



# EXPLORING KEY SCIENTIFIC QUESTIONS WITH THE EMSO REGIONAL FACILITIES OR GROUP OF REGIONAL FACILITIES

## EMSO-LIGURIAN

[Laurent Coppola et al. CNRS & IFREMER]

*EMSO Strategic Workshop*

*Rome, 11-13th March 2025*



# EMSO-LIGURIAN IN A NUTSHELL

**Location:** Ligurian Sea and central Gulf of Lion

**Distance from land:** 1 to 50 km

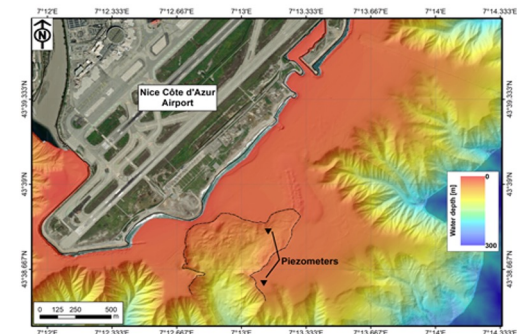
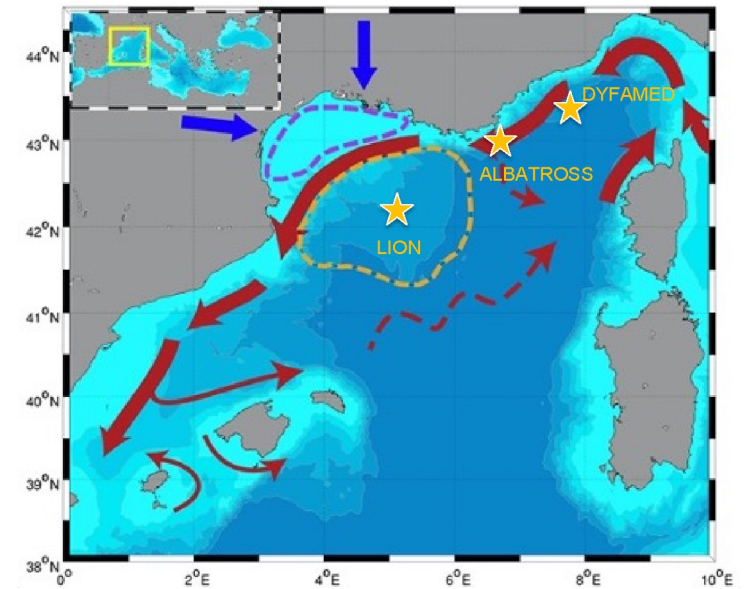
**Max water depth:** 2400m (DYF, LION), 20-30m (Nice)

**Date 1st deployment:** 1988 (DYF), 2007 (LION), 2010 (Albatross), 2015 (Nice)

**Supported by:** France

**Operated by:** CNRS & IFREMER

**Regional Team Leader:** L.Coppola CNRS



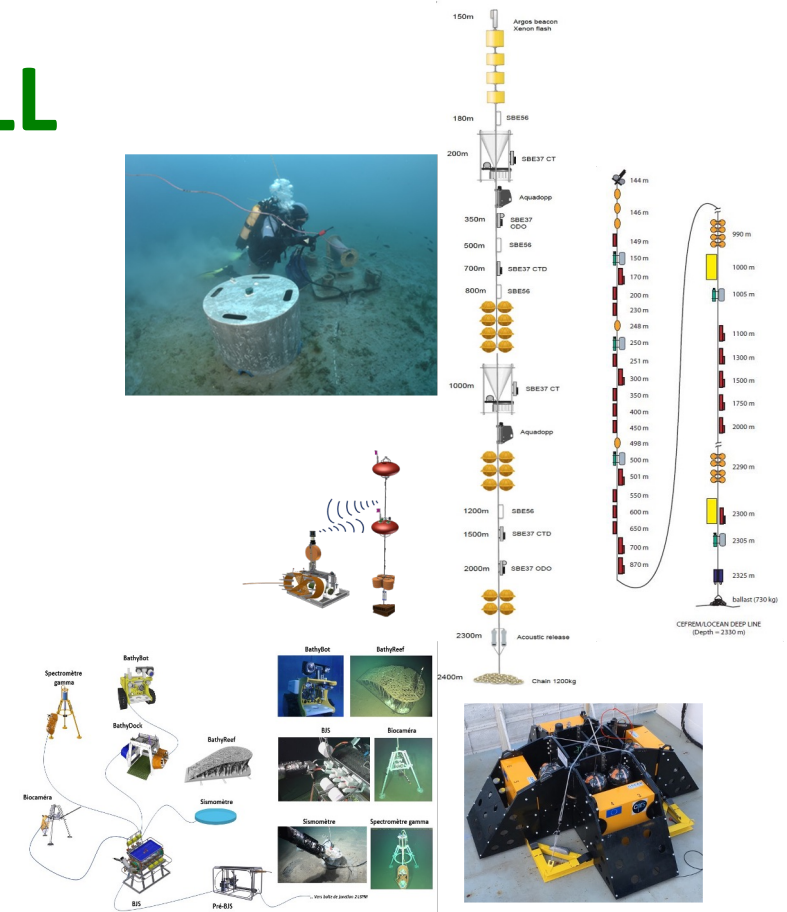
# EMSO-LIGURIAN IN A NUTSHELL

## RF specificity science and technology

**Science objective:** impacts of the physical processes on chemical content and plankton communities in intermediate and deep waters. Evolution of the BCP and C export. Assess changes in groundwater flow and gas changing & monitoring the slope instability in coastal area (Nice)

### Technology:

- 2 standalone fixed mooring with autonomous sensors (TSO<sub>2</sub>, currents) and sediment traps (particle flux): DYFAMED, LION
- One inductive line with broad acoustic transmission equipped with TSO<sub>2</sub>, pH, current, acoustic sensors: ALBATROSS
- Lander (MUGO-OBS), junction box and marine robot (Bathypot) with different sensors (camera...)
- Piezometers (autonomous)

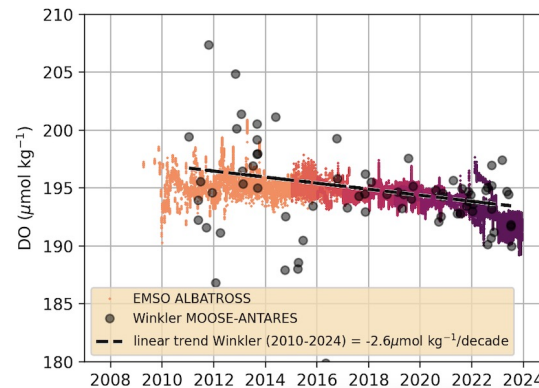
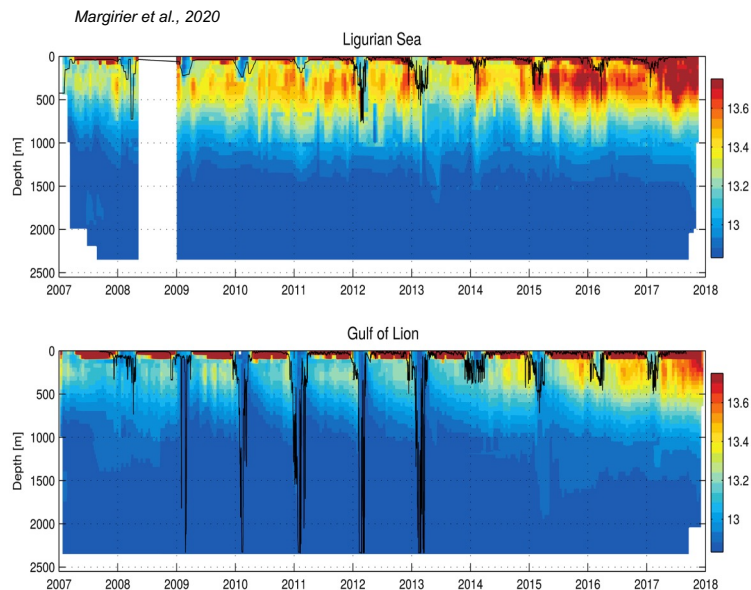


# EMSO-LIGURIAN: SCIENTIFIC CHALLENGES

## Key scientific question 1:

How does the temporal variability of open ocean EOVs impact and propagate from local to regional scales?

KSQ1.1: How do long-term trends influence the open ocean environment and lead to long-lasting (or irreversible) impacts at regional and local scales?



- 2007-2008: Marked by weak deep convection.
- 2009-2013: Strong convection (mixing down to the bottom).
- Since 2014: Weak convection due to atmospheric forcing and stratification, with a rise of  $+0.3^\circ\text{C}$  in temperature and  $+0.08$  in salinity in intermediate waters (200-600m)
- DW =  $+0.002^\circ\text{C}/\text{an}$  since 2019 ; LIW =  $+0.5^\circ\text{C}$  over the last 10 years
- Decrease of DO in LIW and WMDW ( $-3 \mu\text{mol}/\text{kg}/\text{yr}$  and  $-3 \mu\text{mol}/\text{kg}/\text{decade}$ )

# EMSO-LIGURIAN: SCIENTIFIC CHALLENGES

## Key scientific question 2:

What are the spatiotemporal scales and variability of the processes preconditioning and triggering natural hazards events?

KSQ 2.1: How do climate change, sedimentary and geodynamic processes interact at local and regional scales ?

Development of predictive capabilities to predict flash floods, storm waves, or earthquakes

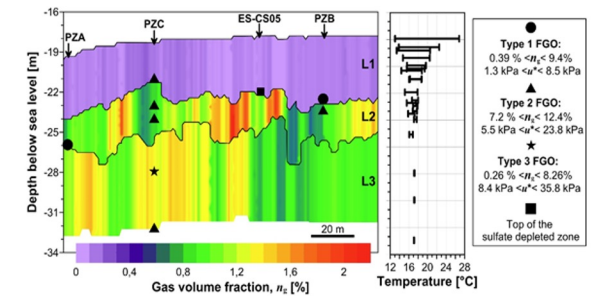
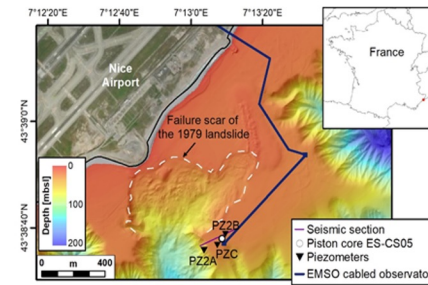
KSQ 2.3: What are the processes and scales of variability that affect fluid flow and seepage to the water column ?

Assessment of seasonal changes in groundwater flow and gas charging

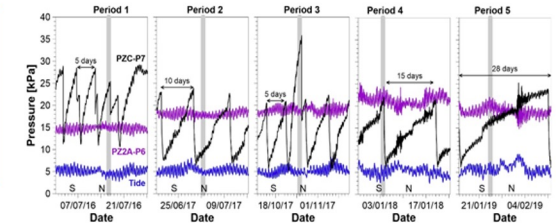
KSQ 2.4: How to resolve the various processes leading to catastrophic events ?

Study the interactions between local and regional factors in triggering tsunamic landslides

## Influence of gas charging on slope stability



- 3 different types of free gas occurrence detected in shelf sediments
- One type associated with high pore pressure and fracturing predispose slope failure
- With a timing influenced by seasonal changes in temperature



# EMSO-LIGURIAN: SCIENTIFIC CHALLENGES

## Key scientific question 4:

### How does climate change affect the carbon storage in the open ocean along the water column?

KSQ 4.1: How is the physical pump affected by medium and long term variability of the atmospheric forcing?

Air-sea CO<sub>2</sub> fluxes variability

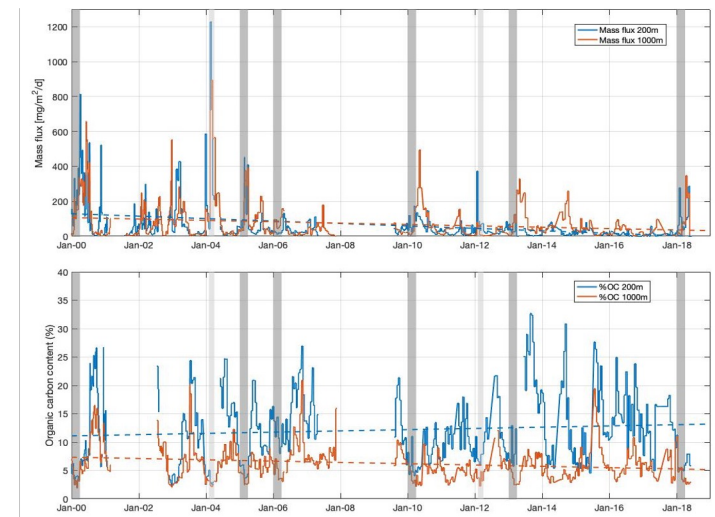
KSQ 4.2: How are the biological pumps (organic and carbonate/inorganic) affected by variability at different time scales?

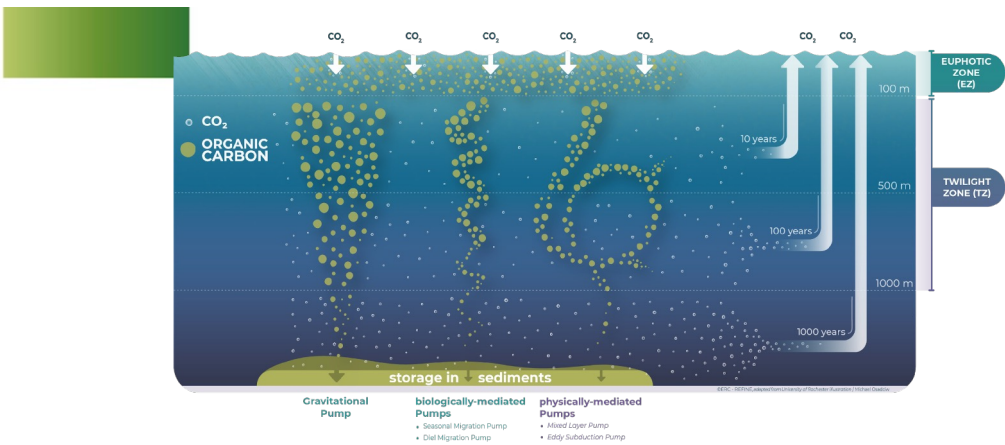
Carbon export related to seasonal scales and long term trends

KSQ 4.3: How does marine biodiversity and ecosystem dynamics influence carbon cycling through the biological carbon pumps?

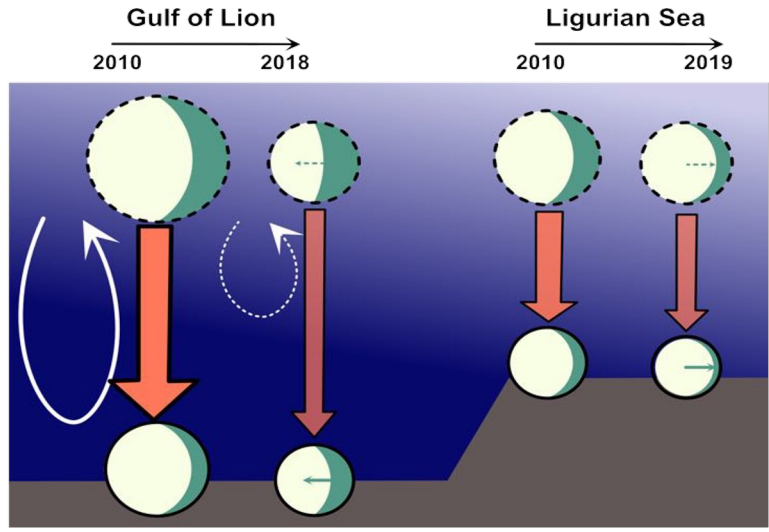
Influence of particles composition, plankton species, respiration ...

- Mass and POC fluxes are driven by the deep convection intensity
- Impact of respiration vs. export efficiency: increase of fresh OC below the photic zone compared to degraded OC in the mesopelagic layer
- Identify eukaryotes and bacteria related to the surface production & remineralisation impacts (DNA approach)



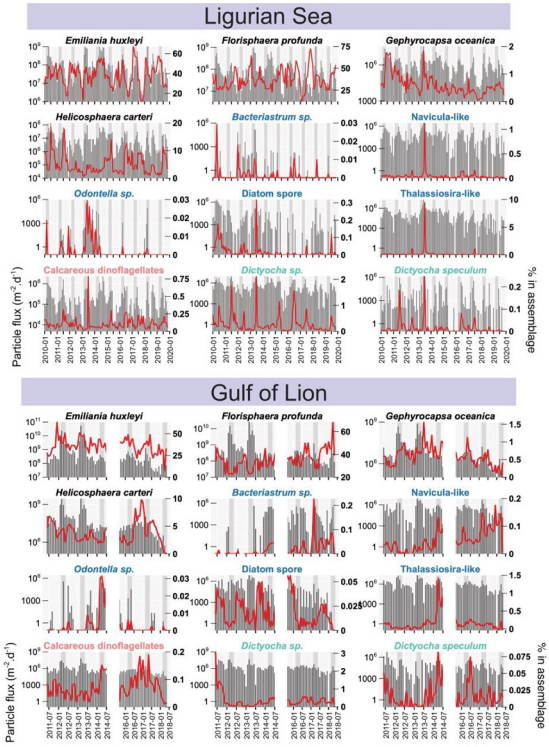


### Schematic representation of carbon burial evolutions in the NW Mediterranean Sea between 2010 and 2019 (POC concentrations)



**The Gulf of Lion and Ligurian Sea experience contrasting trends (Godbillot et al., 2025)**

- Ligurian Sea: increasing dominance of small coccolithophores (yellow), reducing carbon burial efficiency
- Gulf of Lion: increased presence of large diatoms and silicoflagellates (green), which may help sustain carbon export and burial
- **The Ligurian Sea is shifting towards a system dominated by smaller phytoplankton, reducing its role in carbon sequestration**
- **The Gulf of Lion's increasing diatom presence may partially compensate for decreasing phytoplankton fluxes by enhancing carbon export efficiency**





# EMSO-LIGURIAN: LOOKING AHEAD

How does your Facility represent regional scale ?

	<b>Hydrodynamics and hydrology</b>	<b>Biochemistry, ecology</b>	<b>Geology and Geophysics</b>
<b>Future objectives</b>	<ul style="list-style-type: none"> <li>Better constrain surface variability related to heat fluxes, MHW, ...</li> </ul>	<ul style="list-style-type: none"> <li>Evolution of plankton biodiversity and its impacts on BCP</li> <li>Acidification issue</li> </ul>	<ul style="list-style-type: none"> <li>Extend the areas affected by groundwater flow and gas charging over the continental shelf using fiber sensing methods.</li> <li>Measure seismic ground shaking with fiber optics.</li> </ul>
<b>Challenges/Technology that EMSO ERIC may provide to support</b>	<ul style="list-style-type: none"> <li>Improve NRT data transmission techniques</li> <li>Reduce the environmental footprint during the maintenance of the RF</li> </ul>	<ul style="list-style-type: none"> <li>Sensors in biology, DNA approach (link with EMBRC)</li> <li>Need to develop accurate EU pH sensors</li> <li>Autonomous sampler to acquire BGC variables (nutrients, carbonates...)</li> </ul>	<ul style="list-style-type: none"> <li>Support the development of fiber sensing imaging and earthquake detection methods</li> </ul>







Thank you for your attention!





Observing the ocean to save the earth

