



# Earth-Sea Science Observations & Cabled Observatories

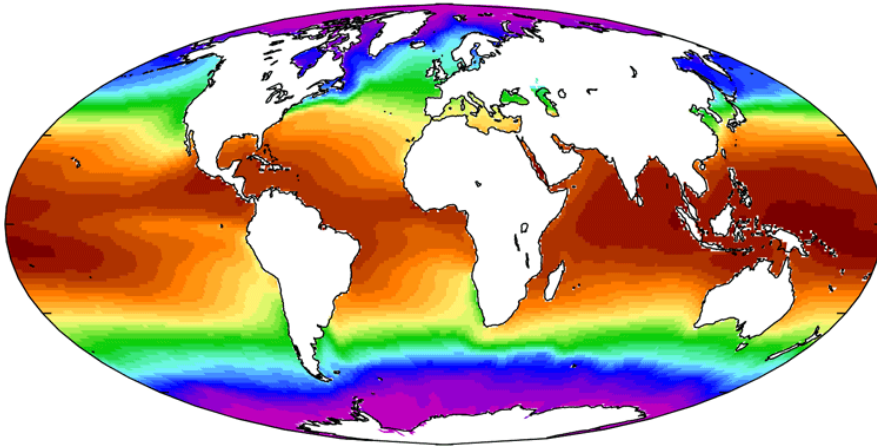
**Imants G. Priede**  
**Oceanlab,**



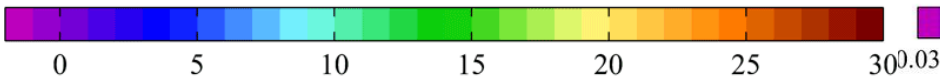
**UNIVERSITY OF ABERDEEN**

# Satellite Remote Sensing

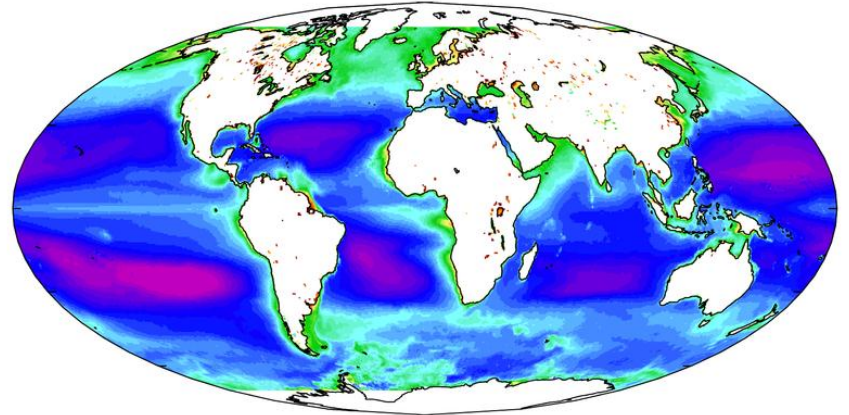
Temperature



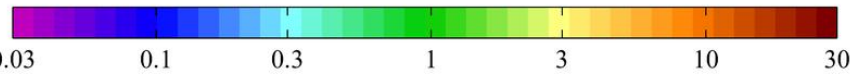
Sea-surface temperature [°C]



Chlorophyll



Average sea-surface chlorophyll, 1998 to 2006 [mg chl m<sup>-3</sup>]



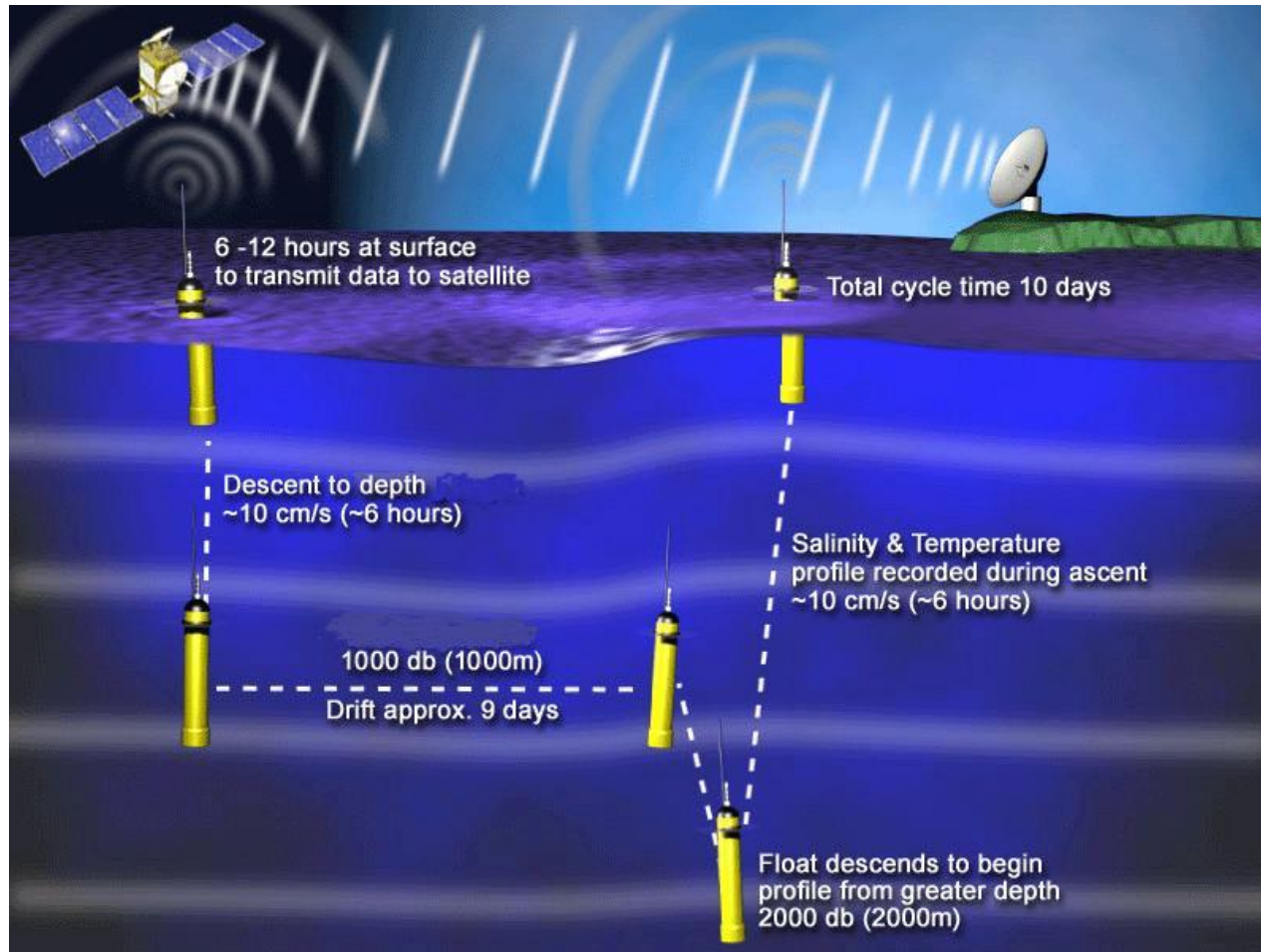
Has revolutionised Oceanography  
but measurements are still required from the  
Ocean Interior

# Oceanographic Measurements

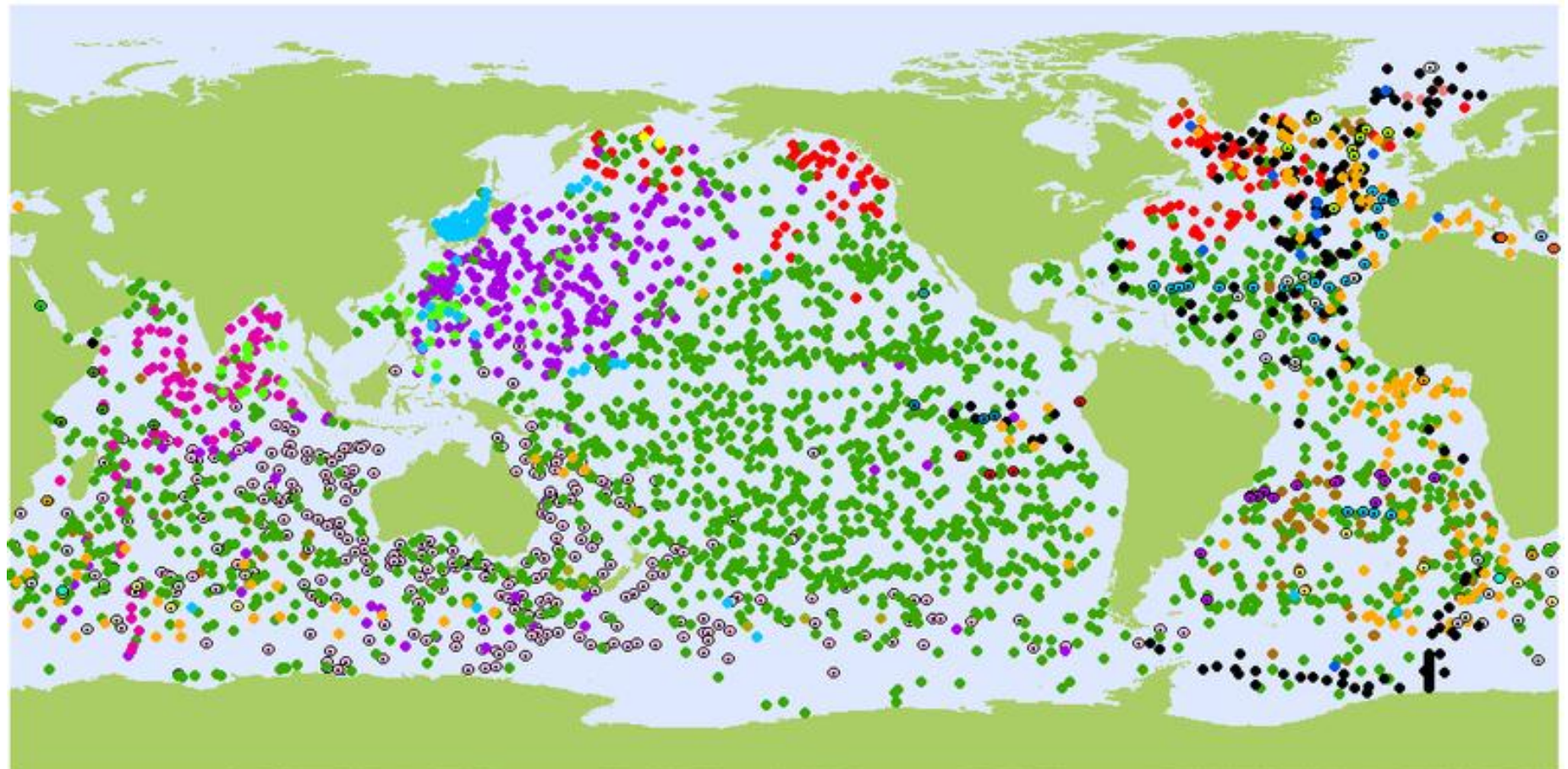
- Ship and Autonomous vehicle transects
- Drifters: Lagrangian
- Fixed Point – Eulerian
  - Moorings
  - Buoys
  - Observatories

# Langrangian ARGO Floats

Controlled buoyancy – Profile every 10 days.



# ARGO array – Contributions by nations

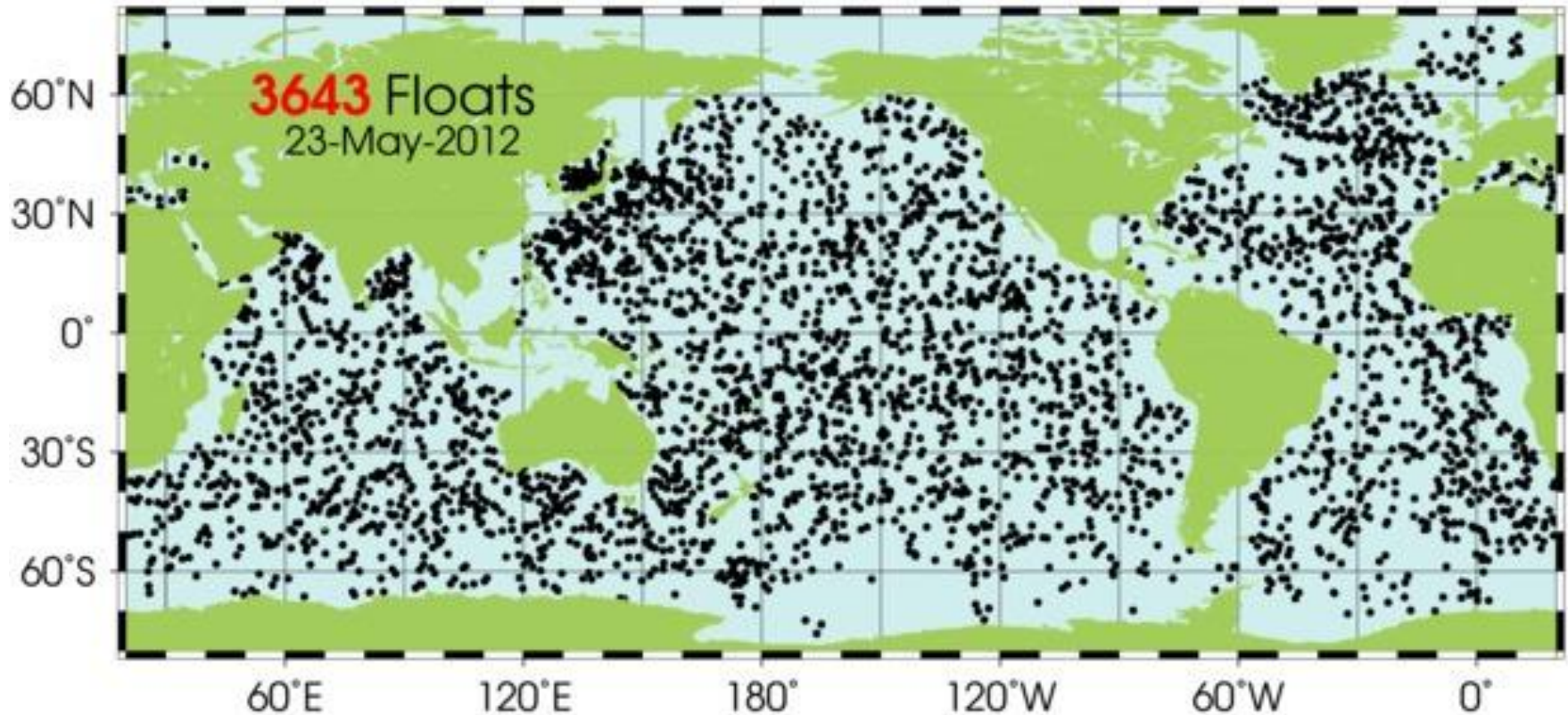


3214 Argo Floats

○ ARGENTINA (10)	● CHINA (46)	● GABON (1)	● ITALY (2)	● MEXICO (1)	● RUSSIAN FEDERATION (2)	● UNITED STATES (1723)
○ AUSTRALIA (296)	● ECUADOR (3)	● GERMANY (173)	● JAPAN (278)	○ NETHERLANDS (31)	● SAUDI ARABIA (1)	
● BRAZIL (14)	● EUROPEAN UNION (12)	○ GREECE (1)	● KENYA (4)	● NEW ZEALAND (7)	● SOUTH AFRICA (2)	
● CANADA (124)	○ FINLAND (2)	● INDIA (83)	● SOUTH KOREA (87)	● NORWAY (4)	● SPAIN (26)	
● CHILE (4)	● FRANCE (162)	● IRELAND (9)	● MAURITIUS (2)	○ POLAND (0)	● UNITED KINGDOM (104)	

February 2011

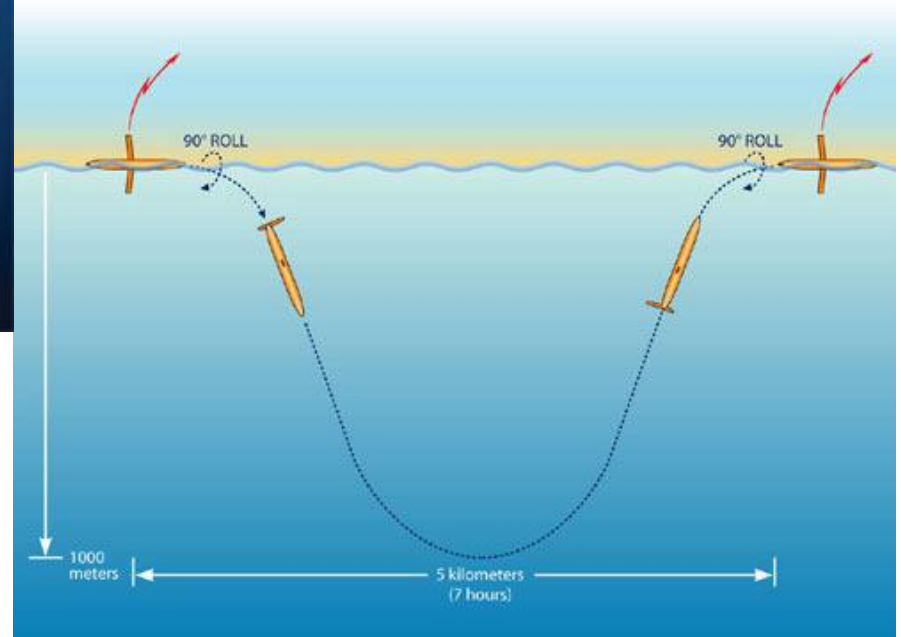
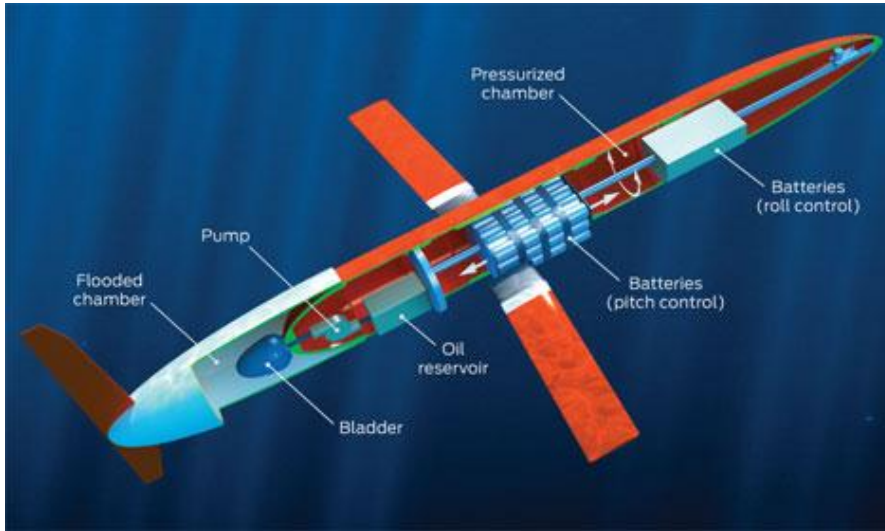
# ARGO array – 23 May 2012



Global Climate Observing System/Global Ocean Observing System ([GCOS](#)/[GOOS](#)).

# GLIDERS – Controlled buoyancy plus wings

## GPS + DEAD RECKONING



# OOI Ocean Observatories Initiative

Cabled Observatories

Plus

Non-cabled observatories

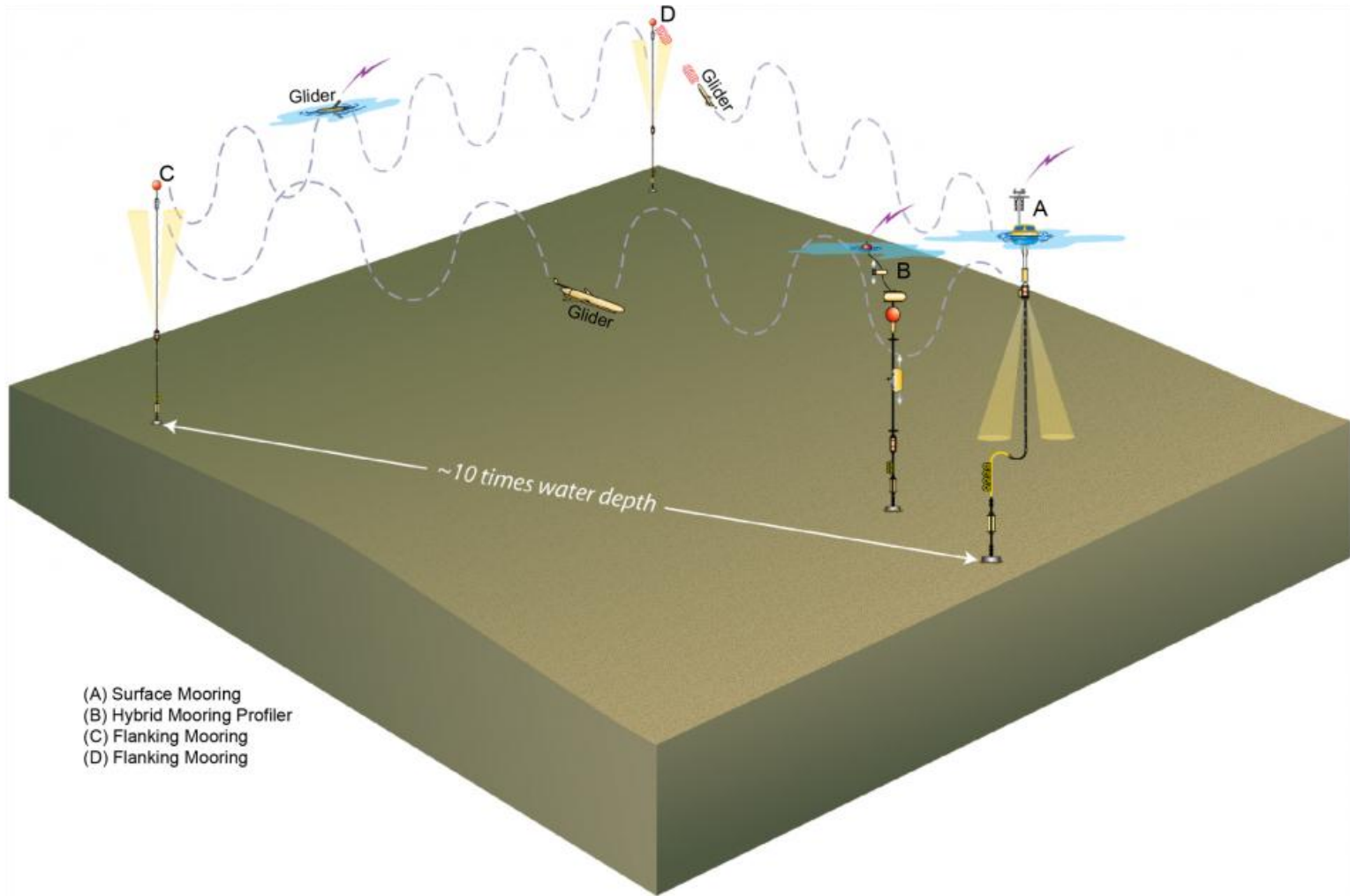
Plus Gliders





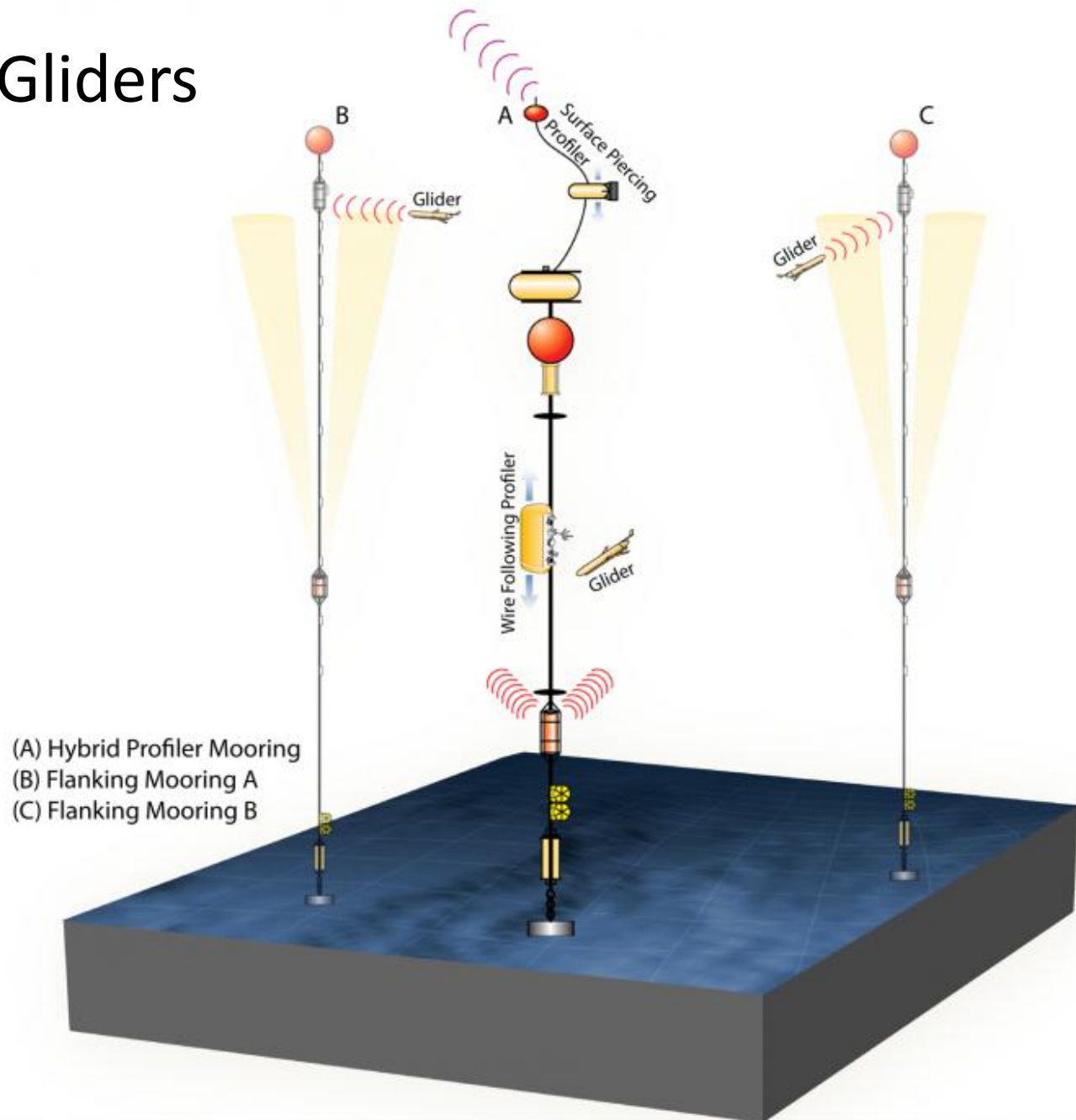
# OOI Moorings + Gliders

Eg. Southern Ocean, Argentine Basin

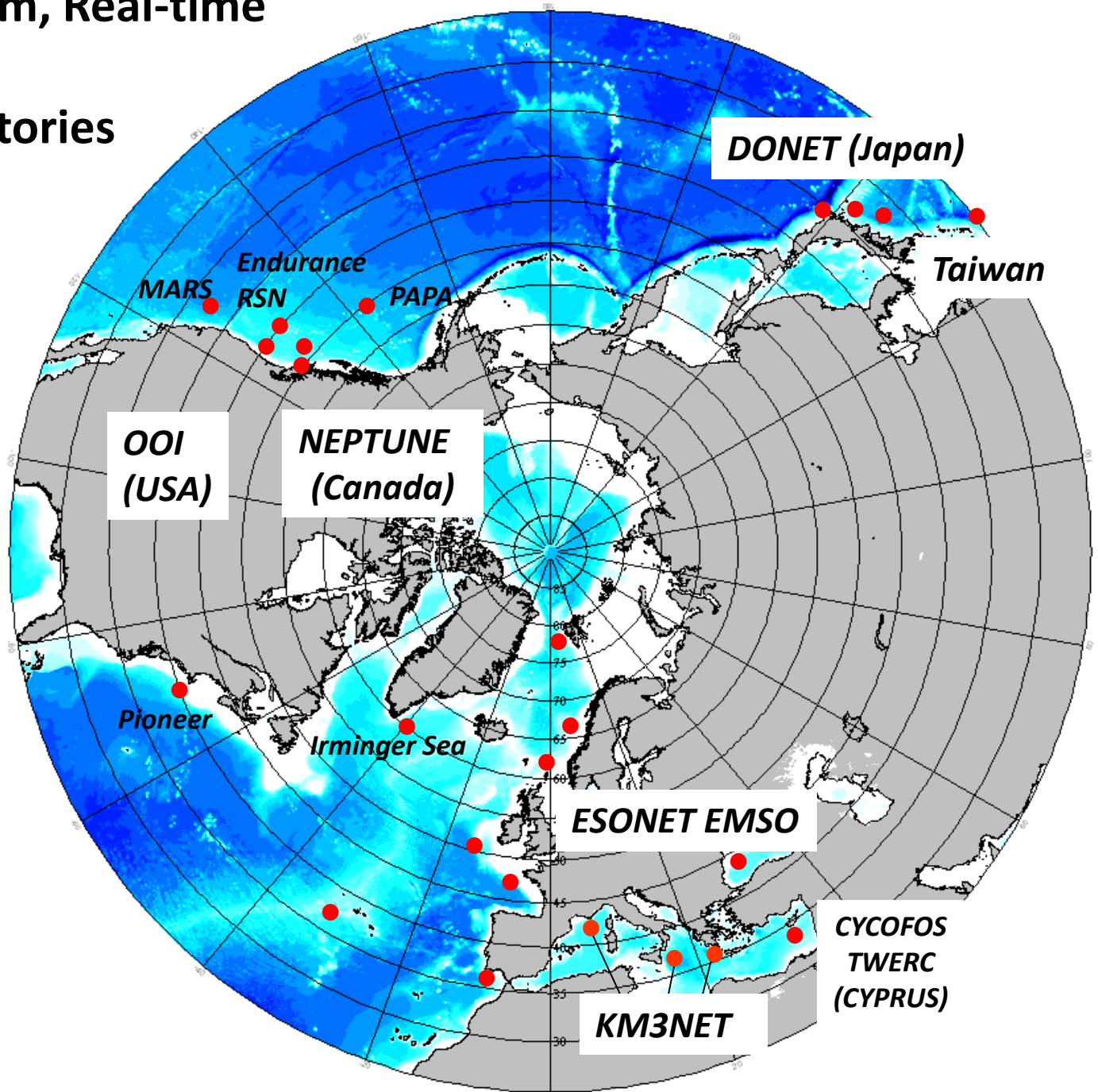


# OOI Moorings + Gliders

Station PAPA

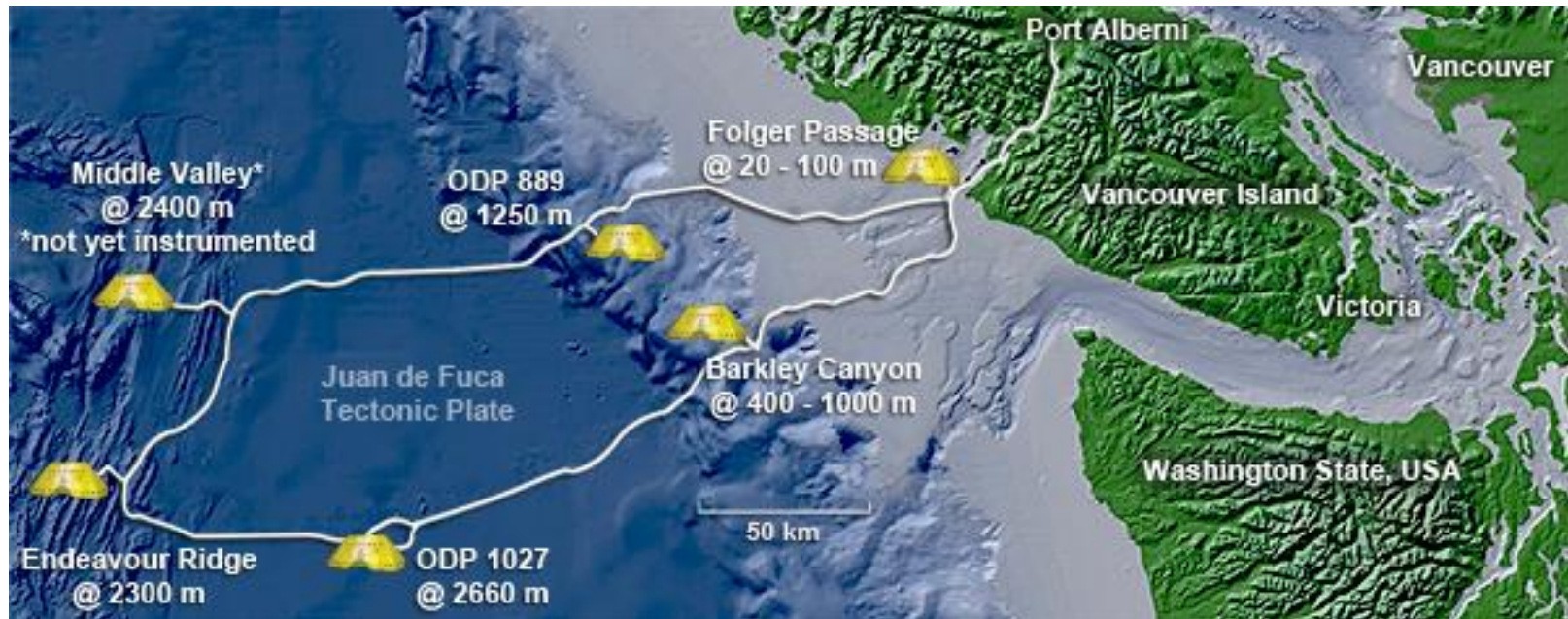


# Long Term, Real-time Cabled Observatories



# NEPTUNE Canada

The world's first regional-scale cabled observatory network  
North-East Pacific Time-series Undersea Networked Experiments



# DONET Dense Oceanfloor Network System for Earthquakes and Tsunamis

Japan Meteorological Agency  
National Research Institute for Earth Science  
and Disaster Prevention

300km length of backbone cable system,  
5 science nodes,  
20 observatories.

completed in July 2011

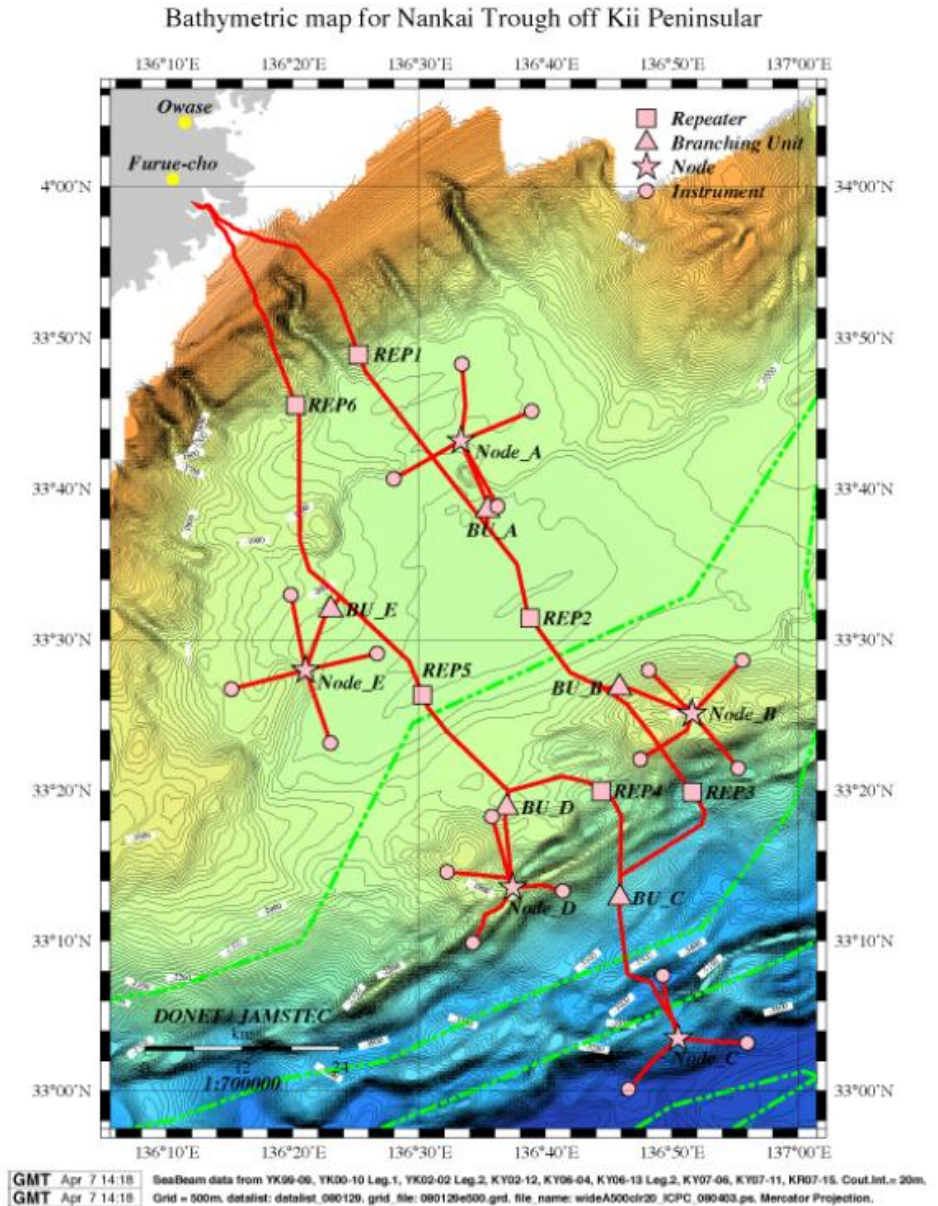
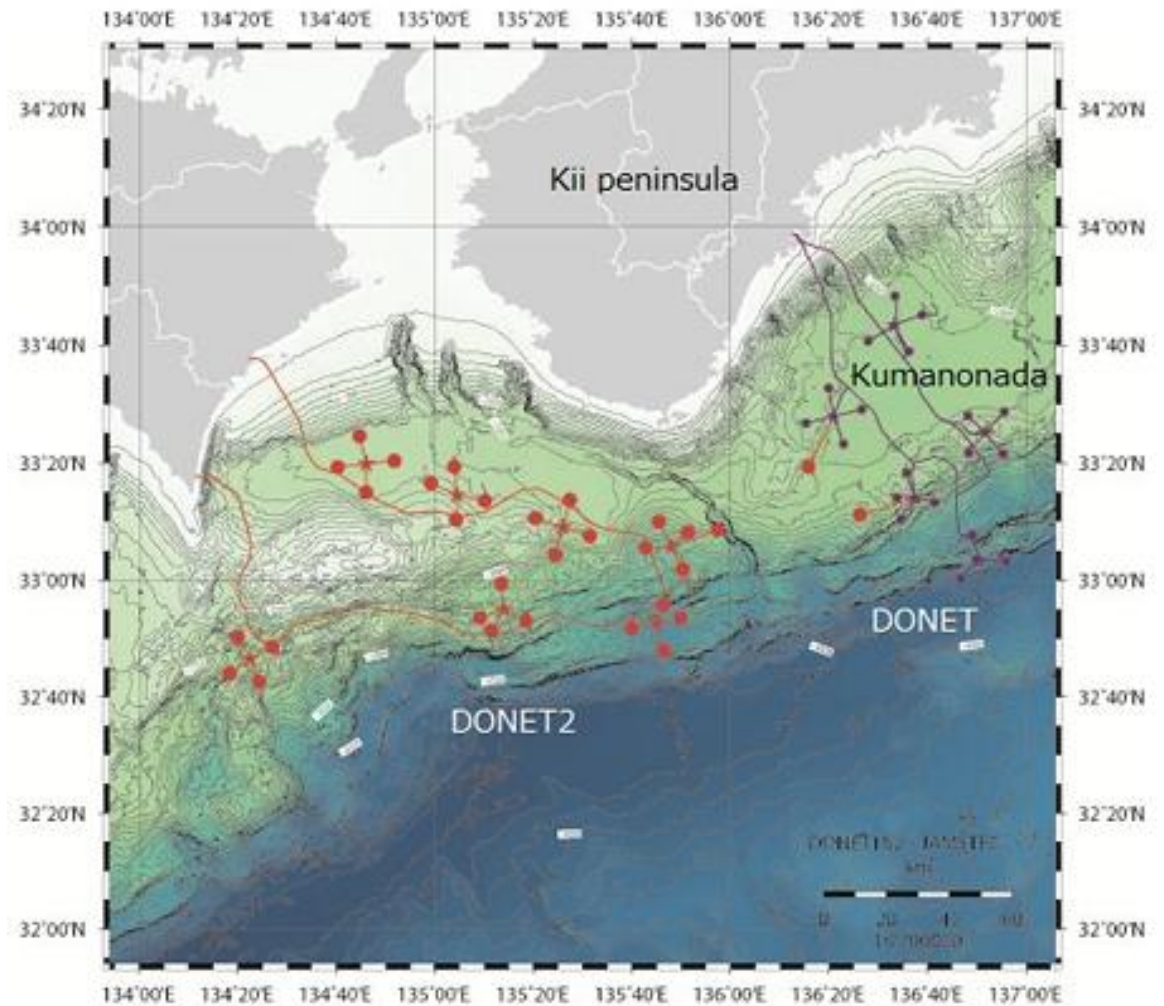


Figure 2 DONET backbone cable route and observatory & node position

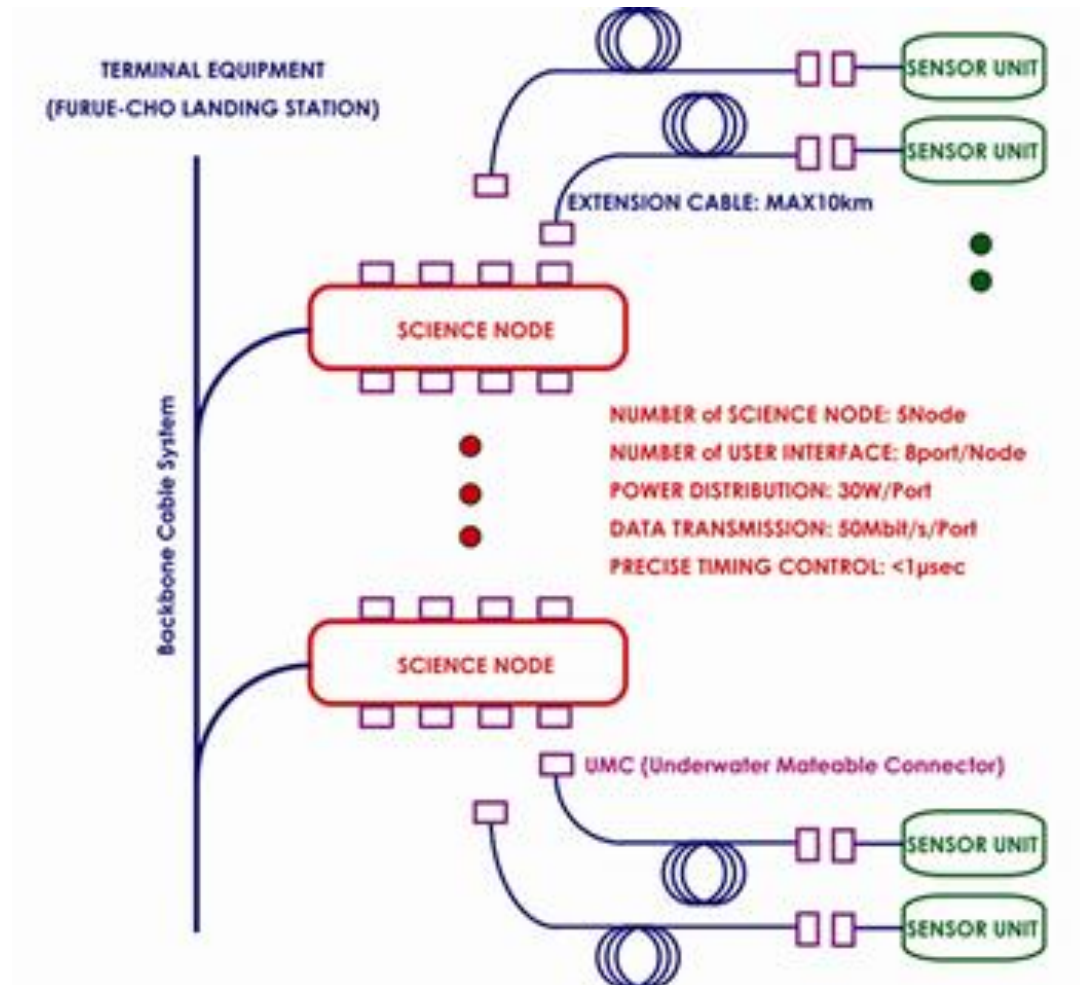
# DONET 2

Extension of the  
System of Kobe



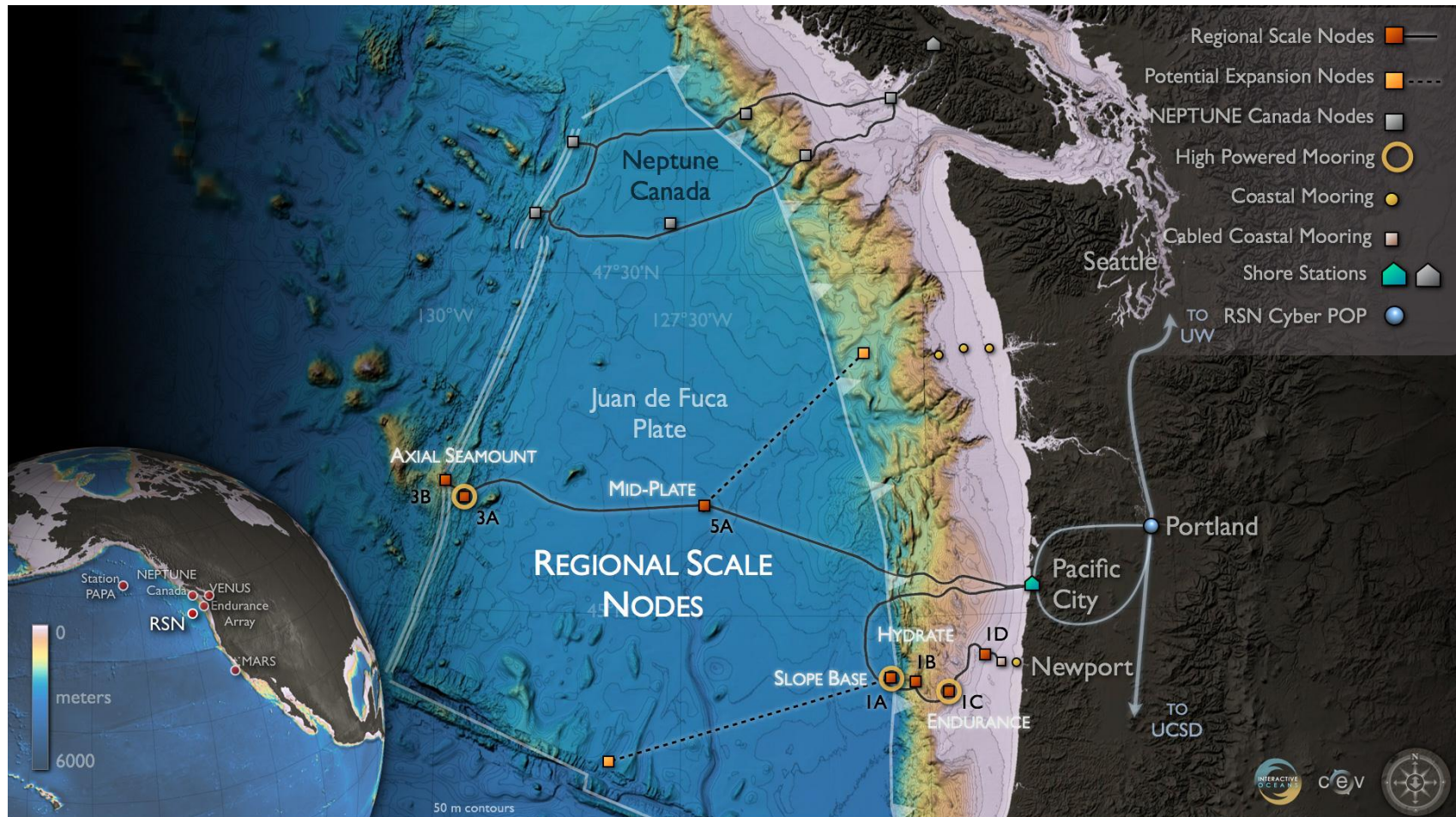
# DONET

Backbone Cable  
And  
Science nodes

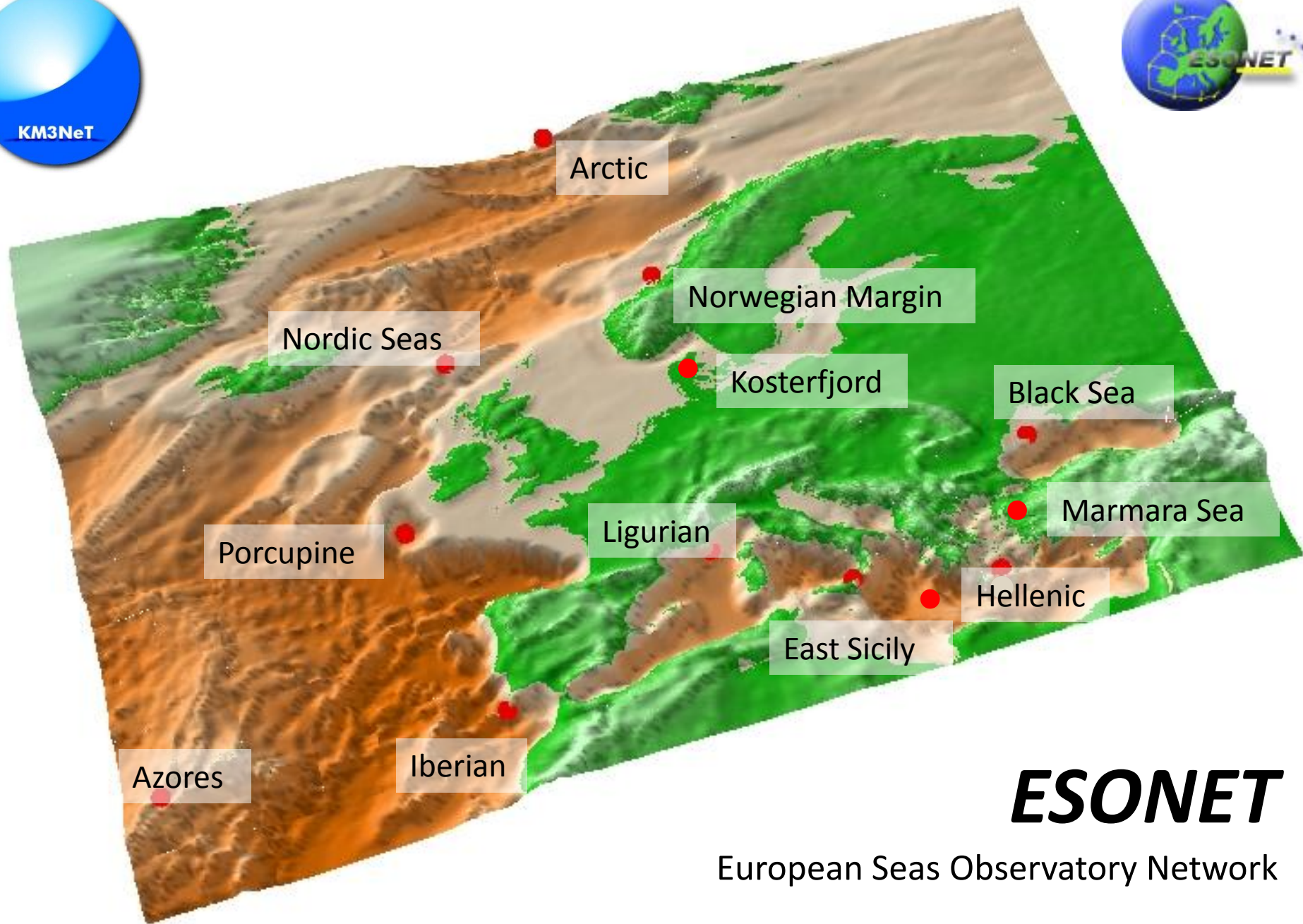


# OOI Ocean Observatories Initiative

## Regional Scale Node (Neptune USA)





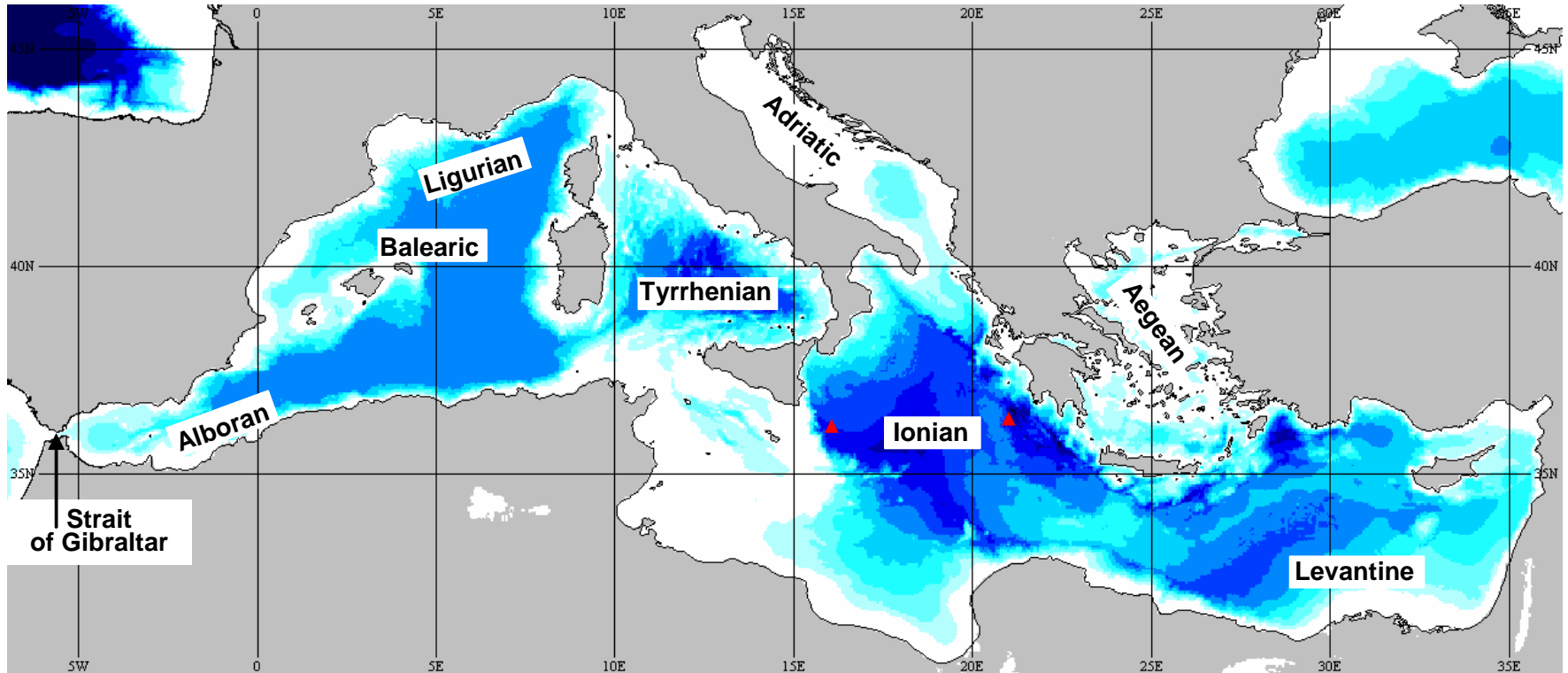


***ESONET***

European Seas Observatory Network



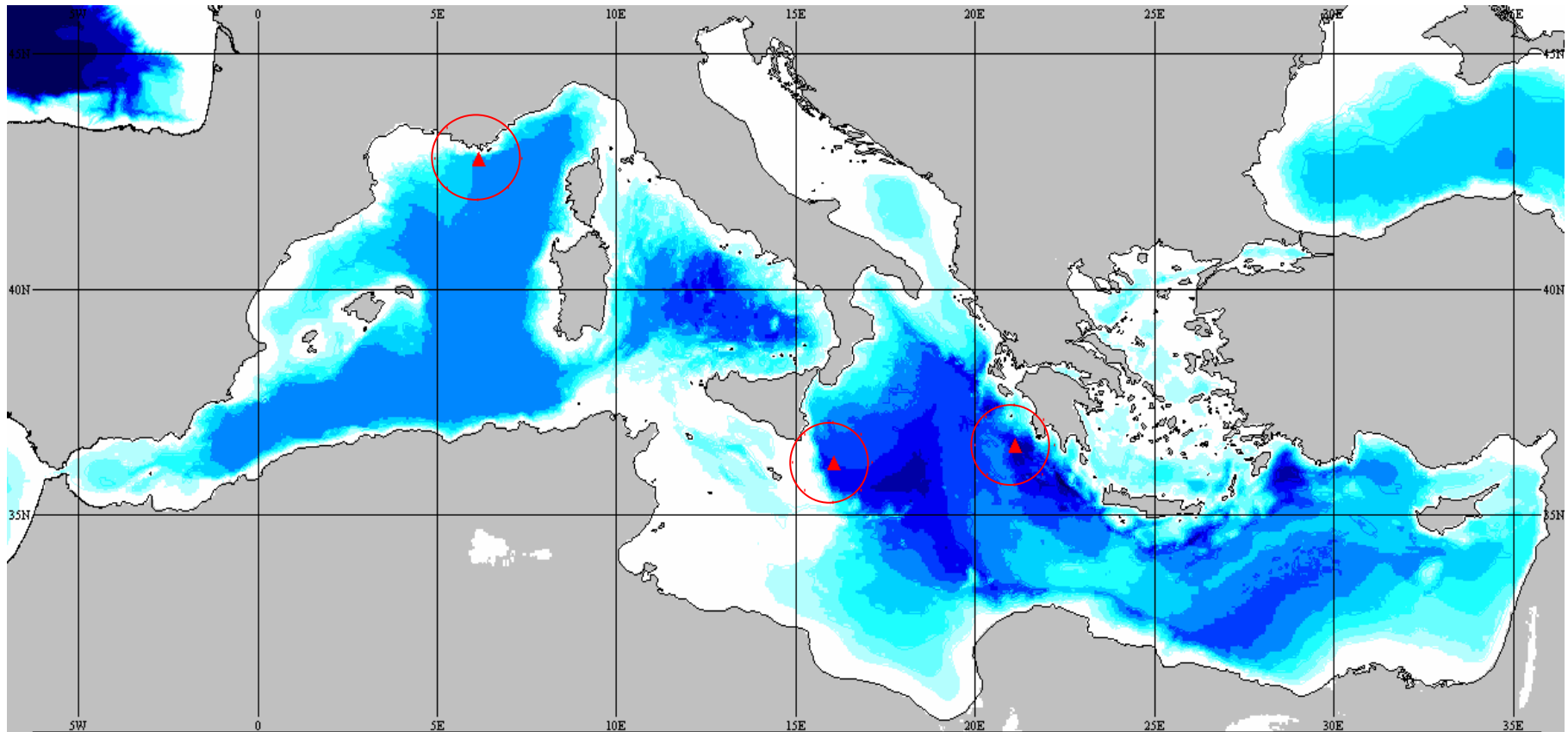
# Mediterranean Regional Seas



Colour depth contours at 500m increments.



# KM3NET Sites 100km radius Potential Footprints



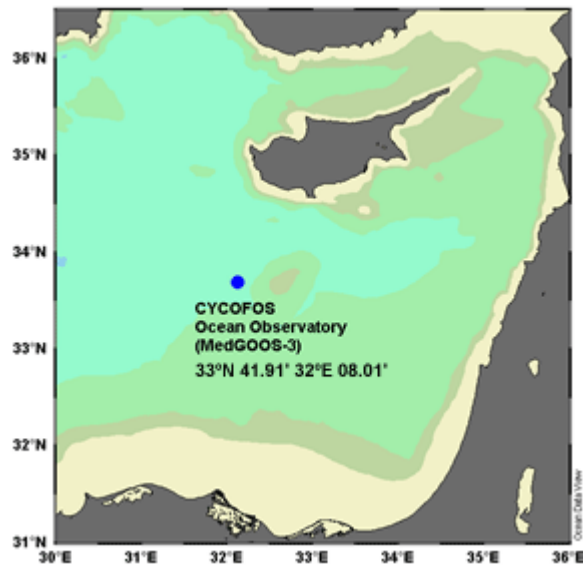
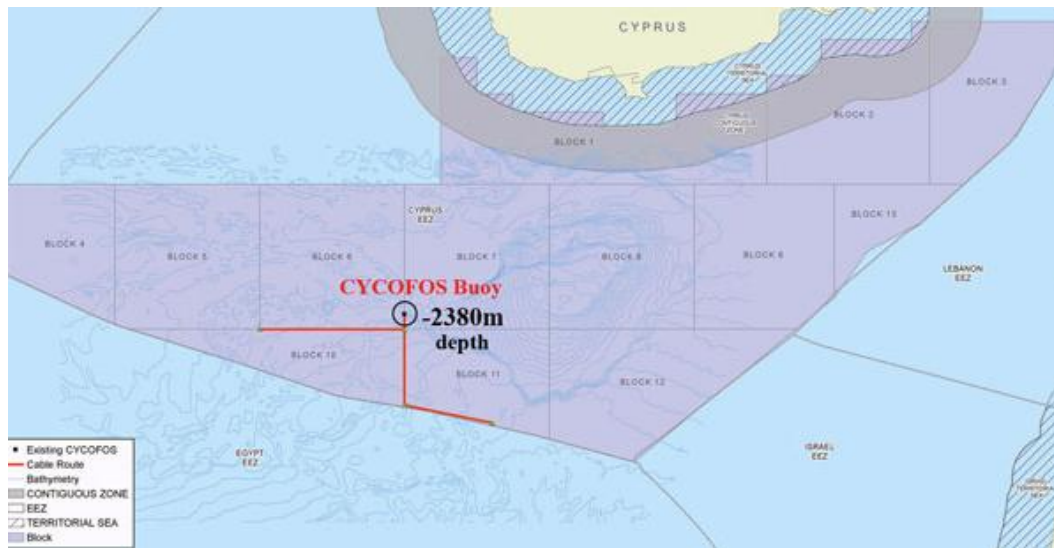
ANTARES- Ligurian Sea  
2475 m

NEMO - Ionian Sea  
3350m

NESTOR - Ionian Sea  
4500/5200m

# Tsunami Warning and Early Response system for Cyprus

<http://cyprus-storms.webs.com/seismictsunami.htm>



# Cyprus Coastal Ocean Forecasting and Observing System CYCOFOS - TWERC



# Advantages of Cabled Observatories

- High Data rate
- Continuous data
- Vigilance for events
- High power supply.

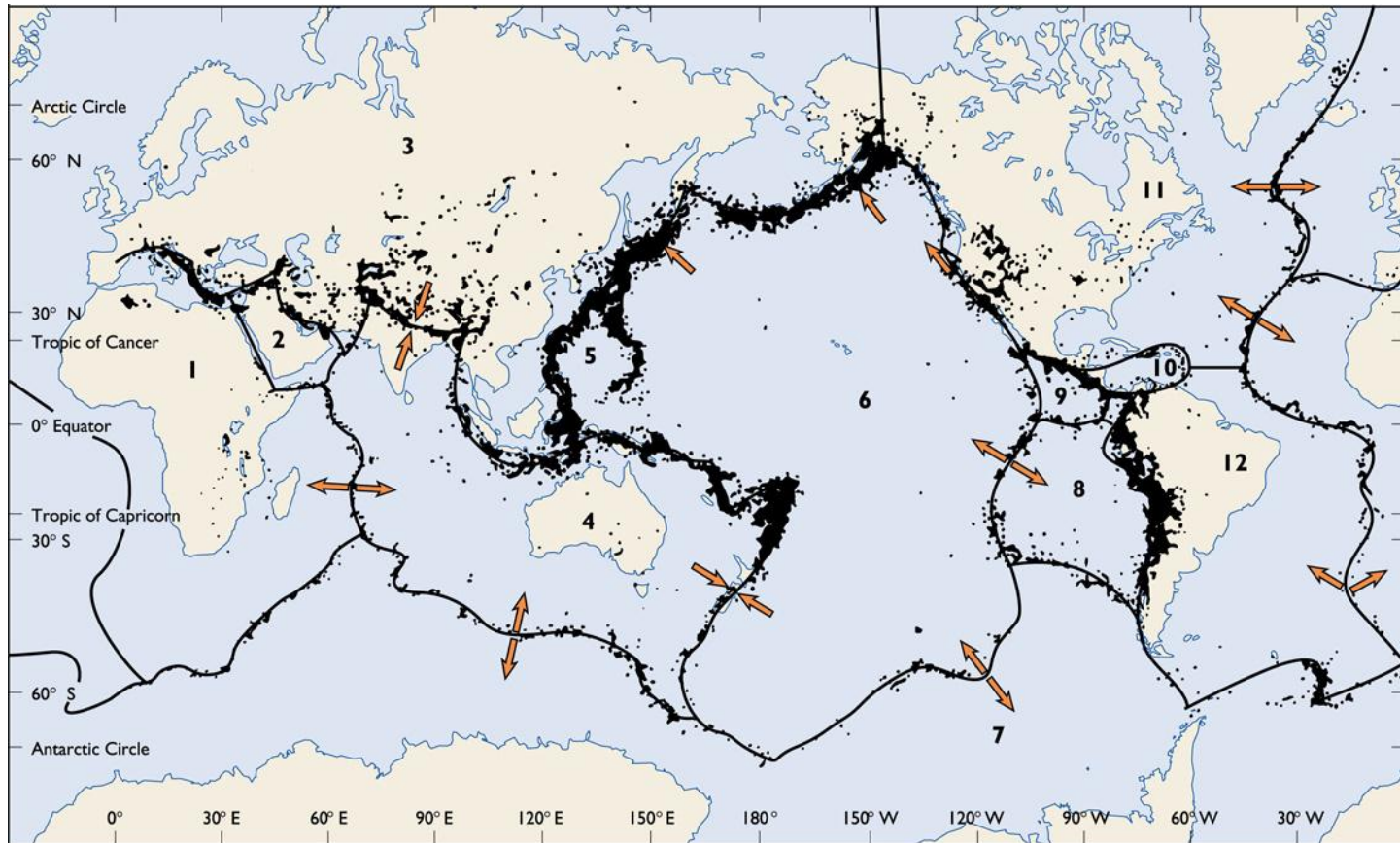
# Themes in Ocean Science

- The solid earth – Geology
- The liquid Ocean – Physical Oceanography
- Life in the Ocean - Biology
- Atmosphere-Ocean Interactions



# Geology

## Tectonic Plates and Earthquakes

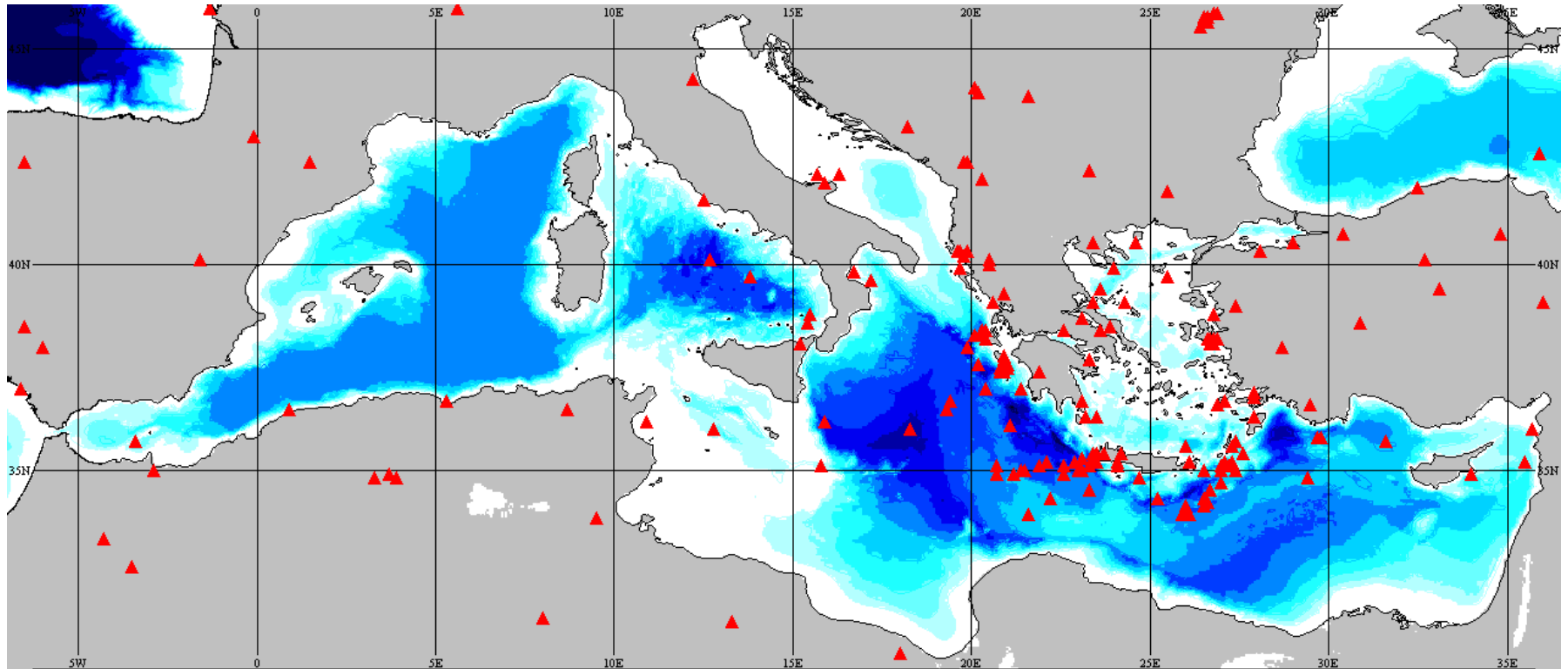


(a) LITHOSPHERIC PLATES



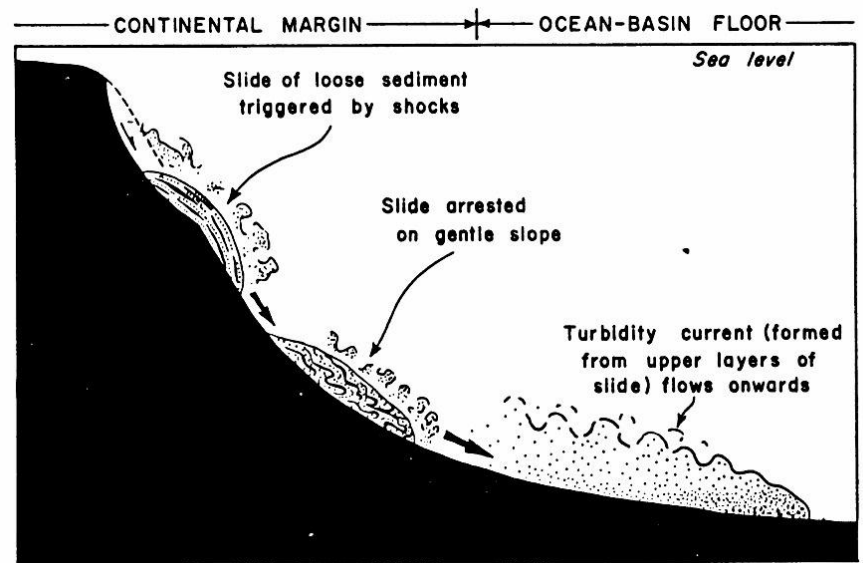
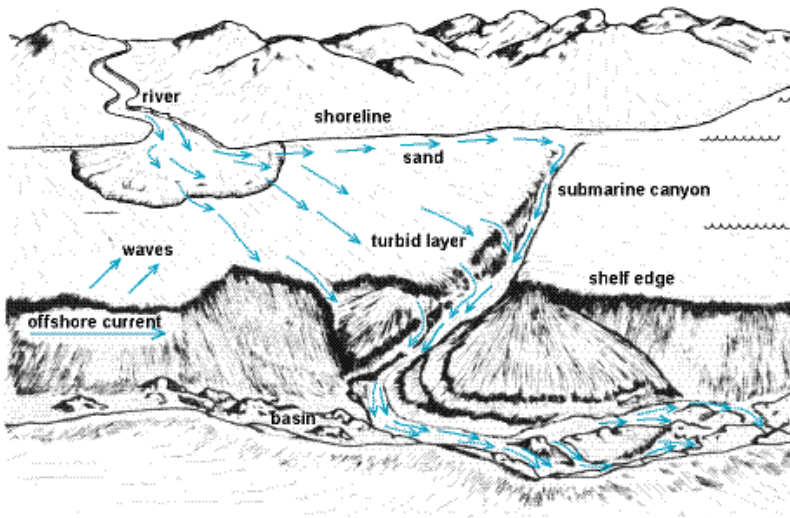


# Earthquakes during 2005 and 2006.

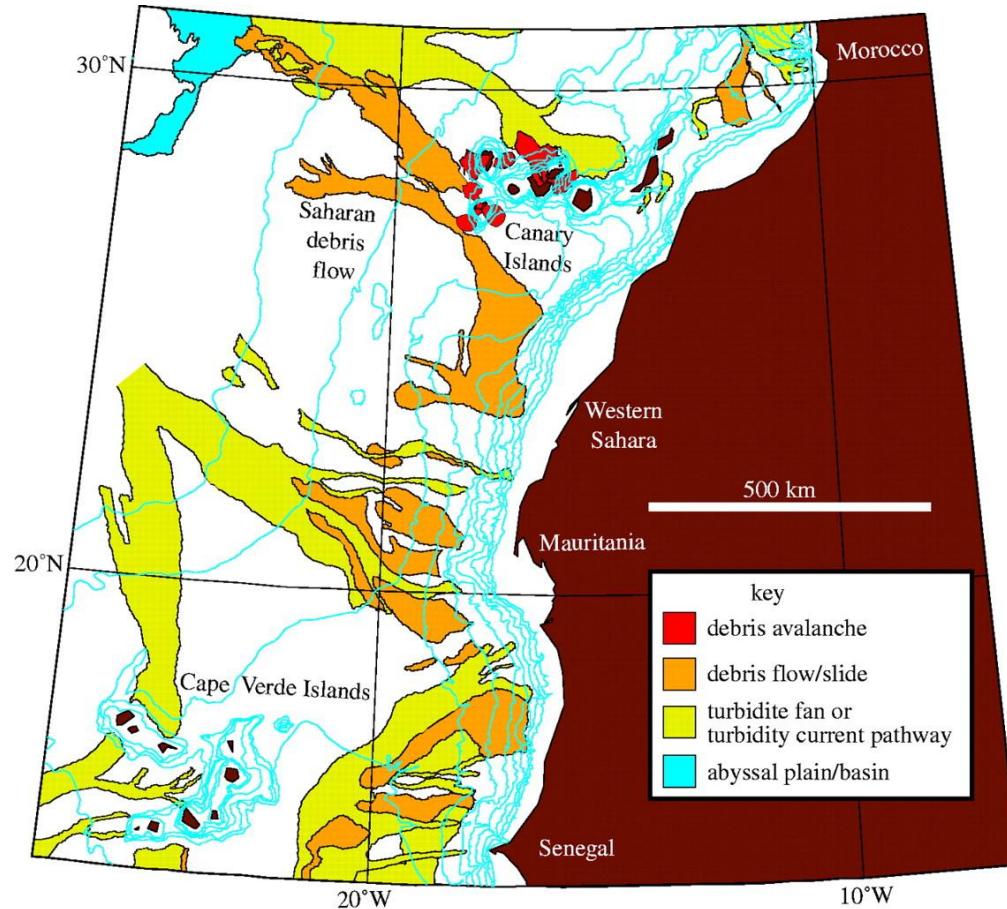


# Sedimentary Geology

## Slope failure, Slides, Turbidites

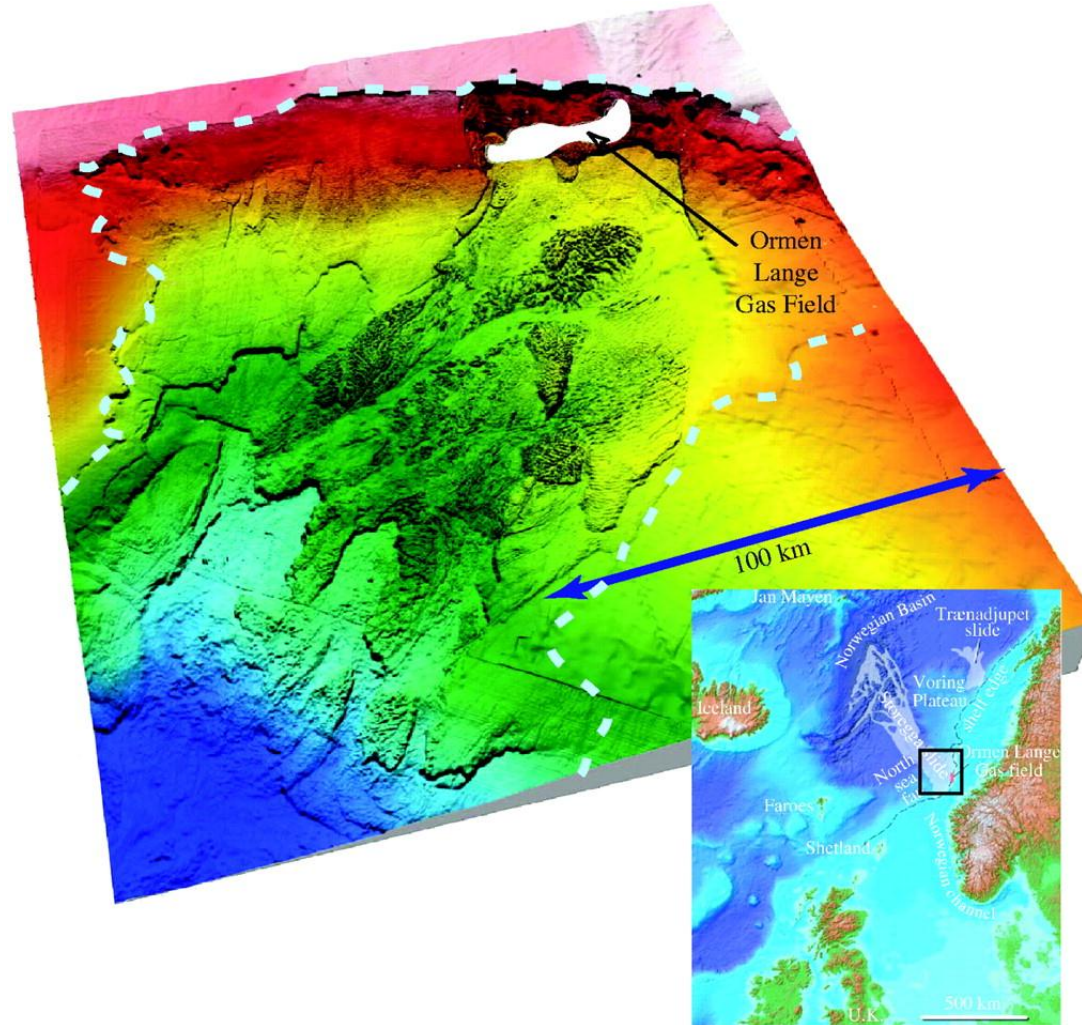


# Landslides are an Important Feature of Sedimentary Margins.



Masson D et al. *Phil. Trans. R. Soc. A* 2006;364:2009-2039

# Storegga slide Off Norway created a Tsunami that devastated Scotland

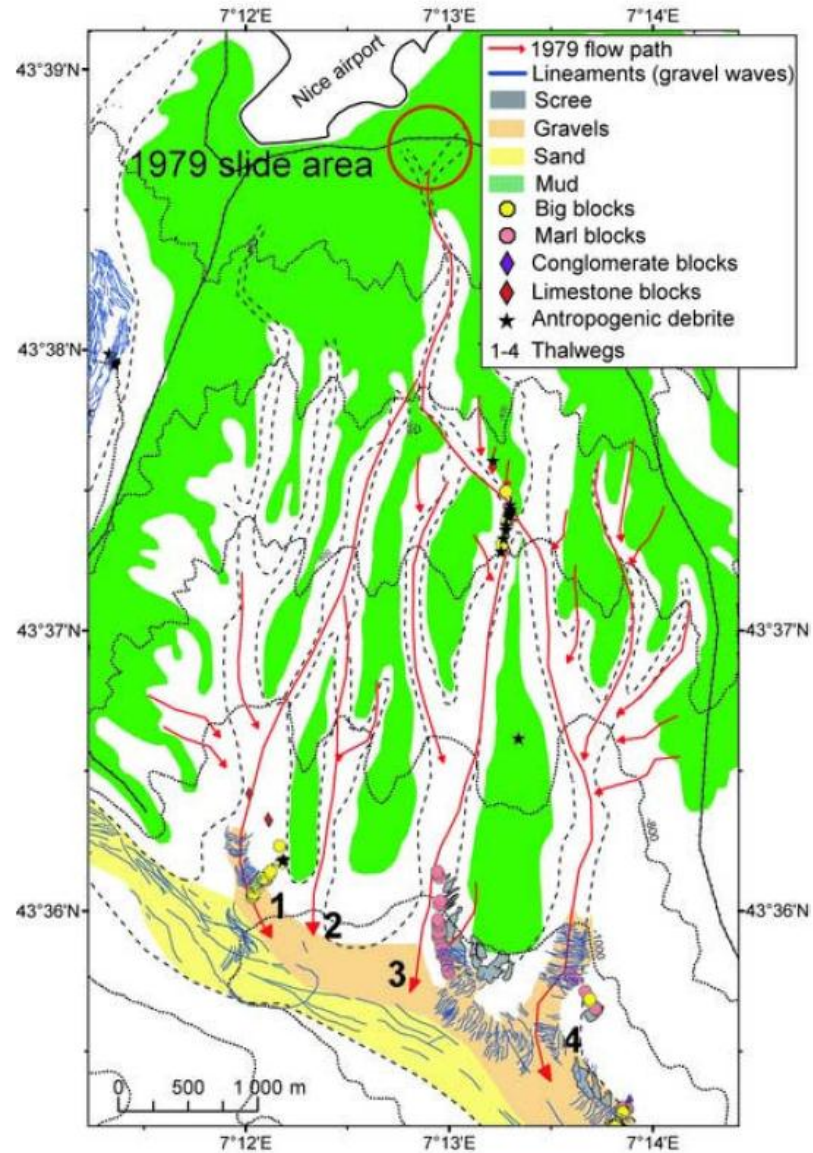


Masson D et al. *Phil. Trans. R. Soc. A* 2006;364:2009-2039

# Nice Airport Runway Extension 1979

Turbidite over 100km underwater  
broke submarine telephone cables.  
End of runway disappeared, several  
People killed and mini-tsunami  
Killed one.

Assier-Rzadkiewicz et al. 2000,  
Numerical modelling of a  
landslide-generated tsunami:  
the 1979 Nice event.  
*Pure Appl. Geophys.* 157, 1717–1727

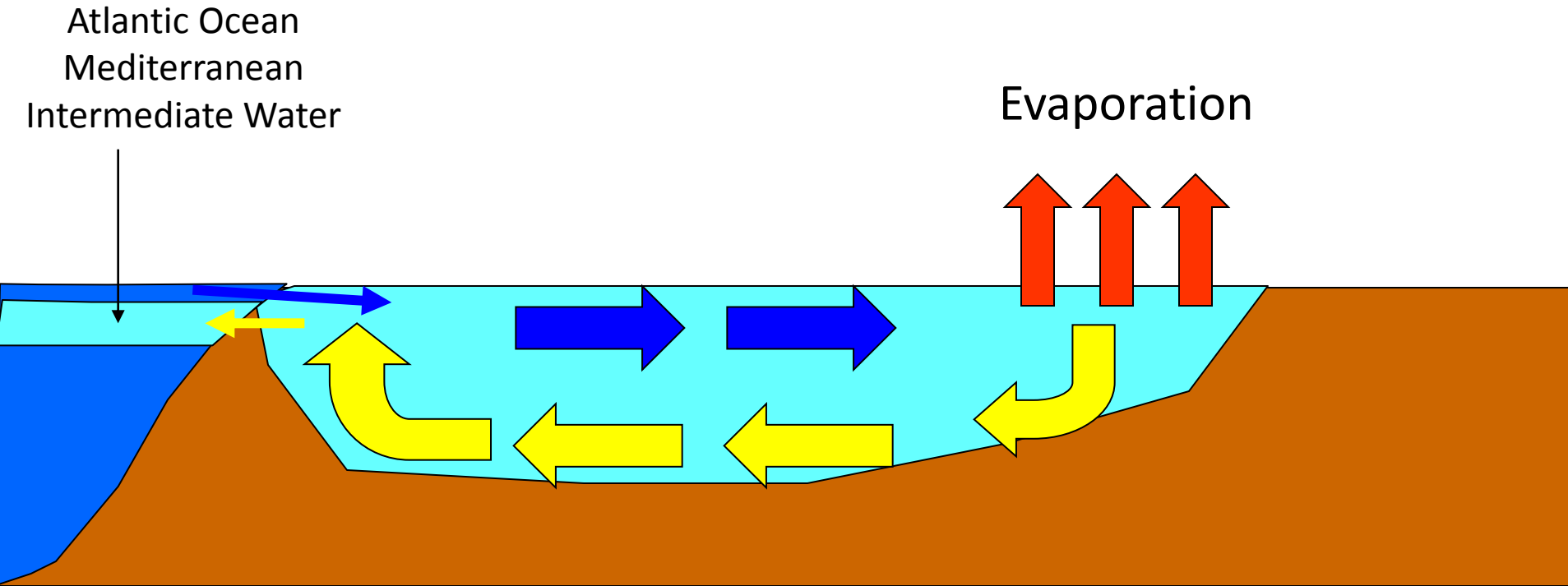




# Mediterranean Sea

## Deep Water Formation

### Thermohaline Circulation

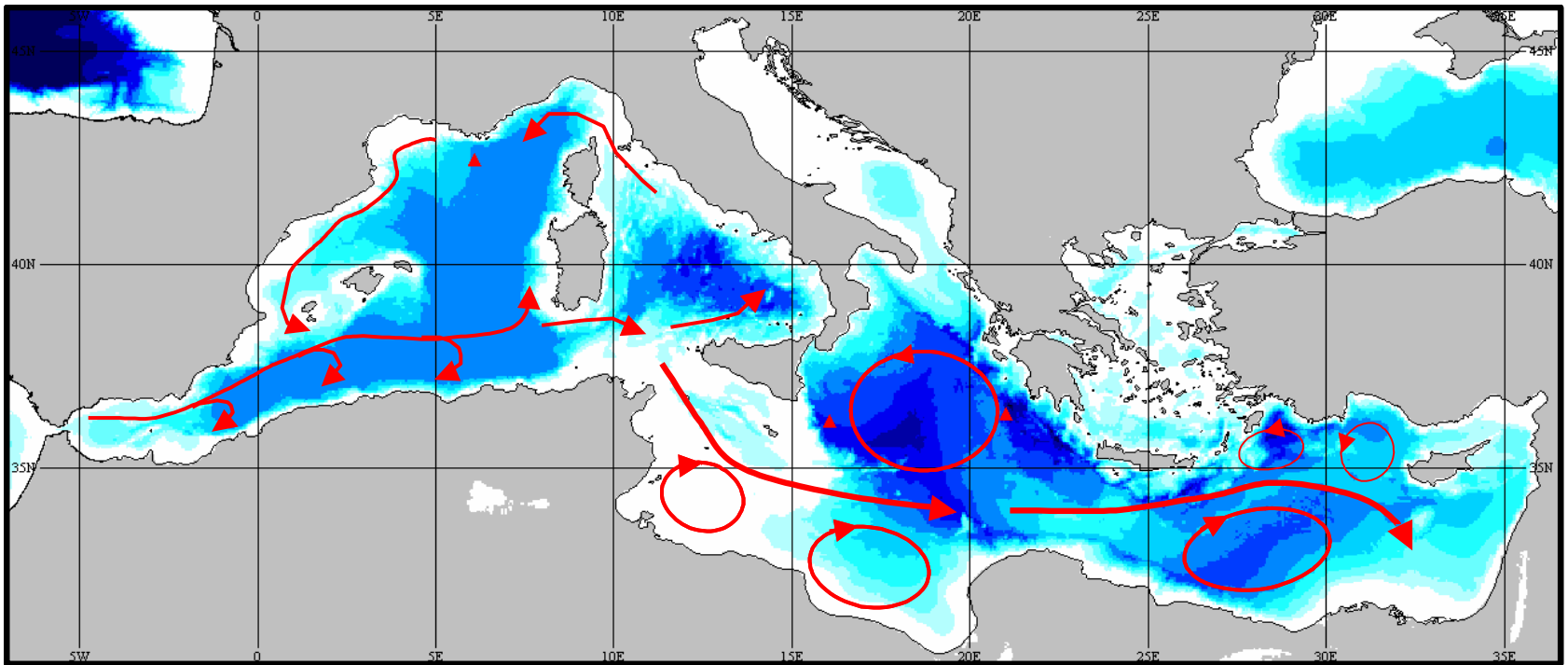


Stagnation events 25,000 and 6,800 years ago.

Sapropels

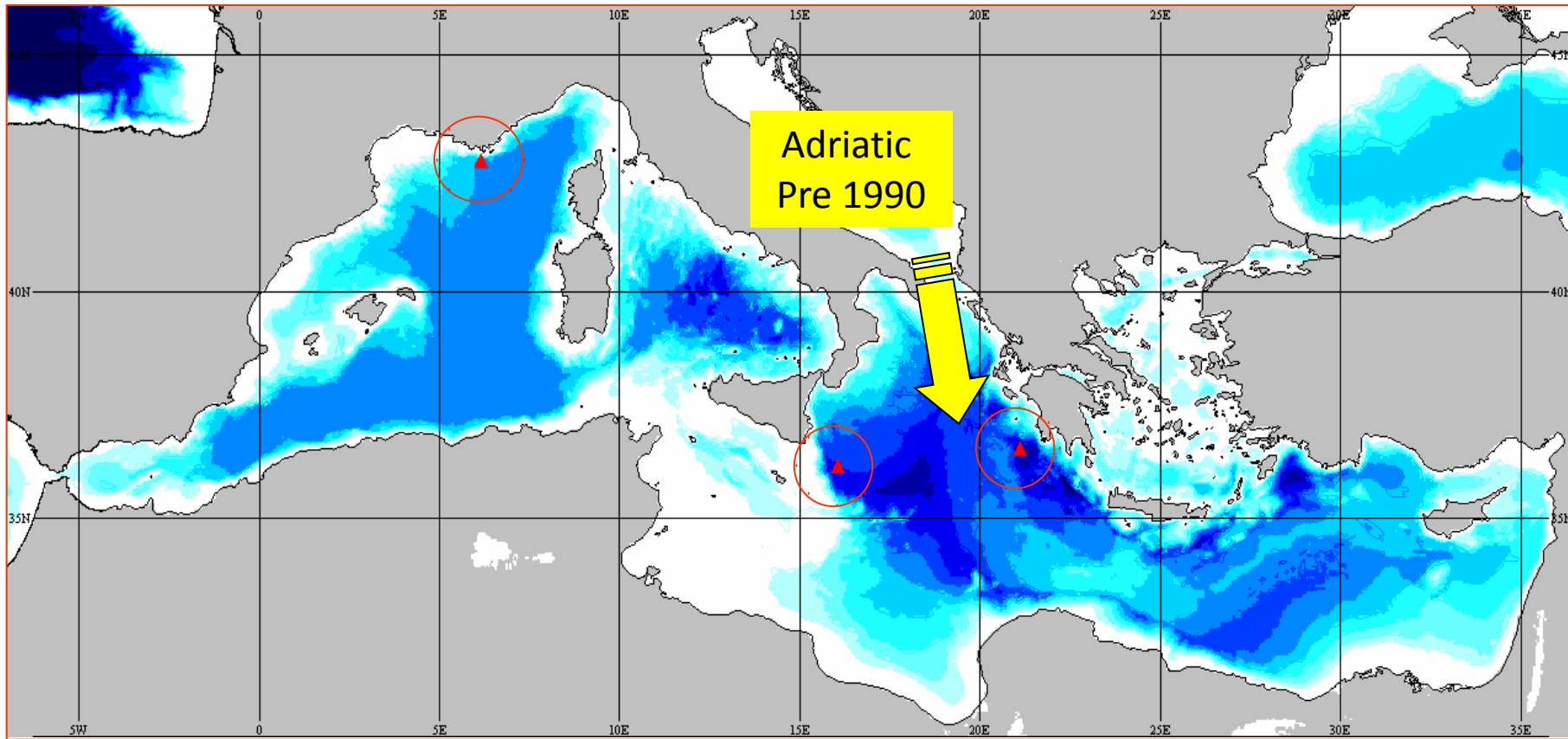


# Surface circulation





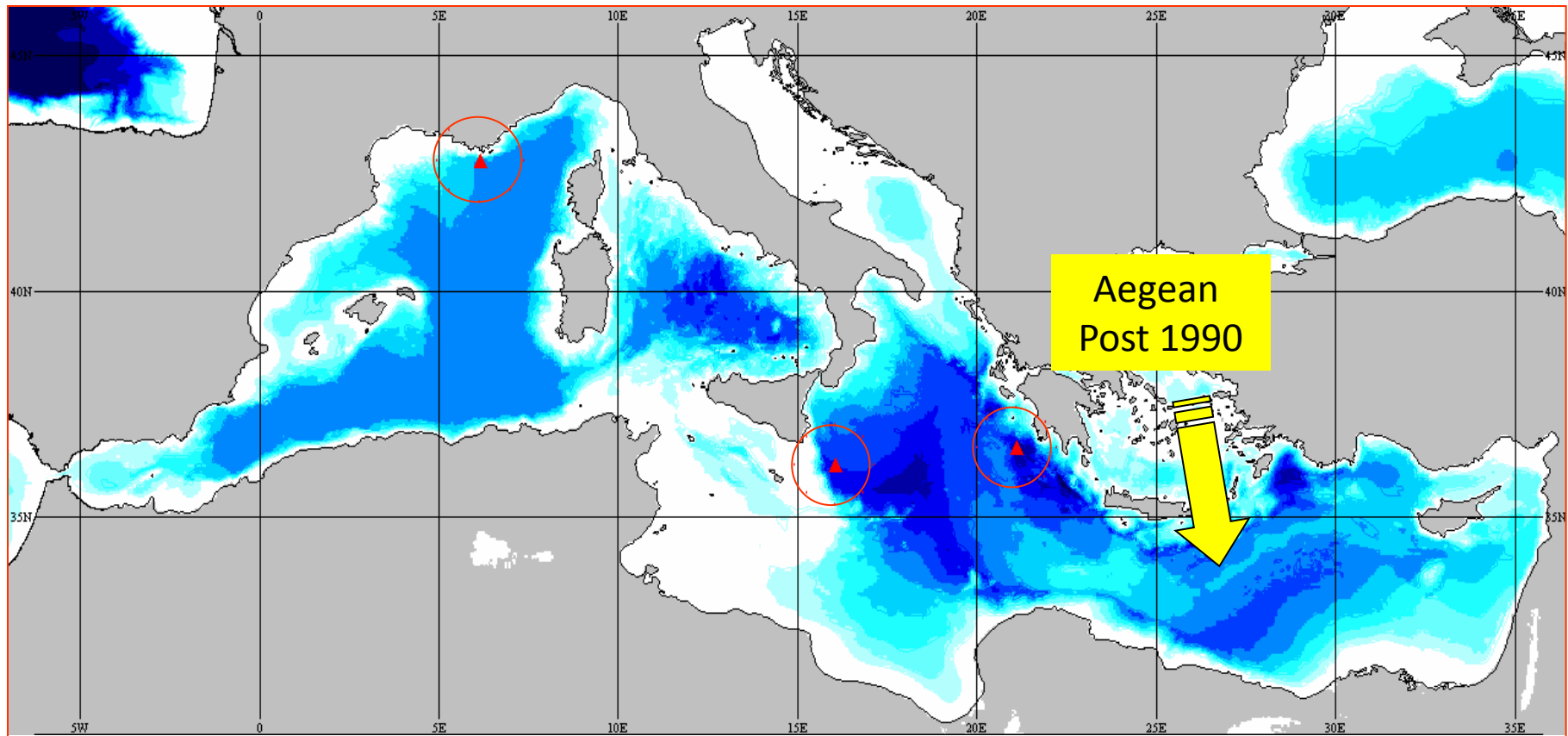
# Deep Water Formation Eastern Mediterranean Transient 1990





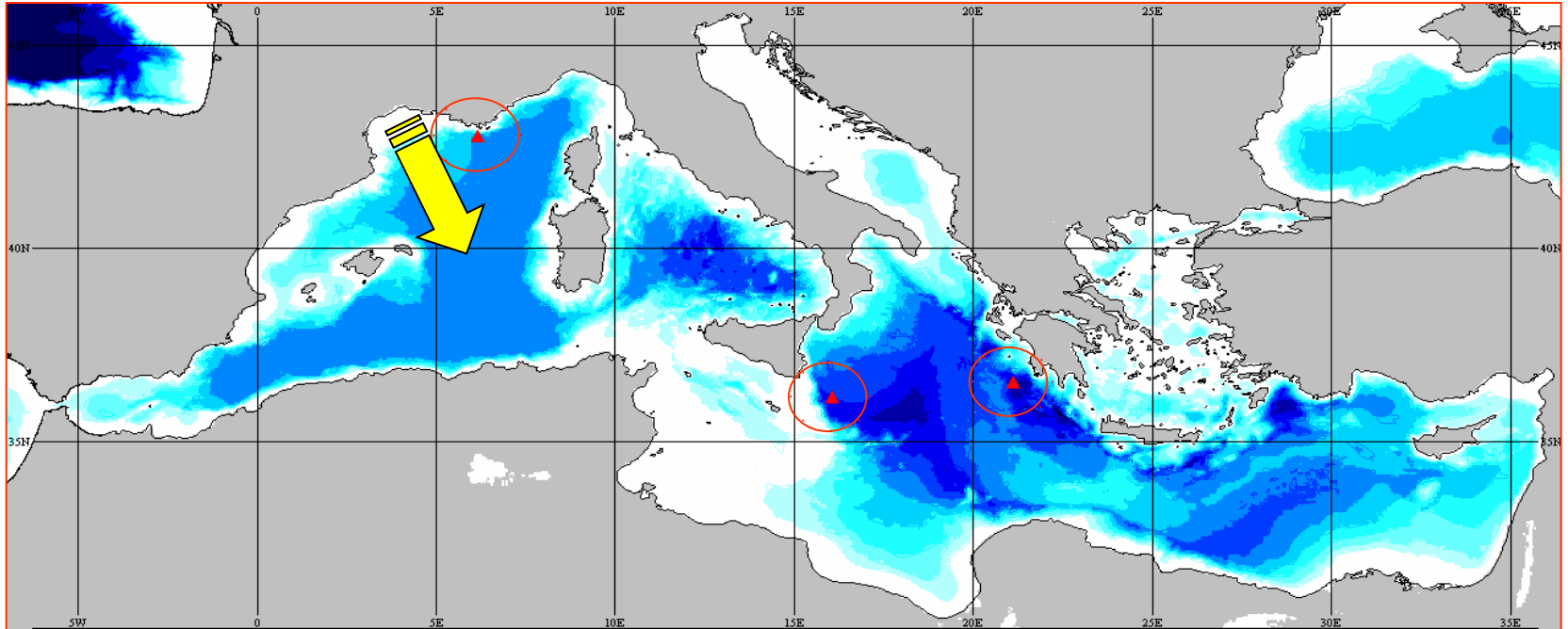


# Deep Water Formation Eastern Mediterranean Transient 1990



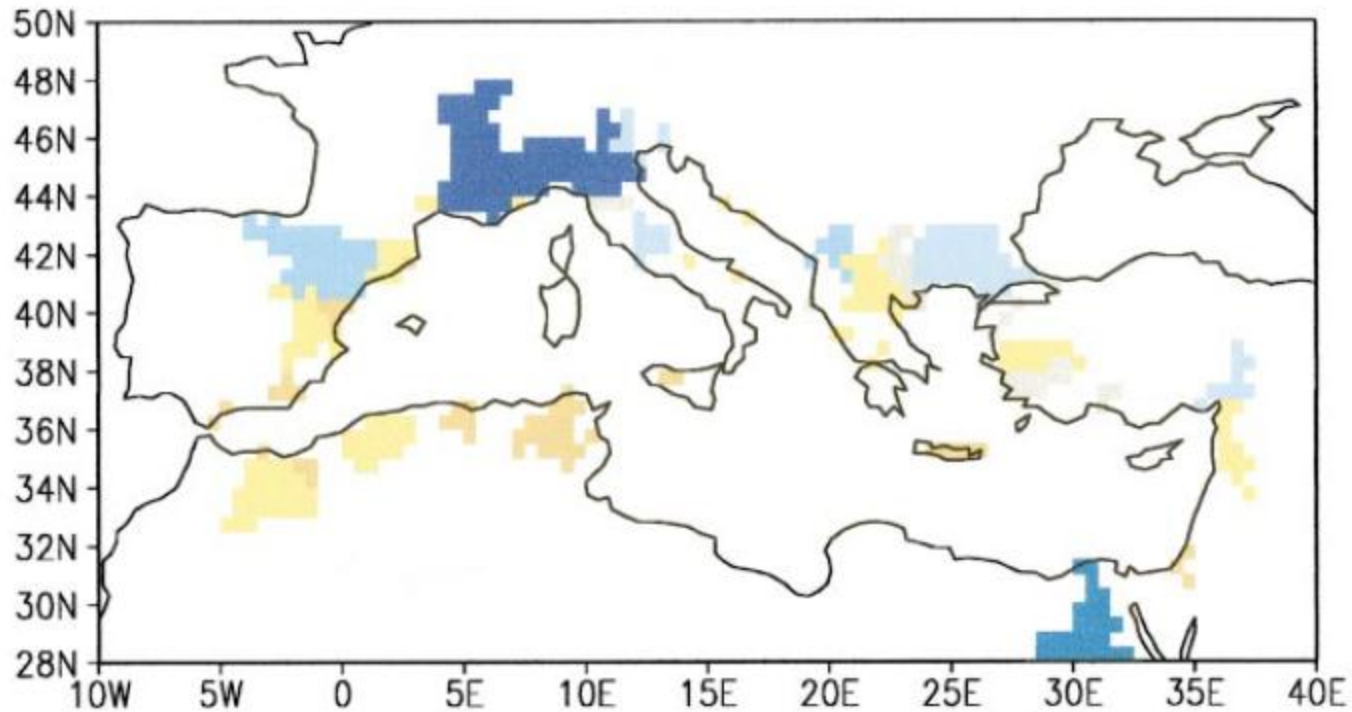


# Dense Shelf Water Cascade



Canals *et al.* (2006) *Nature*: 444, 354-357  
[doi:10.1038/nature05271](https://doi.org/10.1038/nature05271)

## Annual River Discharge into the Mediterranean Sea



Varies year to year linked to North Atlantic Oscillation  
Struglia et al (2004) *Journal of Climate*, 17: 4740



# SeaWifs Satellite Images of chlorophyll concentration



Winter



Spring



Summer

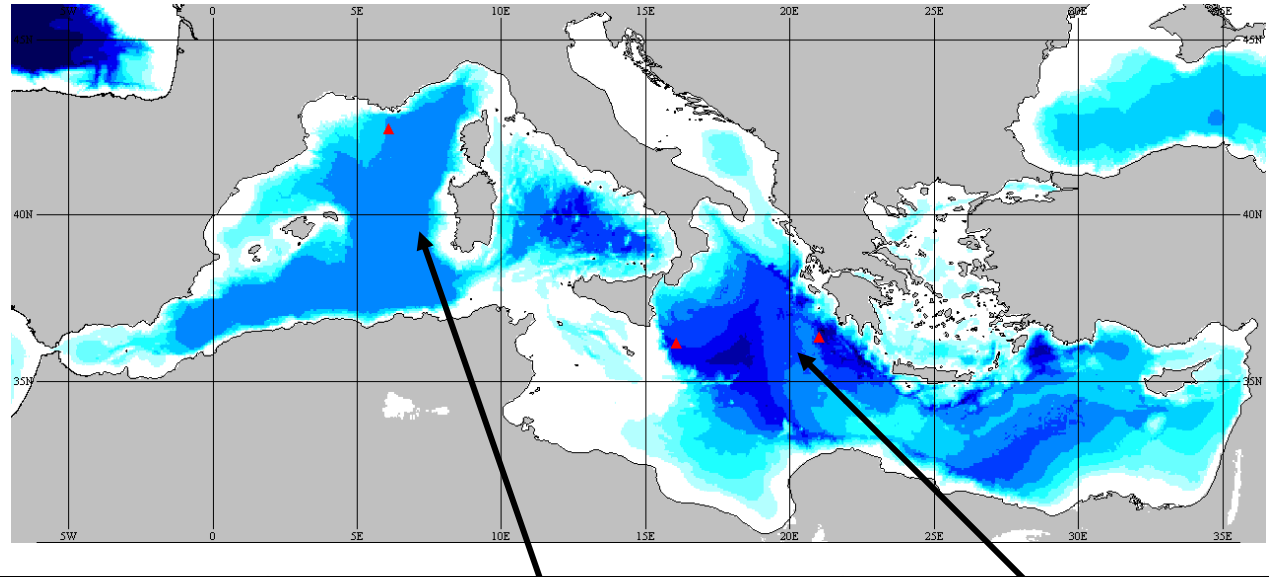


Autumn

High-Red-yellow, green-blue-Low.



# Biology East- West Comparison

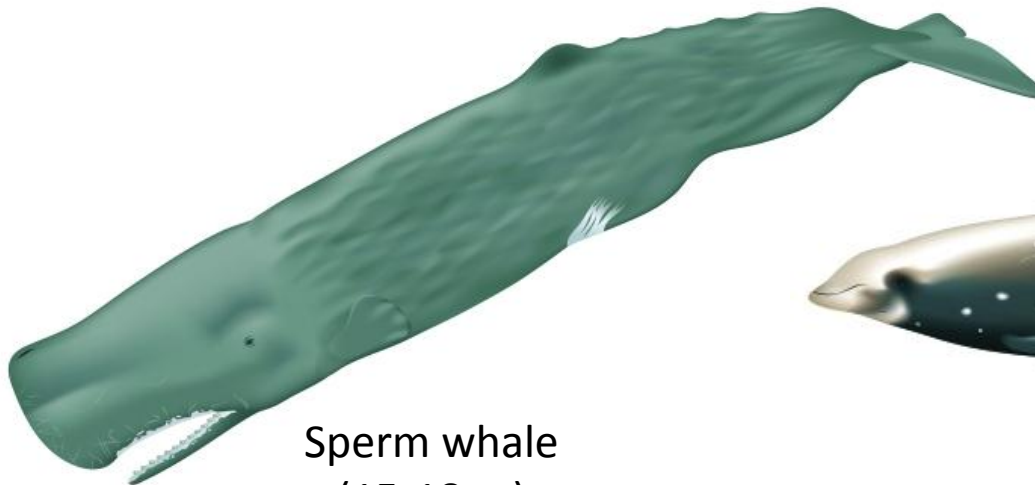


	West	East
Biodiversity (species)	7200	3600
Fish Catch Tonnes.km <sup>-2</sup>	5.25	1.42



# Cetaceans

- Fin whale *Balaenoptera physalus*,
- Sperm whale *Physeter macrocephalus*,
- Striped dolphin *Stenella coeruleoalba*,
- Risso's dolphin *Grampus griseus*,
- Long finned Pilot whale *Globicephala melas*,
- Bottlenose dolphin *Tursiops truncatus*,
- Common dolphin *Delphinus delphis*,
- Cuvier's beaked whale *Ziphius cavirostris*

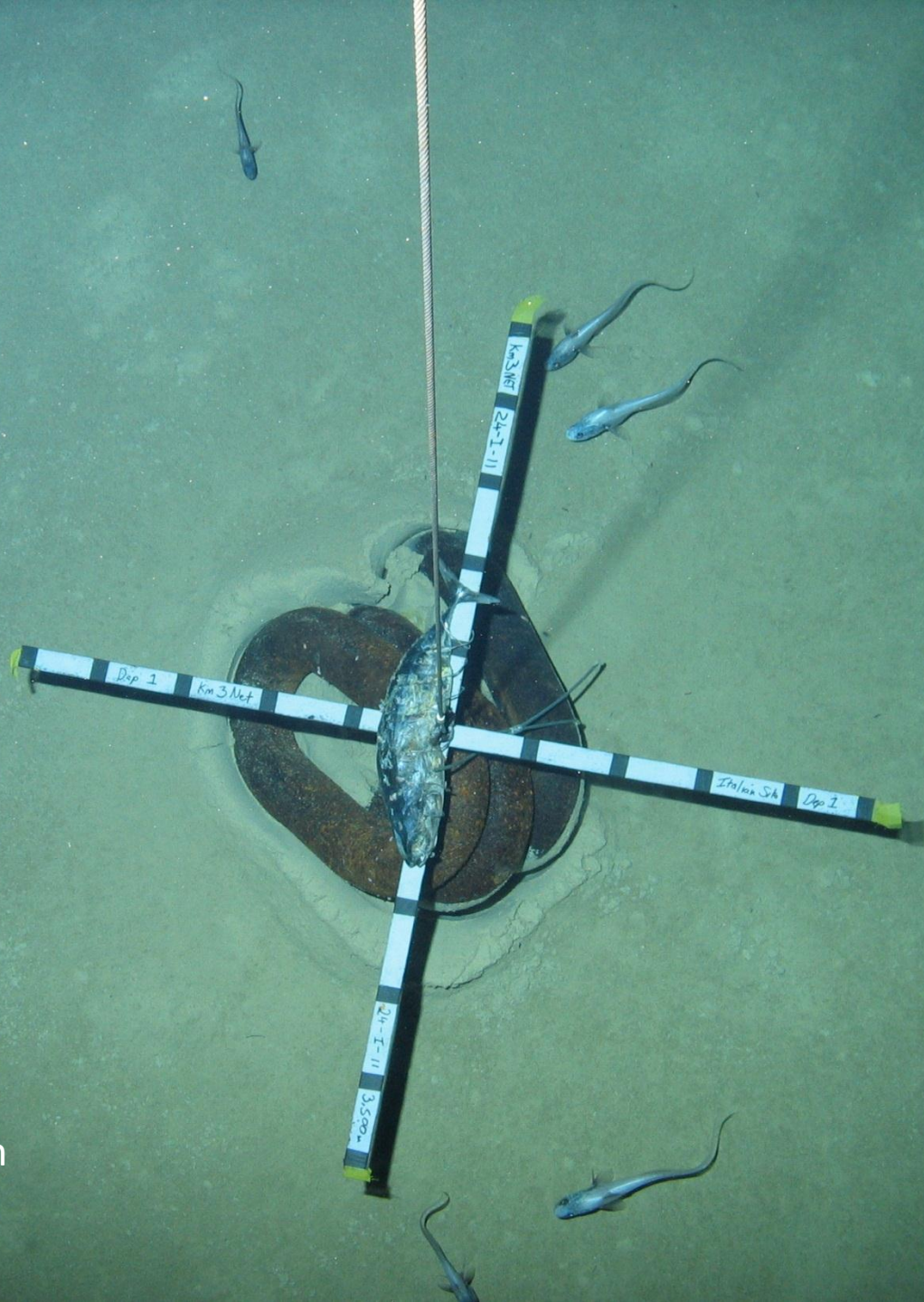


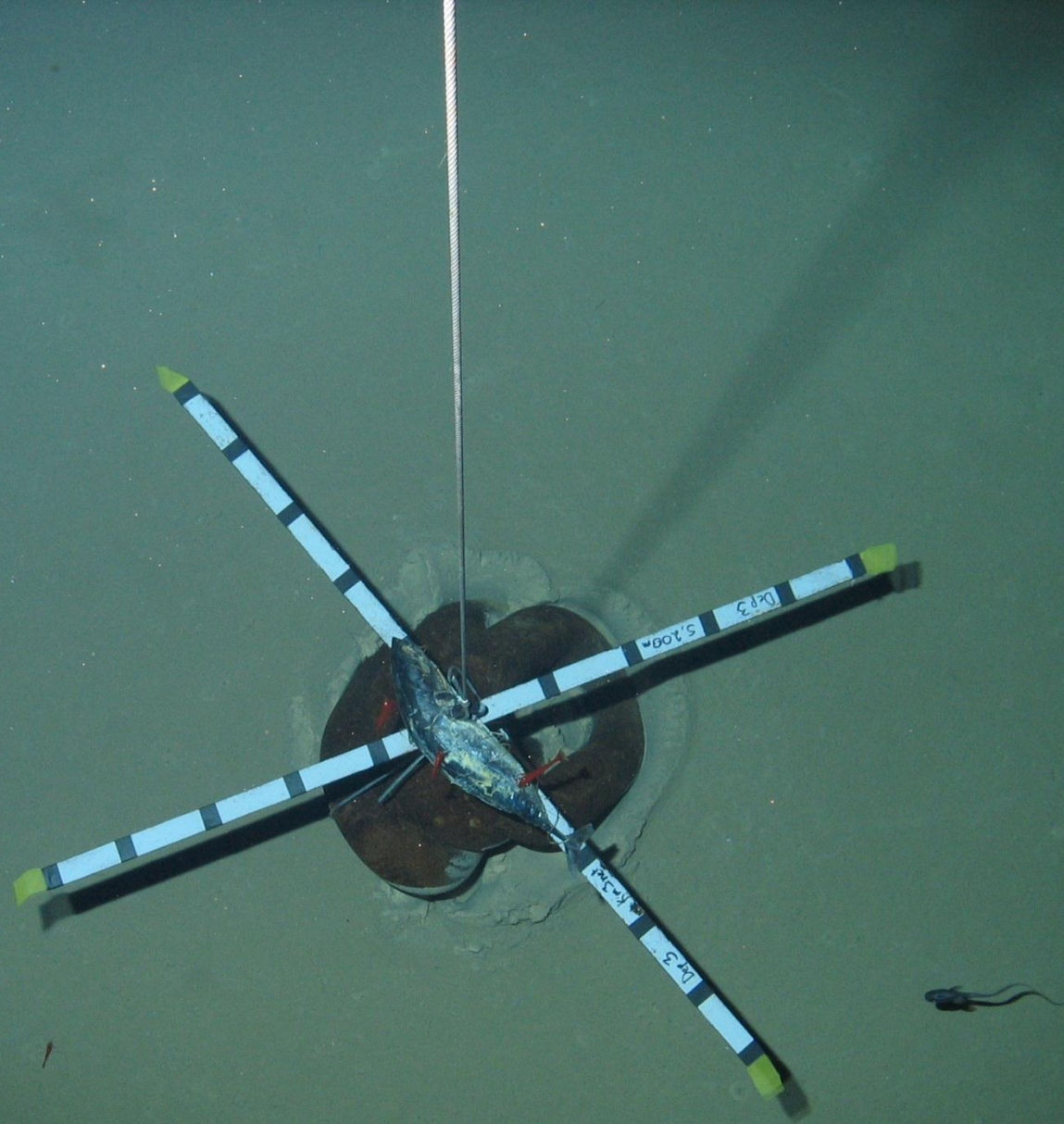
Sperm whale  
(15-18 m)  
depth 1000m



Cuvier's beaked whale  
(7 m) depth 1900m

NEMO 3400m

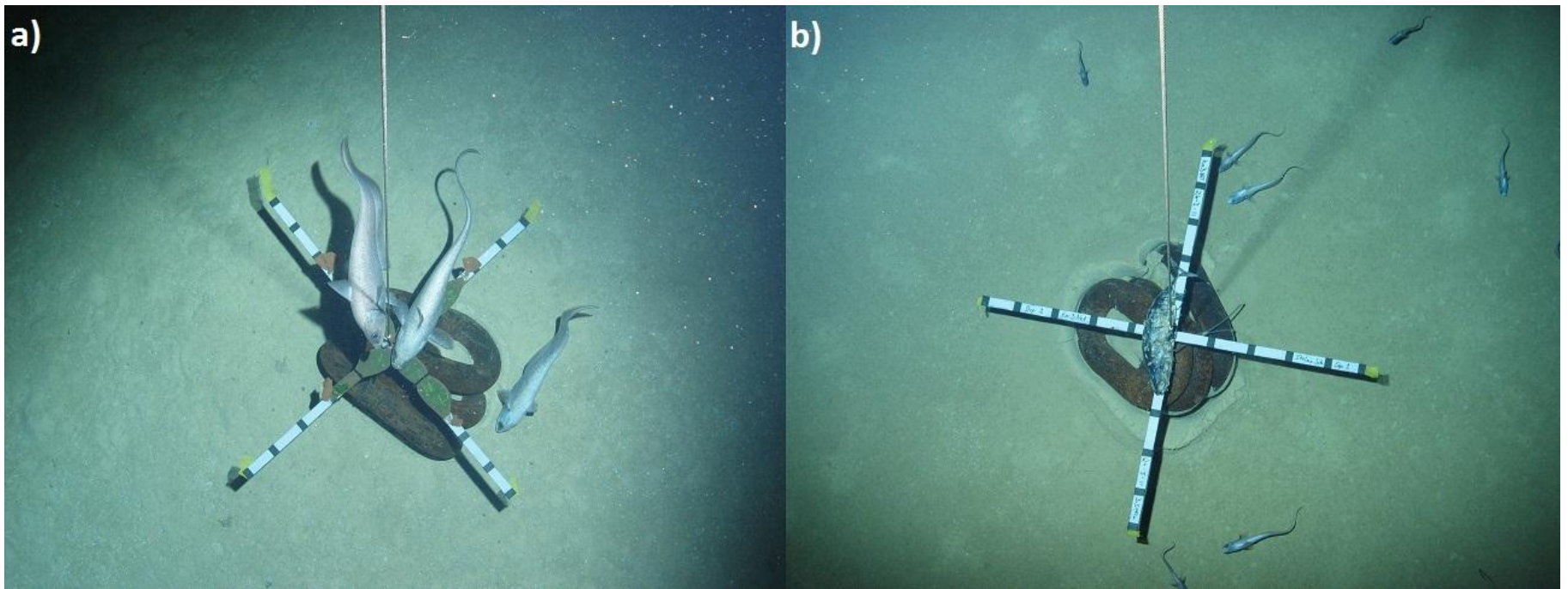




NESTOR 5111m deepest point in European waters, and there is life!



## Mediterranean /Atlantic Comparison



Atlantic

Mediterranean

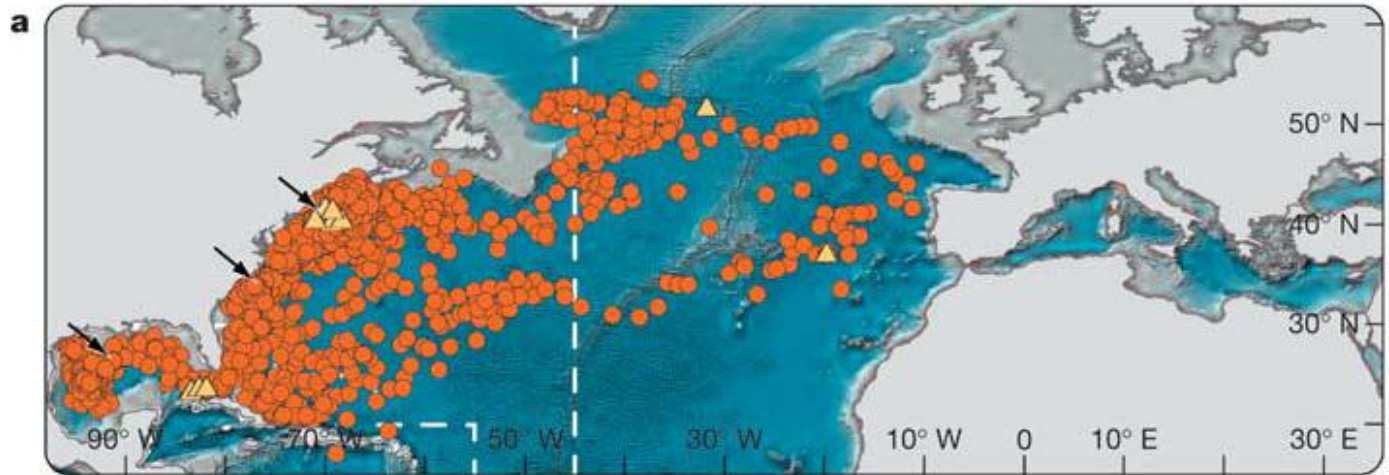
# Blue Fin Tuna – The most valuable Fish in the Mediterranean



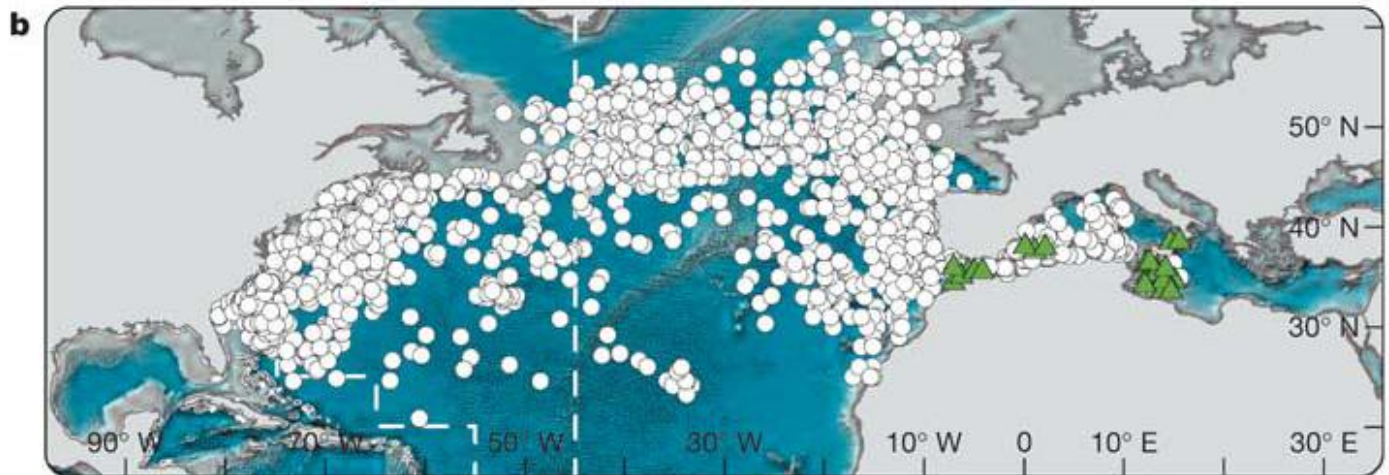
European Parliament 23 May 2012  
TAC reduced 7113 to 5756 tonnes per annum  
Recovery plan

# North Atlantic Blue Fin Tuna

Gulf of Mexico  
Spawners



Mediterranean  
Spawners



The KM3NeT  
Observatory in the Mediterranean  
will form part of a global  
network

- Climate change
- Hazard warning
- Biological productivity