TAlPro2022 CRUISE REPORT

R/V BELGICA Cruise n. 2022/12

17th – 26th May 2022

La Seyne sur Mer – La Spezia

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CNR-Istituto di Scienze Marine

2022

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1. Cruise Summary

The TAlPro2022 cruise has been conducted on the RV BELGICA from 17th to 26th May 2022, thanks to ship time offered through the Eurofleets+ project. In addition, the Mediterranean Science Commission (CIESM) has further provided financial support to cover the participation of the PI and those partners affiliated to institutes of countries that are full CIESM members, as well as to contribute to a future scientific publication. RV BELGICA is the new 71-metres-long Belgian research vessel[1].

The last few decades have seen dramatic changes in the hydrography and biogeochemistry of the Mediterranean Sea. The complex bathymetry, the highly variable spatial and temporal scales of atmospheric forcing and internal processes contribute to generate complex and unsteady circulation patterns and significant variability in biogeochemical systems. Part of this variability can be influenced by anthropogenic contributions. Consequently, there is a need to document its details as well as to understand ongoing trends in order to better relate the observed processes and to possibly predict the consequences of these changes. The main goal of the cruise was to contribute to the understanding of long-term changes and trends in physical and biogeochemical parameters, such as the anthropogenic carbon uptake and to still evaluate the hydrographical situation after the major climatological shifts in the western part of the basin, known as the Western Mediterranean Transition.

During the cruise, multidisciplinary measurements were conducted on 2 meridional sections between the northern and the southern Mediterranean shores, contributing to the global repeat hydrography program GO-SHIP and adhering to the GO-SHIP requirements.

[1] https://odnature.naturalsciences.be/belgica/en/index

2. Participants

2.1 Principal Investigators

Name	Institution
Katrin Schroeder	CNR ISMAR
Toste Tanhua	GEOMAR
Marta Álvarez	IEO - CSIC (INOCEN)
Laurent Coppola	Sorbonne Univ. LOV
Núria Casacuberta and Maxi Castrillejo	ETH - ICL
Chiara Santinelli	CNR IBF

2.2 Scientific Party

Name	Discipline	Institution
Katrin Schroeder	Chief Scientist – CTD/LADCP	CNR ISMAR
Mireno Borghini	CTD/LADCP /Salinometer	CNR ISMAR
Francesco Falcieri	CTD/LADCP /Salinometer	CNR ISMAR
Toste Tanhua	Transient Tracers	GEOMAR
Boie Bogner	Transient Tracers	GEOMAR
Abed El Rahman Hassoun	Transient Tracers	GEOMAR
Marta Álvarez	Carbonate System	IEO - CSIC (INOCEN)
Ruben Acerbi Amigo	Carbonate System	IEO - CSIC (INOCEN)
Maribel García Ibáñez	Carbonate System	ICM - CSIC
Beatriz Manzanares Obispo	Carbonate System	IEO - CSIC (Palma)
Simona Retelletti Brogi	DOC/CDOM/FDOM	CNR IBF
Mirco Guerrazzi	DOC/CDOM/FDOM	CNR IBF
Valtere Evangelista	DOC/CDOM/FDOM	CNR IBF
Laurent Coppola	Oxygen, nutrients, UVP	LOV, SU
Marine Fourrier	Oxygen, nutrients, UVP	LOV, SU
Anthony Bosse	Oxygen, nutrients, UVP	MIO, AMU

Stephanie Jacquet	Barium tracer	MIO, CNRS
Francisca Martínez Ruiz	Barium tracer	CSIC-IACT
Maxi Castrillejo Iridoy	Radionuclides	ICL
Lorenza Raimondi	Radionuclides	ETH
Alberto Pallavicini	eDNA	Univ. Trieste
Christian Clauwers	Photographer	clauwers.com

2.3 Participating Institutions

CNR ISMAR: Consiglio Nazionale delle Ricerche, Istituto di Scienze Marine, Venezia, La Spezia, Italy
GEOMAR: Helmholtz-Zentrum für Ozeanforschung, Kiel, Germany
IEO - INOCEN: Inorganic Chemical Oceanography lab, Instituto Español de Oceanografía (IEO), CSIC, A Coruña, Spain
IEO – Palma: IEO, CSIC, Palma de Mallorca, Spain
ICM - CSIC: Institut de Ciències del Mar (ICM), CSIC, Barcelona, Spain
ETH: Department of Environmental Systems Science, Zürich, Switzerland
CNR IBF: Consiglio Nazionale delle Ricerche, Istituto di Biofisica, Pisa, Italy
LOV: Laboratoire d'Océanographie de Villefranche, France
SU: Sorbonne Universités, Paris, France
MIO: Mediterranean Institute of Oceanography, Marseille, France
AMU: Aix-Marseille University, Marseille, France
CNRS: Conseil National de la Recherche Scientifique, France
CSIC-IACT: Andalusian Earth Sciences Institute, Armilla (Granada), Spain
Univ. Trieste: Department of Life Sciences, University of Trieste, Trieste, Italy
ICL: Department of Physics, Imperial College London, London, United Kingdom

3. Research Program

3.1 Aims of the Cruise

Repeat hydrography, as organised through the GO-SHIP network, is fundamental for detecting trends and variability also in the Mediterranean Sea. For 10 days 22 researchers from European Research institutes have been on the cruise TAlPro2022, on board the brand new R/V Belgica, to repeat the western zonal transects of MedSHIP, the Mediterranean component of GO-SHIP, 6 years after its first occupation in 2016 (Jullion, 2016). The fieldwork will contribute to the sustained observational effort already existing at regional scale by repeating the basin-scale survey of the Tyrrhenian Sea and of the Algero-Provencal basin. These observations will be used to: 1) measure the changes in the thermohaline properties of Mediterranean water masses at the basin-scale; 2) quantify the inorganic and organic dissolved carbon and dissolved oxygen storage in the western Mediterranean; 3) quantify the uptake of anthropogenic carbon in the Western Mediterranean; 4) quantify changes in the ventilation of the deep and intermediate water masses thanks to the transient tracers (CFCs, SF_6, ^{14}C, ^{129}I, ^{236}U); 5) measure concentrations of nutrients (nitrate, phosphate, silicate) in the water column, their ratio and assess changes; 6) measure the particulate size spectrum in the water column and to identify the zooplankton species from imagery sensor (UVP6). With respect to TAlPro2016, now data collected by an Underwater Vision Profiler (UVP6) integrated on the rosette, as well as data on Dissolved Organic Carbon (DOC) and a whole suite of radionuclides (^{14}C, ^{129}I, ^{236}U) have been added.

TAlPro2022 consisted of 24 full depth hydrographic stations crossing the Tyrrhenian Sea from north to south, then the Algero-Provencal Basin from south to north (following recommendations from the CIESM MedSHIP expert group, see CIESM, 2012 and Schroeder et al., 2015).

The deployment of two Argo floats in the Tyrrhenian Sea, sent to the ship by OGS, was also aimed at, in order to contribute to the EuroArgo network.

3.2 Calls for Students on Board and Scientists of Opportunity

When the cruise was planned we issued a call ("Students on board") to accommodate 1-2 Master's level or PhD students in the field of marine sciences from Algeria, Tunisia, Egypt or Malta, to be funded by CIESM (https://ciesm.org/TAlPro2022/Open_call_for_students.pdf). At the same time we also issued a call ("Scientists of Opportunity") to accommodate 1-2 scientists that were interested in taking complementary measurements, to benefit from the fact that a whole suite of other physical and chemical data will be available at the same time (https://eurosea.eu/news/scientists-of-opportunity-call-for-applications-open-to-join-research-vessel-belgica-ii/).

We selected one student from Algeria and one from Tunisia, but unfortunately for different reasons (visa-related and COVID-related) at the very last moment they were both not able to join us on the cruise. For the call for Scientists we selected the proposal by Alberto Pallavicini (University of Trieste, Italy) and by Francisca Martínez Ruiz (CSIC-IACT, Granada, Spain).

A. Pallavicini proposed to analyse environmental DNA, based on DNA metabarcoding, to reinforce both the collected data of zooplankton/particles and possible considerations of vertical migration based on the ADCP data, as well as integrate the abiotic and biotic parameters with information on the community along the two transects and at different depths. This will help link the eukaryotic

communities and biogeochemical fluxes in the Mediterranean Sea, which might be extrapolated to the global ocean.
F. Martínez Ruiz proposed to investigate barite precipitation mechanisms, which has not yet been done in the Mediterranean Sea, to get new insights into the precipitation of this mineral in the western Mediterranean regions but also for reconstructing past enhanced productivity episodes that can in turn contribute to further understand productivity responses in future climate change scenarios.

3.3 RTA project IsoMed

In January 2022 a Remote Transnational Access proposal, called IsoMed (PI Sarah Magozzi, SZN, Naples, Italy), was received by the Eurofleets+ Coordinator, which asked for remote access to the TalPro2022 cruise. The collection of the required samples was considered feasible, both logistically and from the point of view of the timeline dedicated to the cruise, thus the proposal has been accepted.
The IsoMed project aims to generate regional- to basin-scale maps of the distributions of stable carbon and nitrogen isotope ratios (isoscapes) in pelagic food webs of the Mediterranean Sea. The resulting isoscapes will describe the spatial variations in isotope tracers as well as the spatial correlations of these tracers with environmental and anthropogenic drivers. As reference organism(s), mesozooplankton taxonomic or functional groups will be targeted, as they are easy to sample, widespread, fast-growing, relatively immobile, and feed in the pelagic zone. Isoscapes will be generated using Integrated Nested Laplace Approximation (INLA), a Bayesian statistical approach well-suited for developing isoscapes based on multiple reference taxa.
From the point of view of the tasks that we were requested to perform on board, mesozooplankton were collected with an Indian Ocean net equipped with 200 µm mesh, in 2 stations (3 were foreseen, but due to time constraints, we managed only to sample in the Tyrrhenian Sea and in the Ligurian Sea). Plankton has been sampled by means of oblique hauls with the net being deployed at 200 m depth with the ship still, then towed at a speed of 2 knots for 10-15 min, and be recovered onboard with the ship newly still. Mesozooplankton has been fixed in ethanol immediately after collection, by concentrating the sample on a 200 µm sieve and resuspending it in a jar with 70% ethanol. The samples have been unloaded from the ship at the end of the cruise, and will be recovered by the PI of the RTA project, for further analysis.

3.4 The Study Area

We carried out measurements of current and along-track hydrographic and biogeochemical variables with the classical instrumentation of CTD, LADCP and bottle samples on highly resolved sections through the Western Mediterranean Sea.
The sections and CTD-positions are repeat occupations (cruise TAlPro2016 and others) in order to allow long-term trend analyses. Along the different sections, CTD stations including sampling of chemical parameters were conducted in every station. No CTDs without discrete water sampling were done. Between CTD stations, ADCP and TSG measurements were continuously conducted.
The water sampling program included measurements of all level 1 variables as defined by GO-SHIP (i.e. oxygen, macro-nutrients, transient tracers and the carbonate system) and measurements of the biogeochemical EOVs. These data will be used to quantify trends and variability of ventilation and biogeochemical cycles, in particular uptake of anthropogenic carbon.

The main focus of this cruise lied on two north-south transects through the Western Mediterranean Sea (figure 1) crossing the Tyrrhenian and the Algero-Provencal basins, which are candidate to become repeat hydrography associated lines in GO-SHIP (TAl-Pro lines). Primarily, it was planned to end the Western section in Algerian waters, to measure the water masses coming from the Atlantic Ocean. However, diplomatic permissions were not granted by Algeria, so a number of additional stations have been planned in Italian waters. Figure 1 shows the planned station map and the stations that were actually performed (80% of the planned activity). The reasons for this reduction were that we were forced to conduct the cruise following a clockwise route, rather than the originally planned counter-clockwise route (the reasons for this can be read in the narrative of the cruise, in section 4). Also, during the final days of the cruise, the outbreak of severe weather conditions in the Gulf of Lion region was an additional obstacle.

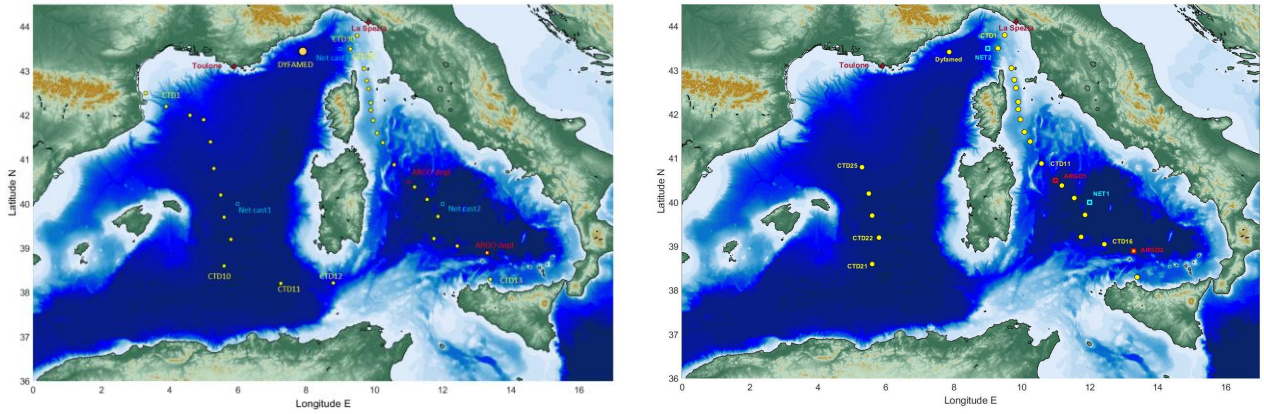

Figure 1. Map of planned stations (left) and map of actual stations carried out (right).

4. Narrative of the cruise

Note that all times in the narrative are expressed as local time

16.05.2022: Arrival of participants and equipment at the port of La Seyne sur Mer, mobilisation, embarkation, set-up of the laboratory spaces.

17.05.2022: at 8:00 all people are on board, we meet for a safety briefing and make a scientific meeting in the Science Lab at Deck 6, and at 11:00 we leave the port. At 12:00 we receive the notice that the Spanish authorizations will not be issued in time. After a briefing with the Captain it is decided to take the clockwise route (first Tyrrhenian Sea from north to south), hoping that when we will be in Spanish water the permissions have arrived. This would take us 1.5 days more of transit time. At 16:00 an abandon ship exercise is done. At 17:00 we make a test cast at the surface to check the well-functioning of the carousel. The test went well. At 20:00 we submit a request of integration to the Italian authorities to have a plan B and do the Algero-Provencal transect (part of it) in Italian waters, instead of Spanish waters.

18.05.2022: At 5:45 we arrive at the first station CTD1. We had some initial problems with managing the cast (the deck unit is 2 decks upstairs with respect to the lab from where we acquire the CTD data). The echo-sounder was not working properly at the beginning, and many bottles were leaking. More caution is required when arming the bottles, since the rubber bands have been replaced with steel springs, which could damage the O-rings if bottles are not opened carefully. We continue with the casts, at 10:48 the CTD2 cast is complete, This time only 2 bottles were leaking. The weather and sea are extremely calm, this allows us during sampling to go to the next station at full speed. At 14:00 we arrive at CTD3, we close to test the bottles that were leaking, without sampling from them. In the meantime we took the decision that the final port should remain La Spezia (and not to Toulon, as proposed by the Captain, to save time), whatever will be the outcome of the authorization issue, we will adapt to the situation. At 14:15 we start the CTD3 cast, and finish 1 hour later. We head towards station CTD4. Bottles are not leaking anymore. We start sampling for salinity. At CTD4 the altimeter has started working, so we can trustfully stop at 10m from the bottom. We spent the night doing CTD5-6-7-8.

19.05.2022: the event logger EARS stopped working during the night. At 8:00 we start the CTD9 after breakfast and at about 10:00 we head towards station CTD10. The O-rings keep getting damaged because of the steel springs, and to replace them the technician is going to take them from the spare rosette. At 18:00 at CTD11 we are reaching deeper and deeper depths, which with the new winch have never been reached before. This means that we are experiencing many technical stops to re-align the wires. We finished 3 hours later and are now heading to the deployment point of the Argo Float sent to us by OGS. At 22:00 we deployed the first Argo Float. We arrived at 24:00 at CTD12, and there were a lot of problems with the winch, such that the station (2925 m) took almost 6 hours.

20.05.2022: At 8:45 we go into the water for CTD13. The salinometer Portsal from OGS seems to perform well and is very stable. Event logger EARS is still not working. At 13:10 we start the net cast for the EF+ RTA project IsoMed by Sarah Magozzi (SZN, Naples) at 40° 06,620'N, 11° 34,184'E, we reached 200 m depth at 13.24 and started towing it for 10 minutes at 1,8 knots. We needed to put 30 kg weight on the net to make it downcast properly. We caught a jellyfish and a lot of tiny plastic items. We did just 1 cast (instead of 3) and we will skip the Algero-Provencal net cast. We will try to make 3 casts in the Ligurian Sea if there is still time. At 16:40 the Spanish diplomatic clearances arrived, so we re-calculated the timing of the whole route. Unfortunately a Mistral event will not allow us to complete the second transect, but we will do it only partially. At 21:20 we finished station CTD14, the deepest of the whole campaign (3500 m), and it took us 5 hours. Winch is slow and needs frequent stops.

21.05.2022: Today the risk level of the ship goes from orange to yellow, this means that we can finally stop using masks during work. Today we start doing the last 3 casts of the Tyrrhenian Sea, and after that we will have 36 hours transit time. CTD17 started at 14:19 with just a quick surface cast to close 3 Niskin bottles to sample seawater at 10 metres for an incubation experiment of the CNR-IBF group. Then we proceeded with the deep cast (3450 m), and after leaving the station we deployed the second Argo float of OGS at 20:49. We arrived at the last Tyrrhenian station at 00:30 on 22.05.22.

22.05.2022: After finishing the cast during night we head full speed towards the first station of the second transect, CTD21, where we will arrive tomorrow morning. The day is used to process some data, bottle files, calibrate the ctd salinity, finish to measure samples, write on the cruise report and prepare the CSR, as well as finally for a proper group photo.

23.05.2022: The sea and the weather conditions are changing, we arrive at 10.30 at the first station of the second transect, CTD21 (CTD19 and CTD20 were cancelled due to lack of time). Arrival at CTD22 at 16:30, cast for 3.5 hours, to rapidly reach CTD23, because tomorrow the Mistral starts. Station CTD23 starts at 23:30.

24.05.2022: We start early morning doing CTD24, the waves are not yet high, so we are comfortable even with sampling. We headed towards CTD25, and then it was decided that the weather would not allow us to do CTD26. At around 17:00 we thus start to transit towards DYFAMED.

25.05.2022: At 16:15 we arrive at the last station, DYFAMED. After the cast, which finished at 19:15, we did the last 3 net casts for the EF+ RTA IsoMed project, to collect the Ligurian Sea samples. At 21:00 we depart towards La Spezia.

26.05.2022: arrival at La Spezia at 11. Cleaning and preparation of boxes waiting for customs.

27.05.2022: Customs, disembarkment of equipment, loading in trucks and vans, and departure.

5. Methods and Preliminary Results

5.1 Physical Measurements

The sampling during the TAlPro2022 cruise can be divided in two main categories: on-station sampling (CTD and LADCP stations) which required the ship to stop in order to deploy instruments over the side and Underway samplings (thermosalinograph, ferrybox, weather station and VM-ADCP) which does not require the ship to stop.

5.1.1 On-station measurements

5.1.1.1 CTD data and sensor calibration

(K. Schroeder, M. Borghini, F. Falcieri, L. Coppola, M. Fourrier)

During TAlPro2022 Cruise a total of 24 CTD-stations were carried out for the hydrographic and biogeochemical survey, as well as for vertical current profiles (LADCP system). At all stations seawater samples were taken, for chemical measurements. The detailed sampling schemes at each station, with all sampled parameters indicated, are shown in Section 6 .
The CTD system used on board was a Seabird SBE9plus + CTD from BELSPO connected to a SBE11 deck unit, configured with a 24- position SBE-32 pylon with 24 10 litre Niskin bottles. The CTD was set up with a temperature sensor, conductivity sensor, oxygen sensor, turbidimeter and altimeter. One test station was performed before starting the programmed ones.

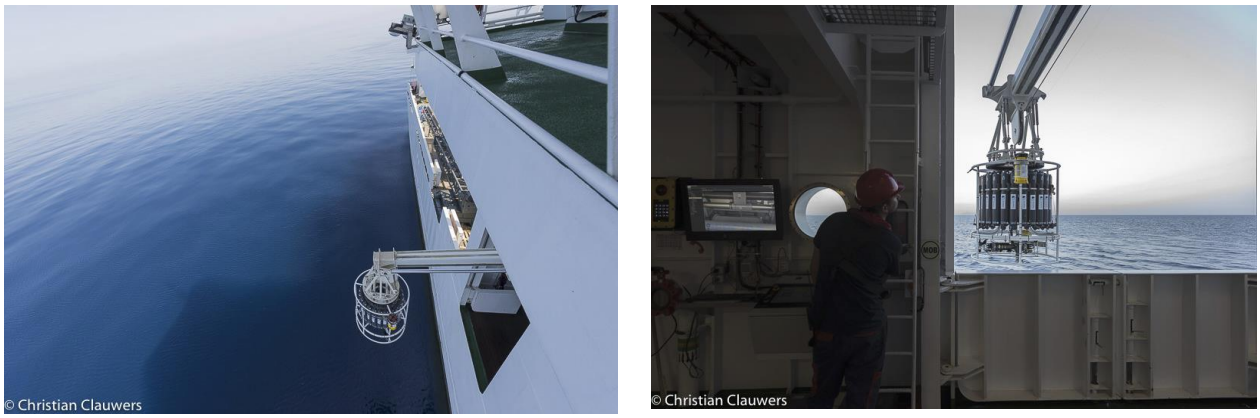

Figure 2. CTD deployment from RV Belgica. Credits: C. Clauwers.

Temperature, salinity and pressure data were post-processed by applying Seabird software and MATLAB routines. At this stage, spikes were removed, 1 dbar averages calculated.

Salinity calibration

During 13 stations probes at up to 15 levels were taken for salinity analysis. The samples were analysed on board using a Guildline Portasal Salinometer (borrowed from OGS, Figure 3 left). The batch-no. of the standard seawater samples is 165 which have a K21 factor of 0.99986 (practical salinity = 34.994).

Figure 3 shows an example of the salinity values from the CTD derived bottle files (blue lines), and the corresponding salinity values measured in the samples (red circles). The conductivity sensor was last calibrated in August 2020. The existing difference is appreciable by eye, showing that a correction was needed.

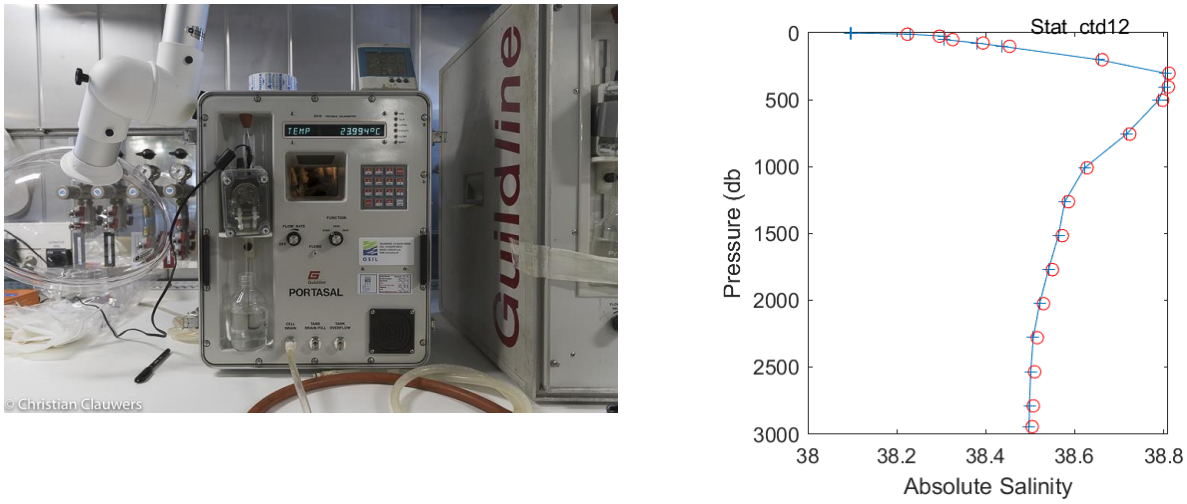

Figure 3. (left) Portasal Salinometer on RV Belgica (credits: C. Clauwers), (right) Comparison between salinity values as measured by the sensor (blue) and by the salinometer (red).

The slope factor, needed to correct the CTD salinity data, is calculated as follows:

$$slope = \frac{\sum_{i=1}^{n} \alpha_i \beta_i}{\sum_{i=1}^{n} \alpha_i \alpha_i}$$

Where n is the number of samples, α is the CTD conductivity and β is the true (bottle sample) conductivity.

CTD pressure (dbar)	CTD pot. temperature (°C)	CTD salinity	Bottle salinity	CTD postcal salinity
3045	12.9905	38.4946	38.5023	38.5042
2035	13.0821	38.5129	38.5287	38.5315
1010	13.3979	38.6071	38.613	38.6167

Table 1. Example of the effect of the post calibration in one of the Tyrrhenian stations

We calculated a slope of 1.00018713, and applied it to the CTD data to correct for this bias. (excluding the first 100 m).
The pre-calibration mean difference between CTD-Sal and BTL-Sal was -0.0108, the post calibration difference was -0.0012. The result of applying this correction factor can be seen in the following graphs.

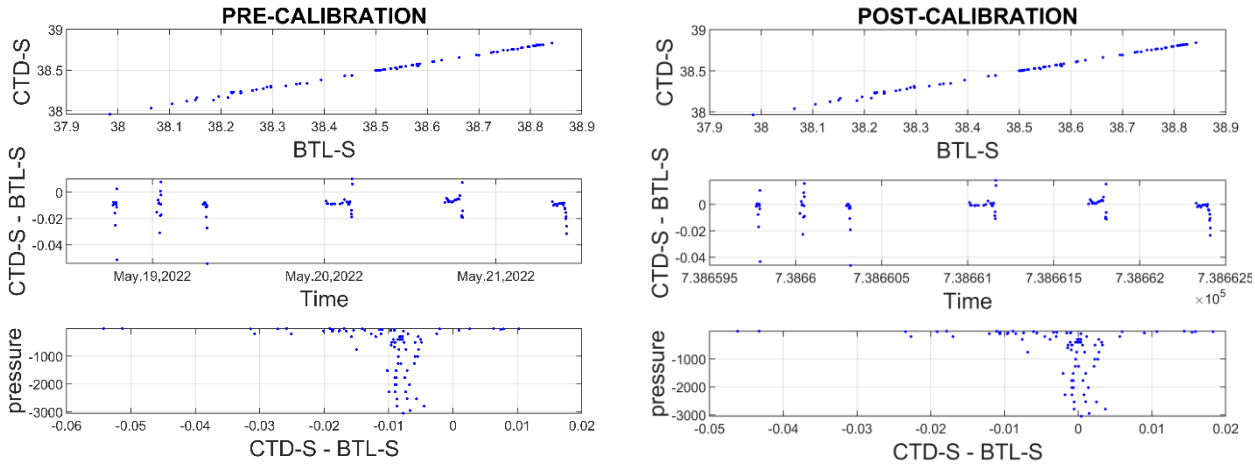

Figure 4. Scatter plot showing the relation between CTD-salinity and bottle-salinity, the evolution over time of the differences between CTD-salinity and bottle-salinity, the vertical distribution of the differences between CTD-salinity and bottle-salinity (left) before applying the slope correction and (right) after applying the slope correction.

There seems not to be any drift in time, while the depth-dependence of the spreading of the (CTD_S – BTL_S) values is quite evident, showing less variability at depth. After calibration, the spread is closer to 0 at depth.

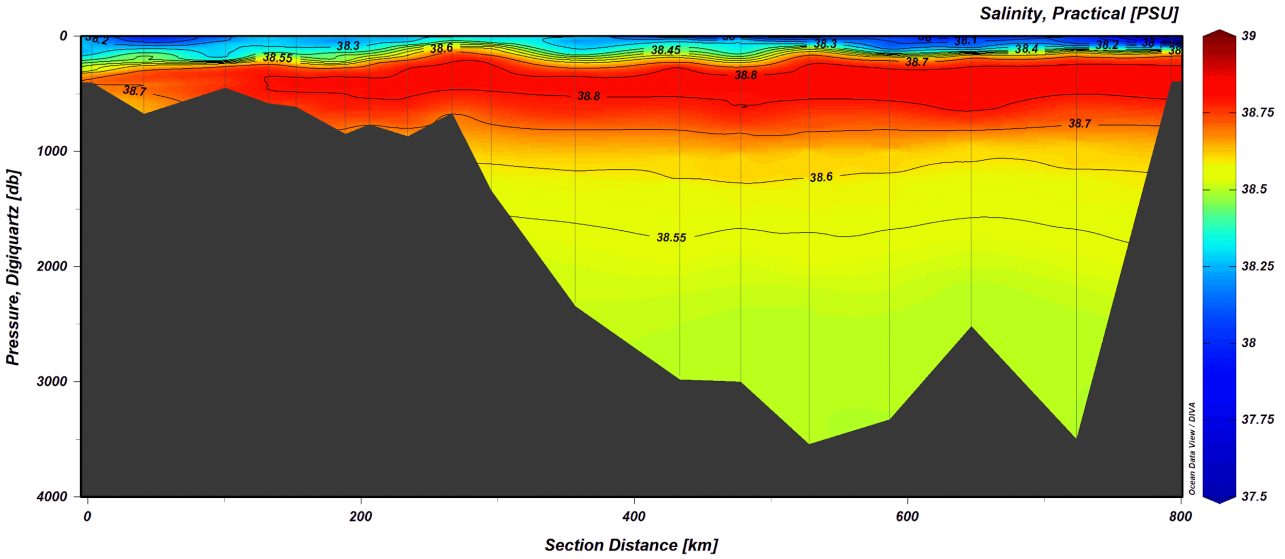

Figure 5. Salinity section in the Tyrrhenian Sea (north is left), using post-calibrated CTD data.

Dissolved oxygen calibration

In this section we describe the Winkler calibration and the method for computing the new SBE43 coefficients. The Winkler analysis performed during the TAlPro2022 cruise provided a reference dataset to adjust the SBE43 calibration coefficients for the entire water column. For that, Winkler samples have been collected at nearly all stations and we applied a least squares method to minimise the difference between the Winkler values and those provided by the SBE43 sensor. Based on the raw data processing algorithm (Owens and Millard, 1985), three SBE43 calibration coefficients were adjusted (the oxygen signal slope, the voltage at zero oxygen signal and the pressure correction factor) by minimising the sum of the square of the difference between the Winkler oxygen values and oxygen derived from the sensor signal. The accuracy of the SBE43 adjusted values is around ± 2 µmol/kg. More details on the chemical methods and sampling procedure can be found in section 5.2.1.

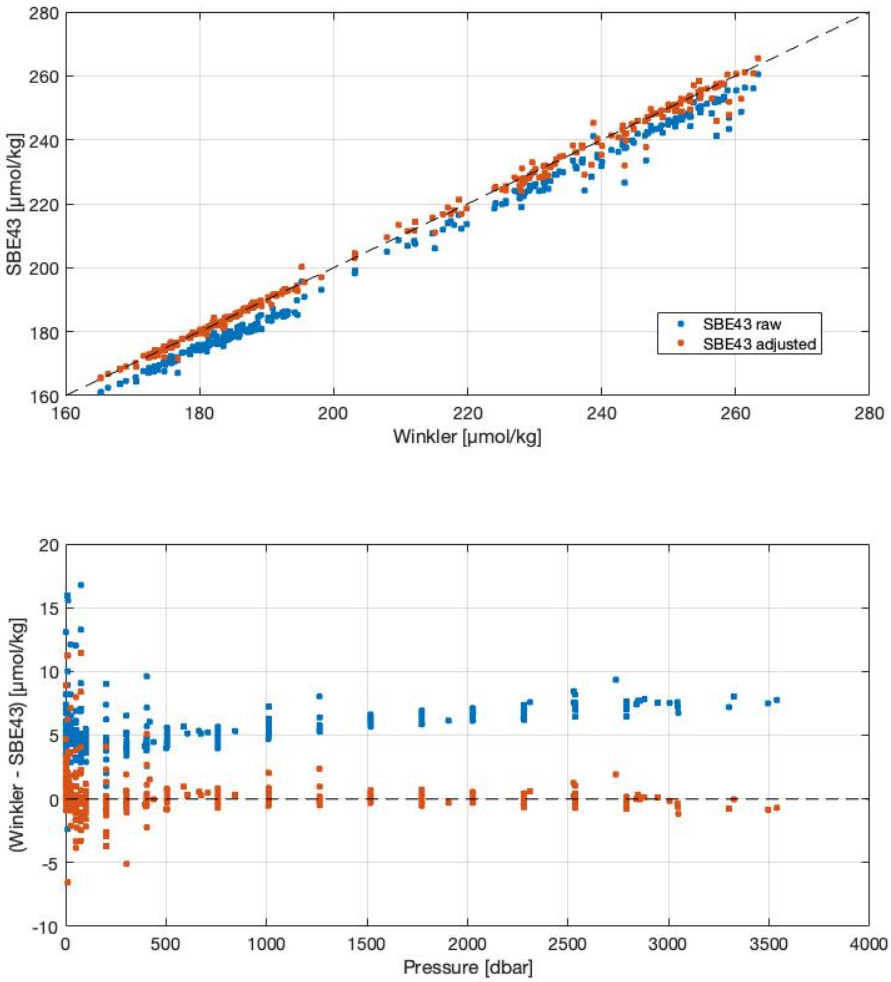

Figure 6. Comparison of SBE43 and Winkler O_2 concentrations (µmol/kg) for all stations (top); dispersion of Winkler - SBE43 data over the whole pressure range (bottom). The blue and red dots represent the raw and adjusted sensor data respectively.

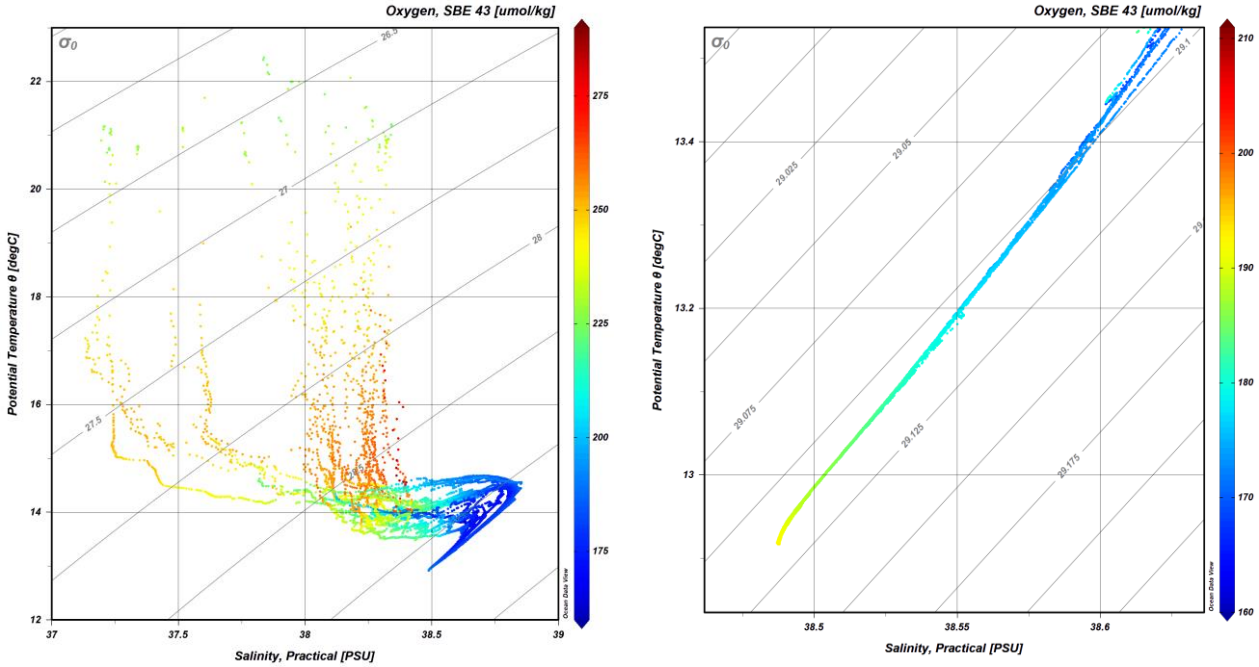

Figure 7. TS-diagram with dissolved oxygen values: (left) for all stations and surface-to-bottom, (right) zoom on the deep layer (>500 m) in the Algero-Provencal basin.

5.1.1.2 LADCP measurements

(M. Borghini, K. Schroeder, F. Falcieri)

In order to obtain full-depth ocean velocities two ADCPs are lowered to some distance above the seabed and raised back to the surface, together with the CTD-rosette system. While the LADCPs are in the water they use acoustic pings to collect short (order 100 m) velocity profiles measured in the frame of reference of the moving instruments. In order to combine those short profiles into a record of full-depth absolute (i.e. in the Earth's frame of reference) velocities, the effects of the instrument motion must be removed, by using additional constraints to reference the velocities.

During the TAlPro2022, the system was composed of two Workhorse ADCPs (WH 300) manufactured by RD Instruments and operating at a frequency of 300 kHz. One of the ADCPs is looking upward (Slave s/n 1805) and the other one is looking downward (Master s/n 1465). Thanks to the downward-looking ADCP, within acoustic range of the seabed, it was possible to track the instrument velocity over ground, providing a constraint for the LADCP profiles near the seabed.

LADCP measurements were done at all CTD stations. The gained data were processed with LDEO Matlab LADCP-processing system Version 9.14 (Thurnherr, 2021). This software uses the raw LADCP data, processed CTD data and navigational data from the CTD. The resulting data are the vertical profiles of u- and v- velocity components. The depth has a bin size of 4 m.

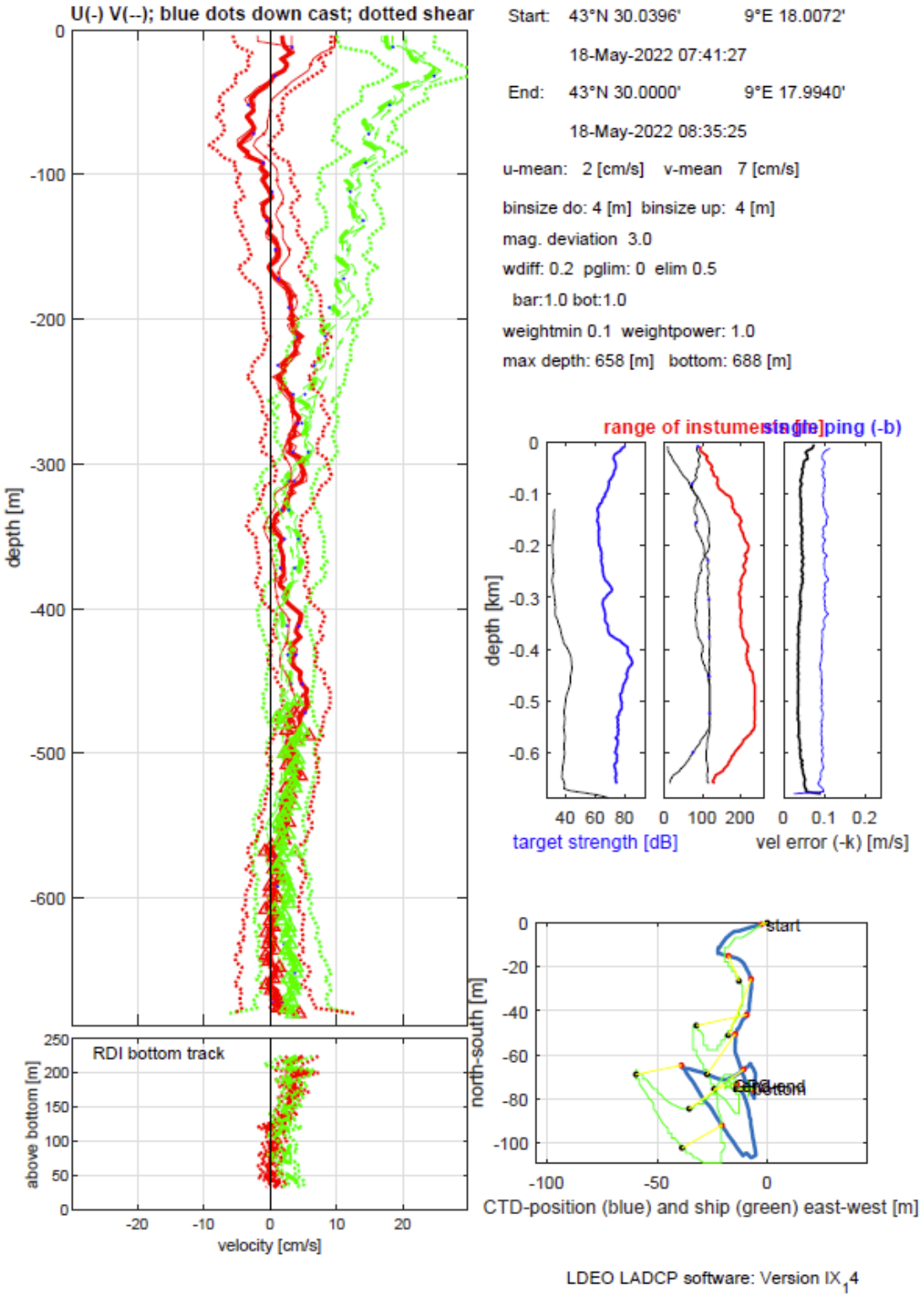

Figure 8. Overview plot of station CTD2. Main panel: eastward (red) and northward (green) velocities: full solution with error bars, down- & up-cast solutions, shear solution and bottom-track. Bottom-left panel: bottom-track velocities. Bottom-right panel: Ship- and instrument-drift during cast. Centre-right panels: target-strength, range and error proles. Top-right text: meta-data and velocity- referencing constraints used for processing.

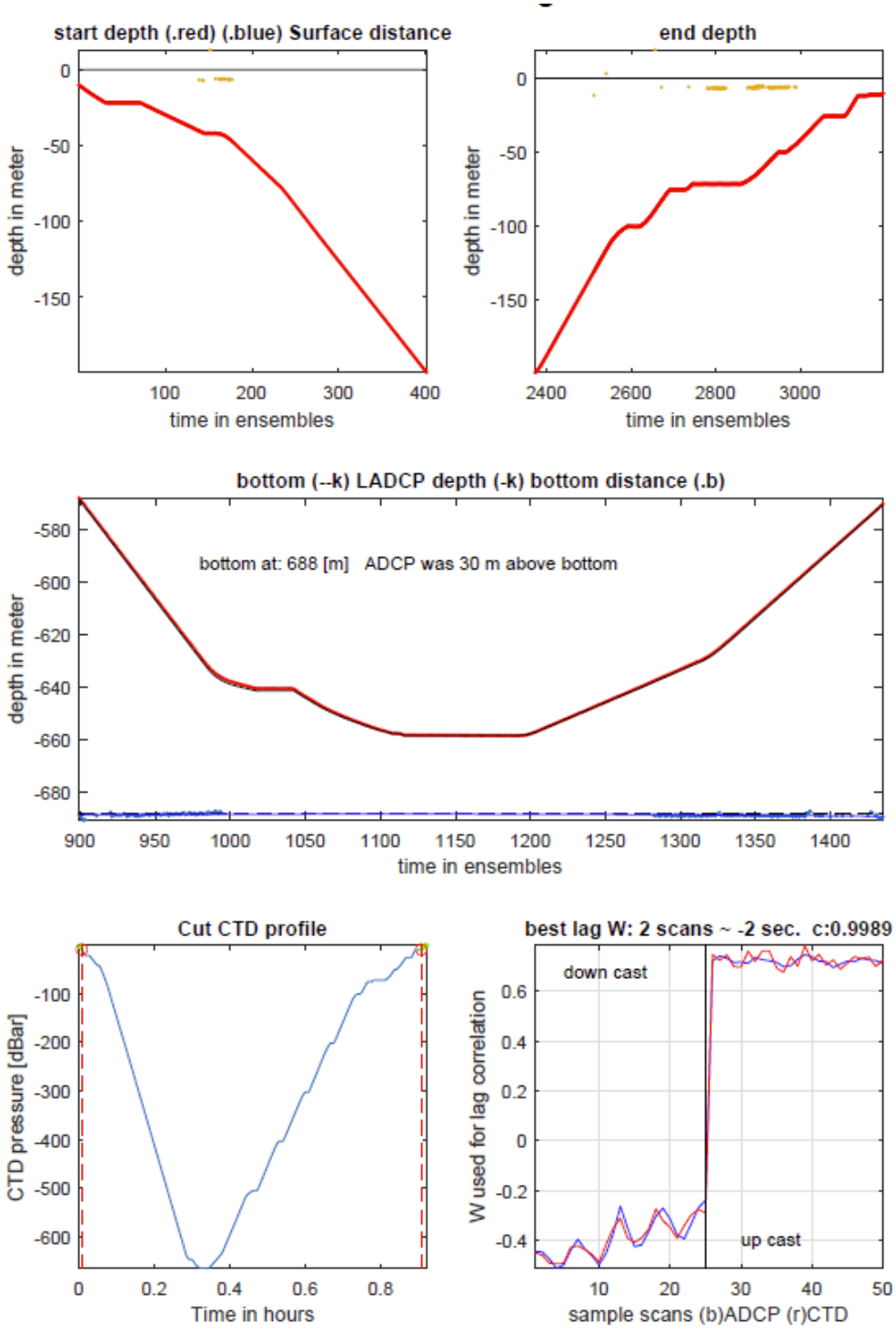

Figure 9. Surface/seabed detection and CTD/LADCP time-series match (example from station CTD2). Upper panels: beginning and end of cast (red) with detected sea-surface (yellow). Centre panel: bottom of cast (black: from CTD depth, red: from LADCP w) with detected sea-bed (blue). Bottom-left panel: Time-range of cast (dashed red lines). Bottom-right panel: details (left: downcast, right: upcast) from CTD/LADCP time-series match.

5.1.2 Underway sampling

5.1.2.1 Thermosalinograph and FerryBox measurements

(A. Bosse, L. Coppola)

Underway temperature and salinity surface measurements were continuously acquired through a SeaBird thermosalinograph (TSG). The vessel manages the data acquisition.
Temperature and salinity measurements were validated and compared with the surface data of each CTD cast. In the visualisation and further analysis, the data was averaged over 15 min intervals, so that spikes and fluctuations were removed. Overall surface temperature and salinity data show reasonable values along the whole cruise. Surface temperature and surface salinity are depicted in Figure 10. For temperature the SBE38 sensor measured directly the SST, while the SBE21 measured temperature inside the TSG circuit and showed slightly higher values.

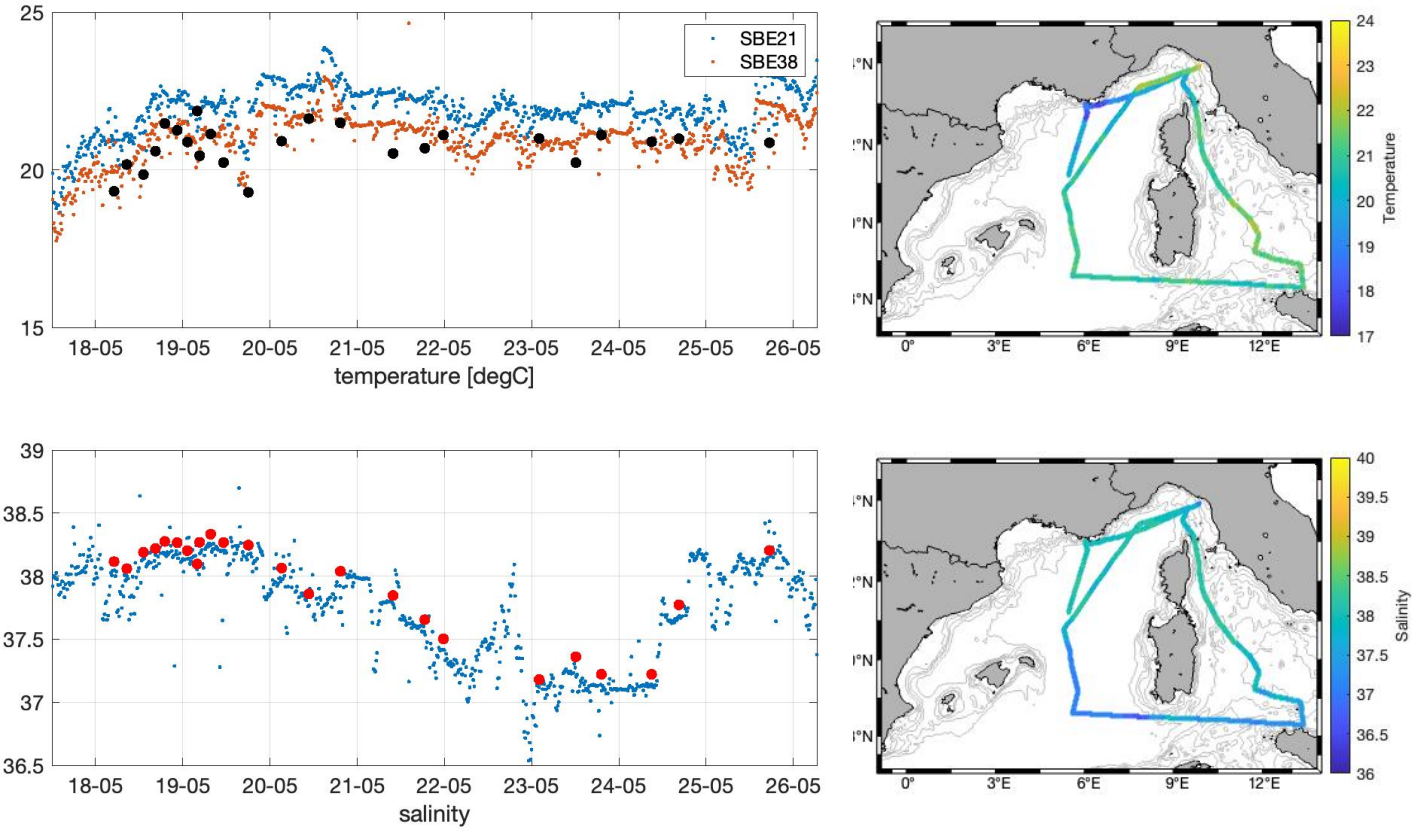

Figure 10. Left panel: Surface temperature recorded by SBE21 and SBE38 sensors (top) and surface salinity, both compared with CTD casts data (dots). Right panel: SST and SSS values measured by the TSG instrument during the cruise route.

The SubCtech OceanPackTM flow-through systems are also known as "FerryBox" or "Underway" systems. It measured all types of environmental parameters in sea water or fresh water such as temperature, salinity, dissolved oxygen, pH value and SubCtech pCO_2. During the TAlPro2022 cruise neither pH nor pCO_2 have been working properly and we will focus here on T, S, O_2 data only. The SubCtech data have been averaged over 15 min intervals to remove spikes and outliers. T, S, O_2 data

have been also compared with CTD casts performed during the CTD stations. For temperature and oxygen we estimated an offset of around -1.52°C and -51.86 µmol/kg (underway sensors overestimated the in situ values), which was probably due to a measurement of temperature inside the circuit for T sensor and a bad calibration for the oxygen sensor (optode).

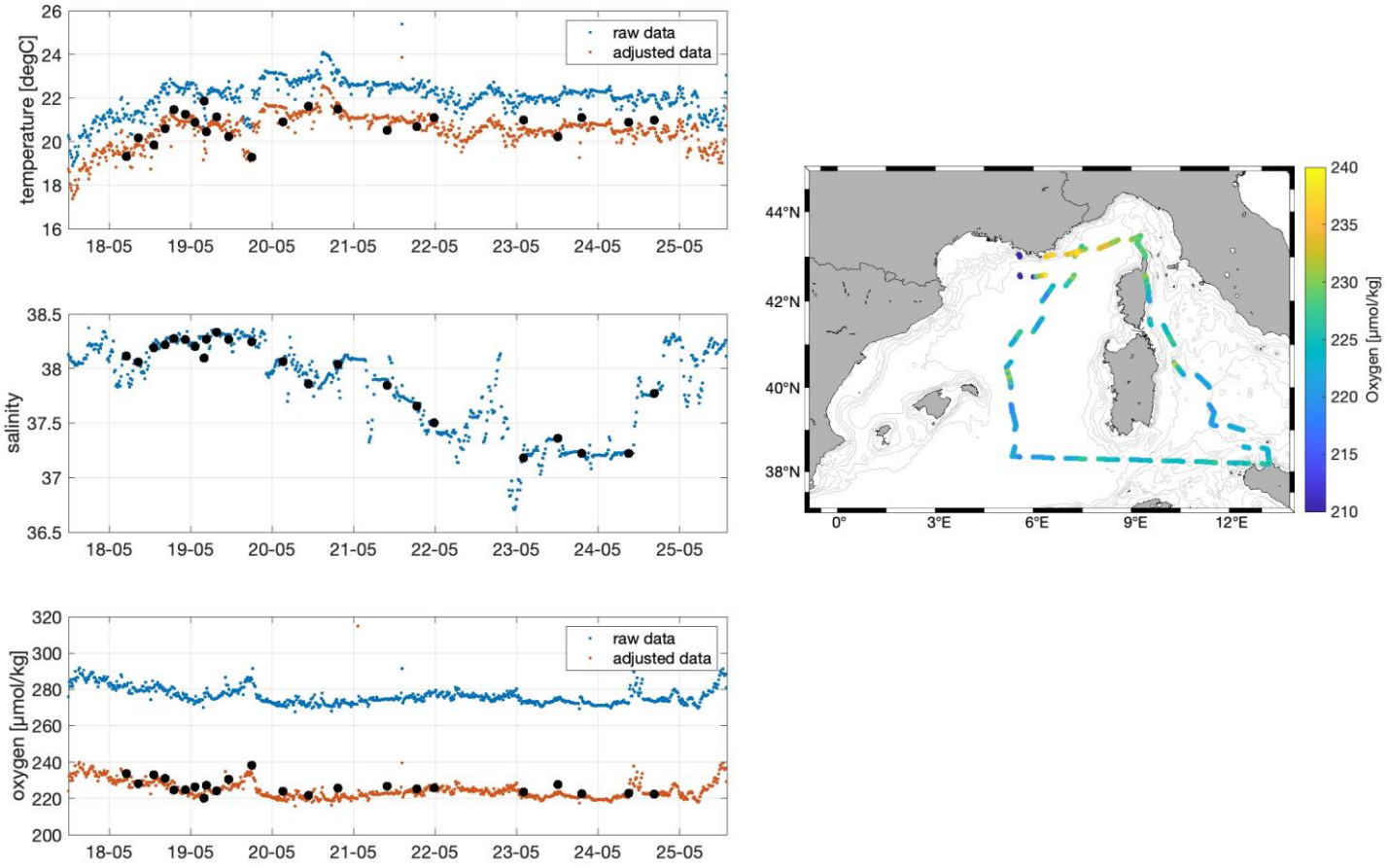

Figure 11. Left panel: Surface temperature, salinity and oxygen measured by the SubCtech system during the cruise and compared to CTD casts (blue dots raw data, red dots adjusted data). Right panel: surface O_2 variability during the cruise route (with removal of bad data).

5.1.2.2 Weather station

(K. Schroeder)

A Campbell Scientific Weather station was installed on a foldable mast on the ship and measured continuously the following parameters: Air Temperature, Relative Humidity, True Wind Speed, True Wind Direction, Atmospheric Pressure, Solar Radiation Density, Solar radiation Total. In Figure 12 only temperature and atmospheric pressure are shown.

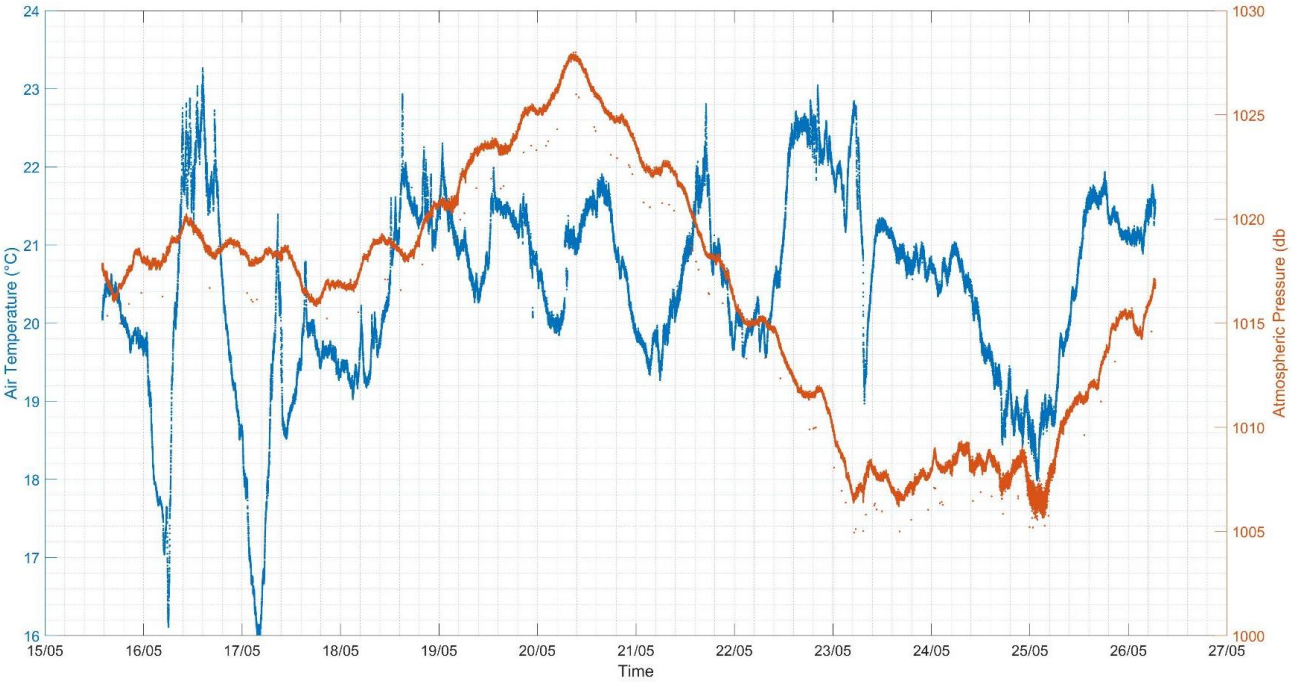

Figure 12. Temporal evolution of air temperature and atmospheric pressure during the whole cruise.

5.1.2.3 Current measurements with two VM-ADCPs

(A. Bosse)

The hydrographic data set has been integrated with direct current measurements. During the whole campaign, underway measurements of horizontal oceanic currents were taken with two vessel-mounted VMADCPs Ocean Surveyor (Acoustic doppler Current Profiler, ADCP) from RDI. The first works with a frequency of 75 kHz and covers approximately the top 500-700m of the water column. The number of bins was set to 45 with a bin size of 16 m. The second works with a frequency of 600 kHz and covers the top 33 m with a higher resolution (128 bins of 0.25 m), but in practice only the top ~12 m were sampled with good data.

Both instruments run in narrowband mode and were controlled by computers using the conventional RDI VMDAS software under a MS Windows system with a pinging set as fast as possible. No interferences with other used acoustical instruments were observed. The ADCP data will afterwards be post-processed with the CODAS3 Software System, which allows extracting data, assigning coordinates, editing and correcting velocity data. Moreover, the data were corrected for errors in the value of sound velocity in water, and misalignment of the instrument with respect to the axis of the ship.

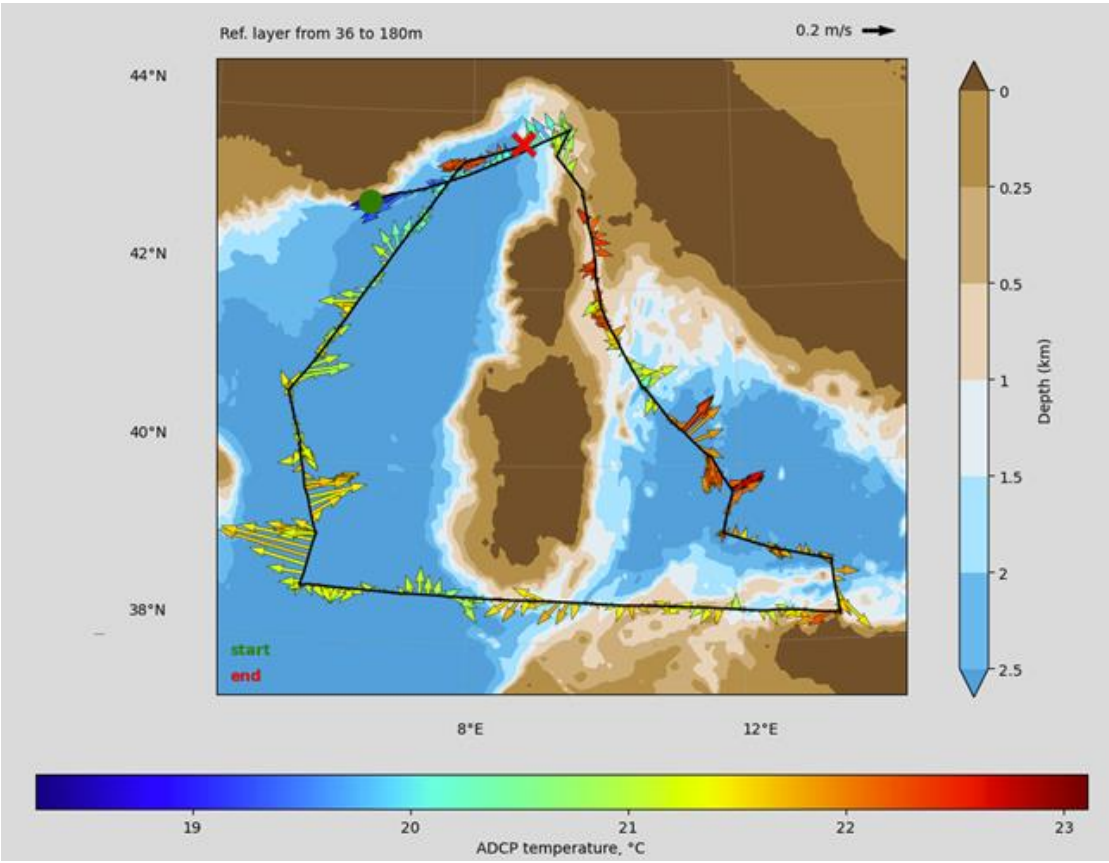

Figure 13. Ship trajectory during the TalPro2022 cruise with arrows representing the mean horizontal currents between 36 m and 180 m measured by the RDI Ocean Surveyor 75kHz VM-ADCP and colored by sea surface temperature.

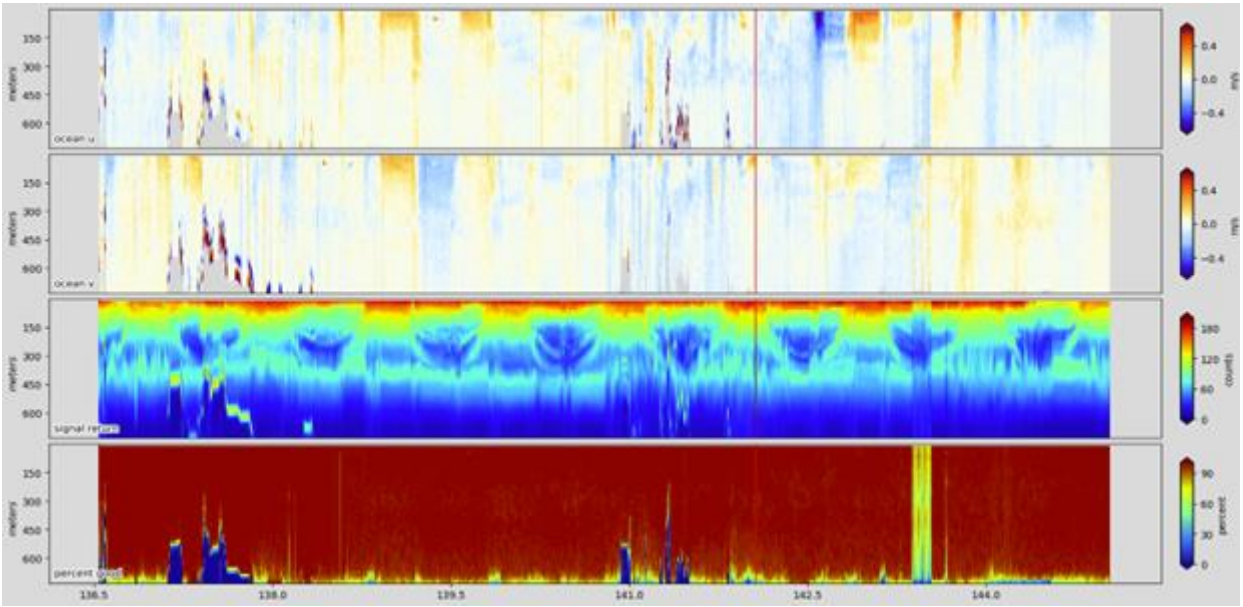

Figure 14. ADCP data acquired by the RDI Ocean Surveyor 75kHz ADCP according to depth (from top to bottom): zonal and meridional component of horizontal ocean currents, signal return and percent good.

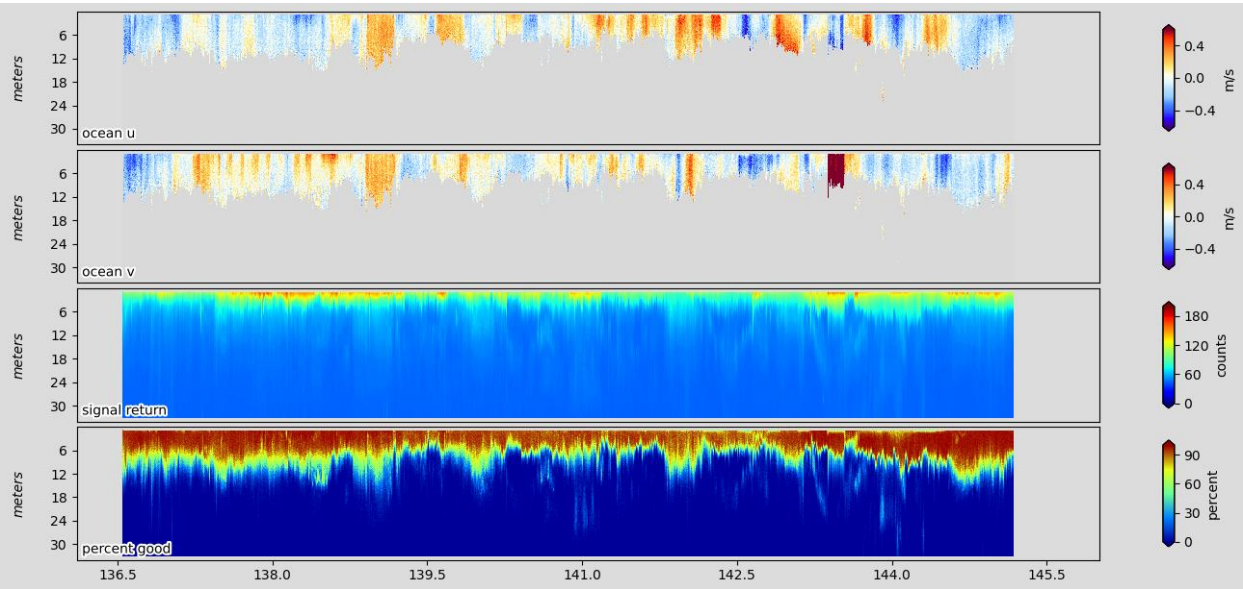

Figure 15. Same as Figure 14, but for the RDI Workhorse Mariner 600kHz ADCP.

5.2 Chemical Measurements

5.2.1 Dissolved Oxygen

(L.Coppola, M.Fourrier)

The O_2 measurements were performed using a Seabird SBE43 sensor calibrated with Winkler measurements performed on board. Water samples were collected from CTD-rosette casts equipped with Niskin bottles. Seawater was sampled at different depths from the surface to just above the seafloor at all stations. The calibration coefficients of the SBE43 sensor were adjusted for the whole cruise using the least-squares method as described in section 5.1.1.1.

The Winkler method (Winkler, 1888; modified Carritt and Carpenter, 1966) is based on photometric endpoint detection (Williams and Jenkinson, 1982). Samples were collected in borosilicate vials with a nominal volume of 120 mL and fitted with diving caps. The bottles were calibrated/weighed at the MIO (Mediterranean Institute of Oceanography) laboratory. For this sampling, a flexible silicone tubing is added to the nipple of the Niskin bottle and is placed at the bottom of the bottle. After three successive rinses, the bottle is filled to overflowing to ensure no air bubbles were present. After the immediate addition of RI and RII reagents, the samples are closed, shaken (once directly after closing them and a second time before placing them in the dark until analysis) and kept in the dark in a water bath making sure the neck of the bottle is underwater to prevent any gas exchange until their analysis, which was performed within a minimum of 4 hours and a maximum of 24 hours.

The titrations were performed in vials (previously weighed) with a Metrohm 765 Dosimat titrator with a 1 ml exchange burette, a transmittance measurement system equipped with a photocell (made by D. Lefèvre) and a Metrohm E649 magnetic stirrer. The titrator is controlled by the acquisition software under Virtual Basic. The thiosulfate solution was calibrated by titrating it against a potassium iodate certified standard solution of 0.0100 N (CSK standard solution, WAKO).

Figure 16. Sampling detail and Winkler titration system used during the cruise. Credit: C. Clauwers.

In total, 326 Winkler analyses at 20 stations were carried out (see details on sampling on the schemes at the end of this document). Of these samples, 14 have been classified as being of poor quality (QF 4), due to leaking Niskin cylinders, problems with the software during measurements and/or with the volume supplied by the H_2SO_4 dispenser.

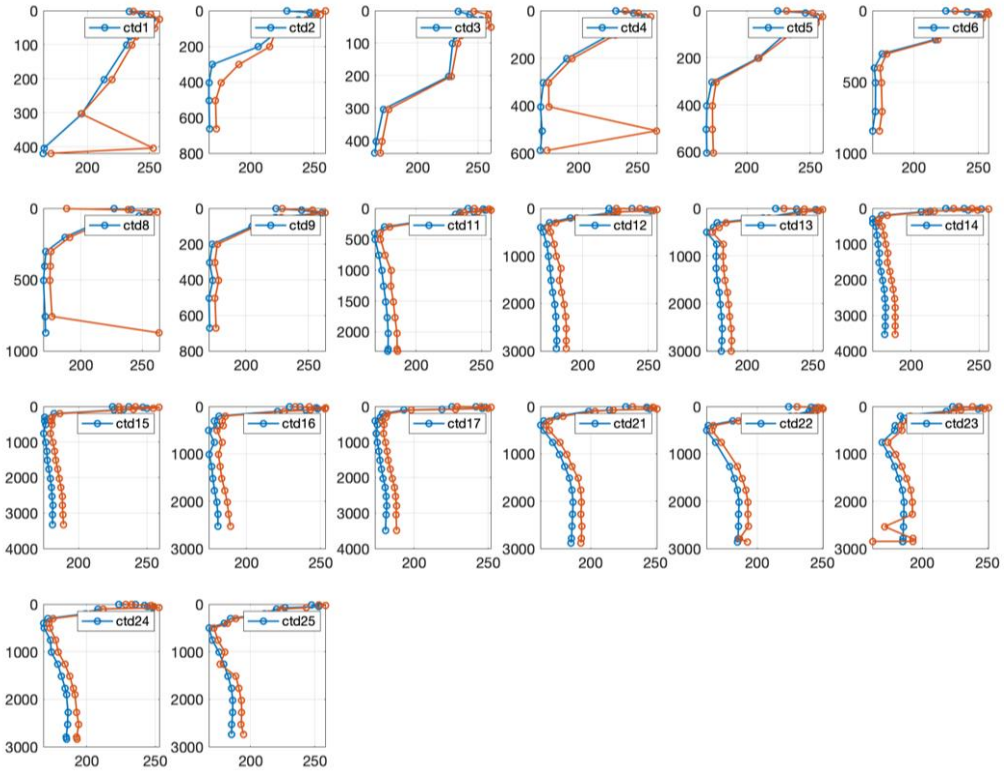

Figure 17. Vertical profiles of O_2 concentrations provided by the SBE43 sensor (raw data in blue) and Winkler (red data) over the 20 stations sampled during the cruise.

5.2.2 Nutrients (nitrite, nitrate, phosphate, and silicate)

(A. Bosse, N. Garcia)

Inorganic nutrients were collected onboard by A. Bosse for each CTD casts and all bottles. After the cruise, the samples were shipped back to the Mediterranean Institute of Oceanography in Marseille (France) for laboratory analysis (N. Garcia, V. Lagadec).

Samples for nitrate, nitrite, soluble reactive phosphorus (SRP) and silicate determination, were collected into 20mL polyethylene flasks and immediately poisoned with mercuric chloride (10 μgmL^{-1}), according to Kirkwood (1992), and stored for subsequent laboratory analysis. A total of 361 samples were collected on board.

Nitrate (detection limit = 0.05 µM), nitrite (detection limit = 0.03 µM), phosphate (detection limit=0.02 µM) and silicate (detection limit=0.05 µM) concentrations were measured according to the method of Aminot and Kerouel (2007). To ensure the reproducibility of nutrient measurements between analyses, in-house standards were used, which were regularly compared to the commercially available products (OSIL).

5.2.3 CO_2 system variables

(M. Álvarez, R. Acerbi Amigo, M.I. García-Ibáñez, B. Manzanares Obispo)

Three different CSIC centres (IEO A Coruña, IEO Palma, and ICM) collaborated to measure three of the four measurable CO_2 variables during the TAlPro2022 cruise: pH, Total Alkalinity (TA) and Dissolved Inorganic Carbon (DIC). The Inorganic Chemical Oceanography Laboratory from IEO A Coruña (INOCEN, PI Dr. Marta Álvarez, member Rubén Acerbi) led the effort supported by IEO Palma de Mallorca (Beatriz Manzanares) and ICM (Dr. Maribel I. García-Ibáñez). The three sets of CO_2 equipment were installed in the wet laboratory on the main deck next to the hangar, the lab was temperature controlled around 22-23ºC. The lab space and comfort really facilitated the daily work, managing and analysing many heavy sampling bottles.

The number of stations and samples analysed during the TAlPro2022 cruise are summarised in Table 2. CO_2 samples were taken in the following order: pH, DIC, and TA, after samples for CFCs, ^{14}C, and dissolved oxygen (see also sampling schemes in section 6). All samples were taken and analysed on board on every station and depth for pH, and at selected stations and depths for TA (92% of the pH dataset) and DIC (52 % of the pH dataset).

	DIC	**pH**	**TA**
Stations	21	24	23
Samples	195	376	346

Table 2. Sampling and analytical CO_2 effort: total number of stations and samples analysed during the TAlPro2022 cruise.

pH samples were collected directly from the Niskin bottles into cylindrical special optical glass 10-cm pathlength cells, which were filled to overflowing and immediately stopped. After sampling, the cells were stored in an incubator, in which the temperature was controlled at 25 °C. Measurements were usually accomplished within two hours after finishing the rosette sampling.
DIC samples were taken in 500 mL borosilicate bottles. Sampling bottles were rinsed and filled smoothly from the bottom, avoiding the formation of air bubbles, overflowing the water by at least a half bottle volume, and immediately stopped, and kept in the dark at lab temperature until analysis, usually no later than 2 days.
TA samples were collected in 500 mL borosilicate bottles filled to overflowing and immediately stopped, and kept in the dark at lab temperature until analysis, usually no longer than 2 days.
No poisoning with $HgCl_2$ was used.

5.2.3.1 pH determination

Seawater pH was measured using the manual spectrophotometric procedure described by Clayton and Byrne (1993) and Dickson et al. (2007). This method consists of adding a volume of indicator solution to the seawater sample at controlled temperature and measuring a set of four absorbances in the visible spectrum. Spectrophotometric pH in seawater is finally reported at 25 °C and on the Total scale (pH_{25T}), quality flags are also reported using 2 for good data, 3 for questionable and 9 for not measured.

All the absorbance measurements (λA) were obtained in the thermostatted (25 ± 0.2 °C) cell compartment of a SHIMADZU UV-2600 double beam spectrophotometer. The temperature was controlled with a JULABO (12 L) thermostatic bath. The indicator was a solution of purified m-cresol purple (PUR mCP provided by Prof. Byrne, batch FB5-2017) prepared in NaCl (2 mM).

After blanking with the sampled seawater without indicator solution, 50 µL of the indicator solution were added to each sample using an adjustable repeater pipette (Eppendorf Multipette plus). Sample absorbance was measured at four fixed different wavelengths (λ1 = 434 nm, λ2 = 578 nm, λ3 = 487.6 nm, and λ4 = 730 nm), corresponding with the acidic (λ1) and basic (λ2) forms of the indicator corrected for baseline absorbance (λ4). In addition, the sample absorbance was also measured at the isosbestic point (λ3) to monitor sample manipulation and pipette functioning, as the absorbance value at the isosbestic point only depends on the amount of indicator added. The sample pH was calculated on the total hydrogen ion concentration scale, applying the formula by Loucaides et al. (2017) relating the Ratio ($R = (\lambda2 - \lambda4)/(\lambda1 - \lambda4)$) and the mCP characterization covering the salinity conditions in the western Mediterranean Sea.

Since the addition of the indicator into seawater slightly perturbs the sample pH, the absorbance ratios measured in the seawater samples (Rm) have to be corrected into the R values that would have been observed in an unperturbed sample (Rreal). This was accomplished by a series of double additions of indicator to some of the samples, after the regular analysis, thus obtaining two different absorbance readings at the different wavelengths for each sample, each corresponding to the single (R1) and the double (R2) addition of indicator. The second addition of the indicator was performed over 129

samples that covered a wide range of pH (i.e., R), although some results were discarded. This permitted obtaining the correction equation that was used for readjusting the R of all the samples as a function of the measured absorbance ratio (Rm). Figure 18 shows the relationship between the first addition (R1) and ΔR (R2-R1) over a range of R (range of pH). The correction equation was calculated as the linear fit between ΔR (R2-R1) and R1 (=Rm). The final equation obtained was:

$Rreal = Rm - (-0.014 \pm 0.003 \cdot Rm + 0.020 \pm 0.004)$; $r^2 = 0.18$, N = 129

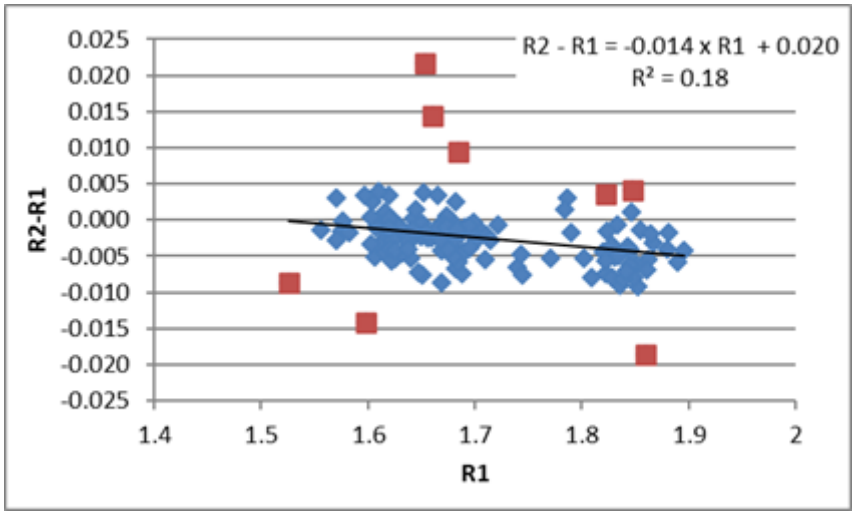

Figure 18. Perturbation of sample pH induced by the amount of indicator (PUR mCP) added, expressed as ΔR (=R_2–R_1) as a function of R_1. R_1 is the first addition and R_2 the double addition of indicator. R is the ratio between absorbances ((578A–730A)/(434A–730A)). Blue dots are those considered good and used to calculate the equation.

This function also corrects for deviations in the linear relationship between absorbance and indicator concentration; i.e., deviations from the Beer Law in the spectrophotometer.

All the pH measurements were referred to 25 °C and corrected for the addition of the indicator using the former formula. The magnitude of that correction over the range of pH observed is small, ranging from 0.0001 to 0.0017 pH units. Along with the calculated pH values and corresponding flags, we report the absorbance measurements, the ratio of absorbances, and the measured temperature of the cell. The ratios should be corrected for the ΔR equation to obtain the ratio introduced in the Loucaides et al. (2017) or any other purified mCP characterization.

The PUR mCP indicator was characterised at the beginning and at the end of the cruise, by measuring R with a 1 mm cuvette (blank = distilled water), to control for any modification in its properties. The indicator was kept in the dark with a butyl stopper. Unfortunately, the labtainer bags bought one year ago did not arrive for this newly prepared indicator solution. The following table shows the R values obtained:

mCP PUR used in the cruise	
Just prepared (05/05/2022)	1.62
End of the cruise (25/05/2022)	1.39

The accuracy of the measurements was controlled by measuring one bottle of Tris buffer (batch #72) provided by Prof. Dickson and calculating the reference Tris pH with the formula by DelValls and Dickson (1998). Results are shown in Table 3.

Cuvettes	pH_T is Meas	Temp (ºC)	Dif Meas - Theoretical
1	8.1051	24.73	0.0032
2	8.0944	24.69	~~-0.0089~~
3	8.1029	24.74	0.0012
4	8.1016	24.76	0.0006

Table 3. pH values of four Tris samples, obtained from one bottle of Tris buffer (batch #72). Mean and standard deviation (STD) of the differences are shown.

Overall, results suggest that the pH measurements are accurate since they show a difference of 0.002 ± 0.001 pH units from the theoretical TRIS pH value at around 24.7 °C. These differences are within the uncertainty of the methodology.
Due to water and time availability, only one reproducibility exercise was performed during the cruise. Several samples were collected from the same Niskin bottle (Table 4). The STD was ±0.0003, which could be considered as the reproducibility of pH measurements during the cruise.

Station - Cast	Niskin	Pressure (dbar)	Salinity	pH_{25T}	Mean ± STD (# samples)
16_1	14	404	38.84	7.9227	7.9228 ± 0.0003 (5)
				7.9228	
				7.9227	
				7.9224	
				7.9232	

Table 4. Characteristics of the replicate samples taken once during the cruise, the mean and standard deviation and number of cells collected for the pH analysis.

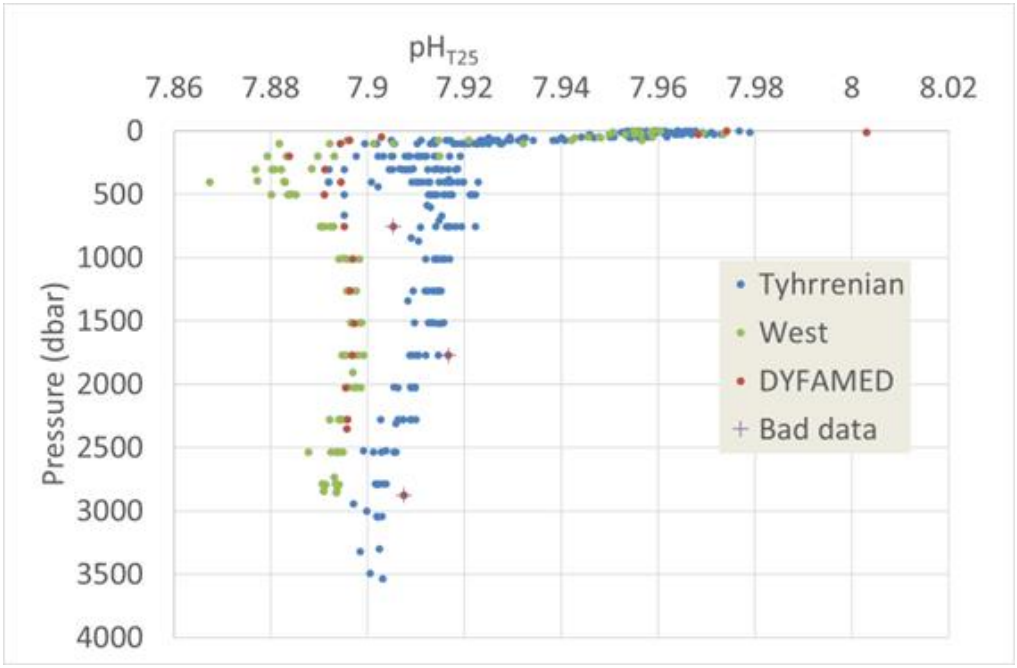

Figure 19. Vertical distribution of pH_{T25} values for different areas: the Tyrrhenian Sea, the Western Basin, and the DYFAMED stations. Three pH measurements flagged as bad are also shown.

5.2.3.2 Total Alkalinity determination

TA was analysed following a double end point potentiometric technique by Pérez and Fraga (1987) further improved in Pérez et al. (2000). This technique is faster than the whole curve titration but produces similar results (Mintrop et al., 2000).

TA was measured using an automatic potentiometric titrator "Titrando 909 Metrohm", with a Metrohm Aquatrode Plus 6.302.6150 combining a glass electrode and a Pt-1000 probe to check the temperature. The system is coupled with a 5 mL exchangeable unit. Potentiometric titrations were carried out with hydrochloric acid ([HCl] = 0.1N) to a final pH of 4.40 (Pérez and Fraga, 1987). The electrodes were standardised using an ftatalate buffer of pH 4.42 made in CO_2 free seawater (Pérez et al., 2002). The 0.1N hydrochloric acid was prepared mixing 0.5 mol (18.231 g) of commercially HCl, supplied by Riedel-deHaën® (Fixanal 38285), with distilled water into a graduated 5 L beaker, at controlled temperature conditions. The HCl normality is exactly refereed at 20 °C. The variation of salinity after the titration is lower than 0.1 units, which is considered in the final TA calculation. Concentrations are given in µmol kg^{-1}.

CO_2 Certified Reference Materials (CRM) analyses were performed to control the accuracy of the TA measurements (Table 5.5.4). Accordingly, the final pH obtained after titrating a CRM at the beginning of each batch of analysis was adjusted to obtain the mean TA closer to the certified CRM value and this adjustment was used for correcting the final pH of all the titrations performed in the respective batch of analysis. Table 5 shows the pH correction (ΔpH) applied to each of the five batches of TA analyses performed and the mean value of the CRM determinations after applying the correction. To check the precision of the TA measurements, surface seawater was used as a "quasi-steady" seawater substandard (SWS). It consists of surface seawater taken from the test station at 5

m depth and stored in the dark into a large container (30 L) for 2 days before use. This SWS was analysed at the beginning and at the end of each batch of analyses to control the drift of the electrode. Each TA sample was analysed twice, being the mean difference between replicates analysed lower than 1.5 µmol kg^{-1} overall.

Batch	Date 2022	Stations	ΔpH	Fitted TA	N	Drift SWS
1	19-5	ST 1 - 9	0.035	2213.64 ± 0.76 (2)	92	-3.1
2	21-5	ST 11-16	0.030	2213.79 ± 0.07 (2)	108	1.7
3	22-5	ST 17-18	0.034	2213.50 ± 0.73 (2)	36	1.7
4	24-5	ST 21-23	0.034	2213.5 ±0 .63 (2)	59	2.0
5	25-5	ST 21-25 & DYFAMED	0.033	2213.59 ± 0.54 (3)	57	3.8

Table 5. Alkalinity analysis supplementary information for each batch of analysis: N_{HCl} is the normality referred to 20 °C of the hydrochloric solution used; ΔpH is the pH correction applied to refer the TA determinations on the CRM to the corresponding nominal value (batch #195, with a certified TA of 2213.51 ± 0.66 µmol kg^{-1}). The mean value of the TA measurements on the CRM samples is also shown (Fitted TA ± standard deviation (number of analysis)). N is the number of samples analysed and Drift is the difference in µmol kg^{-1} for the substandard seawater at the beginning and end of the batch of analysis. N_{HCl} was 0.099177 during the whole cruise, no new HCl was prepared.

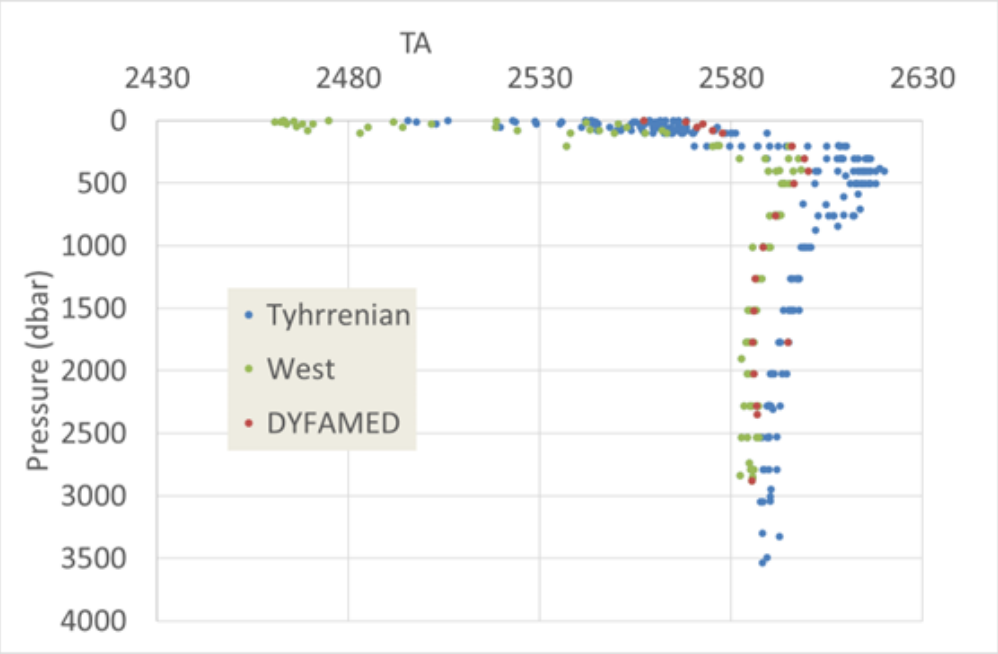

Figure 20. Vertical distribution of TA (µmol kg^{-1}) values for different areas: the Tyrrhenian Sea, the Western Basin, and the DYFAMED stations.

One TA reproducibility exercise was performed during the cruise. Four TA bottles were collected from the same Niskin 1 at station 17_1 (pressure 3500 db, salinity 38.502, and pH_{T25} 7.900) and were analysed twice each. The mean ± STD of the replicates was 2588.77 ± 0.42 µmol kg^{-1}. The cruise TA measurements have an estimated accuracy and precision better than 2 µmol kg^{-1}.

5.2.3.3 Dissolved Inorganic Carbon determination

DIC measurements were performed through a coulometric determination using a VINDTA 3D #75 system (Marianda, Kiel, Germany) coupled with a UIC 5017O coulometer. The sample is drawn into a calibrated pipette (volume of about 20 mL) with controlled temperature of about 20 ºC, this volume is acidified with H_3PO_4 in a stripping chamber. The generated CO_2 is carried into a coulometer cell by a free-CO_2 gas (pure N_2 also passing through ascarite) going through a condenser at a constant temperature of ~ 2 °C. Before entering the coulometric cell the gas is dried passing through magnesium perchlorate. In the coulometer cell, the acid (hydroxyethylcarbamic acid) formed from the reaction of CO_2 and ethanolamine is titrated coulometrically (electrolytic generation of OH^-) with photometric endpoint detection. The product of the time and the current passing through the cell during the titration (charge in Coulombs) is related by Faraday's constant to the number of moles of OH^- generated and, thus to the moles of CO_2 which reacted with ethanolamine to form the acid (Johnson et al., 1993).
The final DIC value (µmol kg^{-1}) is calculated using the following formula:

DIC = (µmol C_{exp}) / Titrated mass

Titrated mass = Corrected Volume (mL) · Density (kg mL^{-1})

Counts: counts from the coulometer.
Blank: number of counts in 10 min. Units: count/min
RT: run time.
CALFACTOR (calibration factor): the ratio of the theoretical CRM concentration and the experimentally obtained one
Temp: measured temperature when the sample is pumped into the pipette (20 ºC - 22.5 ºC).

Each coulometric cell was newly prepared for each batch of analysis, usually after titrating a maximum of 30 total carbon units (the TCT count by the VINDTA system).
Unfortunately, no calibration unit, neither gas loop or other approach were available during the cruise. Therefore, no independent method for checking the accuracy was available. Instead, the accuracy of DIC measurements was assessed using CRM analysis (batch #195 provided by Prof. Andrew Dickson; certified DIC = 2024.96 ± 0.52 µmol kg^{-1}).
The Calibration Factor (CALFACTOR) was calculated by means of obtaining the ratio between the theoretical DIC value of the CRM and the measured one, for each batch of analysis (i.e., each time that a new titration cell was prepared). The CALFACTOR was used for adjusting the final DIC of each sample measured in the corresponding batch of analysis. Table 6 shows the CALFACTOR values obtained for each batch of analysis and the corresponding fitted DIC value obtained after applying it to the measured values of the CRM.

In addition, an extra control was conducted by analysing a seawater substandard at the beginning of each batch of samples. This seawater substandard (SWS) consisted of surface seawater collected from the test station and stored in the dark into a large container (30 L) (salinity 38.046, pH_{25T} 7.948, TA 2542 µmol kg^{-1}). SWS was analysed at the beginning of each batch just before the CRMs and after the junk samples, to check the DIC system. The DIC of the SWS clearly increases over time (Table 6) as it probably equilibrates with the lab atmosphere higher in CO_2 than the atmosphere. Unfortunately, we had no means of producing substandard water with stable DIC values.

About 40 % of the measured samples were replicated, the mean and standard deviation of those differences is also shown in Table 6.

Three samples from the same Niskin bottle were taken to perform a typical reproducibility analysis at station CTD18 niskin 5 (303 dbar, 38.815 salinity, 7.917 pH_{25T} and 2616 µmol kg^{-1} TA). The mean ± STD of the 5 analyses on the replicates was 2336.6 ± 0.8 µmol kg^{-1}.

The cruise DIC measurements have an accuracy and precision better than 3 µmol kg^{-1}.

Batch	Date 2022	Stations	CALFACTOR	Fitted CRM	N data (% replicated)	Mean± STD replicates	Mean± STD SWS
1	19-5	1, 2, 3	1.005971	2025.0 ± 0.2	30 (40 %)	-0.3 ± 1.8	2256.6 ± 0.1
2	20-5	4, 5, 6, 8	1.006174	2025.9 ± 0.3	33 (37 %)	0.6 ± 0.9	2260.4 ± 0.5
3	21-5	11 - 13	1.005001	2023.6 ± 2.1	28 (40 %)	0.3 ± 0.9	2261.6 ± 0.5
4	22-5	14 - 16	1.006708	2025.0 ± 0.6	30 (47 %)	-0.1 ± 1.5	2264.5 ± 1.1
5	23-5	17, 18, 21	1.005778	2025.0 ± 0.5	27 (45 %)	0.6 ± 1.2	2264.9 ± 0.7
6	24-5	22 - 23	1.005483	2025.6 ± 0.6	19 (58 %)	0.2 ± 0.9	2267.0 ± 0.6
7	25-5	24 - 26	1.005794	2026.3 ± 1.9	28 (54 %)	0.1 ± 1.5	2269.9 ± 0.5

Table 6. Dissolved Inorganic Carbon analysis supplementary information for each batch of analysis: CALFACTOR is the correction applied to refer the DIC determinations on the CRM to the corresponding nominal value (batch #195, certified DIC of 2024.96 ± 0.52 µmol kg^{-1}). The mean value of the DIC measurements on the CRM samples is also shown (Fitted DIC ± standard deviation, usually 2 to 3 analyses were done on the same CRM bottle). N is the number of samples analysed. Information about the replicated samples and the SWS used is also provided.

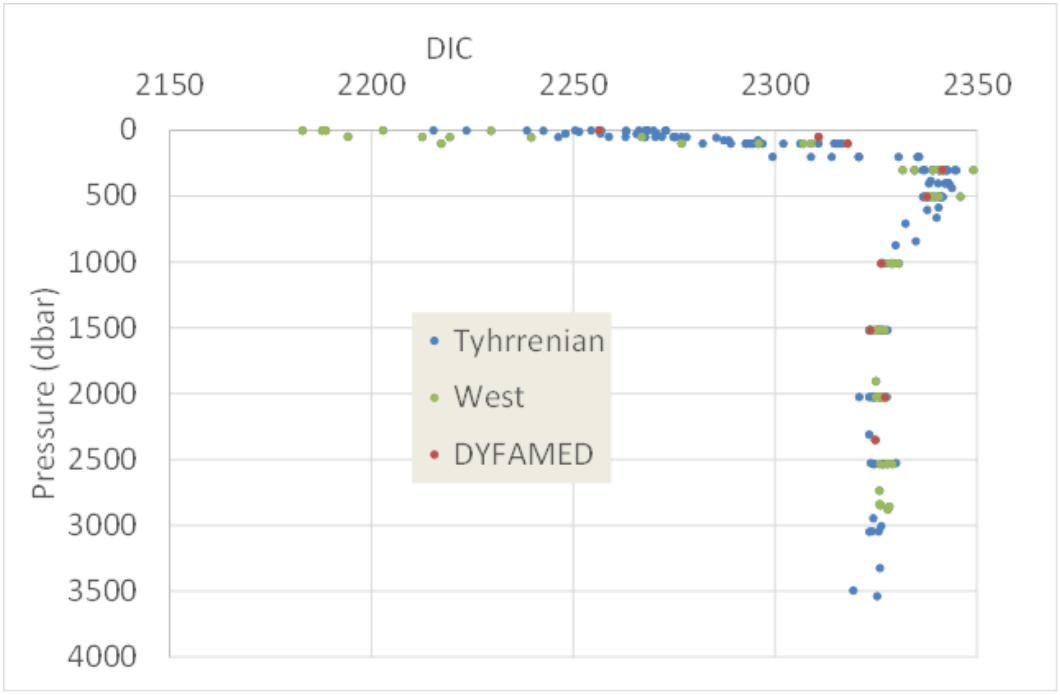

Figure 21. Vertical distribution of DIC (µmol kg^{-1}) values for different areas: the Tyrrhenian Sea, the Western Basin, and the DYFAMED stations.

5.2.4 Measurements of CFC-12 and SF_6

(T. Tanhua, B. Bogner, A.E.R. Hassoun)

Measurements of the transient tracers CFC-12 and SF_6 are used to characterise ventilation in the Mediterranean, and particularly temporal changes in ventilation (e.g. Stöven and Tanhua, 2014; Schneider et al., 2014, Li and Tanhua, 2020).

During the cruise, one GAS CHROMATOGRAPH / PURGE-AND-TRAP (GC/PT) systems were used for the measurements of the transient tracers CFC-12 and SF_6 (system PT4). The systems are modified versions of the set-up normally used for the analysis of CFCs (Bullister and Weiss, 1988; Bullister and Wisegarver, 2008). Samples were collected in 250 ml ground glass syringes. An aliquot of about 200 ml of the samples was injected into the analytical systems. The analytes were stripped out of the water phase by a flow (120 ml/min) of ultra-clean N_2 during 10 minutes to the trap. The trap consists of 100 cm of 1/16" tubing packed with 70cm Heysep D, and is kept at -65 to -73°C during the trapping phase. The trap was desorbed at 100°C and the analytes passed on to the gas chromatograph (GC). The GC was setup with a 1/8" main column packed with 180 cm Carbograph 1AC (60-80 mesh) and a 20 cm Molsieve 5A post-column, kept isothermal at 55°C. The pre-column was packed with 10 cm Porasil C and 20cm Molsieve 5A in a 1/8" stainless steel column. Detection was performed on an Electron Capture Detector (ECD). This set-up allowed efficient analysis of SF_6 and CFC-12.

Standardisation was performed by injecting small volumes of gaseous standard containing SF_6 and CFC-12. This working standard was prepared by the company Dueste-Steiniger (Germany, DS1) and was calibrated vs. a reference standard obtained from R.F Weiss group at SIO in April 2021, and the

tracers are reported on the SIO98 scale in gravimetric units (i.e., pmol kg^{-1} for CFC-12 and fmol kg^{-1} for SF_6). Two calibration curves were measured to characterise the non-linearity of the system, and point calibrations were always performed between stations, or every 6 hours, to determine the short term drift of the detector. Thirteen (13) replicate measurements were taken on as many stations; the determined values for precision and accuracy are listed in Table 7. In total 348 samples were measured for its transient tracer content on 24 stations.

Compound	Precision
SF_6	1.9 %
CFC-12	1.1 %

Table 7. Precision of tracer measurements determined from replicate measurements and approximate limit of detection.

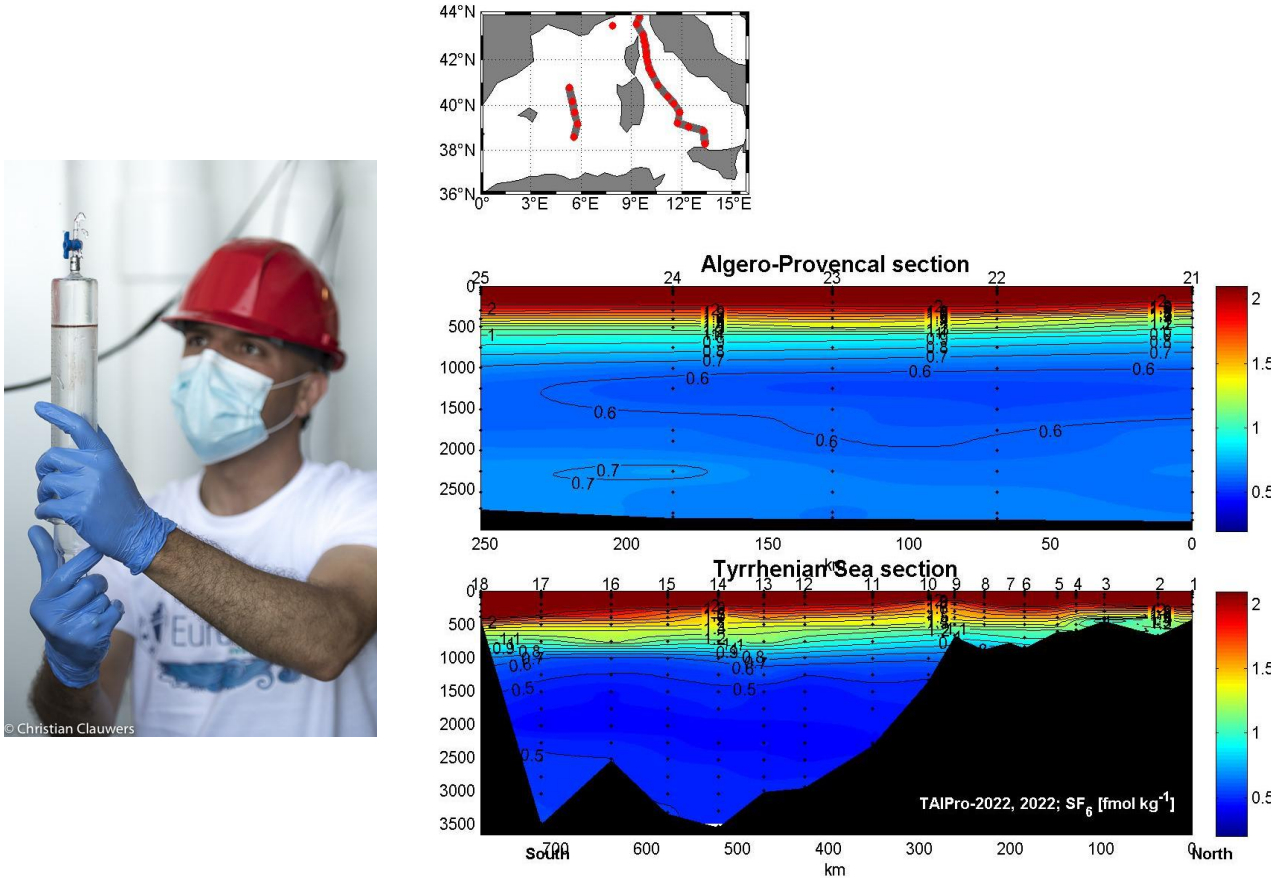

Figure 22. (left) detail on the CFC-12 sampling; (right) preliminary sections of SF_6 concentration along the two transects.

5.2.5 DOC and CDOM

(S. Retelletti Brogi, V. Evangelista, M. Guerrazzi, C. Santinelli)

Samples for dissolved organic matter (DOM) analyses were collected directly from the Niskins, into 250 ml polycarbonate, acid-washed bottles, after 3 rinsing, and immediately filtered through 0.2 µm PES filters, under low pressure. Samples were collected at the following stations: CTD1, 5, 7, 9, 11, 13, 15, 17, 21, 22, 23, 24, 25 and Dyfamed, at all the depths. The filtered sub-samples for dissolved organic carbon (DOC) were collected into 20 ml vials, acidified to pH ≈ 2 with 2M HCl, and stored at 4°C. The filtered sub-samples for chromophoric DOM (CDOM) were collected into 200 ml dark glass bottles and stored at 4°C.
The measurements will be carried out in the laboratories of the Biophysics Institute of CNR in Pisa. DOC concentration, which gives information on DOM concentration, will be measured by high temperature catalytic oxidation through a Shimadzu TOC-L analyzer.

Figure 23. Sampling bottles for CDOM measurements.

On samples collected for CDOM analyses, both absorption and fluorescence analyses will be carried out. The absorption of CDOM will be measured with a spectrophotometer by using a 10 cm quartz cuvette. Absorbance spectra will be recorded between 230 and 800 nm. The absorption coefficient at 254 nm (a_{254}) will give information on the whole CDOM pool, the spectral slope between 275 and 295 nm ($S_{275\text{-}295}$) will give indirect information on the average molecular weight and aromaticity of the molecules.
Fluorescence properties of DOM will be studied by measuring excitation-emission fluorescence matrices (EEMs) using an Aqualog (Horiba) spectrofluorometer. EEMs will be recorded between 250 and 450 nm excitation wavelengths, and between 212 and 600 nm emission wavelengths. The statistical analysis of the EEMs made using parallel factor analysis (PARAFAC) will give information on the main group of fluorophores occurring in DOM pool, such as: terrestrial humic-like, marine humic-like, protein-like, polycyclic aromatic hydrocarbon (PAH)-like.

5.2.6 Radionuclides

(L. Raimondi, M. Castrillejo, N. Casacuberta)

As a result of atomic bomb testing, accidental release and radioactive waste, the Mediterranean Sea is heavily impacted by anthropogenic radionuclides which can be used as tracers of ocean circulation. Our goal during the TAlPro2022 cruise is to track decadal changes in the circulation of the Western Mediterranean Basin by means of three radionuclides: ^{129}I, ^{236}U and ^{14}C. To capture such decadal variability, we focused our sampling of all three tracers on 5 stations previously occupied in 2011-2013 by Castrillejo et al, (2017) and Tanhua et al. (2013). During the expedition we collected 260 samples for the determination of ^{129}I and ^{14}C along 18 full-depth profiles (stations: CTD1, 4, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 21, 22, 23, 24, 25 and DYFAMED), as well as, 70 samples for ^{236}U along the 5 repeated stations (stations: CTD14, 21, 24 and DYFAMED). Samples of ^{129}I, ^{236}U and ^{14}C were collected in 250 mL opaque plastic bottles, 3 L plastic cubitainers and 100mL borosilicate glass bottles, respectively. In order to remove any biological activity that could affect the isotopic composition, samples of ^{14}C were immediately poisoned using ~ 50 μL of a Mercuric Chloride ($HgCl_2$) saturated solution.

The radiochemical extraction and purification of all three radionuclides, as well as, their measurement by Accelerator Mass Spectrometry (AMS) will be performed at ETH Zurich. Whereas the preconcentration of the ^{129}I and ^{236}U samples will be performed following the protocols described in Castrillejo et al. (2017), the extraction of ^{14}C as CO_2 and the following step of graphitisation will be performed as described in Casacuberta et al., (2020). During this process we intend to take a small aliquot from ^{14}C samples for the determination of the stable ^{13}C in collaboration with Stefano Bernasconi at ETH-Zurich.

Finally, following the extraction process, the samples of ^{129}I, ^{236}U and ^{14}C will be measured in the Laboratory of Ion Beam Physics at ETH-Zurich using the TANDY, MILEA and MICADAS AMS facilities, respectively. The high-quality of measurements will be ensured by using external and in-house standards, blanks and replicate samples.

5.2.7 Dissolved and particulate Barium

(S. Jacquet, F. Martinez-Ruiz)

3 to 6 L of seawater collected from Niskins in HDPE bottles were filtered onto 47 mm polycarbonate membranes (0.4 µm porosity) under slight overpressure supplied by filtered air (0.4 µm). The filters were rinsed with Milli-Q grade water (<5 mL) to remove sea salt. For particulate Ba, one part (around ⅔) of the filter was then dried (50°C) and stored in Petri dishes for later analysis. The remaining filter (around ⅓) was preserved in Eppendorf tubes in glutaraldehyde (2.5%) with a buffer solution of sodium cacodylate (0.05M) for 24 hours at 4ºC. After that, the filter pieces were transferred to a buffer solution sodium cacodylate (0.1M), and preserved at 4ºC until further critical point drying for examination under Scanning and Transmission Electron Microscope.

For dissolved Ba, 30 mL of unfiltered seawater were collected from Niskins in polypropylene bottles (Nalgene; rinsed three times with the same seawater sample), acidified with 30 µL of HCl (Optima grade) and kept at room temperature for later analysis. No filtration of the seawater was done based

on the well-documented knowledge that dissolved Ba represents, in general, a very large fraction (>99%) of total Ba.
Dissolved and particulate samples were collected at all stations and depths, except at station DYFAMED (for dissolved and particulate Ba) and at stations 7 and 8 (for particulate Ba). Analyses will be performed by HR-ICP-MS (High Resolution /sector field -Inductively Coupled Plasma- Mass Spectrometry (Thermo Finnigan Element XR instrument) at the MIO laboratory.

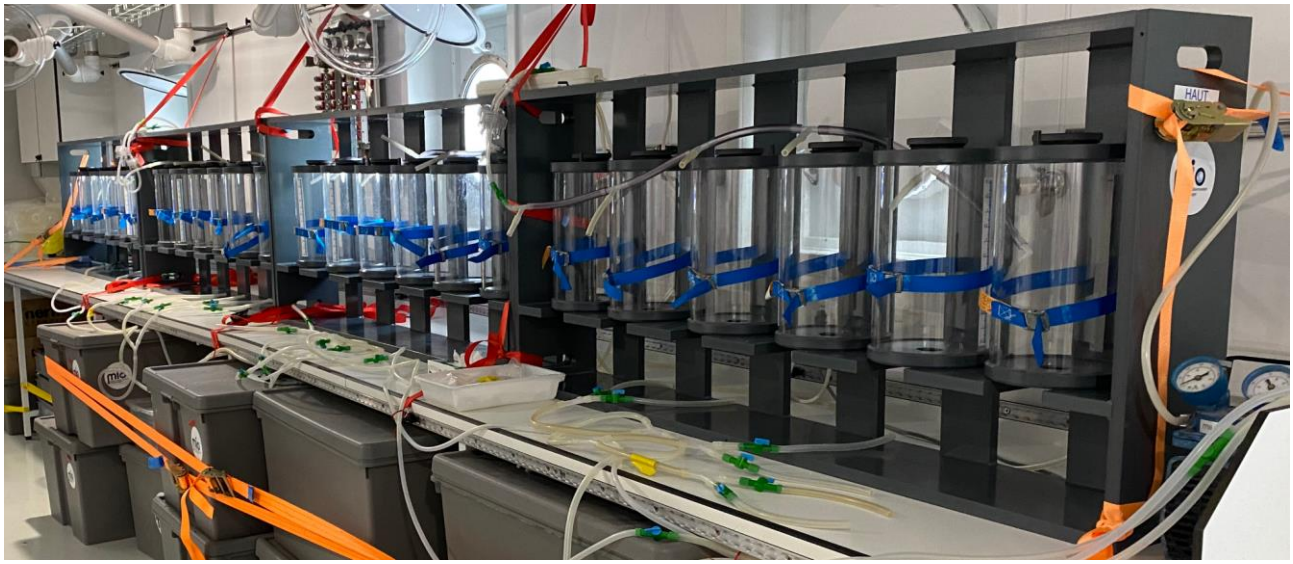

Figure 24. Filtration units used during the cruise for seawater filtration (particulate Ba sampling).

5.2.8 Underwater Vision Profiler

(A. Bosse, L. Coppola)

During CTD casts, an "Underwater Vision Profiler" (UVP6, https://sites.google.com/view/piqv/piqv-manuals/instruments-manuals) was deployed attached to the rosette in stand-alone functioning mode. The UVP6 consists of a main camera, a mezzanine image processor unit, an image sensor board, a lens and a passband light filter centred on 630nm wavelength and a pressure sensor. The light unit contains a controlling board, a laser diode and lenses. It is attached at a fixed distance from the camera.
The UVP6 was switched on during the rinsing stage of the CTD at 20m. It was then taking images at 25 Hz during the descent of the CTD to the maximum depth reached. The data were stored internally and downloaded at the end of the cruise due to a limited bandwidth of the communication cable. Between each cast, metadata was stored and entered in the dedicated laptop. A total of 18 casts were sampled successfully with the UVP. Post-processing of the data was done on land to compute the particulate concentration spectrum and automatic taxonomic recognition from imagery. The final data is available online (freely upon registration) on the Ecotaxa server (https://ecotaxa.obs-vlfr.fr/prj/6095).

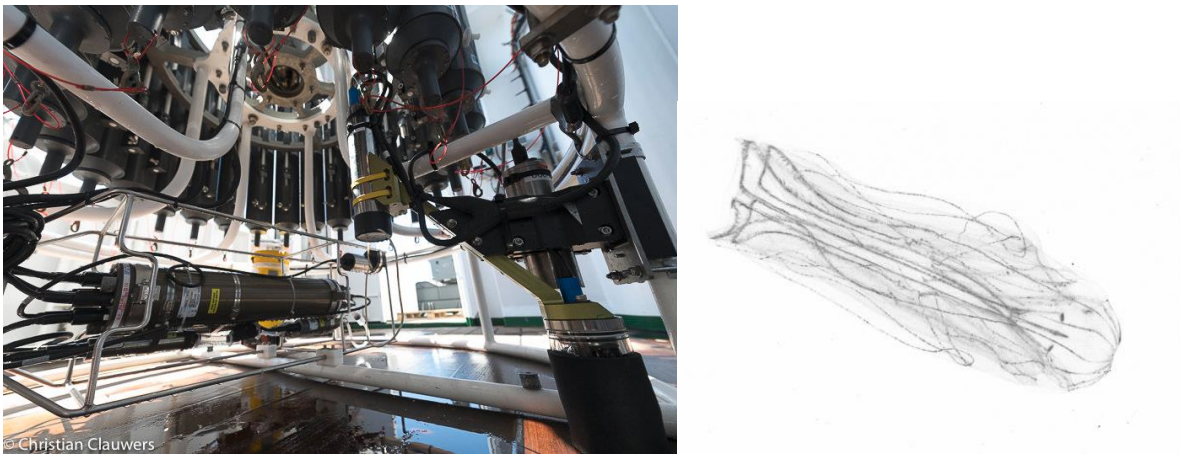

Figure 25. (left) UVP6 mounted on the rosette during the TalPro2022 cruise; (right) example of an image of a ctenophora taken by the UVP6 during the cruise.

5.2.9 Environmental DNA

(A. Pallavicini)

Environmental DNA (eDNA) metabarcoding is a relatively new methodology for the detection of organisms in an environmental sample, with emerging applications in the fields of ecology, conservation, invasive biology, biomonitoring and more. eDNA has been suggested as a tool to improve the spatio-temporal resolution of biodiversity surveys. It can offer the advantage of detecting species communities from a single sample using universal primer sets targeting taxa of interest and high throughput sequencing. Several studies use eDNA nowadays, yet its use is limited chiefly to DNA isolated from plankton communities collected from netcasts in the Mediterranean marine ecosystems. Moreover, eDNA studies in the marine environment have typically focused on detecting community differences at small spatial scales in coastal environments or comparing point-based samples between regions. Taking advantage of the TalPro22 cruise opportunity, we want to validate the method on a large spatial scale sampling, including samples even at considerable depths. As a first challenge to sampling marine environmental DNA, we want to reduce the amount of water passing from the current protocols that foresee 5-10 litres per sample to just 2 litres. In this way, it would be possible to reduce the number of cast repetitions and/or exploit chemical-physical oceanographic campaigns that do not initially plan to sample large quantities of water for biological studies. We then embarked on a 4-channel peristaltic pump (VWR), portable UV-c sterilisation systems (led based), eight 2-litre bottles, 2.5 cm diameter nitrocellulose filters with 0.45 um porosity, tubes and other small material. No chemical reagents have been embarked, for a total of 2 small boxes of 7 kg each. 2 litres from each bottle were filtered in parallel on two filters. The dried filters were preserved in filter paper (tea bags) and inserted in zip lock bags together with a silica gel desiccant. During the cruise we kept the filters at -80°C. We collect water samples from Niskin bottles closed at the bottom, 75 m and surface at every CTD sampling. Filters will be processed in the Applied and Comparative Genomics laboratory of the University of Trieste (Applied and comparative genomics lab, https://dsv.units.it/en/research/researchareas/researchfocus/7406?q=en/node/18400).

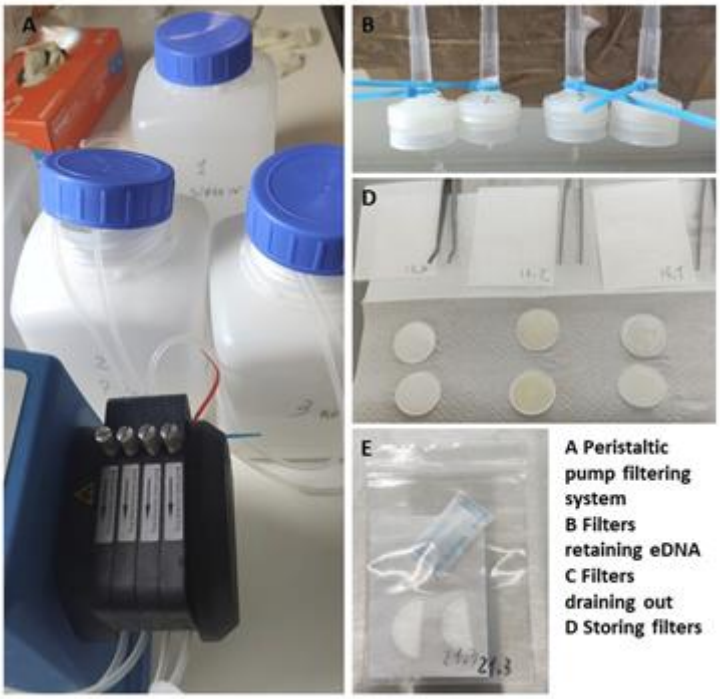

Figure 26. Portable filtering systems

6. Station list and sampling schemes

The detailed station list is shown in Table 8 and Figure 27. Net cast and ARGO floats positions are only shown in Figure 27.

Station	yyyy-mm-ddThh:mm:ss.sss	Longitude [°E]	Latitude [°N]	Bot. Depth [m]	Data file	Comments
CTD1	2022-05-18T04:11:24	9.501	43.8015	400	dctd1.txt	
CTD2	2022-05-18T07:34:26	9.30083	43.50017	671	dctd2.txt	
CTD3	2022-05-18T12:18:22	9.70067	43.0515	446	uctd3.txt	upcast was used
CTD4	2022-05-18T15:15:09	9.7775	42.77983	580	dctd4.txt	
CTD5	2022-05-18T18:03:08	9.8285	42.6	611	dctd5.txt	
CTD6	2022-05-18T21:14:08	9.896	42.28033	844	dctd6.txt	
CTD7	2022-05-19T00:03:37	9.89983	42.12333	761	dctd7.txt	
CTD8	2022-05-19T03:14:15	9.966	41.87967	761	dctd8.txt	
CTD9	2022-05-19T06:36:04	10.07917	41.60067	663	dctd9.txt	
CTD10	2022-05-19T09:27:19	10.245	41.37417	1329	dctd10.txt	
CTD11	2022-05-19T15:02:45	10.57983	40.8805	2320	dctd11.txt	
CTD12	2022-05-19T22:37:03	11.1805	40.3845	2945	dctd12.txt	
CTD13	2022-05-20T06:39:06	11.5505	40.09833	2964	dctd13.txt	
CTD14	2022-05-20T14:35:21	11.87083	39.71967	3495	dctd14.txt	
CTD15	2022-05-20T22:45:20	11.74967	39.22467	3285	dctd15.txt	

CTD16	2022-05-21T06:30:19	12.43217	39.048	2490	dctd16.txt	
CTD17	2022-05-21T14:19:18	13.3	38.899671	3452	dctd17.txt	
CTD18	2022-05-21T22:59:52	13.398	38.30067	394	dctd18.txt	
CTD21	2022-05-23T08:45:04	5.59817	38.59883	2850	dctd21.txt	
CTD22	2022-05-23T15:55:45	5.801	39.19883	2852	dctd22.txt	
CTD23	2022-05-23T22:42:57	5.60133	39.70033	2852	dctd23.txt	
CTD24	2022-05-24T05:21:05	5.49983	40.20067	2811	dctd24.txt	
CTD25	2022-05-24T13:14:55	5.30033	40.795	2703	dctd25.txt	
DYFAMED	2022-05-25T14:28:39	7.86833	43.418	2333	ddyfamed.txt	

Table 8. Station list, with name, date and time, longitude, latitude, bottom depth, data file and comments.

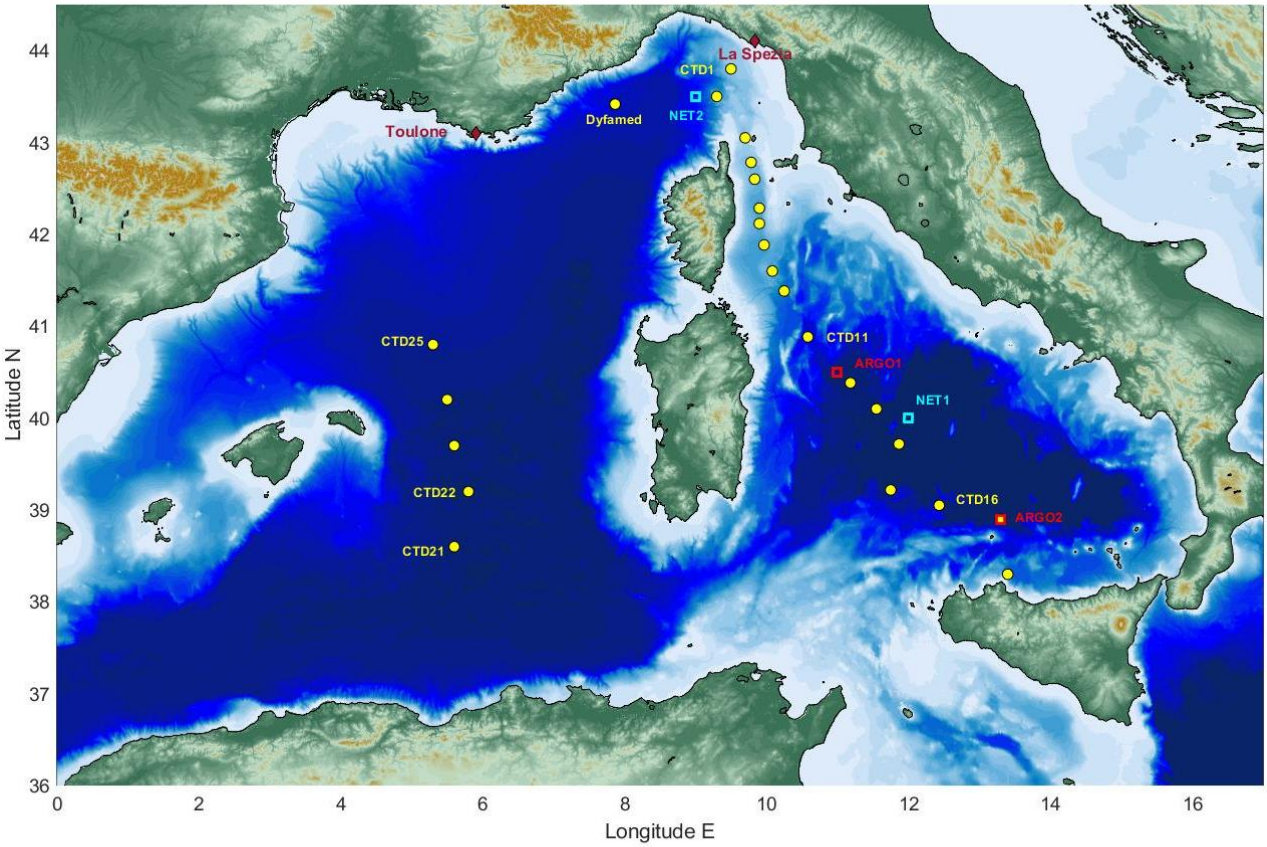

Figure 27. Station map, where also the net cast positions and Argo float deployment positions can be seen

In the following pages, the sampling scheme for each station and each bottle is shown, with the list (in the sampling order) of the parameters that were sampled for, total volume needed (water budget) and notes. The meaning of ⊘ is that the parameter was foreseen at the station but at the end has not been sampled (for any reason).

CTD 001															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	leaking bottle
2	Bot	D.Ba	P.Ba											6200	leaking bottle
3	Bot	eDNA	D.Ba	P.Ba										6200	leaking bottle
4	400	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
5	400	D.Ba	P.Ba											6200	
6	300	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
7	300	D.Ba	P.Ba											6200	
8	200	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	leaking bottle
9	200	D.Ba	P.Ba	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	10650	
10	100	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
11	100	D.Ba	P.Ba											6200	
12	75	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
13	75	D.Ba	P.Ba											6200	
14	75	eDNA												0	
15	50	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	leaking bottle (not Used)
16	50	D.Ba	P.Ba	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	10650	
17	25	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
18	25	D.Ba	P.Ba											6200	
19	10	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
20	10	D.Ba	P.Ba											6200	
21	Sup	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal				3450	
22	Sup	D.Ba	P.Ba	eDNA										6200	
23														0	
24														0	

CTD 002															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
2	Bot	D.Ba	P.Ba											6200	
3	Bot	DNA												2200	
4	500	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
5	500	D.Ba	P.Ba	DNA										8400	
6	400	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
7	400	D.Ba	P.Ba											6200	
8	300	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
9	300	D.Ba	P.Ba											6200	
10	200	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
11	200	D.Ba	P.Ba											6200	
12	100	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
13	100	D.Ba	P.Ba											6200	
14	75	DNA												2200	
15	75	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
16	75	D.Ba	P.Ba	eDNA										6200	
17	50	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
18	50	D.Ba	P.Ba											6200	
19	25	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
20	25	D.Ba	P.Ba	Sal										6450	
21	10	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
22	10	D.Ba	P.Ba											6200	
23	Sup	DO	C14	pH	DIC	TA	Nu	I129	Sal					2950	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 003															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	Bottle 4 was closed @400m, all the numbering was shifted down
2	Bot	D.Ba	P.Ba											6200	
3	Bot	DNA												2200	
4	400	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
5	400	D.Ba	P.Ba											6200	
6	300	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
7	300	D.Ba	P.Ba											6200	
8	300	TEST												0	
9	200	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
10	200	D.Ba	P.Ba											6200	
11	100	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
12	100	D.Ba	P.Ba											6200	
13	75	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
14	75	D.Ba	P.Ba											6200	
15	75	DNA												2200	
16	75	DNA												2200	
17	50	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
18	50	D.Ba	P.Ba											6200	
19	25	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
20	25	D.Ba	P.Ba											6200	
21	10	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
22	10	D.Ba	P.Ba											6200	
23	Sup	DO	pH	DIC	TA	DOC	Nu	Sal						2750	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 004															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	small leak
2	Bot	D.Ba	P.Ba	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal		10150	
3	Bot	DNA												2200	
4	500	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	small leak
5	500	D.Ba	P.Ba											6200	
6	400	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
7	400	D.Ba	P.Ba											6200	
8	300	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
9	300	D.Ba	P.Ba											6200	
10	200	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
11	200	D.Ba	P.Ba											6200	
12	100	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
13	100	D.Ba	P.Ba											6200	
14	75	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
15	75	D.Ba	P.Ba											6200	
16	75	DNA												2200	
17	50	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
18	50	D.Ba	P.Ba											6200	
19	25	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
20	25	D.Ba	P.Ba											6200	
21	10	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
22	10	D.Ba	P.Ba											6200	
23	Sup	DO	C14	pH	DIC	TA	Nu	I129	Sal					2950	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 005															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	slow leak from bottom
2	Bot	D.Ba	P.Ba											6200	
3	Bot	DNA												2200	slow leak from bottom
4	500	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	slow leak from bottom
5	500	D.Ba	P.Ba											6200	
6	400	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
7	400	D.Ba	P.Ba											6200	
8	300	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
9	300	D.Ba	P.Ba											6200	
10	200	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
11	200	D.Ba	P.Ba											6200	
12	100	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
13	100	D.Ba	P.Ba											6200	
14	75	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	slow leak from bottom
15	75	D.Ba	P.Ba	CFC	DO	pH	DIC	TA	DOC	Nu	Sal			9950	
16	75	DNA												2200	
17	50	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
18	50	D.Ba	P.Ba											6200	
19	25	CFC	DO	DIC	DIC	TA	DOC	Nu	Sal					4300	
20	25	D.Ba	P.Ba											6200	
21	10	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
22	10	D.Ba	P.Ba											6200	
23	Sup	DO	pH	DIC	TA	DOC	Nu	Sal						2750	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 006															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	small leak from bot
2	Bot	D.Ba	P.Ba	~~DNA~~										8400	bottom leak
3	750	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	closed at bottom
4	750	D.Ba	P.Ba											6200	
5	500	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
6	500	D.Ba	P.Ba											6200	
7	400	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
8	400	D.Ba	P.Ba											6200	bottom leak
9	300	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
10	300	D.Ba	P.Ba											6200	
11	200	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
12	200	D.Ba	P.Ba											6200	
13	100	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
14	100	D.Ba	P.Ba											6200	
15	75	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
16	75	D.Ba	P.Ba	DNA										8400	
17	50	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
18	50	D.Ba	P.Ba											6200	
19	25	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
20	25	D.Ba	P.Ba											6200	
21	10	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
22	10	D.Ba	P.Ba											6200	closed at bottom
23	Sup	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~						2750	
24	Sup	D.Ba	P.Ba	DNA										8400	

CNR ISMAR
ISTITUTO DI SCIENZE MARINE

CTD 007															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	screw open
2	Bot	D.Ba	P.Ba											6200	S Leak bottom
3	Bot	DNA	D.Ba											2400	screw open
4	500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	screw open Leak small
5	500	D.Ba	P.Ba											6200	screw open
6	400	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
7	400	D.Ba	P.Ba											6200	screw open
8	300	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	screw open Empty
9	300	D.Ba	P.Ba	CFC	C14	pH	TA	DOC	Nu	I129	Sal			9500	screw open
10	200	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
11	200	D.Ba	P.Ba											6200	screw open
12	100	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
13	100	D.Ba	P.Ba											6200	screw open
14	75	DNA												2200	
15	75	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	screw open
16	75	D.Ba	P.Ba	CFC	C14	pH	TA	DOC	Nu	I129	Sal			9500	
17	50	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	screw open
18	50	D.Ba	P.Ba											6200	screw open
19	25	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	screw open
20	25	D.Ba	P.Ba											6200	screw open
21	10	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	screw open
22	10	D.Ba	P.Ba											6200	open
23	Sup	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal				3450	screw open
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 008															
B#	DPT M	Sampling order												ml	Notes
1	Bot	D.Ba	P.Ba	DNA										8400	leak bottom
2	Bot	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
3	750	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	leaking
4	750	D.Ba	P.Ba											6200	leaking
5	500	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
6	500	D.Ba	P.Ba											6200	
7	400	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
8	400	D.Ba	P.Ba											6200	leaking
9	300	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
10	300	D.Ba	P.Ba											6200	
11	200	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
12	200	D.Ba	P.Ba											6200	
13	100	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
14	100	D.Ba	P.Ba											6200	
15	75	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
16	75	D.Ba	P.Ba	DNA										8400	
17	50	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
18	50	D.Ba	P.Ba											6200	leaking
19	25	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
20	25	D.Ba	P.Ba											6200	
21	10	CFC	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~					3750	
22	10	D.Ba	P.Ba											6200	
23	Sup	DO	pH	DIC	TA	~~DOC~~	Nu	~~Sal~~						2750	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 009															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
2	Bot	D.Ba	P.Ba											6200	
3	Bot	DNA												2200	
4	500	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
5	500	D.Ba	P.Ba											6200	
6	400	CFC	DO	C14	DIC	TA	DOC	Nu	Sal					3950	
7	400	D.Ba	P.Ba											6200	
8	300	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
9	300	D.Ba	P.Ba											6200	
10	200	CFC	DO	C14	DIC	TA	DOC	Nu	Sal					3950	
11	200	D.Ba	P.Ba	eDNA										6200	
12	100	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
13	100	D.Ba	P.Ba											6200	
14	75	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
15	75	D.Ba	P.Ba											6200	
16	75	DNA												2200	
17	50	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
18	50	D.Ba	P.Ba											6200	
19	25	CFC	DO	C14	DIC	TA	DOC	Nu	Sal					3950	
20	25	D.Ba	P.Ba											6200	
21	10	CFC	DO	pH	DIC	TA	DOC	Nu	Sal					3750	
22	10	D.Ba	P.Ba											6200	
23	Sup	DO	C14	DIC	TA	DOC	Nu	Sal						2950	
24	Sup	D.Ba	P.Ba	DNA										8400	

CNR ISMAR ISTITUTO DI SCIENZE MARINE

CTD 010															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
2	Bot	D.Ba	P.Ba	DNA										8400	
3	1250	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
4	1250	D.Ba	P.Ba											6200	
5	1000	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
6	1000	D.Ba	P.Ba											6200	
7	750	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
8	750	D.Ba	P.Ba											6200	
9	500	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
10	500	D.Ba	P.Ba											6200	
11	400	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
12	400	D.Ba	P.Ba											6200	
13	300	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
14	300	D.Ba	P.Ba											6200	
15	200	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
16	200	D.Ba	P.Ba											6200	
17	100	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba			9900	
18	75	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba			9900	
21	25	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
22	10	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba			9900	
23	Sup	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD011															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
2	Bot	D.Ba	P.Ba	DNA										8400	
3	2250	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
4	2250	D.Ba	P.Ba											6200	
5	2000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
6	2000	D.Ba	P.Ba											6200	
7	1750	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
8	1750	D.Ba	P.Ba											6200	
9	1500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129				4200	BTL 10 was closed at 1500 instead of 1250
10	Sal	D.Ba	P.Ba											6200	
11	1250	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
12	1000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
13	750	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
14	500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
15	400	CFC	DO	pH	DIC	TA	DOC	Nu	Sal	D.Ba	P.Ba			9950	
16	300	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
17	200	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
18	100	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
19	75	CFC	DO	pH	DIC	TA	DOC	Nu	Sal	D.Ba	P.Ba	DNA		12150	
20	50	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
21	25	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
22	10	CFC	DO	pH	DIC	TA	DOC	Nu	Sal	D.Ba	P.Ba			9950	
23	Sup	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal				3450	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 012															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal	DNA			6150	
2	Bot	D.Ba	P.Ba	DNA										8400	not properly closed
3	2750	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
4	2750	D.Ba	P.Ba											6200	leaking
5	2500	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
6	2250	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
7	2000	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
8	1750	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
9	1500	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
10	1250	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
11	1000	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
12	750	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
13	500	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
14	400	CFC	DO	pH	DIC	TA	Nu	D.Ba	P.Ba	Sal				9450	
15	300	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	leaking
16	200	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
17	100	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
18	75	CFC	DO	pH	DIC	TA	Nu	Sal						3250	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	leaking
21	25	CFC	DO	C14	pH	DIC	TA	Nu	I129	D.Ba	P.Ba	Sal		10150	
22	10	CFC	DO	pH	DIC	TA	Nu	D.Ba	P.Ba	Sal				9450	
23	Sup	DO	C14	pH	DIC	TA	Nu	I129						2700	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 013															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
2	Bot	D.Ba	P.Ba	DNA										8400	
3	2750	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal			4450	
4	2750	D.Ba	P.Ba											6200	
5	2500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
6	2250	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
7	2000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
8	1750	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
9	1500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
10	1250	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
11	1000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
12	750	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
13	500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
14	400	CFC	DO	pH	DIC	TA	DOC	Nu	Sal	D.Ba	P.Ba			9950	
15	300	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
16	200	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
17	100	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
18	75	CFC	DO	pH	DIC	TA	DOC	Nu						3500	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
21	25	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	Sal	D.Ba	P.Ba	10650	
22	10	CFC	pH	DIC	TA	DOC	Nu	Sal	D.Ba	P.Ba				9450	
23	Sup	DO	C14	pH	DIC	TA	DOC	Nu	I129					3200	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 014															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	DNA		9400	leaking top
2	3250	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba			7200	
3	3000	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
4	2750	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
5	2500	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
6	2250	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
7	2000	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
8	1750	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
9	1500	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
10	1250	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
11	1000	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
12	750	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
13	500	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
14	400	CFC	DO	pH	DIC	TA	Nu	D.Ba	Sal					4000	
15	300	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba			7200	
16	200	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba			7200	
17	100	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba			7200	
18	75	CFC	DO	pH	DIC	TA	Nu							3100	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
21	25	CFC	DO	C14	pH	DIC	TA	Nu	I129	U236	D.Ba	Sal		7450	
22	10	CFC	DO	pH	DIC	TA	Nu	D.Ba	Sal					4000	
23	Sup	DO	C14	pH	DIC	TA	Nu	I129	U236					9300	
24	Sup	D.Ba	DNA											2400	

CTD 015															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129				4200	
2	Bot	D.Ba	P.Ba	DNA										8400	Leak
3	3000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
4	2750	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	Leak
5	2500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
6	2250	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	
7	2000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
8	1750	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	
9	1500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
10	1250	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	
11	1000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
12	750	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	Leak
13	500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
14	400	CFC	DO	pH	TA	TA	DOC	Nu	I129	D.Ba	P.Ba			10100	
15	300	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	Leak
16	200	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	
17	100	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
18	75	CFC	DO	pH	TA	DOC	Nu							2850	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
21	25	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	
22	10	CFC	DO	pH	TA	DOC	Nu	D.Ba	P.Ba					9050	
23	Sup	DO	C14	pH	DIC	TA	DOC	Nu	I129					3200	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 016															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
2	Bot	D.Ba	P.Ba	DNA										8400	leak
3	2250	CFC	DO	C14	pH	TA	Nu	I129	Sal					3300	
4	2250	D.Ba	P.Ba											6200	leak
5	2000	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
6	2000	D.Ba	P.Ba											6200	leak
7	1750	CFC	DO	C14	pH	TA	Nu	I129	Sal					3300	leak
8	1750	D.Ba	P.Ba											6200	
9	1500	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal	D.Ba	P.Ba		10150	
10	1250	CFC	DO	C14	pH	TA	Nu	I129	Sal	D.Ba	P.Ba			9500	
11	1000	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal	D.Ba	P.Ba		10150	
12	750	CFC	DO	C14	pH	TA	Nu	I129	Sal	D.Ba	P.Ba			9500	leak
13	500	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal	D.Ba	P.Ba		10150	leak
14	400	CFC	DO	pH	TA	Nu	Sal	D.Ba	P.Ba					8800	
15	300	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal	D.Ba	P.Ba		10150	leak
16	200	CFC	DO	C14	pH	TA	Nu	I129	Sal	D.Ba	P.Ba			9500	
17	100	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal	D.Ba	P.Ba		10150	
18	75	CFC	DO	pH	TA	Nu	Sal							2600	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	TA	Nu	I129	Sal	D.Ba	P.Ba			9500	
21	25	CFC	DO	C14	pH	DIC	TA	Nu						3300	
22	10	CFC	DO	pH	TA	Sal	D.Ba	P.Ba						8700	
23	Sup	DO	C14	pH	DIC	TA	Nu	I129	Sal					2950	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 017															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	DOC			4700	
2	Bot	D.Ba	P.Ba	DNA										8400	
3	3000	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC	P.Ba			10050	
4	2750	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
5	2500	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC	D.Ba	P.Ba		10250	
6	2250	CFC	DO	C14	pH	DIC	TA	DOC	DOC	Nu	I129	D.Ba		4900	
7	2000	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC	D.Ba	P.Ba		10250	
8	1750	CFC	DO	C14	pH	DIC	TA	DOC	DOC	Nu	I129	D.Ba		4900	
9	1500	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC	D.Ba	P.Ba		10250	
10	1250	CFC	DO	C14	pH	DIC	TA	DOC	DOC	Nu	I129	D.Ba		4900	
11	1000	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC	D.Ba	P.Ba		10250	
12	750	CFC	DO	C14	pH	DIC	TA	DOC	DOC	Nu	I129	D.Ba		4900	
13	500	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC	D.Ba	P.Ba		10250	
14	400	CFC	DO	pH	DIC	TA	DOC	Nu	I129	D.Ba				4100	
15	300	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC	D.Ba	P.Ba		10250	leak
16	200	CFC	DO	C14	pH	DIC	TA	DOC	DOC	Nu	I129	D.Ba		4900	
17	100	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC	D.Ba	P.Ba		10250	
18	75	CFC	DO	pH	DIC	TA	DOC	DOC	Nu					4000	leak
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC	D.Ba	P.Ba		10250	
21	25	CFC	DO	C14	pH	DIC	TA	DOC	DOC	Nu	I129	D.Ba		4900	
22	10	CFC	DO	pH	TA	DOC	P.Ba							8750	
23	Sup	DO	pH	DIC	TA	DOC	Nu		DOC	Sal				3250	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 018															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal				3950	
2	Bot	D.Ba	P.Ba											6200	leak
3	Bot	DNA												2200	
4	300	CFC	DO	C14	pH	TA	Nu	I129	DIC	DIC	DIC			5000	
5	300	D.Ba	P.Ba											6200	
6	200	CFC	DO	C14	pH	DIC	TA	Nu						3300	
7	200	D.Ba	P.Ba	DNA										8400	
8	100	CFC	DO	C14	pH	TA	Nu	I129						3050	
9	100	D.Ba	P.Ba											6200	
10	75	CFC	DO	pH	DIC	TA	DOC							3400	
11	75	D.Ba	P.Ba											6200	
12	75	DNA												2200	
13	50	CFC	DO	C14	pH	TA	Nu	I129	Sal					3300	
14	50	D.Ba	P.Ba											6200	
15	25	CFC	DO	C14	pH	DIC	TA	Nu	I129					3700	
16	25	D.Ba	P.Ba	DNA										8400	
17	10	CFC	DO	pH	TA	Nu	Sal							2600	
18	10	D.Ba	P.Ba											6200	
19	Sup	DO	C14	pH	TA	DIC	Nu	I129	D.Ba	P.Ba	DNA			11100	
20	Sup	D.Ba	P.Ba	DNA										8400	
21														0	
22														0	
23														0	
24														0	

CTD 021															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236			7500	
2	Bot	D.Ba	P.Ba	DNA										8400	
3	2750	CFC	DO	C14	pH	TA	DOC	Nu	I129	U236				6850	
4	2750	D.Ba	P.Ba											6200	
5	2500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	D.Ba		7700	
6	2250	CFC	DO	C14	pH	TA	DOC	Nu	I129	U236	D.Ba			7050	
7	2000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	D.Ba		7700	
8	1750	CFC	DO	C14	pH	TA	DOC	Nu	I129	U236	D.Ba			7050	
9	1500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	D.Ba		7700	
10	1250	CFC	DO	C14	pH	TA	DOC	Nu	I129	U236	D.Ba			7050	
11	1000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	D.Ba		7700	
12	750	CFC	DO	C14	pH	TA	DOC	Nu	I129	U236	D.Ba			7050	
13	500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	D.Ba		7700	
14	400	CFC	DO	pH	TA	DOC	Nu	D.Ba	P.Ba					9050	
15	300	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	D.Ba		7700	
16	200	CFC	DO	C14	pH	TA	DOC	Nu	I129	U236	D.Ba			7050	
17	100	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	D.Ba		7700	
18	75	CFC	DO	C14	pH	TA	DOC	Nu	I129	U236	D.Ba			7050	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	D.Ba		7700	
21	25	CFC	DO	C14	pH	TA	DOC	Nu	I129	U236	D.Ba			7050	
22	10	CFC	DO	pH	TA	DOC	U236	D.Ba						6250	
23	Sup	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236				6500	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 022															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	Nu	I129	Sal	DOC			4450	
2	Bot	D.Ba	P.Ba	DNA										8400	
3	2750	CFC	DO	C14	pH	TA	Nu	I129	Sal	DOC				3800	
4	2750	D.Ba	P.Ba											6200	
5	2500	CFC	DO	C14	pH	DIC	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba	10650	
6	2250	CFC	DO	C14	pH	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba		10000	
7	2000	CFC	DO	C14	pH	DIC	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba	10650	
8	1750	CFC	DO	C14	pH	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba		10000	
9	1500	CFC	DO	C14	pH	DIC	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba	10650	
10	1250	CFC	DO	C14	pH	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba		10000	
11	1000	CFC	DO	C14	pH	DIC	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba	10650	
12	750	CFC	DO	C14	pH	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba		10000	leak
13	500	CFC	DO	C14	pH	DIC	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba	10650	
14	400	CFC	DO	pH	TA	Nu	DOC	Sal	D.Ba	P.Ba				9300	
15	300	CFC	DO	C14	pH	DIC	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba	10650	
16	200	CFC	DO	C14	pH	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba		10000	
17	100	CFC	DO	C14	pH	DIC	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba	10650	
18	75	CFC	DO	pH	DIC	TA	Nu	DOC	Sal					3750	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	DIC	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba	10650	leak
21	25	CFC	DO	C14	pH	TA	Nu	I129	DOC	Sal	D.Ba	P.Ba		10000	
22	10	DO	pH	TA	Nu	DOC	D.Ba	P.Ba						8050	
23	Sup	DO	C14	pH	DIC	TA	Nu	I129	DOC	Sal				3450	
24	Sup	D.Ba	P.Ba	DNA										8400	

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CTD 023															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129				4200	
2	Bot	D.Ba	P.Ba	DNA										8400	
3	2750	CFC	DO	C14	pH	TA	DOC	Nu	I129					3550	
4	2750	D.Ba	P.Ba											6200	
5	2500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
6	2250	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	
7	2000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
8	1750	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	
9	1500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
10	1250	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	
11	1000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
12	750	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	leak
13	500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
14	400	CFC	DO	pH	TA	DOC	Nu	D.Ba	P.Ba					9050	
15	300	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
16	200	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	
17	100	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	
18	75	CFC	DO	pH	TA	DOC	Nu							2850	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	D.Ba	P.Ba		10400	leak
21	25	CFC	DO	C14	pH	TA	DOC	Nu	I129	D.Ba	P.Ba			9750	
22	10	CFC	DO	C14	pH	DOC	DOC	D.Ba	P.Ba					9100	
23	Sup	DO	C14	pH	DIC	TA	DOC	Nu	DOC	Sal				3550	
24	Sup	D.Ba	P.Ba	DNA										8400	

CTD 024															
B#	DPTM	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	DOC	Sal		4950	
2	Bot	D.Ba	P.Ba	DNA										8400	
3	2750	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC	Sal			4300	
4	2750	D.Ba	P.Ba											6200	
5	2500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal		7750	
6	2250	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	U236	Sal		7600	
7	1880	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal		7750	
8	1750	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	U236	Sal		7600	
9	1500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal		7750	
10	1250	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	U236	Sal		7600	
11	1000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal		7750	
12	750	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	U236	Sal		7600	
13	500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal		7750	
14	400	CFC	DO	pH	TA	DOC	DOC	I129	U236	Sal				7200	
15	300	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal		7750	
16	200	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	U236	Sal		7600	
17	100	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal		7750	
18	75	CFC	DO	C14	pH	TA	DOC	DOC	I129					3950	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal		7750	
21	25	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	U236	Sal		7600	
22	10	CFC	DO	pH	TA	DOC	U236	Sal						6300	
23	Sup	DO	C14	pH	DIC	TA	DOC	Nu	Sal					3050	
24	Sup	D.Ba	P.Ba	DNA										8400	

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CTD 025															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	DO	C14	pH	DIC	TA	DOC	Nu	I129	DOC			4700	
2	Bot	D.Ba	P.Ba	DNA										8400	
3	2500	CFC	DO	C14	pH	TA	DOC	Nu	I129	DOC				4050	
4	2500	D.Ba	P.Ba											6200	
5	2250	CFC	DO	C14	pH	DIC	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba	10900	
6	2000	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129				4050	
7	2000	D.Ba	P.Ba											6200	
8	1750	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba		10250	
9	1500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba	10900	
10	1250	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba		10250	
11	1000	CFC	DO	C14	pH	DIC	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba	10900	
12	750	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba		10250	
13	500	CFC	DO	C14	pH	DIC	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba	10900	
14	400	CFC	DO	pH	TA	DOC	DOC	I129	D.Ba	P.Ba				9850	
15	300	CFC	DO	C14	pH	DIC	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba	10900	
16	200	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba		10250	
17	100	CFC	DO	C14	pH	DIC	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba	10900	
18	75	CFC	DO	C14	pH	TA	DOC	DOC	I129					3950	
19	75	D.Ba	P.Ba	DNA										8400	
20	50	CFC	DO	C14	pH	DIC	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba	10900	
21	25	CFC	DO	C14	pH	TA	DOC	Nu	DOC	I129	D.Ba	P.Ba		10250	
22	10	CFC	DO	pH	TA	DOC	D.Ba	P.Ba						8950	
23	Sup	DO	C14	pH	DIC	TA	DOC	Nu	DOC	Sal				3550	
24	Sup	D.Ba	P.Ba	DNA										8400	

DYFAMED															
B#	DPT M	Sampling order												ml	Notes
1	Bot	CFC	C14	pH	DIC	TA	DOC	Nu	I129	U236				7000	
2	Bot	DNA	DNA	Sal										4650	
3	2250	CFC	C14	pH	TA	DOC	Nu	I129	U236					6350	
4	2250	Sal												250	
5	2000	CFC	C14	pH	DIC	TA	DOC	Nu	I129	U236				7000	
6	2000	Sal												250	
7	1750	Sal												250	
8	1750	CFC	C14	pH	TA	DOC	Nu	I129	U236	Sal				6600	
9	1500	CFC	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal			7250	
10	1250	CFC	C14	pH	TA	DOC	Nu	I129	U236	Sal				6600	
11	1000	CFC	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal			7250	
12	750	CFC	C14	pH	TA	DOC	Nu	I129	U236	Sal				6600	
13	500	CFC	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal			7250	
14	400	CFC	C14	pH	TA	DOC	Nu	I129	U236	Sal				6600	
15	300	CFC	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal			7250	
16	200	CFC	C14	pH	TA	DOC	Nu	I129	U236	Sal				6600	
17	100	CFC	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal			7250	
18	75	CFC	pH	TA	DOC	Nu								2350	
19	75	DNA	DNA	Sal										4650	
20	50	CFC	C14	pH	DIC	TA	DOC	Nu	I129	U236	Sal			7250	
21	25	CFC	C14	pH	TA	DOC	Nu	I129	U236	Sal				6600	
22	10	CFC	pH	TA	DOC	Sal								2500	
23	Sup	C14	pH	DIC	TA	DOC	Nu	I129	U236					6000	
24	Sup	DNA	DNA	Sal										4650	

7. Data Repositories and Availability

CTD and bottle files (post-calibrated) have been submitted to the EMODNET Ingestion Portal. The assigned links are:

- https://cloud.emodnet-ingestion.eu/index.php/s/wN2FpR9FMWgxU2Y
- https://cloud.emodnet-ingestion.eu/index.php/s/X1lOlkSNXvpu7dE

Furthermore, to allow for data exchanges among the cruise partners, a dedicated page on the GEOMAR data management portal has been set up. The portal offers document exchange, common or individual blogs and fora and integrates internal and external web services and -pages. Moreover it provides access to several project's collaboration sites with personal login. In particular the OSIS-Kiel (Ocean Science Information System) allows data exchange and description for expeditions, numeric models and experiments. Some metadata are already public and can be seen here:

- https://portal.geomar.de/kdmi#_48_INSTANCE_5P8d_=metadata%2Fleg%2Fshow%2F361533

According to the Data Management Plan (DMP) of the TAlPro2022 cruise, all datasets will be shared following the timeline defined by GO-SHIP procedures. According to the recommendations given by CIESM, the data-release guidelines of the GO-SHIP Program (IOC, 2009) will be adopted,
in order to be compliant with the global program requirements. Thus, TAlPro2022 will adopt the following:

- Preliminary data set released within 6 weeks (e.g. all data measured on the ship)
- 6 months for final physical data
- 1 year for final data of all other variables

All data from this cruise will be published according to the GO-SHIP recommendations, which are listed at http://www.goship.org/DataDirect.html. In particular, CTD and bottle data will be sent to CCHDO (CLIVAR and Carbon Hydrographic Data Office), and will be stored at NCEI in addition.

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