European Multidisciplinary Seafloor and Water Column Observatory

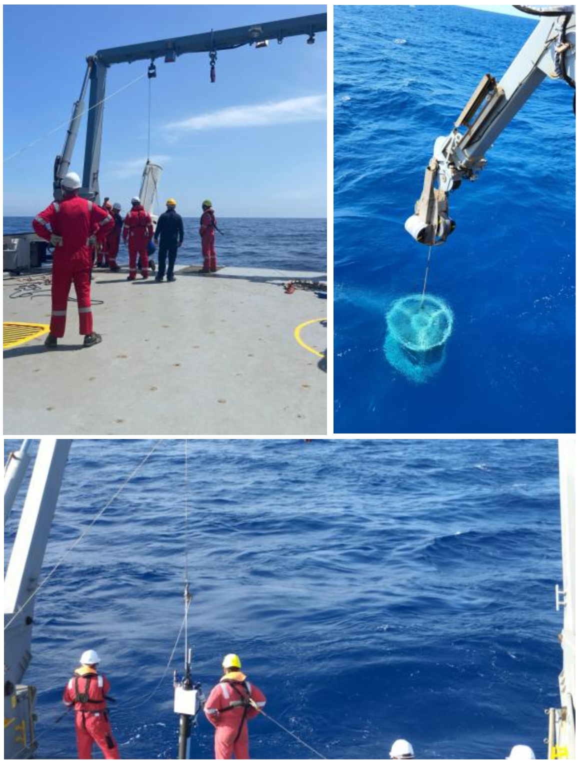
EMSO – SOUTH ADRIATIC REGIONAL FACILITY

Cruise Report

EMSO SA-2025

17-24 May 2025

Francesco Paladini de Mendoza, Leonardo Langone
Carlotta Dentico, Carolina Cantoni, Rocco De Marco



Summary

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Cruise Details

Name	EMSO-SA - 2025
Date	17 - 24 May 2025
Study Area	Southern Adriatic Sea
Project Responsible	Stefano Miserocchi
Head of the cruise	Francesco Paladini de Mendoza
Participant Institutes	CNR - ISP OGS – Oceanography Department CNR – IRBIM CNR – ISMAR
Research Vessel	R/V GAIA BLU
Harbour of Departure	Napoli- Italy
Harbour of Arrival	Ancona - Italy

The EMSO SA-2025 May 2025 survey includes:

- **BB & FF Mooring Maintenance:**
- **CTD casts and Rosette water sampling**
- **Argo floats launch**
- **Test of measurement system for underway acquisitions**

1. Acknowledgement

We would like to extend our sincere thanks to Captain Scotto di Perta Andrea and the crew of the R/V Gaia Blu for their professionalism and invaluable assistance during the mooring recovery and deployment operations. Their dedication and expertise were essential to the success of the campaign, from the meticulous preparation phase to its flawless execution at sea. We also gratefully acknowledge the CNR for providing Gaia Blu ship time for this activity and for partially funding the research (https://www.cnr.it/it/nave-oceanografica-gaia-blu). This cruise was partially supported by the JRU-EMSO Italy and the PNRR-ITINERIS initiative.

2. Scientific and technical crew

Position	*Name*	*Institution*
Party Chief / scientist Mooring and sediment traps maintenance	Francesco Paladini de Mendoza	CNR - ISP
Chief Scientist- Mooring and sediment traps maintenance	Leonardo Langone	CNR - ISP
Scientist/CTD operator	Rocco De Marco	CNR - IRBIM
PhD Student / Carbonatic system, biochemical measurements	Carlotta Dentico	OCE - PHYS
Scientist / Carbonatic system, Ferry box measurements	Carolina Cantoni	CNR - ISMAR

Table 1.- *Scientific Crew*

Figure 1.-*Part of Scientific and Technicians and ship crew participating to the EMSO SA - 2025 Cruise*

3. Scientific Background

Since 2021, observation sites in the southern Adriatic have been integrated into the EMSO-ERIC consortium (European Multidisciplinary Seafloor and Water Column Observatory - European Research Infrastructure Consortium) and form the Southern Adriatic Regional Facility, which consists of the sites BB and FF (CNR-ISP) and E2M3A (OGS-Trieste). Furthermore, these sites have been included in the PNRR-ITINERIS project (WP5 Marine Domain), whose aim is to implement the Italian Integrated Ocean Observing System (IOOS) to address the major challenges of the Ocean Decade and Mediterranean Sea.

The main objective of EMSO ERIC is to provide quality-controlled data, qualified information and knowledge based on the continuous monitoring of environmental processes in EMSO's regional facilities. EMSO is a distributed European research infrastructure that enables long-term and real-time monitoring of oceanic processes through a system of regional facilities at key European marine sites from the Northeast Atlantic to the Mediterranean and Black Sea, equipped with multidisciplinary sensors to measure physical and biogeochemical parameters related to natural hazards, marine ecosystems and climate change.

The southern Adriatic is a cascading area for NAdDW, the dense shelf water that forms in the northern Adriatic, and is also a site for the formation of dense water by convection in the open sea (ADW). In recent years, the role of NAdDW cascading events in the transfer of sediments, organic matter and nutrients to deep benthic communities, as well as the production of a wide range of bottom features on the continental slope or at its base, has been investigated. In the winter of 2012, the northern Adriatic Basin experienced an exceptional cold spell that promoted the formation of particularly dense shelf water. Using an integrated approach that included oceanographic campaigns, the deployment of three additional instrumented moorings (which are still active) and modelling simulations, an experiment was quickly set up. A great deal of information was obtained on the characteristics and amount of newly formed DSW, as well as its pathways and transfer times into the southern Adriatic.

The southern Adriatic is also the area of origin of the intermediate/deep thermohaline cell of the eastern Mediterranean. Scientific interest in this area has increased considerably since the discovery of the circulation mechanism known as BiOS (bimodal oscillating mechanism, Civitarese et al., 2023). Under this mechanism, the Ionian circulation undergoes a cyclic reversal on a ten-year scale caused by the reversal of the centre-to-centre density gradient due to a change in the thermohaline properties of the dense water produced in the southern Adriatic. Considering the influence of this mechanism on the thermohaline properties of the eastern Mediterranean, the continuous monitoring of the characteristics of this area by the EMSO-E2M3A oceanographic REGIONAL FACILITY and hydrological cross-section (Bari-Dubrovnik transect) is of great scientific importance. Moreover, the dynamics associated with the formation of dense water is important in itself, as it affects the biogeochemical and biological function of the basin and its ability to capture atmospheric CO_2.

Currently, the system is part of the European contribution to the OceanSITES Global Array (www.oceansites.org) and is also part of the EMSO (https://emso.eu/observatories-node/south-adriatic-sea/) and ICOS ESFRI infrastructures.

4. Objective of the cruise

Continuing the collection of time series from the moorings is crucial for monitoring the long-term evolution of the cascading process of North Adriatic Dense Water (NAdDW) in the northwestern sector of the Apulian margin off the Gargano promontory and within the Bari Canyon. In these regions, the outflow of NAdDW has been documented through CTD profiles and current measurements. The EMSO-SA 2025 campaign is designed to investigate mesoscale variability in both hydrological and biogeochemical conditions, while also maintaining fixed observation sites to ensure the continuity of long-term oceanographic and biogeochemical time-series.

During the EMSO-SA2025 cruise, the following scientific activities were planned:

1. **Recovery, maintenance, and redeployment of oceanographic moorings**
2. **CTD-Rosette casts**
3. **Deployment of biogeochemical (BGC) Argo floats**
4. **Set up, testing and operation of an underway system for the study of carbonate system**

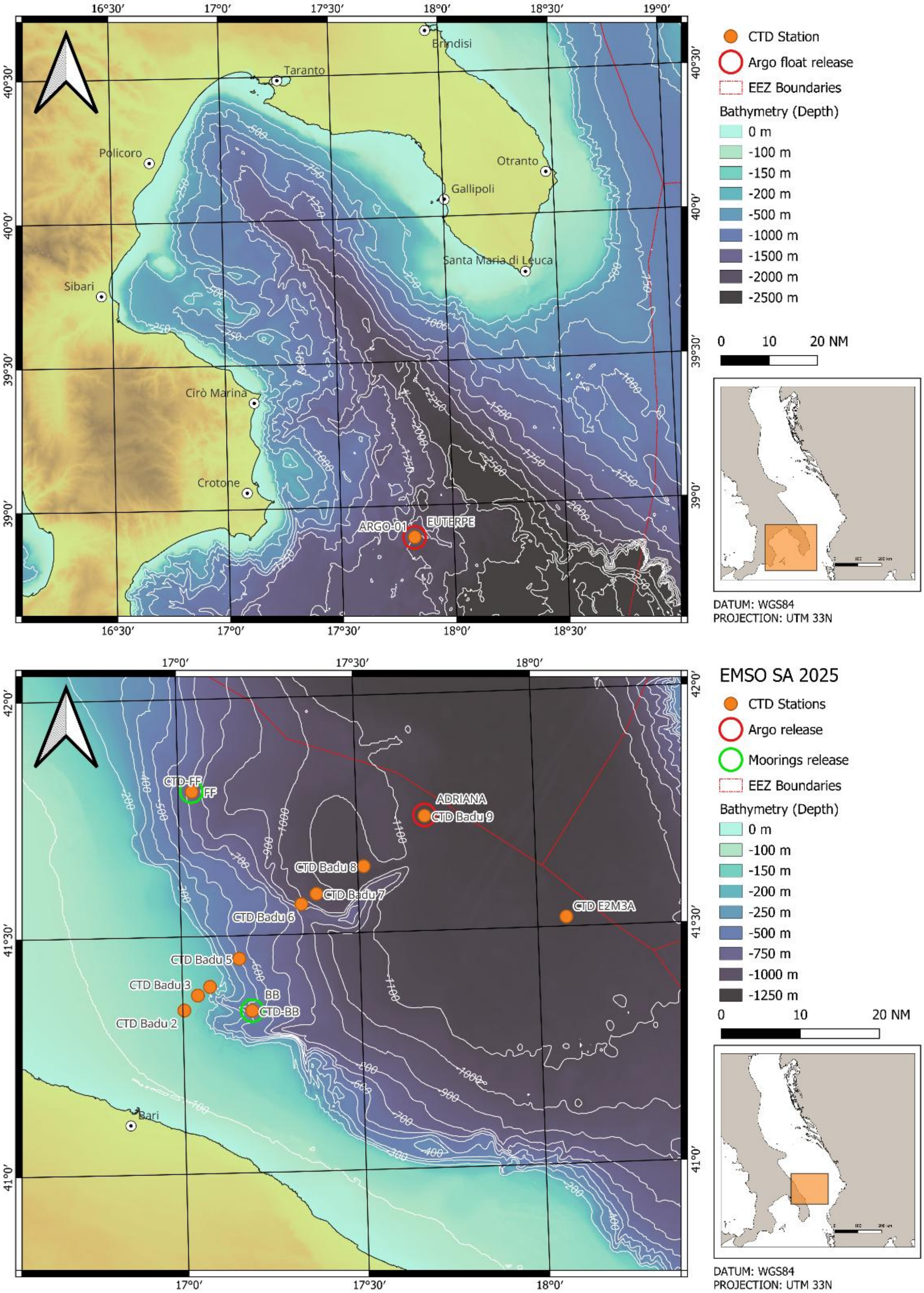


Figure 2.- *Work area of the EMSO SA-2025 oceanographic campaign*

5. Bridge timetable of events

Date	Activity
16/05/2025	Embark of personnel (Paladini, Langone, Dentico, De Marco, Cantoni) between 11:00 and 21:30
17/05/2025	Leaving Napoli
18/05/2025	CTD cast on ARGO 01 and launch of BGC-Argo float
19/05/2025	Underway measurements with Ferry Box
19/05/2025	CTD casts on BB and Recovery mooring BB
19/05/2025	CTD casts on FF and Recovery mooring BB
20/05/2025	Underway measurements with Ferry Box
20/05/2025	CTD casts along Bari Dubrovnik transect and launch of BGC-Argo float
21/05/2025	CTD casts on E2M3A
22/05/2025	Deployment of mooring BB and CTD casts on BB
22/05/2025	Deployment of mooring FF and CTD casts on FF
23/05/2025	Underway measurements with Ferry Box
23/05/2025	Transit to Ancona

N.B.: *UTC times*

WD *= water depth*

<u>Friday 16/05/2025</u>

Embark of CNR-ISP, ISMAR, IRBIM and OGS personnel in Napoli port between the 11:00 and 21:30. Moderate Wind and sunny weather.

Saturday 17/05/2025

10:00 Departure from the Napoli port

13:00 Safety and Security rules presented by ship crew members and general emergency drill

13:30 Transit to ARGO01

23:59 Transit to ARGO01

Sunday 18/05/2025

12:00 Toolbox talk for CTD and ARGO FLOAT launch procedure

13:40: Start CTD cast: (38°53.3960'N 17°49.5013 E).

13:20: End downcast, position: (38°53.3960'N 17°49.5013 E), start upcast, depth= 600m, 24 Niskin bottles closed at 600m

13:25 End Cast, water sampling.

14:00 **Preparation of BGC ARGO-DEPLOYMENT**

15:20 Launch of EUTERPE ARGO-FLOAT at: (38°53.329' N 17°49.458'E).

15:30 Start Transfer toward BB

23:59 Transfer toward BB

Monday 19/05/2025

00:01 Transfer toward BB

06:30 Toolbox talk for CTD and mooring deployment procedure

07:50 Arrival at BB site, good weather

08:05 Release mooring BB

08:10 mooring at surface

08:15 Start mooring recovery

10:20 Mooring BB recovery completed

10:25 Moving to CTD BB site for CTD cast

11:03 Start CTD cast (41°20.471'N 17°11.614'E 604 m depth)

11:25 End downcast position (41°20.471'N 17°11.614'E 604 m depth), start upcast 13 Niskin bottles closed at different depths

11:30 Moving to FF mooring site

15:00 Arrival at FF site, good weather

15:21 Release mooring FF

15:28 mooring at surface

15:40 Start mooring recovery

16:50 Mooring FF recovery completed

17:00 Moving to CTD FF site for CTD cast

19:03 Start CTD cast (41°48.32N 17°02.33'E 740m depth)

19:35 End downcast position (41°48.32N 17°02.33'E 740m depth), start upcast 6 Niskin bottles closed at different depths

Tuesday 20/05/2025

06:00 Toolbox talk for CTD and Argo Float launch procedure

06:20 **Arrival at BADU02**

06:25 Start CTD cast (41°48.32N 17°02.33'E 133m depth)

06:28 End downcast position (41°48.32N 17°02.33'E 133m depth), start upcast 2 Niskin bottles closed at different depths

07:05 **Arrival at BADU03**

07:10 Start CTD cast (41°22.56'N 17°02.57'E 152m depth)

07:14 End downcast position (41°22.56'N 17°02.57'E 152m depth), start upcast

08:05 **Arrival at BADU04**

08:10 Start CTD cast (41°23.62'N 17°04.64'E 173m depth)

06:28 End downcast position (41°23.62'N 17°04.64'E 173m depth), start upcast 2 Niskin bottles closed at different depths

09:40 **Arrival at BADU05**

09:45 Start CTD cast (41°27.09'N 17°09.66'E 502m depth)

09:54 End downcast position (41°27.09'N 17°09.66'E 502m depth), start upcast

11:25 **Arrival at BADU06**

11:30 Start CTD cast (41°33.79'N 17°20.34'E 960m depth)

11:45 End downcast position (41°33.79'N 17°20.34'E 960m depth), start upcast 2 Niskin bottles closed at different depths

12:35 **Arrival at BADU07**

12:40 Start CTD cast (41°35.04'N 17°22.92'E 1072m depth)

13:20 End downcast position (41°35.04'N 17°22.92'E 1072m depth), start upcast

15:25 **Arrival at BADU09**

15:30 Start CTD cast (41°44.50'N 17°41.51'E 1119m depth)

16:10 End downcast position (41°44.50'N 17°41.51'E 1119m depth), start upcast

16:15 **Preparation of BGC ARGO-DEPLOYMENT**

17:03 Launch of ADRIANA ARGO-FLOAT at: (41°44.60'N 17°41.51'E).

18:33 **Arrival at BADU08**

18:38 Start CTD cast (41°44.50'N 17°41.51'E 1195m depth)

19:25 End downcast position (41°44.50'N 17°41.51'E 1195m depth), start upcast 10 Niskin bottles closed at different depths

19:30 Rosette on ship

Wednesday 21/05/2025

06:00 Stand-by meteo due to bad weather, strong wind 30-35knt and 1.5 – 2 meters waves

06:10 Transit to E2M3A site

20:00 Toolbox talk for CTD cast procedure

21:30 The meteo condition allow CTD operation

22:00 **Arrival at E2M3A**

22:09 Start CTD cast (41°31.18'N 18°04.83'E 1183m depth)

22:52 End downcast position (41°31.18'N 18°04.83'E 1183m depth), start upcast 24 Niskin bottles closed at different depths

Thursday 22/05/2025

05:30 Toolbox talk for mooring deployment and CTD cast

06:00 Start preparation of mooring deployment

08:00 **In position for starting the deployment of mooring BB**

08:10 Start deployment of mooring BB following route of 315° (along canyon axis) at 0.6knt

09:05 Release of the mooring ballast and mooring BB sinking 41°20.518' N 17°11.564'E

09:10 Moving to CTD BB site 400 m southeast from mooring position

09:50 **Arrival at CTD-BB**

09:55 Start CTD cast (41°20.475'N 17°11.623'E 606m depth)

10:35 End downcast position (41°20.475'N 17°11.623'E 606m depth), start upcast 2 Niskin bottles closed at 600m depth

11:00 Transit to FF site

13:00 **In position for starting the deployment of mooring FF**

13:10 Start deployment of mooring FF following route of 60° at 0.9-0.7knt

14:50 Release of the mooring ballast and mooring FF sinking 41°48.355’N 17°02.284’E

14:55 Moving to CTD FF site 400 m southeast from mooring position

15:10 **Arrival at CTD-FF**

15:20 Start CTD cast (41°48.19', 17°02.56'E, 606m depth)

15:45 End downcast position (41°48.19'N, 17°02.56'E, 753m depth), start upcast 2 Niskin bottles closed at 723m depth

16:00 Rosette on ship

16:15 End of activities

6. Field Activities

The campaign was planned to last approximately 10 days, including transit to target sites, primary operations, and mobilization/demobilization (MOB/DEMOB) for rotating the scientific team and onboard instrumentation. The entire cruise was completed in a single leg.

During the EMSO-SA2025 cruise, the following field activities were performed:

1. **Recovery, Maintenance, and Redeployment of Oceanographic Moorings**

   Two moorings, designated BB and FF, are located in the Bari Canyon and on the continental slope off the Gargano Promontory, respectively. These moorings collect oceanographic and particulate matter data from the water column. They will be recovered and serviced—this includes data retrieval, collection of particulate samples, battery replacement, instrument inspection, and reprogramming—before being redeployed for a new observation period.

2. **CTD-Rosette Casts**

   The CTD-Rosette system will be deployed to measure key ocean variables, such as temperature, salinity, dissolved oxygen, fluorescence and turbidity, in addition to collecting seawater samples. Sampling will be carried out along the historic Bari-Dubrovnic transect and at the E2M3A site. Additional CTD casts will be conducted at the mooring locations to support sensor calibration.

3. **Deployment of Biogeochemical (BGC) Argo Floats**

   Two autonomous BioGeoChemical-Argo (BGC-Argo) profiling floats developed by CNR-ISMAR will be deployed beyond 12 nautical miles from the coast – one in the Ionian Sea (WMO7902260; PI E. Organelli) and one in the Adriatic Sea (WMO3902641; PI G. La Forgia). These floats are equipped with sensors to measure ocean variables - geophysical, chemical and biological – and include advanced sensors such as hyperspectral radiometers, turbidimeter and zooplankton imaging camera.

4. **Set up, Testing and Measurements of Carbonate System Using and Underway System**

During the cruise, an underway system equipped with multiple sensors, recently installed will be fully tested to allow continuous, semi-autonomous measurements of carbonate system parameters throughout the navigation.

CTD CASTS

Carlotta Dentico, PhD student, Ca' Foscari University of Venice and OGS Oceanography Section - Physical Oceanography (PHYS), Rocco De Marco, CNR-IRBIM

A total of 14 standard hydrographic stations were conducted during the cruise, using a SeaBird SBE911 plus CTD-O2 system, mounted on a SeaBird 24-position carousel water sampler equipped with 24 Niskin bottles (10 lt each). The CTD was fitted with dual temperature and conductivity sensors, two oxygen sensors, a fluorometer, a turbidimeter and a pH sensor. The serial numbers and calibration dates are listed in table 2.

Sensor type	Serial number	Calibration
SBE 3 Temperature 1	6744	17/04/2024
SBE 4 Conductivity 2	6364	27/03/2024
Pressure	1574	22/04/2024
SBE 3 Temperature 2	6914	26/04/2024
SBE 4 Conductivity 2	6345	14/03/2024
SBE 43 Oxygen 1	4521	02/04/2024
SBE 43 Oxygen 1	4559	02/04/2024
Fluorometer WET Labs	8764	05/03/2024
Turbidimeter, Wet Labs	8747	26/02/2024
Ph sensor	0463	27/03/2024

Table 2.- *Sensors installed on the CTD - SBE 911 plus and calibration references*

Samples were collected at several stations for oxygen laboratory analysis following Winkler method, for comparison purposes with oxygen concentration values measured by sensors on moorings. Data was processed using Seabird Data Processing software and a Matlab post-processing package. Spikes were removed from all data by applying instrumental and climatological range criteria, supported by visual checks. Profiles were then averaged every 1 dbar. Overall accuracy is within 0.002°C for temperature and 0.003 for salinity.

Date	Time (UTC)	Station name	Latitude N	Longitude E	depth (m)
18/05/2025	15:40	ARGO-01	38°53.3960'	17°49.5013	600
19/05/2025	13:03	CTD-BB recovery	41°20.471'	17°11.614'	604
19/05/2025	20:03	CTD-FF recovery	41°48.32	17°02.33'	740
20/05/2025	06:20	CTD Badu 2	41°20.71'	17°00.23'	133
20/05/2025	07:05	CTD Badu 3	41°22.56'	17°02.57'	152
20/05/2025	08:10	CTD Badu 4	41°23.62'	17°04.64'	173
20/05/2025	09:40	CTD Badu 5	41°27.09'	17°09.66'	502
20/05/2025	11:30	CTD Badu 6	41°33.79'	17°20.34'	960
20/05/2025	12:40	CTD Badu 7	41°35.04'	17°22.92'	1072
20/05/2025	15:30	CTD Badu 9 – ARGO-02	41°38.36'	17°31.00	1119
20/05/2025	18:38	CTD Badu 8	41°44.50'	17°41.51'	1195
21/05/2025	22:09	CTD E2M3A	41°31.18'	18°04.83'	1183
22/05/2025	09:55	CTD-BB deployment	41°20.475'	17°11.623'	606
22/05/2025	15:20	CTD-FF deployment	41°48.19'	17°02.56'	753

Table 3. *- CTD cast information*

During the cruise,14 CTD casts were conducted at various key locations: the deployment point of *Euterpe* Argo Float, along the Bari- Dubrovnik transect (BADU), at the CNR mooring sites BB and FF, and E2M3A (CTD-E2M3A) were specifically aimed at providing vertical profiles to support the quality control of the time series data recorded by instruments deployed along the mooring lines.

The vertical distribution of hydrographic features along the half-section of the BADU transect in the southern Adriatic is illustrated in Figure 3: A warm, relatively fresh surface layer

extends down to 50 m, capped by a pronounced halocline. The minimum salinity was recorded at station BADU-02 near the Apulian coast. On the continental shelf (down to 200 m), horizontal variability in thermohaline properties is evident. Beyond the shelf edge, vertical variability becomes more pronounced. Below 200 m, temperature decreases from 14.8 to 14.2 with a sharper decline observed below 500 m. Starting from BADU-05, an intermediate layer of high salinity (associated with Levantine Intermediate Water, LIW) is evident between 300 and 700 m depth, with a salinity peak centered around 400 - 600 m.
Dissolved oxygen concentration varies along the transect: higher values are observed in the coastal zone and in the upper 200 m, while below 300 m, oxygen levels remain relatively stable.

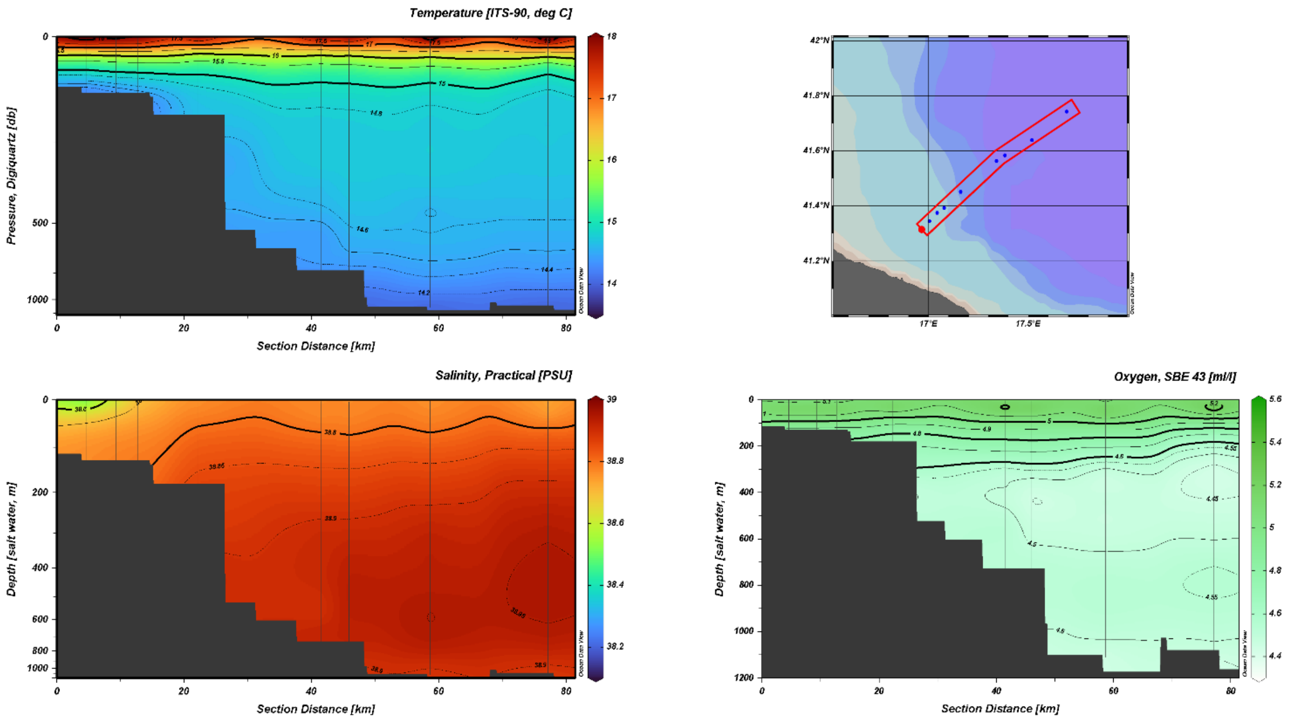


Figure 3.- *Distribution of the hydrographic properties along the half section in the southern Adriatic Sea (BADU Transect).*

Figure 4 presents vertical profiles from the CTD casts conducted in the Ionian Sea (at the BGC Argo float deployment site) and the Adriatic Sea (at mooring sites BB, FF, and E2M3A), showing detailed vertical distributions of physical and biogeochemical parameters.

In the Ionian Sea, the thermocline is located between 50 and 100 m. A maximum salinity layer (>39 PSU) occurs between 100 and 200 m. Dissolved oxygen peaks in the upper 0–100 m, while below 100 m, concentrations remain stable at approximately 4.1–4.3 mL/L. This same surface layer also shows the highest fluorescence values, reaching up to 0.9 mg/m^3.

In the Adriatic Sea, pycnocline and thermocline structures are consistent across all stations, located between 50 and 100 m. At BB and FF, a pool of high-salinity water (>38.9 PSU) is present from 200 m depth. At BB, this saline core is confined between 200 and 300 m; however, during a second cast on 22 May, it shifted upward and weakened, appearing between 100 and 200 m. At station FF, the high-salinity layer extends from 200 m down to the bottom. Across stations BB, FF, and E2M3A, this saline layer corresponds to a zone of reduced oxygen concentrations, while oxygen maxima are consistently found around 50 m depth. Conversely, the Ionian profile below 100 m shows the lowest dissolved oxygen values observed during the cruise.

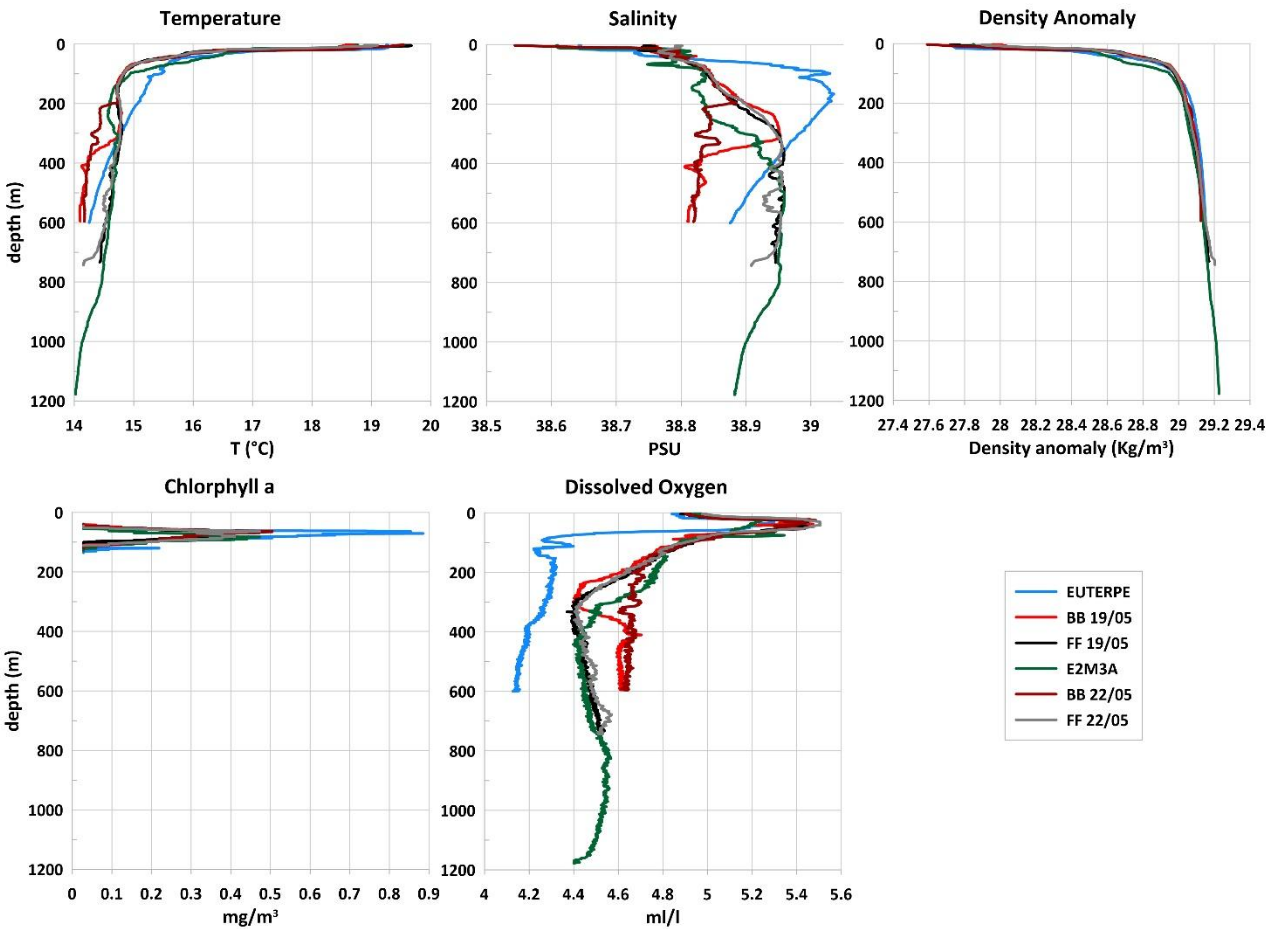


Figure 4.- *Profiles of CTD casts performed in the southern Adriatic Sea (BB – FF – E2M3A) and in the Ionian Sea (Euterpe).*

The θ-S diagrams (Fig. 5) illustrate the stratification of the water column, consistent with late spring conditions. The upper 200 m exhibit densities below 29 kg/m3 and temperature above 15°C. Along the BADU transect, less dense water masses are evident nearshore, where salinity falls below 38.8 PSU. The core of the LIW is characterised by very high salinity values (> 39 PSU), typically located between 300 and 600m depth.

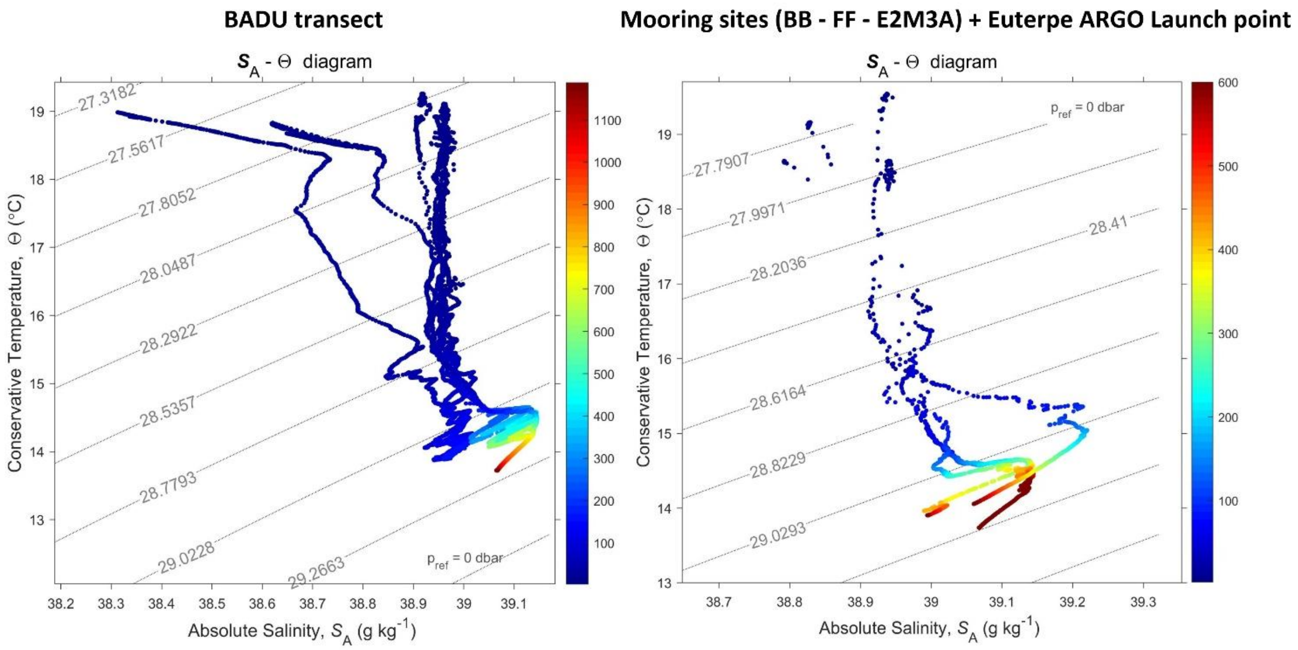


Figure 5.- *θ-S diagrams for left) Casts along the BADU transect; right) BGC-ARGO launching point and moorings,*

Biogeochemical Water Sampling

Carlotta Dentico, PhD student, Ca' Foscari University of Venice and OGS Oceanography Section - Physical Oceanography (PHYS)

The aim of sampling was to characterise the biogeochemical properties of the water column in the southern Adriatic Pit (SAP). Water samples were collected at 4 stations: BB, FF, BADU09 and E2M3A. A rosette with 24 Niskin bottles was used to collect water samples for dissolved oxygen (DO), pH, total alkalinity (AT), inorganic nutrients (NUT; nitrite, nitrate, ammonia, phosphate, and silicate), total dissolved nitrogen and phosphorus (TDN and TDP), and salinity (Table 1). To check the accuracy of the DO sensor of the CTD as well as the sensors attached to the moorings several replicates were taken from the same Niskin bottles at stations BB, FF and E2M3A at different depths. Similarly, replicates for pH and AT were taken from the same Niskin bottle at E2M3A at 1165 m depth to verify the accuracy of the newly deployed ProOceanus CO2-Pro CV sensor and the accuracy and precision of the method. At the remaining stations, (i.e. BADU02, BADU03, BADU04, BADU05, BADU06, BADU07 and BADU08), only CTD casts were performed, and one/two DO and salinity samples were taken. The latter were collected mainly with the aim of verifying the proper functioning of the SBE9 conductivity probe and obtaining an overview of the salinity situation in the deep layer of the station.

***Figure 6** - Carlotta Dentico during water sampling from Niskin bottle*

Sampling date	Station name	Niskin number	Depth (m)	DO	pH/AT	NUT	TDN/TDP	Salinity
19/05/2025	BB	1	595	X	X	X	X	X
19/05/2025	BB	1	595	X	-	-	-	-
19/05/2025	BB	1	595	X	-	-	-	-
19/05/2025	BB	4	400	X	X	X	X	-
19/05/2025	BB	6	300	X	X	X	X	-
19/05/2025	BB	9	200	X	X	X	X	-
19/05/2025	BB	11	100	X	X	X	X	-
19/05/2025	BB	14	40	X	X	X	X	-
19/05/2025	BB	17	15	X	X	X	X	-
19/05/2025	BB	19	0	X	X	X	X	X
19/05/2025	FF	1	723	X	-	-	-	X
19/05/2025	FF	1	723	X	-	-	-	-
19/05/2025	FF	1	723	X	-	-	-	-
20/05/2025	BADU02	1	126	X	-	-	-	-
20/05/2025	BADU02	13	70	X	-	-	-	-
20/05/2025	BADU04	1	168	X	-	-	-	X
20/05/2025	BADU04	13	100	X	-	-	-	-
20/05/2025	BADU06	2	957	X	-	-	-	-
20/05/2025	BADU06	3	550	X	-	-	-	-
20/05/2025	BADU09	1	1190	X	X	X	X	X
20/05/2025	BADU09	3	1000	-	X	X	X	X
20/05/2025	BADU09	5	800	X	X	X	X	X
20/05/2025	BADU09	7	600	-	X	X	X	X
20/05/2025	BADU09	9	400	-	X	X	X	X
20/05/2025	BADU09	11	200	X	X	X	X	X
20/05/2025	BADU09	13	80	-	X	X	X	X
20/05/2025	BADU09	15	25	-	X	X	X	X
20/05/2025	BADU09	17	0	-	X	X	X	X
22/05/2025	E2M3A	1	1183	X	X	X	X	-

22/05/2025	E2M3A	3	1165	X	X	X	X	X
22/05/2025	E2M3A	3	1165	X	X	X	X	X
22/05/2025	E2M3A	3	1165	X	X	X	X	X
22/05/2025	E2M3A	5	1100	X	X	X	X	X
22/05/2025	E2M3A	5	1100	X	-	-	-	-
22/05/2025	E2M3A	5	1100	X	-	-	-	-
22/05/2025	E2M3A	7	1000	X	X	X	X	X
22/05/2025	E2M3A	7	1000	X	-	-	-	X
22/05/2025	E2M3A	7	1000	X	-	-	-	X
22/05/2025	E2M3A	9	900	X	X	X	X	X
22/05/2025	E2M3A	9	900	X	-	-	-	X
22/05/2025	E2M3A	9	900	X	-	-	-	X
22/05/2025	E2M3A	11	800	X	X	X	X	-
22/05/2025	E2M3A	12	730	X	X	X	X	X
22/05/2025	E2M3A	12	730	X	-	-	-	-
22/05/2025	E2M3A	12	730	X	-	-	-	-
22/05/2025	E2M3A	14	600	X	X	X	X	-
22/05/2025	E2M3A	15	520	X	X	X	X	X
22/05/2025	E2M3A	15	520	X	-	-	-	-
22/05/2025	E2M3A	15	520	X	-	-	-	-
22/05/2025	E2M3A	16	400	X	X	X	X	-
22/05/2025	E2M3A	17	320	X	X	X	X	X
22/05/2025	E2M3A	17	320	X	-	-	-	X
22/05/2025	E2M3A	17	320	X	-	-	-	X
22/05/2025	E2M3A	18	200	X	X	X	X	-
22/05/2025	E2M3A	19	141	X	X	X	X	X
22/05/2025	E2M3A	19	141	X	-	-	-	-
22/05/2025	E2M3A	19	141	X	-	-	-	-
22/05/2025	E2M3A	20	70	X	X	X	X	-
22/05/2025	E2M3A	21	50	X	X	X	X	-
22/05/2025	E2M3A	22	30	X	X	X	X	-
22/05/2025	E2M3A	23	10	X	X	X	X	-
22/05/2025	E2M3A	24	5	X	X	X	X	X
22/05/2025	BB deploy	3	595	X	-	-	-	-
22/05/2025	FF deploy	23	723	X	-	-	-	-

***Table 4** - List of the sampled stations. The 'X' indicates where the parameters have been collected.*

DO was measured directly on board using a Mettler Toledo T50 potentiometric titrator using an automated version of the Winkler potentiometric titration method. The samples for the determination of DO were collected in calibrated 50 ml bottles. Water temperature was measured during sampling using a VWR Traceable Platinum Ultra-Accurate Digital Thermometer with Handle Probe (S/N 170759151). The accuracy of the measurements was assessed by averaging the accuracy of multiple replicates collected during the cruise and was equal to 0.26 µmol/L. The analyses of pH, AT, NUT, TDN and TDP were carried out in the OGS MABER laboratory. pH and AT samples were collected in acid-washed 250 ml borosilicate bottles, unfiltered and poisoned with 100 µL saturated mercuric chloride ($HgCl_2$) to stop biological activity. The samples were stored in the dark in plastic boxes at constant temperature. Bottle caps were sealed with parafilm. The pH determination was performed using a dual wavelength spectrophotometer (Cary 100 Scan UV-visible) and using the purified dye m-cresol purple 4 mM as an indicator, as described in SOP 6b (Dickson et al., 2007). The results are expressed on the pH total hydrogen ion scale. On the day of analysis, the samples are brought to 25°C and transferred to a 10 cm diameter cylindrical quartz cuvette by aspirating them with a Tygon tube, avoiding gas exchange so that no headspace remains. The pH value is measured within a few hours of transferring the samples. Throughout the analysis, the temperature of the samples was controlled by thermostatic cuvette holders inside the spectrophotometer, connected to a circulating criothermost at 25°C (LAUDA RE415) and monitored by a digital thermometer (VWR Traceable). AT was analysed by potentiometric titration with open cells using a Mettler Toledo G20 at 25°C. The analysis was performed according to the SOP 3b method (Dickson et al., 2007) using a nonlinear least squares method: 100 g of the sample is weighed and titrated with HCl 0.1 mol kg1 in NaCl 35‰. HCl is calibrated using certified reference materials (CRMs) for AT provided by Prof. A.G. Dickson, Scripps Institute of Oceanography, USA. AT calculations are performed using Alka Open Cell 2.0, a computer program developed by OGS according to the programs listed in SOP 3 by Dickson and Goyet (1994). All other parameters of the carbonate system, including pH at in situ temperature (pH_T), partial pressure of CO_2 in seawater (pCO_2), total carbon dioxide (TCO_2) and saturation state of aragonite and calcite (Ω_{ar} and Ω_{cal}), are calculated using the program CO2SYS (Pierrot et al., 2006) from AT, pH at a constant temperature of 25 °C ($pH_{T25°C}$), *in situ* temperature and salinity (from CTD), and phosphate and silicate concentrations. Water samples for the analysis of NUT were collected in acid-washed 60 ml HDPE Nalgene bottles after filtration and stored at -20 °C until analysis. The analysis is carried out in the OGS-MABER laboratory on land using a colorimetric four-channel continuous Flow QuAAtro seal according to the methods described in Hansen and Koroleff (1999). The detection limits are 0.01, 0.02, 0.03, 0.01 and 0.02 for nitrites, nitrates, ammonia, phosphate and silicate respectively. Total dissolved organic nitrogen and phosphorus were not filtered on pre-combusted 47-mm Whatman GF/F (25 mm, 47 µm) glass fibre philtres and collected in acid-washed 125-ml HDPE Nalgene bottles and immediately frozen at -20 °C until analysis in the OGS laboratory. TDN and TDP are determined in the OGS MABER laboratory by wet persulfate oxidation according to Hansen and Koroleff (1999). Dissolved organic nitrogen (DON) and phosphorus (DOP) are calculated as follows:

DON = TDN – (N-NH4 + N-NO2 +N-NO3) [1]

DOP = TDP – P-PO4 [2]

7. Deck operations

Francesco Paladini de Mendoza, Leonardo Langone, CNR – ISP

Procedures for working on deck were discussed with the captain, first officer, and all personnel involved before cruise and before each day of operation. A plan of action for the use of winches and tasks was developed. The sequence of actions was determined as follows: mooring recovery BB and FF and re-deployment of the mooring.BB and FF. Moorings recovery was successfully conducted during the day of May 19th and redeployed three days later (May 22nd).

The positions and times for deploying the moorings are shown in the bridge plan.

Recovery and deployment of mooring BB and FF

The BB subsurface mooring was successfully recovered on May 19th. Upon arrival at the site at 08:05, acoustic interrogation of the release units was promptly carried out using the Edgetech deck unit with the dedicated transducer lowered to a depth of 10 meters. The first interrogation attempt was direct at the IXSEA OCEANO R5 s/n 73 acoustic releaser, but no response was received. Multiple additional attempts also yielded no response. However, approximately five minutes later, the buoy surfaced. Initial recovery was conducted using the vessel's auxiliary rescue launch. Once the head of the mooring line was secured, it was passed to the onboard crew and full recovery began using the ship's aft winch and a capstan coupled with a pulley. The operation concluded at 10:20. The recovery process is illustrated in Figure 7.

Figure 7.- *Phases of mooring BB recovery*

Preliminary inspection showed that the mooring line and instruments were in good condition, with minimal biofouling and moderate erosion on the zinc anodes.

Following the recovery, a CTD cast was performed at the CTD-BB station. After completing the cast, the vessel proceeded to the FF mooring site for the next recovery.

The FF mooring recovery began at 15:20 with acoustic interrogation using the Edgetech deck unit and the transducer at 10 meters depth. This time, the IXSEA OCEANO R5 Acoustic Releaser, s/n 74, responded successfully, providing an initial range of 770 meters. A second interrogation a few minutes later showed a range of 500 meters, confirming a successful release. About ten minutes later, the buoy surfaced.

Recovery followed the same procedure as for the BB mooring: the auxiliary rescue launch secured the buoy first, followed by handover to the onboard crew, and winch-assisted recovery using the aft capstan and pulley system. The operation ended at 16:50. The recovery sequence is depicted in Figure 8.

Figure 8.- *Phases of mooring FF recovery*

Post-recovery, maintenance activities began, starting with data download from the instruments. The following day, the team continued with inspection, cleaning, and battery replacement. Ropes, shackles, and zinc anodes were checked and any worn components were replaced.

The FF mooring included an additional acoustic release unit (s/n 100454), which was successfully tested and verified via interrogation. All mooring line sections were pre-spooled onto the designated winch and prepared for redeployment. Both BB and FF moorings were upgraded with a new RTsys Sylence LP acoustic recorder.

Figure 9.- *Mooring preparation and deployment*

***Figure 10.-** Mooring ballast and release system before final launch*

For the BB mooring, the mooring line was extended by approximately 5 meters above the ADCP to accommodate the acoustic recorder. In contrast, the FF mooring integrated the recorder directly above the ADCP without requiring additional line extension.

Prior to deployment, the mooring lines were assembled section by section using shackles. Each termination was clearly labeled to indicate instrument orientation (top/bottom). The lines were spooled onto the winch for deployment.

Deployment began with the head buoy (equipped with a beacon), followed by gradual unspooling of the mooring line from the winch as the vessel advanced toward the release point at a speed of 0.5–0.7 knots. For BB, the vessel followed a specific heading toward the canyon axis (315°N).

As each mooring section reached the deck operator, it was secured with an auxiliary rope and the respective instrument was attached using shackles and safety ropes on both ends. The overall mooring line structures and instrument sequences for BB and FF were identical.

The deployment launch point was set 1 nautical mile from the final location. It took approximately 45 minutes to tow the mooring line to the designated drop point. On May 22 at 09:05, the 400 kg concrete deadweight for the BB mooring was released from the crane and descended below the sea surface. The FF mooring was deployed in the same manner at 14:50 on the same day.

The new mooring schemes for the 2025 – 2026 are reported in the Annex 1.

BioGeoChemical-Argo float deployment

During the EMSO-SA 25 cruise, the two BGC-Argo autonomous floats (EUTERPE - WMO7902260; PI E. Organelli & ADRIANA - WMO3902641; PI G. La Forgia) of CNR ISMAR has been successfully deployed from the winch astern of the R/V Gaia Blu (Figure ù) respectively on 18/05/2025 15:20 at Lat 38°53.329' N Lon 17°49.458'E and on 20/05/2025 .17:03 at Lat 41°44.60’N Lon 17°41.51’E (Figure 11). The float models are JUMBO PROVOR CTS5 (NKE Instruments, France) equipped with sensors: CTD (Seabird SBE41-CP) for Temperature, Salinity and Pressure; Dissolved Oxygen (Aandera Optode 4330); Phytoplankton chlorophyll, optical backscattering at 700 nm and CDOM - coloured dissolved organic matter (Seabird/WetLABS ECO3); Downwelling irradiance at 4 bands (Seabird/Satlantic OCR-504); Zooplankton communities and particle size distribution within the range 50-2580 µm (Hydroptic UVP-6). These floats are a contribution to the ARGO-Italy program and the European Research Infrastructure EURO ARGO ERIC. Deployment locations, float trajectories and the first profiling sampling stations are shown in Figure 12. The float successfully transmitted, via iridium satellite communication, the data acquired.

Figure 11.- *Argo deployment*

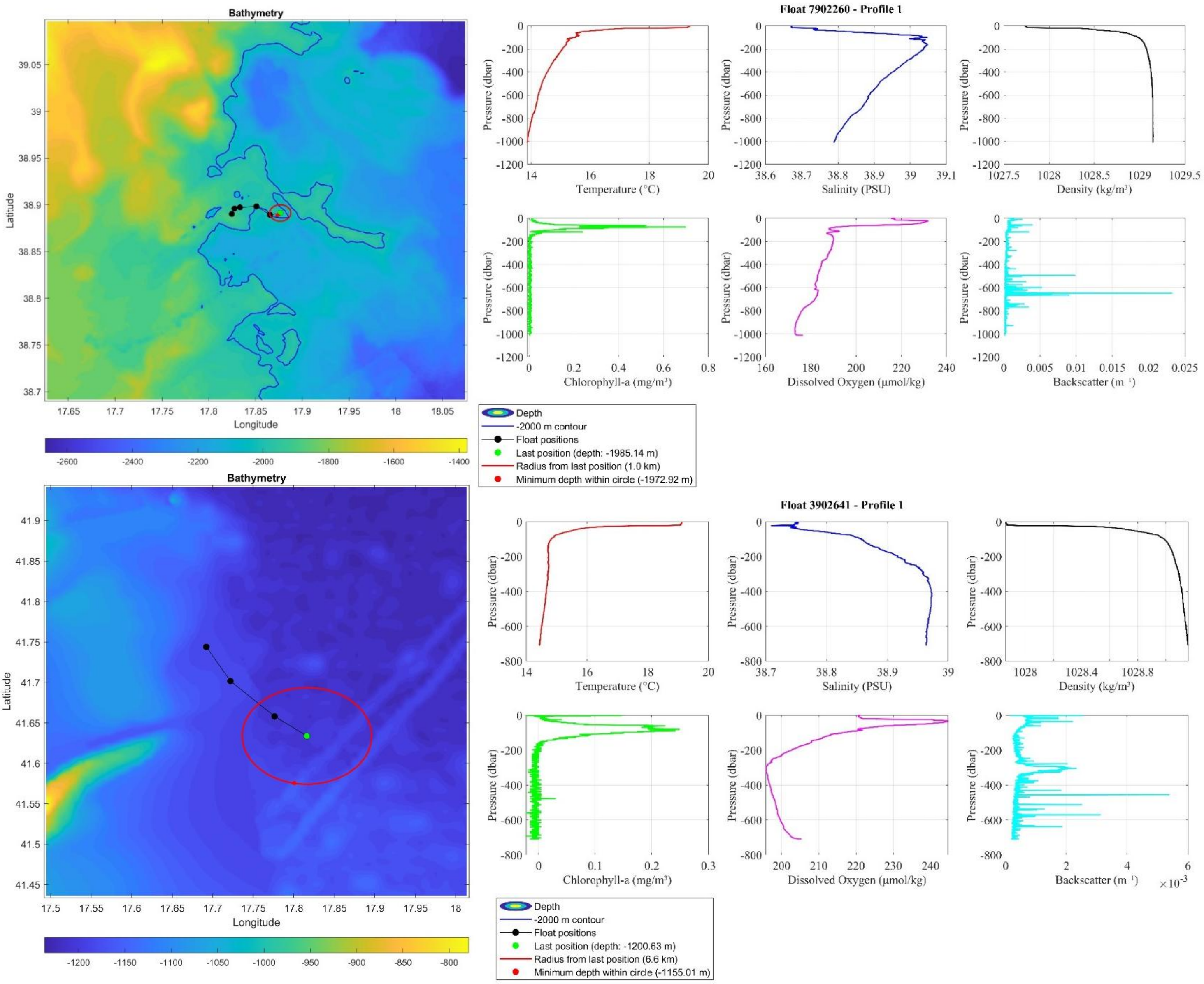


Figure 12 *- BGC-Argo deployment location and trajectory. Right panel: set of selected profiles of biogeochemical variable measured by CTD, Optode and ECO Fluorometer.*

8. Underway carbonate system data acquisition and validation

C. Cantoni ISMAR branch of Trieste

In April 2025, a Ferry-Box system was successfully installed and connected to the uncontaminated seawater intake line of the vessel. The Ferry-Box collected seawater data during navigation from the connected instruments, integrating it with navigational parameters and seawater inlet temperature into a single file with a 1-minute resolution. This setup enables real-time visualization and monitoring of all parameters.

The instruments controlled by the Ferry-Box are summarized in Table 5.

Parameter	*Instrument*	*Acquisition frequency*
SW Temperature	SBE 45 Micro TSG	continuous
SW Salinity		
Inlet SW temperature	SBE 38 (from ship's remote sensor)	continuous
Dissolved oxygen (DO)	Optode 4835 Aanderaa	continuous
CO_2 partial pressure (pCO2)	Contros HydroC CO2 FT	continuous
pH on "total scale" (colorimetric)	Contros HydroFIA pH	9 min
Total alkalinity (TA)	Contros HydroFIA TA	9 min
Chlorophyl	Wetlab ECO-Triplet	continuous
Chromophoric dissolved organic matter (C-DOM)		
Turbidity		

Table: 5 - *Parameters acquired by the instruments controlled by the Ferry-box*

The HydroFIA-pH and HydroFIA-TA analyzers are based on spectrophotometric measurements performed automatically on discrete samples. During the cruise, both instruments were activated, and several operational issues were resolved with continuous remote support from the manufacturers.

The water line supplying 0.22 µm filtered seawater to the two analyzers was carefully inspected. It was confirmed that the available flow rate (~2.6–2.8 L/min) was stable and adequate, albeit below the recommended optimal flow rate of 5 L/min.

Frequent spikes in the pCO_2 signal (99999 and 66666 values) were removed. The manufacturers also resolved issues related to the transmission of TA data, which has now been fully integrated into the Ferry-Box system.

During navigation, discrete samples were collected daily for subsequent analysis of pH and TA at the ISMAR Trieste laboratory. pH will be measured using purified m-cresol purple as an indicator, following the method of Liu et al. (2011). TA will be determined via titration using the derivative end-point method described by Hernandez-Ayon et al. (1999). These laboratory data will be used to validate and perform quality control on the pH and TA data measured by the onboard instruments. Additionally, they will enable comparison and validation of the pCO_2 measurements through values calculated from pH and TA using the seawater speciation program "CO2SYS" (Pierrot et al., 2006).

dd/mm/yyyy	hh:mm UTC	Lat deg.nn	Long deg.nn	T SBE 38 [°C]	T SBE 45 [°C]	S	pCO2 [µatm]	pH tot scale	TA [µmol/kg]	sample n.
17/05/2025	15:05	39.73	14.72	19.56	19.78	37.54	456.74	7.934	2036*	1
18/05/2025	18:50	39.44	18.26	19.4	19.63	38.55	462.65	7.946	2438*	2
19/05/2025	09:52	41.34	17.18	18.59	18.85	38.76	450.17	7.949	2440*	3
20/05/2025	11:24	41.56	17.34	19.29	19.34	38.78	463.73	7.952	2435*	4
21/05/2025	17:54	41.45	18.25	18.73	18.97	38.63	511.11	7.96	na	5
21/05/2025	22:32	41.52	18.08	18.74	18.98	38.62	463.02	7.944	na	6
23/05/2025	16:39	42.83	15.35	19	19.25	38.74	449.22	7.963	2628.7	7

***Table. 6 -** Samples collected during navigation for pH and TA analysis. * uncalibrated data.*

Both the pH and TA analyzers are capable of operating in discrete mode to analyze individual samples. At stations BB and E2M3A, 5 and 6 samples respectively were collected and analyzed for pH directly onboard. Furthermore, 3 samples from station BB and 4 from station E2M3A were collected for subsequent laboratory analysis at ISMAR Trieste.
TA analysis could not be conducted onboard due to issues with the functioning and calibration of the analyzer, which were only partially resolved by the end of the cruise.

***Figure 13 -** Real time acquisition during navigation*

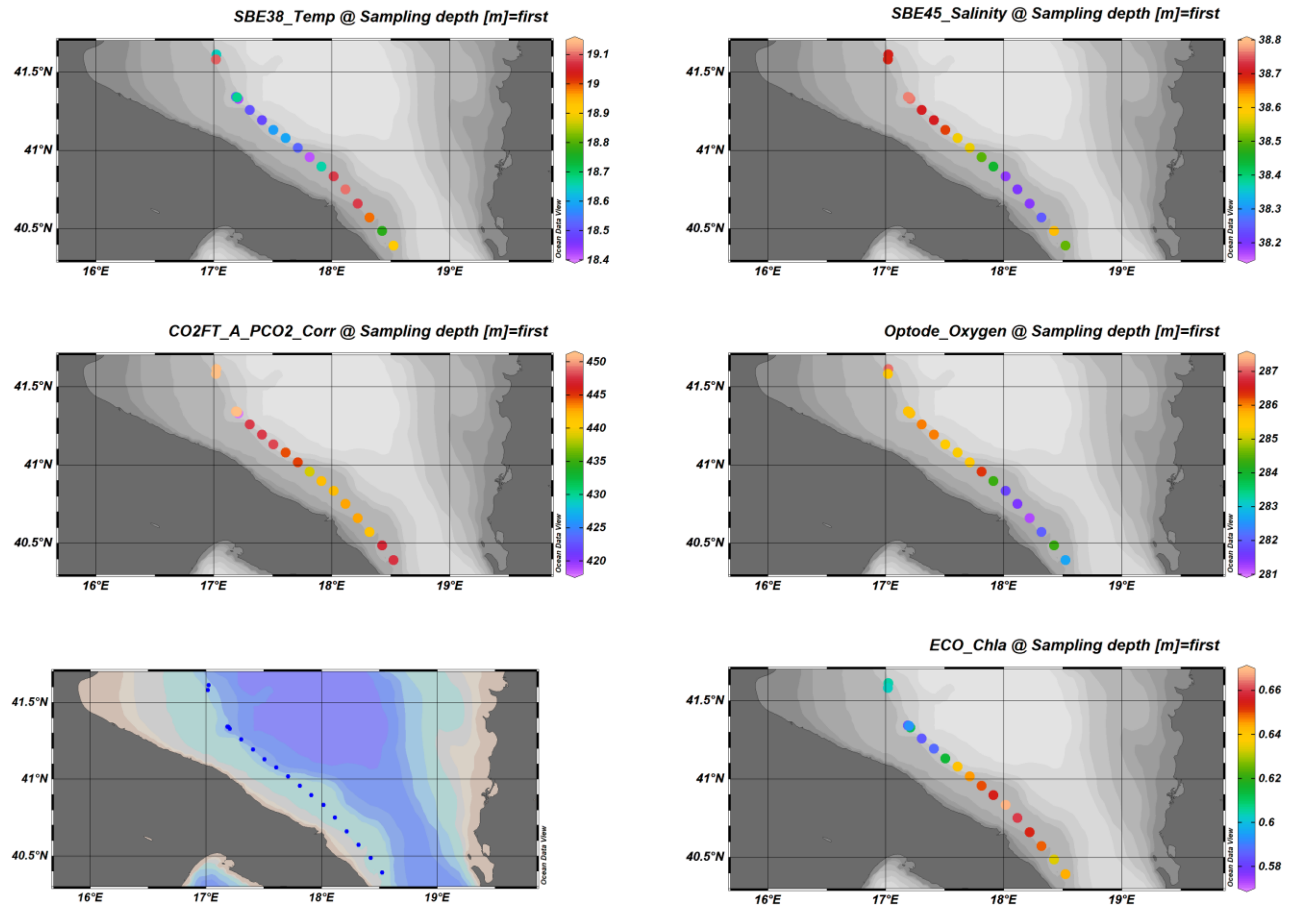


Figure 14 *- Data gathered during the navigation on 19/05/2025.*

Data collected on 19 May 2025 (Figure 14) highlighted the crossing of a water mass along the southern coast of Apulia, characterized by higher temperatures and lower salinities. This water mass also exhibited slightly lower pCO_2 and dissolved oxygen levels, along with higher chlorophyll concentrations compared to the northern area.

9. Communication and Outreach Management

Francesco Paladini de Mendoza, Stefano Miserocchi (CNR-ISP)

Before and after the cruise, informative notes were prepared detailing the planned research activities onboard, the research prospects, and the findings. These notes were submitted to the CNR Press Office and shared with the Communication and Outreach Working Group. Informative notes were also sent to the CNR-ISP Working Group on Outreach and Communication. Below is a comprehensive list of announcements published on various social platforms: an overview of the messages and updates shared to inform and engage the audience across different digital channels.

1. 20 May 2025:

https://www.instagram.com/p/DJ4PgdmBM8C/?img_index=1

2. 26 May 2025:

https://www.instagram.com/p/DKHEyFIsl9A/?img_index=1

3. 20 May 2025:

https://emso.eu/2025/05/20/new-mission-for-gaia-blu-the-emso-southern-adriatic-2025-campaign-on-the-way-to-study-the-oceanography-of-the-southern-adriatic/

emso ERIC About us Observatory Data Science Innovation & Industry Services Updates SIGN UP

NEW MISSION FOR GAIA BLU: THE 'EMSO – SOUTHERN ADRIATIC 2025' CAMPAIGN ON THE WAY TO STUDY THE OCEANOGRAPHY OF THE SOUTHERN ADRIATIC

4. 06 May 2025:

https://www.cnr.it/it/comunicato-stampa/13492/la-nave-da-ricerca-gaia-blu-pronta-a-solcare-il-mare-nostrum

COMUNICATO STAMPA

La nave da ricerca Gaia Blu pronta a solcare il "Mare nostrum"

06/05/2025

Riprendono le campagne scientifiche della nave da ricerca "Gaia Blu" del Consiglio nazionale delle ricerche: per il 2025 sono in programma 19 campagne volte a esplorare il Mar Mediterraneo, con l'obiettivo di migliorare la comprensione degli ambienti marini e contribuire alla definizione di strategie efficaci di conservazione e gestione sostenibile delle risorse

Sono 19 le campagne scientifiche che vedono coinvolta la nave da ricerca "Gaia Blu" del Consiglio nazionale delle ricerche a partire dalla primavera del 2025: spedizioni che porteranno diversi team di ricerca nazionali e internazionali a esplorare il Mar Mediterraneo, studiando sia gli ambienti di profondità che quelli costieri, con l'obiettivo di migliorarne la loro comprensione e di contribuire alla definizione di strategie efficaci di conservazione e gestione sostenibile delle risorse.

Grazie alla strumentazione d'avanguardia presente a bordo, saranno condotti studi multidisciplinari su un ampio spettro di temi: dall'oceanografia fisica alla dinamica del mantello terrestre, dalla cartografia marina alla biodiversità e alle risorse ittiche del *Mare nostrum*, valutando anche gli effetti del cambiamento climatico sugli ecosistemi marini.

Le attività di ricerca a bordo sono partite a marzo con il primo "leg" della Campagna "MarSico": una spedizione coordinata dall'Istituto di scienze marine del Cnr (Cnr-Ismar) dedicata allo studio dei processi oceanografici nel Mar Mediterraneo avvalendosi anche di 4 mooring posizionati in punti chiave dell'area -canale di Corsica e canale di Sicilia, Mar Ionio occidentale- per la raccolta a lungo termine di dati sulla dinamica delle masse d'acqua e i processi biogeochimici.

La nave da ricerca "Gaia Blu"

È, invece, da poco terminata la campagna "SPIN-Gela 2025" che si è concentrata sull'acquisizione di dati batimetrici e di profili sismici a riflessione in un settore della piattaforma continentale della Sicilia meridionale interessato da potenziali rischi geologici che possono interagire con attività di estrazione e stoccaggio di geofluidi. Promossa da Cnr-Ismar nell'ambito dei progetti SPIN e ILG, e finanziata dal MASE, l'iniziativa punta a rafforzare la sicurezza delle attività offshore, in sinergia con il sistema nazionale della ricerca.

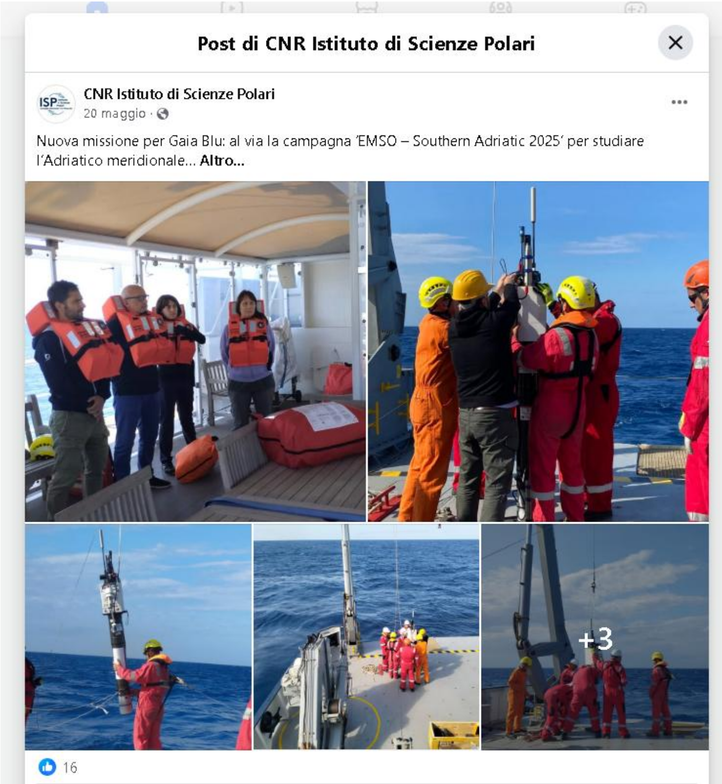
Di seguito il prospetto delle campagne previste per l'estate 2025, mentre il calendario completo è disponibile nella sezione del portale Cnr dedicata a Gaia Blu (link https://www.cnr.it/it/nave-oceanografica-gaia-blu):

17-26 maggio: EMSO-SA2025, spedizione dell'omonimo consorzio di ricerca che riunisce i diversi siti osservativi nell'Adriatico meridionale compresi nella Southern Adriatic Regional Facility: l'obiettivo è raccogliere dati volti a migliorare la comprensione della dinamica oceanica della regione adriatica meridionale, in particolare i processi di cascading e convezione, lo studio dei processi di formazione di acque dense, le proprietà delle masse d'acqua e dei cicli biogeochimici, la comprensione del funzionamento degli ecosistemi in relazione alla dinamica del sequestro di carbonio, nonché i processi di acidificazione nelle acque profonde e la dinamica dei sedimenti

12-23 giugno: POSEIDON, campagna che si concentrerà sui monti sottomarini del Mar Tirreno meridionale Marsili e Palinuro, indagando il loro ruolo nel condizionare la rete trofica e nell'aggregare specie pelagiche. Attraverso l'integrazione di rilievi acustici e campionamenti di plancton e acqua, saranno studiate e caratterizzate le aggregazioni di fauna presente, e saranno studiate le comunità fitoplanctoniche, zooplanctoniche e microbiche, componenti chiave di questi ecosistemi

5. 20 May 2025:

https://www.facebook.com/cnristitutoscienzepolari/posts/nuova-missione-per-gaia-blu-al-via-la-campagna-emso-southern-adriatic-2025-per-s/1138610108284116/



6. [26 May 2025:](https://www.facebook.com/cnristitutoscienzepolari/posts/-missione-completata-con-successo-questa-volta-siamo-pi%C3%B9-distanti-dai-poli-ci-tr/1142931951185265/)

https://www.facebook.com/cnristitutoscienzepolari/posts/-missione-completata-con-successo-questa-volta-siamo-pi%C3%B9-distanti-dai-poli-ci-tr/1142931951185265/

Post di CNR Istituto di Scienze Polari

CNR Istituto di Scienze Polari
26 maggio ·

🌊 Missione completata con successo! 🚢
📍 Questa volta siamo più distanti dai Poli, ci troviamo nel cuore dell'Adriatico, al Porto di Ancona – 26 maggio 2025

Si è conclusa la campagna EMSO SA-2025 a bordo della nave GAIA BLU del CNR Consiglio Nazionale delle Ricerche, portando a termine tutte le operazioni in programma nel Mar Adriatico e Ionio 💪🌍

🔹 Riposizionati i moorings BB e FF, fondamentali per lo studio del cambiamento climatico e delle dinamiche delle acque dense
🔹 Rilievi CTD lungo il transetto Bari-Dubrovnik e al punto E2M3A
🔹 Varati due nuovi profilatori BGC-Argo per monitorare biodiversità e flussi di carbonio 🌱
🔹 Prime misure in continuo per l'analisi del sistema carbonatico con il nuovo strumento underway 🌊

Tutto questo grazie alla collaborazione tra CNR-ISP, CNR-ISMAR, OGS - Istituto Nazionale di Oceanografia e di Geofisica Sperimentale , il consorzio EMSO-ERIC e il progetto PNRR #ITINERIS 🇮🇹 🔬

👏 Un enorme GRAZIE al team scientifico, al Comandante e all'equipaggio della GAIA BLU per l'impegno e la professionalità!

📷: Rocco De Marco, Carolina Cantoni, Carlotta Dentico
#EMSOERIC #CNR #OGS #PNRR #ITINERIS #GAIABLU #OceanScience #AdriaticSea #IonianSea #MarineResearch #BluePlanet

ANNEX 1

Mooring BB and FF schemes