

**The POSEIDON System: An operational monitoring,
forecasting and information system for marine
environmental conditions in the Eastern
Mediterranean**

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What is Operational Oceanography: The delivery of products (data, forecasts) to support the human activities in marine environment



EuroGOOS
European Global Ocean
Observing System



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What is Operational Oceanography?

Operational Oceanography can be defined as the activity of systematic and long-term routine measurements of the seas and oceans and atmosphere, and their rapid interpretation and dissemination.

Important products derived from operational oceanography are:

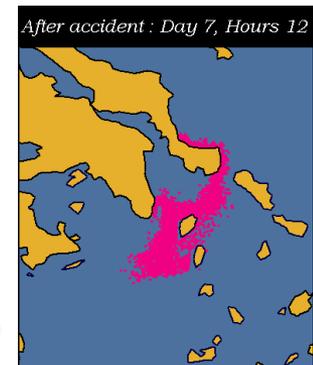
- nowcasts providing the most usefully accurate description of the present state of the sea including living resources
- forecasts providing continuous forecasts of the future condition of the sea for as far ahead as possible
- hindcasts assembling long term data sets which will provide data for description of past states, and time series showing trends and changes

Operational Oceanography usually proceeds by the rapid transmission of observational data to data assimilation centres. There, powerful computers using numerical forecasting models process the data. The outputs from the models are used to generate data products, often through intermediary value-adding organisations. Examples of final products include warnings (of coastal floods, ice and storm damage, harmful algal blooms and contaminants, etc.), electronic charts, optimum routes for ships, prediction of seasonal or annual primary productivity, ocean currents, ocean climate variability etc. The final products and forecasts must be distributed rapidly to industrial users, government agencies, and regulatory authorities.

(Source: EuroGOOS)

Fundamental terms of Operational Oceanography

- **Monitoring:** Measurements in real time (in-situ or remote sensed), numerical models for nowcasting
- **Forecasting:** Numerical forecasting models, data assimilation techniques
- **Dissemination:** Products available to the end users (governmental agencies, industrial users, regulatory authorities, public) in a comprehensive way.



Applications of Operational Oceanography



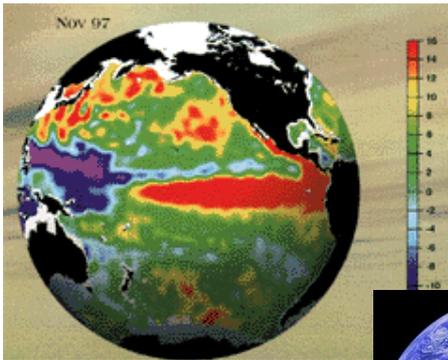
Safety in the sea



Management of marine resources



Effective response to pollution accidents



Global climate change



Efficient planning of marine infrastructure

POSEIDON: An operational monitoring, forecasting and information system for marine environmental conditions in the Eastern Mediterranean

Observations

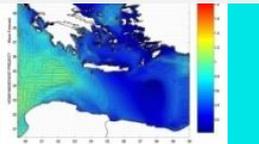
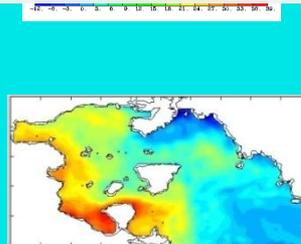


Processing & Modeling

Significant wave height and direction on 08/07/01 Hour:00:00 UTC

Information and Decision Support Systems

- ✓ Targeted to end-user needs (incl. public): maritime transport, fisheries, tourism, environment protection, research
- ✓ **Developed through infrastructure funding (EEA & national funds):**
14.1 M€ in 1997-2000, 9.8 M€ in 2005-2010, 1.2 M€ in 2010-2012
- ✓ Operated by I.O. of HCMR since 2000 – Supported by Greek NMS & Navy
- ✓ Continuously upgraded through collaborative research projects
- ✓ Integrated with / contributing to major European projects and initiatives



End Users

The Vision / Motivation

“An integrated system able to support science, safety, environment and maritime economy in Greece” e.g.

- **Research** oriented applications (climatic variability, ecosystem functioning)
- Support of **maritime transport** (forecasts, SAR)
- Environment **protection** (ecosystem health, oil pollution)
- Support of **tourism** industry (water quality, yachting, ..)
- **Fisheries** and aquaculture management
- **Coastal** zone management (erosion, etc) & Water framework directive

Development Strategy

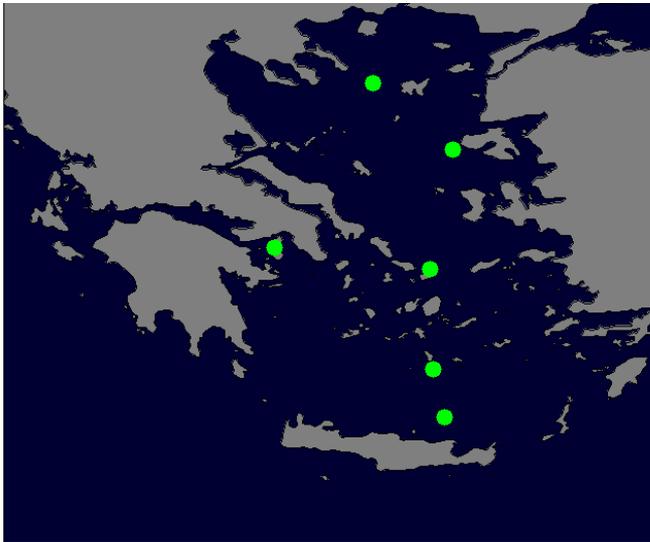
- Embed into appropriate policy frameworks: IOC/GOOS, EuroGOOS, MedGOOS, GEO
- Balance between the operational and research character of the infrastructure
- Integrate national investments with European initiatives: GMES, EMODnet, ESFRI
- Complementarity between national and EU projects: MFSTEP, MERSEA, ECOOP, MARCOAST, MYOCEAN I & II, JERICO, EuroARGO, FixO3 (**25 EU projects since 2000**)
- Integrate coastal - shelf - deep systems & scales: necessary due to specificities of Greek Seas



Poseidon Monitoring Component: 2000-2006

Main system development

11 buoys – 6 locations



- *Measurements at the sea surface*
- *Temperature and Salinity recordings down to 50m in selected locations*



Moorings

Sensors:

Atmospheric

- Air temperature
- Atmospheric pressure
- Wind Speed/Direction

Oceanographic

- Temperature
- Salinity
- Currents
- Waves

Water quality

- Chlorophyll-A
- Oxygen
- Turbidity
- Radioactivity

Poseidon Monitoring Component: 2007-2012

Major System Upgrade and Extension

10 locations – 16 buoys

5 new moorings (WaveScan) to support deep sea monitoring including ecosystem variables

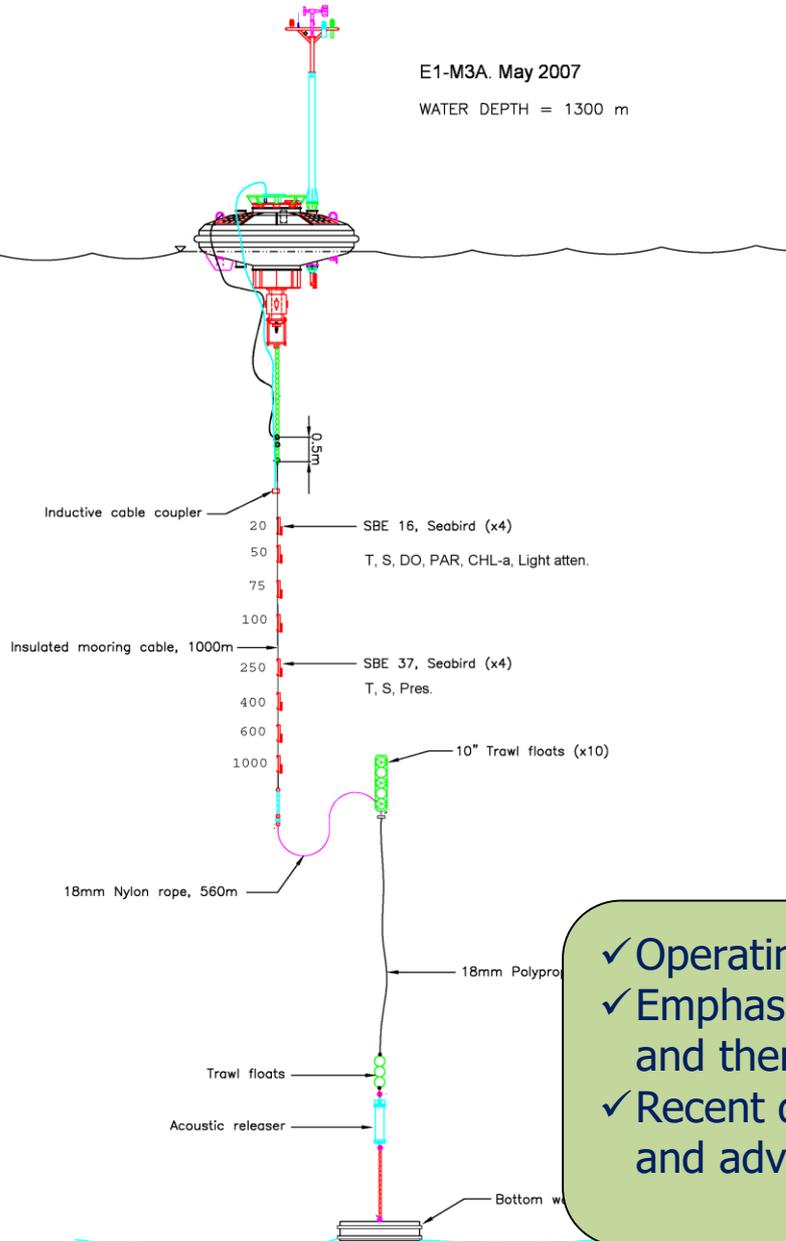


- Monitoring network extended to Ionian Sea**
- ✓ **Eight met-ocean buoys**
 - ✓ Atmospheric data (wind speed & direction, atmospheric pressure, air temperature)
 - ✓ Marine data (waves, surface currents, temperature & salinity down to 100m in selected locations)
 - ✓ **Two reference stations**
 - Cretan Sea
 - Pylos-Ionian Sea
 - ✓ **One seafloor observatory** (bottom platform module)

Reference station E1-M3A (Cretan Sea)

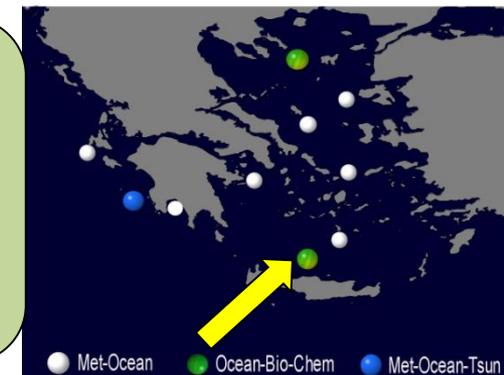
E1-M3A. May 2007

WATER DEPTH = 1300 m



Parameter	Depths measured (m)	Sensor(s) used
Wind speed/dir.,	Surface	Young 04106
Air Pressure,	Surface	Vaisala PTB 220A
Air temperature,	Surface	Omega
Wave Height	Surface	Fugro OCEANOR Wavesense
Pyranometer PSP,	Surface	Eppley
Radiometer PIR,	Surface	Epply
Relative humidity,	Surface	Vaisala HMP 45A
Precipitation sensor,	Surface	Young 50203
Radiance	Surface	Satlantic ocr-507-r10w
Irradiance	Surface	Satlantic ocr-507-ricsw
SST, SSS surface,	Surface (1m)	Aanderaa 3919A
Currents	5-50, 10 bins of 5m	Nortek Aquadopp 400 kHz
Temperature	20, 50, 75, 100m 250, 400, 600, 1000m	Seabird 16plus-IMP C-T Seabird 37-IM C-T
Salinity	20, 50, 75, 100 250, 400, 600, 1000m	Seabird 16plus-IMP C-T Seabird 37-IM C-T
Pressure	250m	Seabird 37-IM C-T-P
Turbidity	20, 50, 75, 100m	Wetlabs flntus-rt
Dissolved Oxygen	20, 50, 75, 100m	SBE43
Chl-a	20, 50, 75, 100m	Wetlabs flntus-rt
PAR	20, 50, 75, 100m	Licor LI-193

- ✓ Operating since 2000
- ✓ Emphasis on bio-chemical processes and thermohaline circulation
- ✓ Recent developments: CO2 sensor and advanced optics

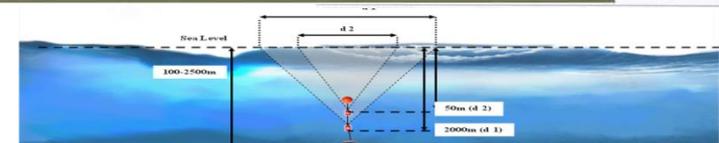
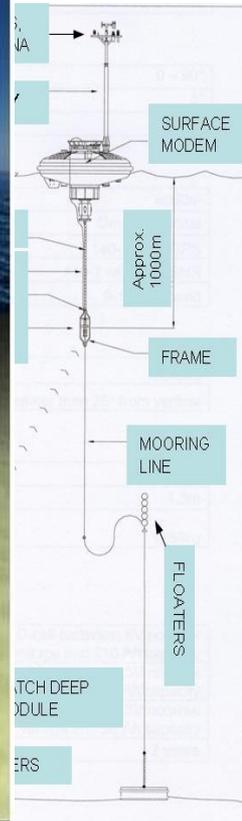
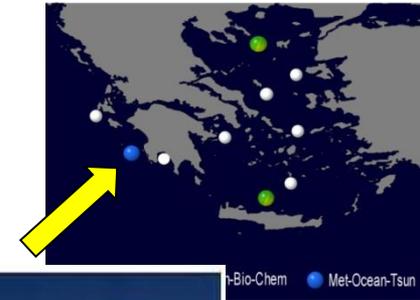


Reference station Pylos

A new Sea-bed observatory developed through POSEIDON –III

Deployed in the sea on October 2013

- ✓ Sensors: Pressure (incl. tsunami mode), T, S, DO, Turbidity, CO₂, CH₄, pH
- ✓ Multi-node autonomous platform (acoustic link between nodes)
- ✓ Upgrade of existing platform to form a node of the network
- ✓ Compatibility of hardware (cpu) with rest of the systems
- ✓ Modular – expandable system



Mooring cable also hosts an experimental PAL (passive aquatic listener) sensor

Calibration Laboratory – Supporting the data quality

Funded through POSEIDON II, turned into operation in 2011



Oxygen

100lit Tank

Winkler Titration

Temperature

Dedicated tank 1.5m³

2 SBE 35 Standard Thermometers

Salinity

Salinometer OSIL

Fluorescence – Chlorophyll A (chl_a) Turbidity

Phytoplankton lab cultures
Fluorescence standards

Turbidity solution of known
concentration

Data from additional sources

Ferry Box System



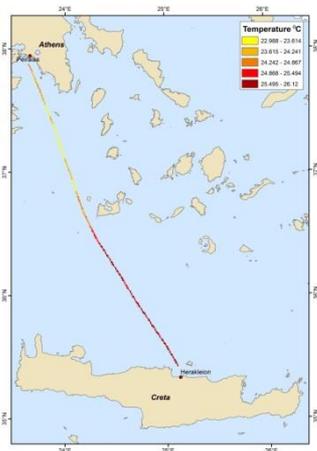
Real time continuous recording of:

- Temperature
- Salinity
- Chlorophyll-a
- Turbidity
- pH

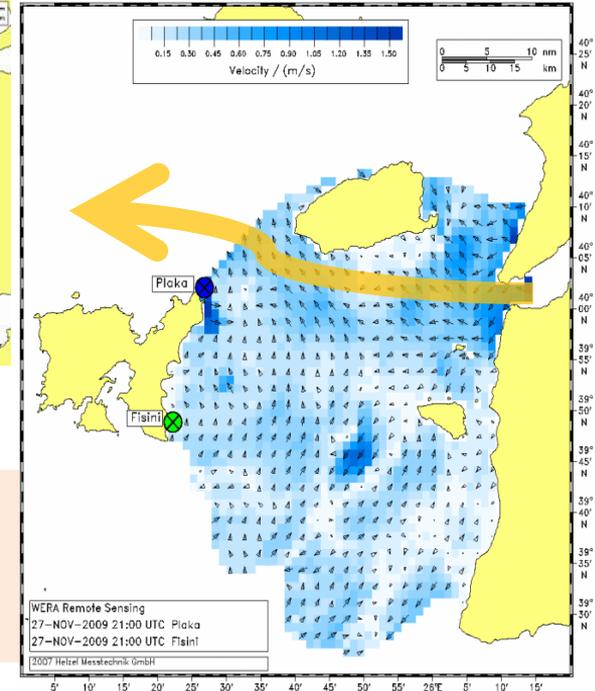
Piraeus-Heraklion

Olympic Champion High Speed

In operation since 2012



HF Radar



In operation since June 2009

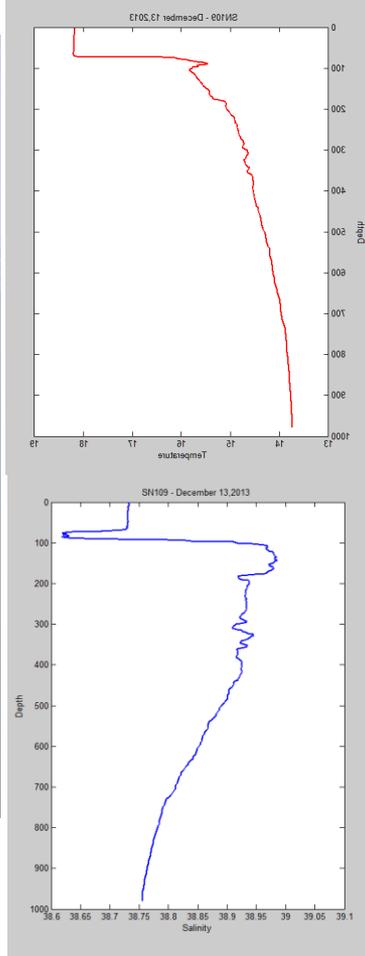
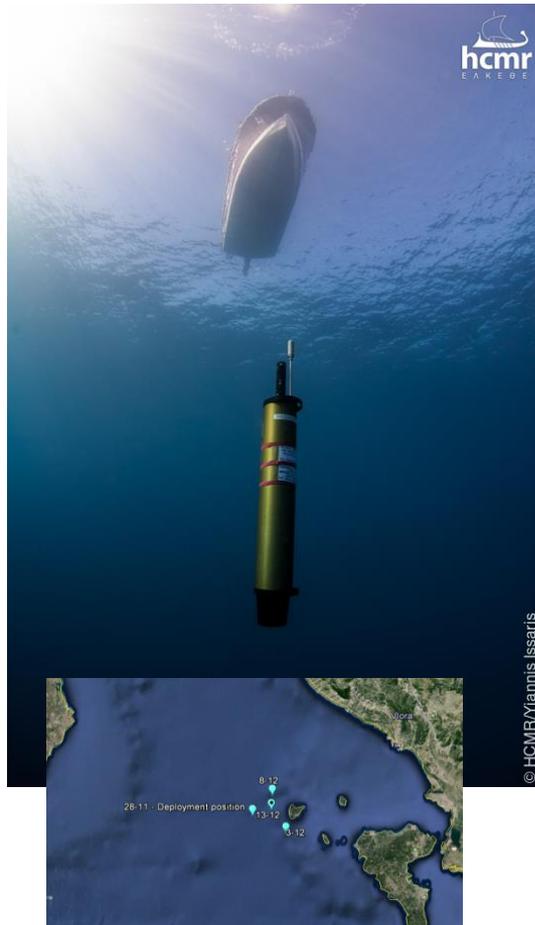
The Black Sea waters outflow through Dardanelles is an important driving mechanism for the Aegean sea hydrology and circulation.

The systematic monitoring of this outflow is a key issue for:

- The validation of the hydrodynamical forecasts
- The improvement on the numerical simulations in the Aegean
- The Search and rescue activities in the area

Data from additional sources

Greek Argo infrastructure



© HCMR/Mannis Issaris



Greek contribution to EuroArgo
Started on 2010

Ecosystem monitoring at E1-M3A site (Cretan Sea)

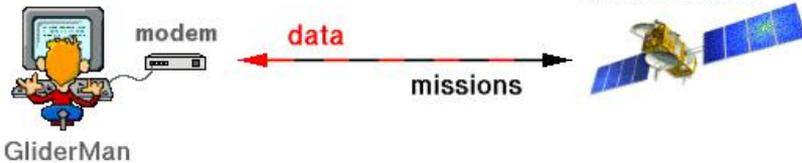


Site is visited in monthly basis
Data available since March 2010

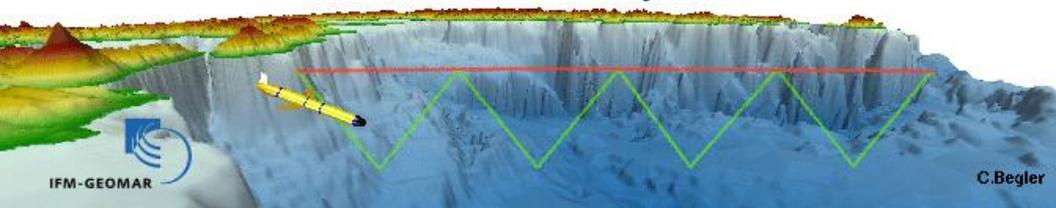
Parameters:

T, S, nutrients, C_T - A_T , CO_2 ,
 Chlorophyll-*a*, pigments (HPLC),
 planktonic community:
 phytoplankton, coccolithophores,
 bacteria, microzooplankton,
 mesozooplankton

SeaExplorer Gliders



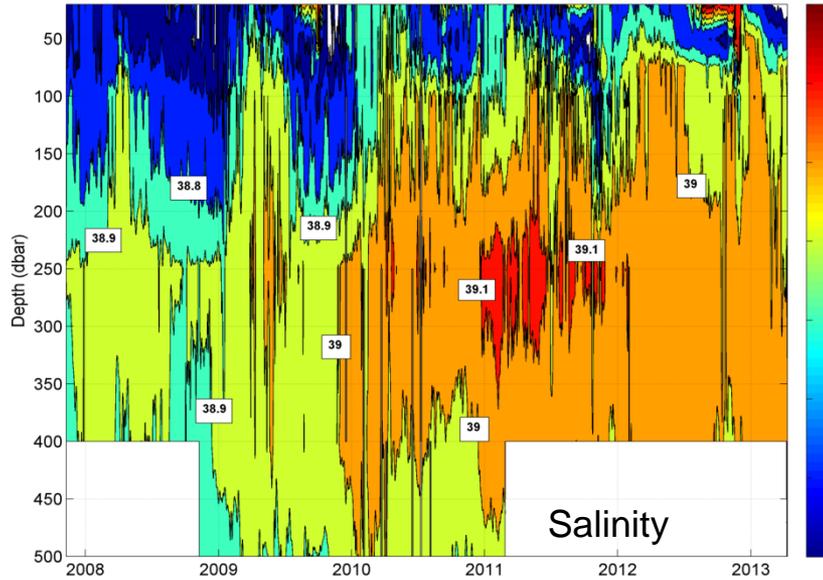
Added to POSEIDON observation facilities
on January 2016



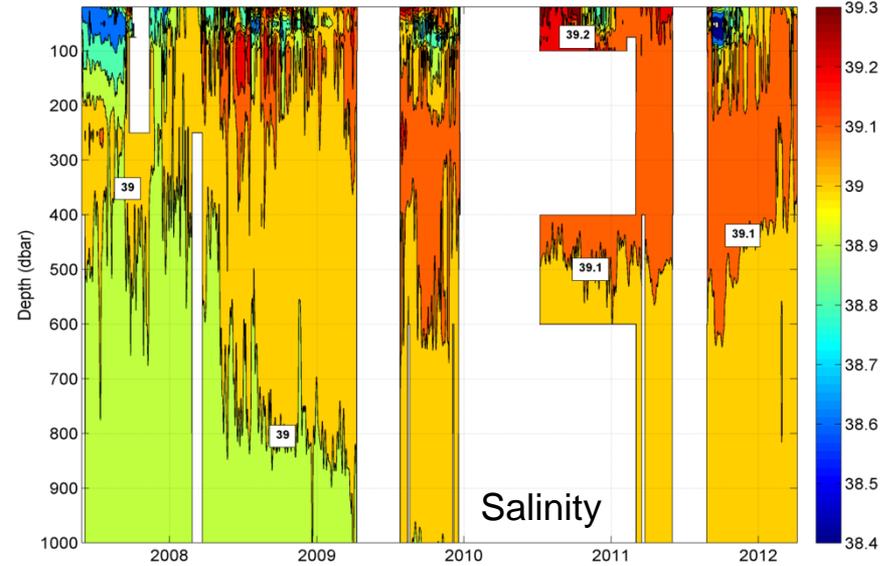
Scientific Payload: CTD, DO
Typical operational cycle:
Dive to 700 m
One descending + One ascending
profile every 4-5 hours
6-10 profiles/day
180-300 profiles/month
High frequency recording of data
Measuring the Ocean variability

Long time series data from the reference stations

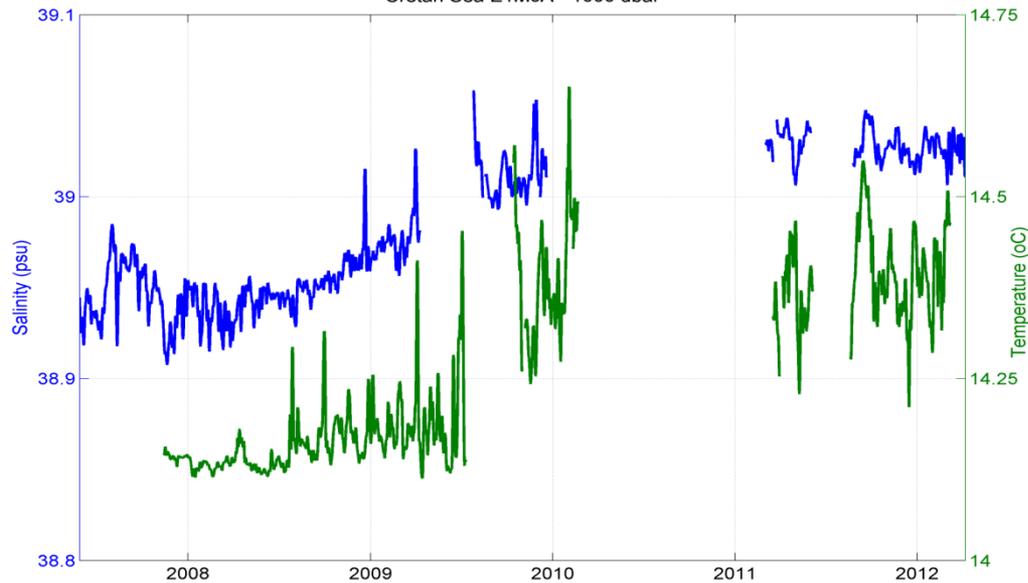
Southeast Ionian Sea (Pylos)



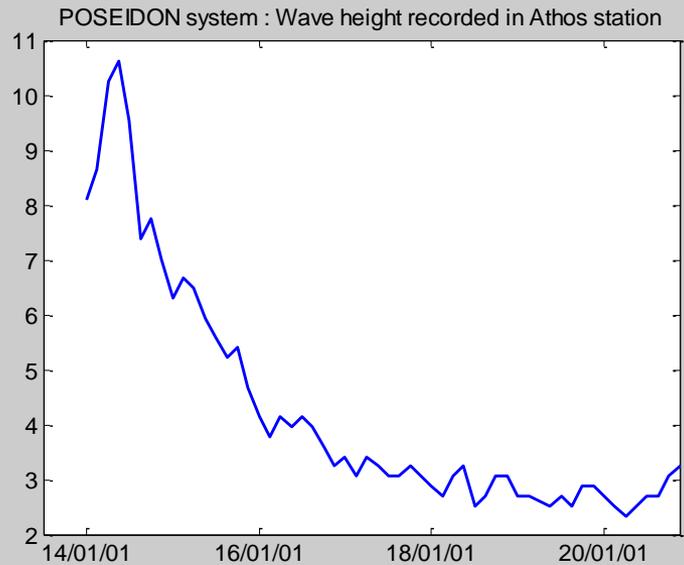
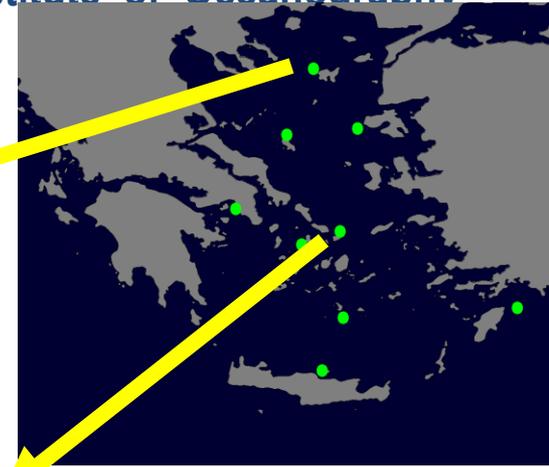
Cretan Sea E1M3A



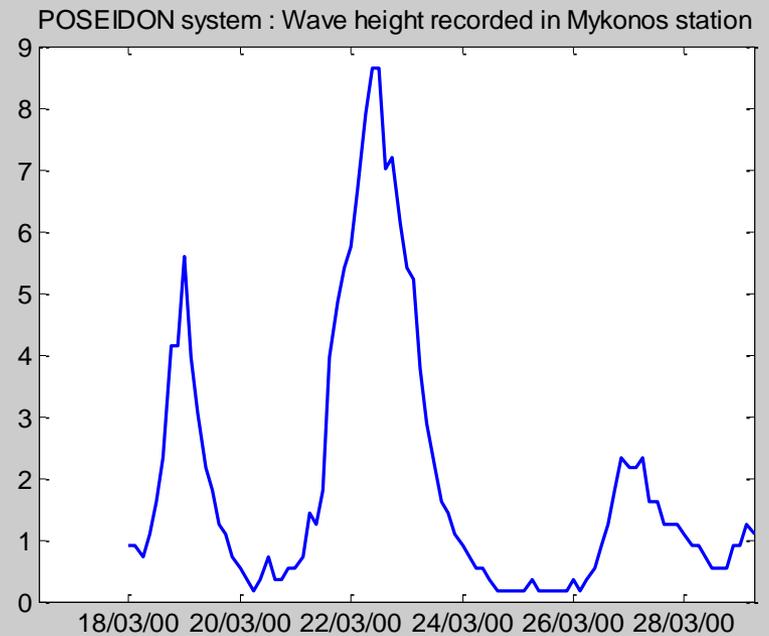
Cretan Sea E1M3A - 1000 dbar



Extreme wave recordings

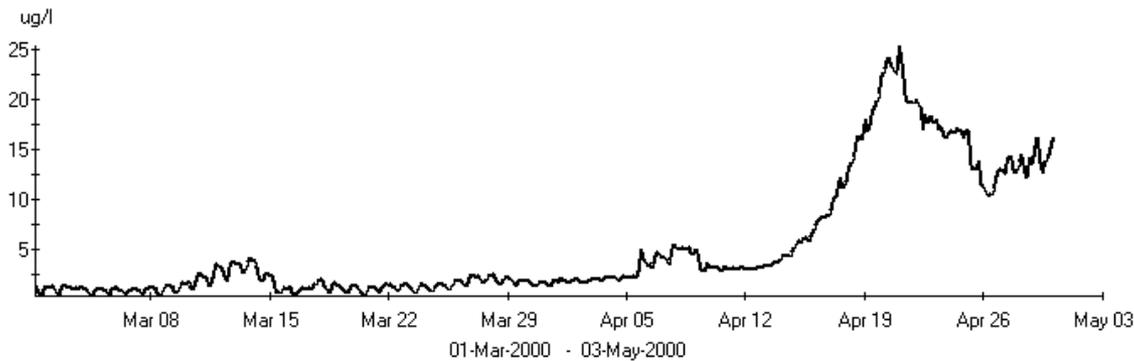


*Athos station : 14 Jan 01,
wave height:10,8m*

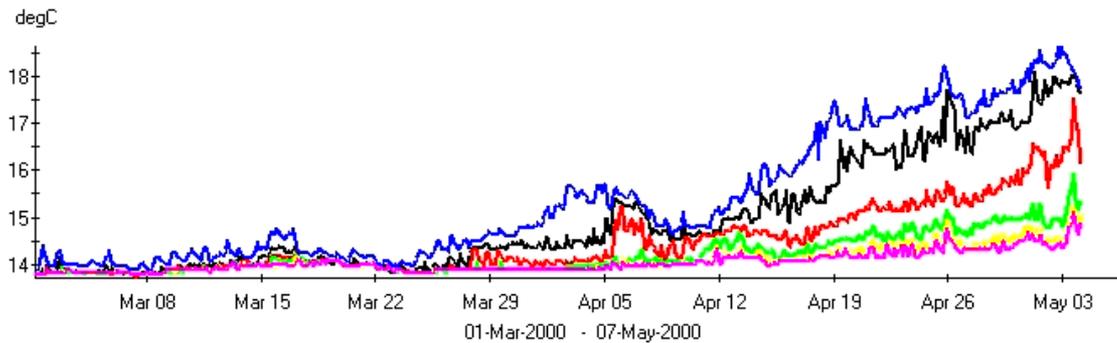


*Mykonos station : 23 Mar 00,
wave height:8,9m*

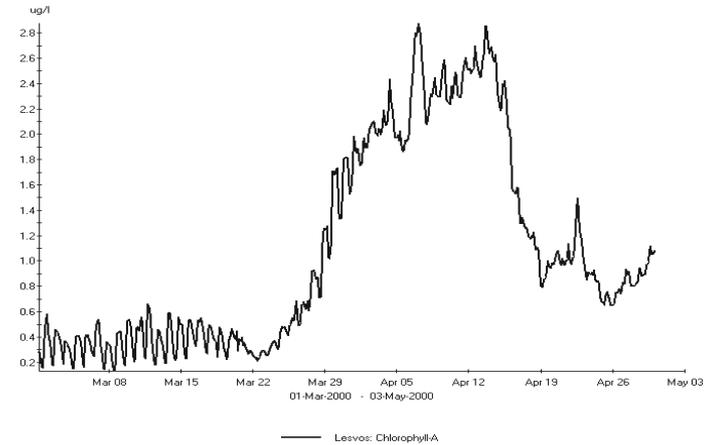
Biochemical processes



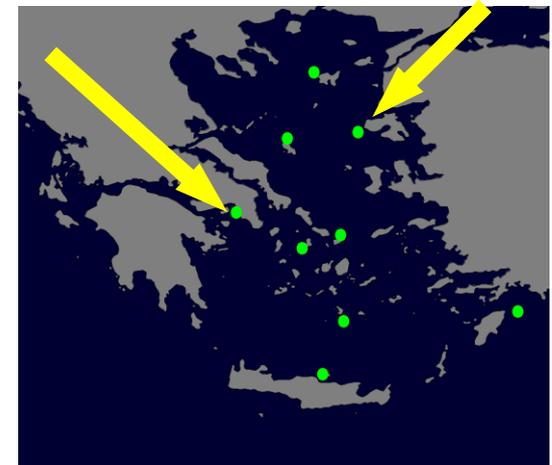
— Egina: Chlorophyll-A



— Egina: WatTemp10m — Egina: WatTemp20m — Egina: WatTemp30m
 — Egina: WatTemp3m — Egina: WatTemp40m — Egina: WatTemp45m



— Lesvos: Chlorophyll-A



POSEIDON participates to the major Operational Oceanography initiatives

EuroGOOS

Home > Members products

Members products

Many of the member agencies of EuroGOOS offer a large variety of operational oceanographic products, both for the national coasts of their countries and for larger sea areas. Products include nowcasts/forecasts, oceanographic databases, and bathymetric maps. Use the map to access the oceanographic web products offered by EuroGOOS members at each location.

Organisation:
Hellenic Centre for Marine Research, Institute of Oceanography (HCMR/IO)

Products:
Poseidon - monitoring, forecasting and information system

EMODnet
European Marine Observation and Data Network

Pilot Portal For Physical Parameters

Home Feedback How to

Data type: Near RealTime Historical

Parameters:

- Waves and winds
- Sea water temperature
- Sea water salinity
- Currents
- Light attenuation
- Sea levels

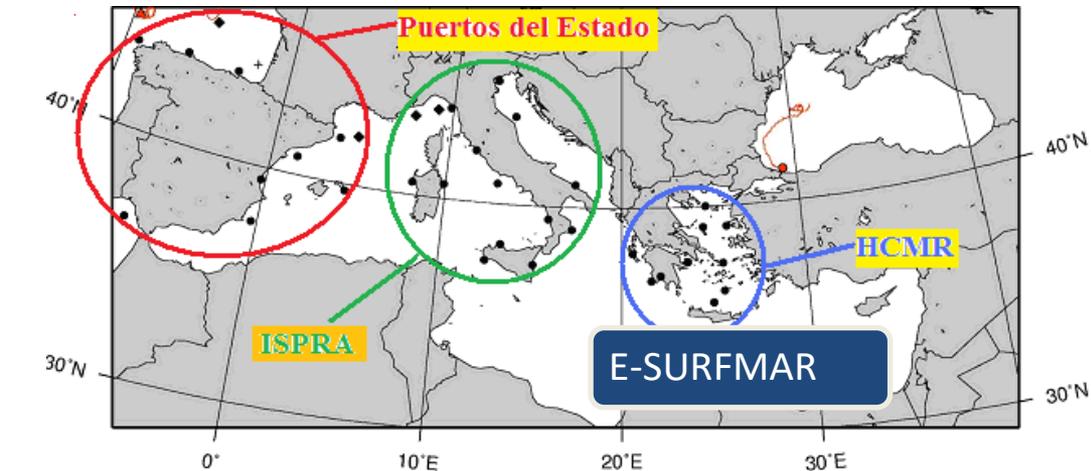
Sea area (EuroGOOS region):

- Arctic Seas
- Baltic Sea
- Atlantic
- North Sea
- Black Sea
- Mediterranean Sea

EMODnet Map

Search by station name: Insert...

EMODnet



Copernicus Marine Environment Monitoring Service

ONLINE CATALOGUE

CATALOGUE PDF FIRST VISIT MY CART

For the Global Ocean: the IFREMER CERSAT Global Blended Mean Wind Fields include wind components (meridional and zonal), wind module, wind stress. The associated error estimates are also provided. They are estimated from scatterometers ASCAT and OSCAT retrievals and from ECMWF operational wind analysis with a horizontal resolution of 0.25x0.25 degrees and 6 hours in time, and available at synoptic time 00h:00, 06h:00, 12h:00, 18h:00 since January, 1st 2013.

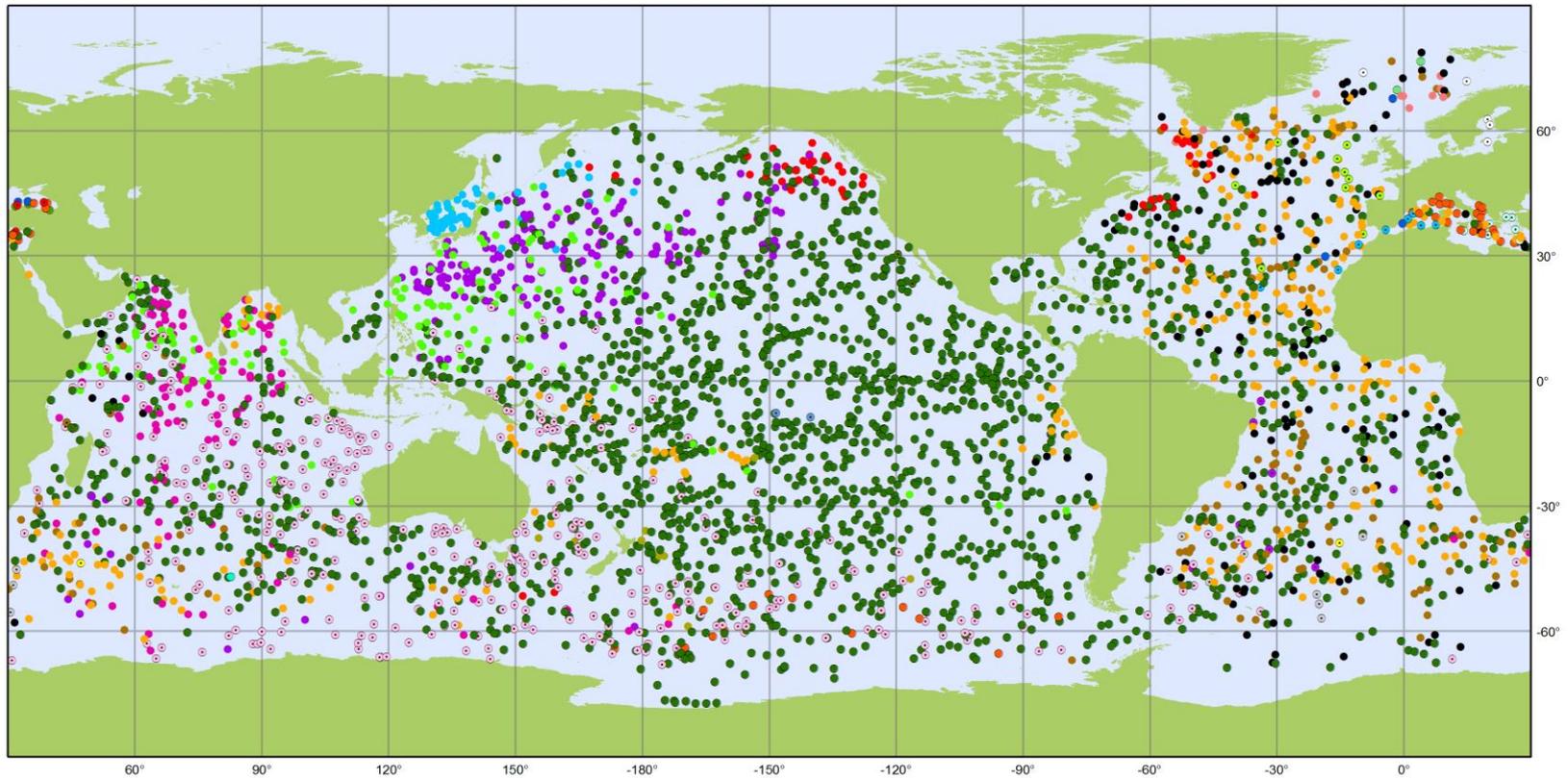
MEDITERRANEAN SEA- IN-SITU NEAR REAL TIME OBSERVATIONS
Observation, Ocean-Chlorophyll, Salinity, Chemistry, Temperature, Currents, Sea-surface-Real-Time, Mediterranean-Sea

MEDITERRANEAN SEA- The In Situ Thematic y Centre (INS-TAC) integrates near real-time in situ data. These data are collected from the OS members and complemented by the in collected by the Global INS-TAC in the area. It is updated continuously and provides ones with 24-48 hours from acquisition in average.

MEDITERRANEAN-IN-SITU OBSERVATIONS YEARLY DELIVERY IN DELAYED MODE (1990-2014)
In-Situ-Observation, Salinity, Temperature, Multi-Year, Mediterranean-Sea

For the Mediterranean Sea- In-situ observation yearly delivery in delayed mode. The In Situ delayed mode product designed for reanalysis purpose, integrates the best available version of in situ data for temperature and salinity measurements. These data are collected from national observing systems operated by Mediterranean RCOs members (MONGOS), scientific cruises from SeaDataNet NODCs. It is updated on a yearly basis. This product is delivered by authenticated FTP and is elaborated jointly with the SeaDataNet2 project.

POSEIDON participates to the major Operational Oceanography initiatives



Argo

National contributions - 3814 Operational Floats

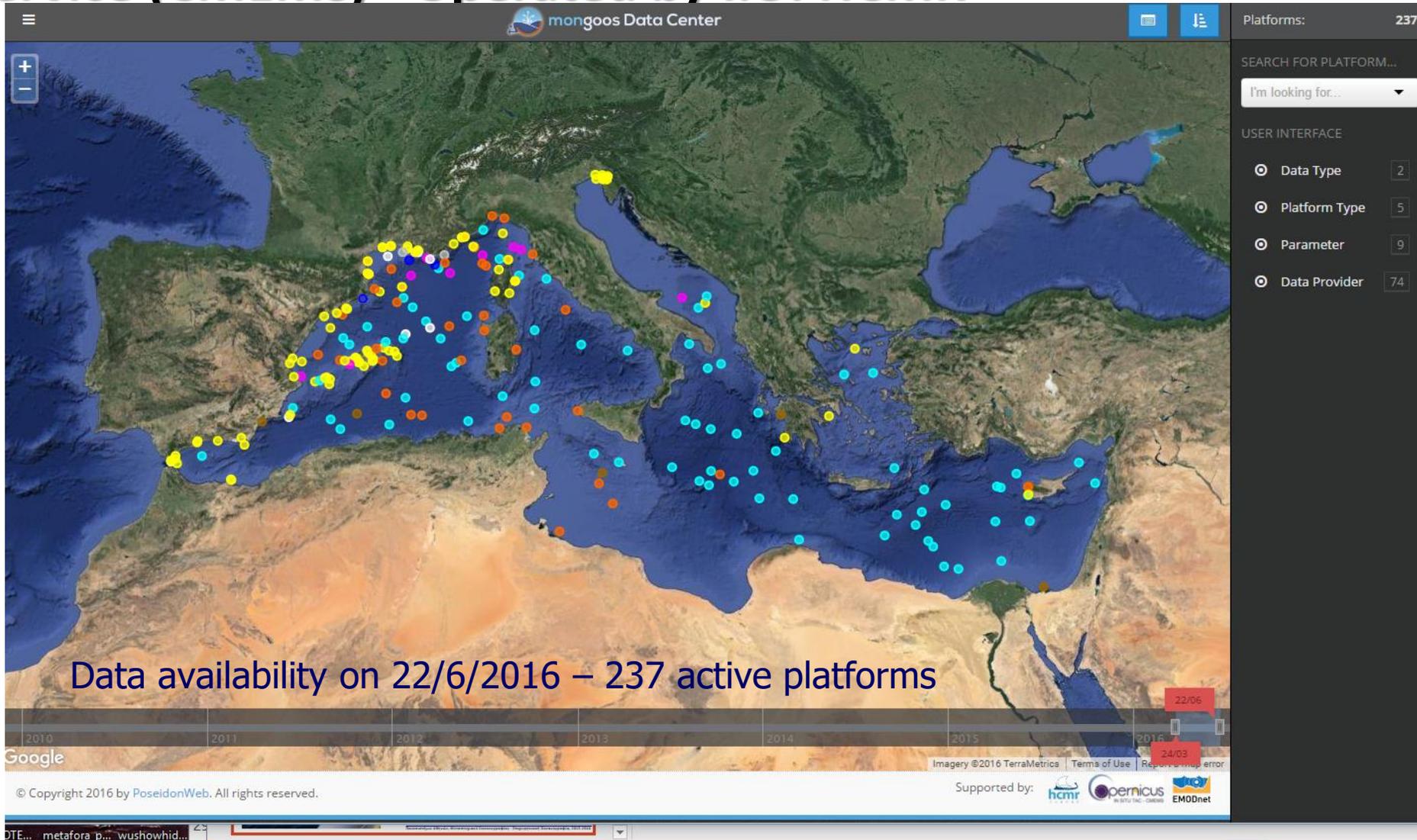
May 2016

Latest location of operational floats (data distributed within the last 30 days)

● ARGENTINA (2)	● CHINA (147)	● GERMANY (140)	● JAPAN (177)	○ NETHERLANDS (11)	● SPAIN (8)
○ AUSTRALIA (380)	● ECUADOR (2)	○ GREECE (8)	● KENYA (1)	● NEW ZEALAND (11)	● TURKEY (3)
● BRAZIL (10)	● EUROPE (6)	● INDIA (123)	● KOREA, REPUBLIC OF (55)	● NORWAY (10)	● UK (132)
● BULGARIA (3)	○ FINLAND (6)	● IRELAND (10)	● MAURITIUS (3)	● POLAND (3)	● USA (2124)
● CANADA (64)	● FRANCE (325)	● ITALY (47)	● MEXICO (2)	● SOUTH AFRICA (1)	



The Mediterranean Insitu Thematic Assembly Center – Module of the Copernicus Marine Environment Monitoring Service (CMEMS) - Operated by I.O. HCMR

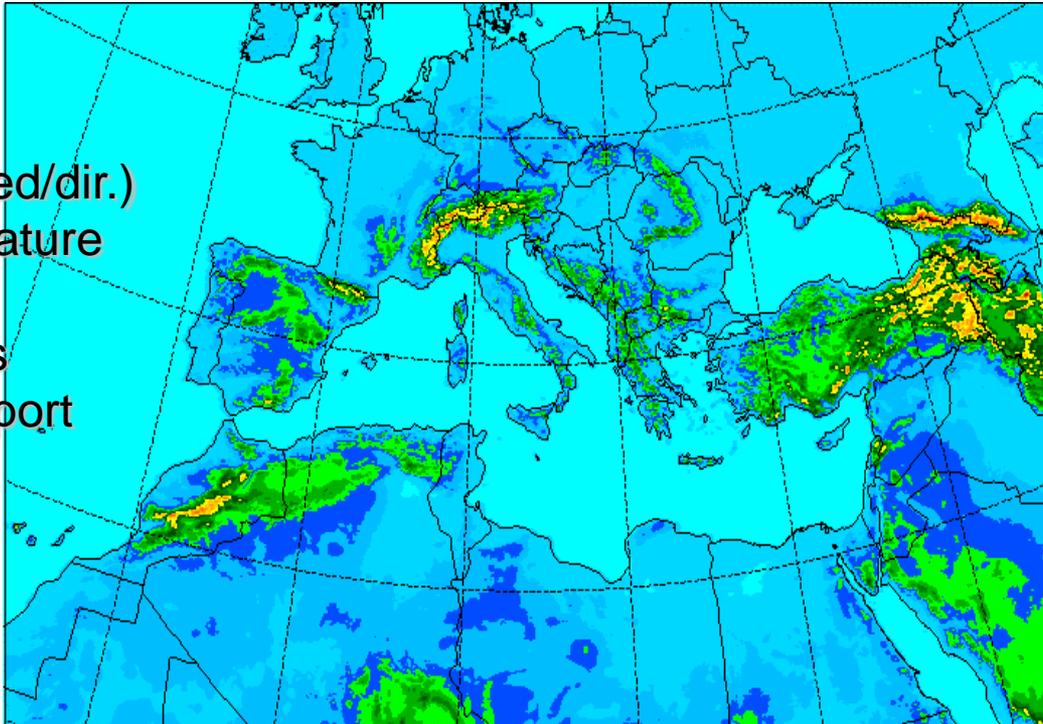


Forecasting component

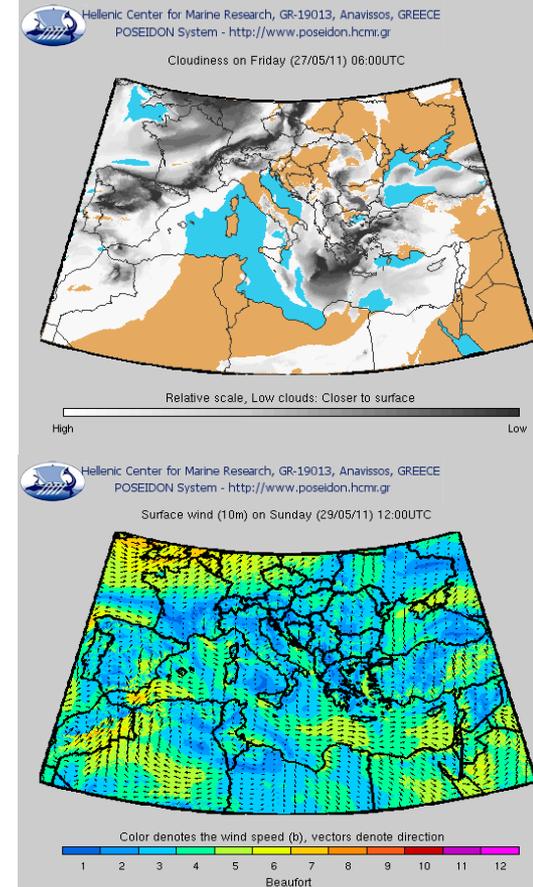
The POSEIDON weather forecasting system

Products:

- ✓ Wind (speed/dir.)
- ✓ Air temperature
- ✓ Rainfall
- ✓ Cloudiness
- ✓ Dust transport
- ✓ Fog
- ✓

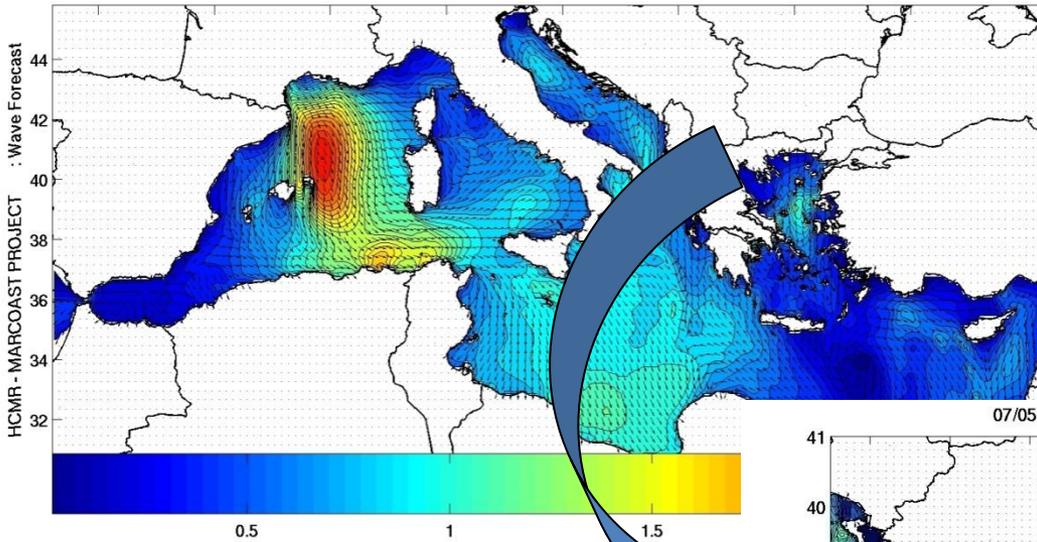


- Non-hydrostatic Eta model
- Horizontal resolution : $0.05^\circ \times 0.05^\circ$ (~ 5 km)
- Vertical resolution: 50 levels up to 25 hPa (~ 25 km)



Sea state forecasting

07/05/07 12:00 UTC : Significant wave height(m) and direction



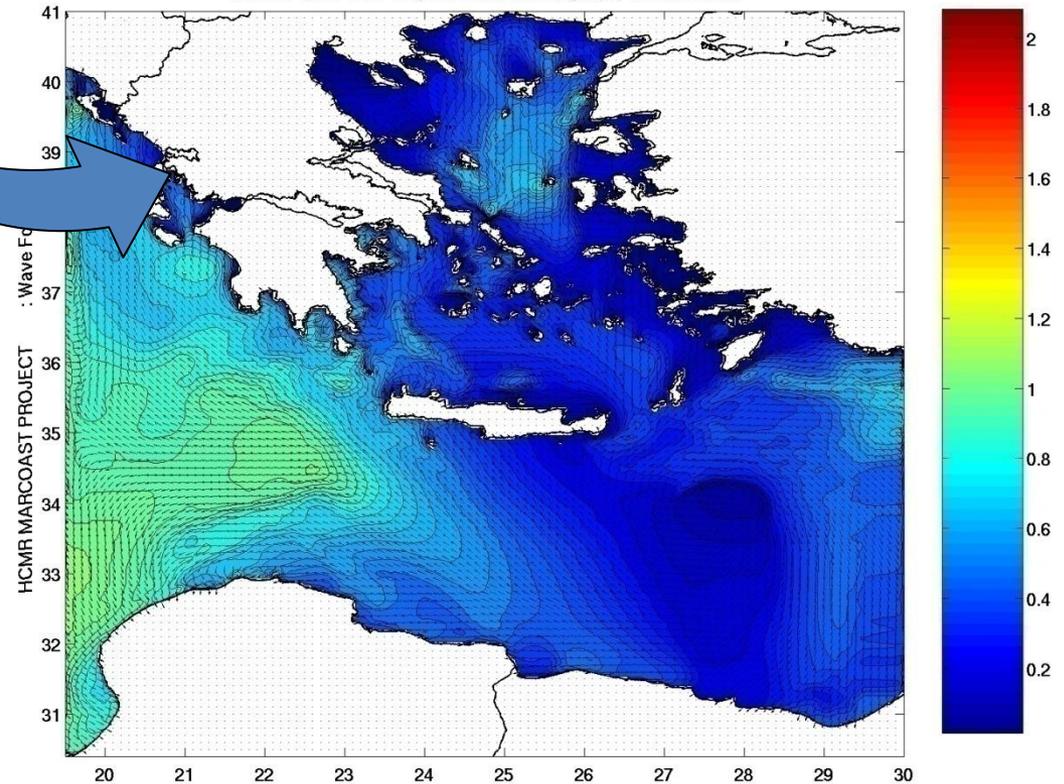
RESOLUTION ~10km

Products:

- ✓ Wave height
- ✓ Direction
- ✓ Period

RESOLUTION ~3km

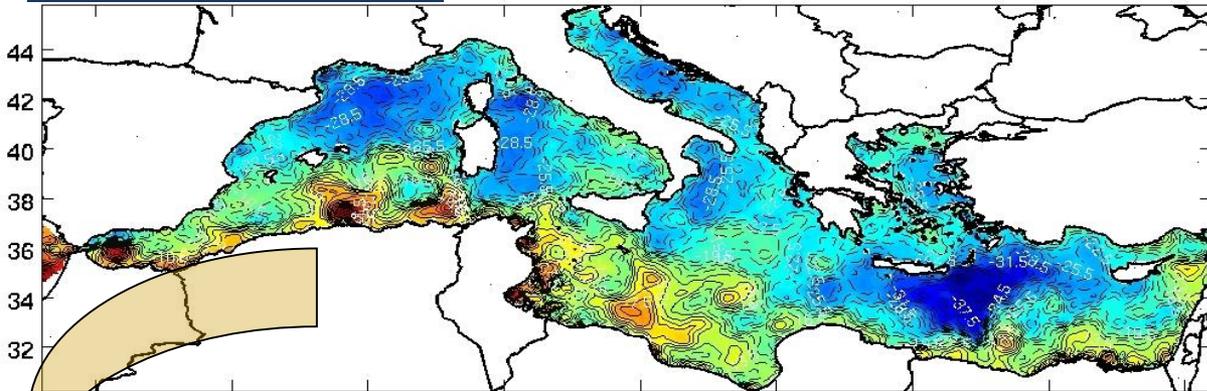
07/05/07 12:00 UTC : Significant wave height(m) and direction



Forecasting of hydrodynamics

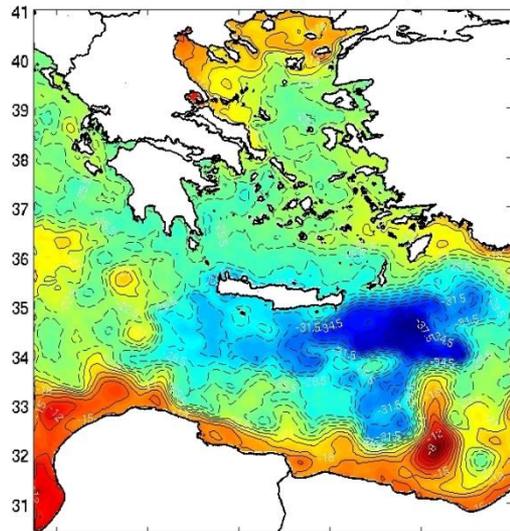
RESOLUTION 10km

07/05/2008 18 UTC

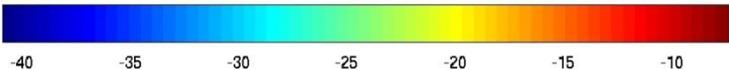


Free surface Elevation (cm), Year=1, Month=5, Day=8.75 Min= -41.0011, Max= 9.5292, CI=1.5

07/05/2008 18 UTC (VERSION 1)



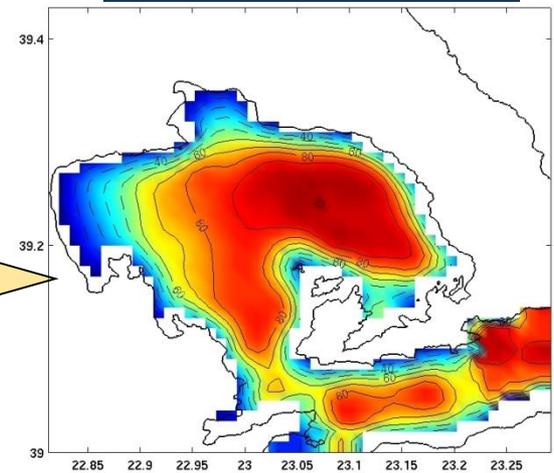
Free surface Elevation (cm), Year=1, Month=5, Day=8.75 Min= -41.017, Max= -7.0698, CI=1.5



Products:

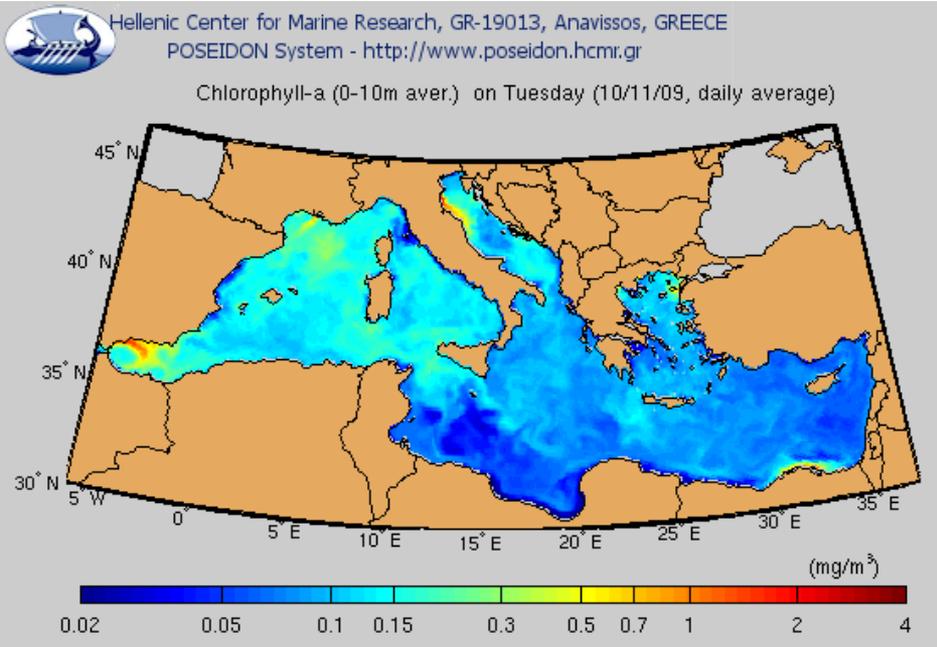
- ✓ Currents
- ✓ Temperature
- ✓ Salinity

RESOLUTION 1km



RESOLUTION 3km

Ecosystem forecasting



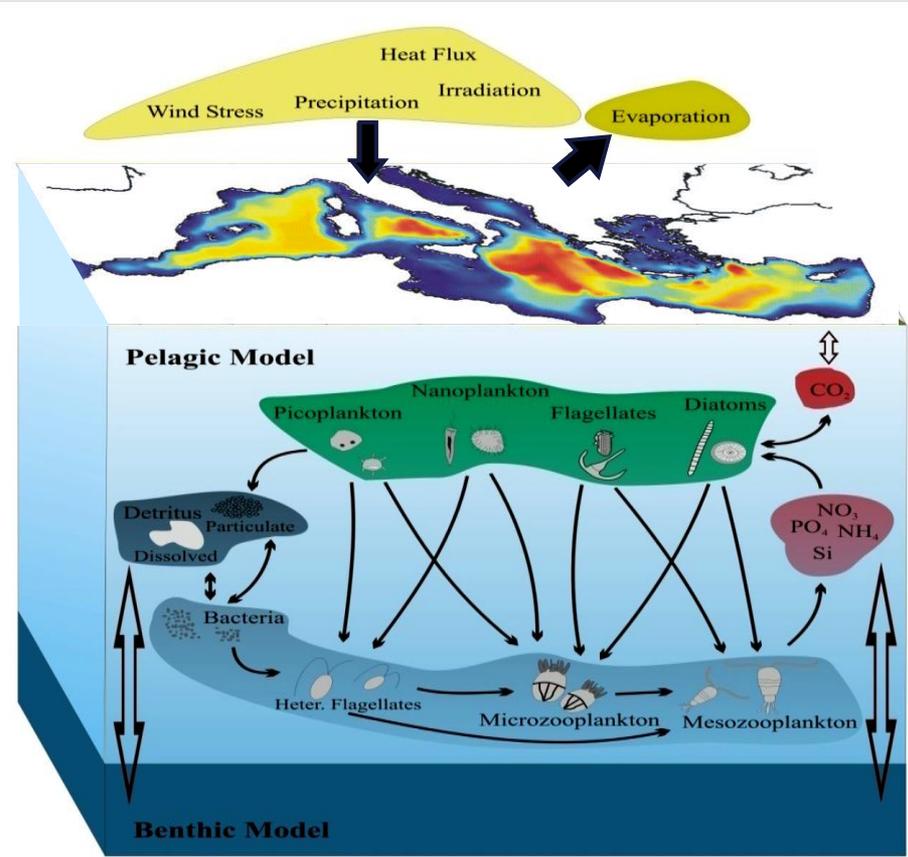
Horizontal Resolution: 1/10° (~10Km)

Vertical Resolution: 25-sigma levels

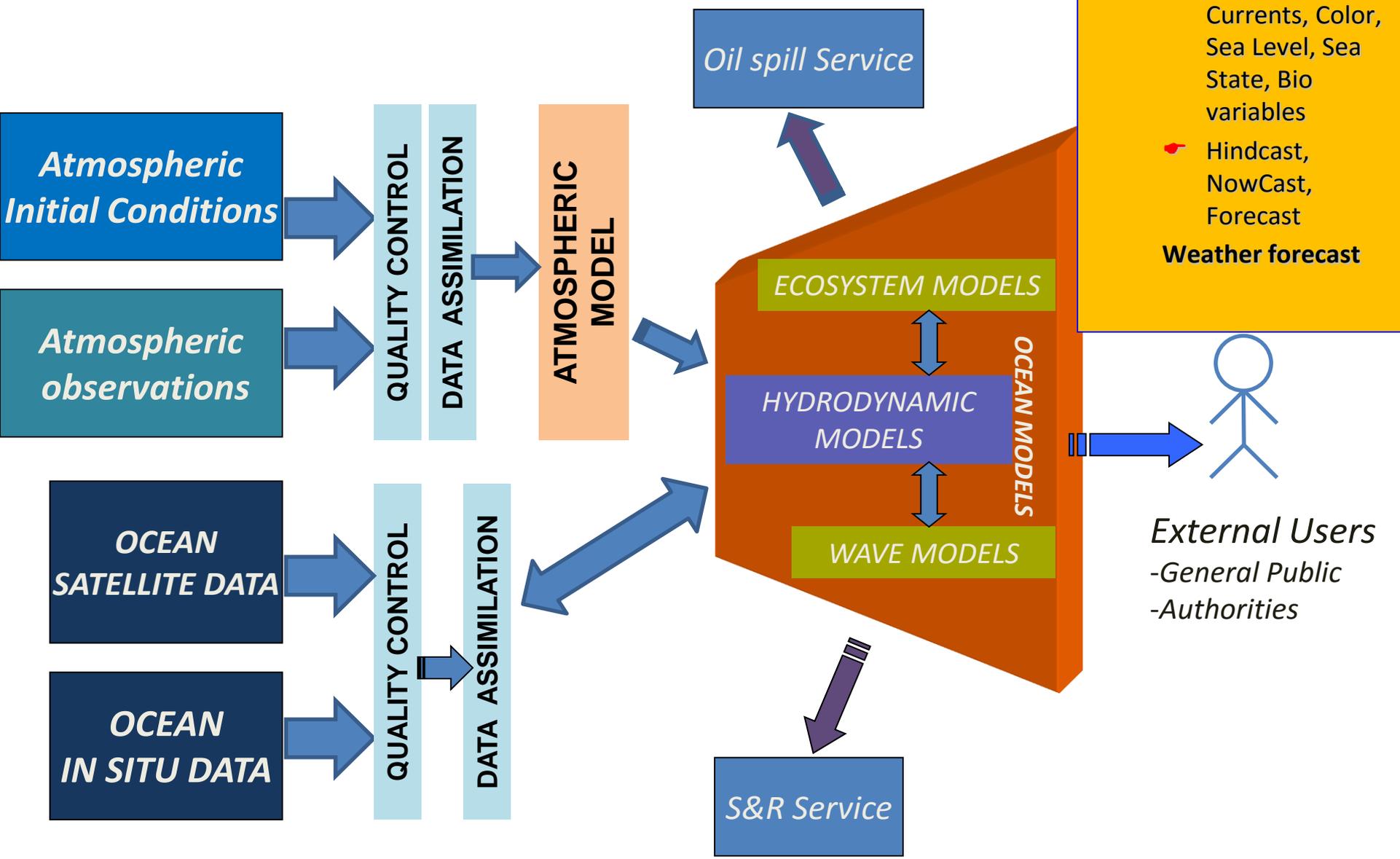
Minimum water column depth : 30m

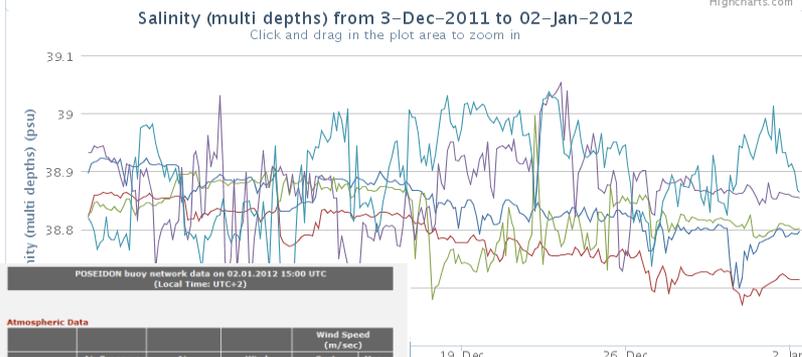
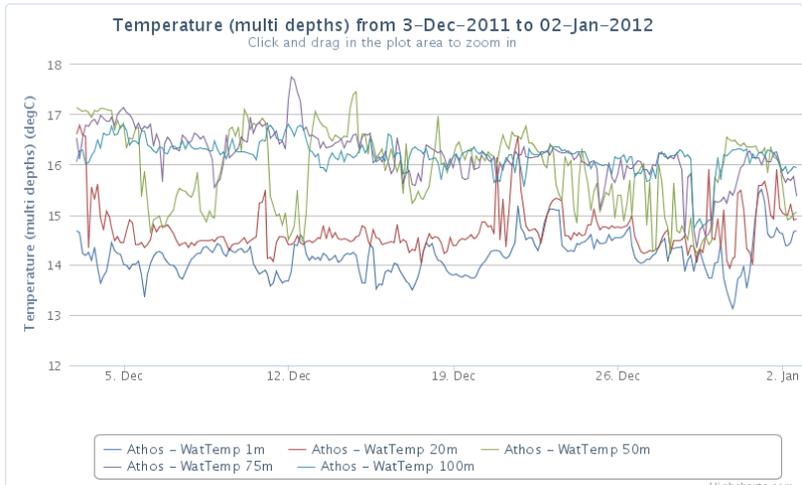
Hydrodynamic model
POM (Blumberg and Mellor, 1983)

Ecosystem model
ERSEM (Baretta et al. 1995)



POSEIDON Production Line





POSEIDON buoy network data on 02/01/2012 15:00 UTC (Local Time: UTC+2)

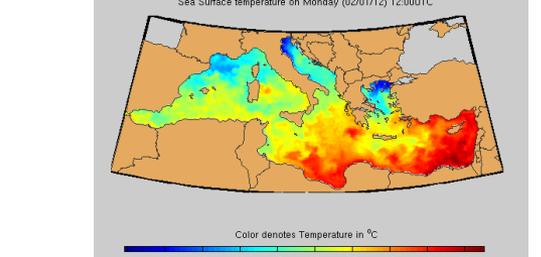
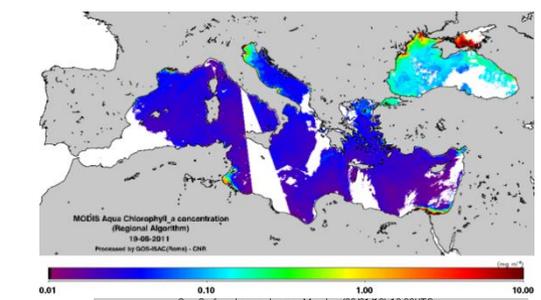
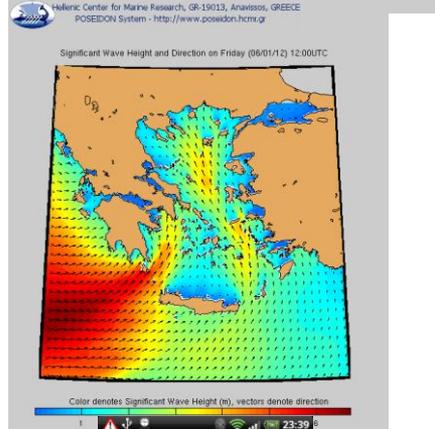
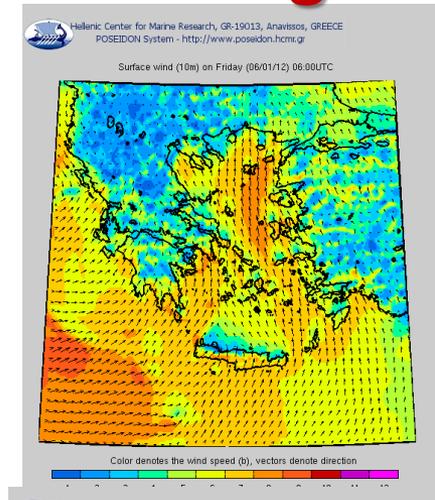
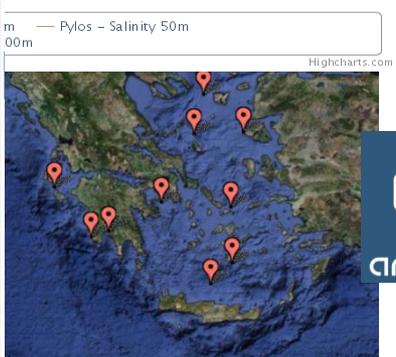
	Air Pressure (mbar)	Air Temperature (°C)	Wind direction (degrees)	Wind Speed (m/sec)	Gust	Mean speed
Athos	1025.76	11.11	22.50	1.17	0.23	
EIM3A	N/A	N/A	N/A	N/A	N/A	N/A
Lesvos	1025.13	9.53	1.41	9.04	6.30	
Mykonos	1017.95	11.06	350.42	13.11	9.48	
Saronikos	1018.99	11.22	12.04	3.69	2.26	
Pylos	N/A	N/A	N/A	N/A	N/A	N/A
Santorini	1024.23	33.82	344.53	11.48	8.67	
Skyros	N/A	N/A	N/A	N/A	N/A	N/A
Zakynthos	1019.94	12.65	99.93	1.60	0.82	

N/A denotes a non-available value

Marine Data

	Current Data			Waves data			Surface Temperature (°C)
	Direction (degrees)	Speed (cm/sec)	Significant height (meters)	Maximum height (meters)	Main direction (degrees)	Temperature (°C)	
Athos	156.45	3.22	0.39	0.39	313.59	14.67	
EIM3A	N/A	N/A	N/A	N/A	N/A	N/A	
Lesvos	78.66	8.64	0.59	0.64	343.92	16.11	
Mykonos	97.47	9.16	1.58	2.10	350.24	15.27	
Saronikos	145.02	13.40	0.36	0.37	35.99	14.67	
Pylos	N/A	N/A	N/A	N/A	N/A	N/A	
Santorini	228.52	23.14	1.09	1.56	352.97	14.81	
Skyros	N/A	N/A	N/A	N/A	N/A	N/A	
Zakynthos	226.14	N/A	0.46	0.68	254.44	17.49	

N/A denotes a non-available value



Web: ~1.200.000 user sessions/month

Products and Services

Oil Spill forecasting

Results for the Oil Spill Modeling Application
Information about the oil spill event

[Download KML](#)

Date:	10/11/11
Time (UTC):	00:00
Initial Position:	21.0278 E 38.1216 N
Duration of Integration (Hrs):	168 (7 days)
Evacuation time (Hrs):	Instant
Output graphic every (Hrs):	12

Date: 14/11/11 Hour: 12:00 UTC
Vectors denote surface current velocity and direction

Initial volume: 10000
Evap. volume: 31.4 %
Emuls. volume: 23.1 %
0.5% of points on beach

▲ Initial point of accident
● Sea points, depth=0-10m
● Sea points, depth=10m
● Sedimentation points
● Land points

14/11/11 Hour: 12:00 UTC [Animation](#)

All the graphical outputs with a summary text are available in zip file.
Click here to download the zip file (size: 482.19 KB)

Search and Rescue



The step forward : Towards an Integrated Observatory



Three **multi-parametric moorings** (Cretan Sea, Ionian Sea, North Aegean) – Biochemical parameters (nutrients, pH, CO₂) at several depths

Coastal monitoring: Three stations (+on demand)

Argo component : Greek Argo infrastructure, 20 deployments up to 2017

Introduce the **Glider component**: Two SeaExplorer gliders are ready to begin the missions at the sea

Ferry Box System: Introduce a new line in the Northern Aegean

Integrate the **EMSO Hellas** infrastructure: **Cabled observatory**, Pylos, Ionian Sea (in operation during 2016)

High resolution recording of surface currents: Integrate the **surface drifter component** (University of Aegean – National Roadmap) – Add another **HF Radar** system

Introducing a **sea level monitoring component**: Integrate the existing network of HHS (National Roadmap), addition of new stations

Monitoring the ocean on multiple scales