Addressing regional variability by monitoring the water column with underwater gliders: examples of SeaExplorer current missions

European Pavilion
Digital Ocean
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2 - 13 JUNE 2025

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How to monitor the Ocean?

Jun 4, 2025

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Laurent BEGUERY

Oceanographic Department Director

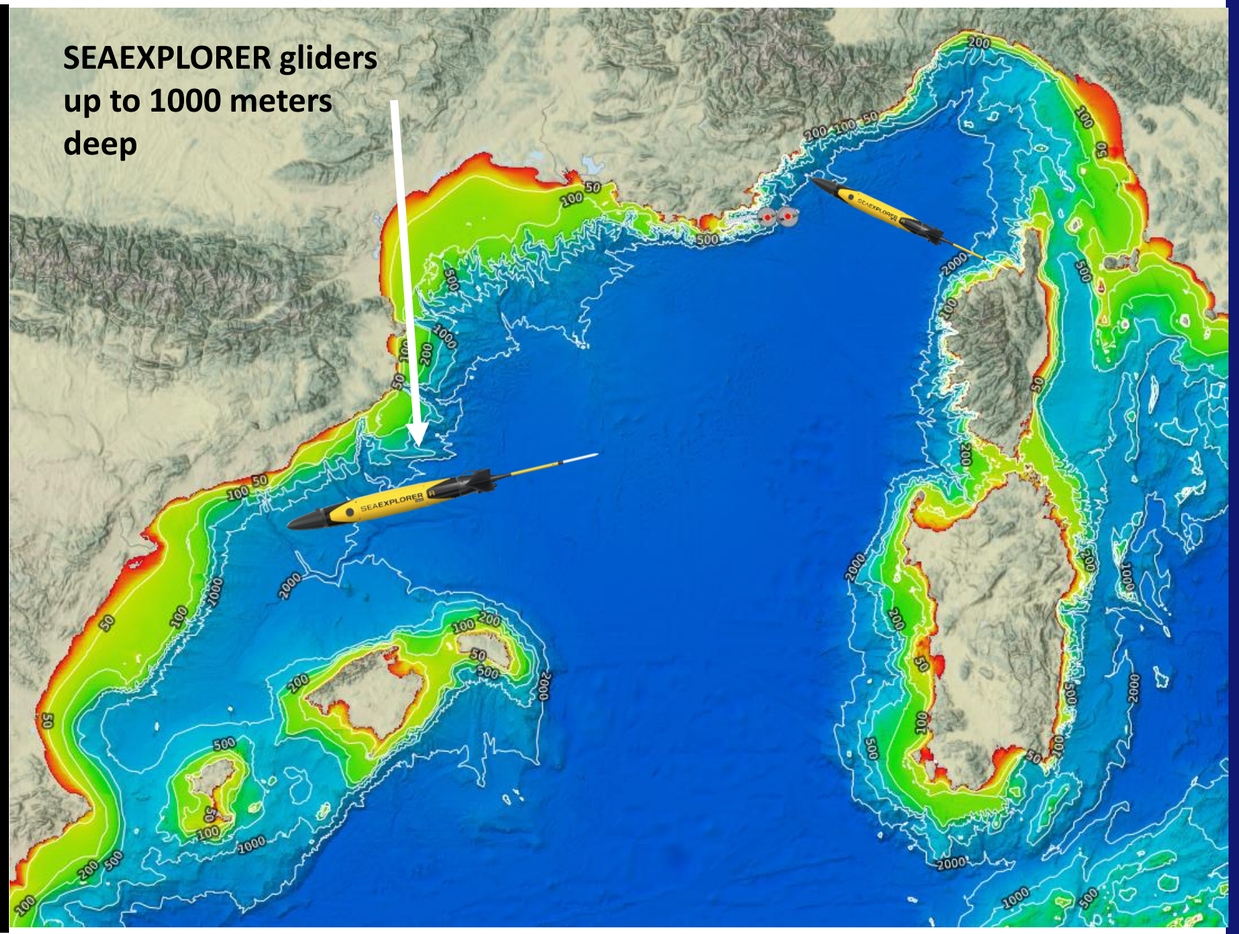
innovation & services at sea

Presenting the

SeaExplorer Glider

GLOBAL SCALE

REGIONAL SCALE



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Presenting the

SeaExplorer Glider

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Studying oceanic

PROCESSES

Providing scientists with reliable and accurate data to decipher the mechanisms of ocean transformation

Piloting an underwater

OBSERVATORY

Operating autonomous underwater observatories to guarantee continuous real-time monitoring of ocean health

Monitoring a wide area with a

FLEET

Producing rapid maps of vast underwater areas to inform development and investment decisions

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PROCESSES

Seasonal evolution of plankton distribution in the Thracian Sea

ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ
DEMOCRITUS UNIVERSITY OF THRACE

Horizon 2020

Iliad

This project has received funding from the European Commission's Horizon 2020 Research and Innovation program under grant agreement No 101037643.

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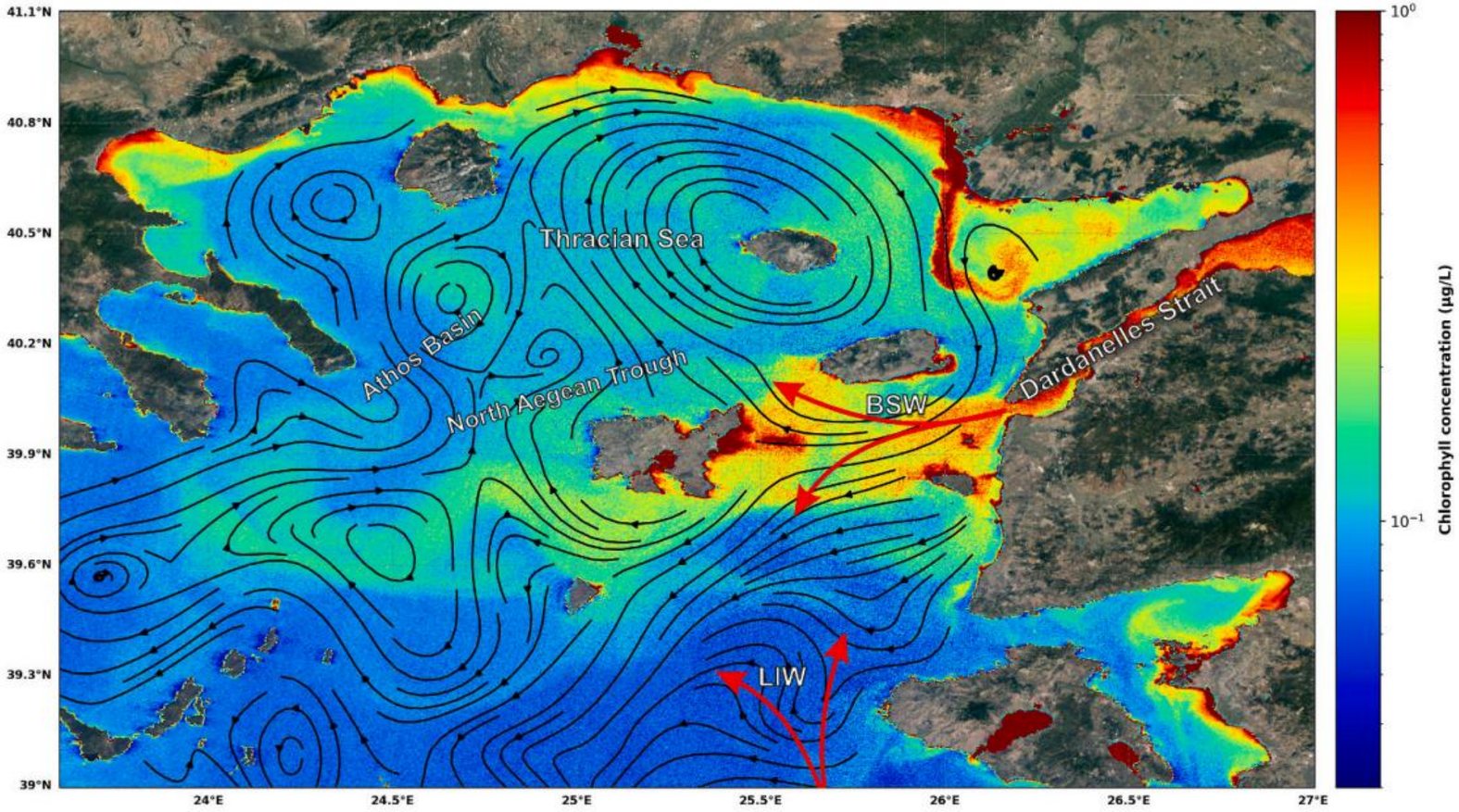
Seasonal evolution of plankton distribution in the Thracian Sea



- Complex and largely undersampled area
- Strong impact of river input

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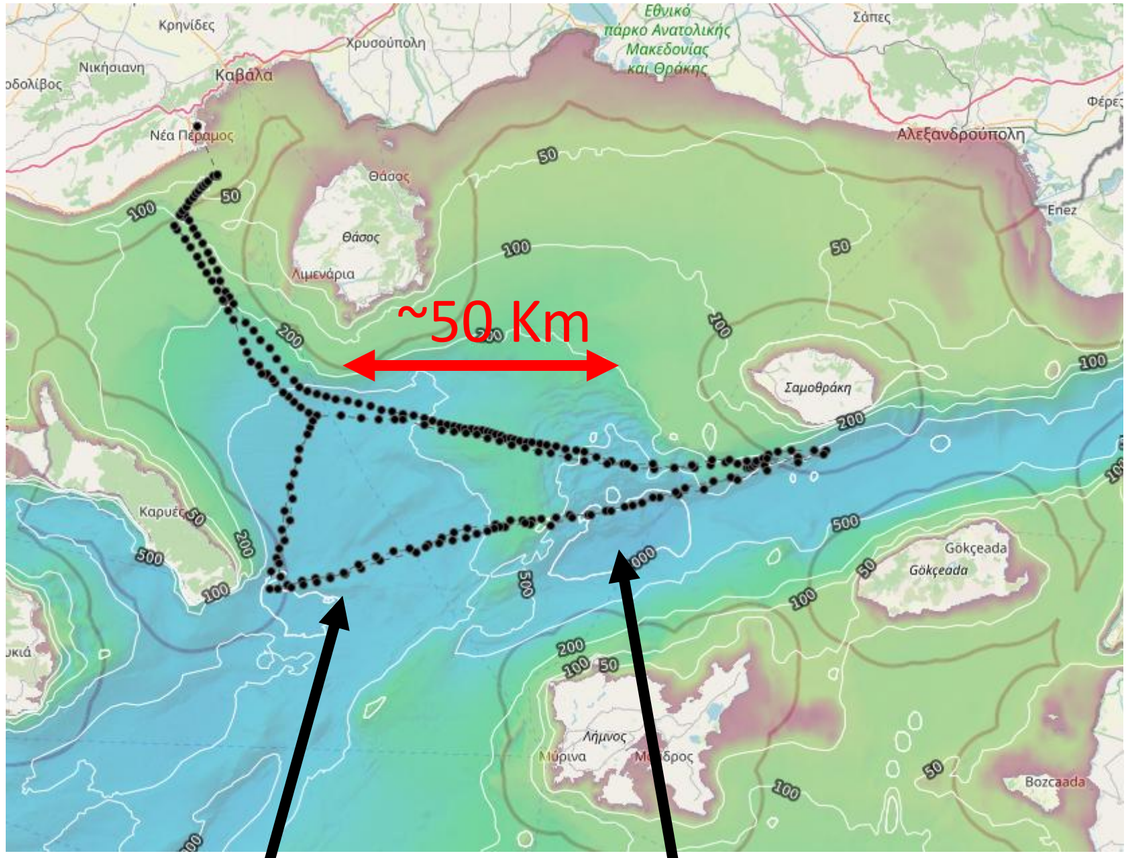
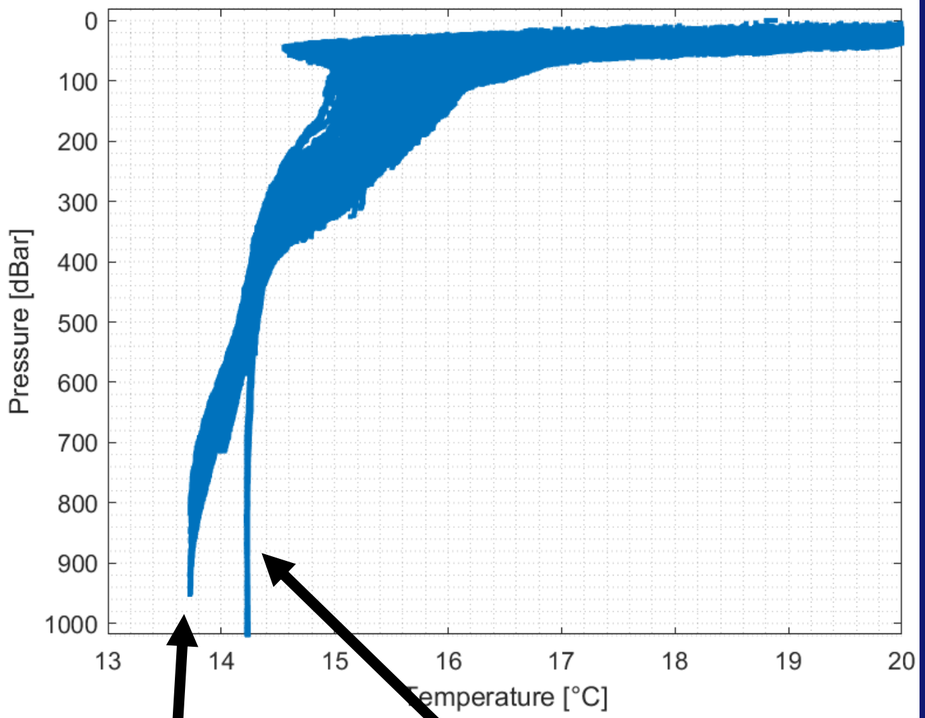
Seasonal evolution of plankton distribution in the Thracian Sea



Athos Basin

Thracien Basin



Athos water

Thracien water

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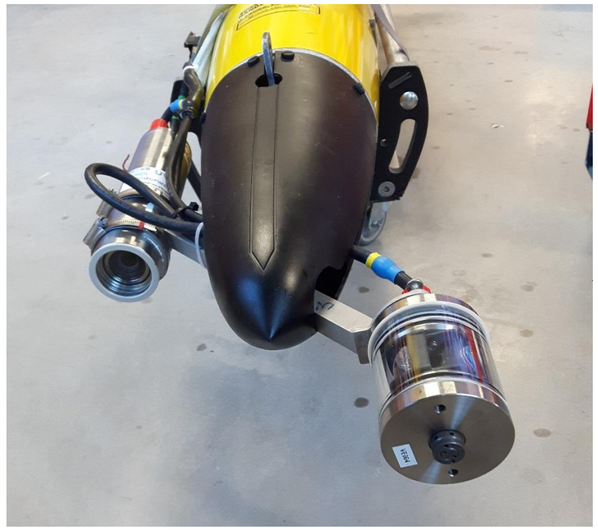
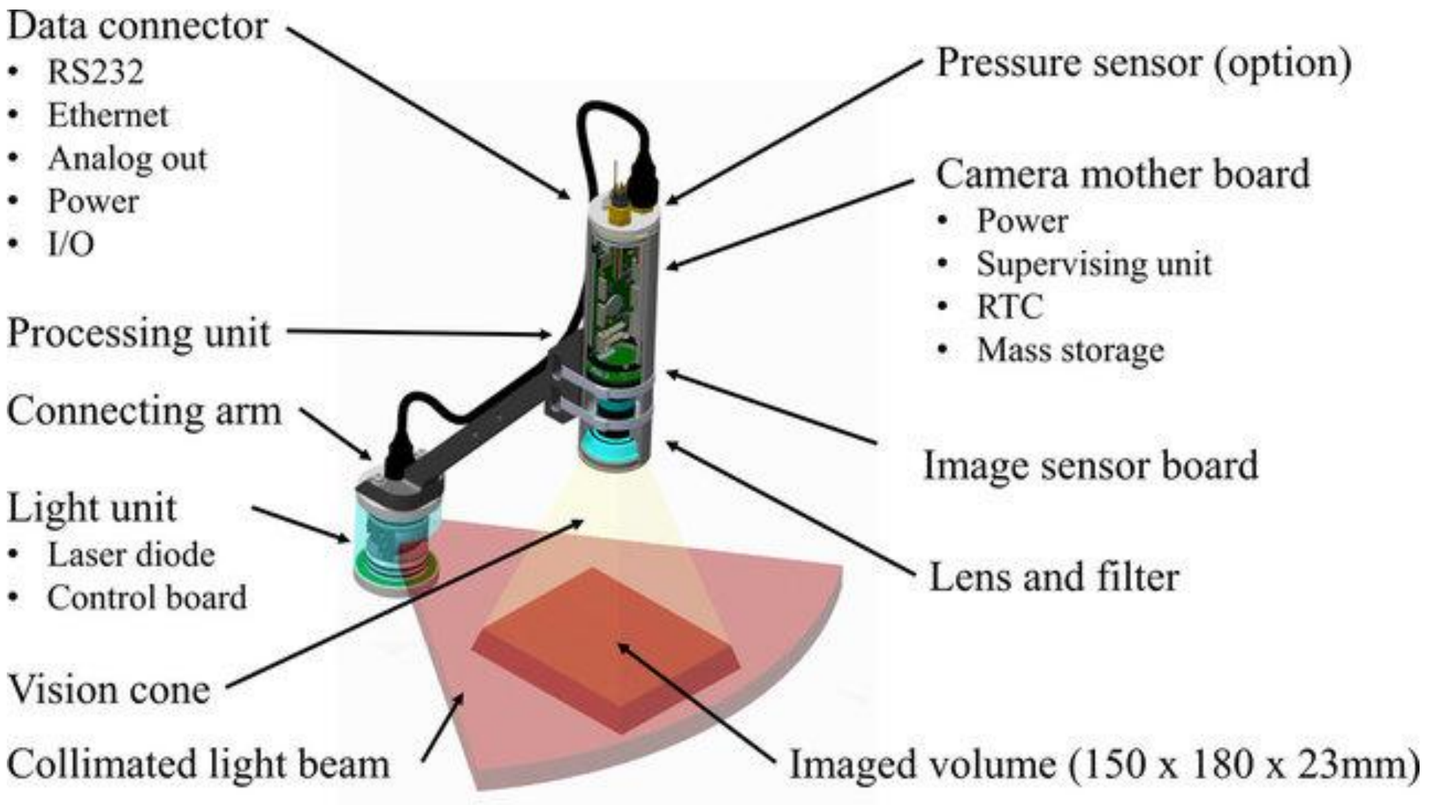
Seasonal evolution of plankton distribution in the Thracian Sea



UVP6 Sensor



For sensor information: http://www.hydroptic.com/

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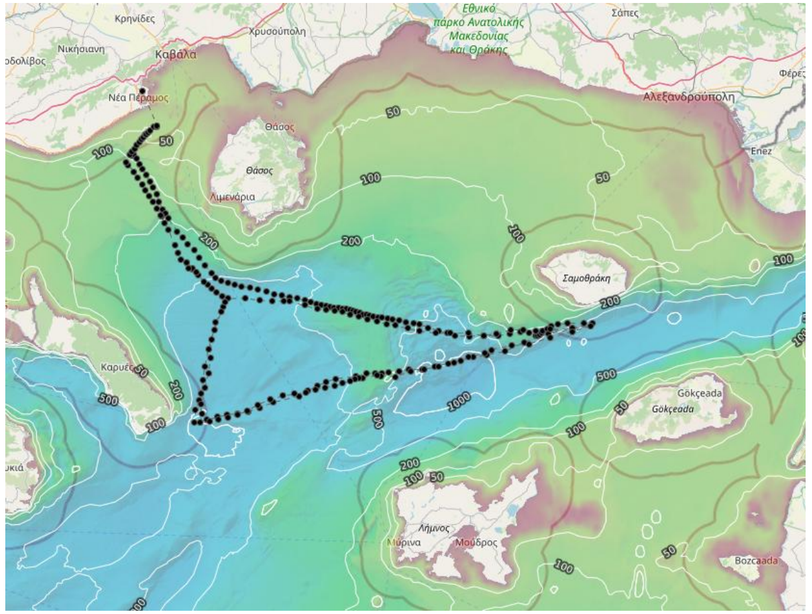
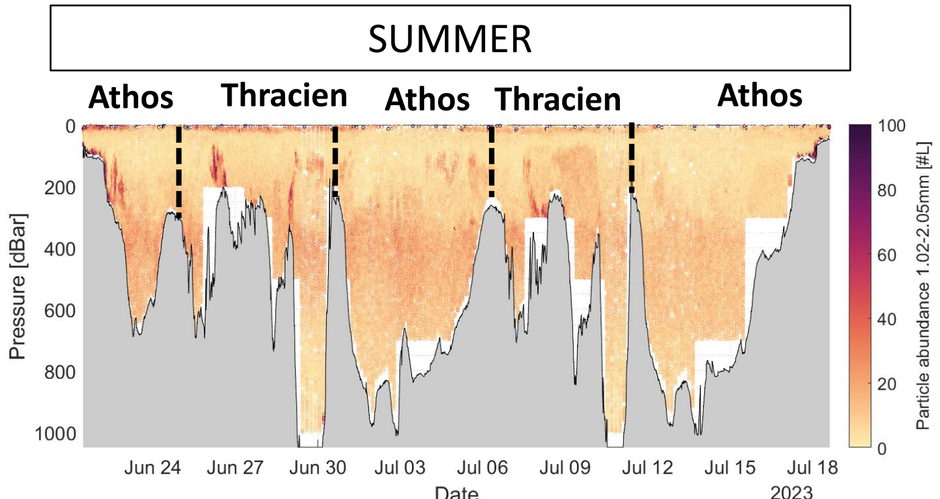
Seasonal evolution of plankton distribution in the Thracian Sea

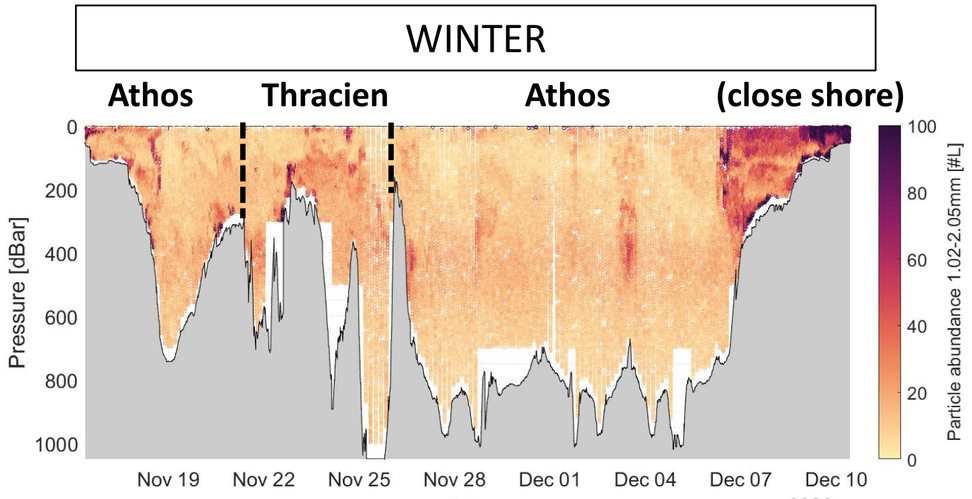
Data provided during the mission every time the SeaExplorer surfaces:

- Gives particles abondance at different sizes.

- The vertical mixing due to underwater bathymetry shows more particles which are probably plankton's signature







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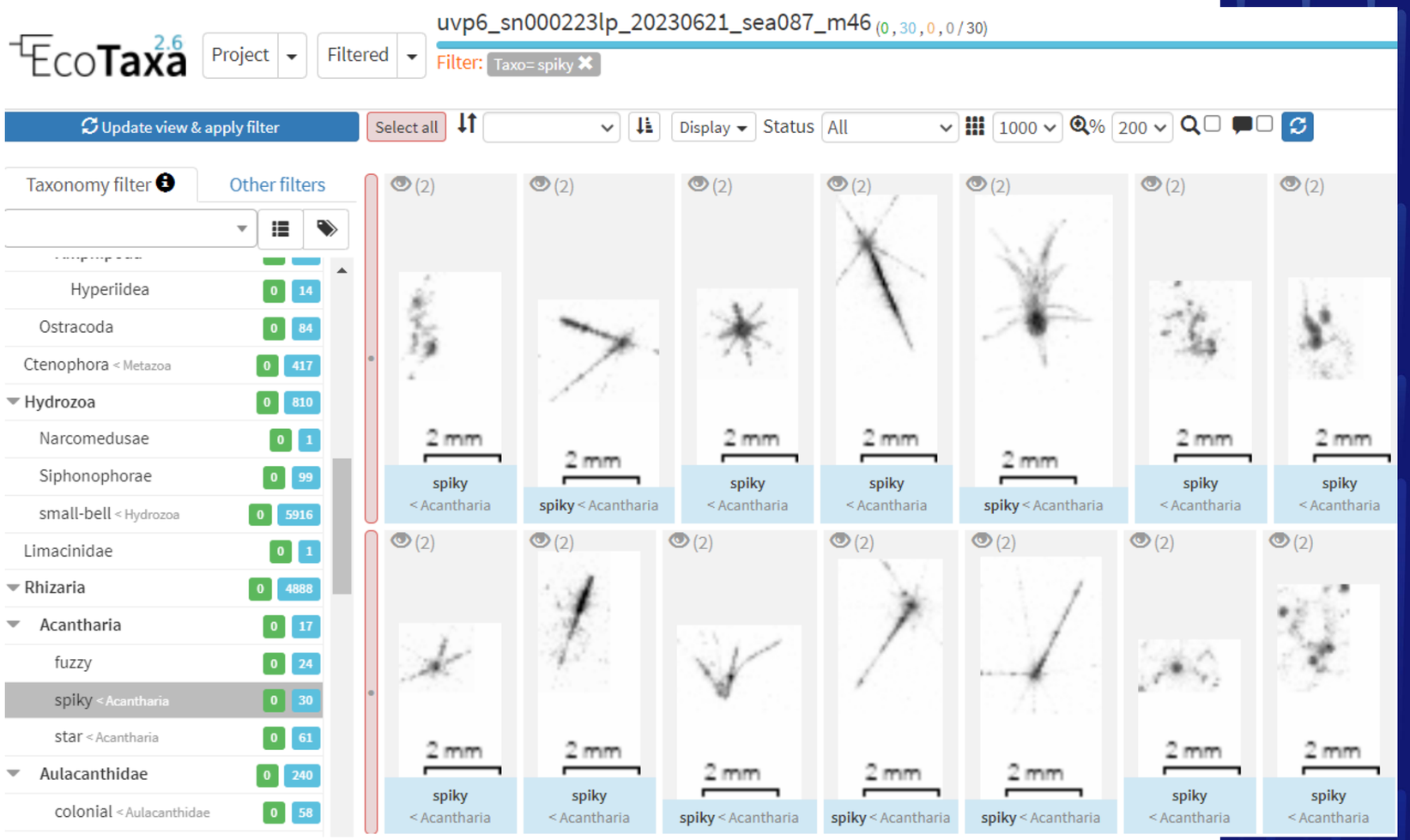
Seasonal evolution of plankton distribution in the Thracian Sea

Data provided after the mission once the UVP6 pictures are retrieved:

- Each picture is analyzed by AI, classifying plakton species based on the work of 800 institutions and 3500 taxonomists



For Ecotaxa information: https://ecotaxa.obs-vlfr.fr/

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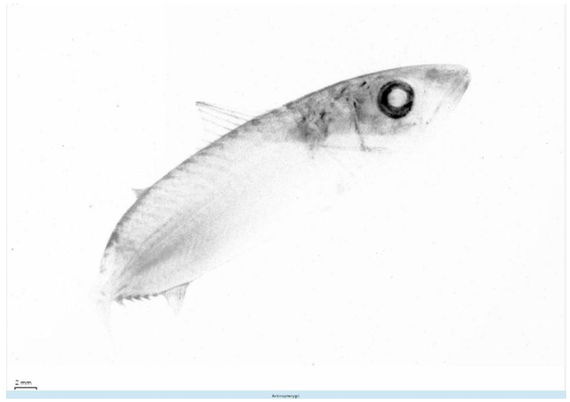
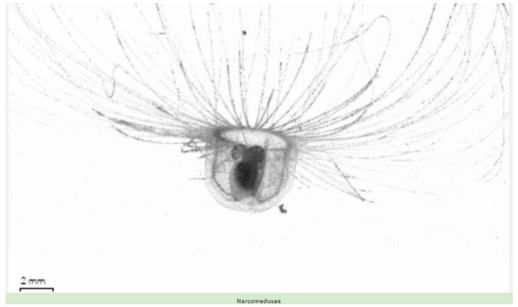
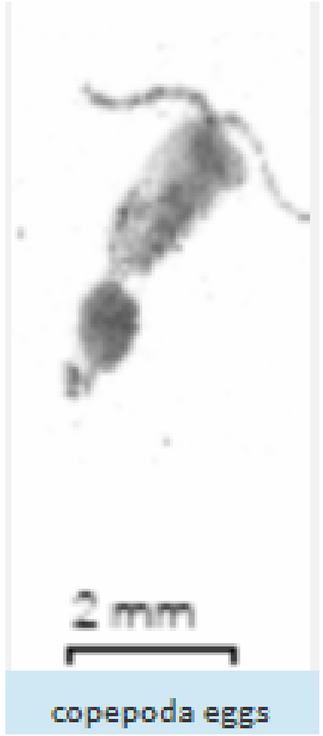
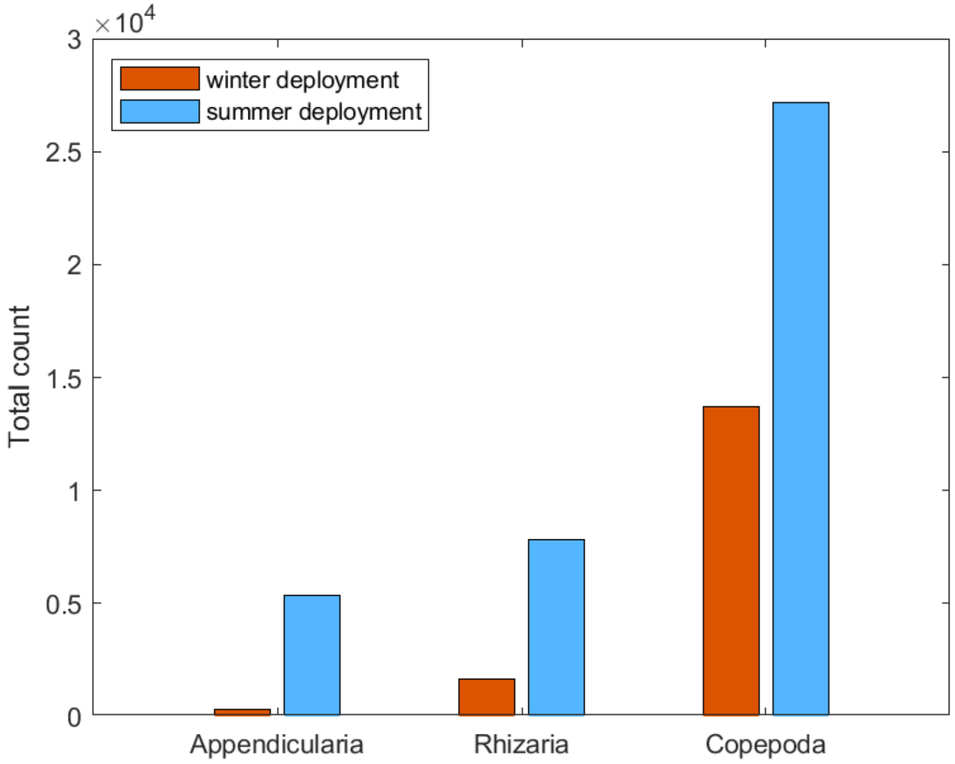
Seasonal evolution of plankton distribution in the Thracian Sea

Main results: After recovery: plankton's species, distribution and abondance can be followed with large data set provided by the glider with UVP6 sensor.









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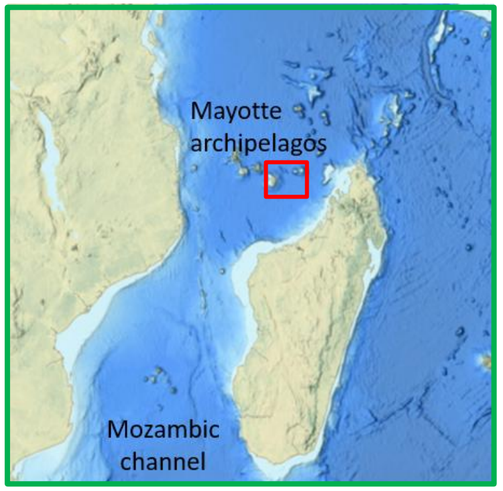
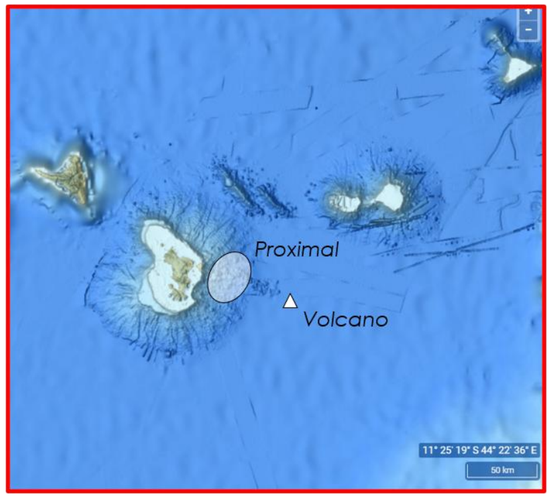
Piloting an underwater

OBSERVATORY

Long term monitoring close to Fani Maore underwater volcano





Data credit: B. Lambrieu and C. Scalabrin IFREMER

REVOSIMA

IPGP

brgm

Ifremer

cnrs

RÉPUBLIQUE FRANÇAISE

REVOSIMA: *doi:10.18715/MAYOTTE.REVOSIMA*
MAYOBS: *doi:10.18142/291*
SeaExplorer: *doi:10.5194/essd-2024-377*

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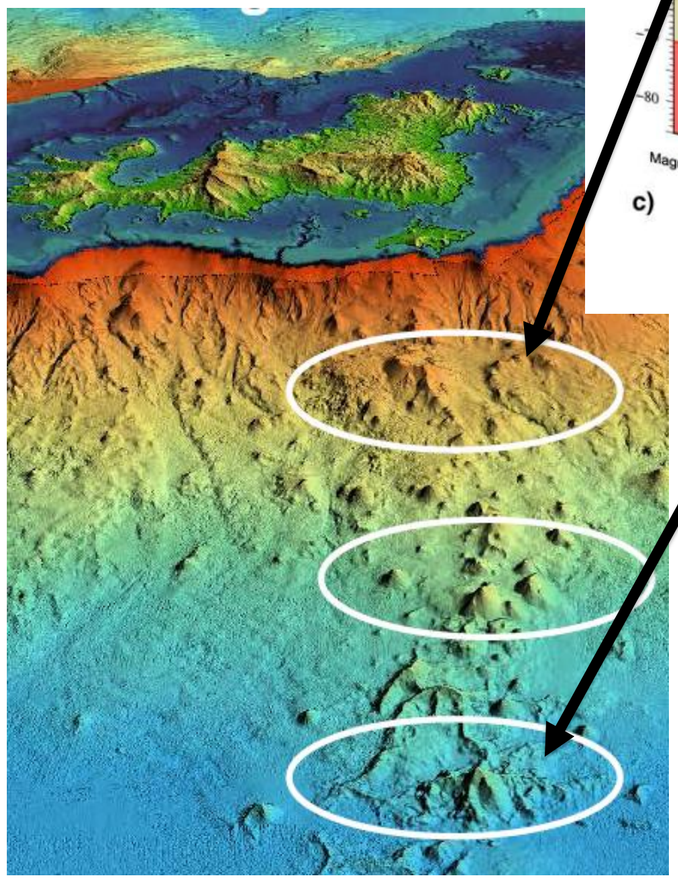
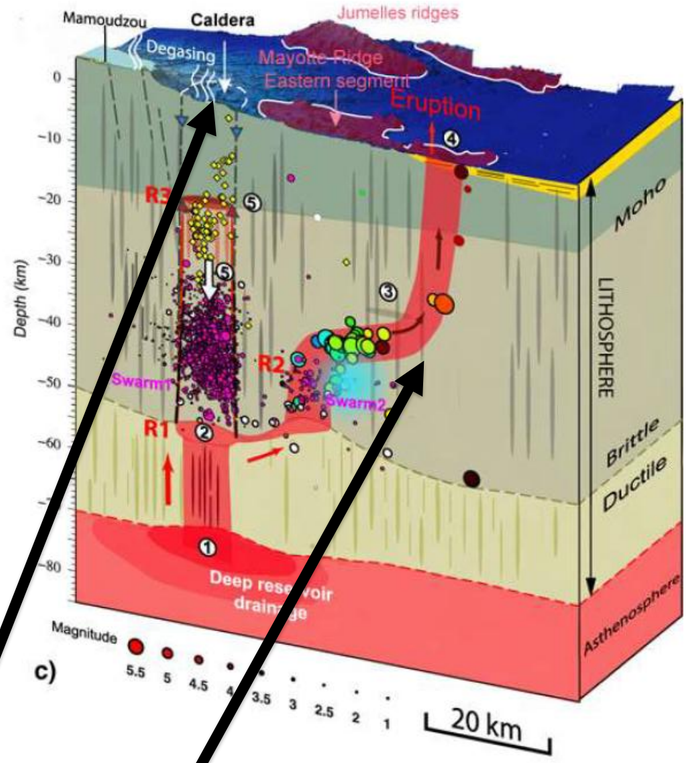
Long term monitoring close to Fani Maore underwater volcano

Regional context

- 2018: seismovolcanic crisis in Mayotte: a volcano is born!
- Creation of the REVOSIMA network in charge of onshore and offshore monitoring (20 MAYOBS scientific cruises)
- 2019 : Discovery of the hydrothermal fluid escape zone
- September2021: SeaExplorer monitoring begins





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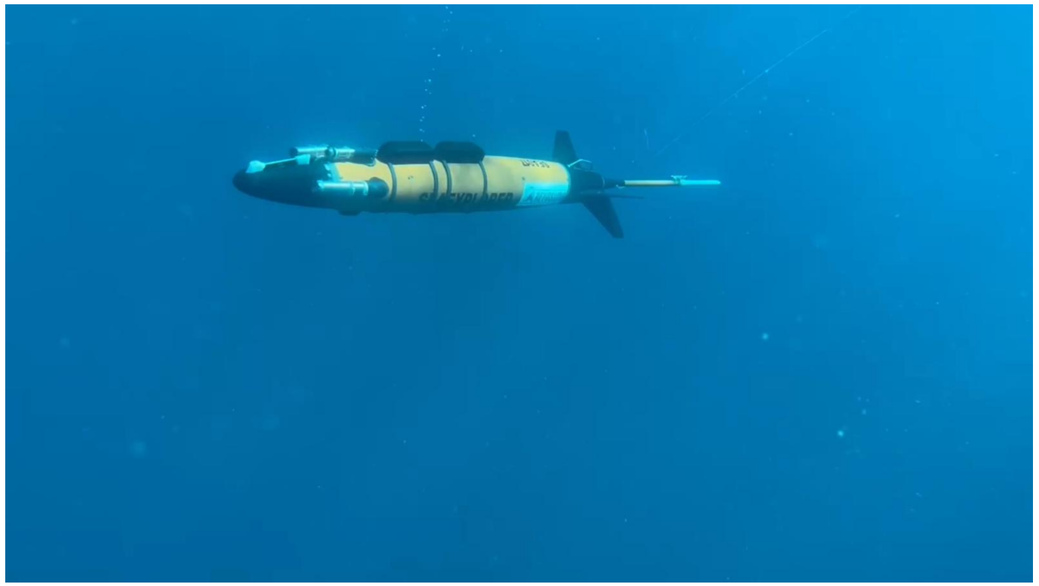

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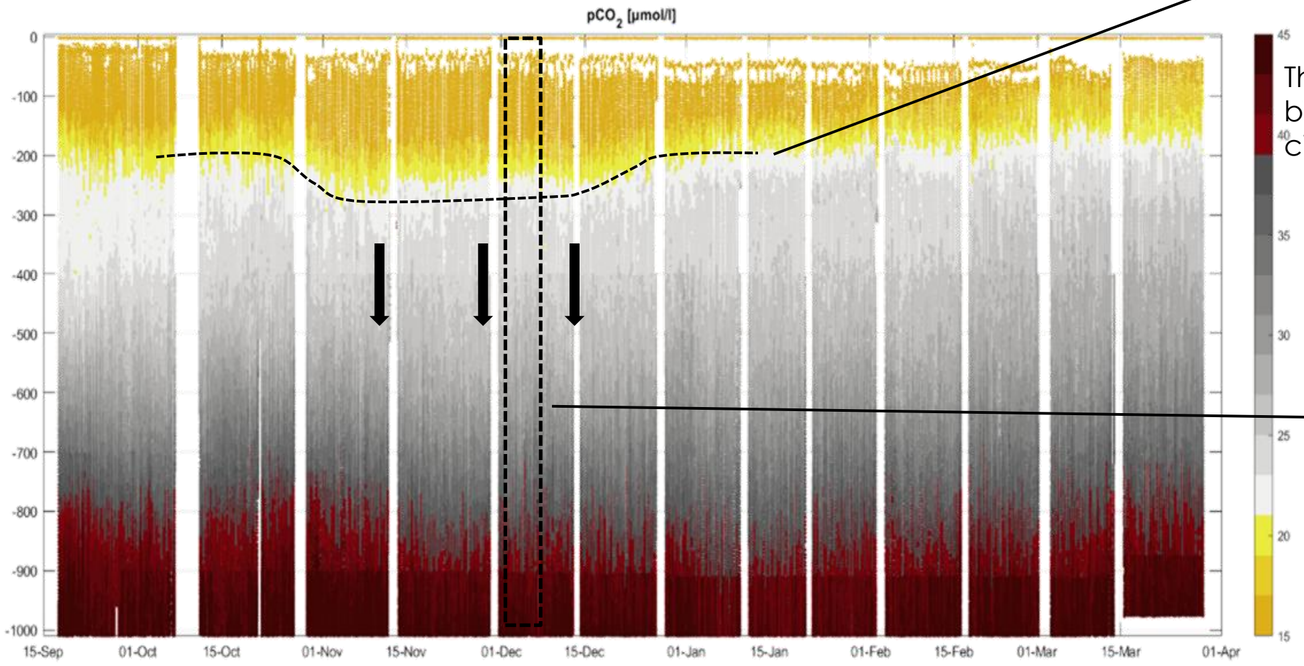
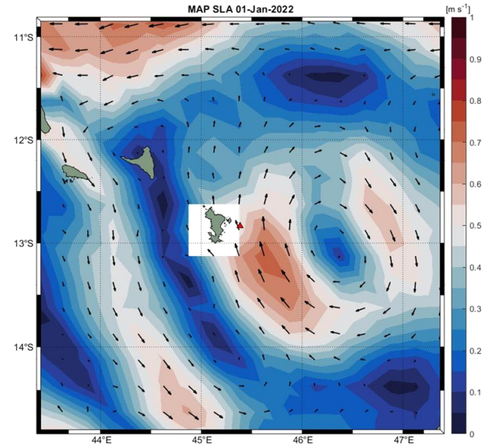
Long term monitoring close to Fani Maore underwater volcano

- CO2 anomalies are extracted from natural CO2 variation
- CH4 anomaly confirms CO2 detection
- Back scatter detections of droplets (liquid dropplet confirmed by ADCP)

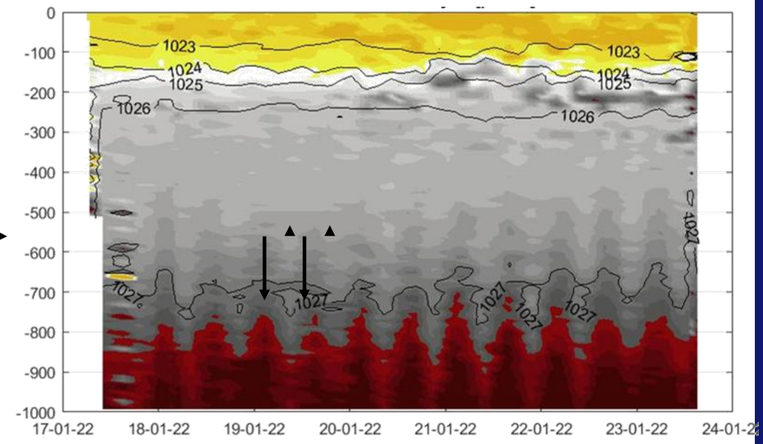
Example of 8 months of monitoring



(*) Data were converted in physical units, TLC, adjusted from drift and QC (**factory calibration**)



The vertical distribution of physical and biogeochemical properties is affected by the circulation (e.g. eddies)



Correlation between CO2 vertical distribution and the semi-diurnal tide (up to 1000m-depth)

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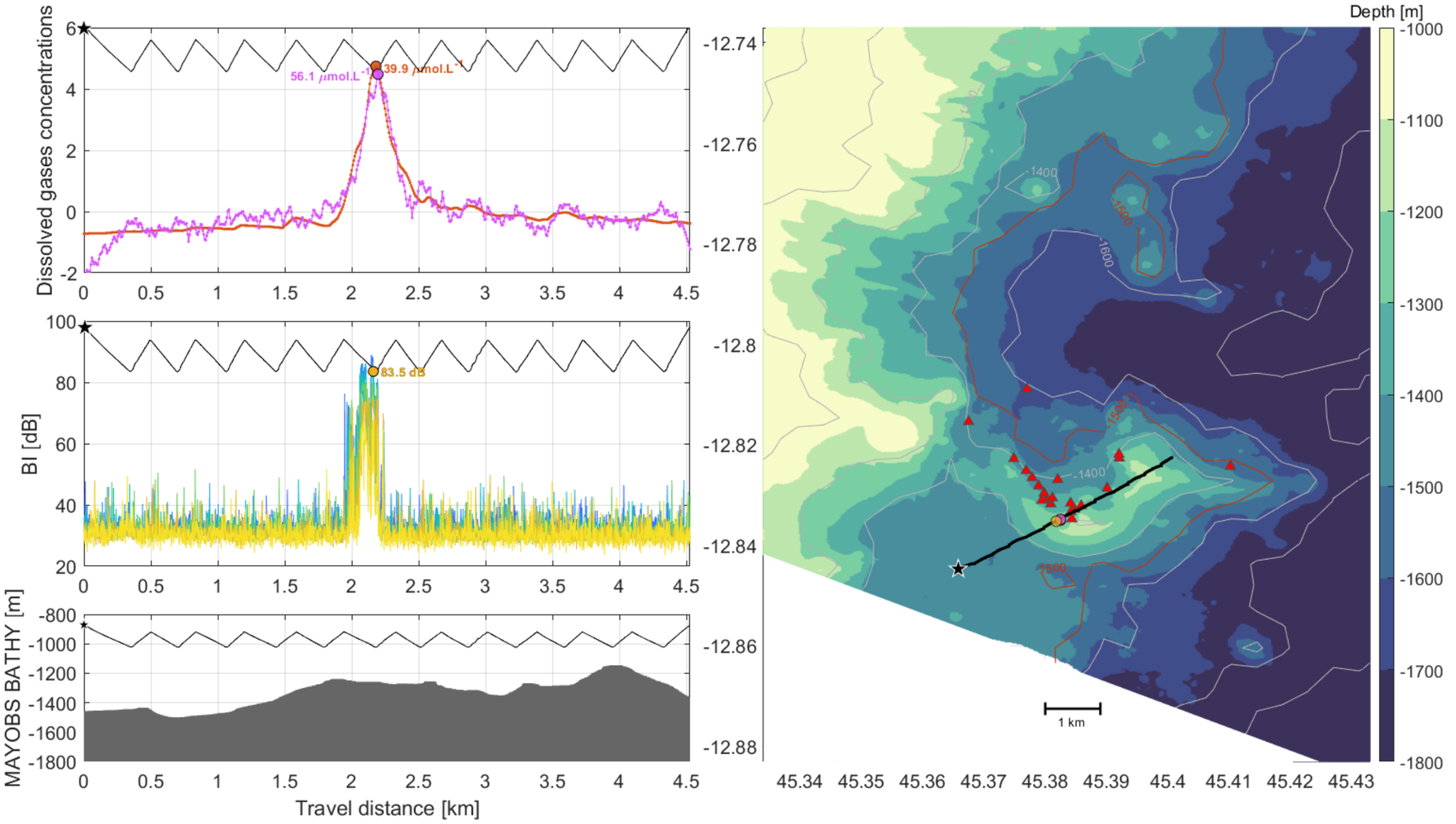

Dissolved gases

Disclaimer : relative values

- CH4
- CO2
- CH4 max
- CO2 max

Backscatter Index

- BI max
- Cell 12
- Cell 10
- Cell 8
- Cell 6
- Cell 4
- Cell 2
- Glider depth 900-1000m

Map legend

- Starting point at 900m
- Active site

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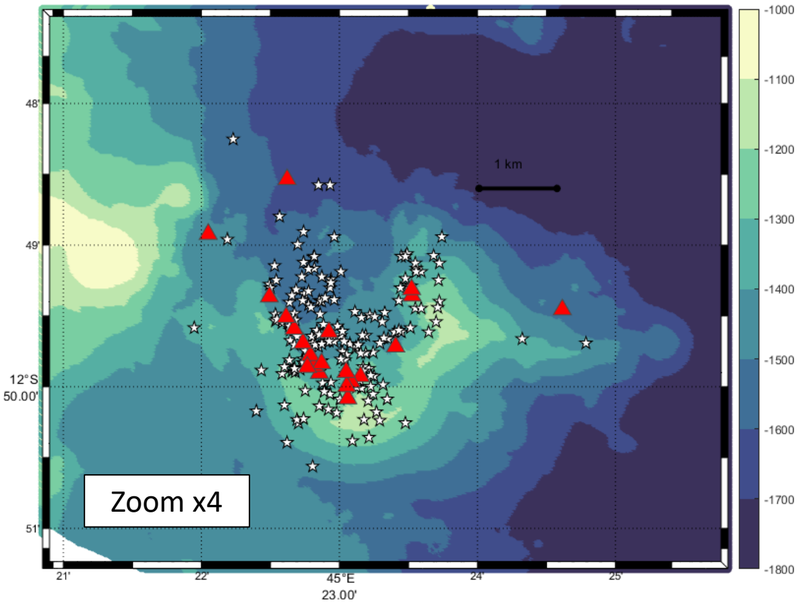
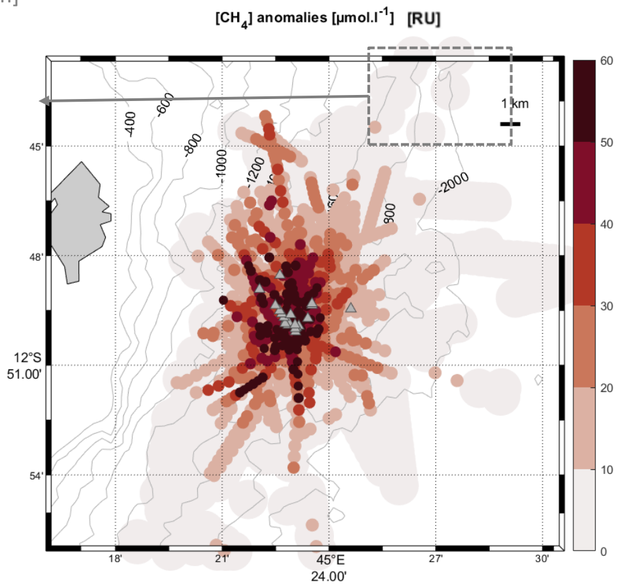
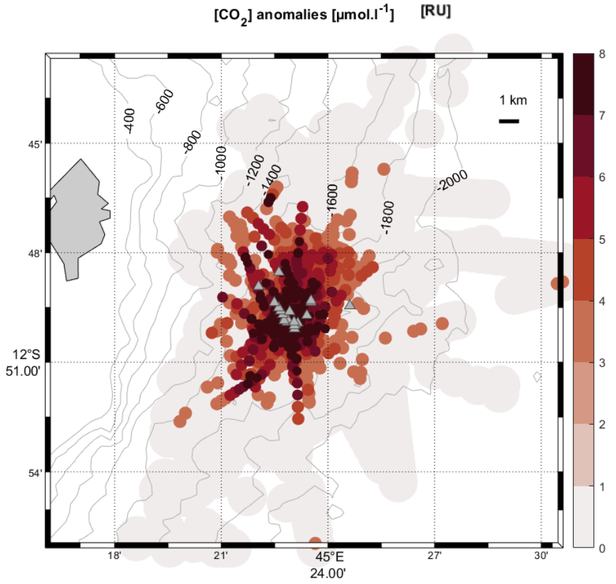
Long term monitoring close to Fani Maore underwater volcano

- Fluids impacts an area greater than 300 km²
- ~ 95 % of anomalies are within 560m from known active area
- Underwater current impact plume dispersion

Acoustic plumes







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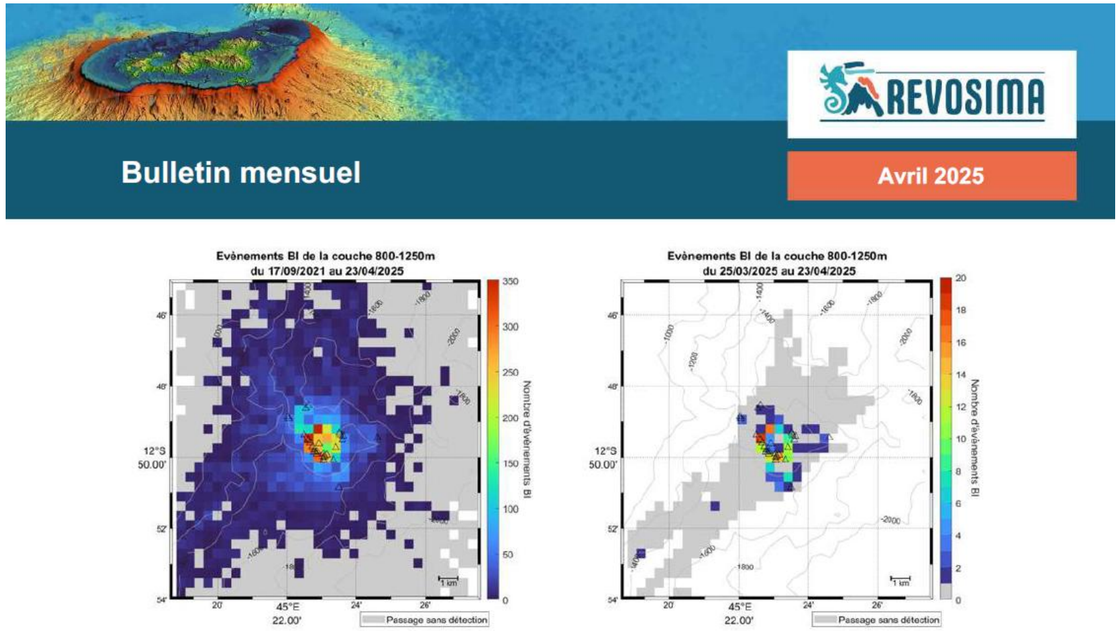

Figure 20 : Cartes centrées sur le Fer à Cheval représentant le nombre d'évènements BI (Backscatter Index) entre 800 et 1250 m de profondeur. A gauche, depuis le début de la surveillance par planeur du 17/09/2021 au 23/04/2025 ; à droite, pour la période du 25/03/2025 au 23/04/2025 (missions 75 à 78). Le maillage est illustré par des cellules carrées mesurant 500 m de côté (0,25 km²). La couleur représente le nombre de d'évènements de BI détectés dans chaque cellule. La bathymétrie est indiquée par des isobathes tous les 200 m. Les triangles noirs correspondent à la position du barycentre des sites actifs d'émissions de fluides déjà répertoriés (Scalabrin, C. (2023), https://doi.org//10.12770/070818f6-6520-49e4-bafd-9d4d0609bf7d).

Main results:

<u>Surveillance Part</u>

The SeaExplorer glider participate to the surveillance of the underwater volcano Fani Maore by providing 24/7 data in the water column from the surface to 1250 meters depth.

This data is presented in the REVOSIMA monthly bulletin.

<u>Scientific knowledge</u>

- A. Heuman, a pHD student at Alseamar, is using this dataset for his doctoral research in collaboration with Ifremer

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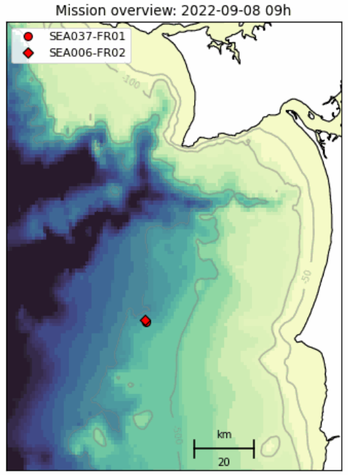
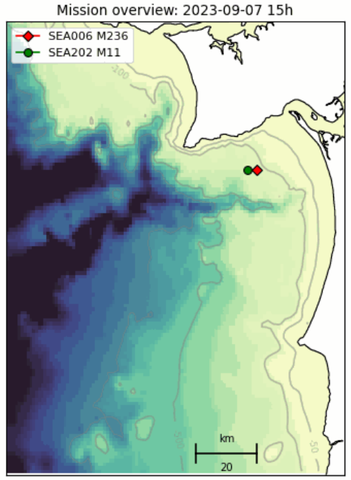
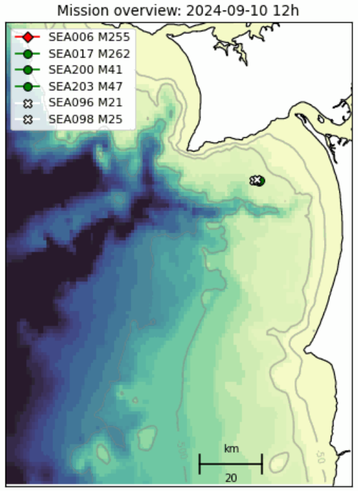
Monitoring a wide area with a FLEET

Participation in the REP(MUS) exercises

- Participation within the REA group in 2021, 2022, 2023, and 2024
- Provision of various types of oceanographic and acoustic payloads
- Demonstrated new features in an operational context
- REP(MUS) 2024 : deployment and recovery of 6 gliders in under 2 hours by the Navy







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Life Project: PIAQUO

Goal 4: detection and localization of sperm whales and fin whales

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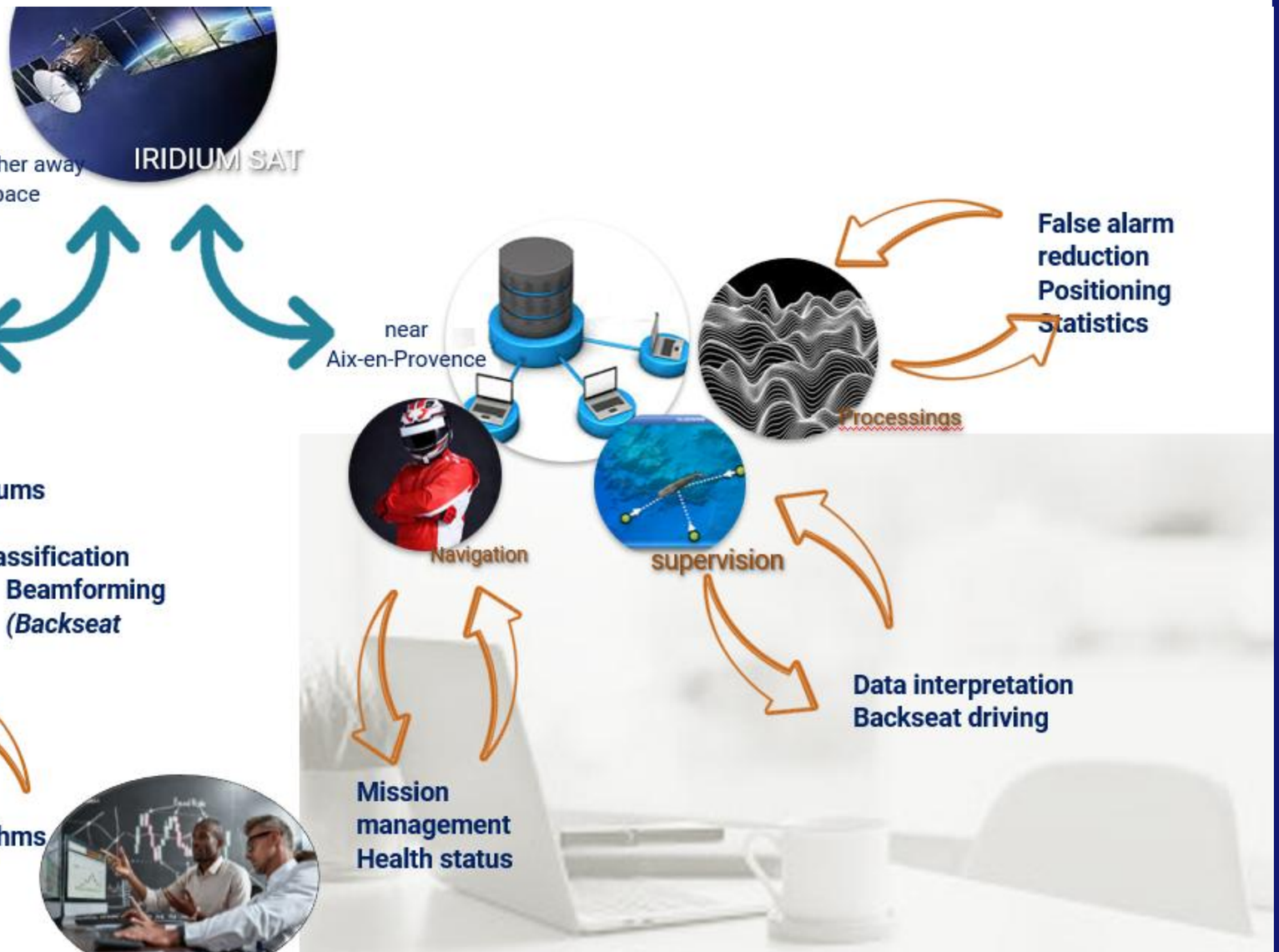
PIAQUO Goal 4: detection and localization of sperm whales and fin whales



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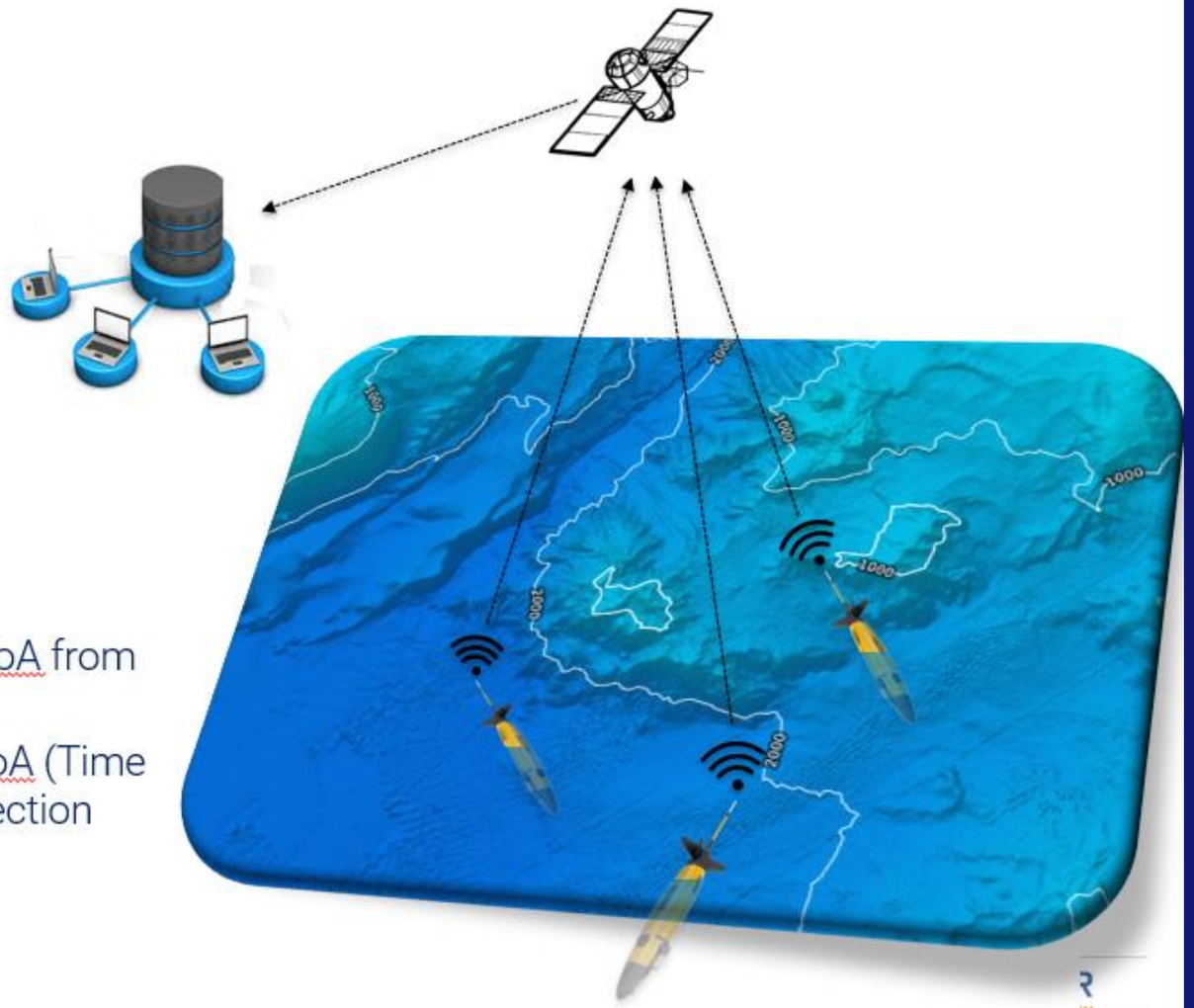
PIAQUO Goal 4: detection and localization of sperm whales and fin whales

SEMI-REAL TIME LOCALIZATION

hyperbolic localization

Cross-bearing localization



- 2 remote localization processing
  - 1 **cross-bearing** algorithm using multiple DoA from embedded beamforming
  - 1 **hyperbolic localization** using multiple TDoA (Time Difference of Arrival) from 20Hz-Pulse detection

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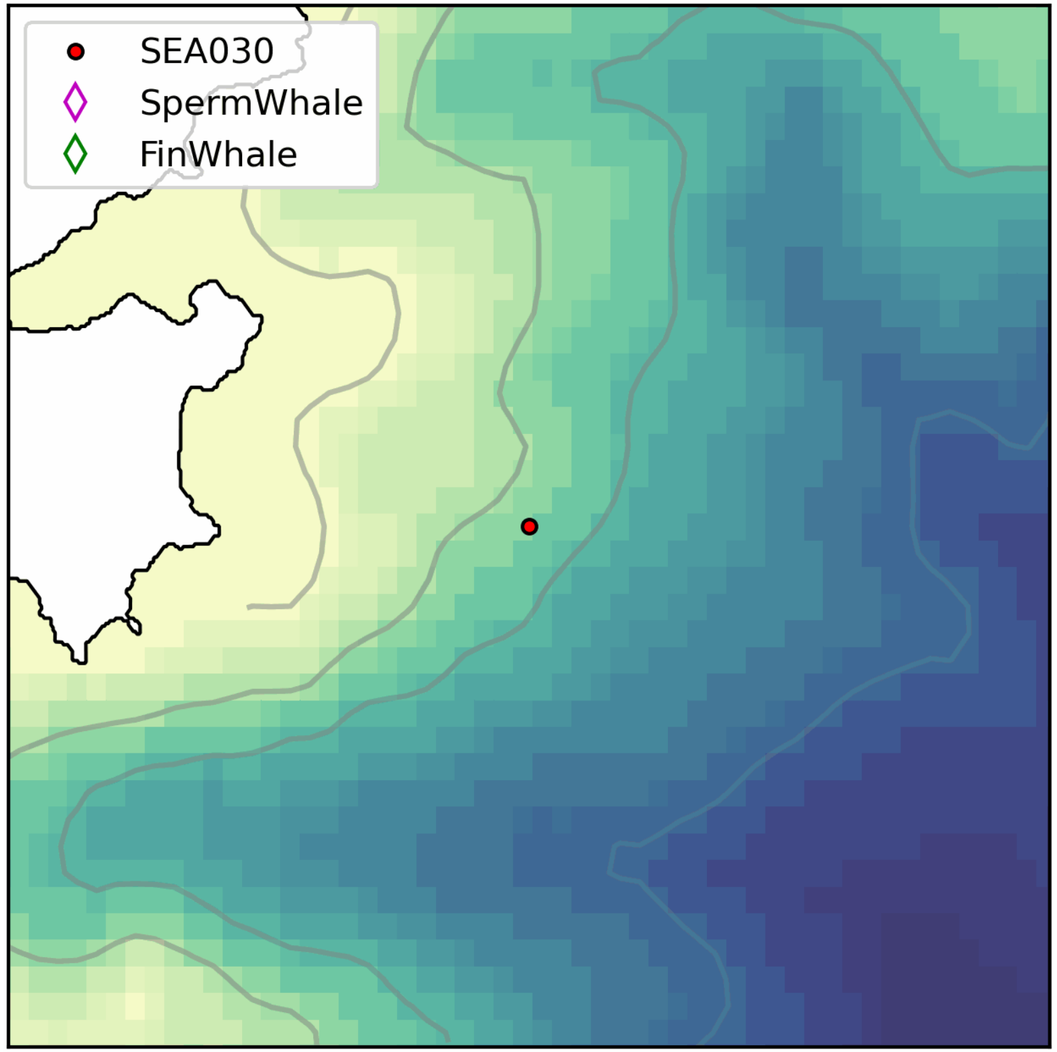
PIAQUO Goal 4: detection and localization of sperm whales and fin whales

Mission overview: 2022-11-02 11h



Main results

The SeaExplorer fleet performed one mission each season between 2022 and 2023

Each mission is
- 350 km long
- Last 20-25 days
- Monitor an area > 5000Km2

Detection and localization of
- Sperm whales (signature: 8 kHz)
- Fin Whales (signature: 20 Hz)

During the last mission, whales positions have been share to ship in the Pelagos sactuary using REPCET® system.

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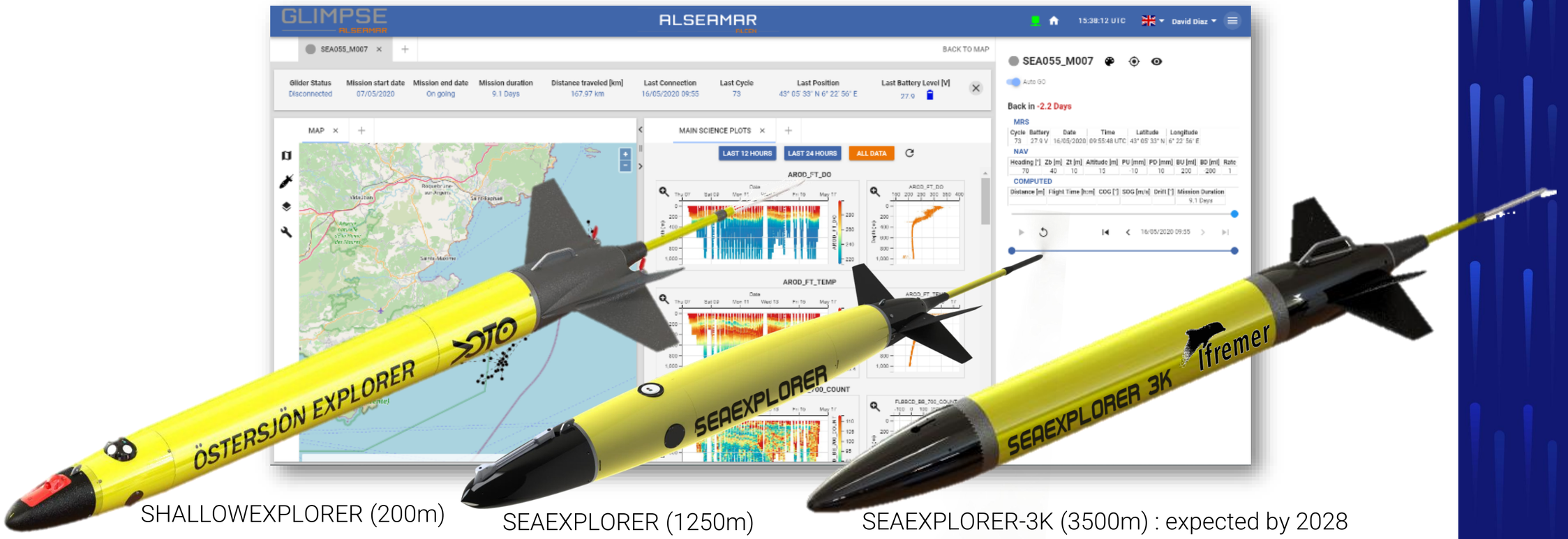
Blue Economy

By providing in-situ data collection services, SEAEXPLORER gliders support informed decision-making, facilitate the monitoring of marine ecosystems, and contribute to the implementation of sustainable management policies.
Various mission scenarios can be conducted, whether for process studies, observatory deployment, or coordinated fleet missions.
The SeaExplorer is available in multiple depth-rated versions and features a modular payload system capable of accommodating a wide range of sensors



SHALLOWEXPLORER (200m)

SEAEXPLORER (1250m)

SEAEXPLORER-3K (3500m) : expected by 2028

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Wide variety of sensors

- Conductivity, Temperature and Depth (CTD)
- Dissolved Oxygen
- pCO2 & CH4
- Fluorescence & Backscatter
- Irradiance
- ADCP & Turbulence Microstructure
- Nitrate, Nitrite, Phosphate, Silicate
- Zooplancton & fish
- Hydrophones & antenna

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Thank you for your attention

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Europe's eyes on Earth

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RESTORE OUR OCEAN & WATERS

Copernicus
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MERCATOR OCEAN
INTERNATIONAL