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

EMSO Canarias

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EMSO Strategic Workshop

Rome, 11-13th March 2025

EMSO-CANARIAS IN A NUTSHELL

Location: ESTOC mooring, 29°10'N, 15°30' W,

Distance from land: 60NM North of Gran Canaria

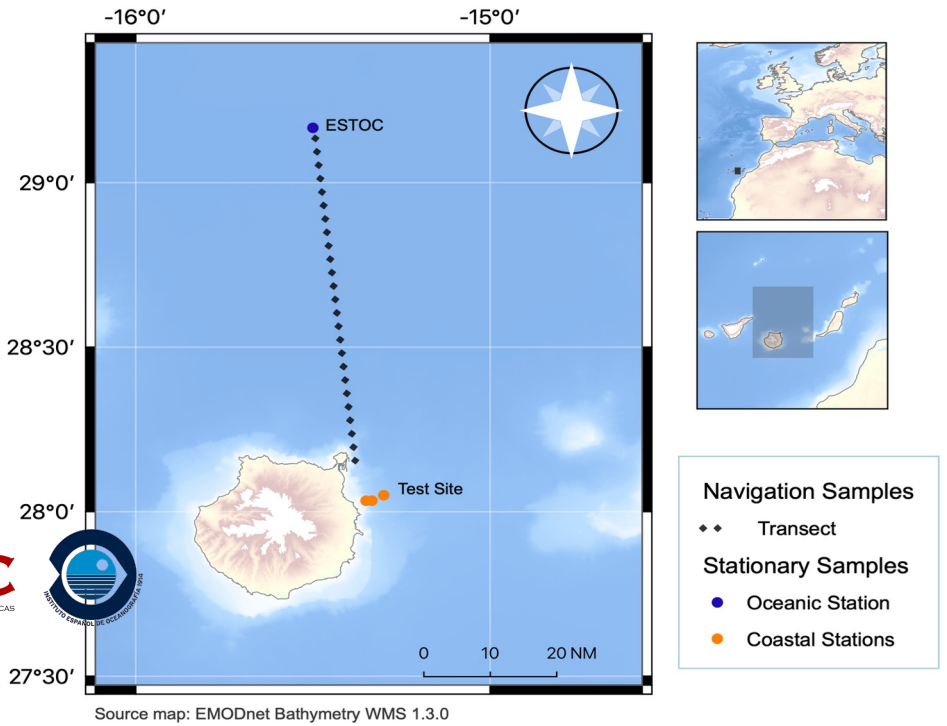
Max water depth: 3650

Date 1st deployment: 1994

Supported by: PLOCAN Plataforma Oceánica de Canarias · ULPGC Universidad de Las Palmas de Gran Canaria · CSIC Consejo Superior de Investigaciones Científicas

Operated by: PLOCAN Plataforma Oceánica de Canarias

Regional Team Leader: Eric Delory



Source map: EMODnet Bathymetry WMS 1.3.0

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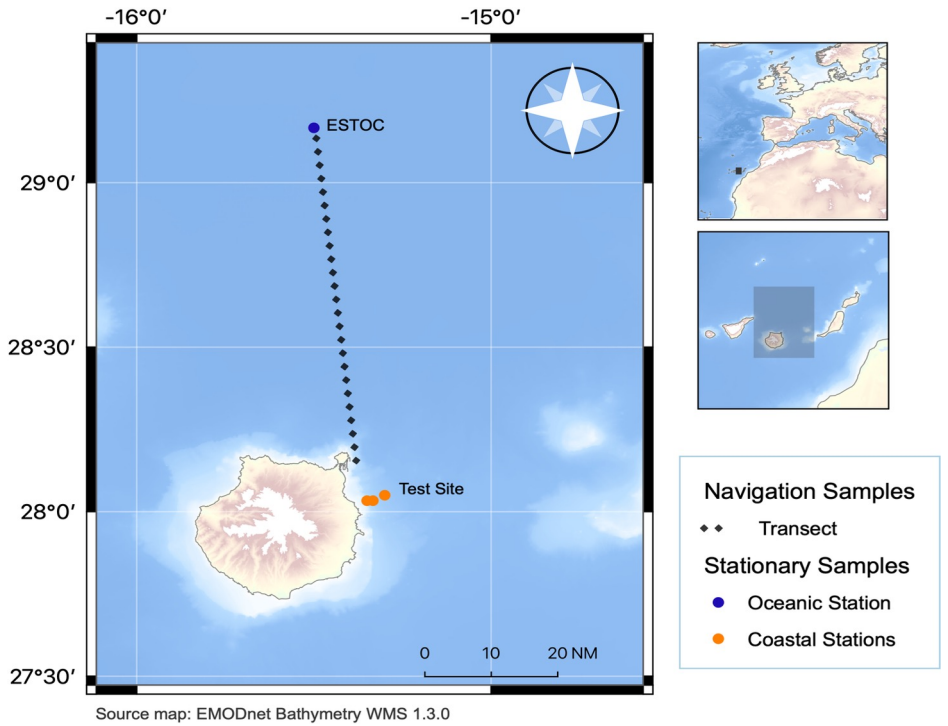
EMSO-CANARIAS IN A NUTSHELL

Science:

- Oceanography (physics, chemistry (ULPGC), biology (ULPGC))
- Ocean Sound incl. bioacoustics
- Biodiversity restoration

Technical:

- Mooring operations, instrument configuration
- Sensors: integration, preparation, testing
- Sample analysis
- Data curation and processing
- Glider preparation and piloting
- Project development and management



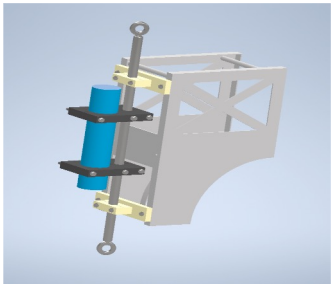
Source map: EMODnet Bathymetry WMS 1.3.0

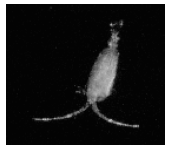
EMSO CANARIAS:SCIENTIFIC CHALLENGES

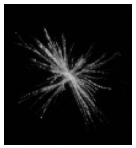
Key scientific question 1:

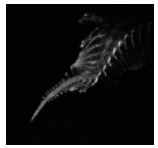
How does the temporal variability of open ocean EOVs impact and propagate from local to regional scales?

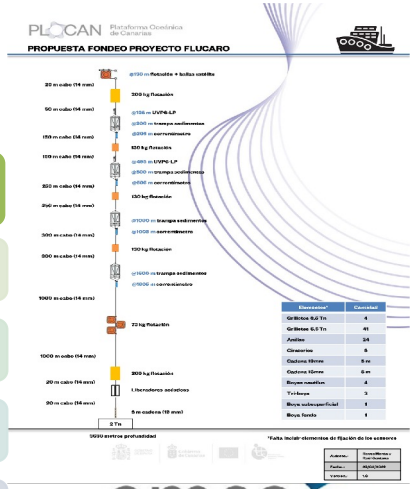
Hydrodynamics and Hydrology Processes	
Oxygen Variability & Ventilation	• Long-term oxygen trends and water mass dynamics at ESTOC.
(Future) Climate Change & Oxygen Trends –	• Oxygen and temperature shifts under broader climate change.
Saharan Dust & Stratification	• Influence of episodic dust events on water column structure.
Climate Oscillations & Oxygen	• Basin-scale climate modes driving regional oxygen variability.
Climate Modes & Circulation	• NAO, AMO influences on temperature, salinity, and flow.
(Future) Water Masses & Carbon Cycle	• Climate-driven variability in deep-water carbon processes.











Biogeochemistry, Biology, and Ecology Processes	
Ocean Acidification & Productivity	• Effects of long-term acidification on primary production and carbonate chemistry.
Plastic Pollution & Ecology	• Ecological consequences of persistent marine plastic pollution.
(Future) Acidification & Biological Impact	• Impacts of acidification on carbonate chemistry and biological systems.
Nutrient Pulses & Plankton	• Upwelling-driven nutrient inputs affecting respiration and carbon export.
Dust Deposition & Biogeochemistry	• Open ocean responses to pulses of atmospheric dust deposition.

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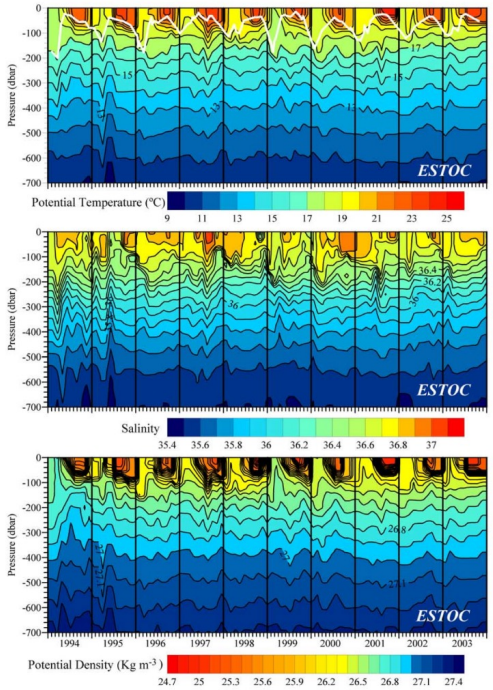
Key scientific question 2:

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

Hydrodynamics and Hydrology Processes

Hydrographic Variability & Climate

- Long-term hydrographic shifts linked to climate-driven water mass changes.



Time series of potential temperature, salinity and potential density at ESTOC. White lines represent the MLD calculated by the 0.5ºC threshold criterion. From Cianca, A., Helmke, P., Mouriño, B., Rueda, M. J., Llinás, O., & Neuer, S. (2007). *Decadal analysis of hydrography and in situ nutrient budgets in the western and eastern North Atlantic subtropical gyre*. *Journal of Geophysical Research: Oceans, 112*(C7), C07025. https://doi.org/10.1029/2006JC003788

Geology and Geophysics Processes

(Future)Ocean Pressure & Sedimentation

- Tsunami meter data revealing pressure-driven sedimentation patterns.

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Key scientific question 3:

What are the impacts of geophysical dynamic events, climatic and anthropogenic changes on open ocean benthic and pelagic ecosystems?

Biochemistry, Biology, and Ecology Processes	
Upwelling & Carbon Flow	• Upwelling intensity and nutrient pulses altering plankton communities, trophic interactions, and carbon cycling.
Chlorophyll Variability & Productivity	• Interannual phytoplankton shifts reflected in chlorophyll concentration trends.
Bioacoustics & Cetacean Behavior	• Using passive acoustics to monitor cetacean activity and biodiversity.
Ferry Routes & Cetaceans	• Assessing ferry traffic impacts on cetaceans and mitigation strategies for collisions.
Plastic Pollution	• Long-term ecological impacts of plastic pollution
Offshore Wind Farms & Ecosystems	• Effects of wind farm noise on marine ecosystems.

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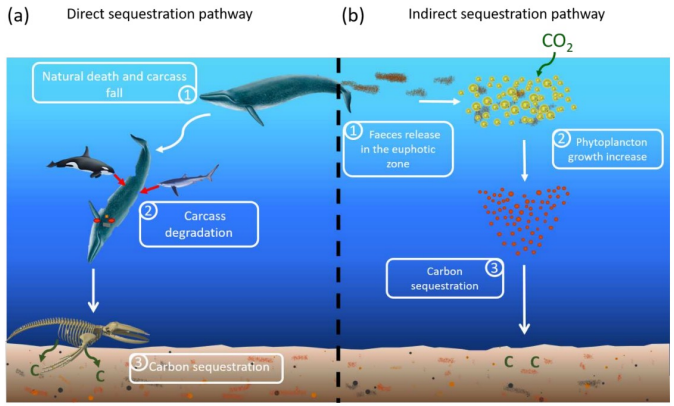
Key scientific question 4:

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



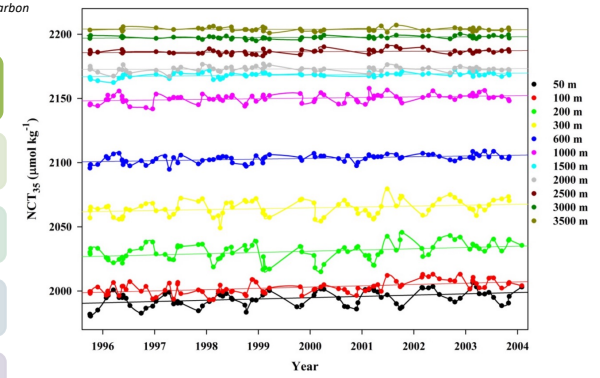
The two main ways of carbon sequestration in the deep ocean by baleen whales. Directly through the sinking of their carcasses (a) and indirectly through the fertilization of the ocean by nutrients in faeces and the sinking of resulting surplus of phytoplankton (b). From㉂Pre-print)**Durfort, A., Mariani, G., Troussellier, M., Tulloch, V. J. D., & Mouillot, D. (2020).** *The collapse and recovery potential of carbon sequestration by baleen whales in the Southern Ocean.*

Hydrodynamics and Hydrology Processes

CO_2 Uptake & Ocean Ventilation	• Influence of ocean ventilation and mixing on CO_2 absorption and storage.
(Future) CO_2 & Mixing Interactions	• Atmospheric CO_2 interactions driving carbon uptake changes at ESTOC.

Biochemistry, Biology, and Ecology Processes

Climate Shifts & Carbon Pump	• Decadal climate shifts impacting carbon export and sequestration.
Carbon Pump Efficiency	• Seasonal and interannual controls on biological carbon pump performance.
Plankton Shifts & Carbon Storage	• Effects of plankton community changes on carbon sequestration.
(Future) Cetacean Carbon Sequestration	• Role of cetaceans in biological carbon storage.



Long-term trends of the water column CT normalized to a constant salinity of 35, NCT (µmol kg−1) for the mixed layer and for selected depths at ESTOC. From: González-Dávila, M., Santana-Casiano, J. M., Rueda, M. J., & Llinás, O. (2010). *The water column distribution of carbonate system variables at the ESTOC site from 1995 to 2004. Biogeosciences, 7*(9), 3067–3081. https://doi.org/10.5194/bg-7-3067-2010.

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Key scientific question 5:

How to develop innovative observation technologies and strategies for the open ocean and increase EMSO observatory capabilities?

EMSO Technology and Marine Observation	
AI-Driven Bioacoustic Monitoring	• Application of artificial intelligence in bioacoustics for real-time biodiversity assessment.
Use of Fixed Cable Stations. Integration of Hydrophone Arrays in Fiber Optic Cables	• Deployment of permanent cable infrastructure for continuous ocean monitoring. Embedding hydrophone networks in fiber-optic cables for real-time acoustic ocean sensing.
Implementation of DAS in Marine Observation:Promotion of DAS in Biodiversity, Geology, and Oceanography Research	• Advancing Distributed Acoustic Sensing (DAS) applications across marine biodiversity, geological, and oceanographic studies.

EMSO-CANARIAS:LOOKING AHEAD

	Hydrodynamics and hydrology	Biochemistry, biology and ecology	Geology and Geophysics
Future objectives	• **Climate Change & Oxygen Trends** Understanding how long-term variability in oxygen and temperature at ESTOC reflects broader climate change patterns. • **Water Masses & Carbon Cycle** Investigating how climate-driven variability in water mass properties influences the deep-water carbon cycle • **CO_2 & Mixing Interactions** Understanding how interactions between atmospheric CO_2 levels and ocean mixing drive changes in carbon uptake at ESTOC.	• **Water Masses & Carbon Cycle** Investigating how climate-driven variability in water mass properties influences the deep-water carbon cycle. • **Acidification & Biological Impact** Assessing how long-term ocean acidification at ESTOC impacts carbonate chemistry and biological processes • **CO_2 & Mixing Interactions** Understanding how interactions between atmospheric CO_2 levels and ocean mixing drive changes in carbon uptake at ESTOC • **Cetacean Carbon Sequestration** Exploring the role of cetaceans in biological carbon storage and sequestration.	• **Ocean Pressure & Sedimentation** Investigating how variations in dynamic ocean pressure (measured by tsunami meters) impact regional sedimentation.
Challenges/Technology that EMSO ERIC may provide to support	• Advanced oxygen sensors, long-term monitoring infrastructure, and data integration with global climate models. • High-resolution CTD profiling, autonomous underwater gliders, and real-time sensor networks. • CO_2 flux monitoring systems, real-time satellite data integration, and physical-biogeochemical coupled models.	• High-resolution CTD profiling, autonomous underwater gliders, and real-time sensor networks. • pH and carbonate chemistry sensors, biogeochemical modeling tools, and AI-driven analysis of long-term datasets. • CO_2 flux monitoring systems, real-time satellite data integration, and physical-biogeochemical coupled models. • Passive acoustic monitoring through hydrophones in fyber optical nodes,use of DAS for biodiversity detection, AI-driven bioacoustic analysis, and ecosystem-based modeling. Fecal matter ID and sampling	• Deployment of DAS (Distributed Acoustic Sensing) on underwater fiber-optic cables for continuous pressure monitoring.

Thank you for your attention!

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Observing the ocean to save the earth