

# **HCMR Operational Oceanography activities**

## **Present status and future perspectives**

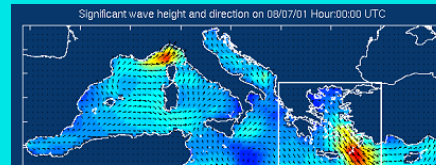
**Leonidas Perivoliotis, Institute of Oceanography, HCMR**

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

### Observations



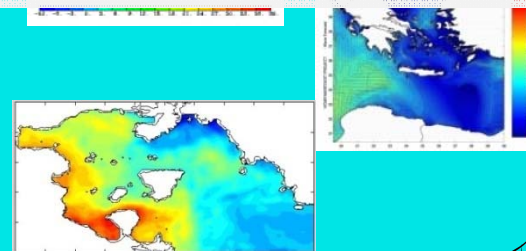
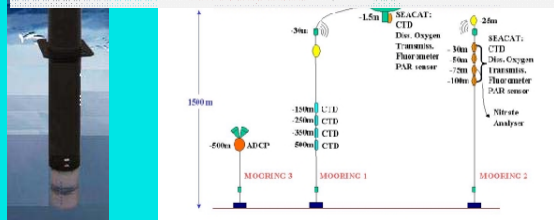
### Processing & Modeling



### Information and Decision Support Systems



- ✓ 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*

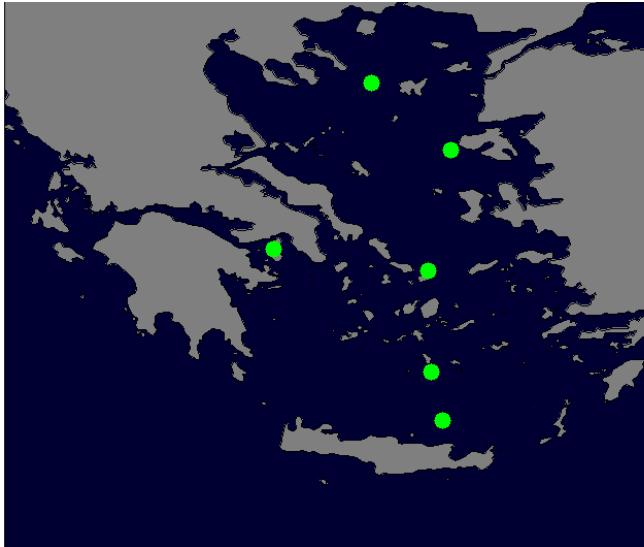
- Embed into appropriate policy frameworks: IOC/GOOS, EuroGOOS, MedGOOS, GEO
- Balance between the operational and research character of the infrastructure
- Integrate national investments with European initiatives: GMES, EMODnet, ESFRI
- Complementarity between national and EU projects: MFSTEP, MERSEA, ECOOP, MARCOAST, MYOCEAN I & II, JERICO, EuroARGO, FixO3...(20 EU projects since 2000)
- Integrate coastal - shelf - deep systems & scales: necessary due to specificities of Greek Seas



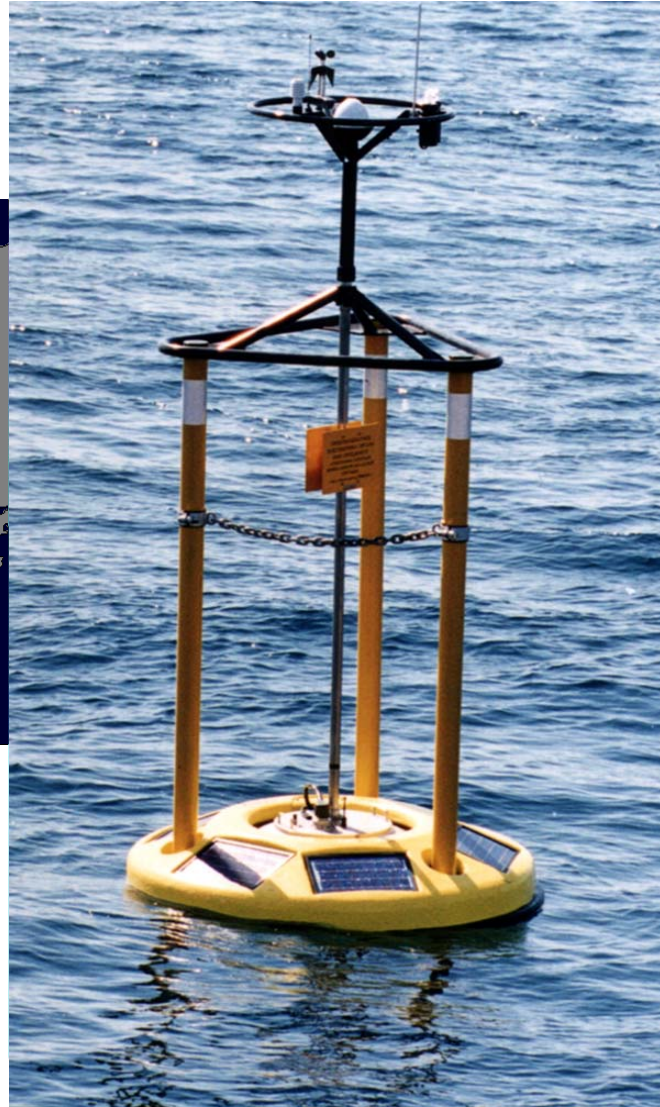
# Poseidon Monitoring Component: 2000-2006

## 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

## Mooring network

10 locations – 16 buoys

5 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)

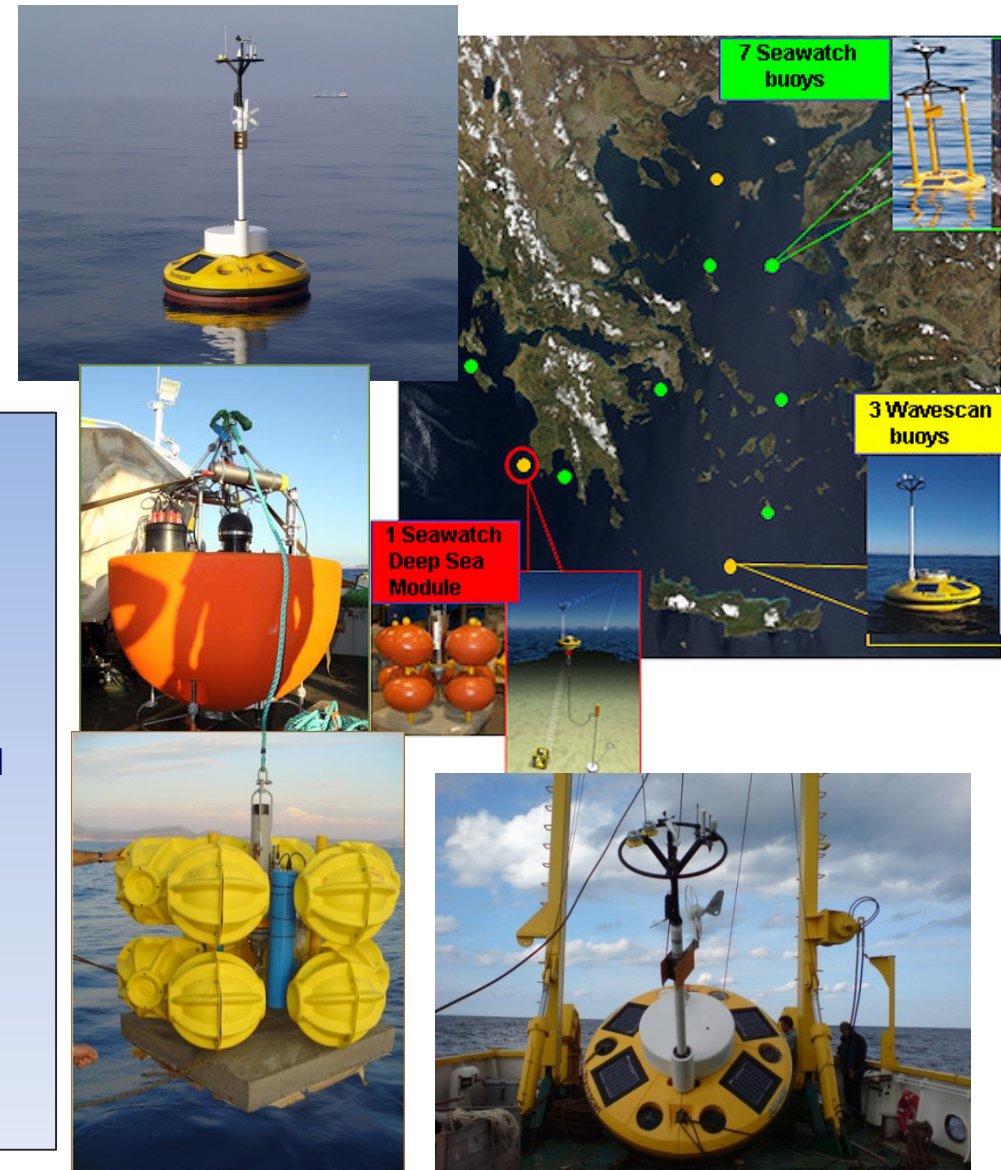
✓Marine data (waves, surface currents, temperature & salinity down to 100m in selected locations)

#### ✓Two reference stations

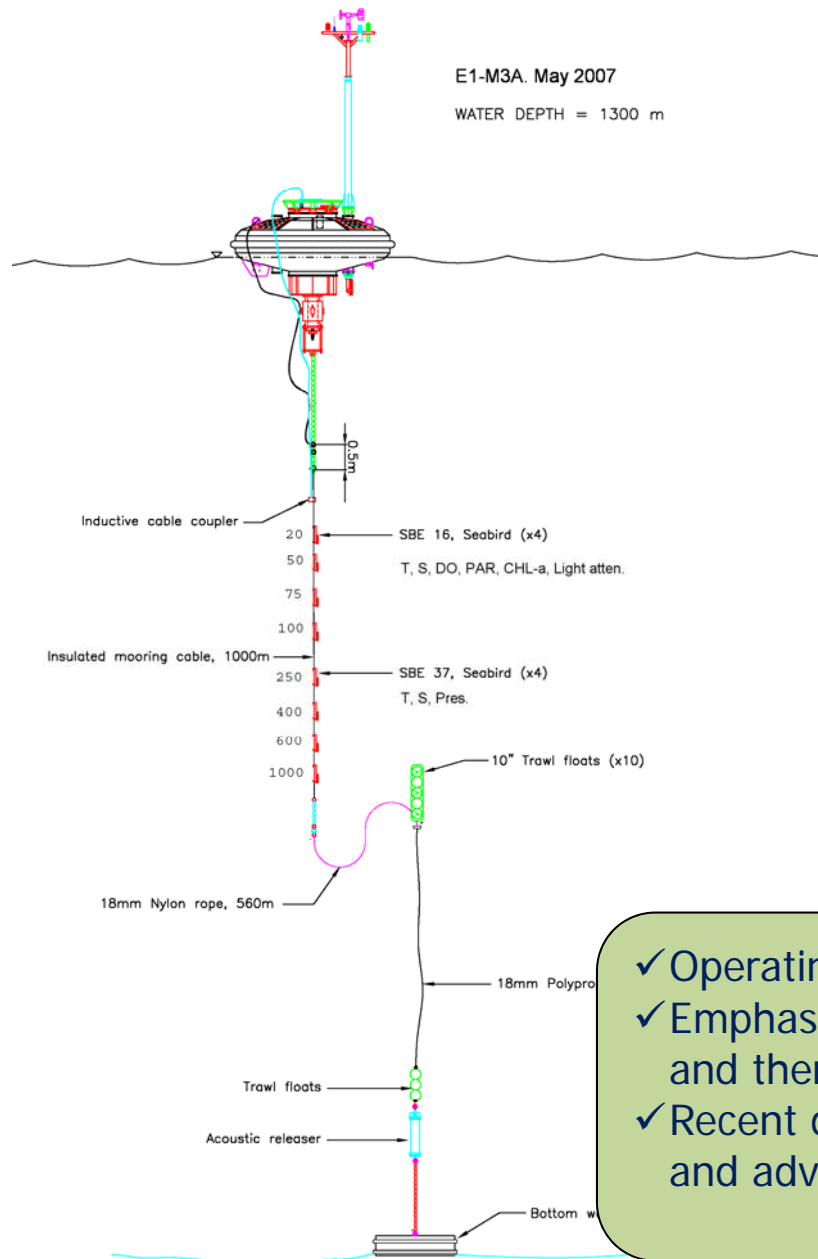
Cretan Sea

Pylos-Ionian Sea

✓One seafloor observatory (bottom platform module)

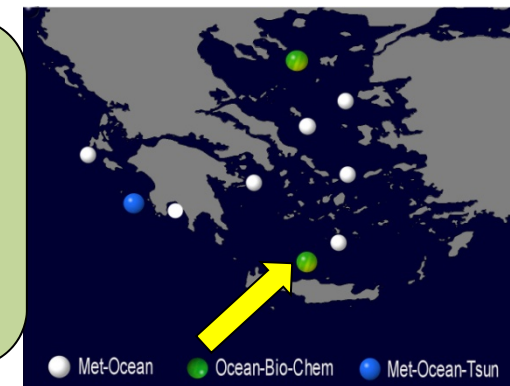


# Reference station E1-M3A (Cretan Sea)



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	Epply
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 flintus-rt
Dissolved Oxygen	20, 50, 75, 100m	SBE43
Chl-a	20, 50, 75, 100m	Wetlabs flintus-rt
PAR	20, 50, 75, 100m	Licor LI-193

- ✓ Operating since 2000
- ✓ Emphasis on bio-chemical processes and thermohaline circulation
- ✓ Recent developments: CO<sub>2</sub> sensor and advanced optics



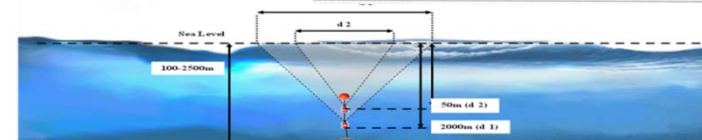
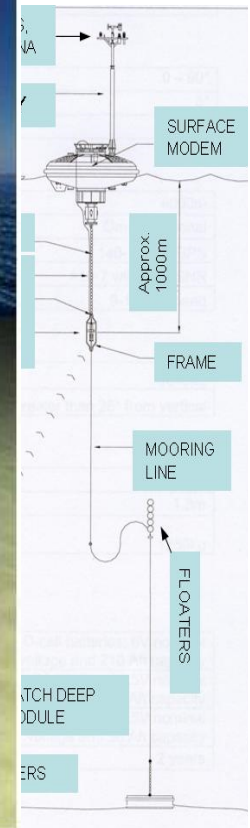
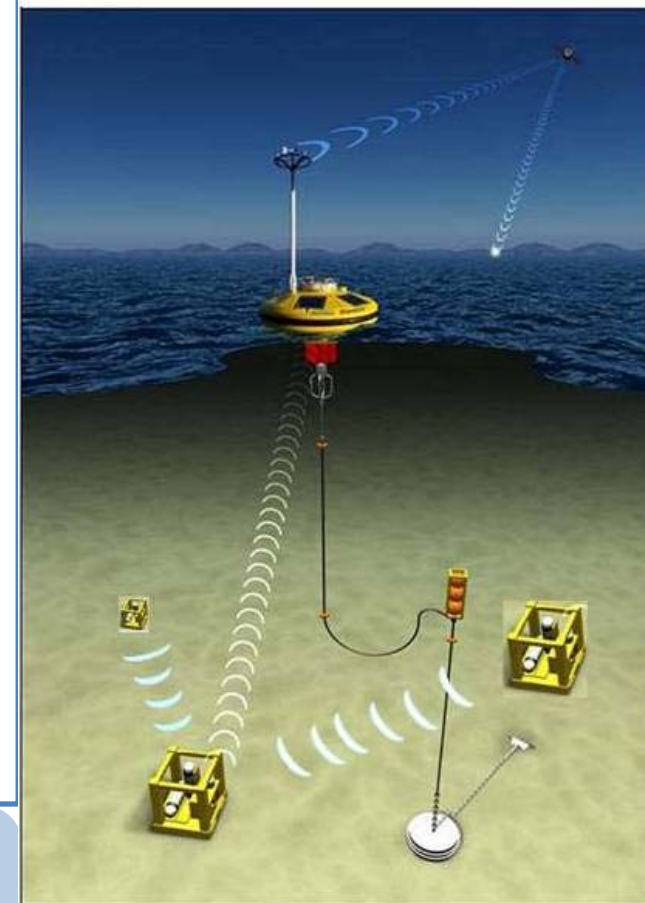
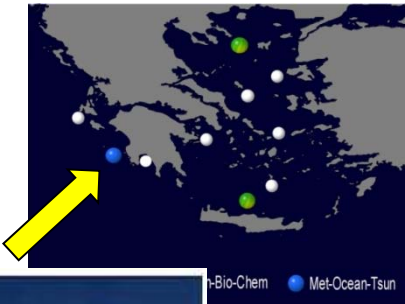
# Reference station Pylos

**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, CO<sub>2</sub>, CH<sub>4</sub>, 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



# Data from additional sources

## Ferry Box System



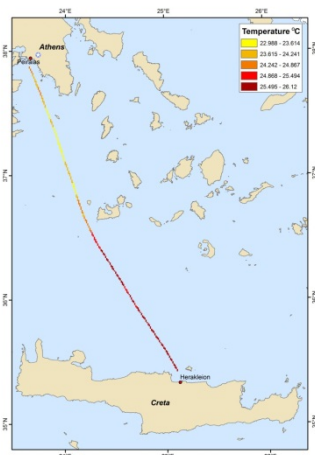
Real time continuous recording of:

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

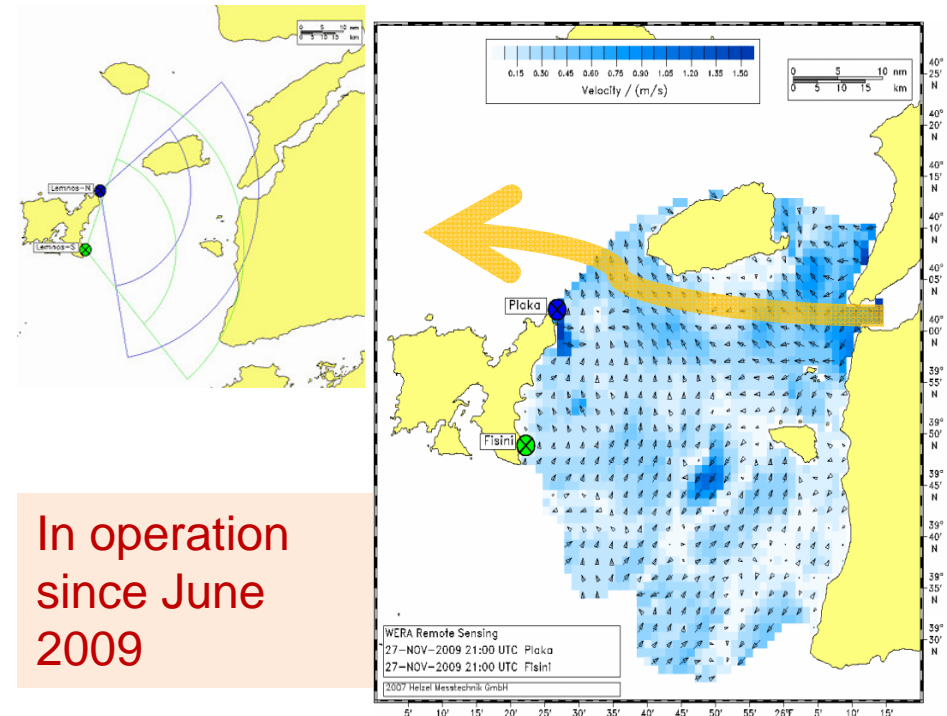
Piraeus-Heraklion

*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.

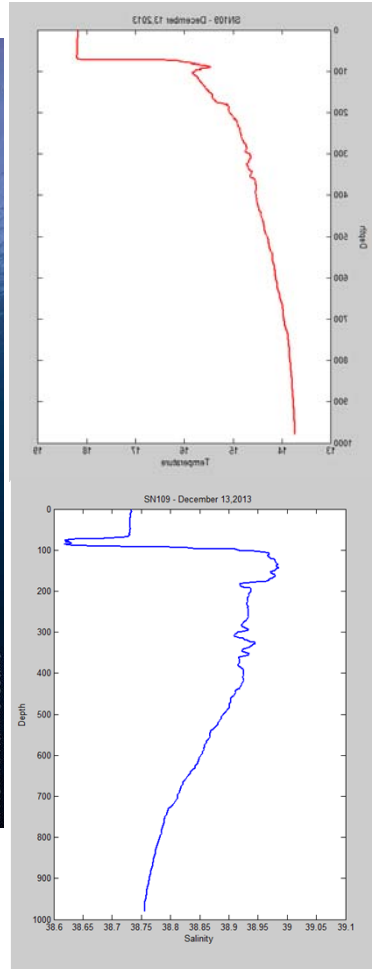
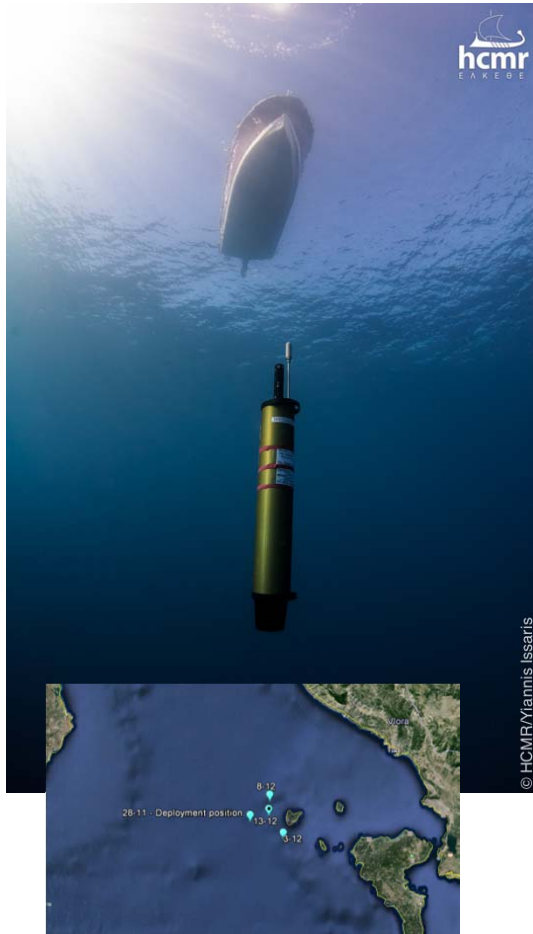
The systematic monitoring of this outflow is a key issue for:

- 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



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

# POSEIDON Quality Control procedures

## Check 1: Instrument Range test

The values are tested against thresholds assigned regarding the measuring range of the sensor measuring. The values fail this check are flagged as "bad" values (flag 4)

Fail: flag 4

## Check 2: Physical Range test

The values are tested against thresholds reflecting the physical range within every measured parameter may vary regarding the regional climatology, the seasonal variations, the measuring depth etc. Values fail this test are flagged either as "probably bad" or "probably good" (flags 3 & 2)

pass

Fail: flag 3

## Check 3: Rate of Change (spike) test

The fluctuation of the values upon time should be within specific limits which are defined by taking into account the climatological status and depth. This limits may change with time (Constant\*STD) or be prefixed thresholds. Every value is tested with its previous and its following one. Values fail this tested are considered as "bad" or "probably bad" (flag 3 & 4)

pass

pass  
Flag 2

Fail: flag 3, 4

## Check 4: Stuck Value (stationarity) test

The recorded values should vary in time and present a minimum expected fluctuation depending the physical processes are involved in. This test check whether values remain constant in a number of sequential time steps. This number may vary regarding the parameter, the depth and the characteristics of the sensor (resolution, AD conversion etc.). Values fail this test are consider as "bad" or "probably bad" (flags 4 & 3)

pass

pass  
Flag 2

Fail: flag 3, 4

## Check for profiles : Pressure increasing test (PR, TS)

Check for set of constant or reversed pressure. Affected values flagged as bad data (4)

pass

Flag 1

pass

Flag 2

Exit  
From  
The QC  
Procedure

Additional delayed mode QC:  
Comparison against climatological values

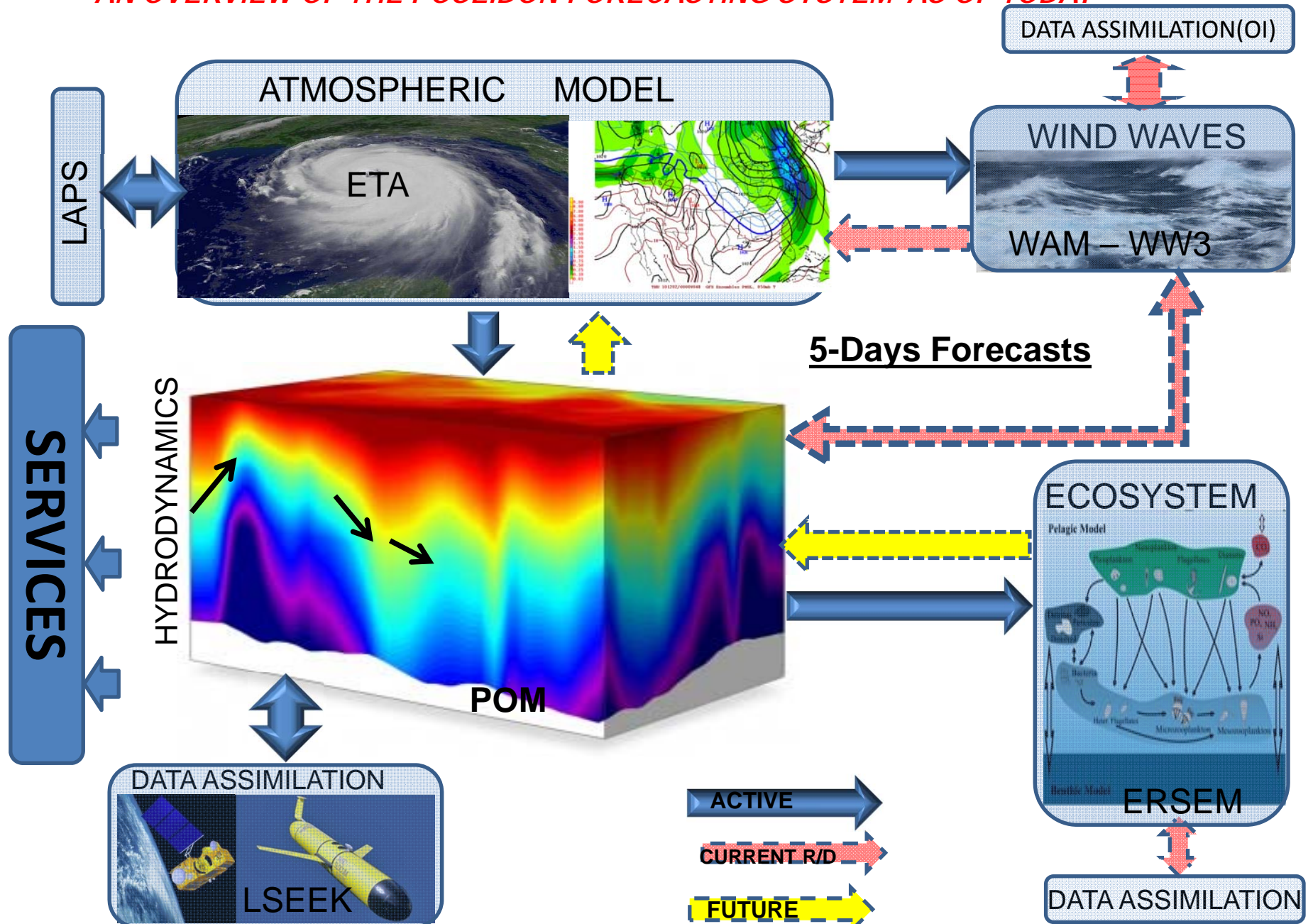
Update Data Base and Generate file with QC flags

# MonGOOS Data Center

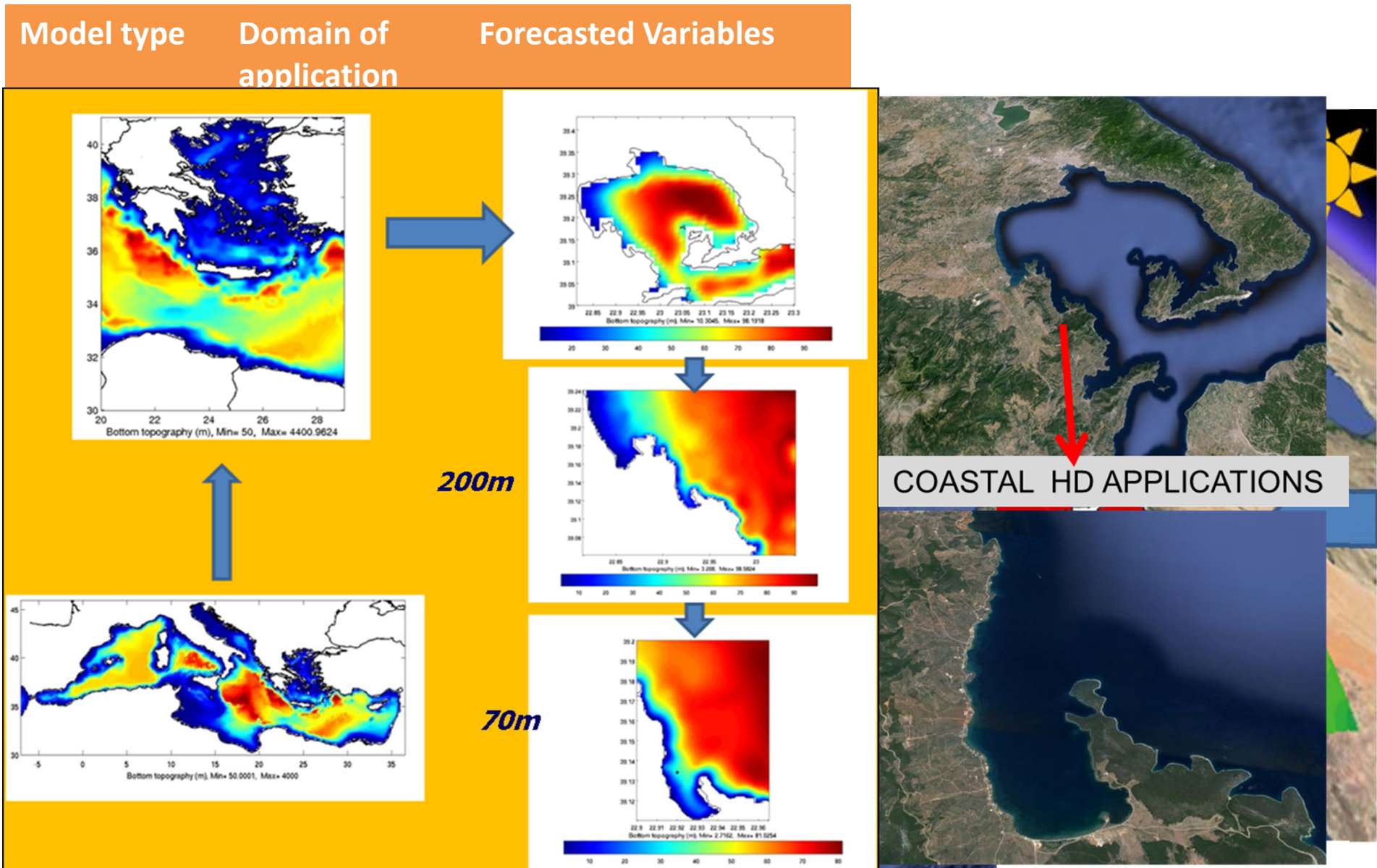


<http://www.mongoos.eu/data-center>

**AN OVERVIEW OF THE POSEIDON FORECASTING SYSTEM AS OF TODAY**



# The atmospheric, hydrodynamic and wave models

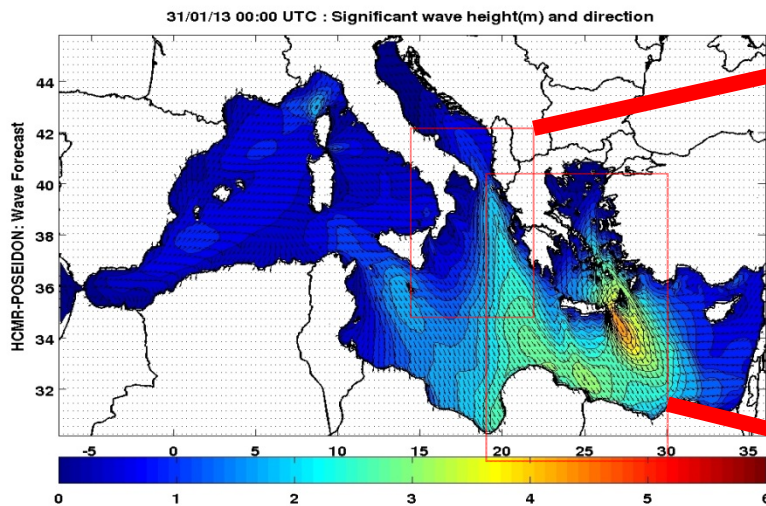


# Wave forecasting system

5-days forecasts daily

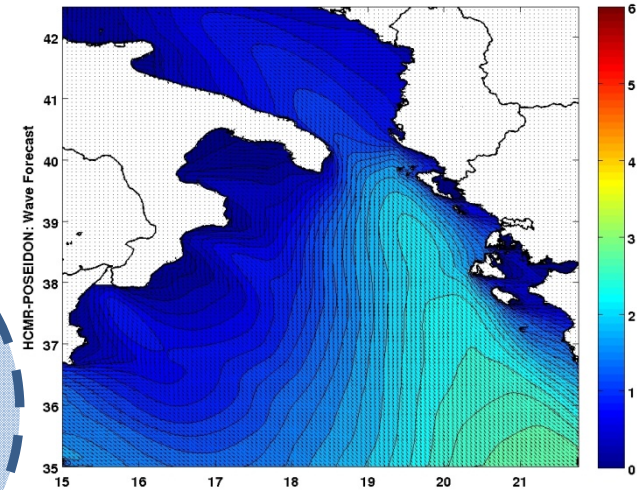
Based on WAM Cycle-4.5 code

1/10 x 1/10



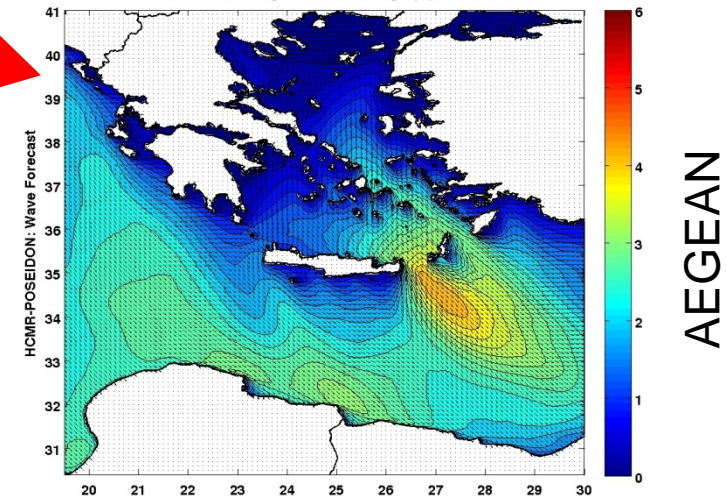
1/50 x 1/50

31/01/13 00:00 UTC : Significant wave height(m) and direction

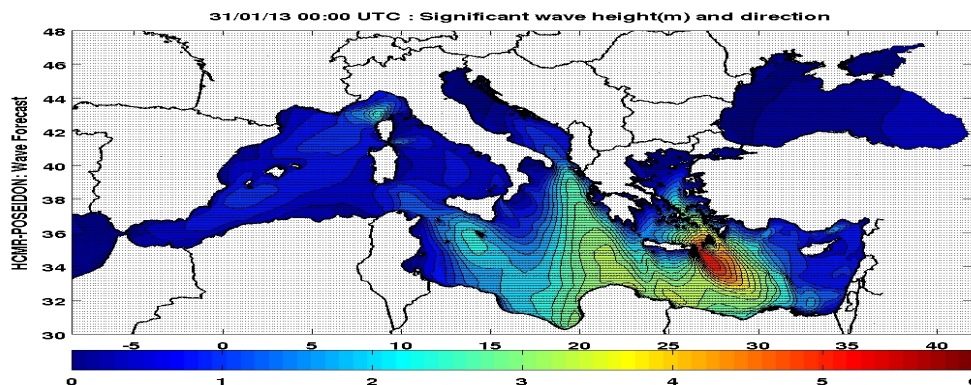


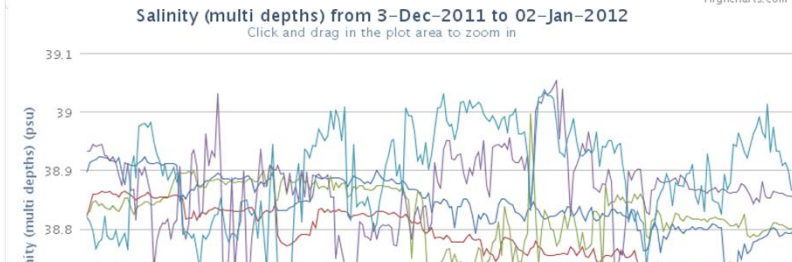
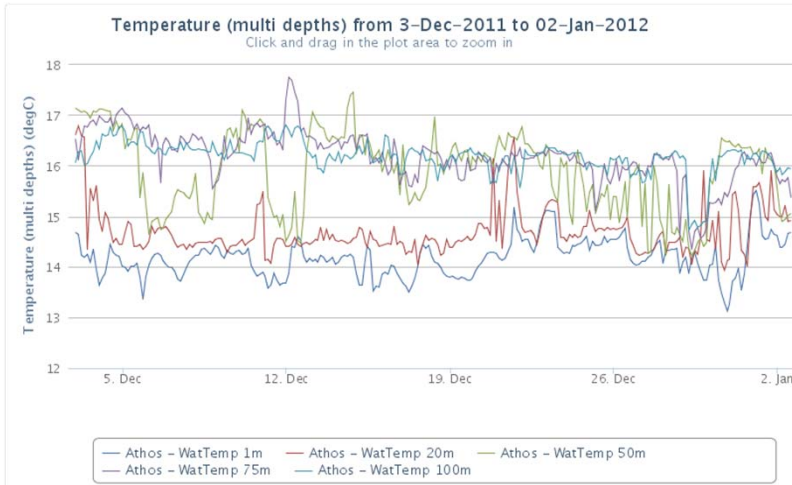
1/30 x 1/30

31/01/13 00:00 UTC : Significant wave height(m) and direction



Based on WW-III MED + BLACK SEA 1/20 x 1/20





POSEIDON buoy network data on 02.01.2012 15:00 UTC  
(Local Time: UTC+2)

**Atmospheric Data**

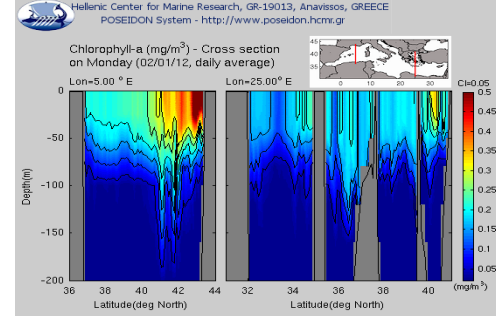
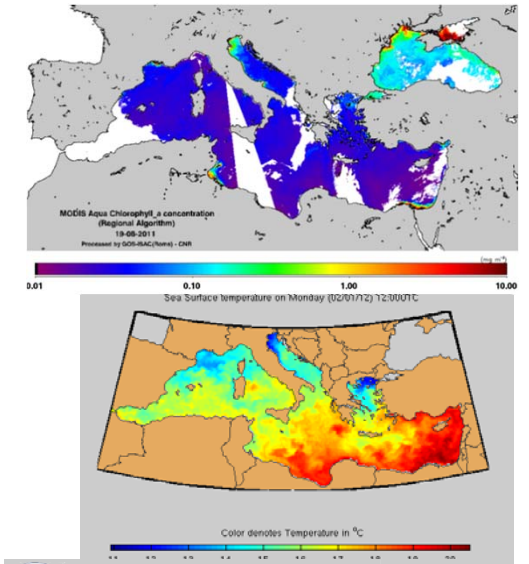
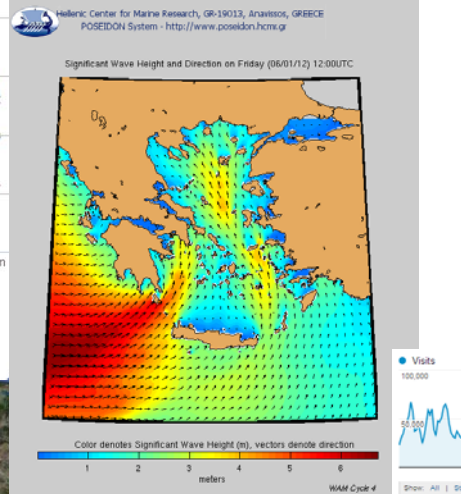
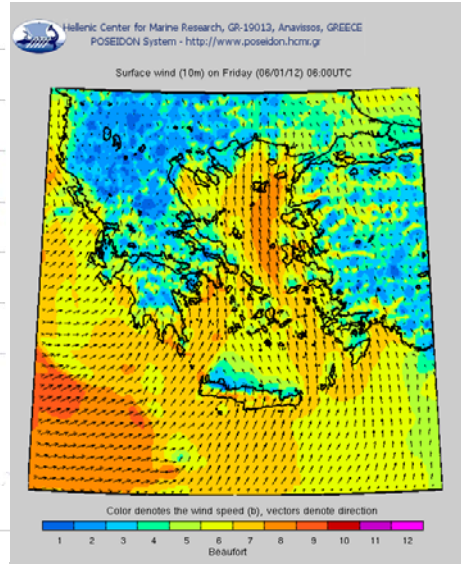
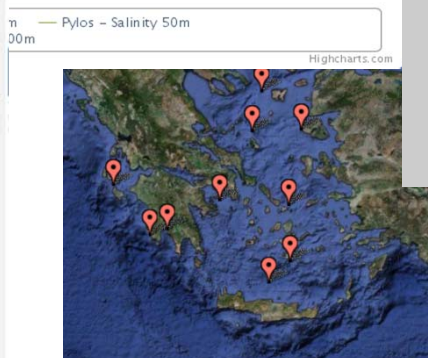
	Air Pressure (mbars)	Air Temperature (°C)	Wind direction (degrees)	Gust	Mean speed (m/sec)
Athos	1025.76	11.11	22.50	1.17	0.23
EIM3A	N/A	N/A	N/A	N/A	N/A
Lesvos	1025.12	9.82	1.41	9.04	6.20
Mykonos	1017.95	11.46	350.40	13.11	9.48
Saronikos	1018.98	11.32	12.04	3.66	2.36
Pylos	N/A	N/A	N/A	N/A	N/A
Santorini	1024.23	33.32	344.53	11.48	8.87
Skyros	N/A	N/A	N/A	N/A	N/A
Zakynthos	1019.94	12.65	99.92	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)	Period (sec)	
Athos	156.45	3.22	0.39	0.39	312.09	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	55.99	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

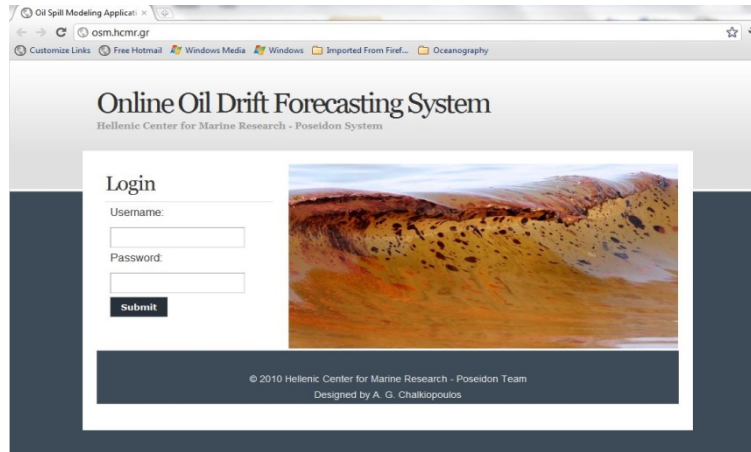


Web: ~ 1.000.000 user sessions/month

# Products and Services

## OIL DRIFT FORECASTING

## SEARCH & RESCUE



Oil Spill Modeling Application  
osm.hcmr.gr

Online Oil Drift Forecasting System  
Hellenic Center for Marine Research - Poseidon System

Login

Username:

Password:

© 2010 Hellenic Center for Marine Research - Poseidon Team  
Designed by A. G. Chalkiopoulos

Home Request Results About Contact

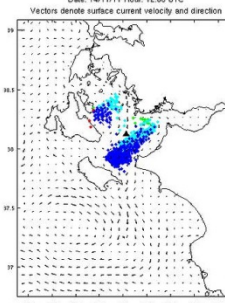
### Results for the Oil Spill Modeling Application

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

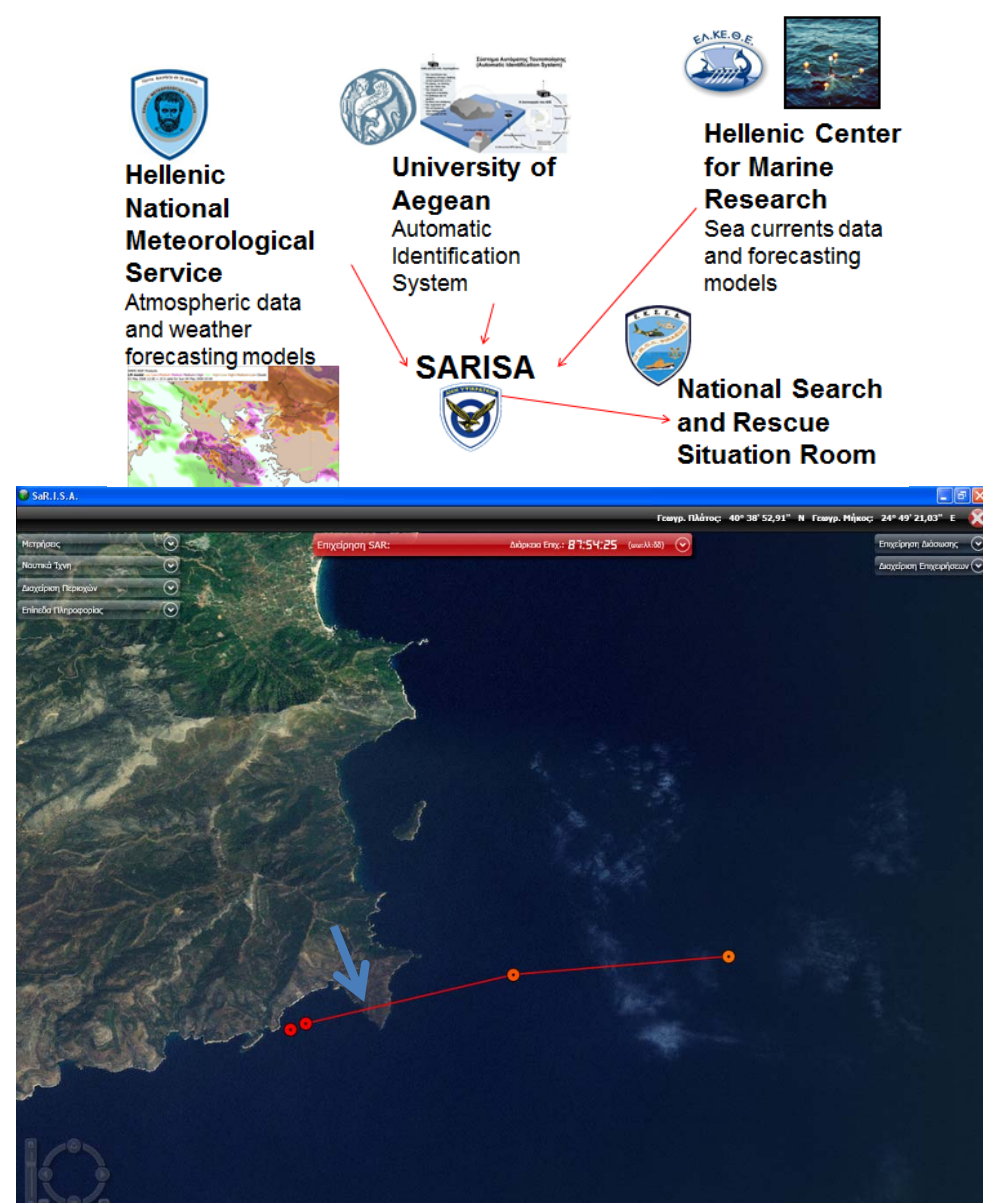
- ▲ Initial point of accident
- Sea points (depth=10m)
- Sea points (depth=10m)
- Sedimentation points
- Land points

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)

**About**  
The POSEIDON Oil Spill fate and trajectory model is based on PARCEL model (Pollani et al. 2001) which is able to simulate not only the drift of the oil but also the chemical transformations under the specific environmental conditions. more...

**Links**  
Poseidon System  
Hellenic Center for Marine Research  
Ecoop project  
Roses project  
MarCoast network



Hellenic National Meteorological Service  
Atmospheric data and weather forecasting models

University of Aegean  
Automatic Identification System

Hellenic Center for Marine Research  
Sea currents data and forecasting models

National Search and Rescue Situation Room

**SARISA**

SaR.I.S.A. Interface

Γεωγρ. Πλάτος: 40° 38' 52,91" N Γεωγρ. Μήκος: 24° 49' 21,03" E

Επιλογή SAR: Διάρκεια Ερωγ: 87:54:25 (σεολ:00)

Επιλογή Διάταξης: Ζαρούριση Επισκερτών

Map showing SAR satellite coverage and search area over the Aegean Sea.



## Priorities and Targets for the period 2014-2020

### Modeling system upgrades (Hydrodynamics)

- Implement a new HD model (ROMS) to run in parallel with POM for the Med Sea
- Improve horizontal resolution (5 km for the Med Sea)
- Improve open boundary conditions (nest with the MyOcean Global and Marmara & Black Sea models) and rivers input.
- Introduce wave-current interaction terms (coupling HD and wave models)

### Extending operational oceanography to the coast

- Ocean prediction for the open ocean has reached maturity. Take the necessary actions to boost for coastal predictions and extend the operational oceanography to the coast
- Develop integrated coastal forecasting systems in key areas (i.e. Saronikos Gulf) efficient to resolve coastal geometry and to assimilate high frequency and regular coastal data sets that are already available

### Wave forecasting

- Improve wave forecasting (with data assimilation) at the Mediterranean basin scale in close collaboration with the European wave community (**Copernicus Service**)

### Coupled systems

- Integrate the coupled atmosphere – wave system into the POSEIDON operational chain
- Develop a coupled atmosphere – wave – ocean prediction system

# The step forward : Towards an Integrated Observatory



Three **multi-parametric moorings** (Cretan Sea, Ionian Sea, North Aegean) – Biochemical parameters (nutrients, pH, CO<sub>2</sub>) at several depths

**Coastal monitoring**: Three stations (+on demand)

**Argo component** : Greek Argo infrastructure, 25 deployments up to 2017

Introduce a **Glider component**: Two will be purchased in 2014 through national funding. Up to five is foreseen in the national research roadmap

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

Integrate the **EMSO Hellas** infrastructure: **Cabled observatory**, Pylos, Ionian Sea (in operation during 2015)

**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**