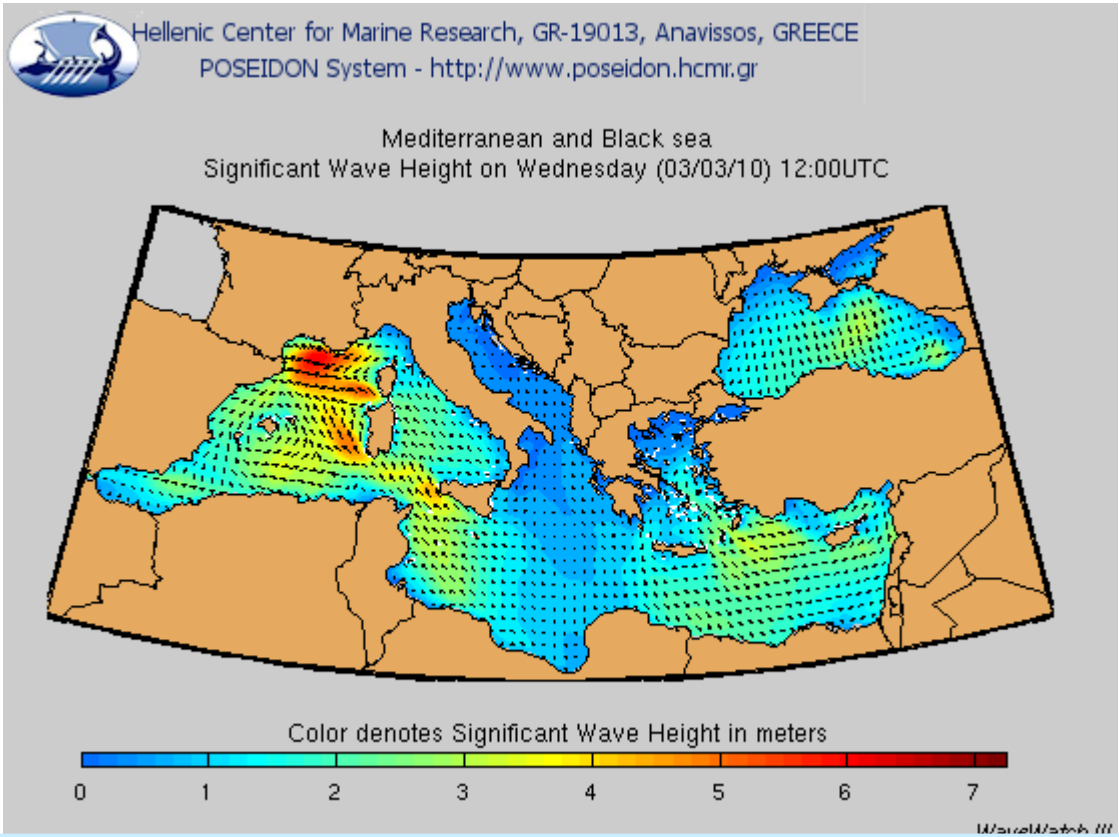
- Estimation of survival times at sea(NMS)
- poseidon.hcmr.gr: coastal flooding (civil protection)
- poseidon.hcmr.gr: maritime transport, civil protection
- S&R application (SARISA application-Greek Air Forces)
- Oil spill forecasting web application (@Evi Bourma)

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

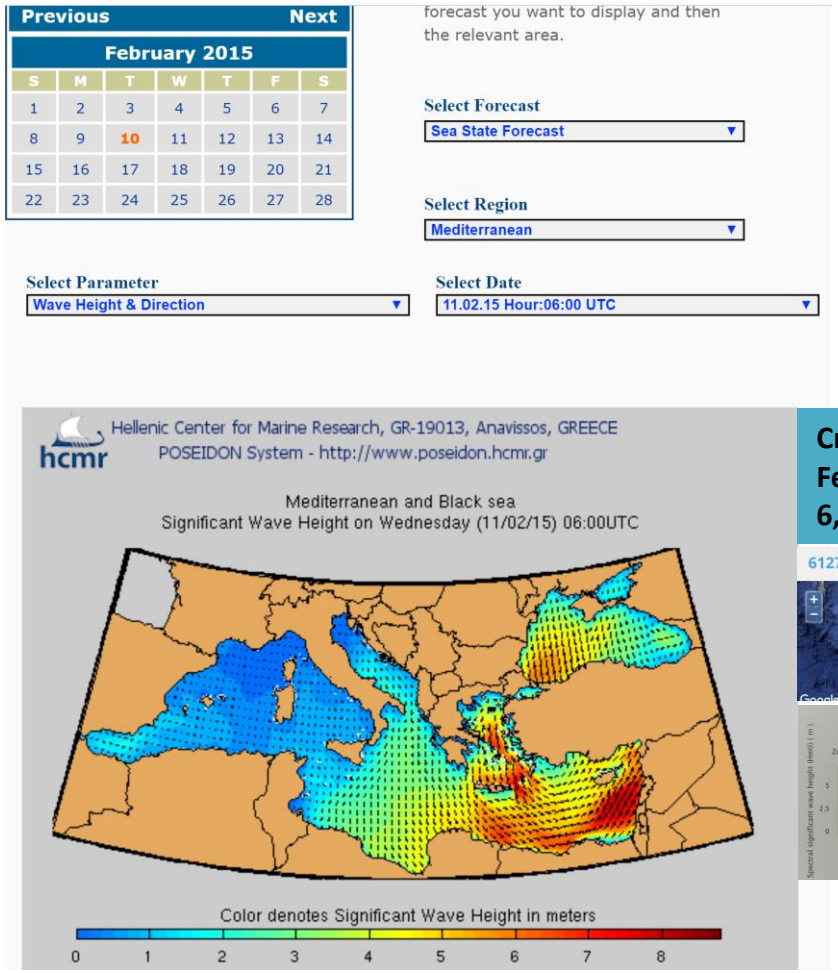
POSEIDON Wave Forecast issued on 2 March 2010



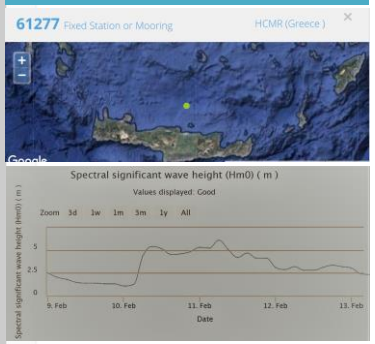
The wind waves forecasting component

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

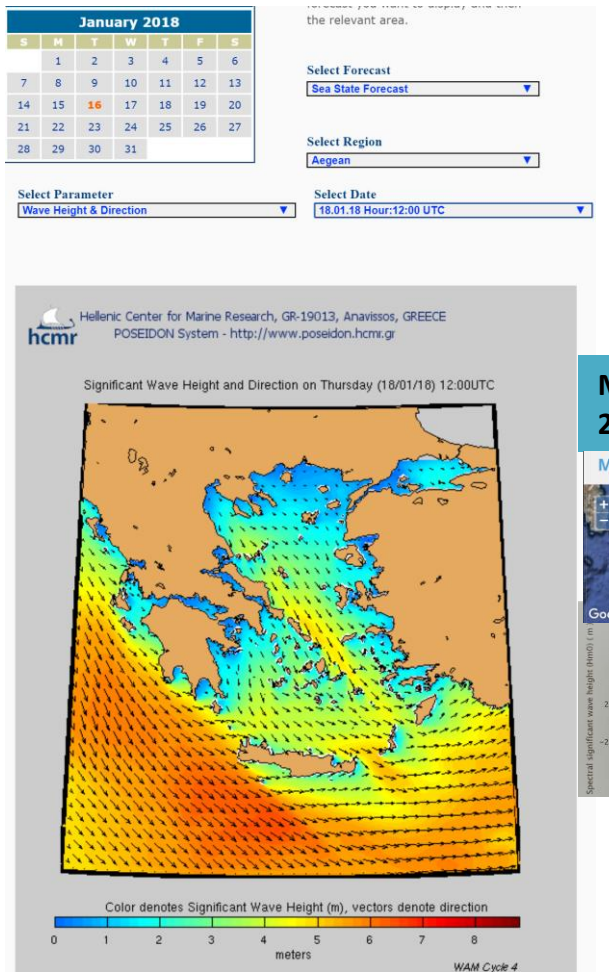
~5km resolution -WaveWatch III



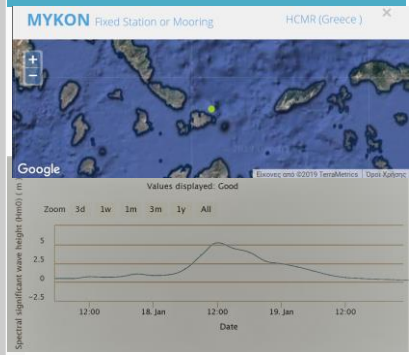
Cretan Sea buoy - 11 Feb 2015 06:00 UTC: 6,093m



~3km resolution –WAM 4.6.2



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

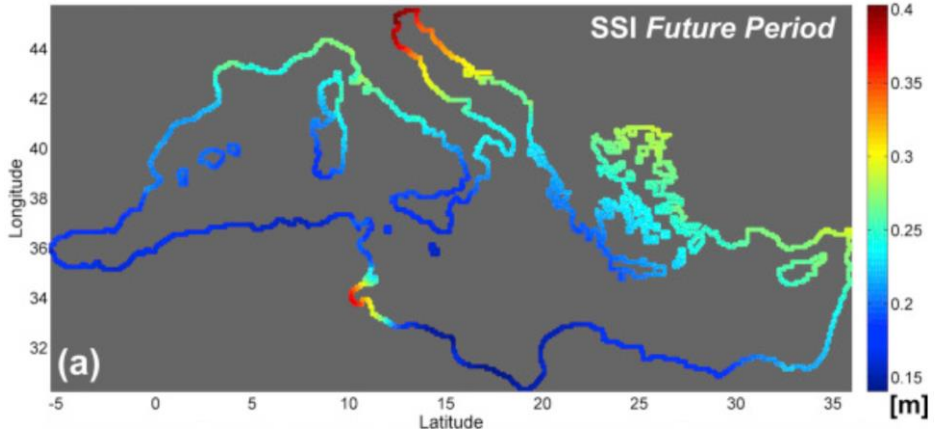


The POSEIDON storm surge forecasting component

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

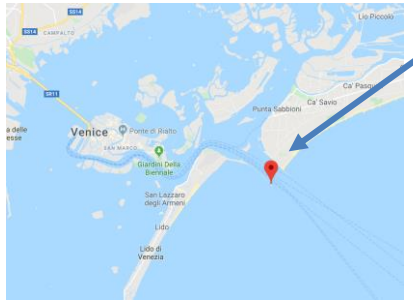
Sea level rise will increase the frequency of extreme sea level events, which occur for example during high tides and intense storms. **Indications are that with any degree of additional warming, events that occurred once per century in the past will occur every year by mid-century in many regions, increasing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

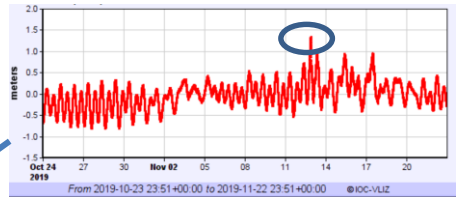


Storm Surge Index (1950-2100)

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

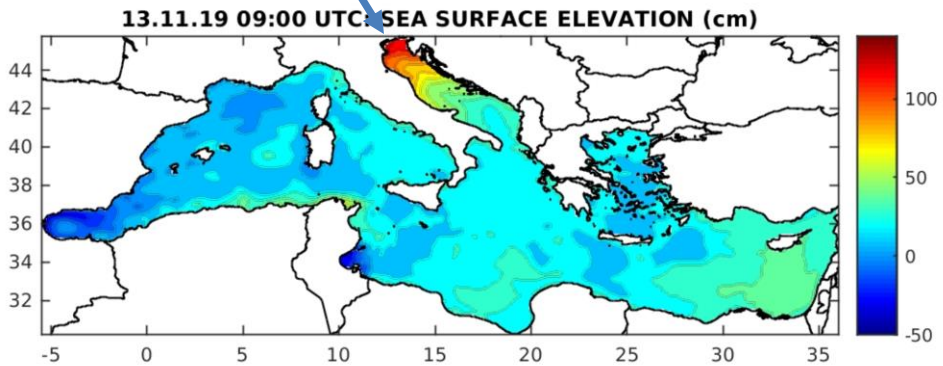




Tide gauge recording

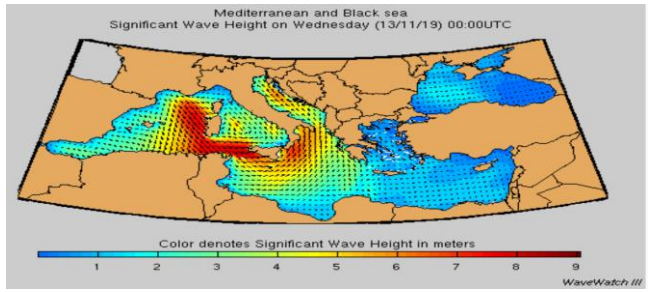
Storm surge in the north Adriatic produces extreme flooding in Venice: 13 Nov 2019

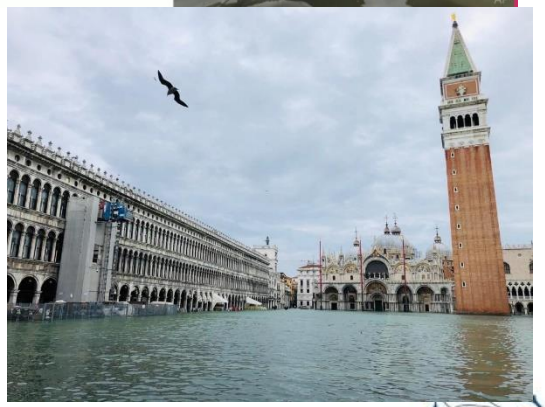
140 cm



13.11.19 09:00 UTC: POSEIDON SSH FORECAST

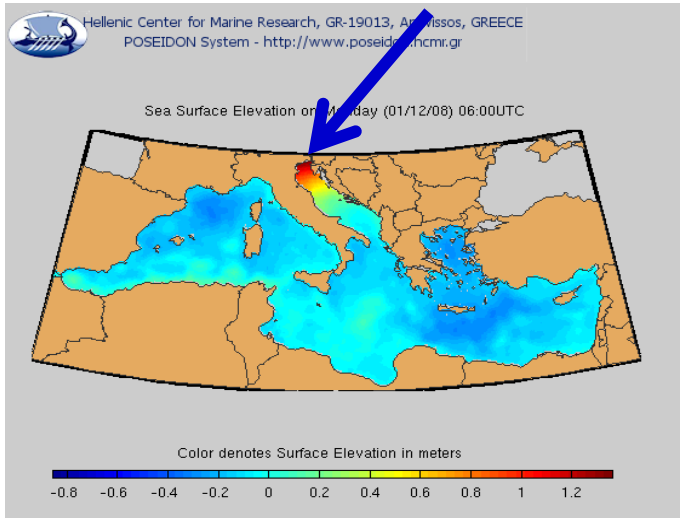
Wind waves few hours before the event

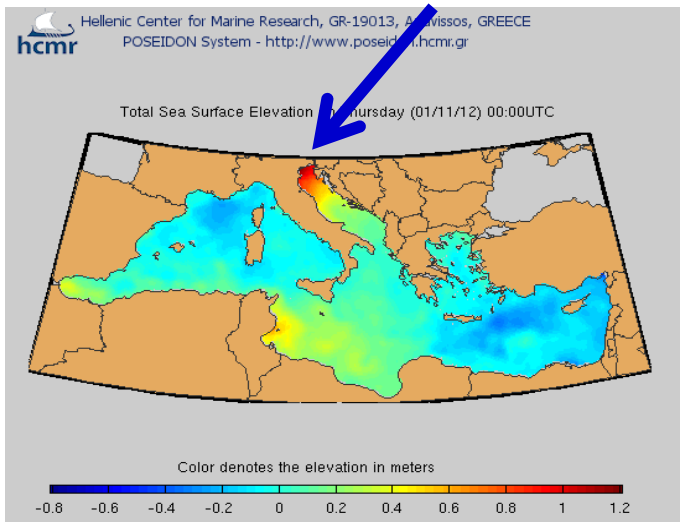




North Adriatic storm surges predicted by the POSEIDON system

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

Tourists walk in a flooded street during a period of seasonal high water in Venice (reuters_tickers)

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

COPERNICUS
MARINE ENVIRONMENT MONITORING SERVICE
Providing PRODUCTS and SERVICES for all marine applications

CMEMS: Monitoring and forecasting the ocean

MULTI-YEAR
10 to 45 years

REAL-TIME
Daily, hourly

FORECAST
2 to 10 days

MED MFC: Med-waves by HCMR

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

ESSENTIAL MARINE VARIABLES

- Blue (Physics)
- White (Sea Ice)
- Green (Biogeochemistry)

OBSERVATIONS
In-situ & Satellites

NUMERICAL MODELS &
data assimilation

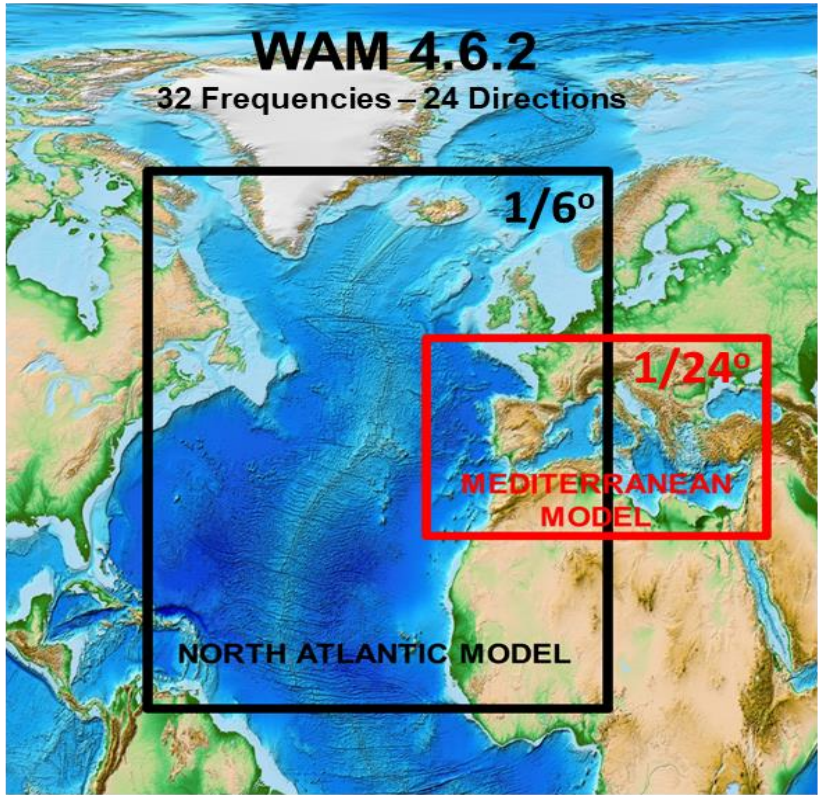
Open and Free access

Atmospheric forcing
1/8°
ECMWF

GLOBAL-CURRENTS
1/12°
Copernicus

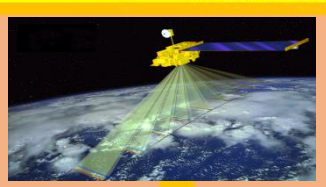
Atmospheric forcing
1/8°
ECMWF

MED-CURRENTS
1/24°
Copernicus



JASON3, SENTINEL-3A, SARAL/AltiKa, CRYOSAT-2

SATELLITE
ALONG-TRACK SWH
ERSAT ifremer
Copernicus
WAVE TAC



OPTIMAL INTERPOLATION
DATA ASSIMILATION SCHEME

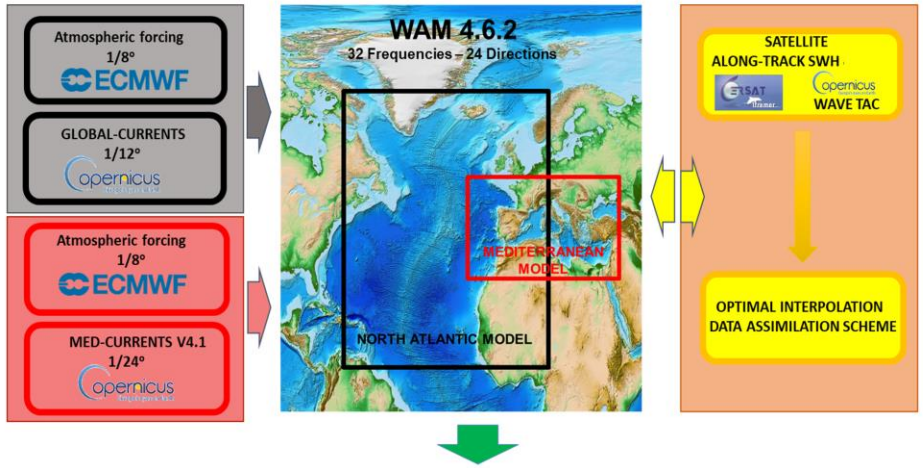
MED-WAVES

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

- spectral significant wave height (Hm0),
- spectral moments (0,2) wave period (Tm02),
- spectral moments (-1,0) wave period (Tm-10),
- 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.

Cal/Val module
In-situ Copernicus and Satellite observations

Continuous check of Med-waves product quality

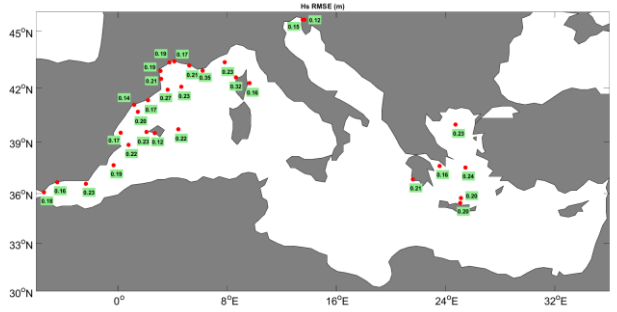


Quality check using InSitu and Satellite wave products:

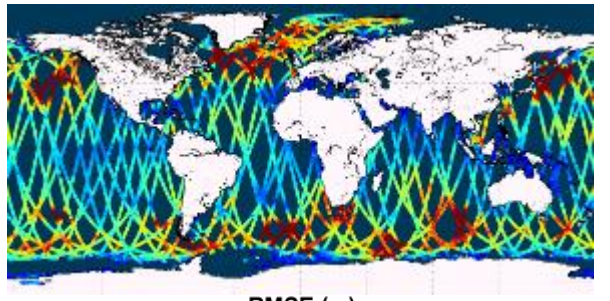
- INSITU MED NRT OBSERVATIONS
- SATELLITE WAVE PRODUCTS from CMEMS & CERSAT - IFREMER

2018

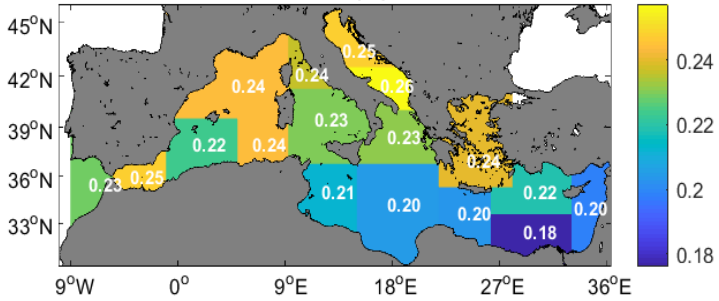
Locations of wave buoys



Satellite SWH along track observations



RMSE (m)



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

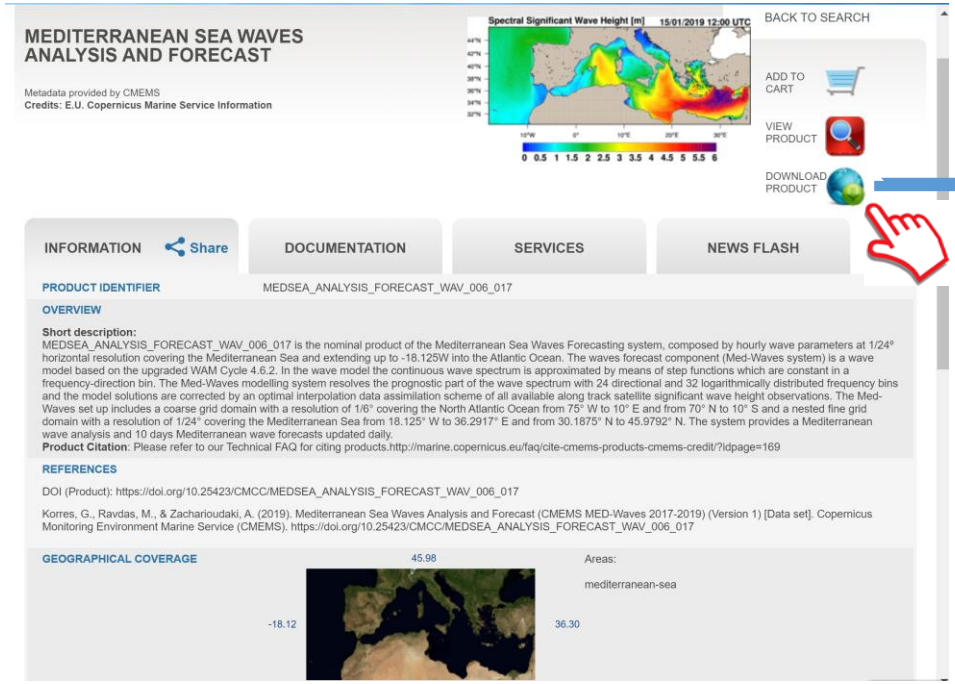
Intercomparison with other operational centers (2014)

	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

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

http://marine.copernicus.eu/



Index of /Core/MEDSEA_ANALYSIS_FORECAST_WAV_006_017/med-hcmr-wav-an-fc-h/2019/11/

[parent directory]

Name	Size	Date Modified
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20191102_h-HCMR--WAVE-MEDWAM3-MEDATL-b20191030_fc-sv05.00.nc	131 MB	31/10/2019, 04:59:00
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
20191105_h-HCMR--WAVE-MEDWAM3-MEDATL-b20191030_fc-sv05.00.nc	134 MB	31/10/2019, 05:02:00
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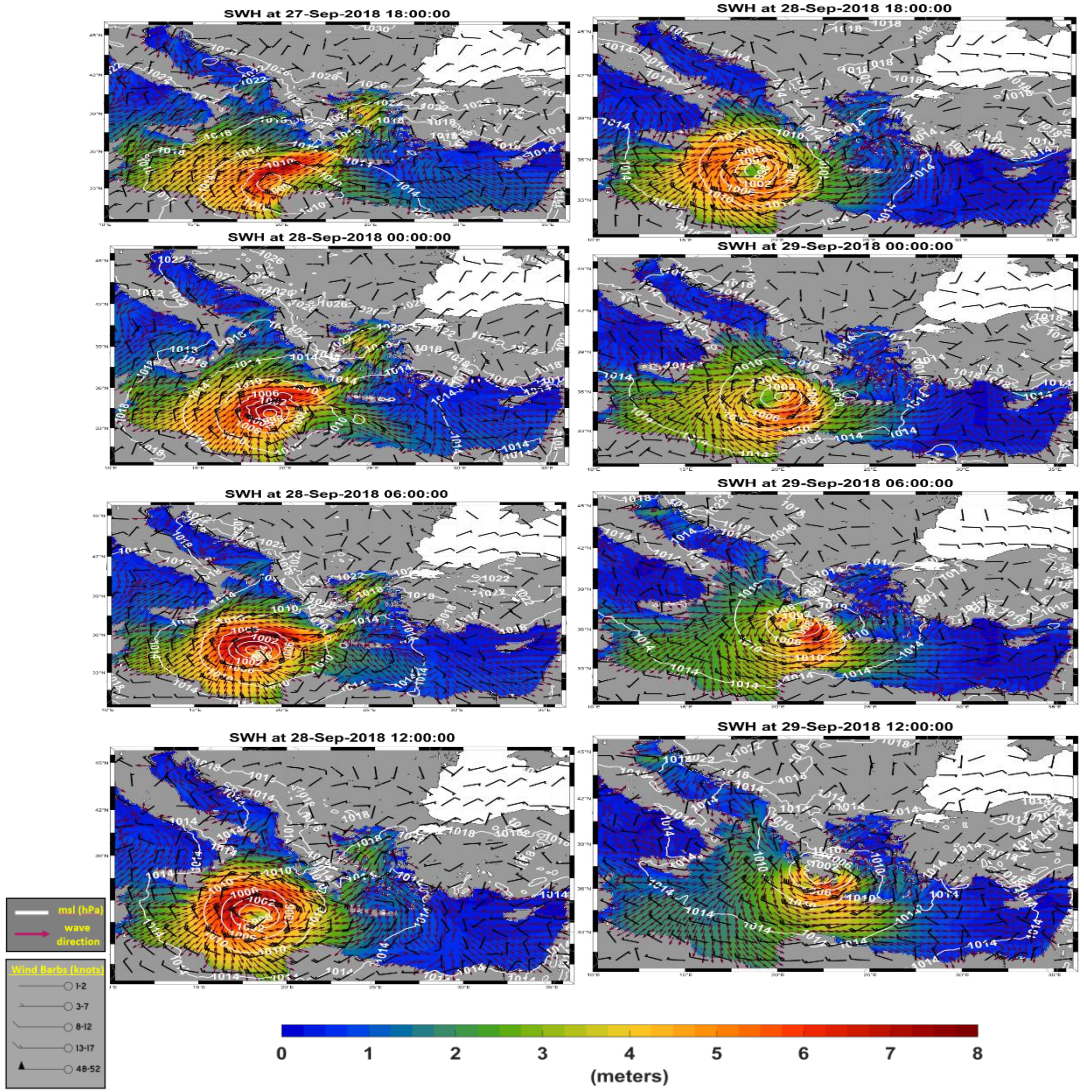
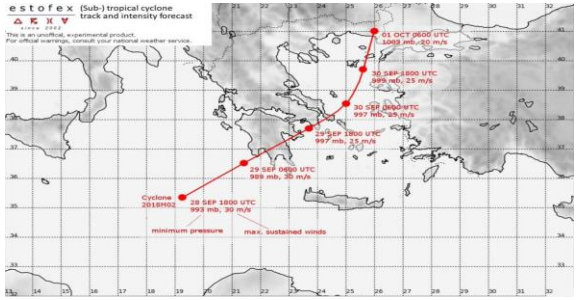
20191109_h-HCMR--WAVE-MEDWAM3-MEDATL-b20191030_fc-sv05.00.nc	136 MB	31/10/2019, 05:07:00

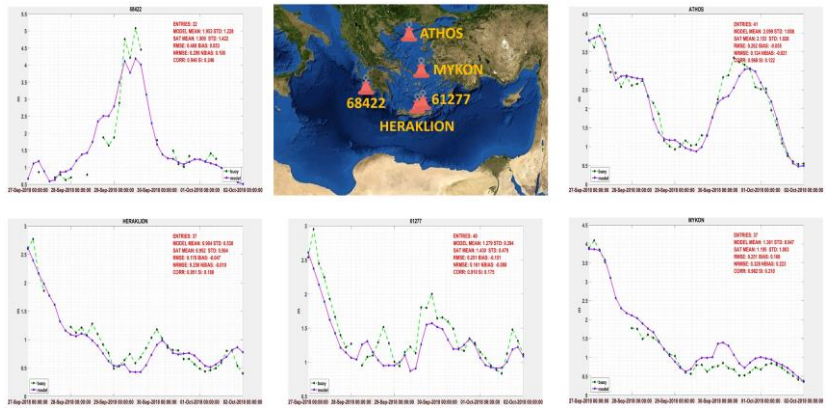
Medicane Zorba (27 Sep 18 – 01 Oct 18) as seen by Med-waves system



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

Future perspectives

- 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

Σας ευχαριστώ