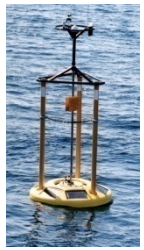
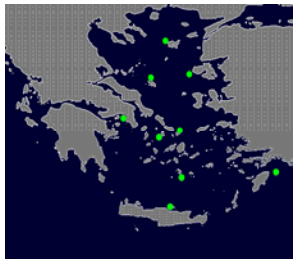
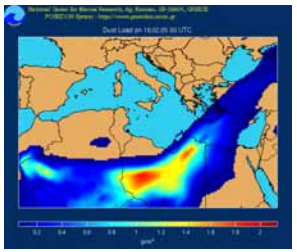
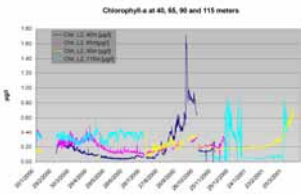
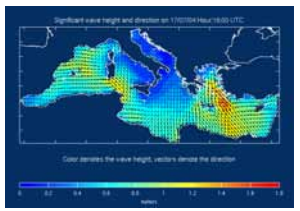
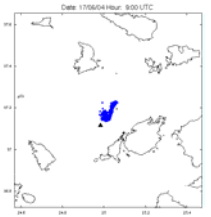
POSEIDON System

An Integrated Monitoring, Forecasting & Information System for the Aegean Sea and the Eastern Mediterranean

Leonidas Perivoliotis
Institute of Oceanography, Hellenic Center for Marine Research (HCMR)

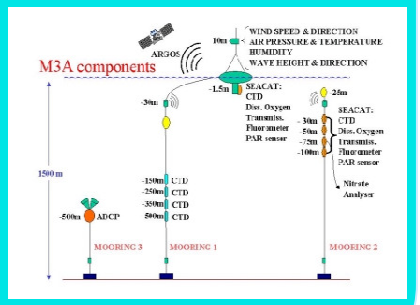







Momar Workshop, Livorno, 18-19 April 2012

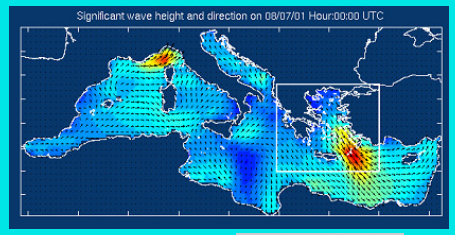
WHAT is POSEIDON ?

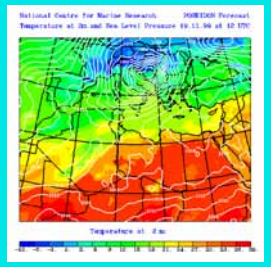
*An operational **monitoring**, **forecasting** and **information** system for the marine environmental conditions of the Aegean Sea and Eastern Mediterranean*

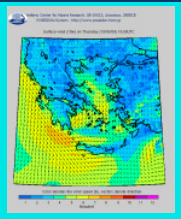
Observations

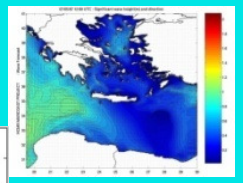


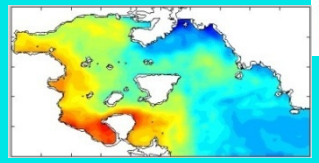
Processing & Modeling



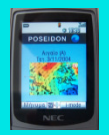








Information and Decision Support Systems



End Users

WHY ? (Motivation – Justification)

Greece is a Maritime country

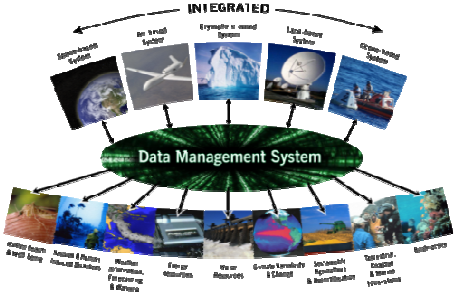
- ✓Support of **maritime transport** (forecasts, SAR)
- ✓Environment **protection** (high risk of oil pollution)
- ✓Support of **tourism** industry (water quality, yachting, ..)
- ✓**Fisheries** and aquaculture management
- ✓**Coastal** zone management (erosion, etc) & Water framework directive
- ✓**Research** oriented applications (process studies, validation of satellite data and models)
- ✓**Support to all kinds of maritime activities**

WHY ? Policy context

✓ Rio Conference – Agenda 21: Global Ocean Observing System **GOOS** – UNESCO

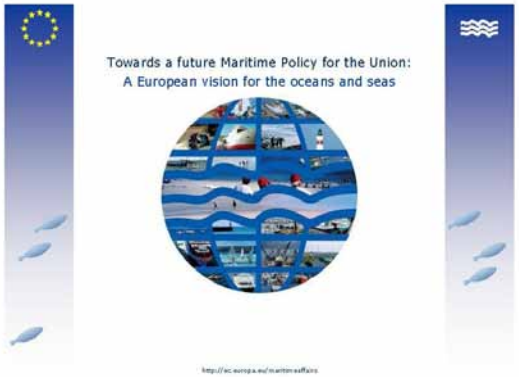
✓EuroGOOS – MedGOOS

✓Greek Contribution to **GMES** (EU – ESA Initiative), **GEO**



✓**Marine Strategy Framework Directrive** (marine assessments, EMMA process, EEA)

✓ **Integrated Maritime Policy** (e.g. EMODNet: European Marine Observations and Data Network)



How ? System development in 3 phases

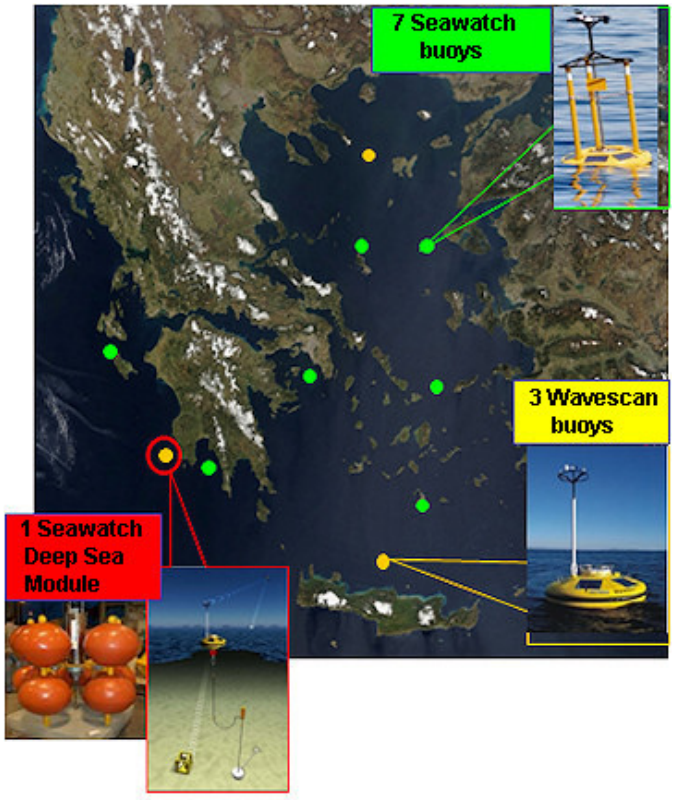
POSEIDON I (1997-2000): 14.1 M€ (EFTA/EEA:85%, Hellenic State 15%)
Implementing Agency: HCMR, ELSYP
Contractor: *OCEANOR (Norway), sub: Univ. of Athens, Thessaloniki, NTUA*
Main System development

POSEIDON-II (2005-2008): 9.8 M€ (EFTA/EEA:75%, Hellenic State 25%)
Implementing Agency: HCMR
Contractor: Fugro-*OCEANOR , sub: Univ. Athens, Aegean & Connecticut*
Major System Upgrade and Extension. New Applications

POSEIDON-III (2009-2011): 1.1 M€ (EFTA/EEA:50%, Hellenic State 50%)
Implementing Agency: HCMR
Contractor: : Fugro-*OCEANOR, sub Aanderaa*
Towards Deep Sea exploration

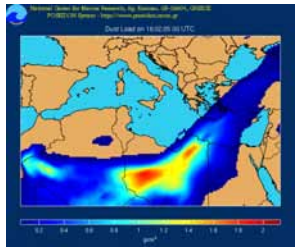
System components

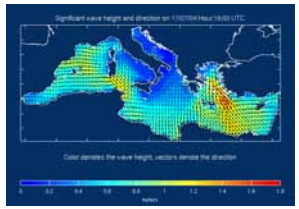
Buoy Network:
16 buoys to support 10 sites

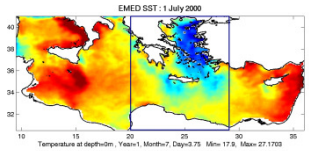


Operational centre at HCMR

Forecasting system







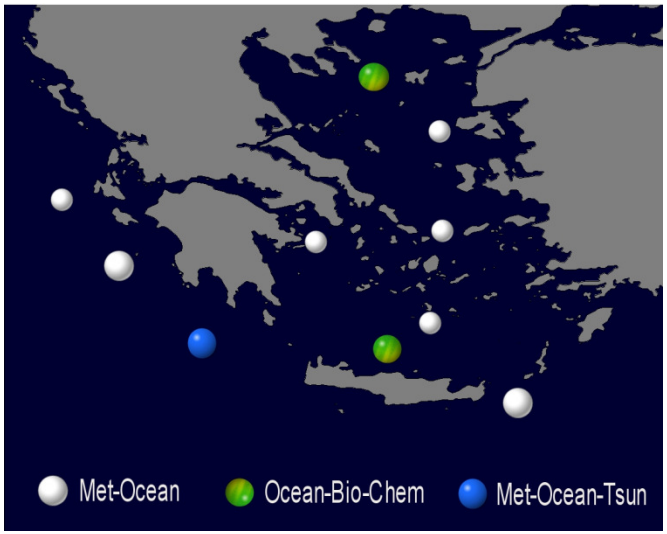
Human resources: a group of 12 scientists, engineers and technicians

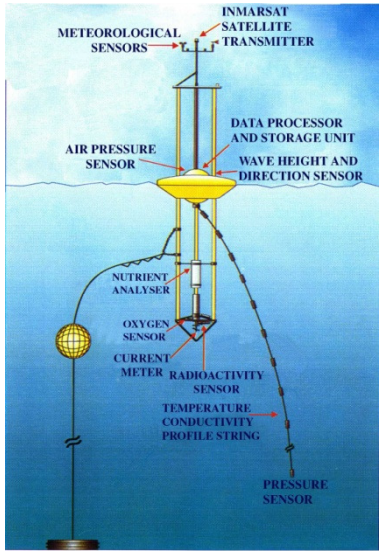
POSEIDON buoy network

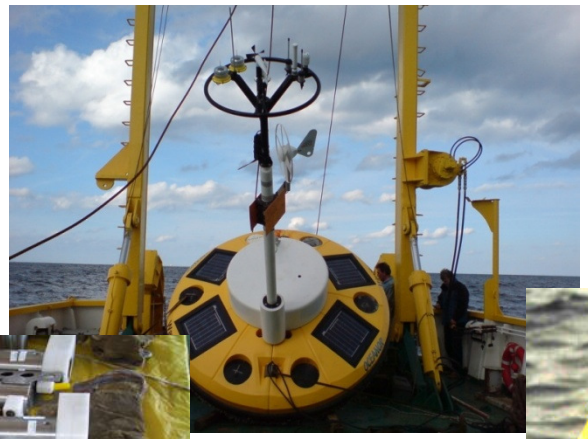
Eleven (11) SeaWatch buoys (mainly metocean)

Five (5) Wavescan buoys to support deep sea monitoring including ecosystem variables

A deep sea (bottom platform) module

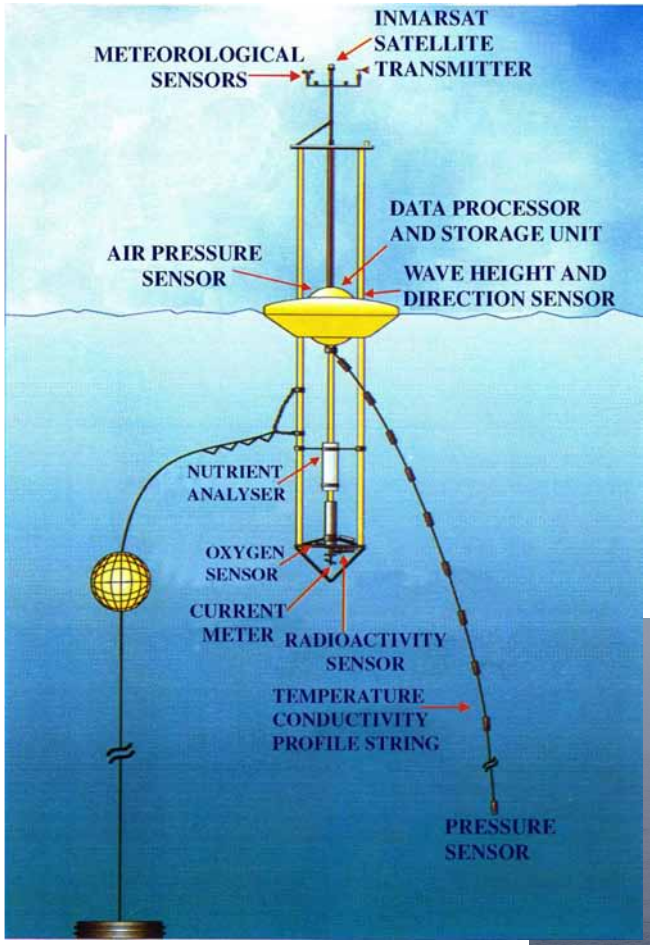




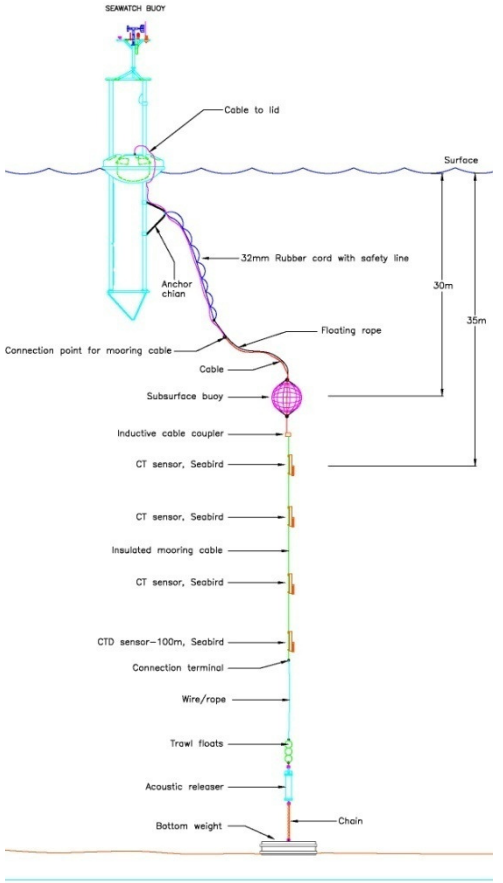


Momar Works

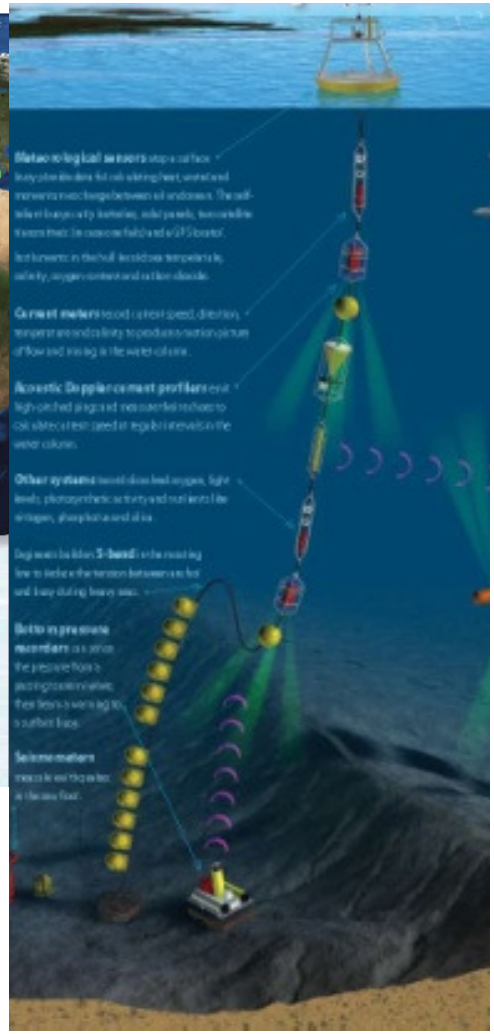
Standard (coastal) buoys



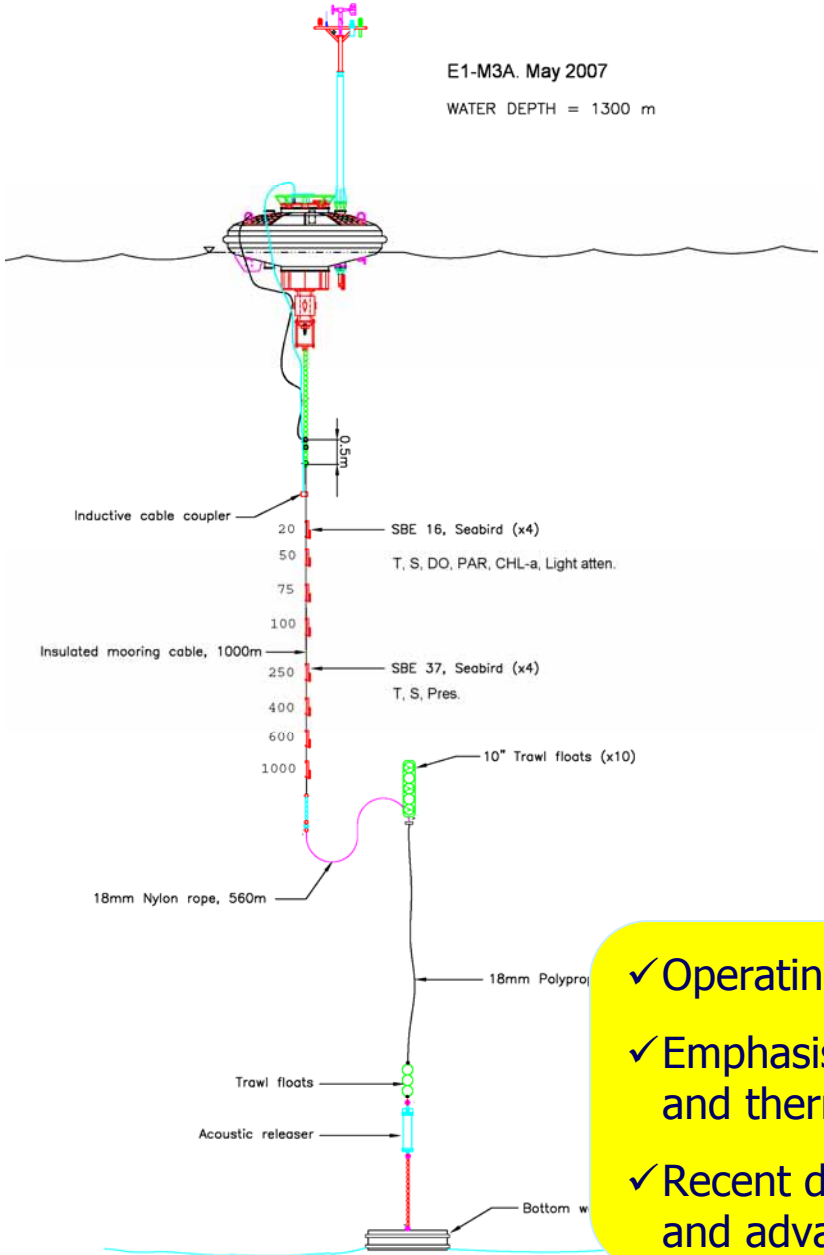
- Air temperature
- Atm. Pressure
- Wind speed – direction
- Wave height, direction, period
- Sea Surface Temp (1, 3m)
- Sea Surface Salinity (1, 3m)
- T – S 10-100m
- Current speed direction



Two multi-sensor observatories (part of OceanSITES global progr.)

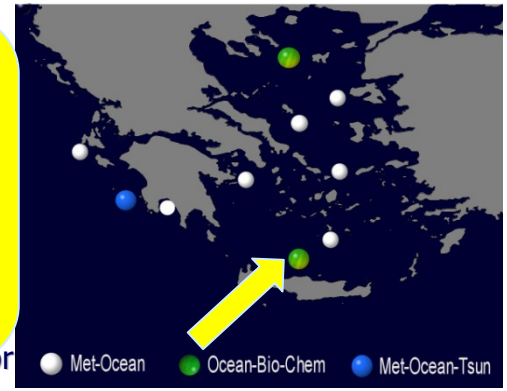


A: Multi-sensor reference station E1-M3A



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

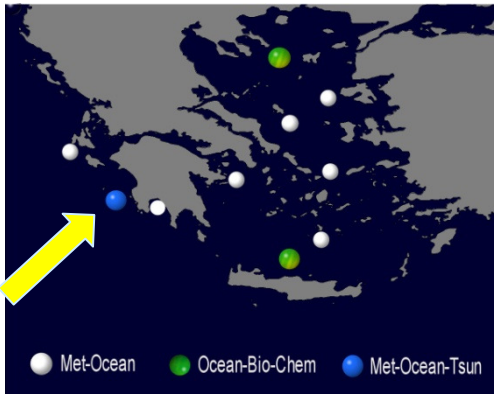
- ✓Operating since 2000
- ✓Emphasis on bio-chemical processes and thermohaline circulation
- ✓Recent developments: CO2 sensor and advanced optics

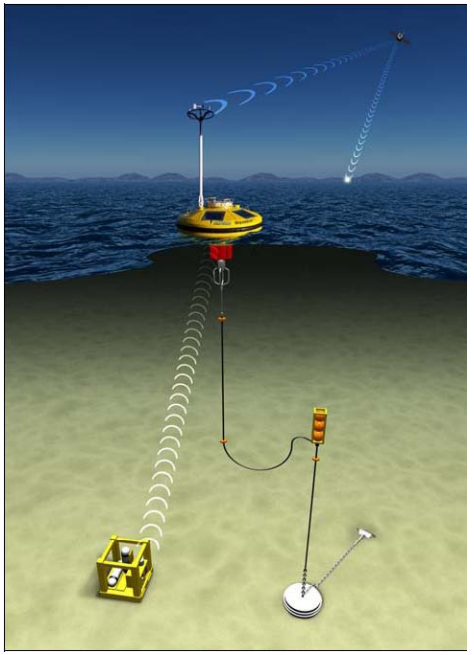


B: Reference station Pylos

Central mooring:

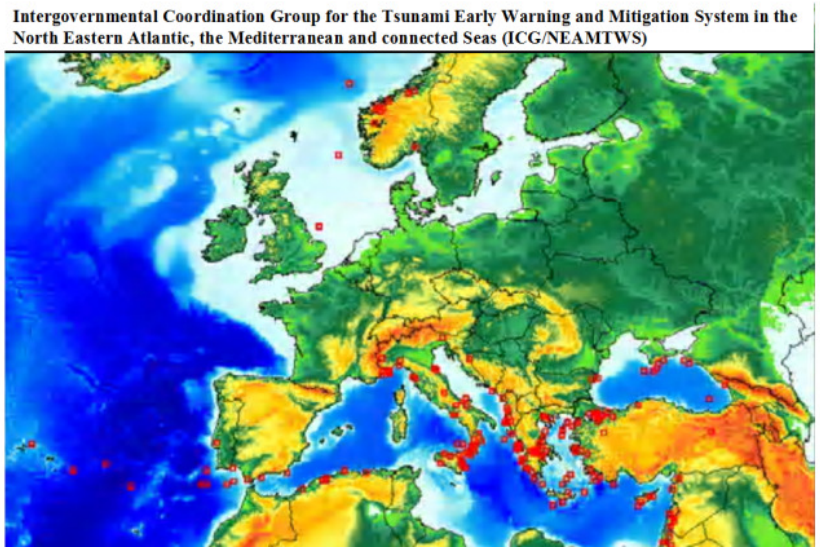
- ✓ Open sea WaveScan buoy
- ✓ Standard Meteo and surface Ocean parameters
- ✓ Water column T, S 0-1000m
- ✓ Passive Acoustic Listener (PAL) sensor at 500m



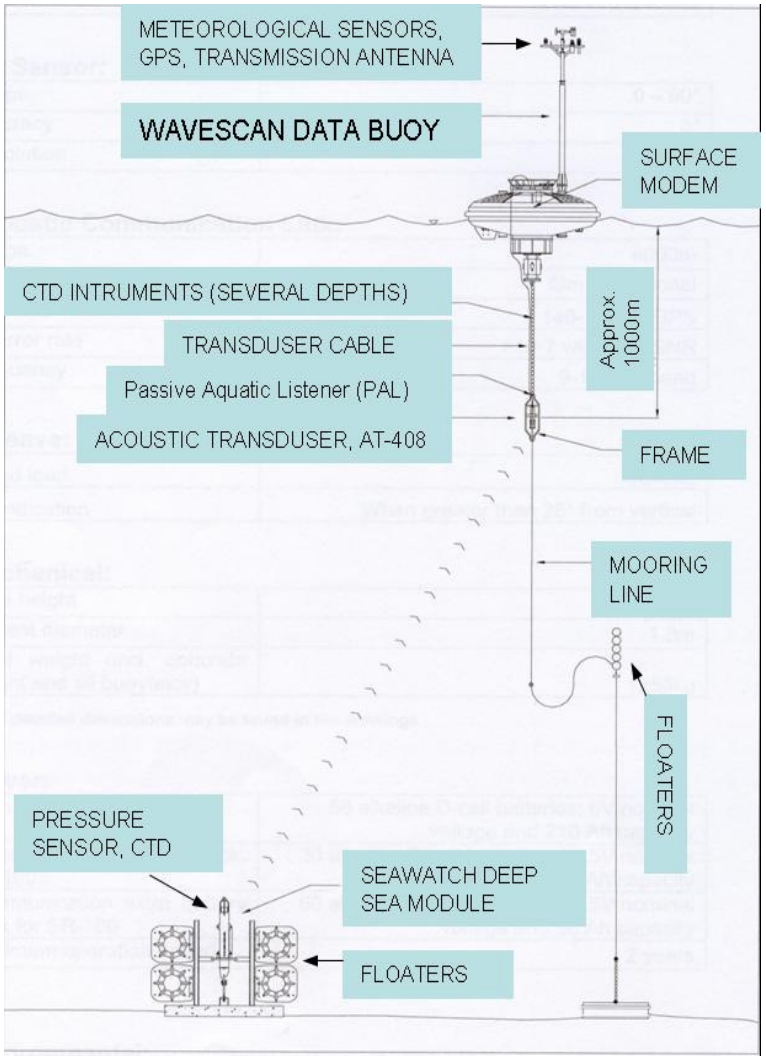


Sea-bed platform:

- ✓ Acoustic link to surface buoy
- ✓ Standard: pressure sensor (15sec)
- ✓ Additional sensors: D.O., T, S
- ✓ 6-12 months operation
- ✓ At 1670m depth



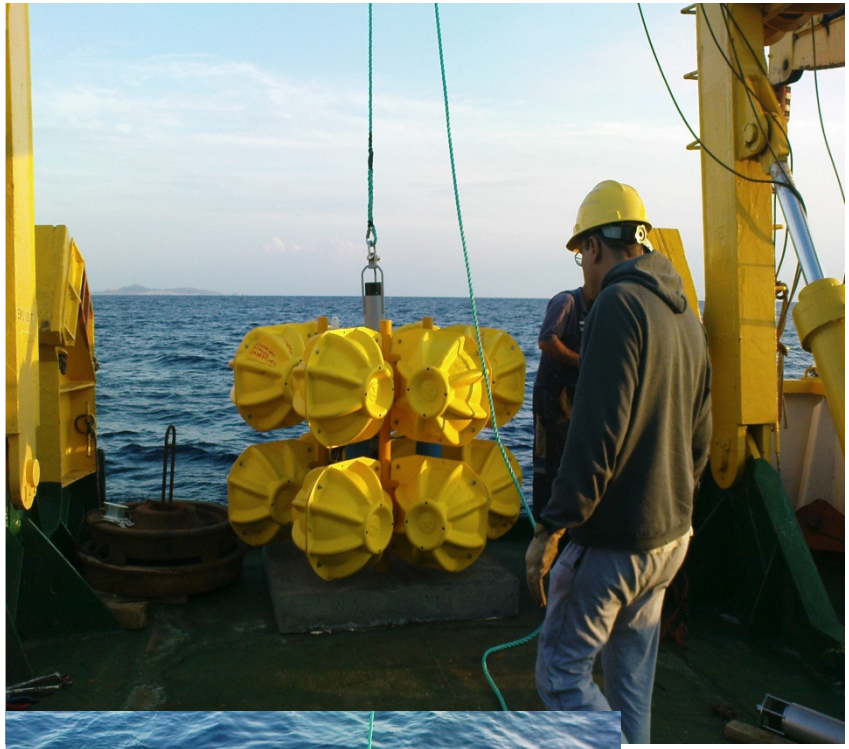
System outline



Parameter	Depths measured (m)	Sensor(s) used	Accuracy
Wind speed/dir.,	Surface	Young 04106	1m/sec, 10 deg
Air Pressure,	Surface	Vaisala PTB 220A	-+0.15hPa
Air temperature,	Surface	Omega	-+0.1oC
Wave Height, direction, period	Surface	Fugro OCEANOR Wavesense	0.1m, 0.5 deg, 0.5 sec
SST, SSS surface,	Surface (1m)	Aanderaa 3919A	-+0.1 oC, 0.05 mS/cm
Currents	Surface (1m)	Nortek Aquadopp 400 kHz	Sp: -+0.5 cm/sec Dir: -+2 deg
Temperature	20, 50, 75, 1000m 100, 250, 400, 600m	Seabird 16plus-IMP C-T Seabird 37-IM C-T	0.005 oC
Salinity	20, 50, 75, 1000m 100, 250, 400, 600m	Seabird 16plus-IMP C-T Seabird 37-IM C-T	0.0005 S/m
Pressure	1000m	Seabird 16-IM C-T-P	

Temperature	1670m	Seabird 16plus-C-T	0.005 oC
Salinity	1670m	Seabird 16plus-C-T	0.0005 S/m
Dissolved oxygen	1670m	Aanderaa Optode	<5% saturation
Pressure	1670m	Paroscientific	0.01%

The Seabed platform

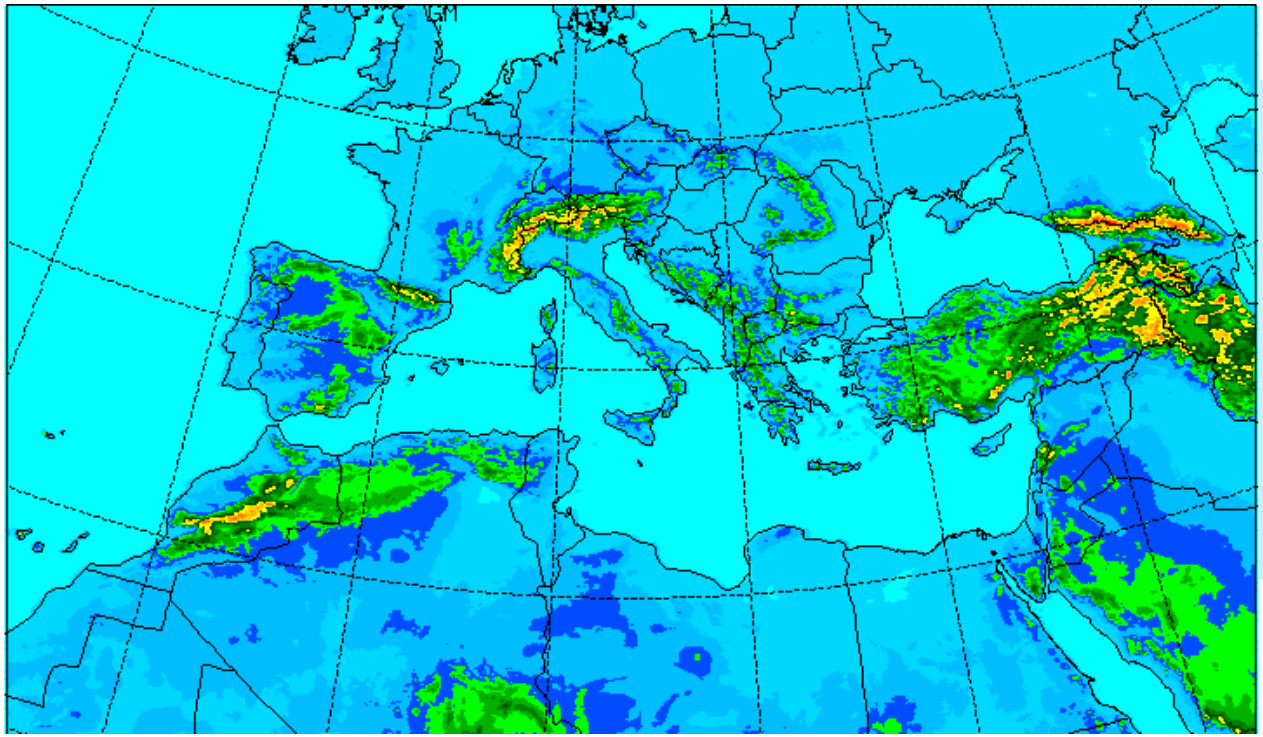


- Hosting the high-resolution pressure sensor (43K-101 from Paroscientific) sampling every 15 sec
- The pressure samples are compared to the calculated values using the DART algorithm (Gonzalez et al. 1998). In case the difference exceeds the user defined threshold the unit's state changes to tsunami mode.
- Also hosting a Seabird 16plus equipped with conductivity temperature and depth sensors .
- Data transmitted to surface buoy via hydroacoustic modem every 3-h in normal mode and 15sec in "Tsunami mode"

Forecasting Components

Weather forecasting

Operational since1999 – Upgraded in 2007



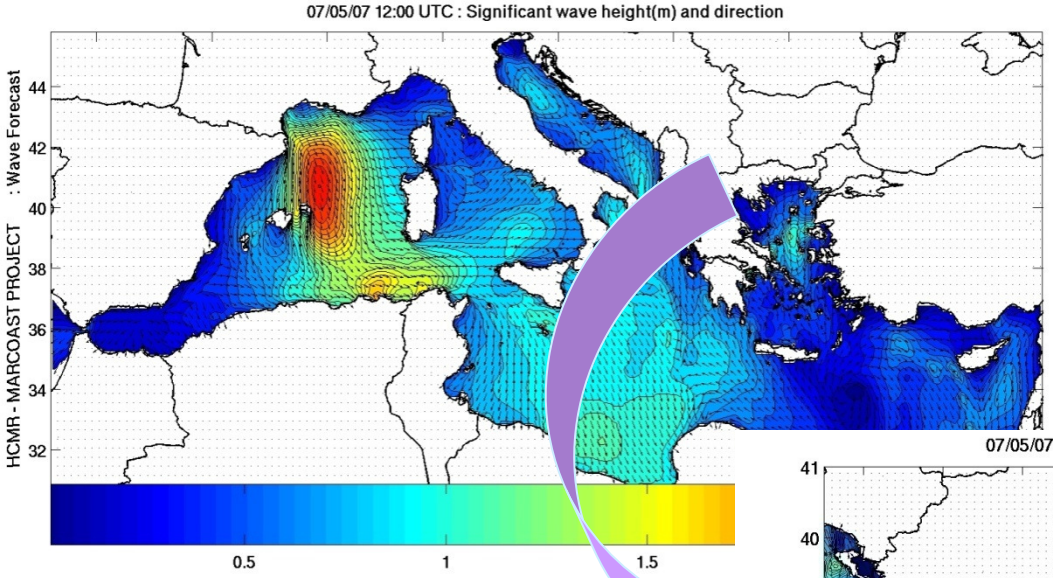
Results:
- ✓Wind (speed, direction)
- ✓Temperature
- ✓Rainfall
- ✓Cloudiness
- ✓Dust load
- ✓Fog
- ✓……

Based on non-hydrostatic ETA model

Spatila resolution: 0.05° x 0.05° (~5 km)

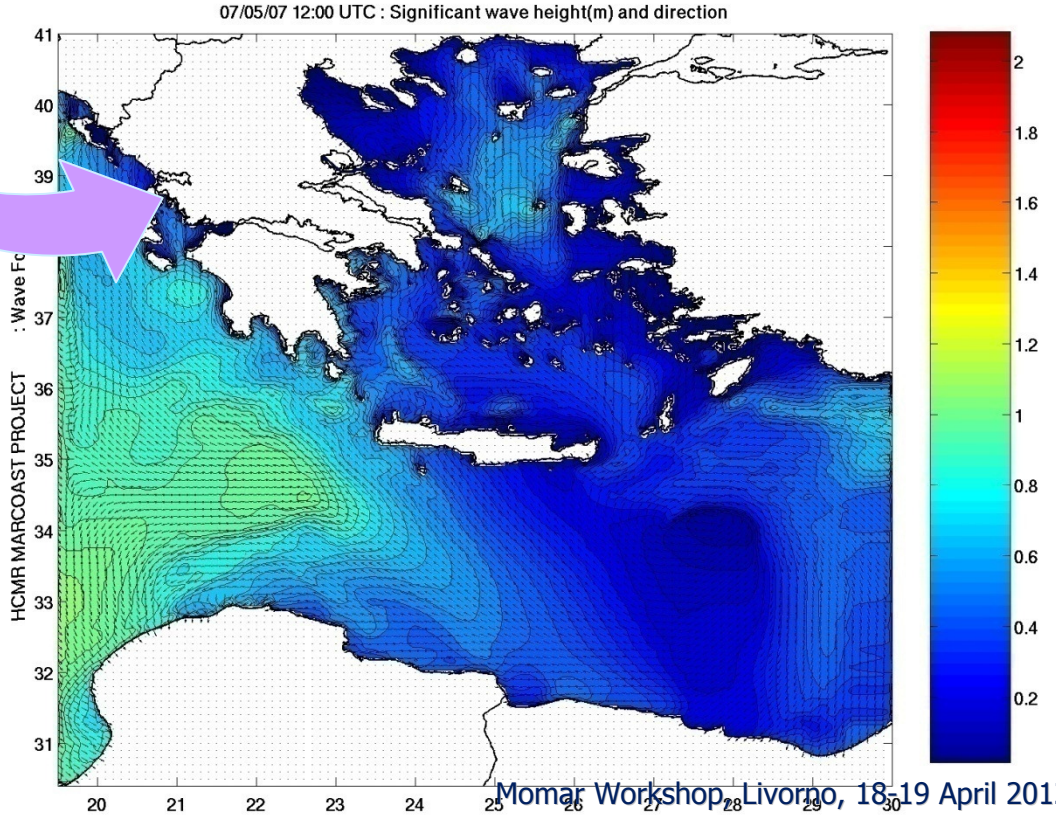
Vertical resolution: 50 levels up to 25 hPa (~25 km)

Wave forecasting



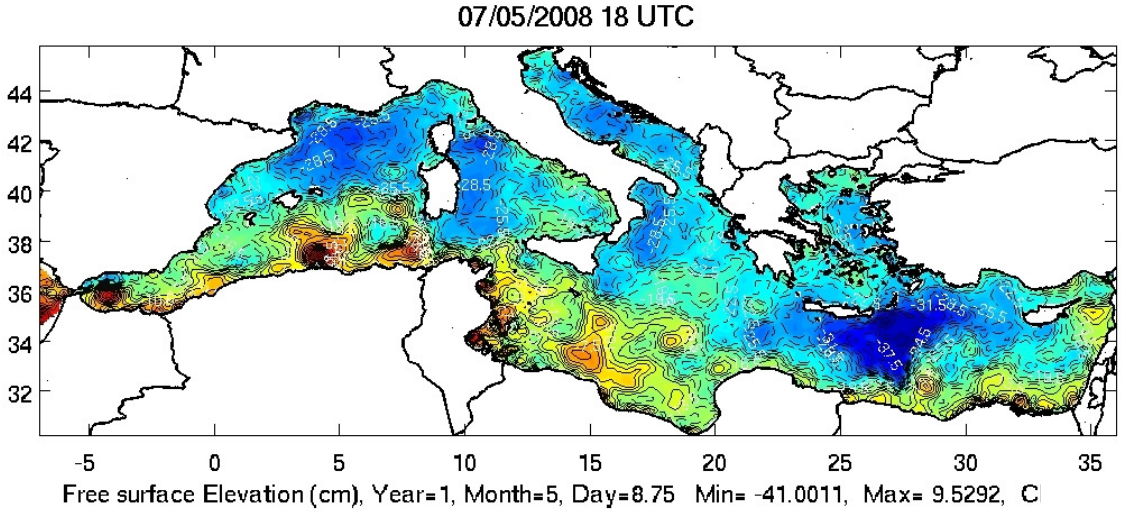
RESOLUTION 1/10

WAVE SYSTEM BASED ON WAM CYCLE-4



RESOLUTION 1/30

H/D Forecasting



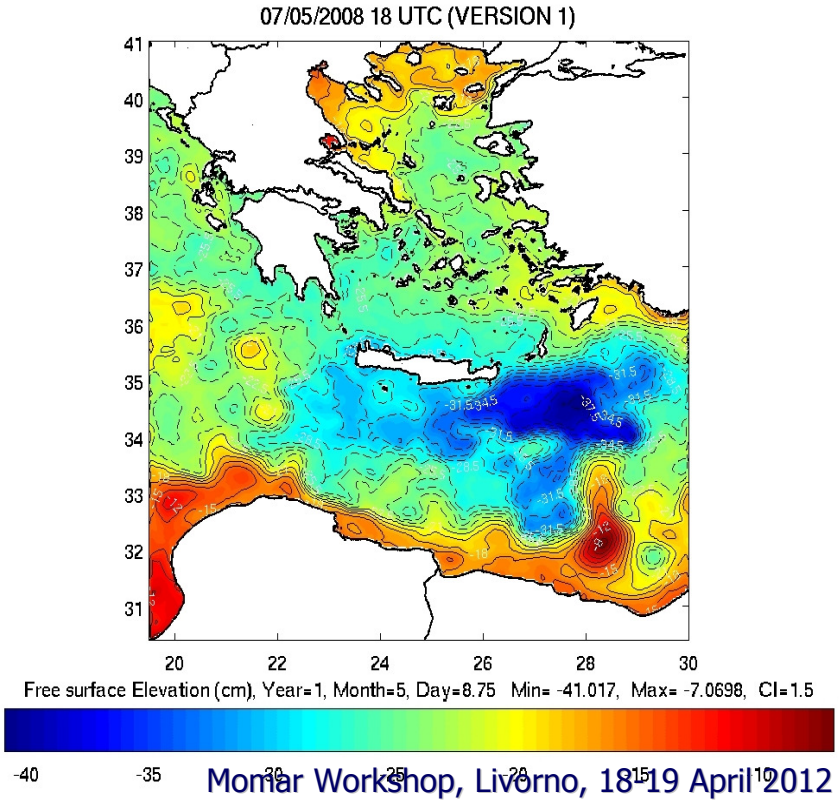
DOWNSCALING THE MEDITERRANEAN HYDRODYNAMICS TO THE AEGEAN SEA REGION USING THE VIFOP PACKAGE AND MODEL NESTING TECHNIQUES

INITIALIZATION: ONCE A WEEK (MONDAY)

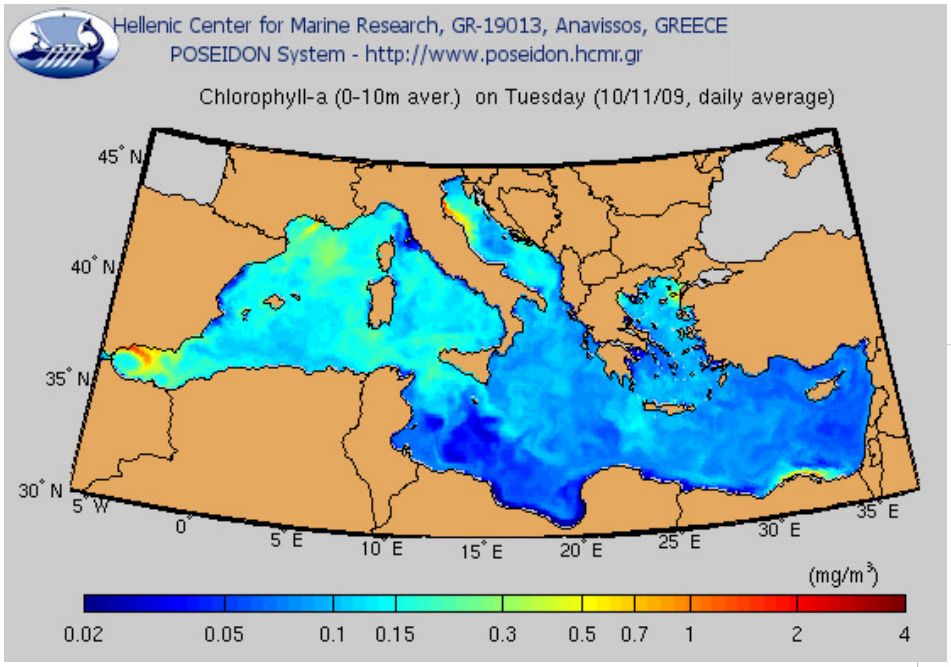
Using MFS (MERSEA) MED 1/16^{o} product and /or

HCMR 1/10^{o} product

At Med scale assimilation of SLA, SST, T & S (ARGO, Moorings, XBT)



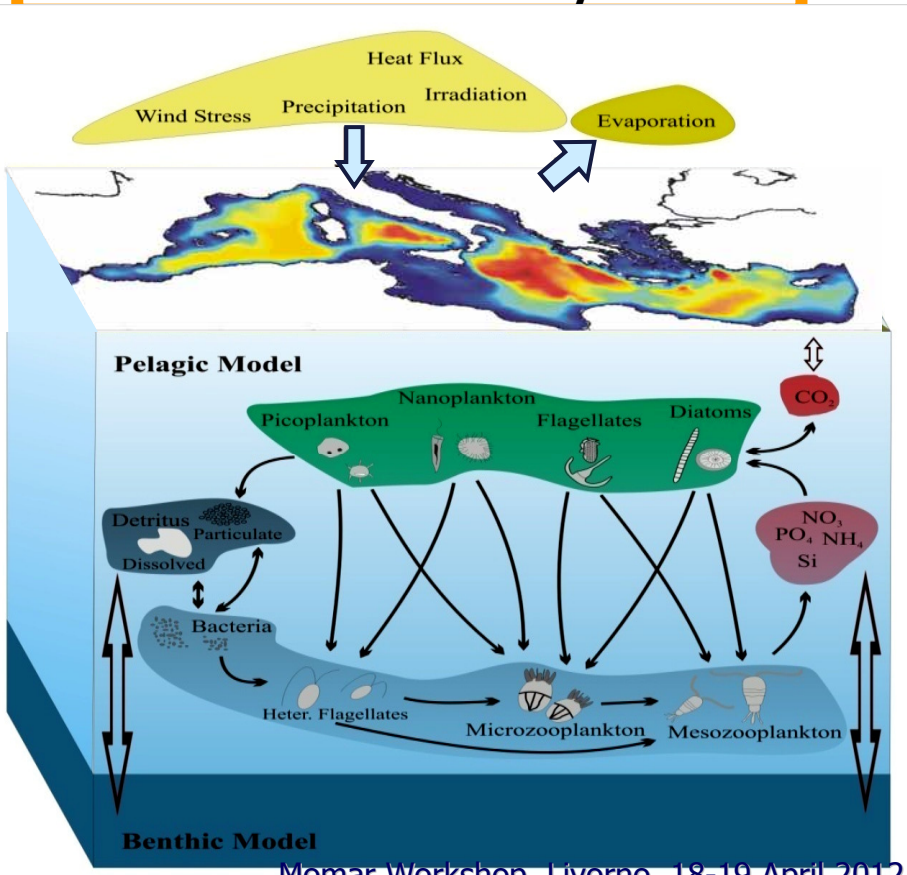
Ecosystem forecasting



Horizontal Resolution:1/10º (~10Km)

Vertical Resolution: 25-sigma levels

Minimum water column depth : 30m



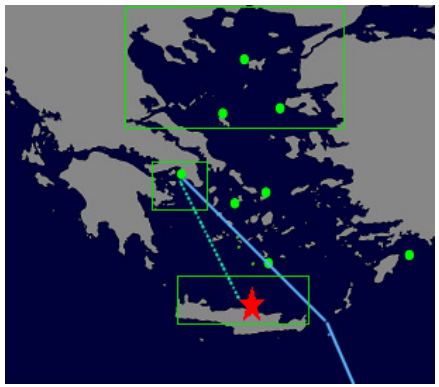
Hydrodynamic model
POM (Blumberg and Mellor, 1983)

Ecosystem model

ERSEM (Baretta et al. 1995)

Data from additional sources

Ferry Box System

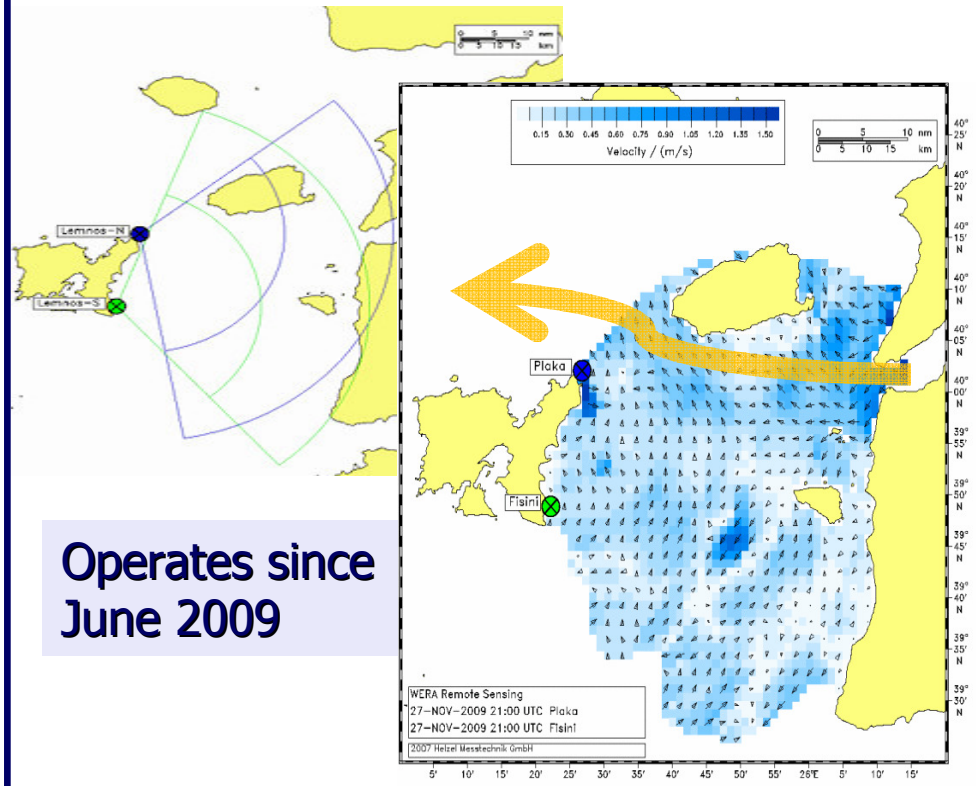


Real time continuous recording of:
- Temperarure
- Salinity
- Chlorophyll-a
- Turbidity

Athens-Crete
Operated on 2005-2006
Will be back in life during 2012

New line: Italy-Patras (Ionian Sea - ENEA & HCMR, 2013)

HF Radar



Operates since June 2009

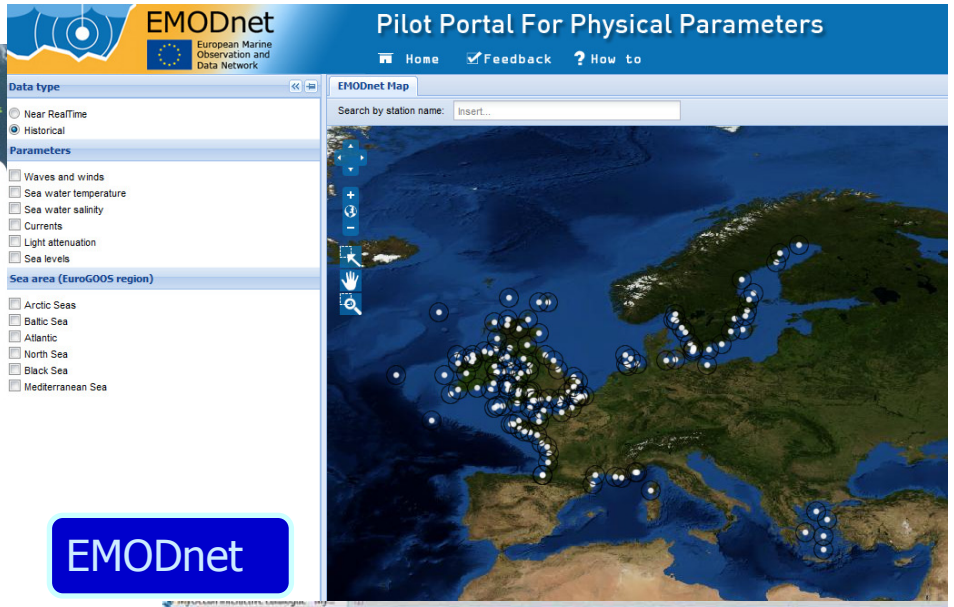
The Black Sea waters outflow through Dardanelles straits strongly affects both the general circulation and the hydrological characteristics of the Aegean Sea.

The systematic monitoring of this outflow will provide significant help on:

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

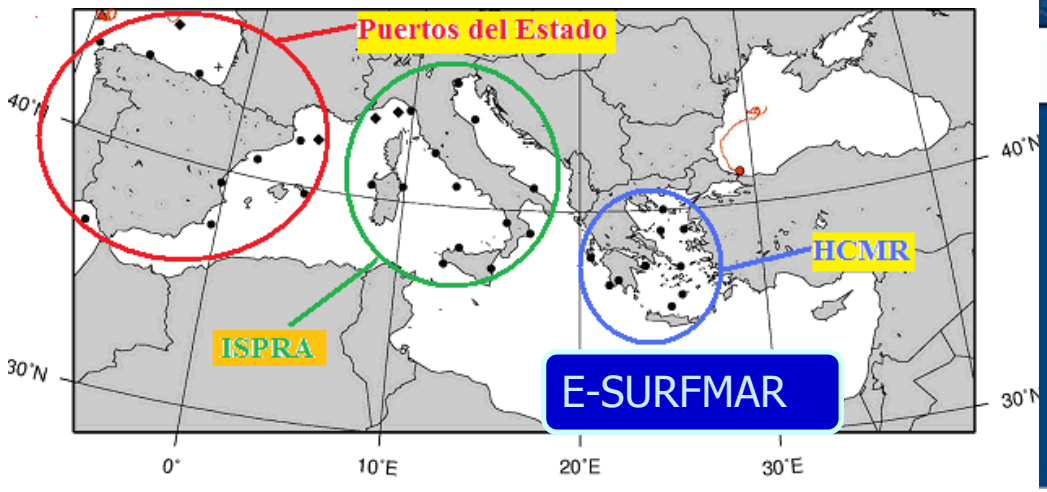
POSEIDON participates to the major operational oceanography initiatives

EuroGOOS



EMODnet

MyOcean

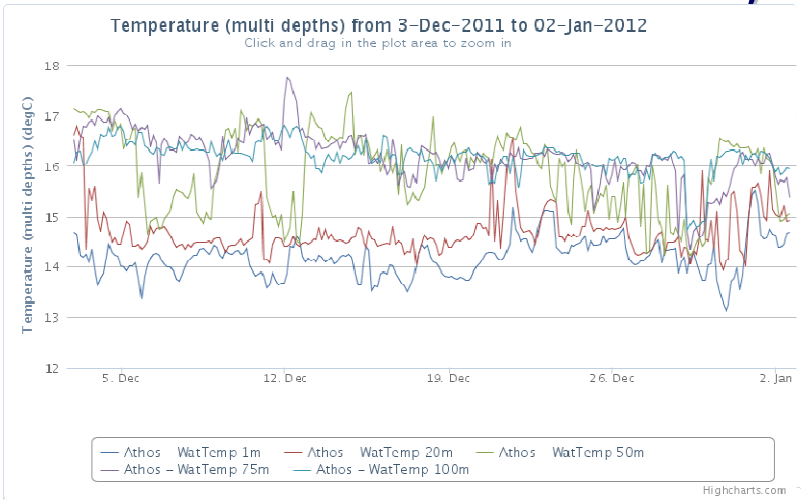


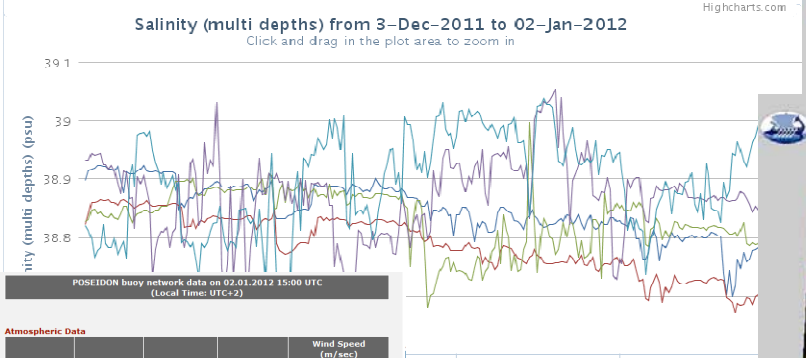
E-SURFMAR

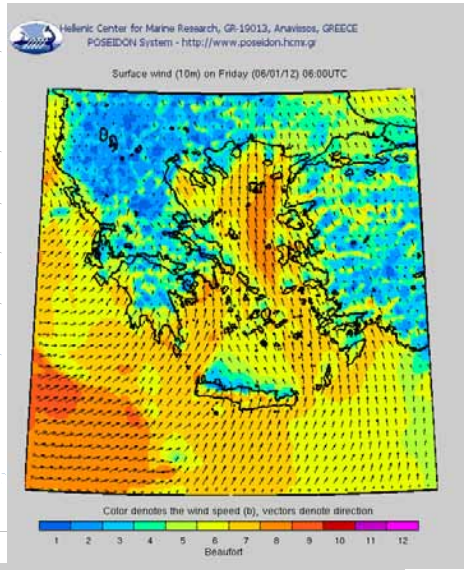
Products – Services

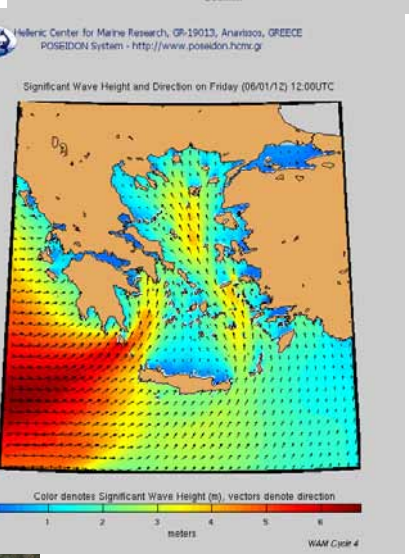
Information to the public

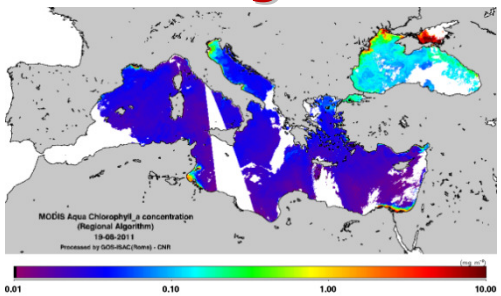
Poseidon Web Site, http://www.poseidon.hcmr.gr

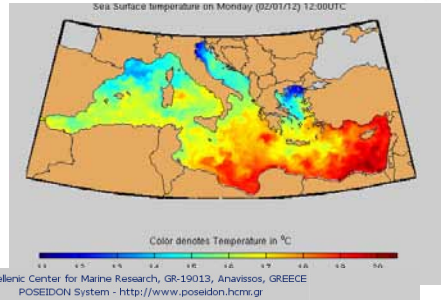


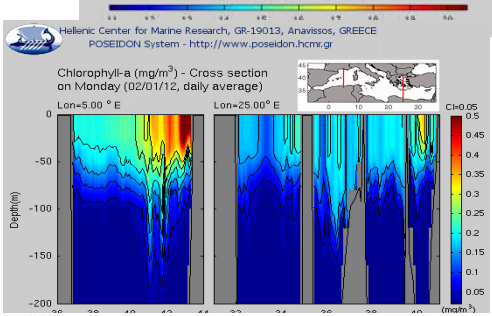


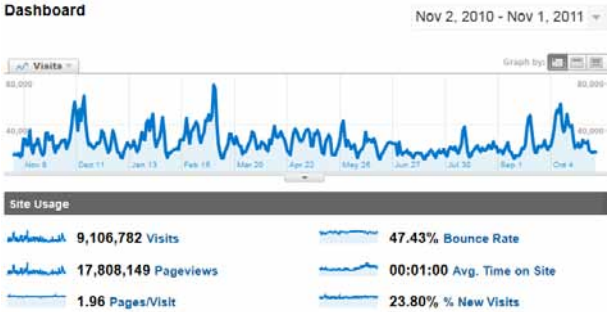












POSEIDON buoy network data on 02.01.2012 15:00 UTC (Local Time: UTC+2)

Atmospheric Data

	Air Pressure (mbars)	Air Temperature (oC)	Wind direction (degrees)	Wind Speed (m/sec) Gust	Wind Speed (m/sec) Mean speed
Athos	1025.76	11.11	22.50	1.17	0.23
E1M3A	N/A	N/A	N/A	N/A	N/A
Lesvos	1025.13	9.83	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
Santorini	1024.23	33.82	344.53	11.48	8.67
Skyros	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 Direction (degrees)	Current Data Speed (cm/sec)	Waves data Significant height (meters)	Waves data Maximum height (meters)	Waves data Main direction (degrees)	Surface Temperature (oC)
Athos	156.45	3.22	0.39	0.39	313.59	14.67
E1M3A	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: ~800.000 user sessions/month

Information to the public
Mobile telephony

SMS Service

Operational since August 2002

SMS to 54546

MyView Service (COSMOTE)

Operational since August 2004

MMS/SMS weather forecast (WIND)

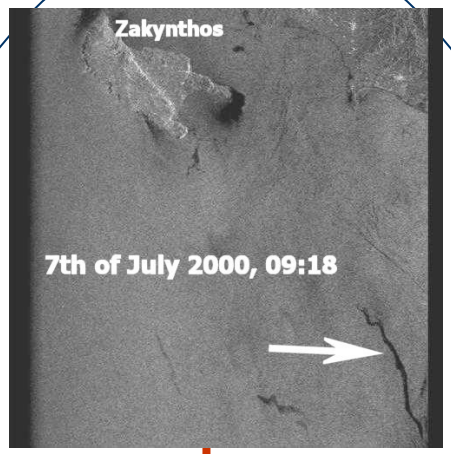
Operational since February 2003

iphone app – "Kairos"

Development: M-Stat S.A.
Operational since February 2011

Available through Android Market since April 2011

Integrated Services: oil spill



Telespazio

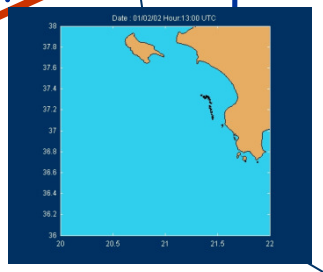
Italy

Detection report

HCMR

Greece

Run oil spill model and produces 3-day forecast



Report + forecast

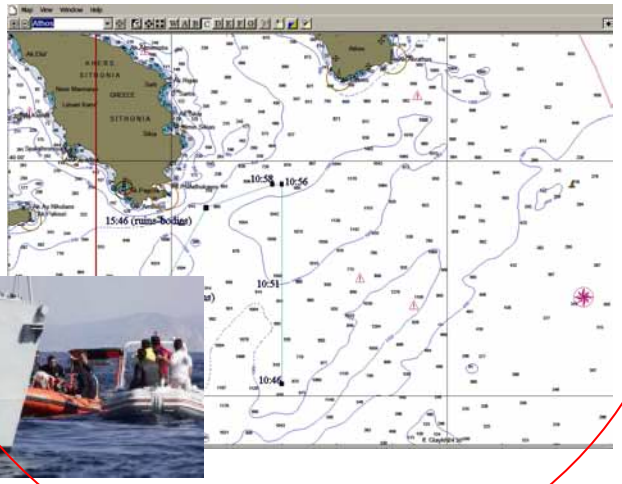
End user: MMM

Greece

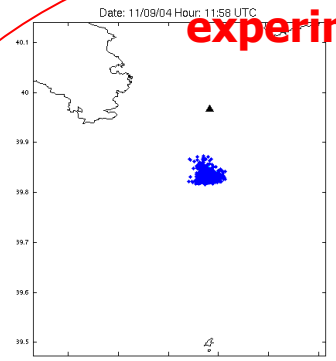
Average delay since detection: 4 hours

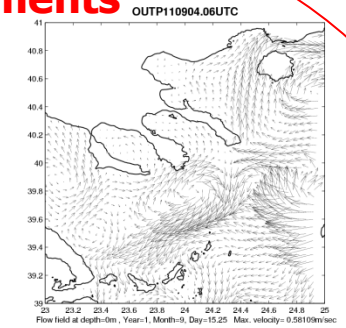
Object drift forecast service

Sep 2004 Helicopter crash: Initial Data

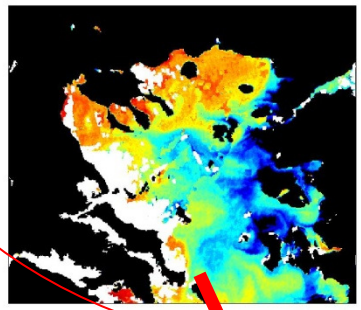


Drift backtrack experiments





06 September 2004



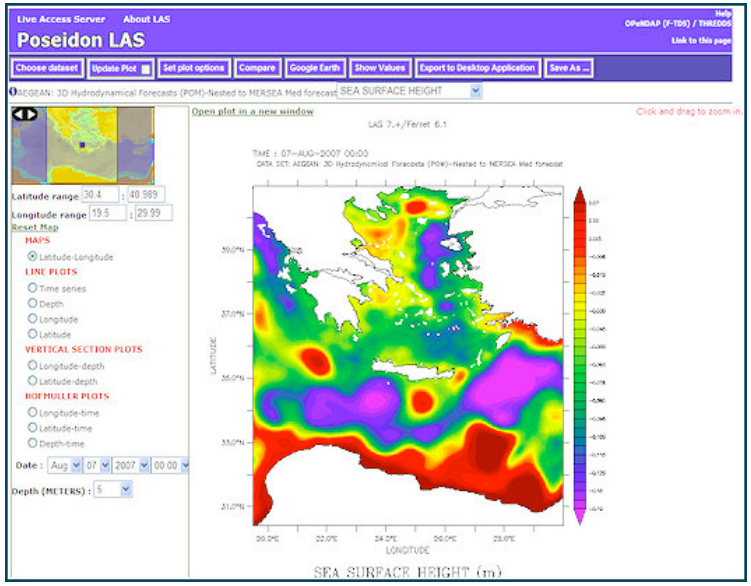
NRT validation

Accident site best guess (delay 2-24h)

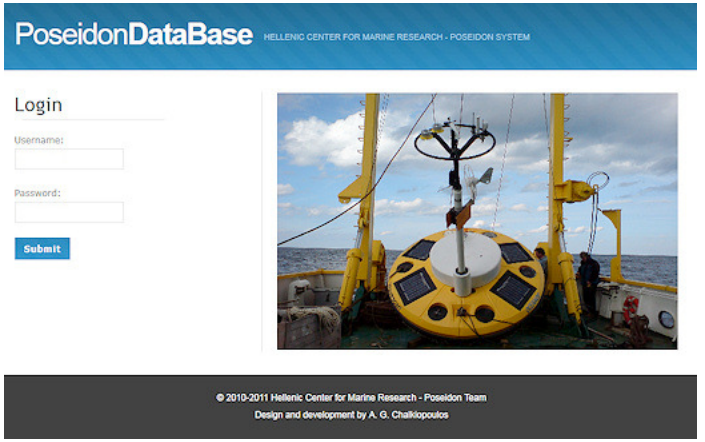
Search & Recovery

Services – additional components

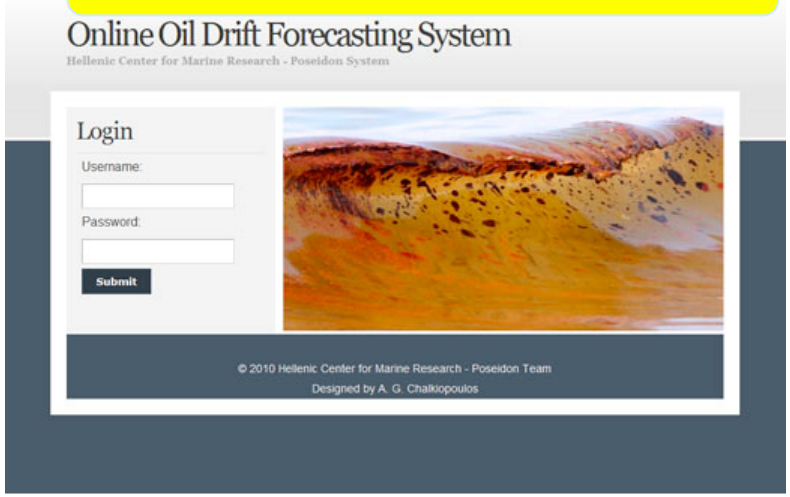
LAS For access to model data



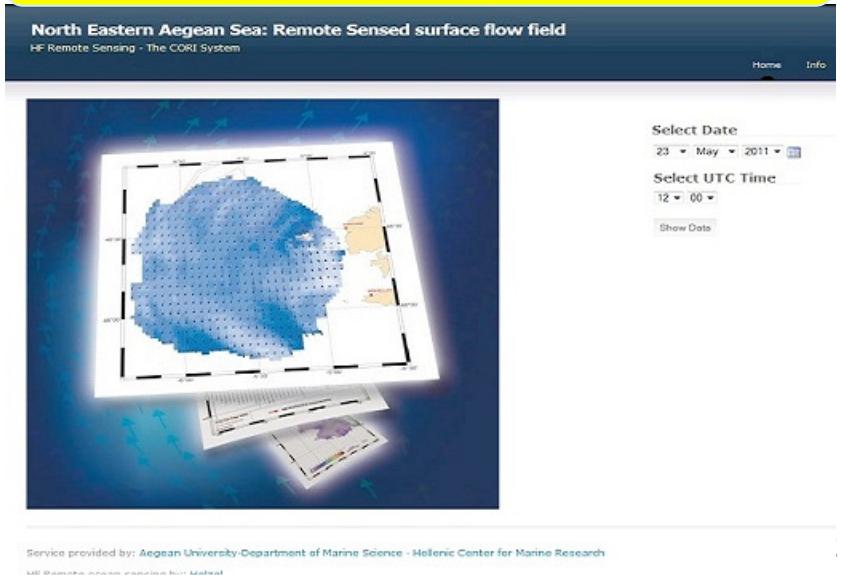
Online retrieval of historic data



Online oil-drift forecasting service

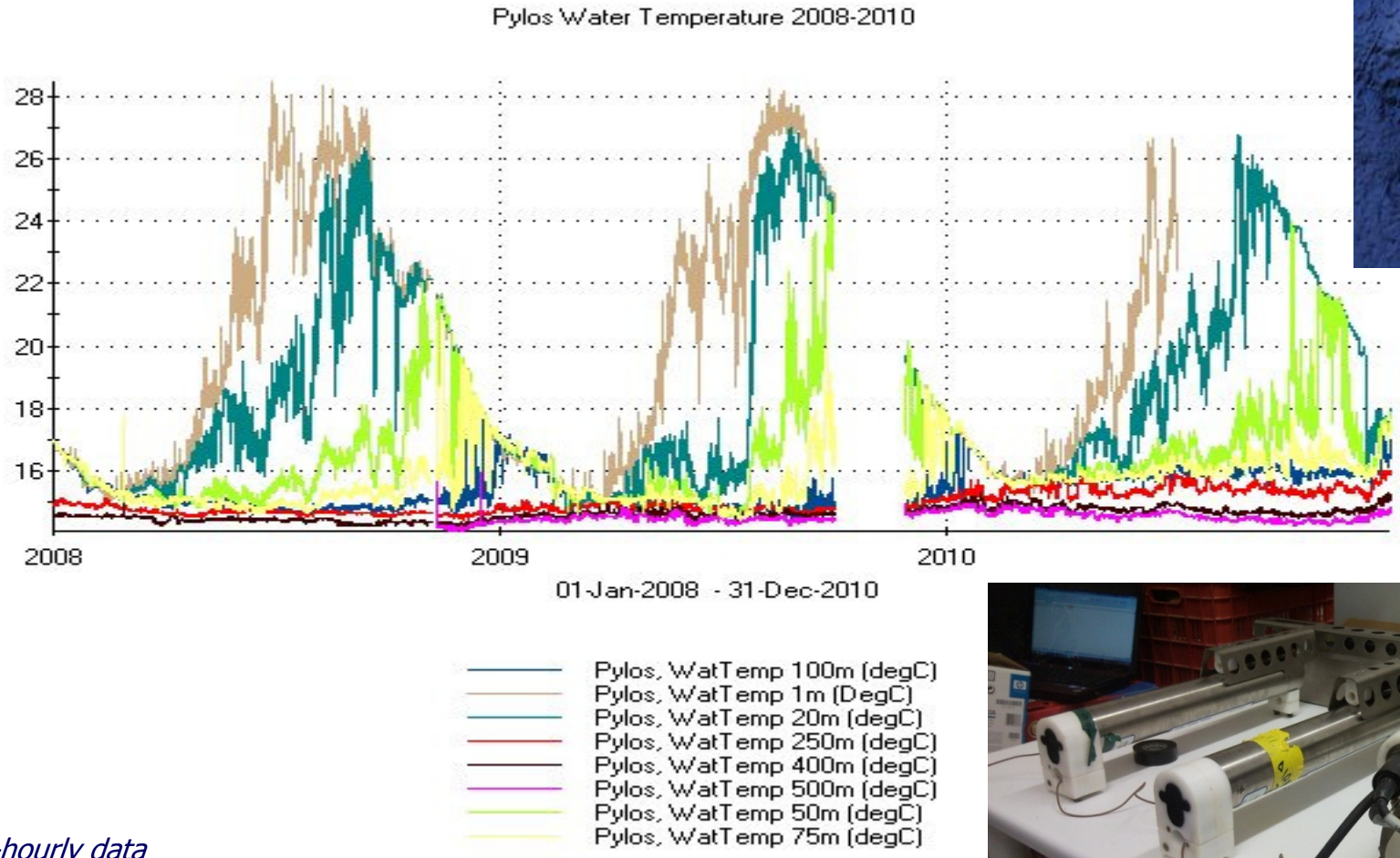


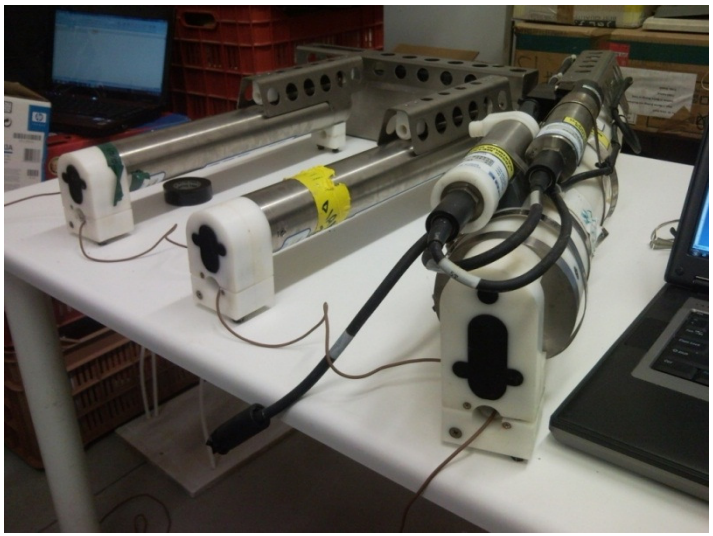
HF Radar system: online data every 30min



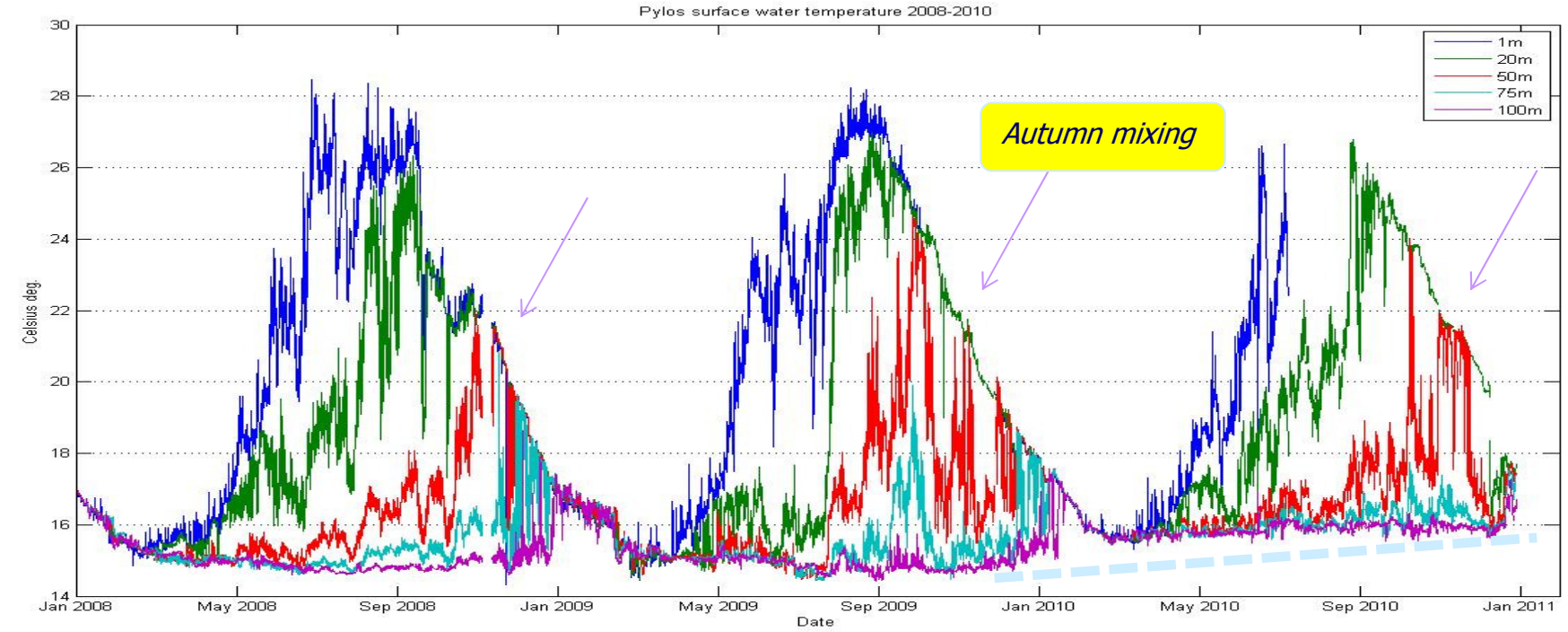
Examples of time-series data

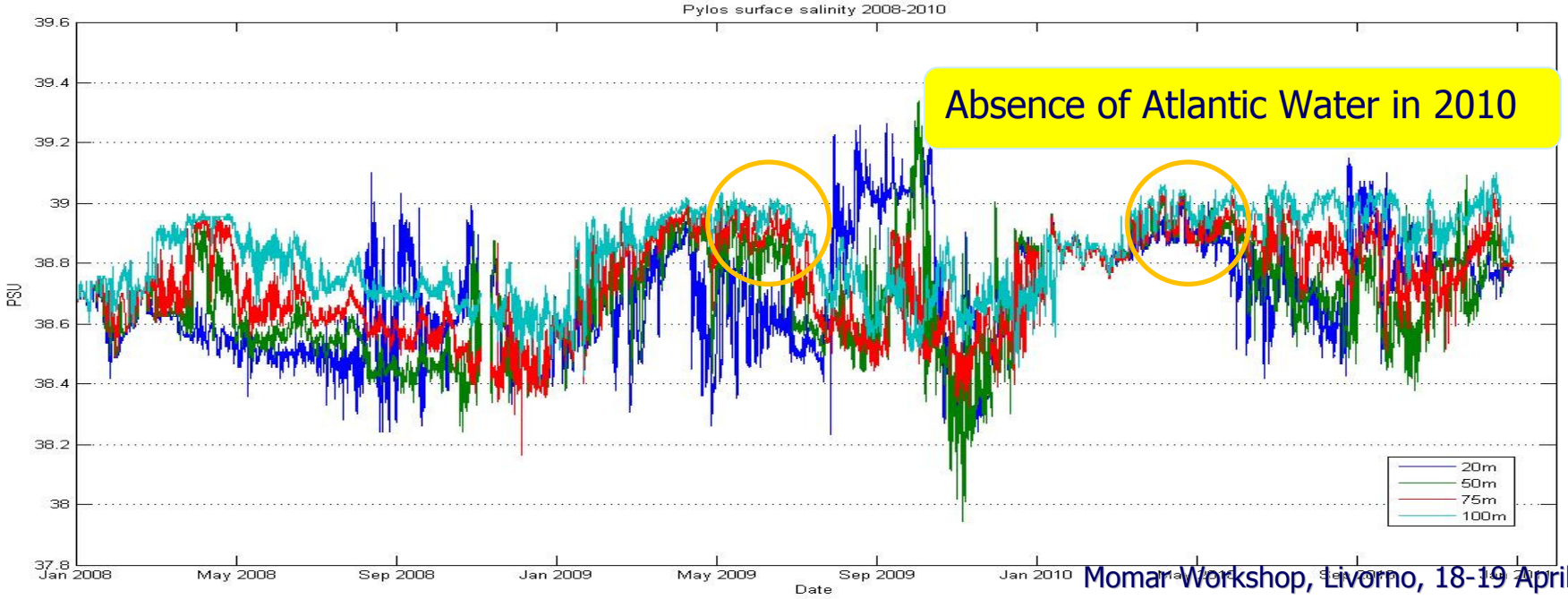
Examples of Time-series 2008–2010 (water column Temperature & Salinity)

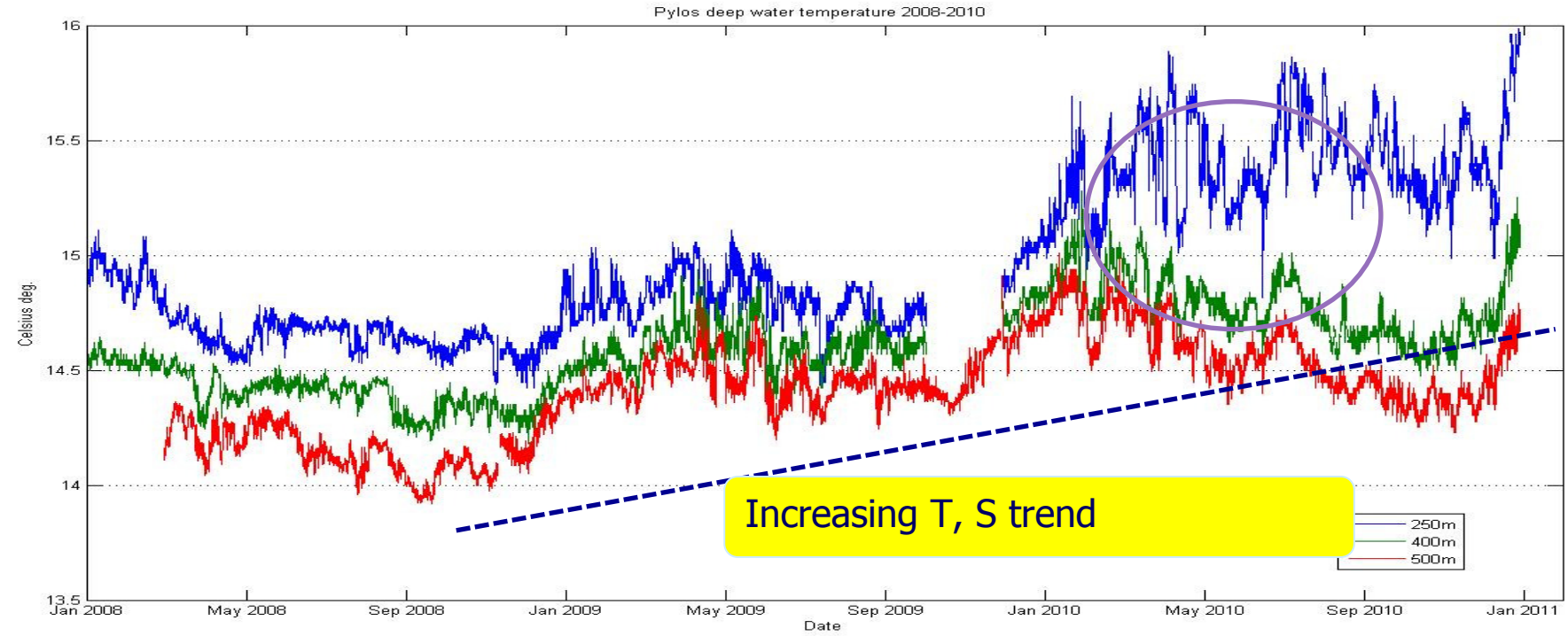


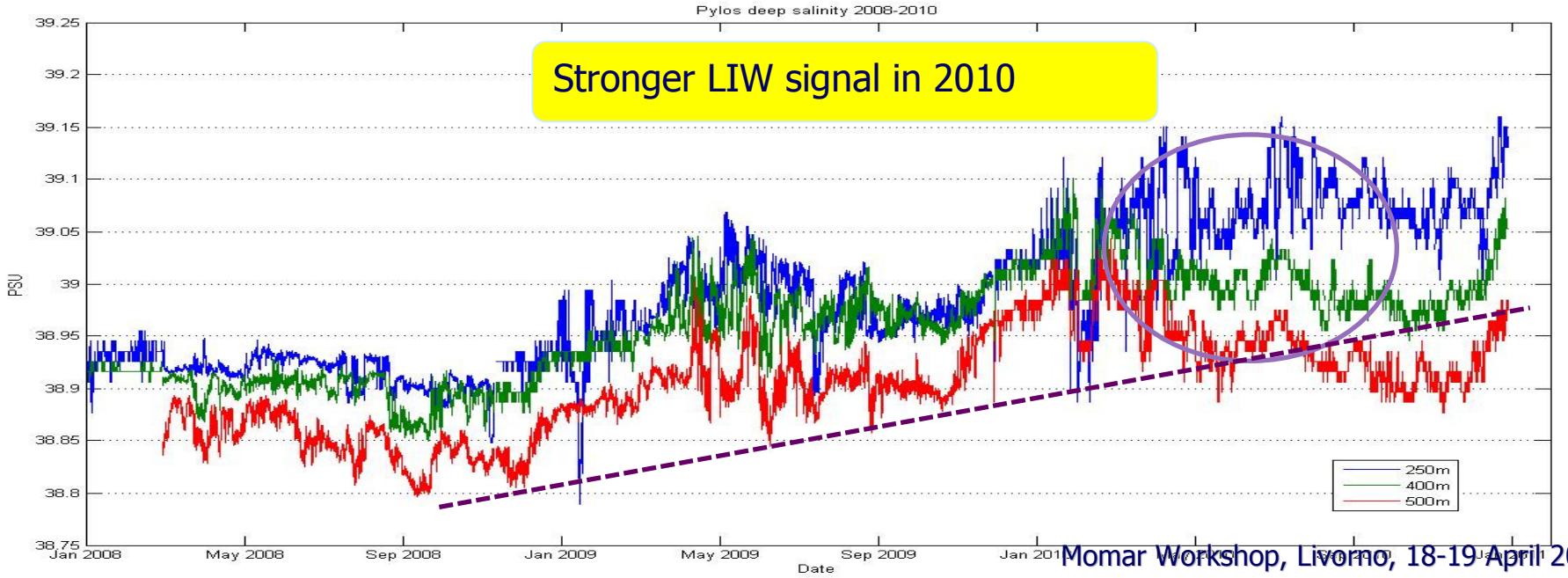


- *3-hourly data*
- *Real – Time QC procedure is performed daily*
- *Data stored in POSEIDON's DB*
- *Available through web interfaces and data portals*
- *A delayed mode data validation procedure has started*


Pylos surface water temperature 2008-2010
Celsius deg.
Date
1m
20m
50m
75m
100m
Autumn mixing
Jan 2008
May 2008
Sep 2008
Jan 2009
May 2009
Sep 2009
Jan 2010
May 2010
Sep 2010
Jan 2011

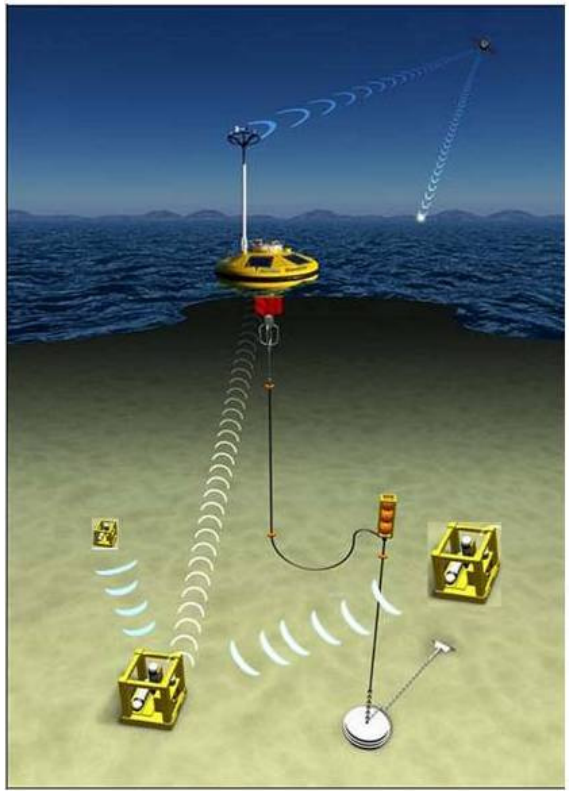

Pylos surface salinity 2008-2010
PSU
Date
Absence of Atlantic Water in 2010
20m
50m
75m
100m
Jan 2008
May 2008
Sep 2008
Jan 2009
May 2009
Sep 2009
Jan 2010


Pylos deep water temperature 2008-2010
Celsius deg.
16
15.5
15
14.5
14
13.5
Jan 2008
May 2008
Sep 2008
Jan 2009
May 2009
Sep 2009
Jan 2010
May 2010
Sep 2010
Jan 2011
Date
250m
400m
500m
Increasing T, S trend


Pylos deep salinity 2008-2010
PSU
39.25
39.2
39.15
39.1
39.05
39
38.95
38.9
38.85
38.8
38.75
Jan 2008
May 2008
Sep 2008
Jan 2009
May 2009
Sep 2009
Date
250m
400m
500m
Stronger LIW signal in 2010

Present developments - perspectives

Present developments: the POSEIDON III deep platform



A new Sea-bed observatory

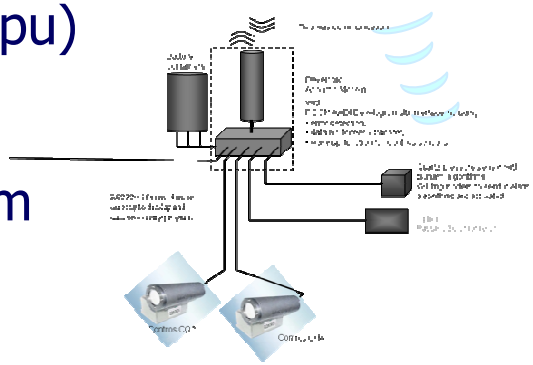
✓Multi-node autonomous platform (acoustic link between nodes)

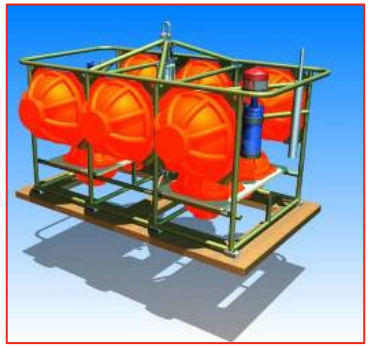
✓Development of the main node through POS-III. Upgrade of existing platform to form a node of the network

✓Sensors: Pressure, T, S, DO, Turbidity, CO2, CH4, pH

✓Compatibility of hardware (cpu) with rest of the systems

✓Modular – expandable system





Targeted applications of POSEIDON III:

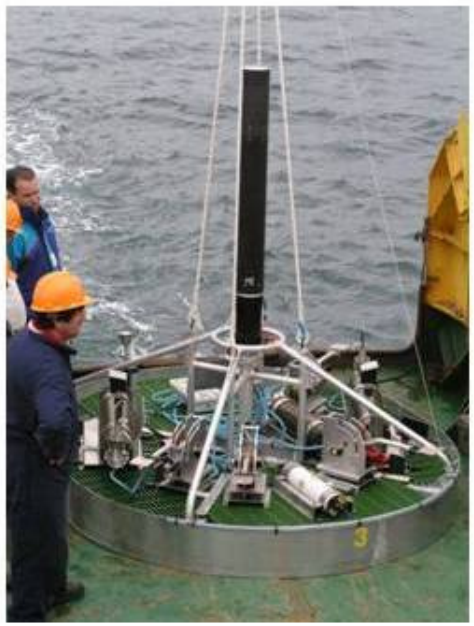
Integration of air-sea, water column and seafloor observations to address:

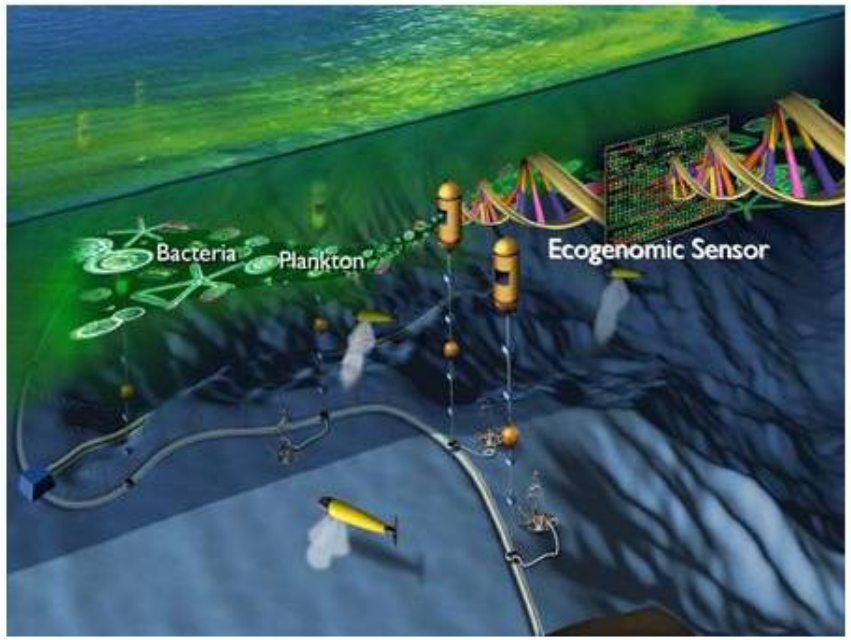
✓Detection & analysis of Climate Change signals & impacts

✓Deep Geophysical processes – effects of episodic events - Seismic risks

✓Gas hydrates – New energy sources

✓Deep sea biology; marine genomics





Conclusions – perspectives

- ✓ The POSEIDON infrastructure addresses both monitoring/operational (safety, environ. management, sutain. exploitation) and science/research needs
- ✓ Increasing user base - of high public interest and visibility
- ✓ Successful partnership between public entities, academia and private sector
- ✓ Based on and aiming to scientific and technological excellence
- ✓ Contributing to global (GOOS, OceanSITES, GEO) and European initiatives (EuroSITES, EMSO, EMODNET, GMES)
- ✓ Delivering valuable data to advance our understanding of Mediterranean dynamics

Glance into the future

Integration of multiple platforms

Buoys (existing POSEIDON)

Research Vessel Operations

Floating Profilers

Gliders (autonomous vehicles)

Complex Moorings

Seabed Platforms