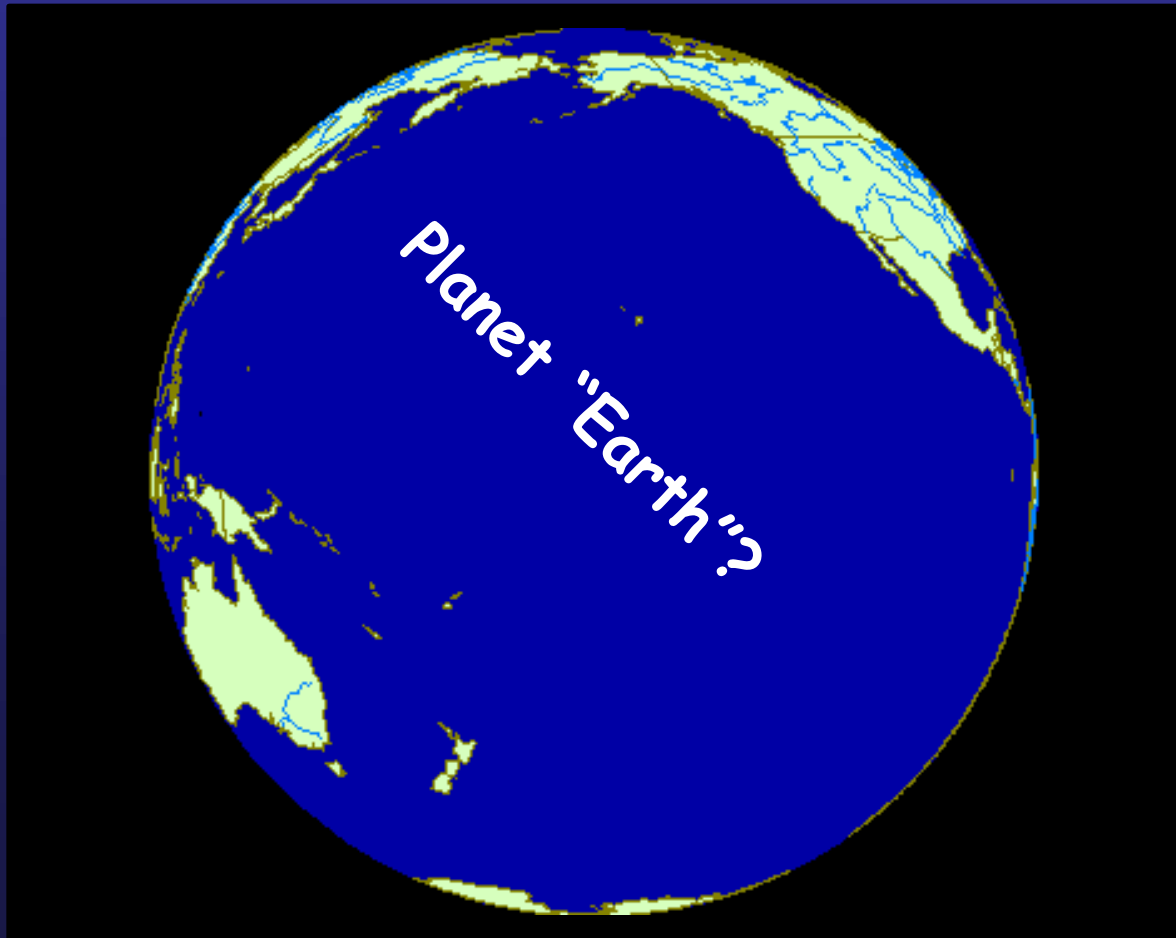


# EuroSITES to FixO<sup>3</sup>.

Richard Lampitt  
National Oceanography Centre  
Southampton  
UK

If we are to understand the role of the oceans in the global climate system and respond appropriately, we must observe them at a range of temporal and spatial scales.



1. What are the ways to make observations?
2. What is the current status of fixed point (Eulerian) observatories?
3. What are the limits to progress?







*Winslet and Di Caprio 1997*











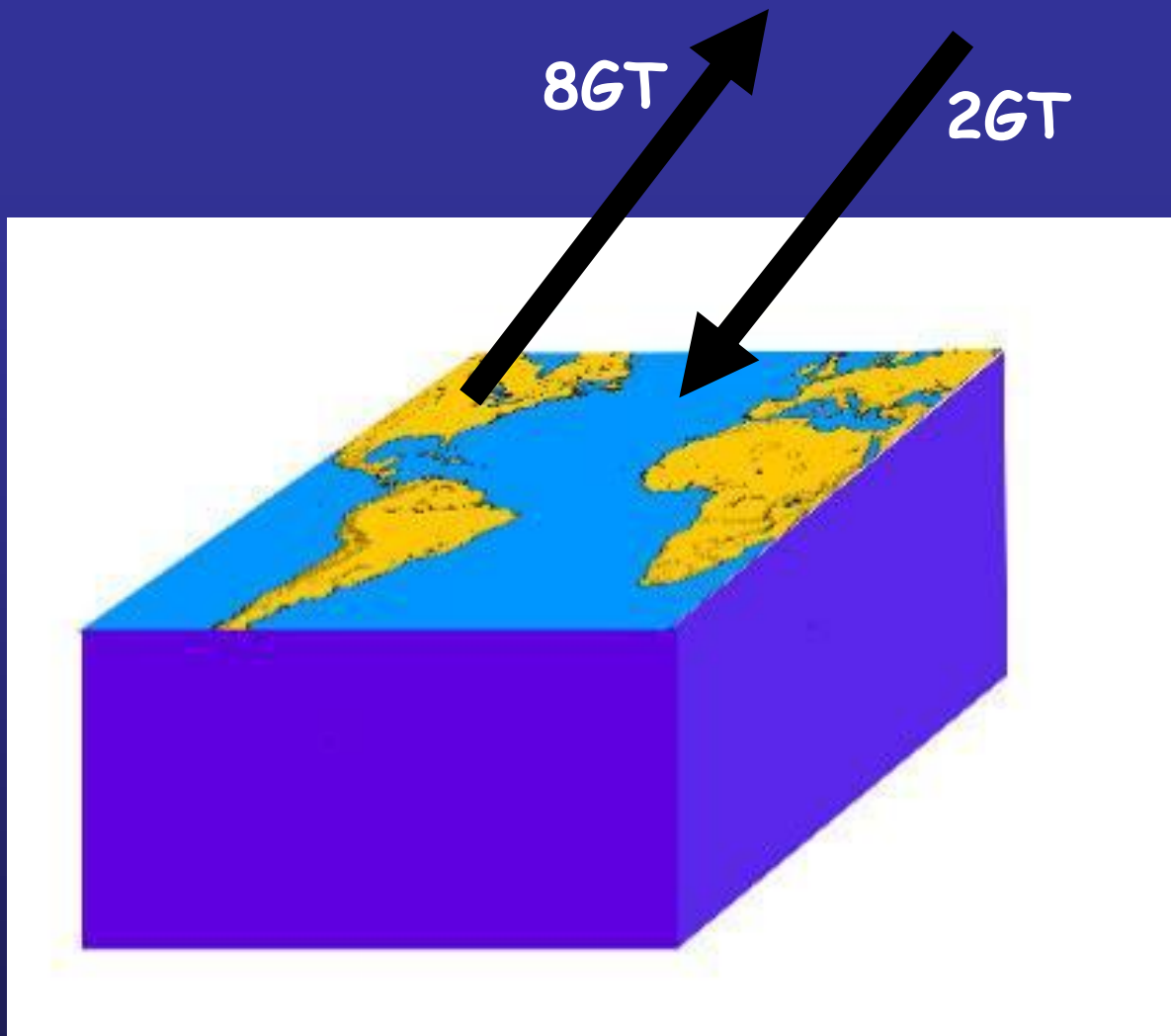
## The Humpback Whale











Global annual carbon fluxes



# Observing systems:

Ships of opportunity

Research cruises

Satellite (Altimetry, ocean colour & SST)

Floats

Autosub

Gliders

Benthic crawlers

Fixed point observatories



Data Management

Conceptual and computational models

All approaches have strengths and weaknesses

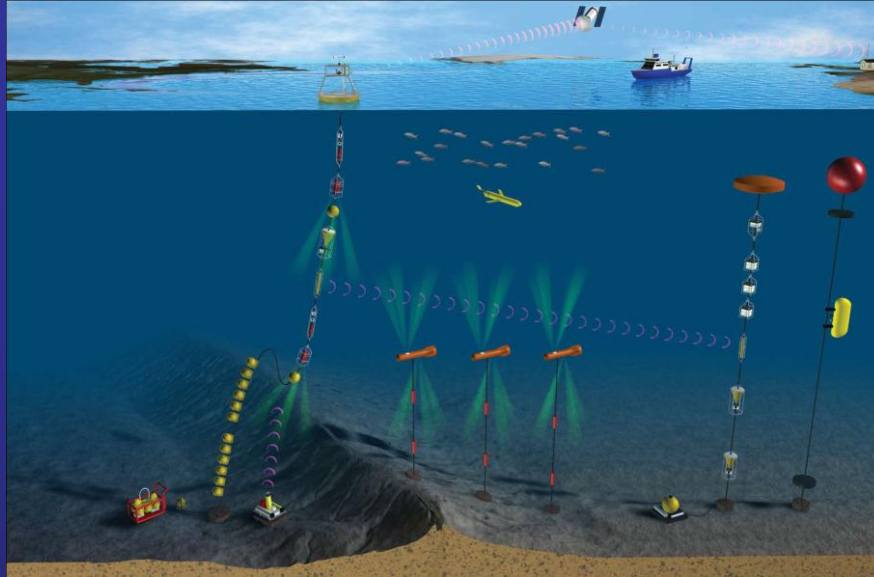
User community

**Autonomous systems have many advantages**



Observations are sometimes challenging at sea

# Unique strengths of Eulerian Observatories

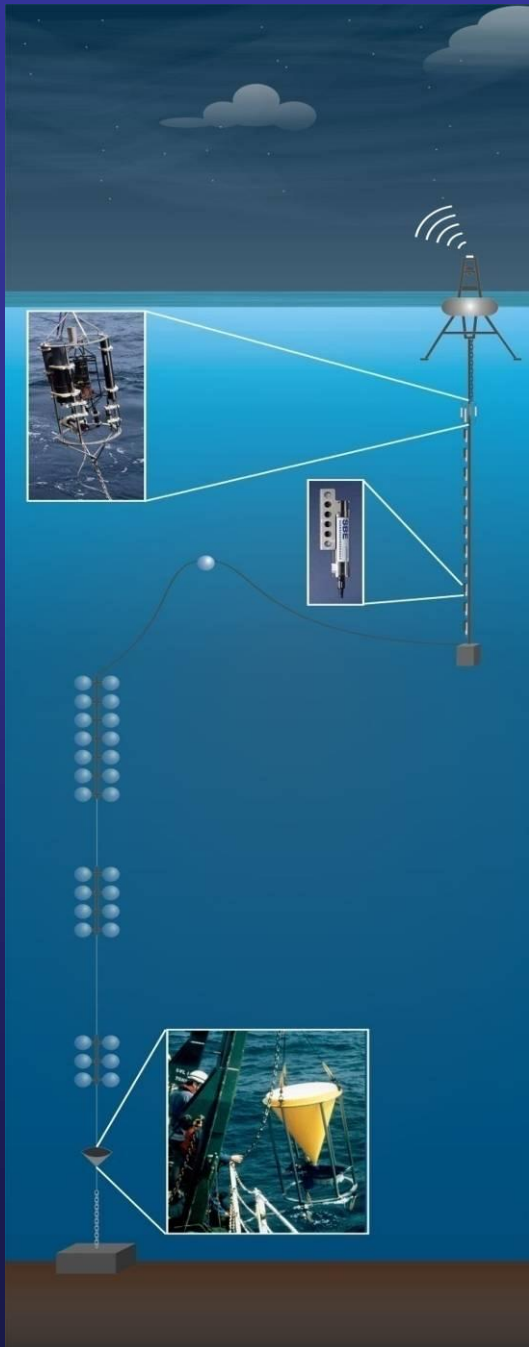


1. Sensors which are large or power-hungry
2. Real-time sub-surface data supply
3. Repeated site-specific sample collection (Water, biota, particles)
4. High frequency, un-aliased data, such as for reference data.
5. Deep ocean location (below maximum depth of floats and gliders)

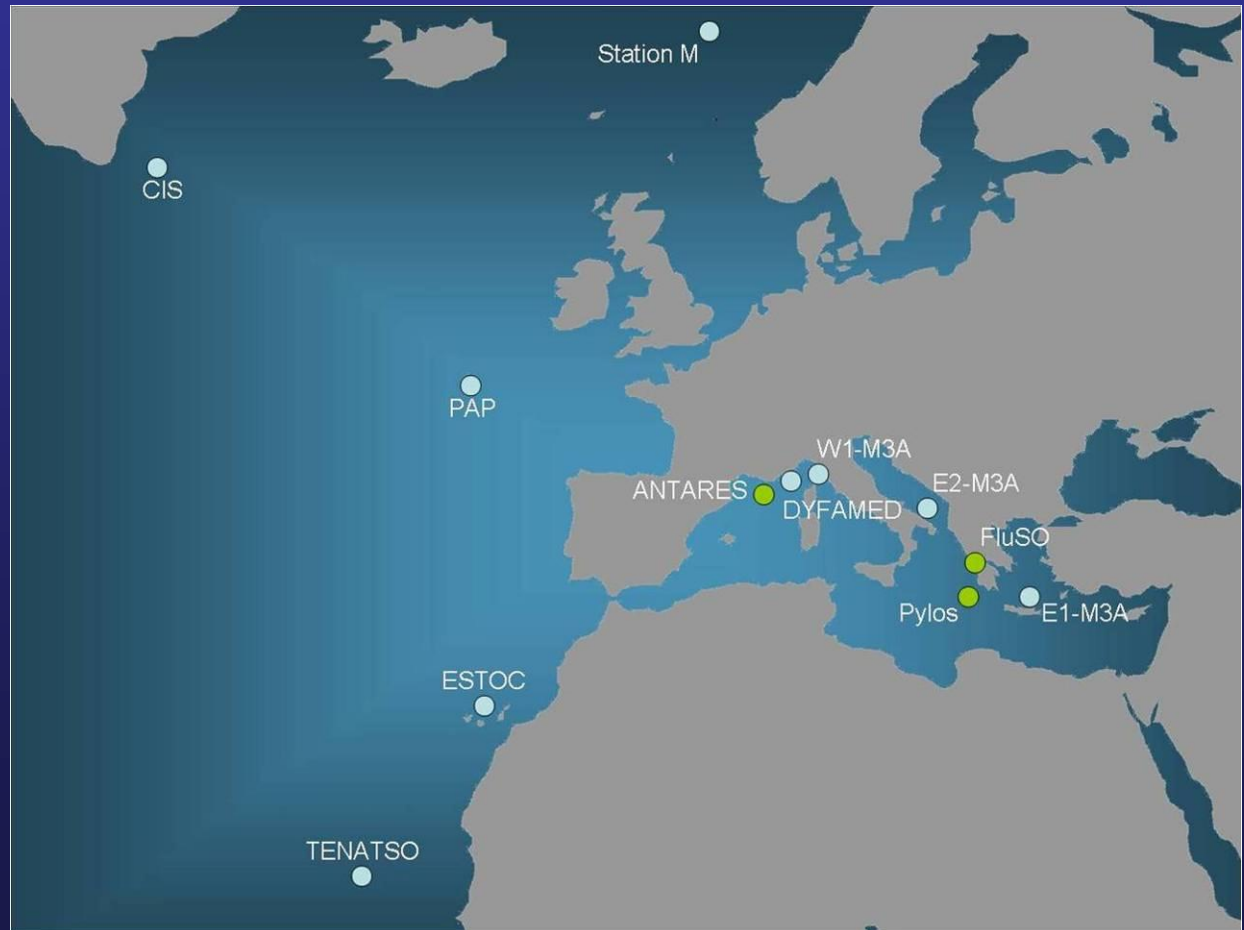


1. What are the ways to make observations?
2. What is the current status of fixed point (Eulerian) observatories?
3. What are the limits to progress?





EuroSITES integrates and enhances the 9 existing deep ocean (>1000m) fixed point observatories.





- EU FP7 Collaborative Project
- 3 years: April 1<sup>st</sup> 2008 - March 31<sup>st</sup> 2011
- Coordination: NOC, UK
- 13 partners (8 countries)
- International Oversight Committee
- Open ocean (>1000m)
- Full depth, *in situ*: Ocean interior, seafloor and subseafloor

# Dual function of funding:

## 1: Observatory support

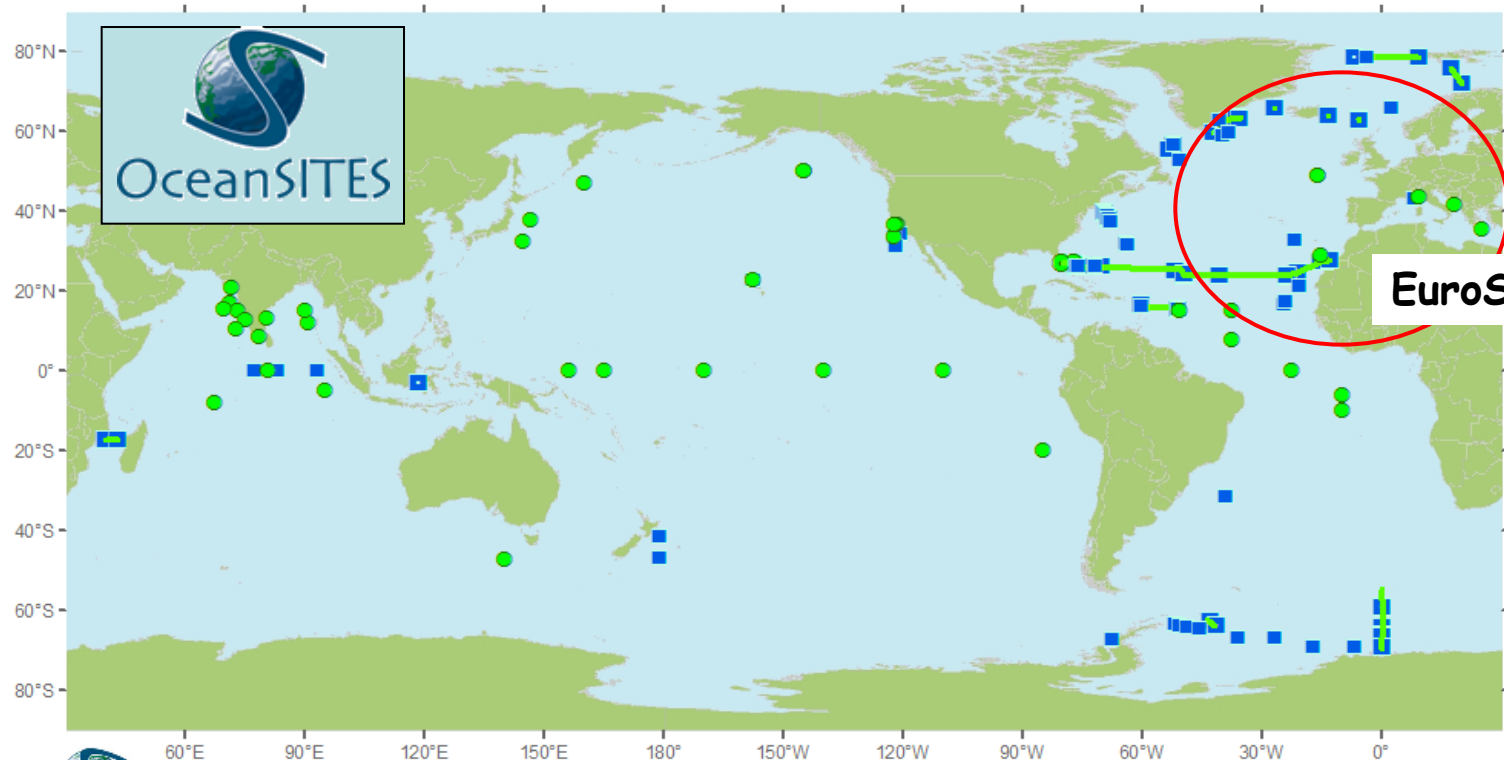
- Staff
- Equipment

## 2: Glue

- Efficiency of operation
- Enhanced national funding
- Outreach & knowledge transfer
- Effectiveness



# OceanSITES: Global network. An essential component of GOOS.



EuroSITES



## OceanSITES Status Map 2009 - Operating Sites

OceanSITES Moorings and Observatories (91) Transport sites (16) Transport Stations (67)

● OPERATING Real time data (44)

— OPERATING

● OPERATING Real time data (2)

■ OPERATING Delayed Mode data (47)

■ OPERATING Delayed Mode data (65)

Note: This status was based on information provided in 2009.

# Connection to national initiatives

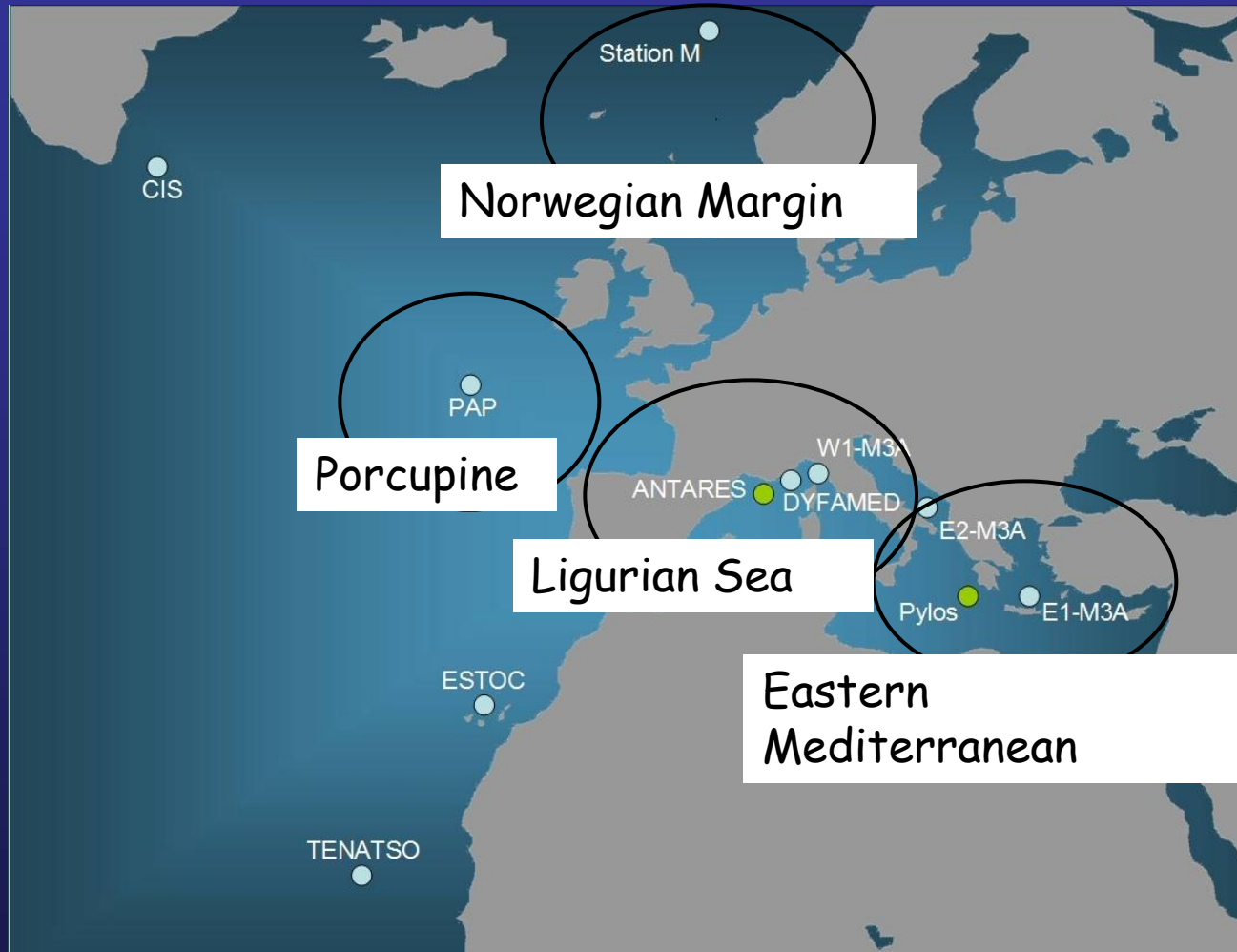


## Ocean Observatories Initiative

6 of the EuroSITES oversight committee were key players in OOI and Neptune Canada



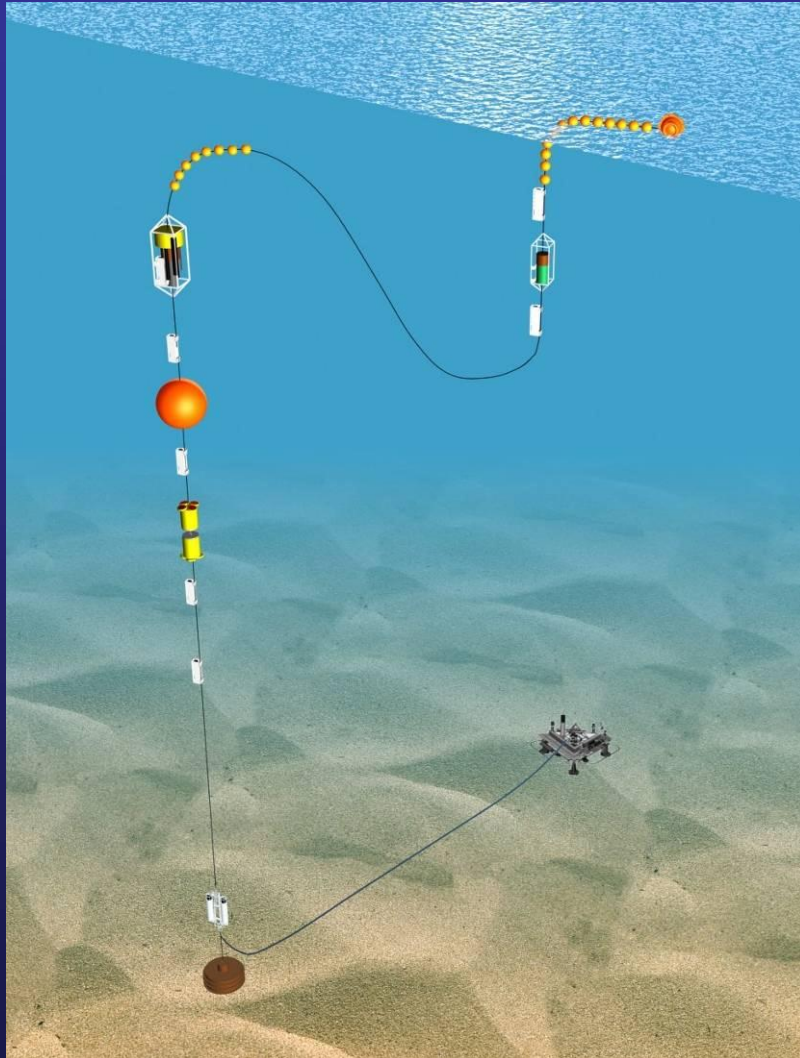
# Regional, collaborative science



EuroSITES and ESONET/EMSO: 4 Common regions

# Multidisciplinary time-series

## Vertical coverage: Surface to seafloor

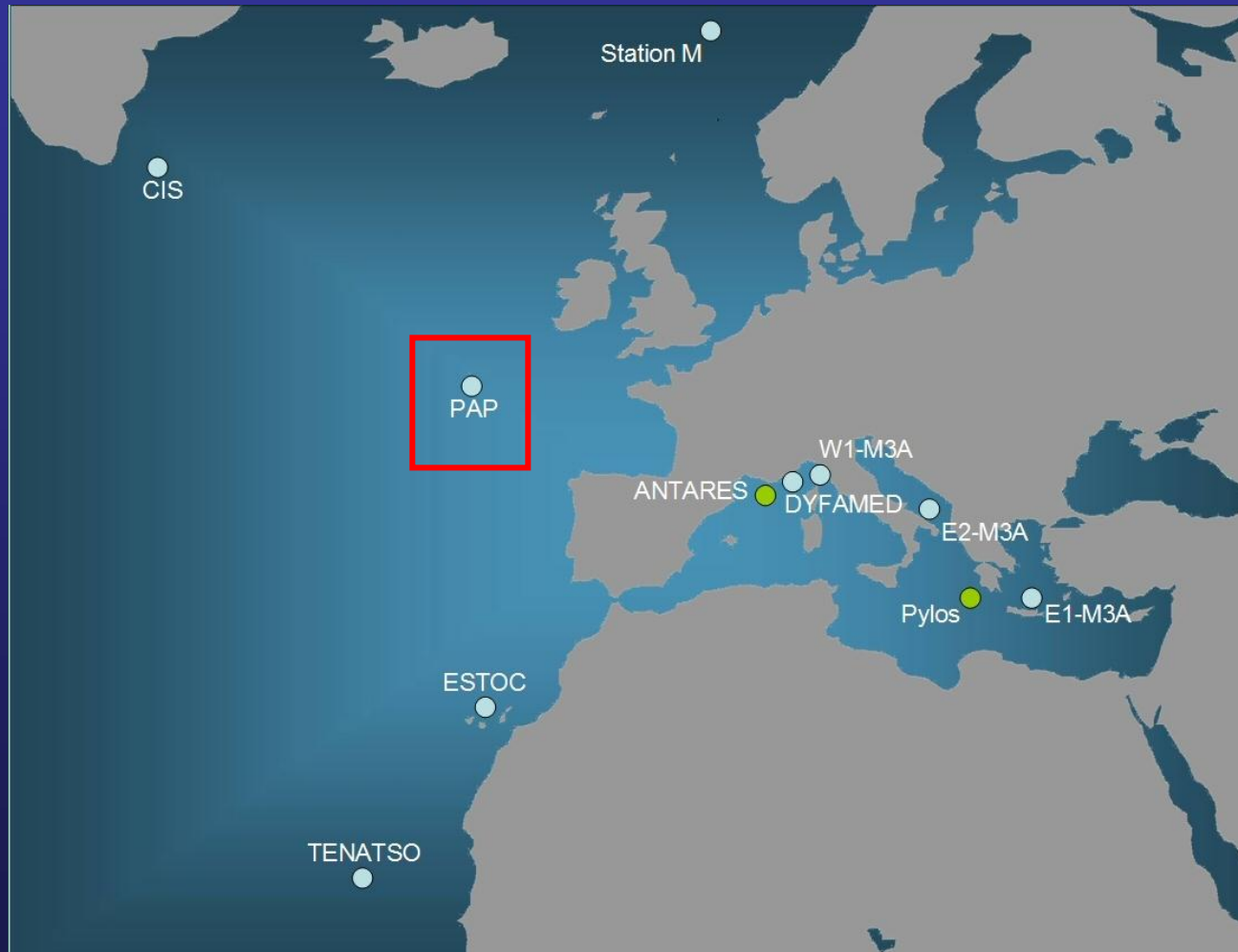


- Temperature
- Salinity
- Currents
- Nutrients
- Chl-a
- $\text{CO}_2$
- $\text{O}_2$
- Particle flux
- Benthic components

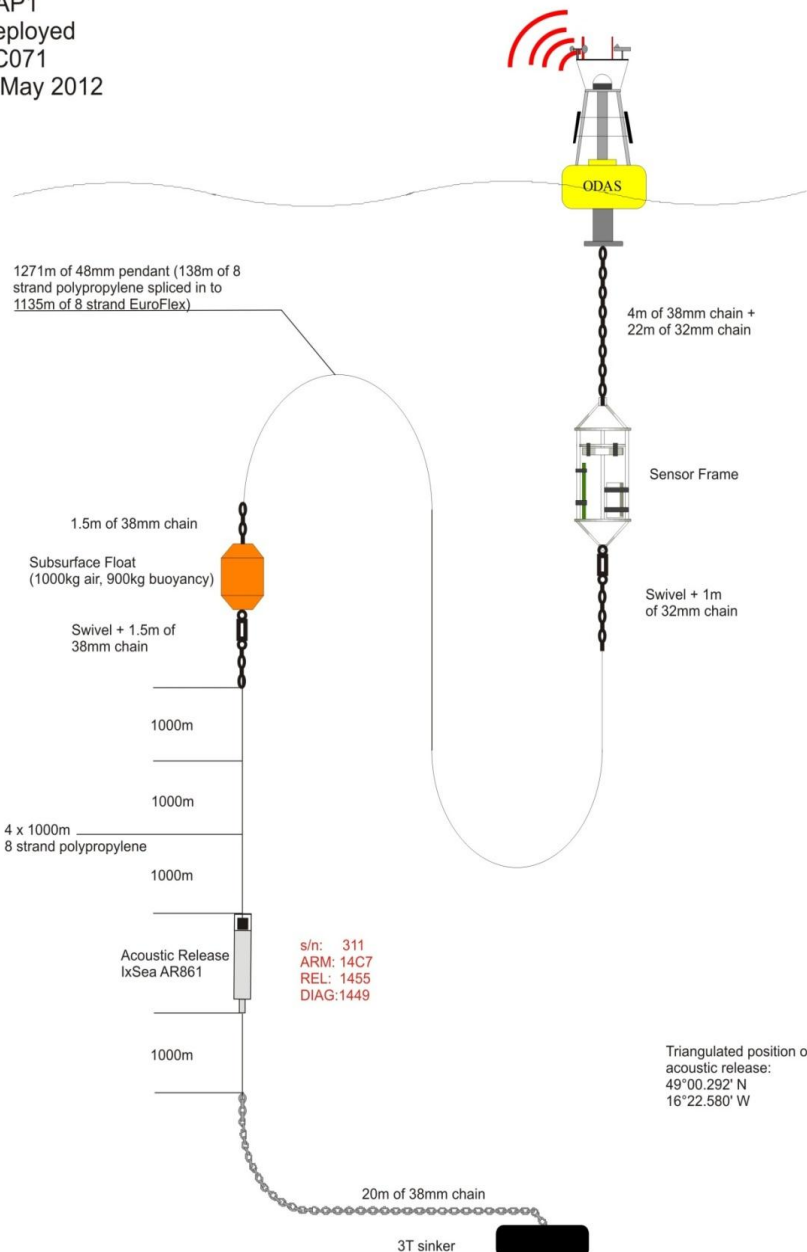
## Real-Time Telemetry

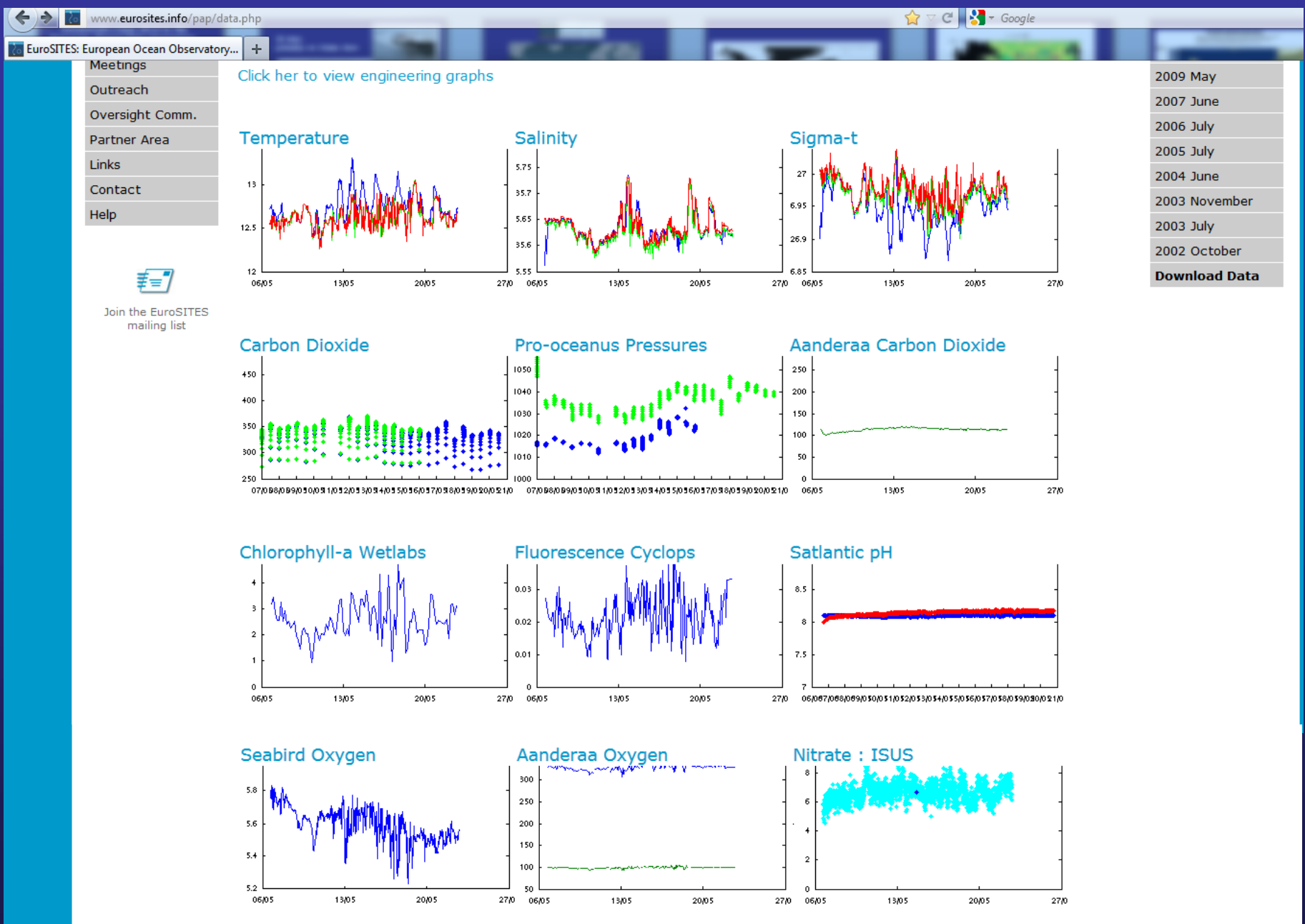


# Porcupine Abyssal Plain (PAP)



PAP1  
 deployed  
 JC071  
 6 May 2012

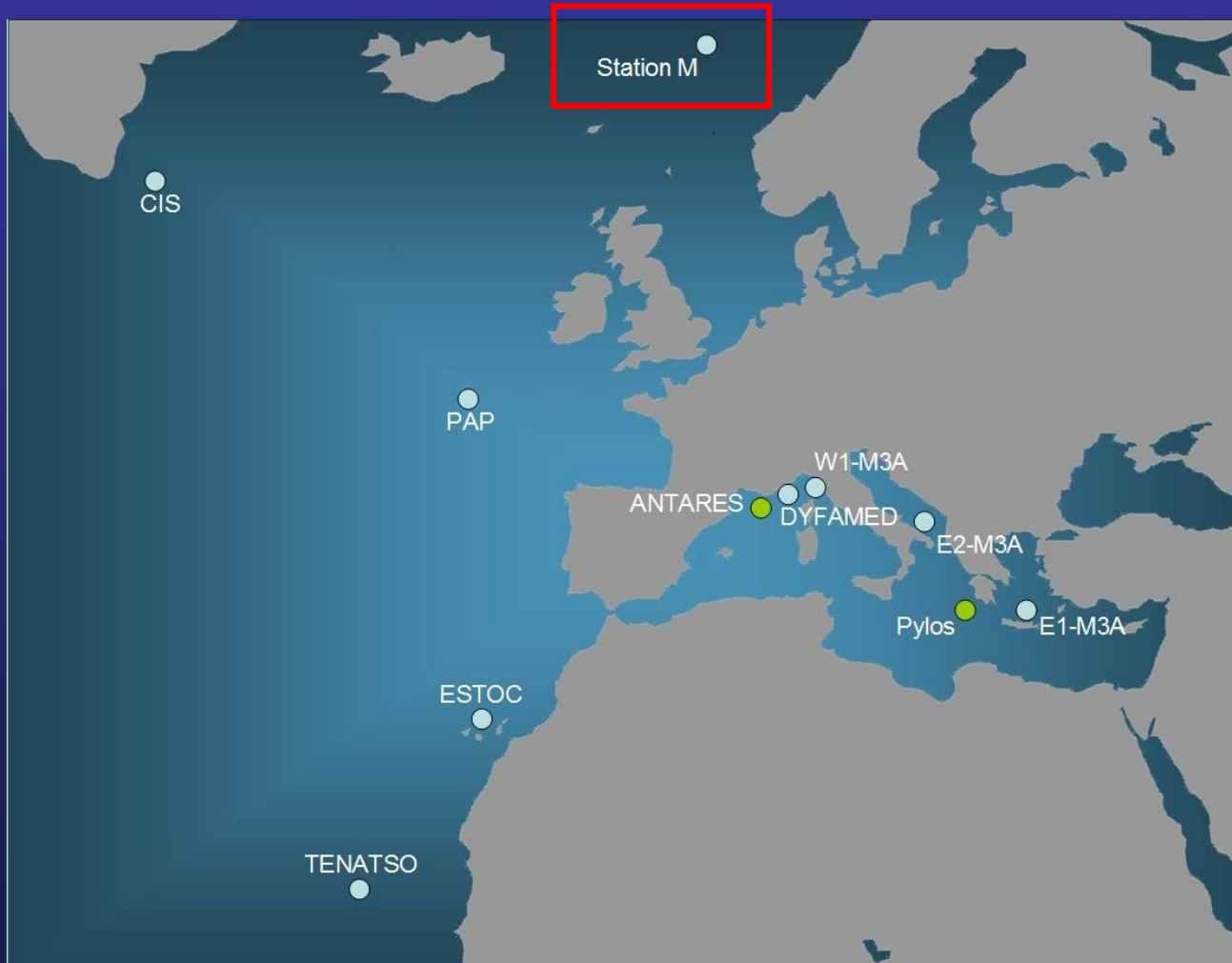




Data from PAP up to today

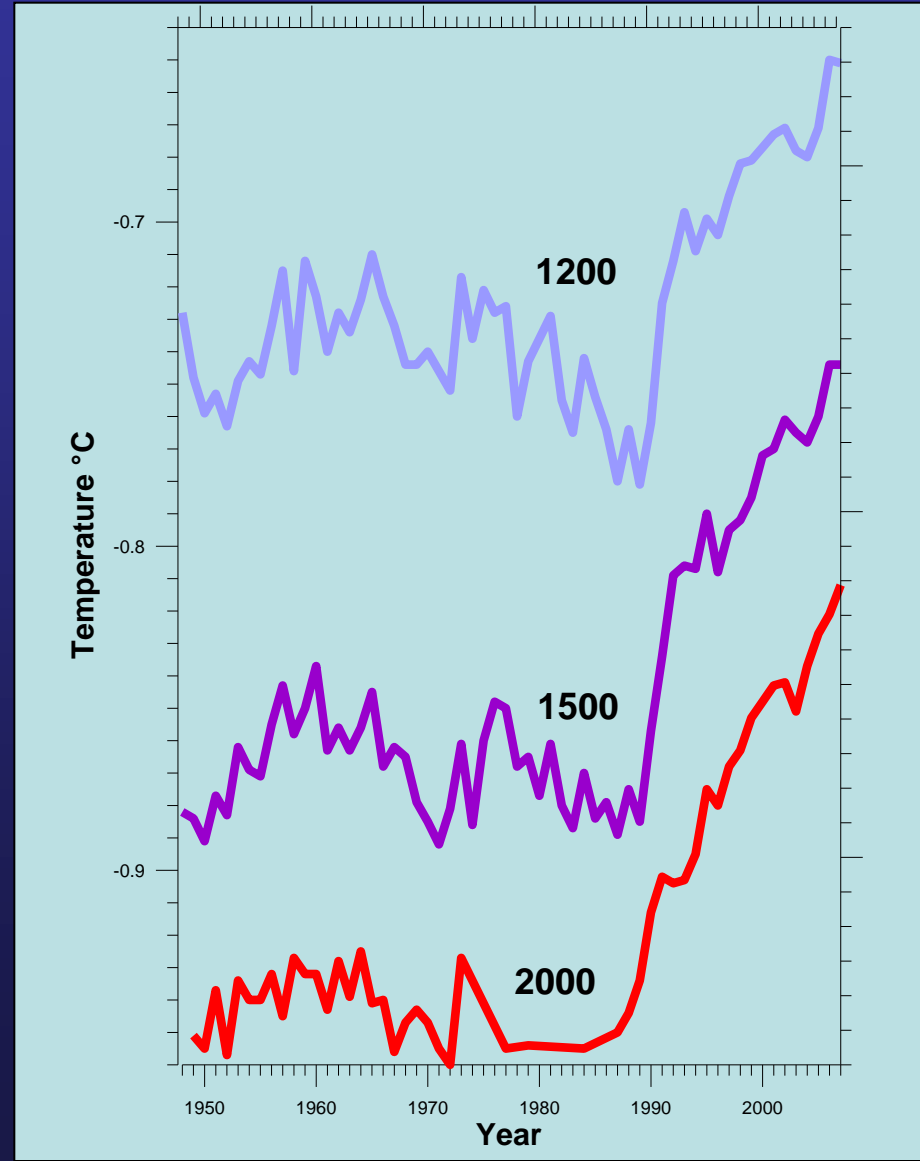
www.eurosites.info

# Station M, Norwegian Sea

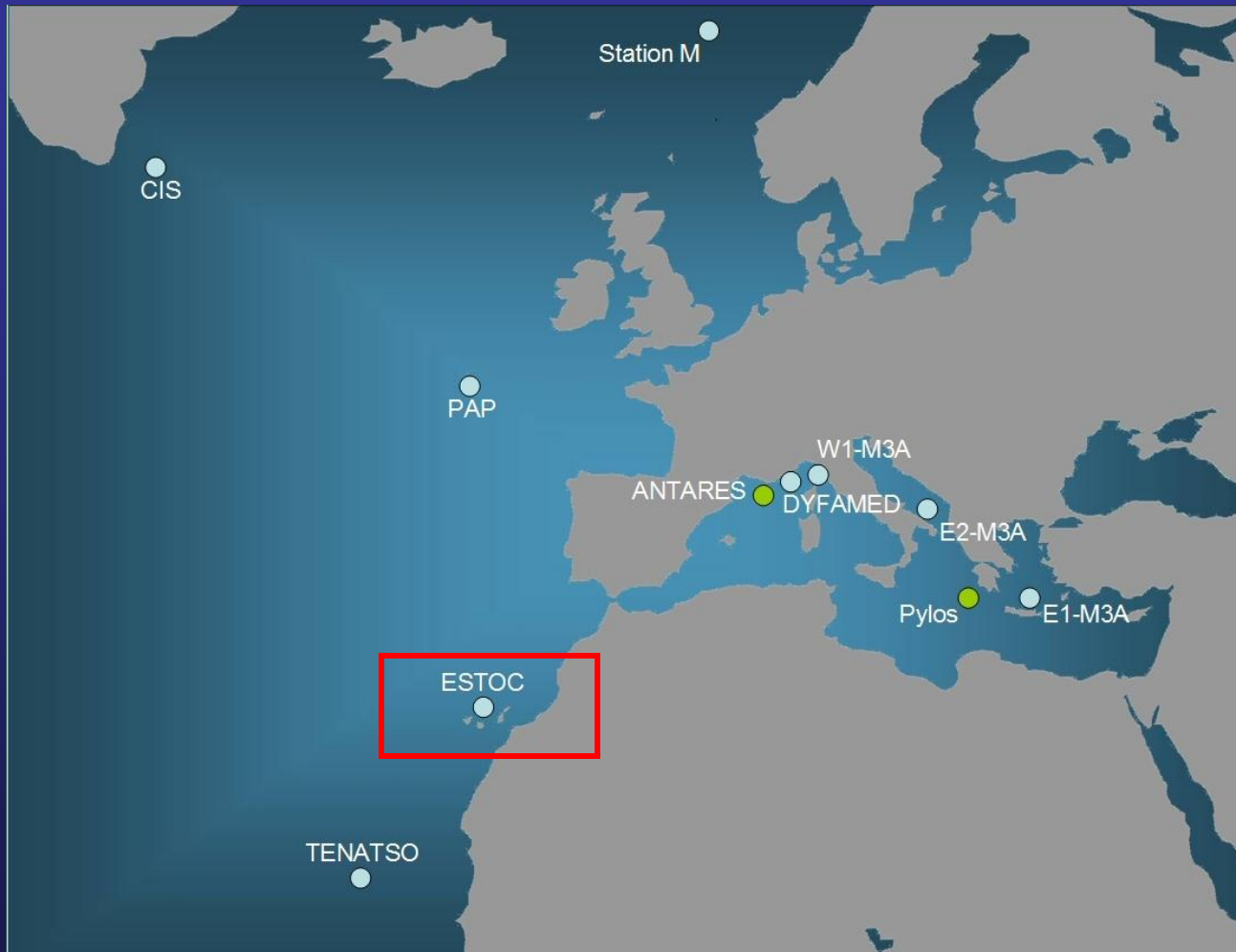


# Station Mike

Dramatic deep water temperature increase



# ESTOC

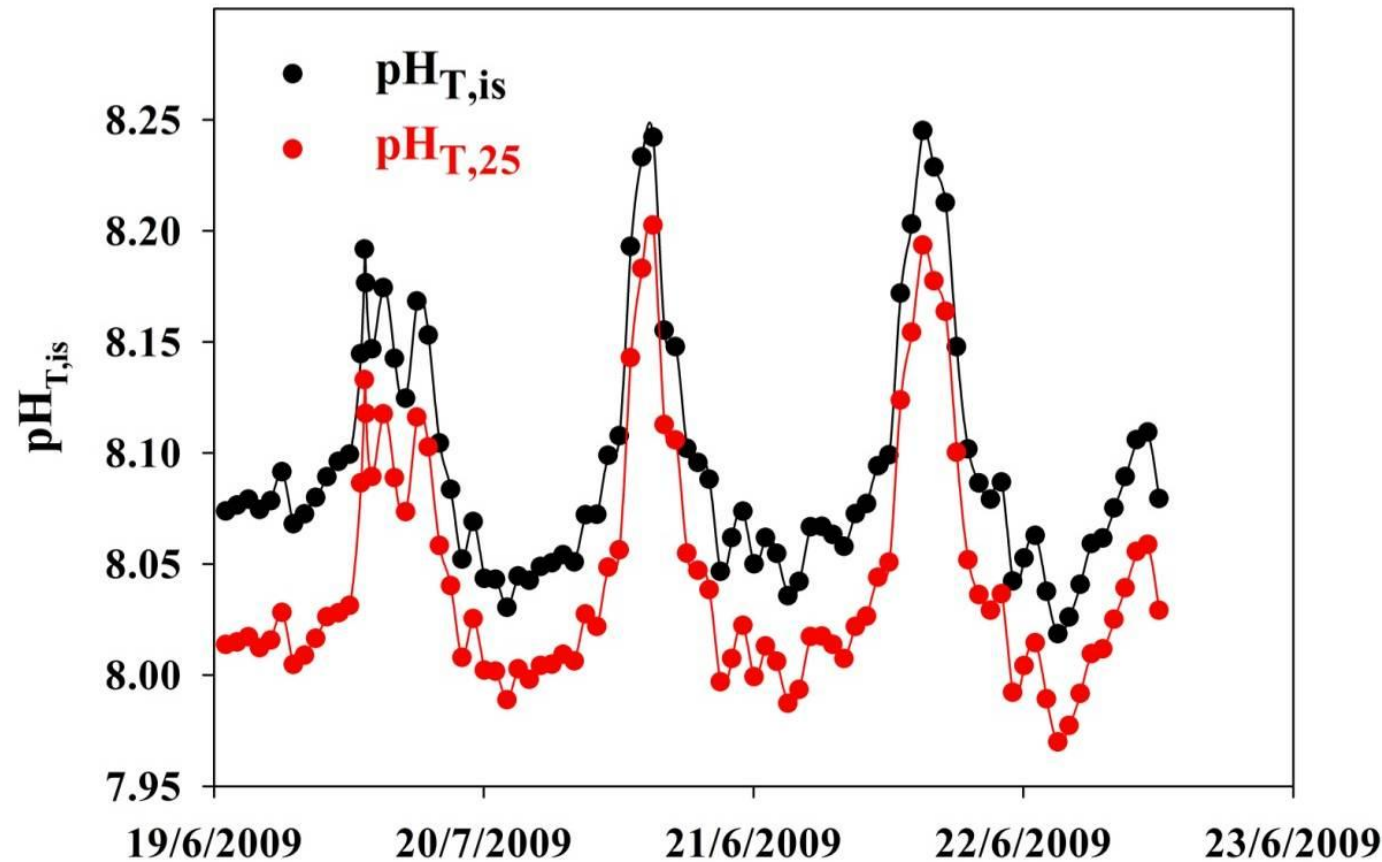
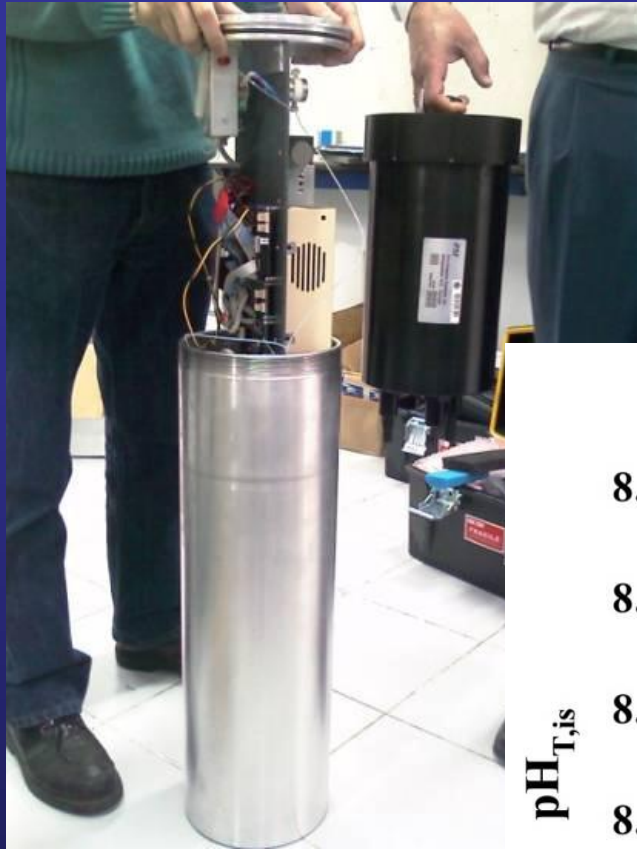




# Ocean acidification

-autonomous pH time-series sensor

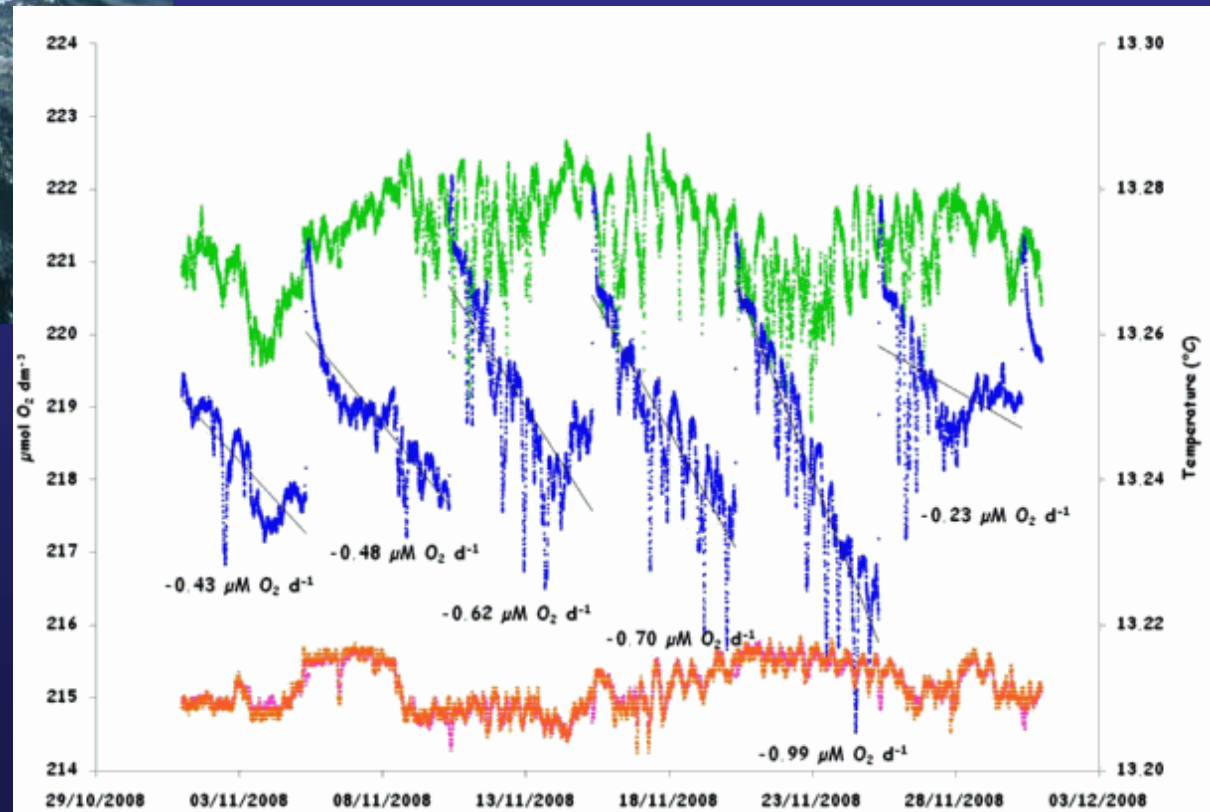
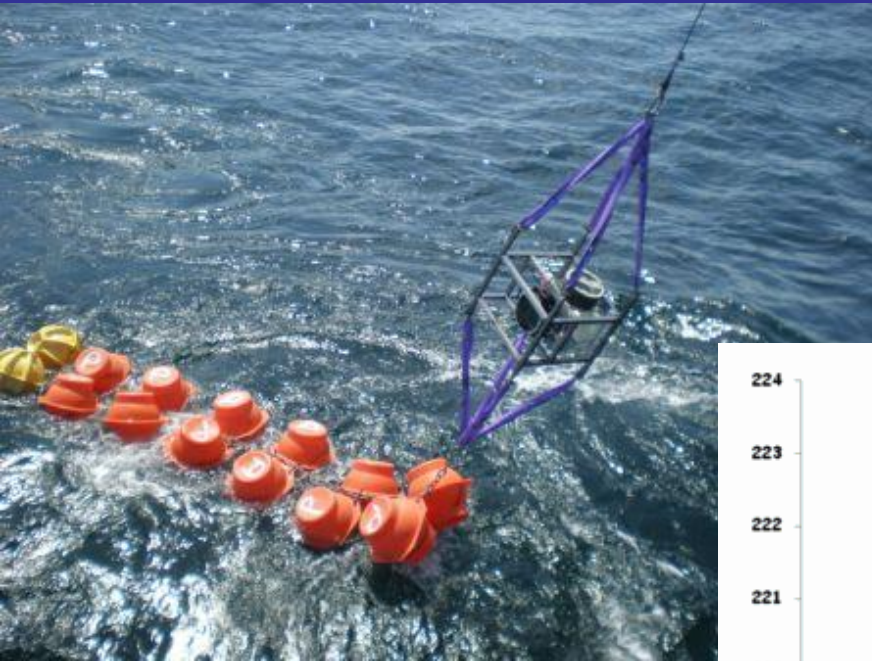
- Links with EPOCA and CARBOOCEAN



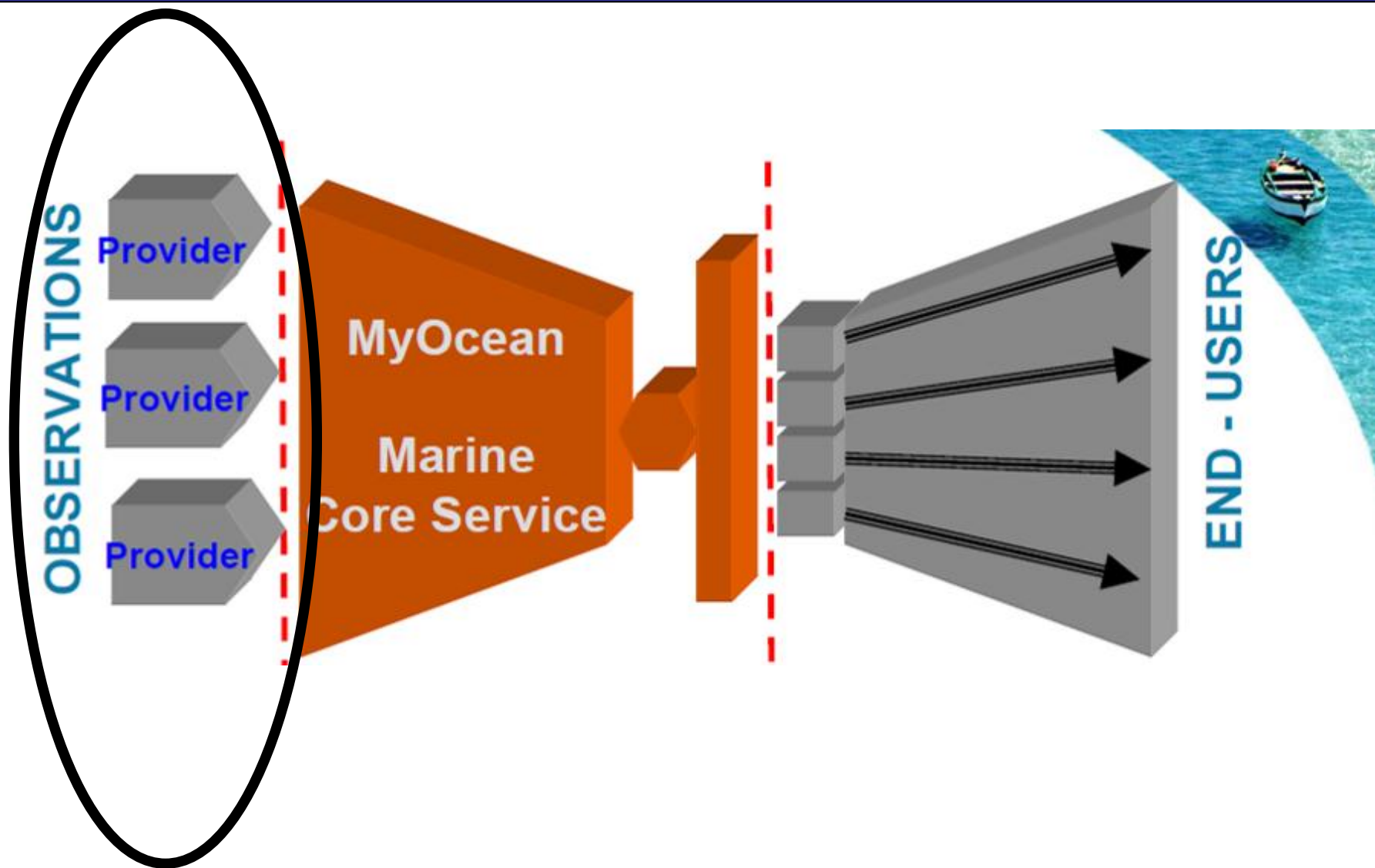
# Western Mediterranean



# Deep ocean oxygen consumption - *in situ* measurement



O<sub>2</sub> concentration inside and outside of IODA chamber

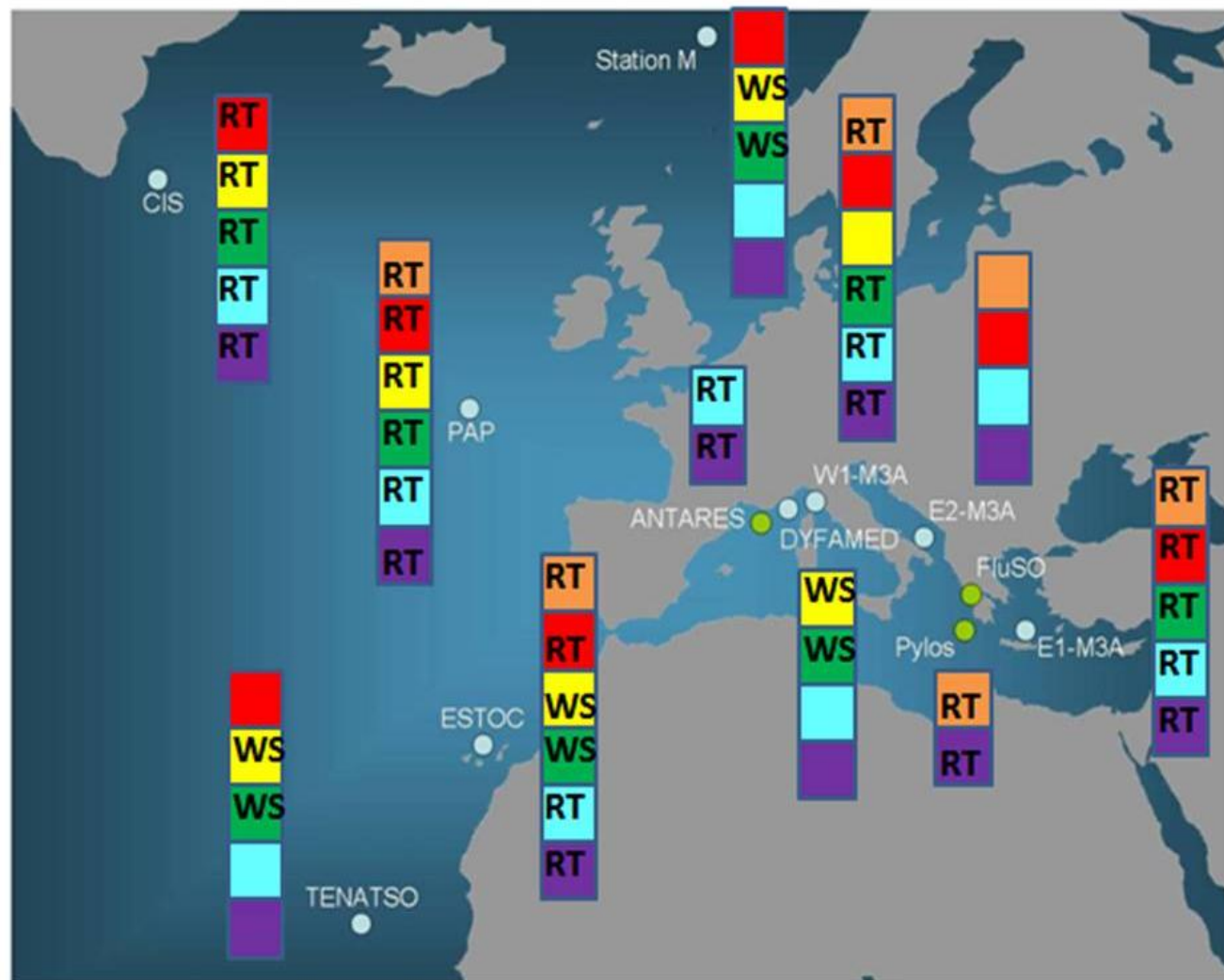


The vision of MyOcean

## Data:

- freely available to all immediately after collection and QC (Website, ftp & GTS)
- Associated metadata
- Using internationally agreed protocols and formats







Connection to modelling  
initiatives and communities  
such as met offices.

EuroSITES dissemination:

Outreach and Knowledge Transfer

- Website
- Fact Sheets
- On-line Cruise diaries
- Film

[www.outreach.eurosites.info](http://www.outreach.eurosites.info)



**EuroSITES** is an European project integrating and enhancing 9 open ocean observatories across Europe. Moored at key locations in the ocean these observatories measure physical, chemical and biological seawater properties from the sea surface all the way down to the sea floor.

### Observing the Oceans : Why?

The global Ocean is a powerful force in regulating our climate and often has a greater influence than dry land. Observing the oceans is therefore one of the most fundamental ways to understand the global climate system.

#### Carbon cycle

The global Ocean is an important regulator of climate change as it absorbs carbon dioxide from the atmosphere. Some of this carbon is locked away in deep sea sediments for long periods of time. Observations are vital to give us clues about how much carbon dioxide the waters can hold, and for how long.

#### Ocean acidification

The amount of carbon dioxide dissolved changes the acidity of the oceans, which then affects the distribution and abundance of phytoplankton and zooplankton particularly those with calcareous exoskeletons.

#### Currents and circulation

Measuring the physics and chemistry of the oceans allows scientists to track individual water masses. These move both vertically and horizontally through the global Ocean forming a complex circulation system. Monitoring currents and circulation patterns is key to understanding how climate change is affecting heat (energy) and nutrient transfer around the planet.

#### Ecosystems

Monitoring environmental change in the oceans (e.g. temperature, salinity, pH, nutrients) is vital as this will affect the distribution and functioning of all marine organisms from phytoplankton to whales. Huge population changes can occur in deep sea animals e.g. holothurians (sea cucumbers). This is related to the availability and quality of food arriving on the seafloor (e.g. marine snow).

For more details about the EuroSITES science and outreach visit our website: <http://outreach.eurosites.info/> or contact us: [education@eurosites.info](mailto:education@eurosites.info)



The 9 EuroSITES open ocean observatories are moored off-shore in waters deeper than 1000 metres. The locations are chosen far from the coast to reduce the influence of land (e.g. river input) and human activity (e.g. pollution). A diverse range of sensors record changes in the physical, chemical and biological properties of the ocean, such as temperature, salinity, nutrients and currents from the sea surface to seabed.

The surface buoy collects the data acquired by the ocean sensors and sends the data via satellite to scientists ashore.

### Observing the Oceans : How ?

Strong mooring wire extends from the sea surface down to the sea floor. Sensors are attached to monitor the ocean properties at different depths. The equipment remains submerged for months on end autonomously collecting time-series of data. Buoyancy is also attached to aid recovery.

#### SUNLIT ZONE

The sunlit (euphotic) zone is an important region for the cycling and exchange of dissolved gases (e.g. oxygen and carbon dioxide) between the atmosphere and ocean. Phytoplankton use carbon dioxide and sunlight in this zone to capture energy through photosynthesis. A knowledge of how these processes and nutrient cycles are changing is crucial to understand how the atmosphere and ocean interact to regulate our climate.

Sensors in this zone measure the temperature and salinity together with biological and chemical properties of the seawater (e.g. chlorophyll-a, nutrients and dissolved gases).

#### TWILIGHT ZONE

The twilight zone is the transition between the sunlit and the dark deep ocean, and forms a large proportion of oceanic waters. Only organisms adapted to the dark and the high pressures can survive. Food is available as marine snow particles sinking from the sunlit zone (e.g. dead organisms, shells, dust particles and faeces). Many animals also migrate upwards at night where the food is more abundant. They then retreat back to the darker twilight zone in the daytime to avoid predators. Scientists monitor this environment to study the carbon cycle and transport of carbon to the deep seafloor. This is also a key region for monitoring variations in water masses and circulation patterns.

#### SEA FLOOR

Sediment traps collect sinking marine snow particles. Physical sensors measure temperature, salinity, current speed and direction. Oxygen sensors and respiration chambers measure biological activity. The seafloor reaches depths of several thousands of metres. Most species living here feed on the flux of marine snow sinking from surface layers. Changes in this flux profoundly affect these species. Climate variability at the surface impacts deep-sea biological communities 5000 metres underneath!

A lander deployed as deep as 3000 metres on the sea floor acts as a platform for environmental sensors e.g. time-lapse cameras, sedimenters, pressure sensors and others.

EuroSITES data sets are used to understand key ocean processes at both short-term and longer-term time-scales. EuroSITES contributes to the international Global Earth Observation System of Systems (GEOSS) which aims to understand the current climate and ocean system and to predict future change.

For more details about the EuroSITES programme and the observatory of action, contact us: [outreach@eurosites.info](mailto:outreach@eurosites.info) or contact us: [education@eurosites.info](mailto:education@eurosites.info)




« PAP Cruise : Friday 17th July 2009

PAP Cruise : Monday 20th July 2009 »

### PAP Cruise : Saturday 18th July 2009

#### Measuring Bioluminescence at the PAP site

Some small plankton species are able to produce flashes of light which can be seen in the water at night. These organisms are said to be bioluminescent. As part of the scientific work happening here on the RRS Discovery we are taking measurements to estimate the amount of bioluminescence which can be stimulated in the surface water and to identify which organisms are creating it. This is done using an instrument named Glowtracka.

To make measurements with the Glowtracka we take samples of surface water collected from the niskin bottles on the CTD and because we like to take samples during the night it means staying up very late or waking up very early in the morning. The water collected is placed into a blacked out holding chamber attached to the instrument. The water sample is then left for a set amount of time in the dark before it is allowed to run from the holding chamber and through a mesh grid which stimulates any bioluminescent organism in the water to glow.

The flashes of light emitted by the bioluminescent organisms are detected by a sensor called a photodiode and the signal is recorded on a computer. We then take samples of the water which can be analysed in the lab when we get back to shore and from these we hope to identify which organisms created the bioluminescent signals recorded.

From a piece of equipment called Flowcam we have already identified that there are some bioluminescent organisms called dinoflagellates present in the water column.








### EuroSITES Open Ocean Observatories

Visit the observatories and learn more about them!



OUTREACH HOME  
POLICY  
EDUCATION  
EUROSITES OPEN OCEAN OBSERVATORIES  
STATION M  
CIS  
PAP  
DYFAMED  
W1-M3A  
E1-M3A  
E2-M3A  
ESTOC  
TENATSO  
GALLERY  
NEWS  
CONTACT

1. What are the ways to make observations?
2. What is the current status of fixed point (Eulerian) observatories?
3. What are the limits to progress?



# The funding gap



FP7 I3 call.

Fixed point open ocean observatories.

FixO<sup>3</sup>

Submitted November 2011

EU Contribution requested  $\approx$  10M Euro

29 partners

Coordinated by NOC, Southampton



# FixO<sup>3</sup>

Open seas and ocean

Fixed critical locations.

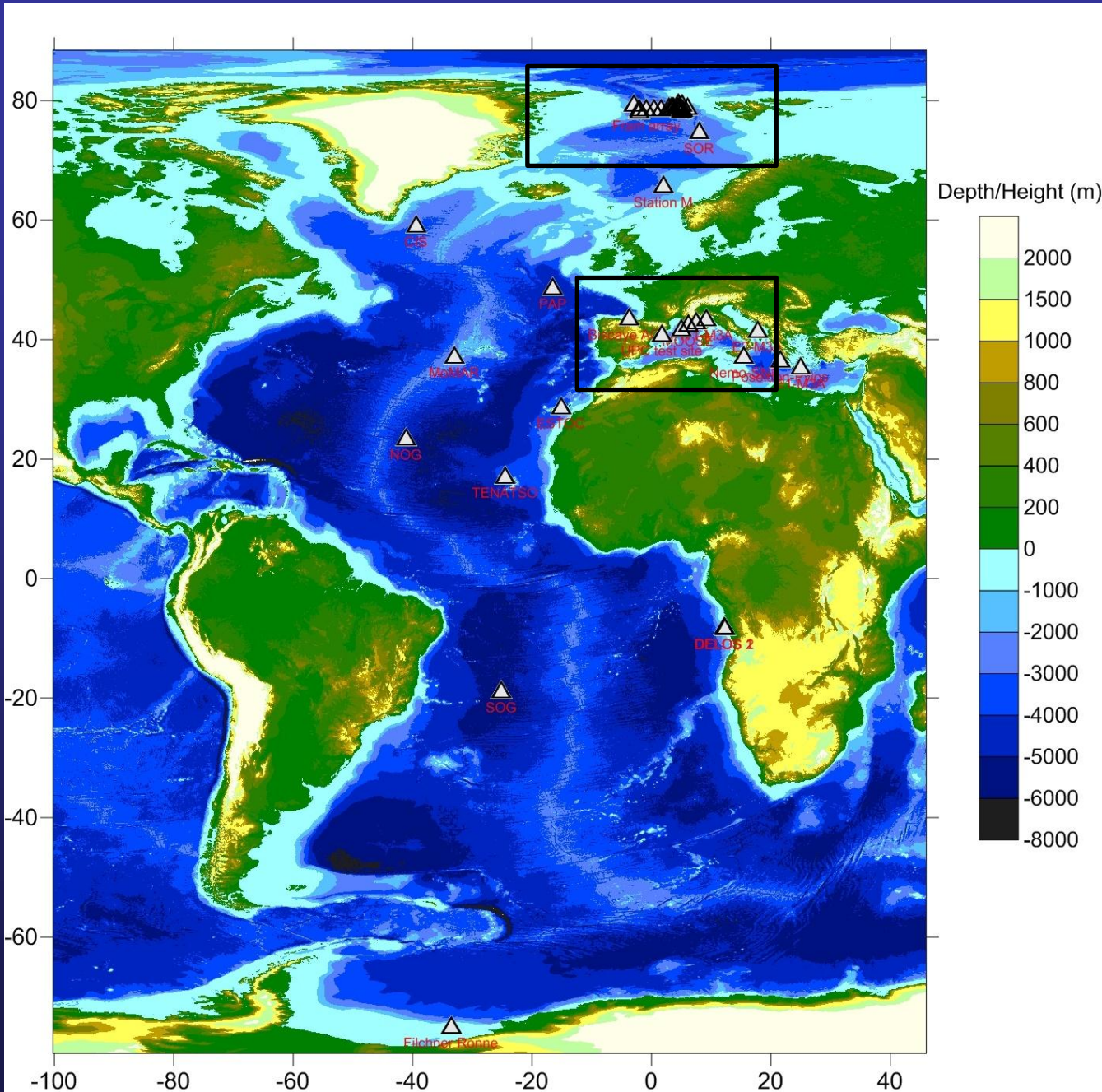
EuroSITES, ESONET and CARBOOCEAN

EMSO and ICOS

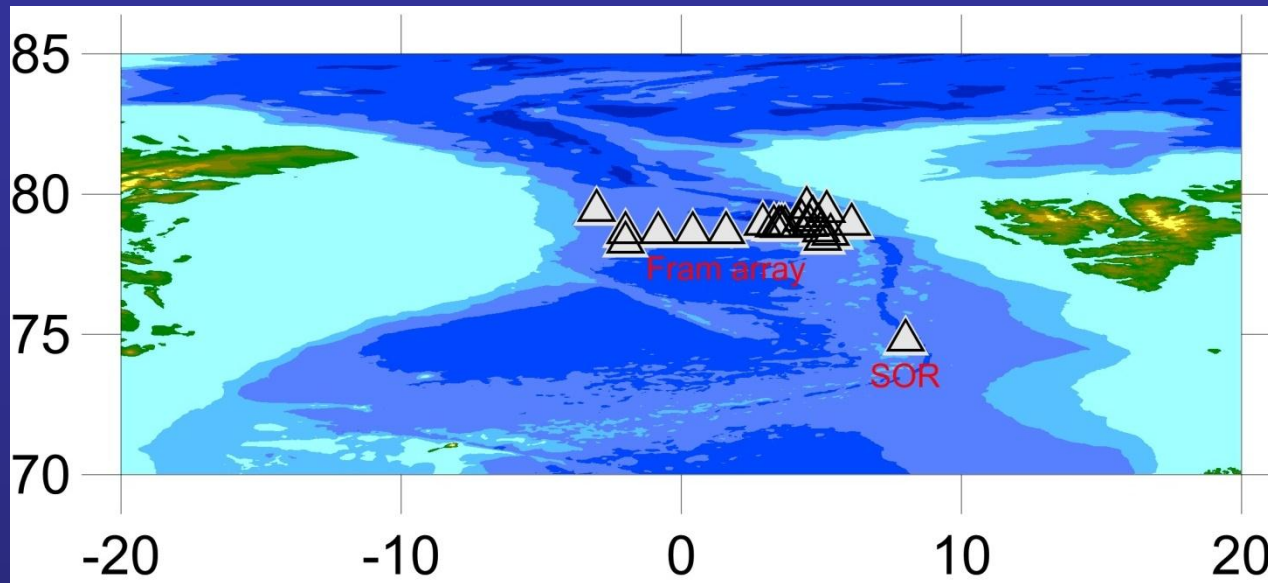
SeaDataNet standards

GMES initiative

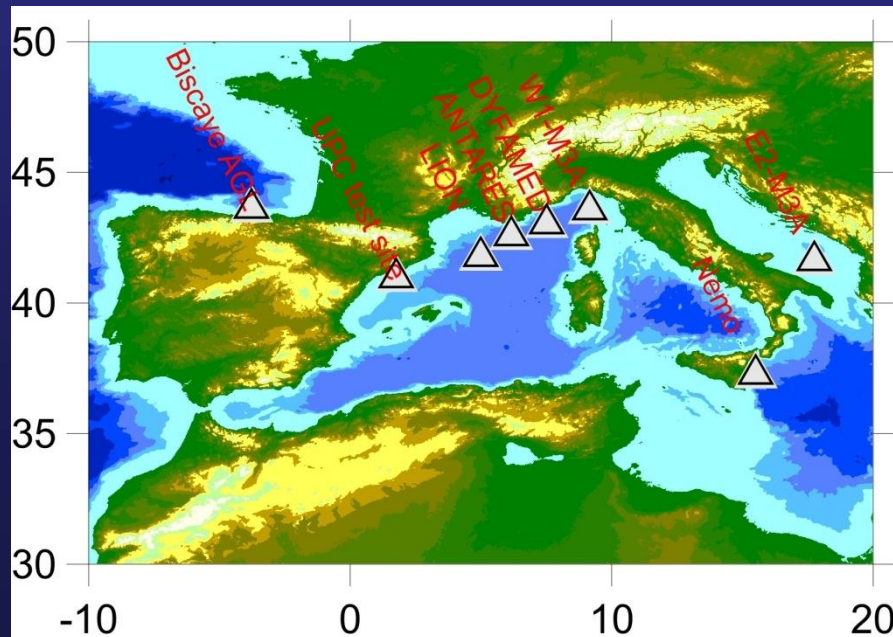
European SME



FixO<sup>3</sup>

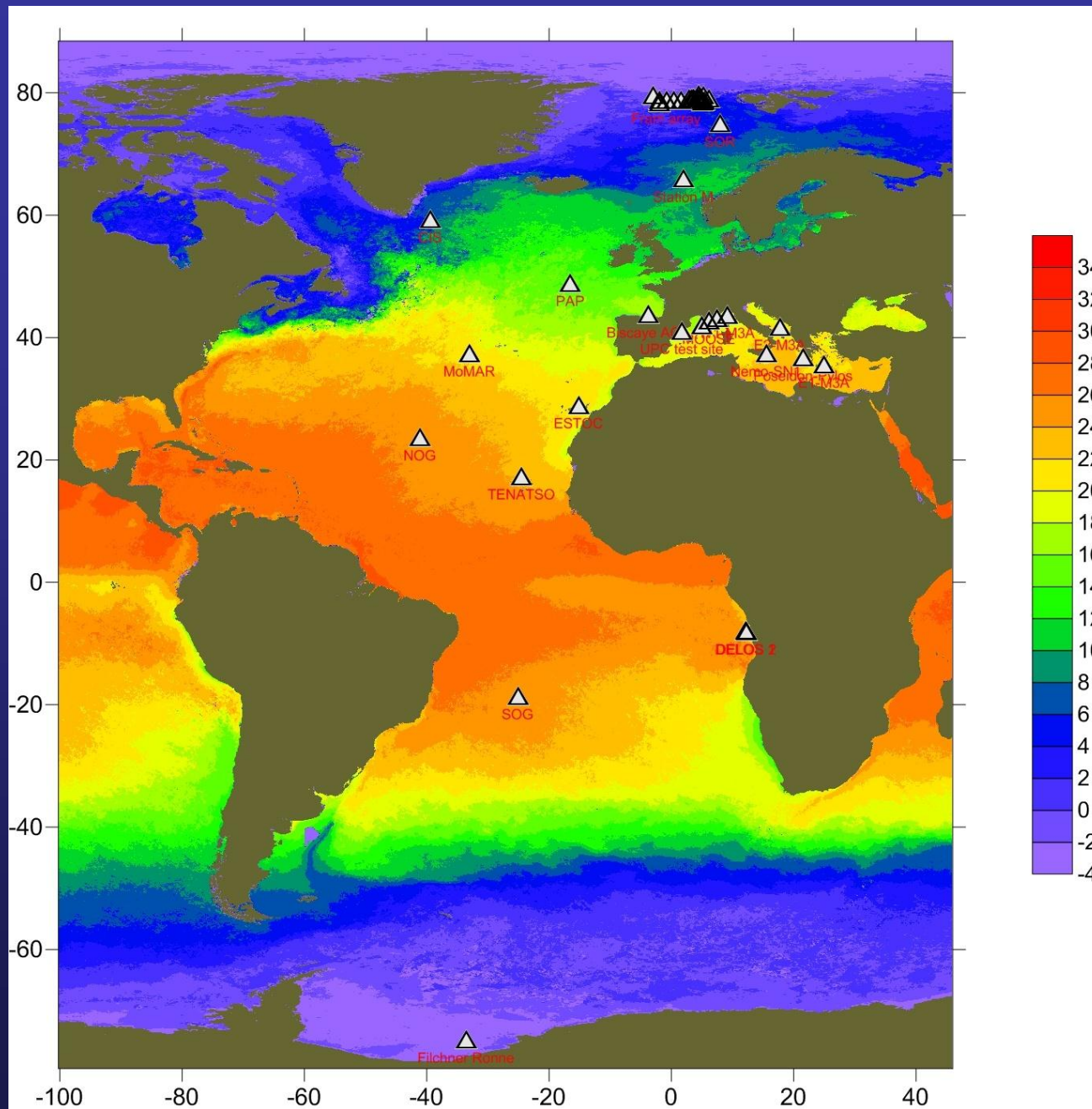


Across the  
Fram strait



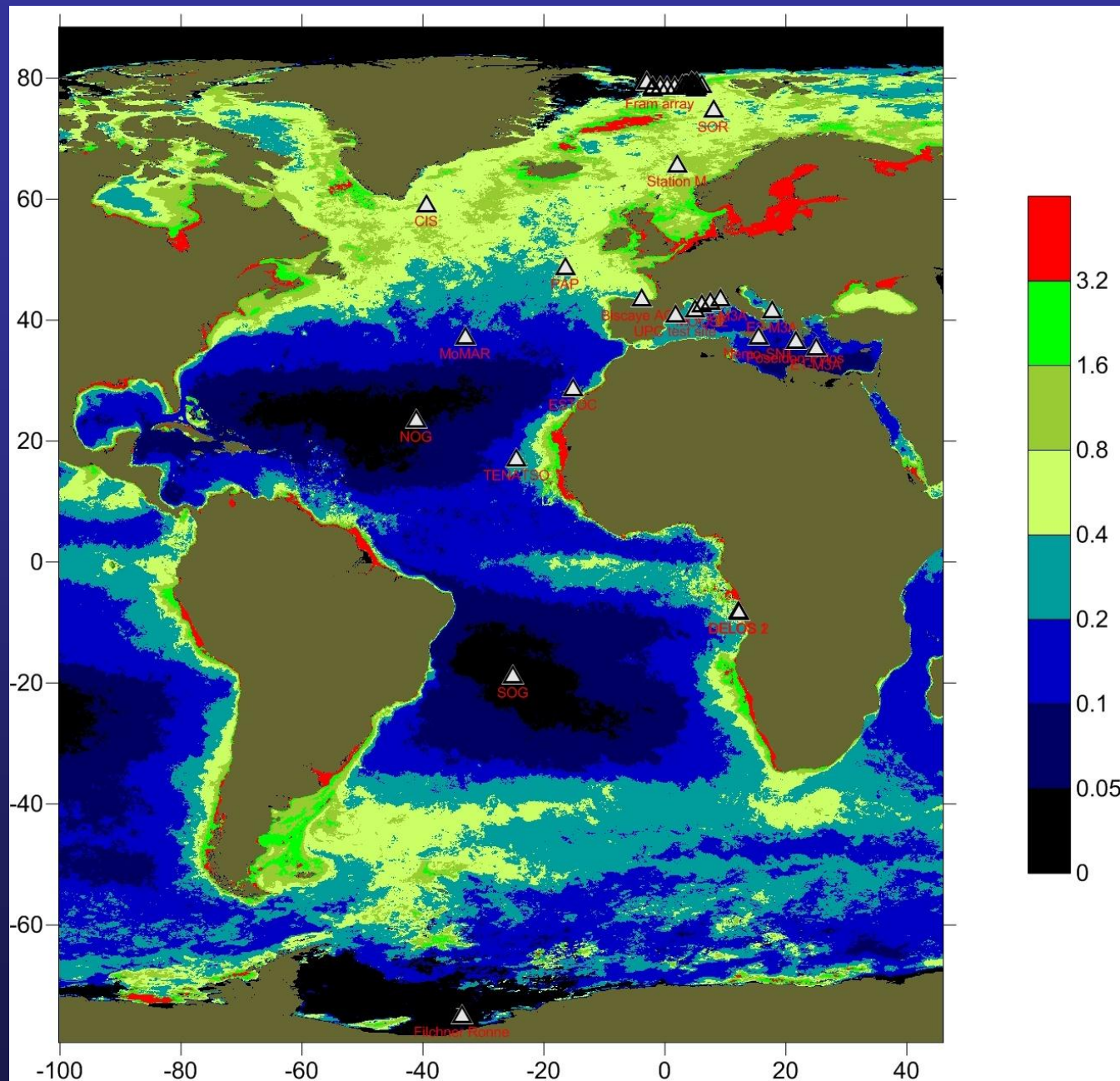
Within the Mediterranean





# FixO<sup>3</sup>

With Surface  
temperature  
climatology

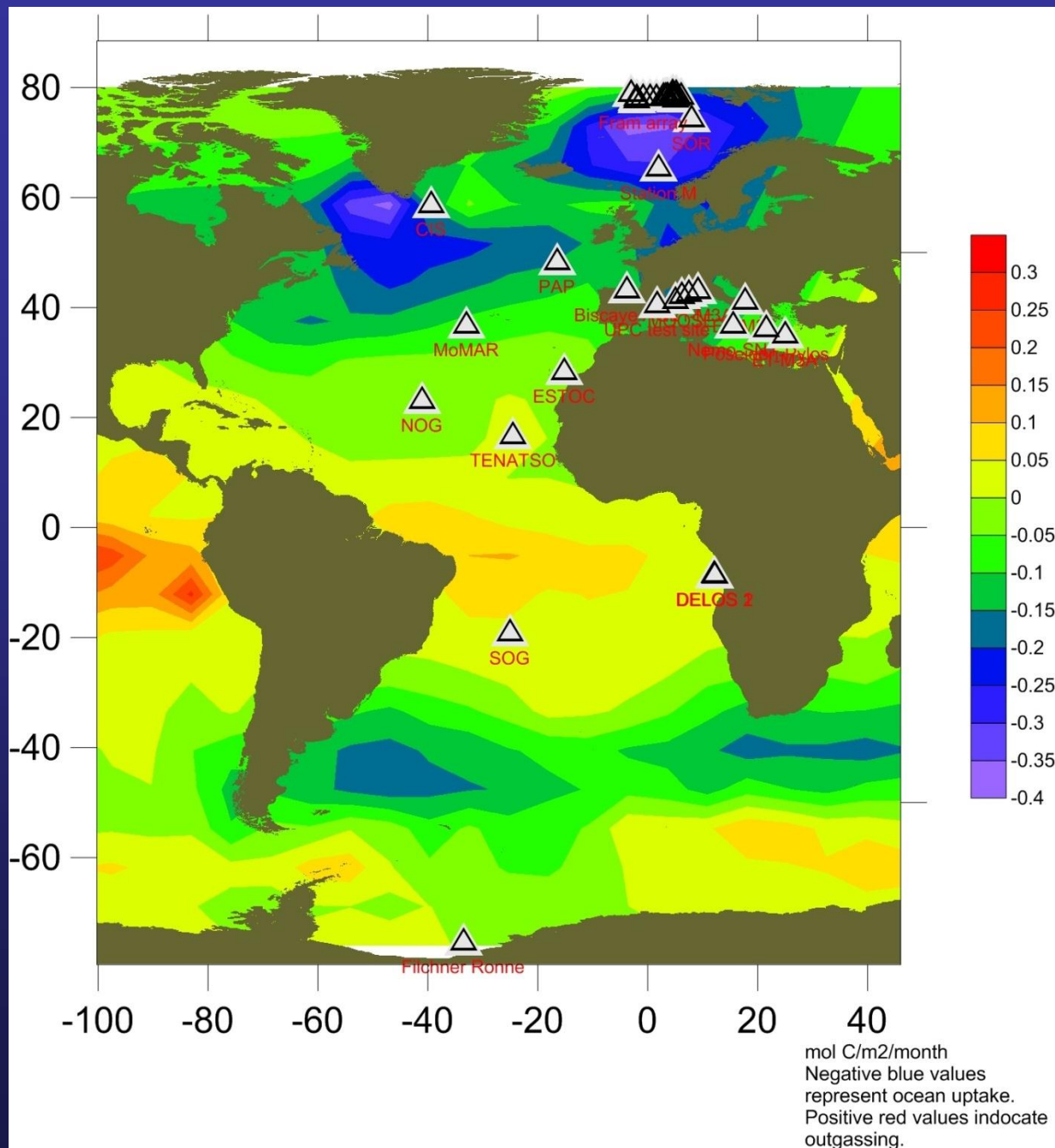


# FixO<sup>3</sup>

With surface  
chlorophyll  
(average 2007)

*Courtesy RSDAS*

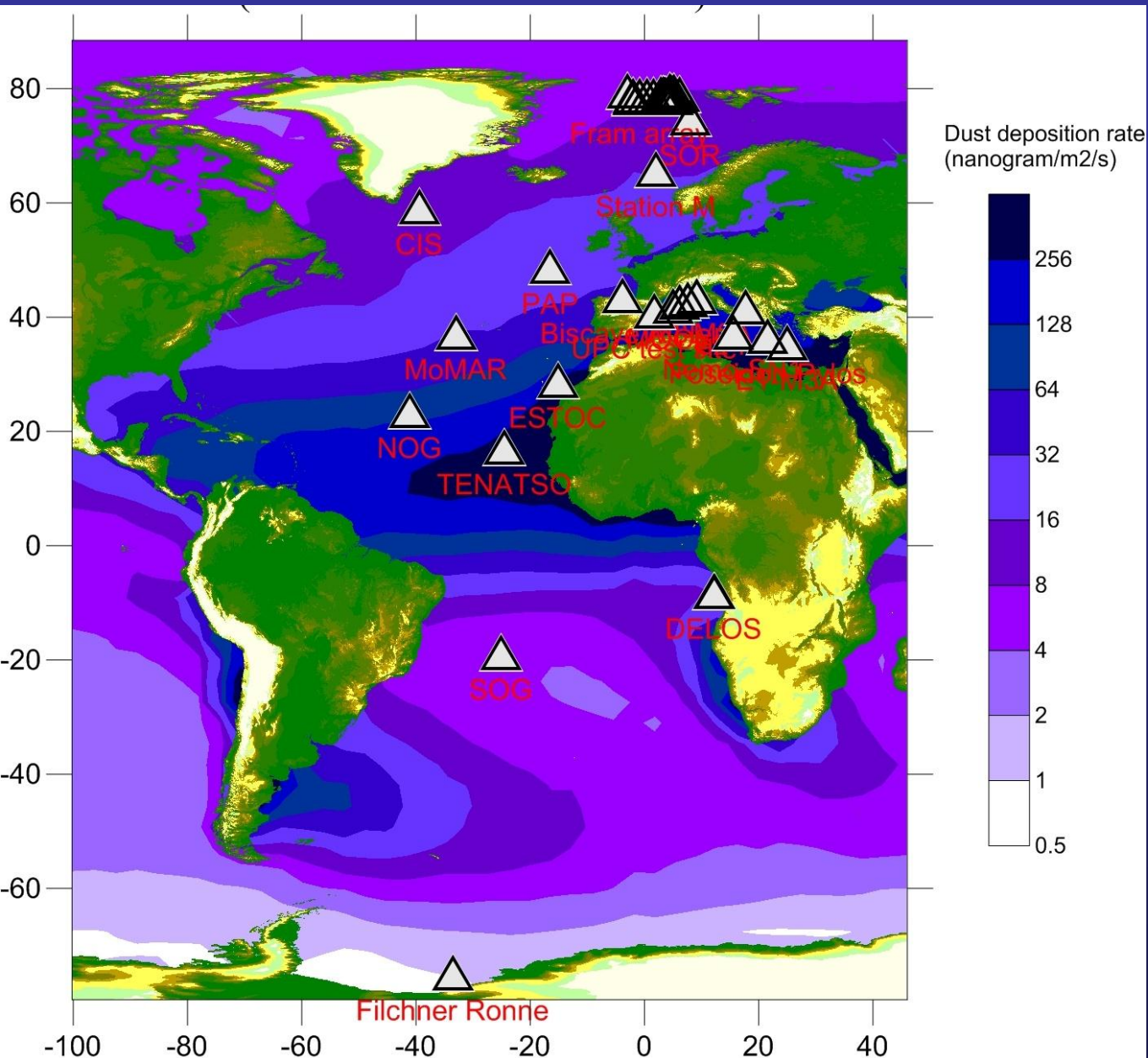




# FixO<sup>3</sup>

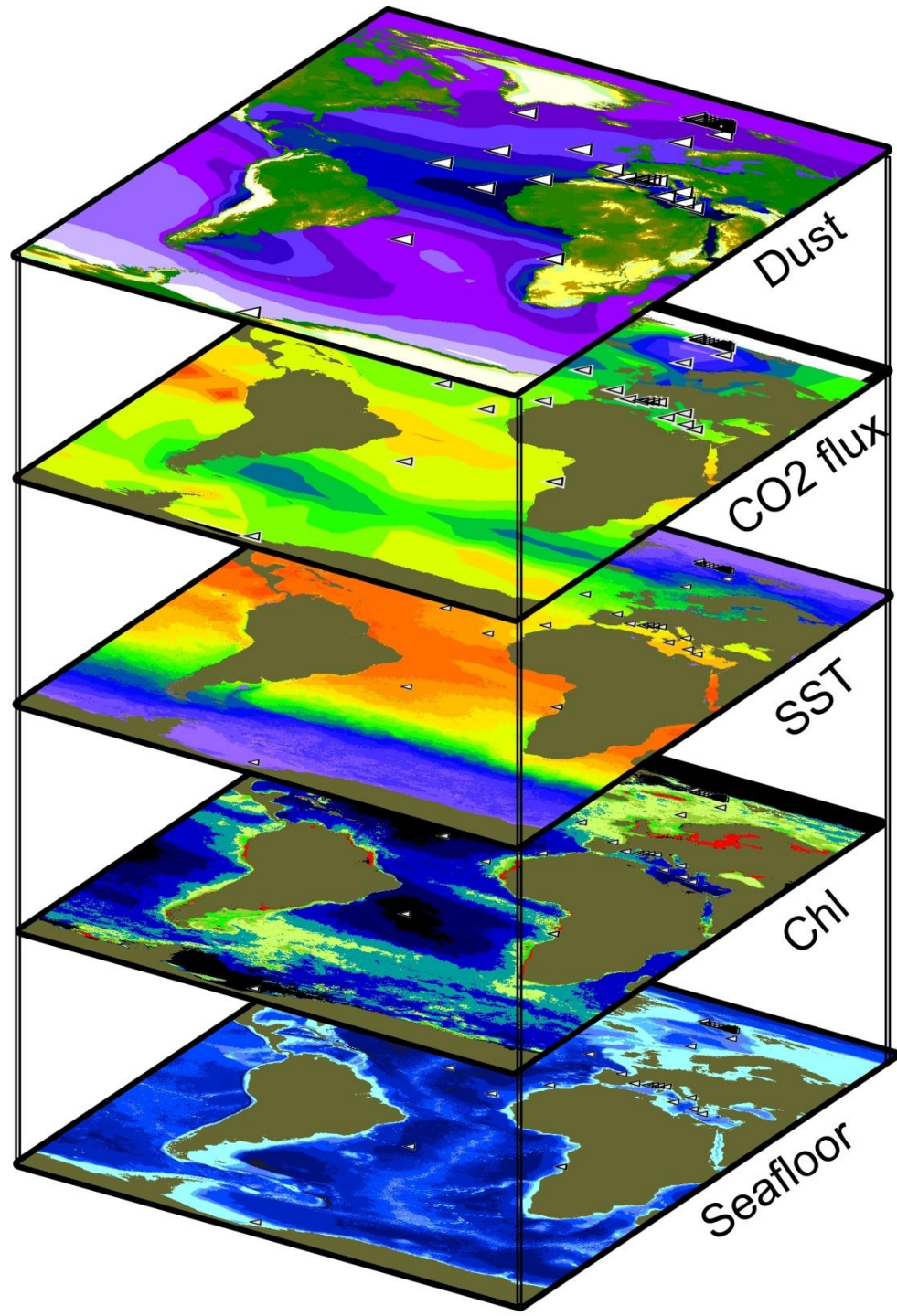
With air-sea flux  
 of CO<sub>2</sub>  
 (average 2000)

(From Takahashi et al  
 2009)



FixO<sup>3</sup>

With dust  
deposition rate  
annual  
climatology  
(from Mahowald 2005)



## Structure of FixO<sup>3</sup>

COORD: Networking activity (7 WPs)

SUPP: Service Activity and Transnational Access (2 WPs)

RTD: Research (2 WP's)

External advisory board



## Outstanding issues

Engineering development:

Sensors, Platforms, data transmission, power supplies

Geographical coverage

Model development

Cabled or not?

Power requirement

Data transmission

Flexibility

Cost to install and maintain



The AstroParticle Physics community is already involved in some of the ocean observatories. Now is the time to explore additional interactions.

