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The Expeditions PS147/1 and PS147/2 of the Research Vessel POLARSTERN to the Atlantic Ocean in 2025

Edited by

Yvonne Schulze Tenberge and Björn Fiedler
with contributions of the participants

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Dr. Horst Bornemann

Redaktionelle Bearbeitung und Layout

Susan Amir Sawadkuhi

Alfred-Wegener-Institut
Helmholtz-Zentrum für Polar- und Meeresforschung
Am Handelshafen 12
27570 Bremerhaven
Germany

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Editor

Dr. Horst Bornemann

Editorial editing and layout

Susan Amir Sawadkuhi

Alfred-Wegener-Institut
Helmholtz-Zentrum für Polar- und Meeresforschung
Am Handelshafen 12
27570 Bremerhaven
Germany

www.awi.de
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Titel: Gemeinsame Lernsituation der Fahrtteilnehmenden am Multinetz während der WASCAL Floating University. (Foto: Björn Fiedler, GEOMAR)

Cover: Joint learning situation with the multinet for participants during the WASCAL Floating University. (Photo: Björn Fiedler, GEOMAR)

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**PS147/1
PS147/2**

12 March 2025 – 14 April 2025

Stanley – Mindelo – Bremerhaven

**Chief scientists
Yvonne Schulze Tenberge
(PS147/1 Stanley – Mindelo)**

**Björn Fiedler
(PS147/2 Mindelo – Bremerhaven)**

**Coordinator
Ingo Schewe**

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1. ÜBERBLICK UND EXPEDITIONSVERLAUF

Björn Fiedler¹, Yvonne Schulze Tenberge²

¹DE.GEOMAR

²DE.AWI

Der Fahrtabschnitt PS147 war der letzte Abschnitt der antarktischen Forschungssaison 2024/25 und diente der Überführung des Schiffes in seinen Heimathafen Bremerhaven. Die Expedition PS147 startete in Stanley am 12. März 2025 und endete am 14. April 2025 in Bremerhaven (Abb. 1.1). Am 1. April 2025 fand ein Zwischenstopp in Mindelo statt, der die Fahrt in die Abschnitte PS147/1 und PS147/2 gliederte. Auf dem ersten Abschnitt lag der Fokus auf dem Bergen einer Verankerung, die als Teil des Europäischen Projektes TRIATLAS ausgesetzt wurde und die zur Verbesserung der Daten über die südatlantische meridionale Umwälzzirkulation (SAMOC) beitragen wird. Des weiteren wurden atmosphärische, bathymetrische und meteorologische *en route* Messungen durchgeführt, welche ebenfalls auf dem zweiten Abschnitt fortgeführt wurden. Ab Mindelo lag der Schwerpunkt auf einer akademischen Ausbildungsfahrt („Floating University“) für westafrikanische M.Sc. Studierende, bei welcher zusätzlich auch tägliche Stationsarbeiten durchgeführt wurden. Die Ausbildung auf diesem Abschnitt war Teil des vom Bundesministerium für Bildung und Forschung (BMBF)¹ finanzierten WASCAL Programms (West African Science Service Centre on Climate Change and Adapted Land-Use) im Masterstudiengang „Klimawandel und Meereswissenschaften“.

Auf der gesamten Reise wurden folgende *en route* Messungen und Tätigkeiten durchgeführt:

- Mit den schiffsinternen hydroakustischen Systemen wurde auf der gesamten Strecke ein Streifen Meeresbodentopographie bathymetrisch vermessen. Die Gesamtfahrtzeit von vier Wochen enthielt einige Stunden Stationszeit für die Kalibration der Echolotsysteme mittels Wasserschallsonde und CTD Messungen.
- Mit dem PAMOS-Prototyp wurden kontinuierlich Luftproben genommen, um die Verteilung von Aerosolen und Spurengasen, insbesondere von Ruß, in verschiedenen Klimazonen zu bestimmen.
- Weiterhin wurden Radiosondenaufstiege durchgeführt, unter anderem um die Struktur und Variabilität der intertropischen Konvergenzzone (ITCZ) zu untersuchen und aktuelle Daten für Wettervorhersagen zu liefern
- Biogeochemische Messungen im Oberflächenozean mittels im Durchfluss betriebener Sensorik (u.a. CO₂ Partialdruck und gelöster Sauerstoff).

In Mindelo sind 26 Personen, davon 13 Studierende des WASCAL Programms, eine Studentin sowie ein Schüler aus Deutschland, eine deutsche Nachwuchs-Journalistin sowie 10 Wissenschaftlerinnen und Wissenschaftler verschiedener Institute zugestiegen. Die Fahrtleitung des zweiten Fahrtabschnitts wurde vom GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel übernommen. Dort begannen tägliche Stationsarbeiten (bis zum Erreichen des Ärmelkanals) mit dem bordeigenen CTD Kranzwasserschöpfer sowie einem

¹ Aus dem ehemaligen Bundesministerium für Bildung und Forschung (BMBF) wurde im Zuge des Regierungswechsels seit Anfang Mai das Bundesministerium für Forschung, Technologie und Raumfahrt (BMFTR).

Multischließnetz. Es wurden außerdem die beiden Zeitserienstationen CVOO nördlich von Cabo Verde („Cabo Verde Ocean Observatory“) sowie ESTOC nördlich von Gran Canaria („European Station of Time-Series in the Ocean of the Canary Islands“) beprobt, um Langzeit-Datenerhebungen fortzuführen. Darüber hinaus wurde ein biogeochemischer Argo Tiefendrifter ausgelegt sowie ein weiterer Tiefendrifter im Rahmen des internationalen Argo Programms aufgenommen. Die zur Verfügung stehende Stationszeit konnte sehr effizient genutzt werden, um auf dem zweiten Fahrtabschnitt wissenschaftliche Daten auch in der Wassersäule zu erheben.

Diese Expedition wurde vom Bundesministerium für Bildung und Forschung (BMBF) im Rahmen des WASCAL-Programms (Förderkennzeichen 01LG2302A) gefördert und war Teil der Programmorientierten Förderung (PoF IV) des Helmholtz-Forschungsprogramms „Erde im Wandel – Zukunft sichern“, zu dessen Zielen die Themen 2 (Ozeane und Kyrosphäre im Klimawandel) mit Unterthemen 2.1 und 2.3, und Thema 6 (Meeres- und polares Leben) mit Unterthema 6.3 beitrugen.“

SUMMARY AND ITINERARY

Expedition PS147 was the last leg of the 2024/25 Antarctic research season and brought back the ship to its home port of Bremerhaven. Expedition PS147 started in Stanley on 12 March 2025 and ended in Bremerhaven on 14 April 2025 (Fig. 1.1). On 1 April 2025, there was a stopover in Mindelo, which divided the voyage into legs PS147/1 and PS147/2. On the first leg, the focus was on the recovery of a mooring that was deployed as part of the European TRIATLAS project and will contribute to the improvement of data on the South Atlantic Meridional Overturning Circulation (SAMOC). Furthermore, atmospheric, bathymetric and meteorological *en route* measurements were carried out, which were also continued on the second leg. From Mindelo, the focus was on an academic training cruise ("Floating University") for West African M.Sc. students, during which daily station work was carried out. The training on this leg took place as part of the WASCAL Programme (West African Science Service Centre on Climate Change and Adapted Land-Use) funded by the German Federal Ministry of Education and Research (BMBF)² in the Master Research Programme "Climate Change and Marine Sciences" (MRP-CCMS).

Throughout the voyage, the following *en route* measurements and activities were carried out:

- With the ship-mounted hydroacoustic systems, a swath of seabed topography was bathymetrically surveyed along the ship's track. A few hours of station time were spent on calibrating the echosounding systems by sound velocity profiler and CTD casts.
- The PAMOS prototype was used to continuously take air samples in order to determine the distribution of aerosols and trace gases, in particular black carbon, in different climate zones.
- Furthermore, radiosonde launches were carried out, among others to investigate the structure and variability of the intertropical convergence zone (ITCZ) and to provide current data for weather forecasts.
- Biogeochemical measurements in the surface ocean using flow-through sensors (e.g., CO₂ partial pressure and dissolved oxygen).

In Mindelo, 26 participants, among which 13 students from the WASCAL programme, one pupil and one student from Germany, one early-career journalist and 10 scientists from different institutes, joined the team. From here, the GEOMAR Helmholtz Centre for Ocean Research Kiel took over the scientific lead of the cruise. Daily station work began from Mindelo onwards until the English Channel with the on-board CTD rosette water sampler and a multinet. The two time series stations CVOO north of Cabo Verde ("Cabo Verde Ocean Observatory") and ESTOC north of Gran Canaria ("European Station of Time-Series in the Ocean of the Canary Islands") were also sampled to continue long-term data collection. In addition, one biogeochemical Argo Float was deployed, and a second Argo Float was recovered as part of the international Argo programme. The available station time could be used very efficiently to collect scientific data in the water column as well during the second leg of the cruise.

² The former Federal Ministry of Education and Research (BMBF) became the Federal Ministry of Research, Technology and Space (BMFTR) in the course of the change of government at the beginning of May.

This expedition was supported by the German Federal Ministry of Education and Research (BMBF) via the WASCAL Programme (Grant No. 01LG2302A) and was part of the programme-orientated Funding (PoF IV) of the Helmholtz Research Programme “Changing Earth – Sustaining our Future” to whose goals Topics 2 (Ocean and Cyrosphere in Climate Change) with Subtopics 2.1 and 2.3, and Topic 6 (Marine and Polar Life) with Subtopic 6.3 were contributed.”

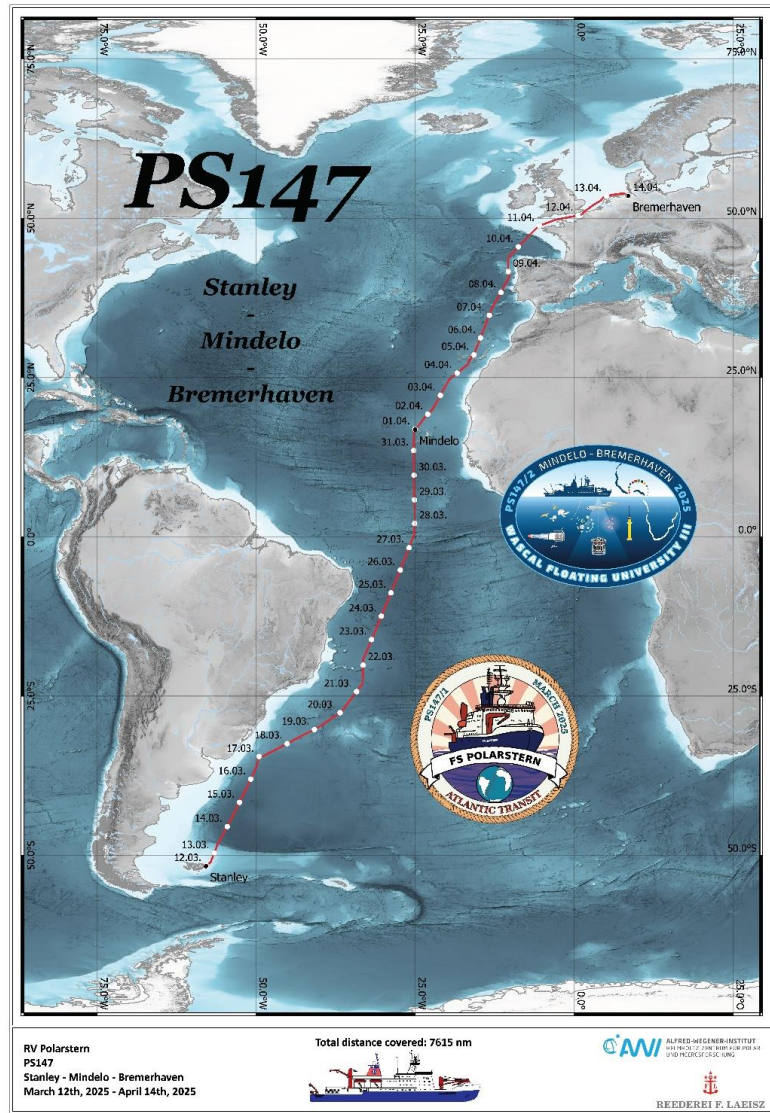


Abb. 1.1: Fahrtverlauf der Expedition PS147 von Stanley nach Bremerhaven. Siehe <https://doi.pangaea.de/10.1594/PANGAEA.982368> und <https://doi.pangaea.de/10.1594/PANGAEA.982376> für eine Darstellung der master tracks in Verbindung mit den Stationslisten für PS147/1 (Stanley – Mindelo) und PS147/2 (Mindelo – Bremerhaven). (Karte: J. Pliet)

Fig. 1.1: Cruise track of expedition PS147 from Stanley to Bremerhaven. See <https://doi.pangaea.de/10.1594/PANGAEA.982368> and <https://doi.pangaea.de/10.1594/PANGAEA.982376> to display the master tracks in conjunction with the station lists for PS147/1 (Stanley – Mindelo) and PS147/2 (Mindelo – Bremerhaven). (Map: J. Pliet)

2. CONTINUOUS AIR MONITORING AND PROFILES OF THE ITCZ

Laura Köhler*

DE.AWI

*laura.koehler@awi.de

Grant-No. AWI_PS147_00

Objectives

The air monitoring box PAMOS (Portable Atmospheric Measurement Box On Sea) is developed within the innovation platform SOOP (Shaping an Ocean Of Possibilities for science-industry collaboration). The PAMOS is designed for continuous and automatic air monitoring on commercial ships to improve the data coverage over the oceans. On the PS147 expedition, we tested and improved the hardware and software of two PAMOS prototypes with serial numbers 001 and 003 in the different climate zones crossed by the *Polarstern*. During the cruise, different tests of the prototypes were performed to examine instrument stability, aerosol losses due to geometry, robustness with respect to different weather conditions, and reliability of the software.

The transit from Stanley to Bremerhaven provides interesting insights into the aerosol and trace gas distribution over the Atlantic. It is especially interesting to see the black carbon distribution with respect to the frequently used shipping routes. In particular, we expect increased aerosol concentrations when approaching Europe and in the English Channel. However, there might also be signatures from other events in the data such as wild fires or Sahara dust.

The Intertropical Convergence Zone (ITCZ) exhibits a rich inner structure which is so far not fully understood (Windmiller & Stevens 2024). By launching radiosondes in the ITCZ with a high temporal frequency of three hours, we sampled a complete profile of the Atlantic ITCZ while crossing it. This crossing complements measurement during SO284, MSM114/2, and M203 where similar profiles were taken. They allow to study questions like how the structure of the ITCZ changes in different seasons and at different latitudes. The ITCZ crossing during PS147 adds a new season, namely spring, to the existing data sets and improves the statistics for ITCZ studies.

Work at sea

The two PAMOS boxes were installed in the front of the upper observation deck, right on top of the bridge. At this position, the air flow came mainly from the front due to the ship's motion which means that it was only minimally influenced by the *Polarstern* itself and the probability of measuring our own emissions was reduced. Due to the high position of approximately 21 meters above sea level, the devices were less exposed to sea spray.

Although they are supposed to run fully automatically on a long-term perspective, the prototypes still needed some maintenance during the cruise and some fixes in the software were done.



Fig. 2.1: PAMOS 001 (right) and PAMOS 003 (left) installed on the upper observation deck of Polarstern during PS147

We performed humidity and temperature measurements inside the cabinets and tested different settings of the dryer to learn what works best for the different climate zones. To estimate the losses from different dryer setups, we did reference aerosol measurements with a commercial dryer and without dryer.

To assess the stabilities of the built-in instruments, we conducted parallel measurements of the two prototypes. Ship integrated instruments like the weather station provided further valuable reference data to check the data quality of the PAMOS.

A radiosonde was launched every day at 11 UTC, except for the period in Brazilian waters. This sounding is part of the international observation network and the data was immediately transferred to the German weather service.

To obtain a profile of the Atlantic ITCZ, we additionally launched radiosondes every three hours within the moist tropics from 24 March 20 UTC to 29 March 23 UTC. During this period, we launched in total 42 radiosondes, i.e. 38 additional radiosondes to the daily 11 UTC radiosonde.

Preliminary (expected) results

The two prototypes run steadily during the whole cruise. Useful modifications were identified and will be implemented in the future. We also gained valuable insights in the temperature and humidity management within the cabinets which is particularly challenging in the moist tropics.

Figure 2.2 shows the black carbon concentration raw data measured with a microAethalometer MA350 within the PAMOS with serial number 003. The instrument measures at different wavelengths indicated by the light colours. The dark blue line represents the average over all wavelengths. As expected, we find a very low black carbon concentration at the beginning of the journey. We find enhanced concentrations when we were close to the Cape Verde and Canary Islands end of March/beginning of April. However, the largest concentrations, we observed at the end of the journey after 8 April where we approached Europe and entered the English Channel two days later. Thus, we find clear signatures of industrial emissions and

shipping routes. In the future, we will study the aerosol concentration during this transit in more detail.

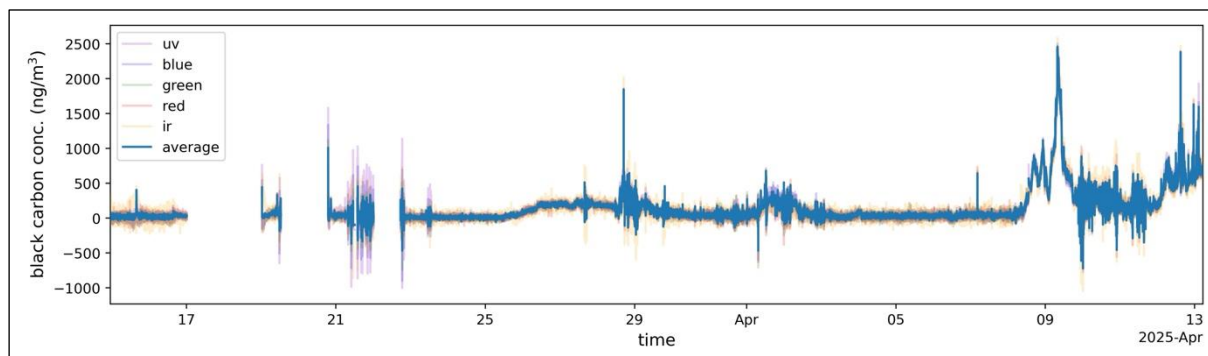


Fig. 2.2: Black carbon concentration measured by PAMOS 003 with a microAethalometer at different wavelengths. The dark blue line shows the average over all wavelengths.

During our crossing of the ITCZ, we found a very pronounced southern edge with strong precipitation and even some lightnings during the first night in the ITCZ. Precipitation continued for the next day until we reached the northern edge and left the ITCZ. The doldrums were not as pronounced as in other crossings from the past. However, it is the first crossing we sampled with steady rain in the ITCZ and thus a very nice complementation of the profiles sampled during MSM114/2.

This will be a valuable addition to the existing profiles and improve the statistics and data basis for studying the Atlantic ITCZ. The radiosoundings within the moist tropics will be processed with the python packages pysonde (Schulz et al. 2024) and shipspy (Köhler 2024).

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (<https://www.pangaea.de>) within two years after the end of the expedition at the latest. By default, the CC-BY license will be applied.

This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 2, Subtopic 2.1.

In all publications based on this expedition, the **Grant No. AWI_PS147_00** will be quoted and the following publication will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. <http://dx.doi.org/10.17815/jlsrf-3-163>.

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- Windmiller JM, Stevens B (2024) The inner life of the Atlantic Intertropical Convergence Zone. Quarterly Journal of the Royal Meteorological Society 150:523–543. <https://doi.org/10.1002/qj.4610>
- Schulz H, Stolla K, Köhler L, et al (2024) pysonde: Postprocessing of Atmospheric Soundings. <https://doi.org/10.5281/zenodo.10023462>
- Köhler L (2024) shipspy. <https://github.com/shipspy-development/shipspy>

3. BATHYMETRIC UNDERWAY MEASUREMENTS

Yvonne Schulze Tenberge¹, Sophia Künzig²

¹DE.AWI

Not on board: Boris Dorschel*¹, Simon Dreutter¹

²DE.UNI-Potsdam

*boris.dorschel@awi.de

Grant-No. AWI_PS147_01 / AWI_PS147/2_01

Objectives

Accurate knowledge of the seafloor topography, hence high-resolution bathymetry data, is key basic information necessary to understand many marine processes. It is of particular importance for the interpretation of scientific data in a spatial context. Bathymetry, or geomorphology, is a basic parameter for the understanding of the general geological setting of an area and geological processes such as erosion, sediment transport and deposition. Even information on tectonic processes can be inferred from bathymetry. Supplementing the bathymetric data, high-resolution sub-bottom profiler data of the top 10s of meters below the seabed provide information of the sediment architecture and the lateral extension of sediment successions. This can be used to study depositional environments on larger scales in terms of space and time, of which the uppermost sediments may be sampled.

While world bathymetric maps give the impression of a detailed knowledge of worldwide seafloor topography, most of the world's ocean floor remains unmapped by hydroacoustic systems. In these areas, bathymetry is modelled from satellite altimetry with a corresponding low resolution. Satellite-altimetry derived bathymetry therefore lack the necessary resolution to resolve small- to meso-scale geomorphological features (e.g. sediment waves, glaciogenic features and small seamounts). Ship-borne multibeam data provide bathymetry information in a resolution that is sufficient to resolve those features.

Therefore, the main tasks of the bathymetry group on board *Polarstern* during PS147 were:

- collection of bathymetric data, including calibration and correction of the data for environmental circumstances (sound velocity, systematic errors in bottom detection, etc.)
- post processing and cleaning of the data
- data management for on-site map creation
- collection of sound velocity data

Work at sea

Technical description

During cruise PS147, bathymetric surveys were conducted with the hull-mounted multibeam echosounder (MBES) Teledyne Reson HYDROSWEEP DS3. The HYDROSWEEP is a deep-water system for continuous mapping with the full swath potential. It operates on a frequency of ~14 kHz. On *Polarstern*, the MBES transducer arrays are arranged in a Mills cross configuration of 3 m (transmit unit) by 3 m (receive unit). The combined motion, position (Trimble GNSS), and time data comes from an iXBlue Hydrins system and the signal is directly

transferred into the Control Module (CM) of the MBES to carry out real-time motion compensation in Pitch, Roll and Yaw. With a combination of phase and amplitude detection algorithms the CM computes the water depth from the returning backscatter signal. The system can cover a sector of up to 140° with 70° per side. In the deep sea, an angle of ~50° to both sides could be achieved.

Data acquisition and processing

Data acquisition was carried out throughout the entire cruise between Stanley and Bremerhaven where permitted. The MBES was operated with Sonar UI and for online data visualization, Teledyne PDS was used. The collected bathymetry was stored in S7K raw files. Subsequent data processing was performed using Caris HIPS and SIPS. For generating maps, the data were exported to QGIS in the GeoTIFF raster format.

Sound velocity profiles

For best survey results with correct depths, frequent CTD (Conductivity Temperature Depth) and SVP (Sound Velocity Probe) casts were performed by the Bathymetry group, and were used to measure the water sound velocity in different depths. This is essential, as the acoustic signal travels down the water column from the transducer to the seafloor and back to the surface through several different layers of water masses with each a different sound velocity. The sound velocity is influenced by density and compressibility, both depending on pressure, temperature and salinity. Wrong or outdated sound velocity profiles lead to refraction errors and reduced data quality. The CTD measures conductivity, temperature, and depth in the water column while the ship is on station. And, the Valeport MIDAS SVP measures pressure and temperature. From these parameters respectively, the sound velocity is calculated.

During PS147/1, the Bathymetry group operated the CTD and MIDAS SVP. The obtained sound velocity profiles were immediately processed and applied within the MBES for correct beamforming during the survey.

During PS147/2, the other science groups conducted CTD casts (for details see chapter 5). The obtained sound velocity profiles were immediately processed and applied within the MBES for correct beamforming during the survey by the Bathymetry group.

Additionally, these profiles were combined/extended with World Ocean Atlas 2018 (WOA18) data to create full ocean depth sound velocity profiles.

Stations

The HYDROSWEET, CTD and MIDAS SVP stations conducted by the Bathymetry group are listed in Table 3.1 (PS147/1) and Table 3.2 (PS147/2). For CTD and MIDAS SVP only station starts are listed. For a complete station list see Appendix A.4.

Preliminary (expected) results

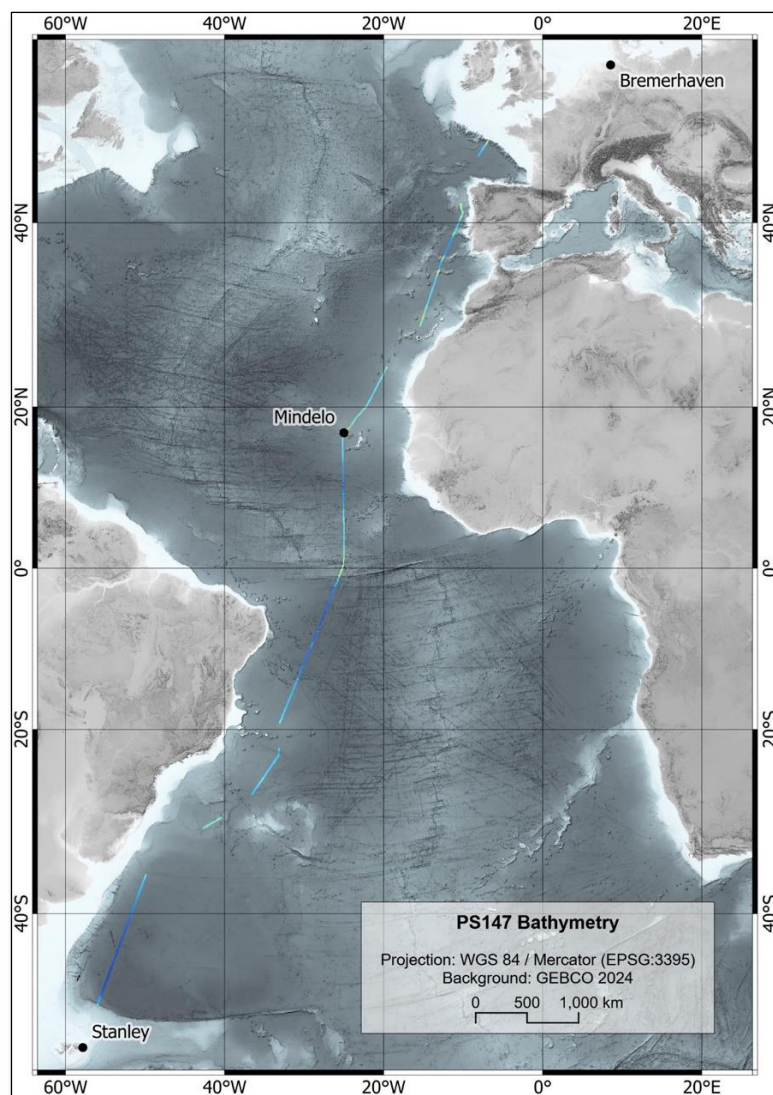
During approx. 22 days, bathymetric data was surveyed along a track of 5,051 nmi (9,355 km) by the swath bathymetry system. Figure 3.1 shows the generated bathymetry grid over the Atlantic.

Tab. 3.1: List of bathymetry related stations during PS147/1

Station Number	Device	Action	Event Time [UTC]	Latitude	Longitude
PS147/1_0_Underway-7	Hydrosweep DS3	profile start	2025-03-13 19:57:29	-48.2231	-55.9954
PS147/1_0_Underway-7	Hydrosweep DS3	profile end	2025-03-17 00:54:13	-36.0980	-49.9055
PS147/1_0_Underway-7	Hydrosweep DS3	profile start	2025-03-19 00:15:47	-31.2072	-42.7289
PS147/1_0_Underway-7	Hydrosweep DS3	profile end	2025-03-19 14:00:21	-30.0694	-40.4307
PS147/1_0_Underway-7	Hydrosweep DS3	profile start	2025-03-20 12:59:13	-27.5043	-36.6061
PS147/1_0_Underway-7	Hydrosweep DS3	profile end	2025-03-22 00:48:30	-22.2002	-33.1899
PS147/1_0_Underway-7	Hydrosweep DS3	profile start	2025-03-22 17:12:17	-19.1907	-33.1162
PS147/1_0_Underway-7	Hydrosweep DS3	profile end	2025-04-01 07:57:22	16.9008	-25.0280
PS147/1_1-1	CTD	station start	2025-03-14 15:55:25	-44.8125	-54.1617
PS147/1_2-1	CTD	station start	2025-03-15 15:00:09	-41.2184	-52.3356
PS147/1_3-1	CTD	station start	2025-03-16 14:54:54	-37.5530	-50.5777
PS147/1_5-1	CTD	station start	2025-03-19 10:21:37	-30.2961	-40.8828
PS147/1_6-1	MIDAS SVP	station start	2025-03-21 10:11:57	-24.2987	-34.1780
PS147/1_7-1	MIDAS SVP	station start	2025-03-23 14:58:45	-15.6608	-31.6136
PS147/1_8-1	CTD	station start	2025-03-24 13:58:09	-12.1478	-30.1440
PS147/1_9-1	CTD	station start	2025-03-25 13:55:27	-8.4848	-28.6336
PS147/1_10-1	CTD	station start	2025-03-26 13:56:27	-4.9136	-27.1779
PS147/1_11-1	CTD	station start	2025-03-27 13:56:54	-1.3716	-25.7979
PS147/1_12-1	CTD	station start	2025-03-28 13:57:18	2.4258	-25.0315
PS147/1_13-1	CTD	station start	2025-03-29 13:59:27	6.1201	-25.0876
PS147/1_14-1	CTD	station start	2025-03-30 13:53:27	9.9734	-25.1533

Tab. 3.2: List of bathymetry related stations during PS147/2

Station Number	Device	Action	Event Time [UTC]	Latitude	Longitude
PS147/2_0_Underway-2	Hydrosweep DS3	profile start	2025-04-01 08:09:30	16.8899	-25.0076
PS147/2_0_Underway-2	Hydrosweep DS3	profile end	2025-04-04 03:19:00	24.6463	-19.6385
PS147/2_0_Underway-2	Hydrosweep DS3	profile start	2025-04-05 21:48:31	29.2701	-15.4612
PS147/2_0_Underway-2	Hydrosweep DS3	profile end	2025-04-09 12:54:12	41.8071	-10.3357
PS147/2_0_Underway-2	Hydrosweep DS3	profile start	2025-04-10 16:03:13	46.1282	-8.1495
PS147/2_0_Underway-2	Hydrosweep DS3	profile end	2025-04-11 04:00:19	47.9072	-6.4380

*Fig. 3.1: Overview of the bathymetric data acquired during PS147*

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (<https://www.pangaea.de>) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied. Furthermore, bathymetric data will be provided to the Nippon Foundation – GEBCO Seabed 2030 Project.

This expedition was supported by the Helmholtz Research Programme "Changing Earth – Sustaining our Future" Topic 2, Subtopic 2.3 Sea Level Change.

The data was obtained as part of the Project BATHY-LTO.

In all publications based on this expedition, the **Grant No. AWI_PS147_01 / AWI_PS147/2_01** will be quoted and the following publication will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. <http://dx.doi.org/10.17815/jlsrf-3-163>.

4. SOUTH ATLANTIC MERIDIONAL OVERTURNING CIRCULATION

Mario Müller, Tim Müller;
Not on board: Peter Brandt*
*pbrandt@geomar.de

DE.GEOMAR

Grant-No. AWI_PS147_02

Objectives

In the frame of the “South Atlantic Meridional Overturning Circulation” (SAMOC) project, which involves institutions from Argentina, Germany, Brazil, the United States of America, France, and South Africa (Chidichimo et al. 2023) a subsurface mooring was installed during an Argentine research cruise with *RV Austral* in December 2022. This mooring was funded by the European project TRIATLAS. The SAMOC project aims to measure the meridional transport of mass and heat across the South Atlantic Ocean using various oceanographic observations along a line located approximately at 34.5°S. It is part of the Atlantic-wide AMOC observing system consisting among others of the OSNAP array in the subpolar North Atlantic and the RAPID array in the subtropical North Atlantic. The newly installed mooring is aimed to strengthen the South Atlantic observing system and enhances knowledge of currents and ecosystems in a data-sparse region of the global ocean. The objective during the cruise is to recover this mooring and contribute data to improve the AMOC estimates in the South Atlantic.

Work at sea

The subsurface mooring, part of the SAMOC project, was located at 34°29.43'S, 49°31.19'W. The mooring consisted of two acoustic releases, 14 MicroCATs, a LongRanger 75 kHz ADCP, six additional point current meters, and floatation elements providing the necessary buoyancy. The primary task during PS147/1 was the recovery of this deep-sea mooring.

On the morning of 17 March 2025, at 10:00 UTC, the recovery of mooring KPO_1231 was scheduled. We approached the designated position to within approximately 1.5 cables and attempted multiple times to activate the two acoustic releases using the GEOMAR release unit with the "Enable" command. Unfortunately, no response was received from the releases. We then repositioned the vessel closer to the mooring and repeated the activation attempt, again without success.

As a next step, we issued the "Release" command in an effort to trigger the mooring. Given that the top element was only about 50 meters below the surface, it should have surfaced within seconds. However, this attempt was also unsuccessful. We then tested from a different location further forward on the vessel, repeating all previous "Enable" and "Release" commands—again without response.

Additionally, we attempted to address **release codes** of two other releases that had been brought on board during the original deployment expedition with ARA Austral, in case a mix-up had occurred at the time. Again, no response was received, and the mooring did not surface.

As a final option, we used the ship's onboard release unit and tested all combinations of "Enable" and "Release" commands. Unfortunately, this attempt also failed. Since the mooring is equipped with both an XMA-Argos transmitter and a Sable-Iridium transmitter, we checked whether its surfacing had been detected by either system—but no signal was received. At around 12:10 UTC, the recovery attempt was abandoned as unsuccessful.

One day later, on 18 March 2025, at 13:25 UTC, the Argos mooring watchdog sent a signal confirming that the mooring had surfaced. As *Polarstern* was already *en route* to Cape Verde, it was no longer possible to return and recover the mooring. The mooring drifted at the surface southwestward. Almost all instruments were ultimately recovered on 3 April 2025, with the help of our Argentinean colleagues by *ARA Austral* at 42°06'S, 53°37'W.

Preliminary (expected) results

The mooring instruments will provide full-depth velocity, temperature and salinity data for a period of more than two years and will be used to analyse intraseasonal to seasonal variability at the western end of the SAMOC array. It will provide important information to describe the circulation and water mass variability in a region typically only measured by bottom mounted CPIES. The combined analysis of bottom pressure and acoustic travel time measurement from the CPIES with the mooring data will improve the overall accuracy of the AMOC estimate at about 35°S. As the mooring is located in an energetic circulation, mooring data will be analysed in comparison to satellite altimetry to better understand flow instability and the resulting mesoscale eddy field. Here, both, the variability of the warm-water path and the cold-water path of the AMOC are of particular importance.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (<https://www.pangaea.de>) within two years after the end of the expedition at the latest. By default, the CC-BY license will be applied.

This expedition is supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 2, Subtopic 2.1.

In all publications based on this expedition, the **Grant No. AWI_PS147_02** will be quoted and the following publication will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. <http://dx.doi.org/10.17815/jlsrf-3-163>.

References

Chidichimo MP, Perez RC, Speich S, et al. (2023) Energetic overturning flows, dynamic interocean exchanges, and ocean warming observed in the South Atlantic. Communications Earth & Environment 4:10. <https://doi.org/10.1038/s43247-022-00644-x>

5. WASCAL FLOATING UNIVERSITY

Björn Fiedler^{1*}, Tobias Hahn¹, Corrine Almeida²,
Henry Bittig³, Manita Chouksey³, Sophie Kache³
Heino Fock⁴, Jamileh Javidpour⁵, Abdoulaye
Sarré⁶, Avan Antia⁷
Not on board: Arne Körtzinger¹, Florian Schütte¹

*bfiedler@geomar.de

¹DE.GEOMAR

²CV.UTA

³DE.IOW

⁴DE.TI

⁵DK.SDU

⁶SN.CRODT

⁷DE.CAU

Grant-No. AWI_PS147_03

Outline

Leg PS147/2 hosted the 3rd edition of the WASCAL Floating University programme (GPF 24-1_035; WASCAL-III) which combined a research expedition with an academic curricular education cruise (Fig. 5.1). This Floating University cruise was a continuation of the successful previous edition during PS135/2, and part of the curriculum of the international Master Research Programme “Climate Change and Marine Sciences” (MRP-CCMS), which is currently implemented at the Atlantic Technical University of Cabo Verde (Universidade Técnica do Atlântico, UTA) in the framework of the BMFTR-funded WASCAL programme (“West African Science Service Centre on Climate Change and Adapted Land Use”).

During PS147/2, several modules of the curriculum were taught theoretically as well as practically. In addition, scientists on board communicated their research to West African students and data were collected for a master thesis project. Therefore, ongoing scientific research efforts off West Africa were integrated into the work program (e.g., ecological and biogeochemical time-series observations). The students benefitted, not only through the teaching component delivered by the lecturing PIs, but even more through their immersion into real, individual research projects as compared to the more “staged” experience of classical field work practicals.



Fig. 5.1: Cruise logo for Polarstern expedition PS147/2

Through the combination of teaching and research (“training-through-research”), the WASCAL Floating University during PS147/2 benefitted academic education as well as for current research projects in the region. The MRP-CCMS including this expedition are endorsed by IOC-UNESCO as a Decade Project hosted by the Decade ECOP programme within the framework of the UN Decade of Ocean Science for Sustainable Development (2021–2030).

Objectives

Primary objective during PS147/2 was the academic education of Master’s degree students in the MRP-CCMS during an authentic research expedition. Therefore, theoretical lectures modules were combined with practical training sessions about classical oceanographic field-sampling methods (e.g., gear deployment/recovery, analytical lab techniques, data reduction and visualization, etc.). Scientific data obtained during the cruise were used instantaneously for teaching and training purposes, and for scientific exploitation.

The following lecture modules of the MRP-CCMS curriculum were addressed on board: (1) Ocean Observations, (2) Hydroacoustics in fisheries and marine ecology, and (3) Communication and scientific writing.

Beside teaching modules, research modules were also carried out to (i) contribute to current research efforts in the region and to global ocean observing programs, (ii) teach the students with state-of-the-art oceanographic technologies and real scientific data, and (iii) collect scientific data for an individual master thesis project.

Therefore, students were split into small groups and rotated during the expedition through the following four research modules:

Oceanography (Module 1)

During the cruise different assets for hydrographic measurements were used to continue and extend long-term observations in the Eastern Tropical North Atlantic to better understand physical transport processes, both from large scale circulation patterns and induced by transient, mesoscale eddies, and how they change over time. To study this, a CTD rosette sampler was used to measure hydrographic parameters in the water column, and surface underway measurements from the ship were utilized to track the evolution of hydrographic parameters at the surface. In addition, an Argo float was deployed and another one recovered.

Biogeochemistry (Module 2)

Sampling and measurements in the water column and surface ocean of key properties (temperature, salinity, DIC/TA and CO₂ partial pressure, dissolved oxygen (DO), chlorophyll-a, and turbidity) were performed that allow to assess the saturation state for CO₂ and O₂ to deconvolute the observed disequilibrium into its physical and biological drivers and calculate air-sea CO₂ and O₂ fluxes.

Marine ecology (Module 3)

The cruise track covered different biomes and offered the opportunity to characterize the associated pelagic ecosystems as well as local communities. This module aimed to characterize micro- and mesoplankton diversity, to quantify organism abundance, and to investigate zooplankton community changes across different ocean depths through targeted seawater sampling as well as different net samples.

Scientific communication (Module 4)

The experiences, data and results which were obtained during this leg were communicated and presented in both a scientific as well as a popular scientific way, also by the students. By choosing appropriate communication methods, tools and guiding questions, the students were able to train their communication skills in translating scientific information and knowledge for

different target audience groups, and sharpen their process of scientific thought and discourse. Those exercises were combined with general public outreach activities during the cruise, e.g., blog posts or short video clips.

Work at sea

Overall, 10 combined CTD/MultiNet stations – two of them being the Cape Verde Ocean Observatory (CVOO) and the European Station of Time-Series in the Ocean of the Canary Islands (ESTOC) – have been sampled during the transit from Mindelo, Cabo Verde to Bremerhaven, Germany (Fig. 5.2). At station 10, only one Argo float was recovered. During transits between the stations, and start and end port, a variety of continuous underway measurements were performed.

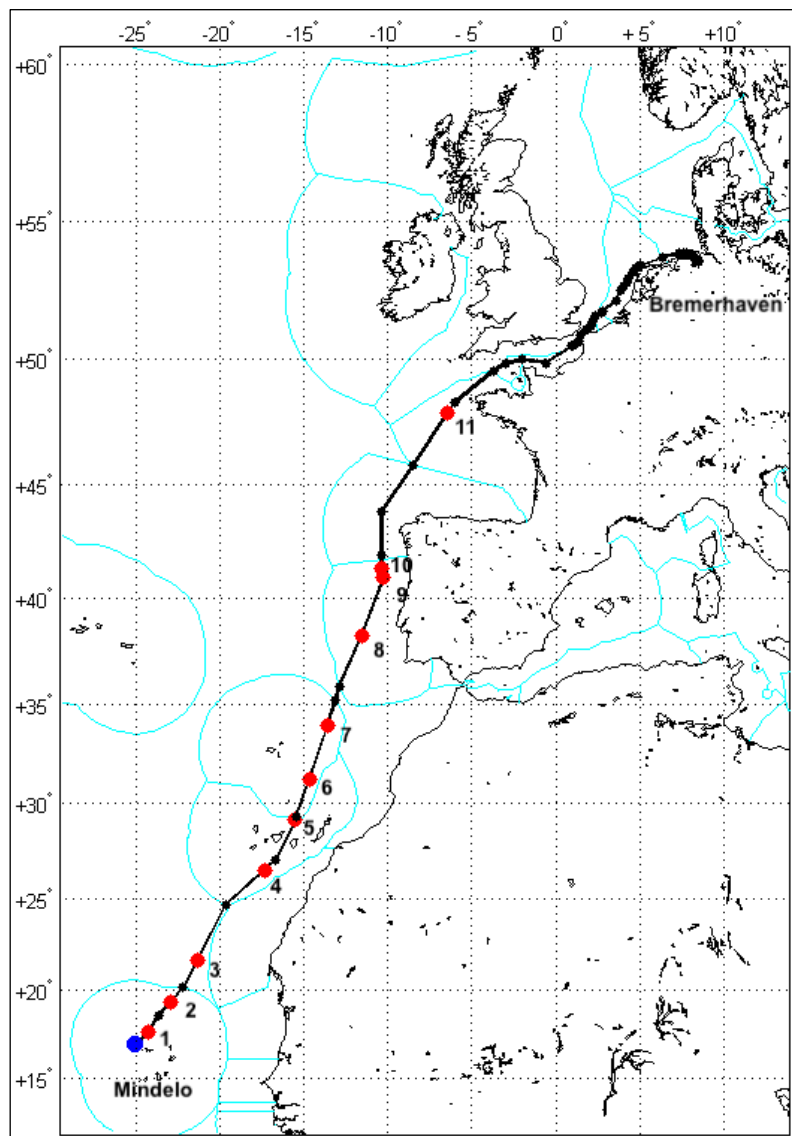


Fig. 5.2: Cruise track of PS147/2 illustrating the locations of station work (red dots) along the transit from Mindelo, Cabo Verde to Bremerhaven, Germany (black dots denote navigational waypoints)

Oceanography

The ocean covers 70 % of the Earth's surface. Through interaction of the ocean with the atmosphere and its currents, which, e.g., redistribute heat across the globe, the ocean plays a key role in regulating Earth's climate. The ocean currents and transport pathways are ultimately driven by the distribution of and differences in temperature and salinity (and thus seawater density). This is true both for the large scale, thermohaline circulation as well as for transient features such as mesoscale eddies. In addition, wind at the ocean surface causes important currents to be created or modified as part of the wind-driven circulation, or, e.g., by causing coastal upwelling. To track the state and changes in the ocean, observations of the ocean are needed. This module focussed on physical oceanography observations of the temperature/salinity distribution.

Applied methods and technologies

CTD rosette sampler

As the main tool, a CTD rosette sampler was used to measure hydrographic parameters in the water column. Additional observational tools were continuous underway measurements (accessed through *Polarstern's* DSHIP system), autonomously profiling Argo floats, and satellite remote sensing. The rosette water sampler equipped with the CTD (conductivity - temperature - depth) instrument was deployed during every station (except station 10) along the track to collect high-resolution hydrographic data as well as discrete water samples from various depth levels (Tab. 5.1). Along with the Niskin bottles the CTD was connected with different types of sensors (Tab. 5.2) which collected autonomously physical and biogeochemical parameters during up- and downcasts. Temperature, oxygen, and conductivity were measured by duplicated sensors unlike the other parameters. More information on the OPUS-DS nitrate sensor is given in section Biogeochemistry, on the UVP6-HF in section Marine ecology.

Tab. 5.1: Maximum depths of CTD profiles and cast numbers done

Station number	Profile depth [m]	Water depth [m]	Cast numbers
1	3585	3595	1
2	1202	3872	1
3	1203	4359	1
4	1206	3609	1
5	3615	3614	1
6	1202	3984	1
7	1204	4441	1
8	1200	5064	1
9	1207	3677	1
10 (float recovery)	-	-	0
11	146	148	1
			Total: 10

Tab. 5.2: Information on sensors mounted on *Polarstern*'s rosette water sampler

Sensors	Sensors ID	Serial number	Calibration Date
Temperature sensor 1	55	2460	2023-12-08
Temperature sensor 2	55	2417	2023-12-08
Conductivity sensor 1	3	2054	2023-11-21
Conductivity sensor 2	3	2055	2023-11-21
Pressure sensor	45	0485	2017-11-14
WET_LabsCStar	71	CST_946R	2023-08-16
FluoroWetlabECO_AFL_FL_Sensor 1	20	1670	2023-11-30
Oxygen sensor 1	38	4555	2024-04-02
Oxygen sensor 2	38	4554	2024-04-02
Altimeter sensor	0	1228	-
TriOS OPUS-DS nitrate sensor	-	71F9	-
Hydroptic UVP6-HF	-	sn000159hf	-

Underway measurements (oceanographic)

The ship's underway systems were used for continuous surface ocean measurements, i.e., the ship's keel intake thermosalinographs (TSGs) for temperature and salinity. For underway measurement of water velocities the vessel-mounted Acoustic Doppler Current Profiler (ADCP, Teledyne, 150 kHz) was used.

Argo Floats

A BGC-Argo float (Argo France, WMO 6990727) with CTD, oxygen, chlorophyll-a/backscatter/CDOM and UVP-sensor was deployed at station 4. Another Argo float (Argo Germany, WMO 3902588) with CTD and oxygen sensor was recovered at station 10 on behalf of the German Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie, BSH) due to malfunctioning of the float's CTD. The float will be refurbished at the manufacturer for future redeployment.

Biogeochemistry

Atmospheric gases, such as oxygen (O₂) can be dissolved in water until an equilibrium with the atmosphere is established. The concentration of O₂ in water is also controlled by biological processes, especially the antagonistic processes of photosynthesis and respiration. Therefore, the O₂ concentration of a water body is an indicator of both physical exchange and of biological and chemical reactions.

Chlorophyll-a (Chl-a) is a pigment found in photosynthetic organisms (phytoplankton, seagrass, algae etc.). It captures solar energy and converts it into chemical energy, resulting in glucose production. Hence, photosynthesis is the key process driving primary productivity.

Applied methods and technologies

During PS147/2, several water samples were collected from Niskin bottles using the CTD rosette system which was deployed at 10 stations between Cabo Verde and Germany to measure biogeochemical parameters. The CTD rosette was deployed to various depths according to the specific research objectives. Water samples were taken during the upcast (ascending profile) at pre-defined depths, based on a sampling grid established by the sample users, to ensure targeted collection. At each station, water samples for the determination of

dissolved oxygen (DO; cf. Tab. 5.3) and Chl-a concentrations were collected. In addition, samples for DIC (dissolved inorganic carbon), and TA (Total Alkalinity) analyses were collected at the CVOO and ESTOC sites.

Tab. 5.3: Number of samples for DO measurements taken per depth, date and station

Station	Date	Depth [m]	Number of Samples
01 (CVOO)	01/04/2025	10 – 3584	23
02	02/04/2025	03 – 1200	19
03	03/04/2025	03 – 1200	17
04	04/04/2025	20 – 1200	15
05 (ESTOC)	05/04/2025	25 – 3614	14
06	06/04/2025	10 – 1200	14
07	07/04/2025	20 – 1200	12
08	08/04/2025	10 – 1200	15
09	09/04/2025	10 – 1200	14
11	11/04/2025	03 – 145	14

Oxygen measurements

Oxygen concentrations were measured using the standard Winkler titration method, following the protocol described by Grasshoff et al. (1999). An overview is given below:

- **Sampling procedure:** Before sampling and after the analyses, the sampling bottles were cleaned with MilliQ water to prevent salt crystallization. After each CTD recovery, oxygen samples were immediately drawn from the Niskin bottles prior to any other sampling, to avoid oxygen exchange and contamination. Oxygen discrete samples (representing a total of 158 samples, including replicates) were taken into 100 mL wide-necked WOCE glass bottles and closed with their paired glass stoppers (Tab. 5.3).
- **Bottle preparation and oxygen fixation:** Each sampling bottle was rinsed with at least three times of its volume before the sample was taken. Then, 1 mL of MnCl_2 and 1 mL of KI solution were added concurrently to fix the oxygen. The bottles were closed without bubbles using its stopper, and shaken for approximately one minute, and subsequently stored in the dark (*here: cupboard*) for a minimum of 1 hour and a maximum of 24 hours before analysis. One to two duplicates, triplicates or quadruplicate samples were collected for each station to measure sampling and titration precision that amounted for $\pm 0.994 \mu\text{mol L}^{-1}$.
- **Analysis:** Oxygen concentrations were measured using the standard Winkler titration method, following the protocol described by Grasshoff et al. (1999). Reagents for Winkler titration were checked at the beginning of the cruise against a certified reference solution of potassium iodate (OSIL, Havant, UK). After storage, the samples were titrated. As a first step, 1 mL of sulphuric acid was pipetted into the sample bottle immediately after removing the stopper. Then, a small magnetic stirring bar was carefully deployed in the bottle. The rotation of the stirrer was slowly accelerated. The liberated iodine was titrated to a light-yellow colour. A volume of 1 mL starch indicator solution was added carefully, and the titration was continued until the solution was translucent. Near the endpoint, the solution becomes 'cloudy' directly after addition of the thiosulphate solution. The endpoint was reached when this 'cloudy' effect can no longer be seen, indicating that the iodine was completely

oxidised. A white paper behind the bottle helped to better determine the endpoint. After the measurement, the bottles, glass stoppers and sampling tubes were cleaned with MilliQ.

DIC/TA sampling

Discrete samples of DIC/TA were taken from the Niskin bottles directly after oxygen sampling to minimize exchanges of CO₂ with the resulting headspace in the Niskin bottle. Glass bottles (500 mL for CVOO, 250 mL for ESTOC) were filled slowly from the bottom using a tube extending from the Niskin bottle drain to the bottom of the glass sample bottle to avoid contamination and bubbles. Once filled, samples were poisoned with aliquots of saturated HgCl₂ solution immediately for preservation. The samples were then stored at room temperature at a dark location. A total of 20 samples each were collected at CVOO and ESTOC stations.

Nutrients sampling

80 nutrient discrete samples from CVOO and ESTOC stations, respectively, were collected from the CTD after sampling of O₂ and DIC/TA. Samples were taken in Polyethylene vials, rinsed three times and then filled. Samples were immediately stored in a -20 °C freezer for later analysis at GEOMAR.

Nitrate measurements

A TriOS OPUS-DS nitrate sensor (serial no. 71F9, TriOS Mess- und Datentechnik GmbH, Rastede, Germany) was used to measure nitrate concentrations in the water column. It was mounted at the lower part of the CTD rosette sampler below the Niskin bottles and power supplied by the AUX-port of the CTD with 14 V DC. For the first 5 stations, it was triggered by a GEOMAR-customized controller. The triggering by the controller failed, however, on subsequent stations, which was discovered only after station 8. From station 9 onwards, the OPUS internal automatic sampling was used with a slightly reduced resolution of 10 s. About two weeks prior to PS147/2, the OPUS sensor has been referenced to zero (blank) with MilliQ to obtain the reference spectrum. Directly after the last profile while still onboard PS147/2, the OPUS sensor has again been referenced with MilliQ.

Chlorophyll-a (Chl-a) measurements

In situ data were obtained during the cruise, from CVOO north of Cabo Verde (first station) to the Bay of Biscay (last station). A total of 10 stations were sampled (Tab. 5.4). Water samples were collected using Niskin bottles mounted on a CTD. At each station, six samples at different water depths between surface and 150 m, were taken, resulting in 60 samples for Chl-a determination.

Tab. 5.4: Overview of the Chl-a data collected from water filtration, using a 25 mm GF/F membrane and an extraction with 5 mL of 90 %-acetone

Station	Depth [m]	Filtration volume [mL]
1	10, 20, 40, 60, 100, 150	500
2	3, 10, 55, 80, 100, 150	500
3	3, 20, 40, 60, 100, 150	500
4	10, 40, 80, 100, 125, 150	200, 250, 300
5	3, 25, 50, 75, 100, 150	500
6	3, 40, 50, 80, 100, 150	500
7	3, 20, 50, 80, 100, 150	450, 500
8	10, 20, 40, 80, 100, 150	500
9	3, 20, 40, 80, 100, 150	500
11	3, 10, 20, 40, 50	500

From stations 1 to 7, Chl-a extraction followed the procedure described by Roesler (2020). However, the resulting Chl-a concentrations appeared to be significantly overestimated. One potential cause identified was the presence of debris from the fiberglass filters at the end of the extraction process. Starting at station 4, an adapted extraction method was used instead of the Roesler (2020) protocol. This second method was more time-efficient, requiring a minimum of 3 hours for extraction instead of 24 hours, and it did not involve freezing of the samples in acetone. Additionally, the acetone-fiberglass filter mixture was manually agitated rather than vortexed. This approach resulted in either no or minimal debris in the final extract but still yielded significantly overestimated results. Upon reviewing the calibration of the fluorometer performed in February 2025, it was identified that the values entered as standard concentrations were in fact the volumes used for dilution. This miscalibration led to systematic overestimation of Chl-a concentrations. Consequently, an 8 % correction factor was applied to all Chl-a concentration results to obtain accurate values.

Underway measurements (biogeochemical)

The vessel's -4H- FerryBox (-4H- JENA engineering GmbH, Jena, Germany) for Chl-a, DO and turbidity, and the ship's GO system for $p\text{CO}_2$ acquired continuous underway measurements in surface waters, as well as from the atmosphere with regards to $p\text{CO}_2$ (every 2.5 hours). The system consists of a water inlet from which seawater is pumped into the measurement circuit containing several sensors. In addition, the GO $p\text{CO}_2$ system which is composed of a wet box and a dry box, measures respectively seawater and air $p\text{CO}_2$, referenced against certified standard gases (Integrated Carbon Observing System, ICOS). All data from these systems were recorded within a time interval of 60 seconds.

Marine ecology

The aim of the marine ecology module was to understand the plankton community (biomass, density and diversity) at different depths and the variations in depth distributions between day and night samples as well as spatial variations along the cruise transect.

Applied methods and technologies

During PS147/2 a HYDRO-BIOS (HYDRO-BIOS Apparatebau GmbH, Altenholz, Germany) Multi Plankton Sampler (MultiNet “Midi”, MN) was deployed at ten stations for collecting zooplankton samples in different water layers (Fig. 5.3, left; Tab. 5.5). Station 5 (ESTOC) was sampled during day and night, thus a total of 11 hauls were conducted. In addition, an Underwater Vision Profiler 6 (UVP6) was mounted at the rosette water sampler and deployed together with the CTD but not analysed during the cruise. The shipboard EK80 echosounder collected continuous hydroacoustic data at different frequencies (Tab. 5.6).

MultiNet

Eleven deployments were carried out with maximum deployment depth of 1000 m and the shallowest at 100 m, collecting a total of 52 samples. The MultiNet midi was equipped with five nets (200 μ m mesh size) attached to a steel frame (Fig. 5.3, right). The net was lowered and heaved with 0.5 m s⁻¹. Nets were opened/closed during heaving. See Tab. 5.5 for details on the sampling intervals. The net was operated offline while opening and closing depths were preset. Sampled volume was calculated from opening cross section of the net times height of the sampled water layer. The samples were qualitatively inspected under a stereo microscope and were then conserved in 3.7 % formaldehyde solution to be further analysed onboard. Samples from CVOO and ESTOC were retained for further laboratory analysis at GEOMAR (PI: Rainer Kiko) using the ZooScan method and will be identified and quantitatively analysed using EcoTaxa (<https://ecotaxa.obs-vlfr.fr/>).



Fig. 5.3: MultiNet sampler used during PS147/2 for the collection of zooplankton samples

Net	Stations 1 to 9	Station 11
1	1000 – 600 m	100 – 50 m
2	600 – 300 m	50 – 0 m
3	300 – 200 m	-/-
4	200 – 100 m	-/-
5	100 – 0 m	-/-

Tab. 5.5: Overview over the MultiNet sampling depths (opening – closing depth). Station 10 was denoted for the recovery of an Argo Float.

Underway hydroacoustic observations

In order to assess the distribution, abundance, and population dynamics of pelagic ecosystem resources, hydroacoustic methods are a standard tool. A high-precision scientific echosounder (EK80 Kongsberg Maritime AS), was used to monitor and analyze the plankton and micronekton community throughout the transect at 38, 70, 120 and 200 kHz. For comparison purpose of results from PS135/2 to PS147/2, the same settings of the echosounder were used in this cruise. The transducer information and ping settings are shown in Tab. 5.6. No calibration was done during the cruise due to lack of time. Continuous hydroacoustic data collection took place during all cruise activities: along transits and during station work, except in Spain EEZ where the echosounder had to be shut down due to environmental regulations.

The Echoview 14 software was used to process and analyze data from 20 m below the surface down to 1200 m. The minimum scattering volumes (Sv) threshold was set to 79 db to have a complete overview of the plankton and micronekton community. The EK80 raw data, echograms from Echoview and echointegration results were transferred to the AWI data center directly after the cruise and will be published in PANGAEA.

For each station, the Sv were integrated from regions where MultiNet was deployed in order to combine acoustic results with food web observations. Frequency response of each region was picked up to characterize the scattering organisms met in the regions.

Tab. 5.6: Overview of the different transducers and configurations used with the EK80 during PS147/2

Transducer model	Serial number	Nominal frequency [kHz]	Ping mode	Pulse duration [s]	Transmit power [W]
ES38-7	438	38	cw	0.004096	2000
ES70-7C	696	70	cw	0.001024	750
ES120-7C	2218	120	cw	0.000512	250
ES200-7C	879	200	cw	0.000512	45

Underwater Vision Profiler 6 (UVP6 hf)

The Hydrooptic Underwater Vision Profiler UVP6 (serial no. 000159HF; Hydroptic SARL, L'Isle-Jourdain, France) is a pressure-safe underwater camera that was mounted on the rosette water sampler to investigate the plankton and particle composition, distribution, and dynamics at depths of up to 6000 m. The UVP6 records grayscale images of a defined volume (0.68 L) illuminated by red light flashes (serial no. of the light unit: 000153VE2) at acquisition speeds of several images per second. Starting at a pixel size of about 73 μm , the UVP6 directly processes the abundance and image characteristics of particles.

Apstein nets

Apstein nets with mesh sizes of 20 μm and 100 μm were deployed concurrently with CTD or MultiNet operations. In total, nine deployments occurred between stations 2 and 11, excluding stations 1 and 10. Nets sampled the upper water column to a depth of approximately 25–30 m. Live samples were immediately examined using a binocular microscope equipped with a camera to identify taxa and categorize them into functional groups.

FlowCam (Water Sampling Procedure)

Water samples were collected using Niskin bottles mounted on the CTD rosette. Different volumes of water were taken from seven distinct depths, ranging from the surface layer (3 m) down to a maximum depth of 750 m, depending on hydrographic conditions (Tab. 5.7). Samples were subsequently filtered through a 38 μm sieve. After filtration, the retained material was preserved with Lugol's solution prior to FlowCam analysis.

Tab. 5.7: FlowCam sampling depth and water volume that was filtered for inspections

Station	Depth of Samples [m]	Volume Water Filtered
2	3, 80, 150, 250, 350, 450	250 mL
3	3, 60, 150, 250, 350, 450	250 mL
4	3, 80, 150, 250, 350, 450	5 L
5	3, 50, 75, 100, 150, 400, 800	5 L
6	3, 50, 100, 150, 200, 350, 450	5 L
7	3, 50, 100, 150, 250, 350, 450,	5 L
8	3, 50, 150, 250, 350, 450	10 L
9	3, 50, 150, 350, 450, 550	10 L
11	3, 10, 100, 70, 100, 145	10 L

Neuston and planktonic sampling

Samples were collected to study neustonic and planktonic communities, with the goal of understanding community shifts across latitudes, ecosystem functioning, and distribution patterns. Water samples were obtained using Niskin bottles mounted on a CTD rosette at depths of 3, 50, and 100 meters. At each station (except Station 1 and 10), three 2 L replicate glass bottles (DURAN blue cap) were injected with calcium bicarbonate (^{13}C), along with one untreated control bottle. To measure carbon uptake rates of different microplankton communities, water samples were incubated for 24 hours in a flow-through aquarium covered with a blue foil to simulate surface water light conditions. After incubation, samples were filtered using pre-combusted GF/F filters (0.2 μm) and stored at $-80\text{ }^{\circ}\text{C}$. Additionally, one bottle from each depth was filtered through Millipore Sterivex filters (0.2 μm) for DNA extraction, and another was used for bulk/seson analysis. All samples were filtered on the same day at the sampling station. Furthermore, 250 ml of water from the same depth as the incubated samples were preserved using Lugol's solution. To trace community changes along latitudinal gradients, two additional samples were collected between stations using the ship's continuous water pumping system. All samples were later transported to the laboratory at the University of Southern Denmark (SDU) under the supervision of Prof. Jamileh Javidpour.



Fig. 5.4: Neuston and planktonic sampling procedure during PS147/2: Sampling process from Niskin bottles (left), incubation (middle left), Lugol samples (middle right) and filtering process (right)

Tab. 5.8: Neuston and planktonic sampling during PS147/2

Station	Depths [m]	Filter [μ m]	No. of bottles	No. of bottles [Lugol]	In-Between Station
2	3, 50, 100	0.7 and 0.2	18*2 L	3	InS ₁₋₂
3	3, 50, 100	0.7 and 0.2	18*2 L	3	InS ₂₋₃
4	3, 50, 100	0.7 and 0.2	18*2 L	3	InS ₃₋₄
5	3, 50, 100	0.7 and 0.2	18*2 L	3	InS ₄₋₅
6	3, 50, 100	0.7 and 0.2	18*2 L	3	InS ₅₋₆
7	3, 50, 100	0.7 and 0.2	18*2 L	3	InS ₆₋₇
8	3, 50, 100	0.7 and 0.2	18*2 L	3	InS ₇₋₈
9	3, 50, 100	0.7 and 0.2	18*2 L	3	InS ₈₋₉
11	3, 50, 100	0.7 and 0.2	18*2 L	3	InS ₉₋₁₁

Preliminary (expected) results

Oceanography

CTD measurements

Sampling stations distributed along the expedition track from the oligotrophic to coastal (Sub)Tropical North Atlantic (Fig. 5.5) and were carried out between the surface and a water depth of 1,200 m. However, exceptions were full depth CTD hydrocasts at time-series stations CVOO and ESTOC, and a shallow bottom hydrocast on the European Shelf.

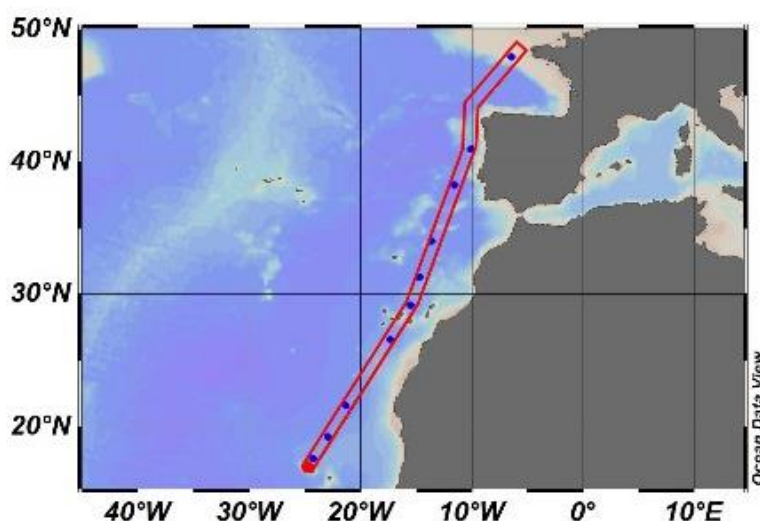


Fig. 5.5: Location of stations where CTD hydrocasts (and MultiNet hauls) were performed during PS147/2

The hydrographic transects (Fig. 5.6 A-E) revealed a distinct latitudinal gradient in oceanographic and biological conditions, and further indicating different water masses in the water column. A transition was observed from warm, saline, stratified tropical waters in the South to colder, oxygen-rich, and less-stratified waters in the North. Sea surface temperature (SST; Fig. 5.6 A and Fig. 5.7) gradually decreased along the route, with fluctuations associated with mesoscale features such as eddies.

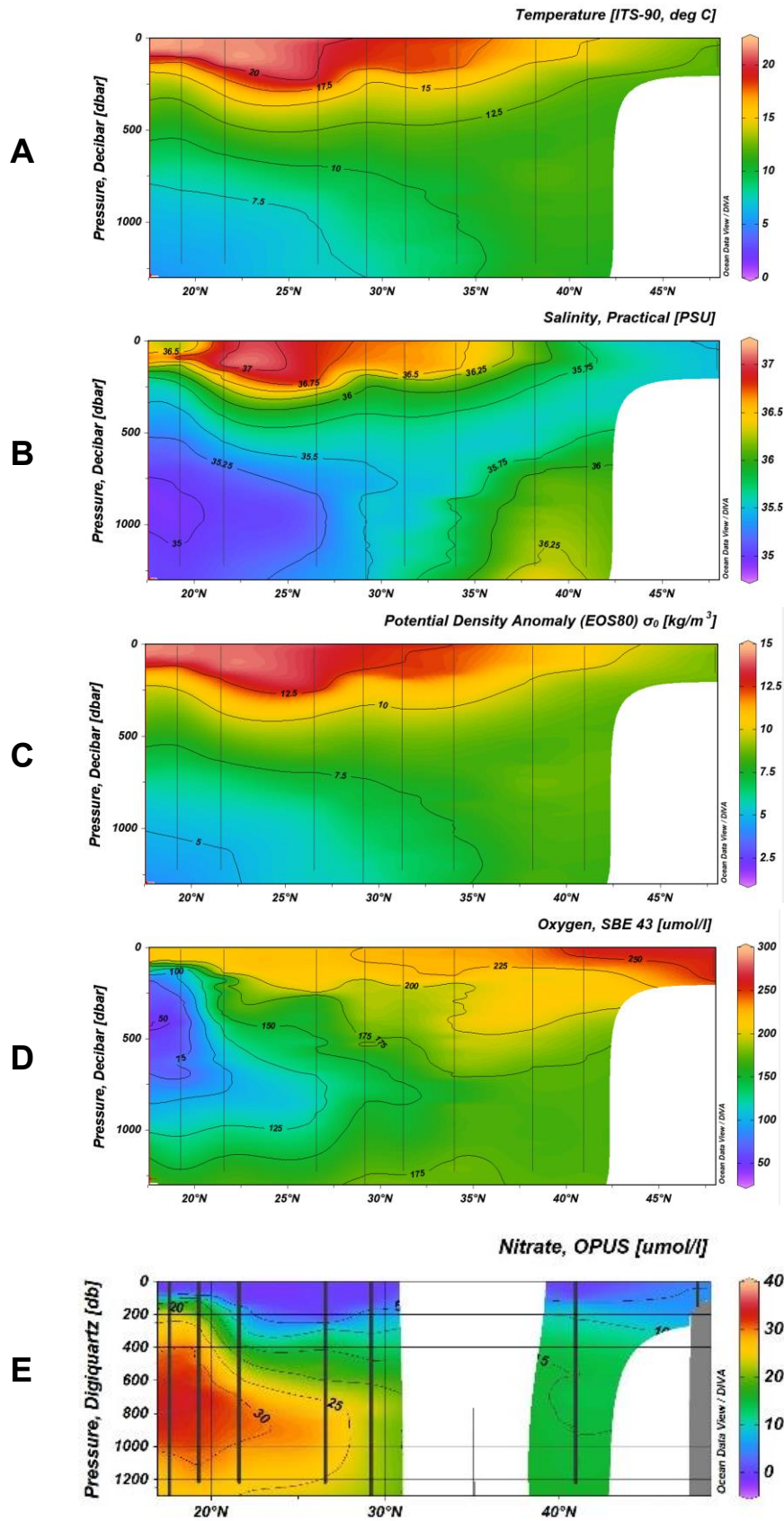


Fig. 5.6: Section plots for temperature (A), salinity (B), potential density anomaly (C), DO (D), and nitrate (E) measured with sensors on the CTD rosette sampler along the 10 CTD stations (Fig. 5.5). Vertical lines in each subfigure indicate the respective CTD down-/upcast, showing data down to 1300 dbar, while contour lines denote concentrations of the respective parameter.

The strong decrease in SST and sea surface salinity (SSS; Fig. 5.6 B and Fig. 5.7) with latitude was associated with an inverse relationship with oxygen. Dissolved oxygen concentrations were generally high at the surface due to photosynthesis and air-sea exchange, decreased with depth due to biological respiration, and increased again below 1,000 m due to oxygen-rich deep-water masses (Fig. 5.6. C and Fig 5.6 D). For example, an oxygen minimum zone is shown in the Cape Verdean waters from 200 to 700 meters depth due to stratification, while high oxygen concentrations were found in the European waters at higher latitudes due to cold water which suggesting vertical ventilation and high productivity that resulted from the spring bloom season. Notably, the deepest mixed layer was recorded within an eddy (station 4) at 26.541°N at around 220 m depth, indicating enhanced vertical mixing, and the Mediterranean waters were found about 30° to 45°N between 600 and 1,200 m depth.

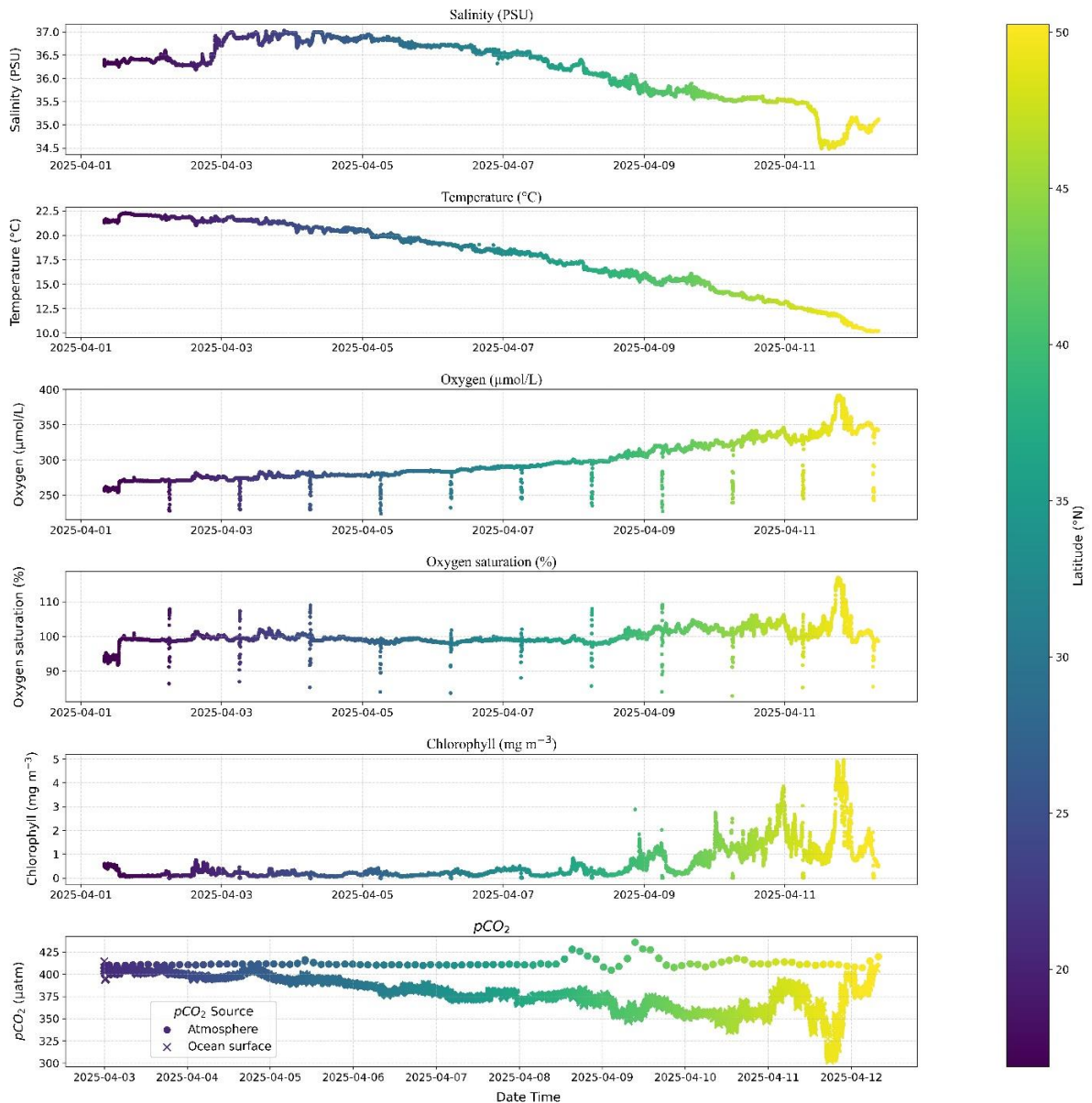


Fig. 5.7: Temporal and spatial view of salinity, temperature, oxygen, oxygen saturation, Chl-a, and atmospheric and ocean surface CO₂ partial pressure. The color scale represents changes in latitude in °N.

As stratification gradually decreased with increasing latitude (Fig 5.6 C), the vertical translocation of nutrients was facilitated from deep waters to the epipelagic zone, as supported by OPUS-based measurements of nitrate concentrations ($\mu\text{mol L}^{-1}$, Fig 5.6 E). Isopleths of nitrate concentration, e.g., 20 or 30 $\mu\text{mol L}^{-1}$, clearly display a pronounced vertical division of layers. For example, subtropical waters are very low in nitrate concentration (0–5 $\mu\text{mol L}^{-1}$) at the surface, while higher nitrate levels occur at greater depths (>800 dbar) in lower and higher latitudes. A strong maximum in nitrate concentrations of about 30–35 $\mu\text{mol L}^{-1}$ was found at the beginning of the transect between 18°N and 20°N, and 600 and 1,000 dbar, showing a strong anticorrelation with oxygen levels that are low at the overlying water between 200 and 700 dbar.

The attenuation of the thermocline along the transect has been beneficial for biological productivity by providing a favourable environment for phytoplankton proliferation. Elevated levels of fluorescence observed in the Northern sampling stations corroborated the existence of chlorophyll-rich phytoplankton assemblages, suggesting a proliferation of phytoplankton probably attributable to the increased availability of nutrients and light penetration.

Underway measurements

Figure 5.7 presents a time series of key oceanographic parameters collected along the latitudinal gradient during PS147/2, between 1 April and 12 April 2025. Each plot illustrates variations in salinity, temperature, dissolved oxygen concentration, oxygen saturation, Chl-a concentration, and $p\text{CO}_2$ in the atmosphere and the ocean surface. The color scale represents changes in latitude, offering insights into spatial and temporal patterns that may be linked to environmental gradients, biological activity, and air-sea gas exchange dynamics.

From a biological point of view, productivity increased towards the North. High Chl-a concentrations (indicated by fluorescence measurements), oversaturated DO levels at surface and decreased $p\text{CO}_2$ values (suggest pronounced phytoplankton blooms with high primary production in Northern waters). The difference in atmospheric and ocean $p\text{CO}_2$ levels indicated a strong sink for atmospheric CO_2 in this region.

Biogeochemistry

Oxygen measurements

Winkler measurements of DO (discrete samples) are needed to calibrate both oxygen sensors attached to the CTD for more accurate measurements, which will be done in the post-processing of the data. The average standard deviation (SD) was calculated for the entire cruise to $\pm 0.994 \mu\text{mol L}^{-1}$. This value is based on 1 quadruplicate, 17 triplicates and 8 duplicates (26 values in total). One outlier each for 4 triplicates and 1 quadruplicate were excluded from the SD calculation.

The results are subject to limitations as the sampling was part of a training and done by the students with limited experience. In total, 14 different students (as part of 4 different groups) participated in the sampling, which might have led to inaccuracies. Therefore, significant outliers were removed. Oxygen concentrations were measured at 10 of the 11 stations (no sampling at station 10). During the cruise, different ocean regimes were passed. Accordingly, the stations can be grouped as follows: oligotrophic (station 1–4), transitional (station 5–7) and temperate (station 8–11).

Figure 5.8 illustrates a consistent increase in oxygen concentrations in surface waters throughout the cruise, which may be due to the decrease in the sea surface temperature and an increase in productivity. Overall, sampling conducted further North, in the temperate zone, revealed higher oxygen levels at all depths. In oligotrophic waters, a prominent oxygen minimum zone was found at depths between 400 and 700 m, with the lowest O_2 concentrations of $54 \mu\text{mol L}^{-1}$ (station 1, at 450 m). Over the course of the cruise, hence moving northward, the oxygen minimum zone diminished progressively and was no longer detectable at later stations due to higher primary production, stronger mixing at the surface and lower O_2 consumption in the deeper water column (at higher latitudes).

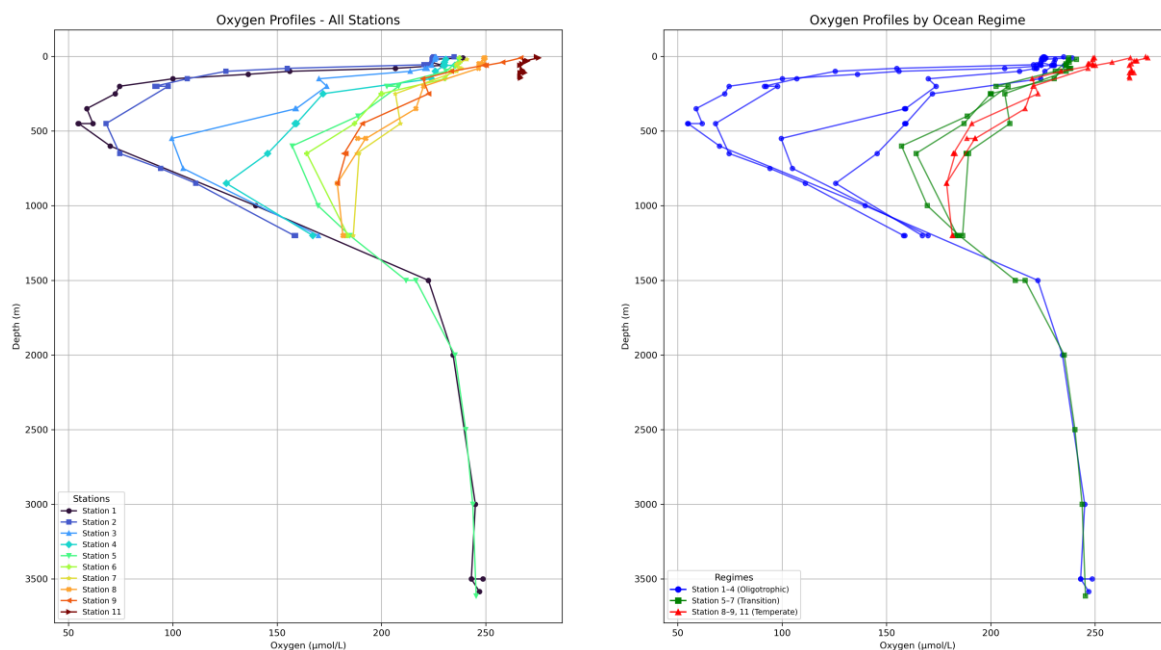


Fig. 5.8: Oxygen concentrations ($\mu\text{mol L}^{-1}$) from Winkler titration over depth for each sampled station (left panel) and grouped into three ocean regimes (right panel; blue is an oligotrophic, green is a transitional and red is a temperate ocean regime)

Chlorophyll-a measurements

The vertical Chl-a profiles (Fig. 5.9) reveal distinct biogeochemical dynamics across the sampled ecological regimes. Stations in oligotrophic waters (station 1–4) exhibit a characteristic deep Chl-a maximum (DCM), aligning with nutrient limitation in surface layers and subsurface productivity. Transitional stations (station 5–7) display intermediate variability, likely reflecting shifting nutrient-light interactions. In contrast, temperate stations (station 8–11) show elevated surface Chl-a concentrations, indicative of mixing-driven nutrient supply and shallower phytoplankton biomass peaks. The consistent subplot structure enables direct cross-regime comparison, emphasizing how regional hydrographic conditions shape productivity gradients. These patterns underscore the critical role of environmental regimes in structuring marine ecosystems, with implications for understanding carbon cycling and trophic dynamics in coastal and open-ocean systems.

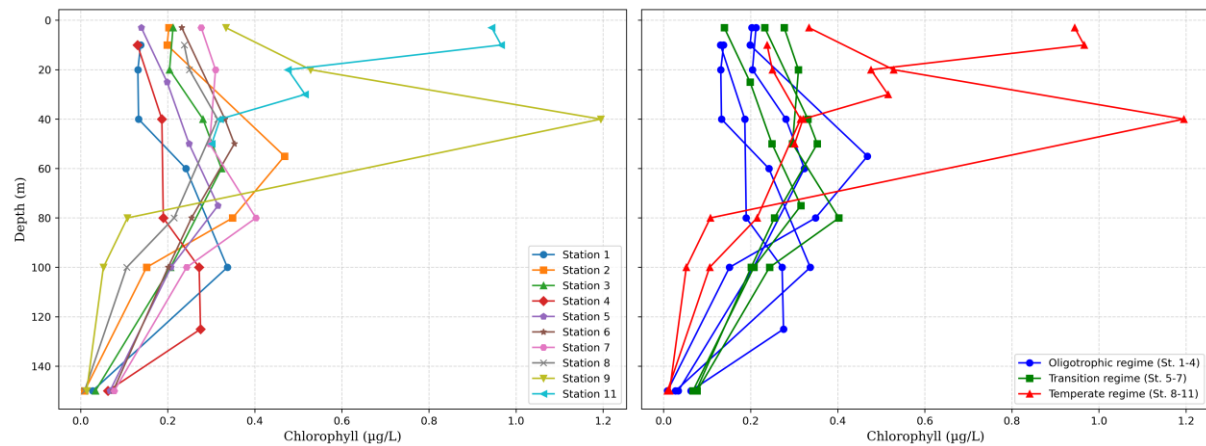


Fig. 5.9: Chl-a profiles over depth for each sampled station (left panel) and grouped into three ocean regimes (right panel; blue is an oligotrophic, green in a transitional and red is a temperate ocean regime)

Marine Ecology

MultiNet hauls

Along the transect three major scenarios were qualitatively observed. From station 1 to 6 an oligotrophic subtropical gyre setting was observed, with a generally high diversity of different taxa, an apparently high diversity of copepods, and occasional catches of small decapod shrimps, krill and mesopelagic fishes (mostly *Cyclothone* sp.). At station 7 to 9, a transition scenario was observed, based on higher numbers of salps, larvaceans, pteropods and foraminifera. At station 9 and 11 a spring bloom was observed and the zooplankton was apparently dominated by North Atlantic species with high abundances of early life stages and inclusion of large phytoplankton in the MultiNet samples.

This primary production forms the fundamental framework of the food web, enabling higher trophic levels to be maintained, including copepods, which are recognised as essential secondary producers in marine ecosystems. The increase in productivity seen in the Northern stations has favoured the proliferation of copepods, amplifying biological activity in the region. In this context, copepods play a vital role in transferring energy to zooplankton, ichthyoplankton and other important consumers, while also contributing to the biological carbon pump by actively transporting organic matter to the abyssal layers through vertical migration and excretion of faecal pellets.

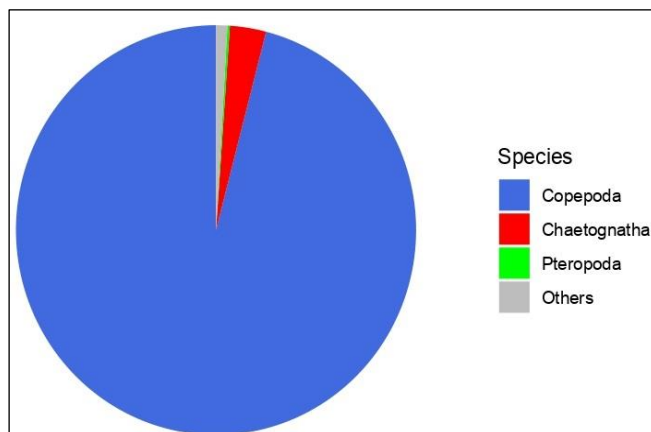


Fig. 5.10: Contribution in terms of abundance of major plankton groups of surface layer (net 5, 100–0 m) from stations 2–9, and 11

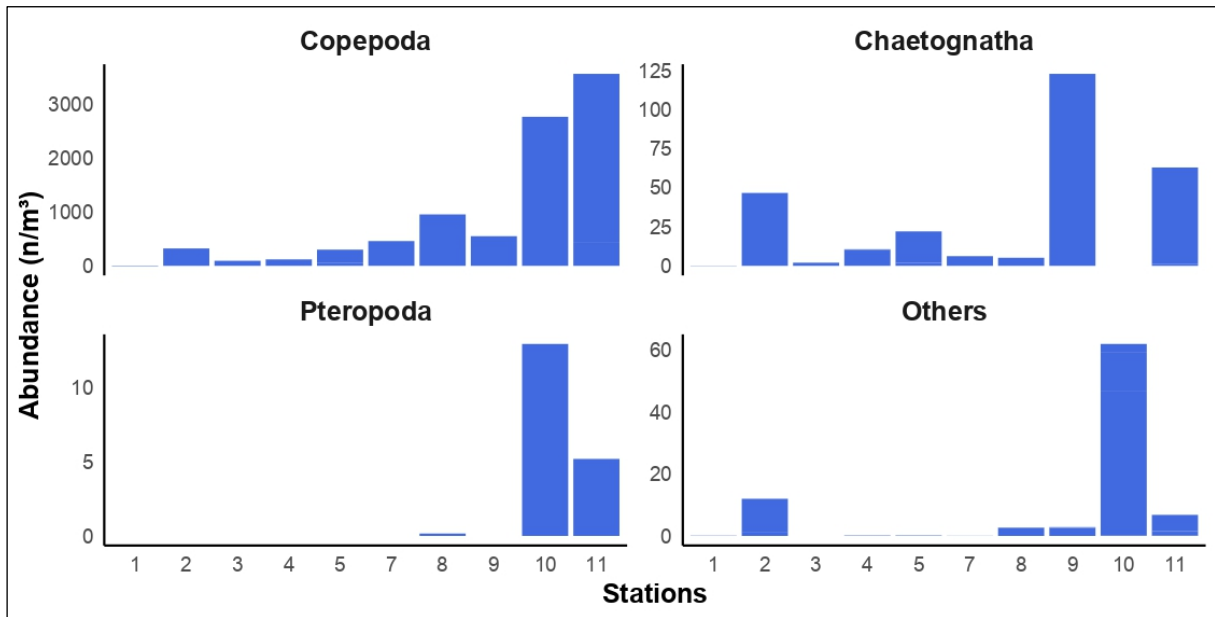


Fig. 5.11: Distribution of major plankton groups by station (surface layer net 5, 100–0 m). No data were generated from station 1, as the samples were preserved for subsequent laboratory analysis

Underway Hydroacoustic Observations

Over the eleven stations of the transect, the EK80 data illustrated typical sound scattering layers at different depths. A notable, persistent deep scattering layer was recorded and observed in depths from 300 to 500 m. Diel vertical migration of organisms from the deep layers to the surface layers at night and back into the deep layers at dawn was observed. The few migrations extending beyond 1,000 m depth during PS135/2 were not observed in PS147/2. Furthermore, concentrations of backscattering organisms in the surface layer, particularly in the upper 100 m, were alternately increased due to the difference in migration between day and night (Fig. 5.12).

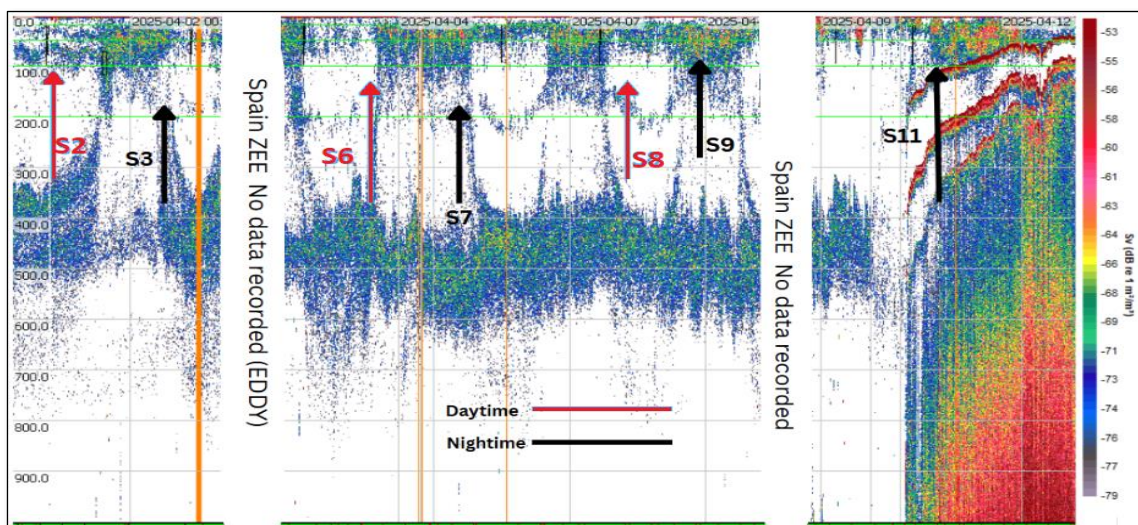


Fig. 5.12: Echogram showing the 38 kHz data from the EK80 for the whole transect

The scattering volume (Sv) patterns gave an increasing trend from oligotrophic region (station 2 to 9) towards temperate coastal region (stations 11) as illustrated in Fig. 5.13. In general, the 200 kHz gave better frequency response from oligotrophic region (stations 2–9) while in the coastal region (station 11) the backscattering was better with 38 kHz, which is typical of gas bearing organisms responses. Table 5.9 summarises the main acoustic properties of the visited regions.

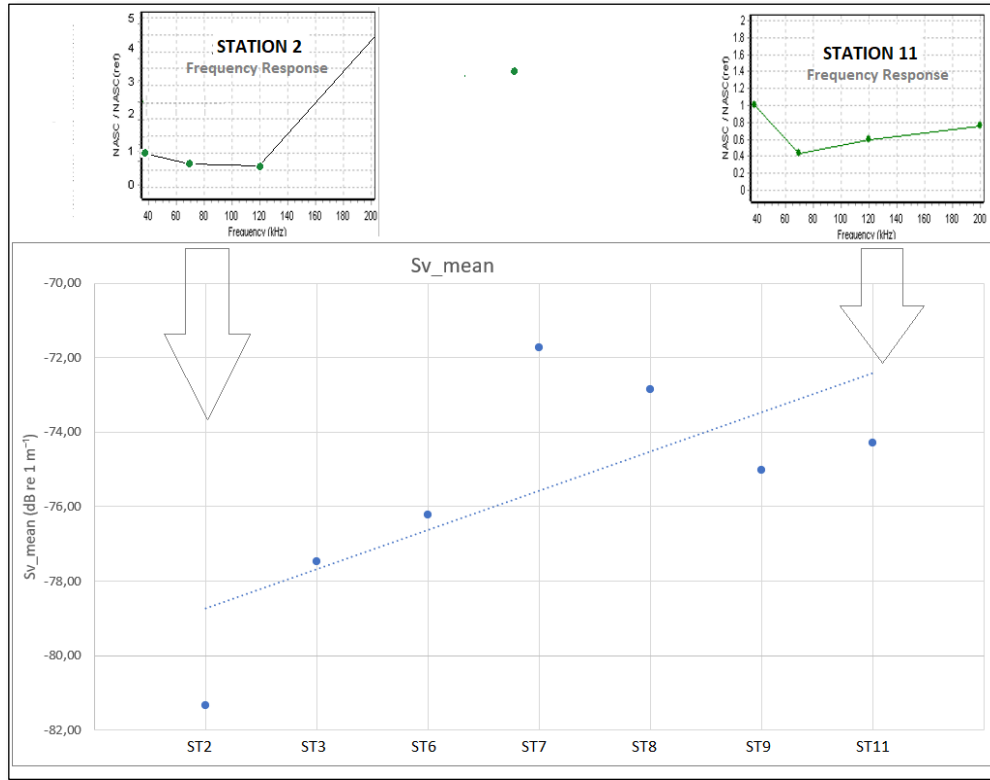


Fig. 5.13: Scattering volume (Sv) patterns from the oligotrophic ocean regime to temperate coastal regions (at the bottom), and frequency response of main regimes (at the top).

Tab. 5.9: Summary of acoustic properties of the stations, given as mean values. At stations 4 and 5, where eddies occurred, as well as at station 10, no data was collected because the vessel was in the EEZ of Spain. Column header legend: Region ID, reflects the station number ST and depth range in meters; Date, states the year, month and day in the format yyyyymmdd; Time, states the hour and minutes in format HH:MM; Lat, states the latitude in decimal degree format; Lon, states the longitude in decimal degree format; Sv, is the mean scattering volume value, measured in dB re 1 m⁻¹; NASC, is the Nautical area scattering coefficient, measured in m² nmi⁻²; Height, gives the height of the region in meters; Depth, gives the depth of the region in meters; Density number, is the number of scatterers per nmi².

Region ID	Date	Time	Lat [°N]	Lon [°W]	Sv [dB re 1 m ⁻¹]	NASC [m ² nmi ⁻²]	Height [m]	Depth [m]	Density number [1 nmi ⁻²]
ST2_20_100m_depth	20250402	11:29	19.254	-22.974	-81.35	22.33	70.680	60.71	17767
ST3_20_100m_depth	20250403	07:24	21.579	-21.355	-77.49	61.03	79.458	57.57	48567

Region ID	Date	Time	Lat [°N]	Lon [°W]	Sv [dB re1 m ⁻¹]	NASC [m ² nmi ⁻²]	Height [m]	Depth [m]	Density number [1 nmi ⁻²]
ST6_20_100m_depth	20250406	11:56	31.245	-14.701	-76.23	75.40	73.416	56.49	60002
ST7_20_100m_depth	20250407	05:24	33.989	-13.617	-71.74	229.72	79.572	59.57	182803
ST8_20_100m_depth	20250408	10:00	38.202	-11.573	-72.86	190.63	85.386	54.61	151700
ST9_20_100m_depth	20250409	03:53	40.930	-10.093	-75.03	104.69	77.292	56.49	83308
ST11_50-100m_depth	20250411	03:16	47.803	-6.542	-82.05	13.53	50.388	75.53	10770
ST11_20-50m_depth	20250411	03:19	47.809	-6.536	-74.30	47.68	29.754	34.43	37942

Microplankton Community

Visual inspection of Apstein net samples revealed a community shift from a highly diverse mesozooplankton group dominated by adult stages at subtropical stations, toward copepod dominance with increased presence of nauplius stages in the 20 µm net at shelf station (Fig. 5.14). Consequently, at the open ocean stations, the quantity of sinking aggregates at greater depths was visualized and quantified using a FlowCam (Fig. 5.14). The presence of heterotrophic microplankton, including dinoflagellates and ciliates, as well as individuals of the cyanobacterium *Trichodesmium*, indicated environmental conditions favorable for heterotrophic communities and microbial loop processes.

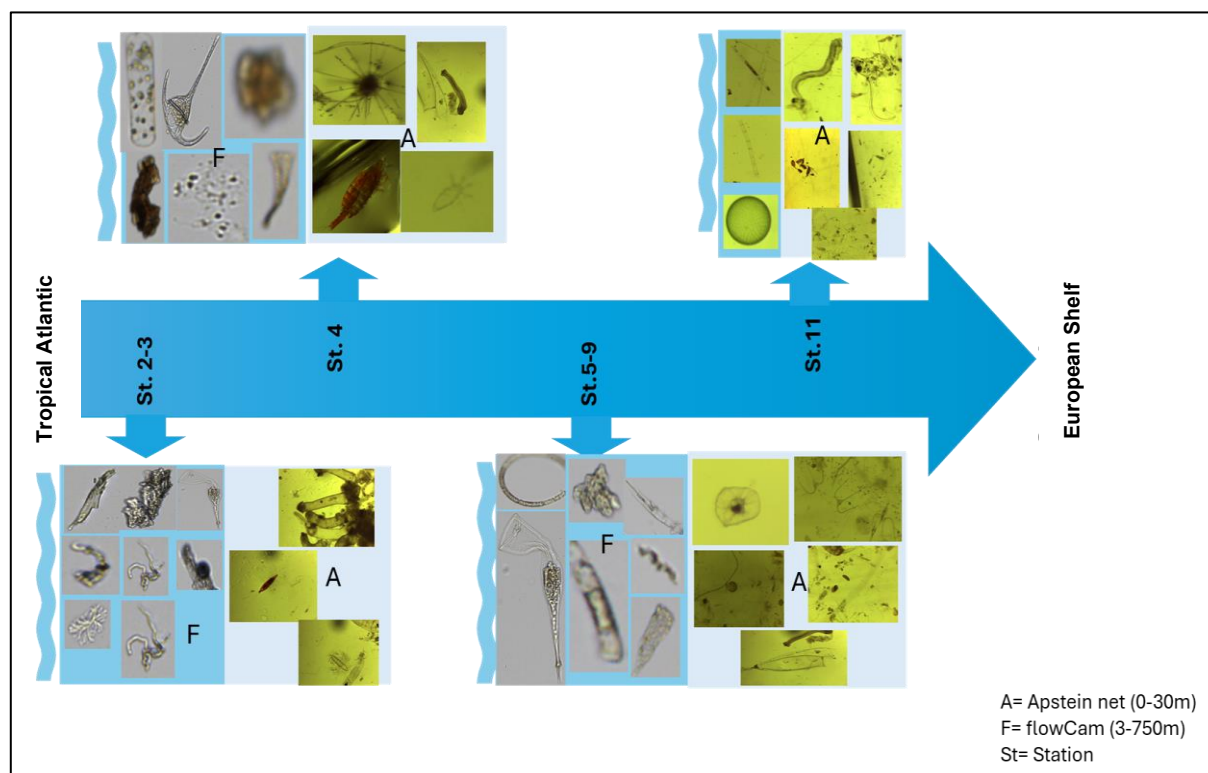


Fig. 5.14: Microplankton community changes alongside the latitudinal transit

Neuston and planktonic sampling

Lugol samples were analysed using an inverted microscope, working with 50 mL volumes to allow for better identification across different stations. Out of the 9 stations, samples of 3 stations were successfully counted by identifying, classifying, and quantifying several taxonomic groups as much as possible. However, 6 stations remain unanalysed, along with additional intermediate station samples that will be processed and post-analysed in the same way after the cruise. For the DNA samples, extractions from all stations were completed. The next steps will involve sequencing and qPCR for different photosystem genes to get an impression on the main primary producers, which can be followed up by 16S/18S sequencing for community analysis if useful. For the incubation samples, drying, acid fusing, and weighing was completed, followed by the next step of performing isotope analysis through mass-spectrometry at SDU in Denmark.

Scientific communication

As scientists, we must communicate! All the effort put into science will have little impact if it is not communicated. Communicating science means informing, raising awareness of science-related topics, and getting involved with audiences that include, at least in part, people from outside the science community. This module is crucial if science is to fulfill its role in tackling societal challenges locally, nationally, and globally.

This module focused on the important role of communication in science, including informing policy, creating public awareness, and promoting interest in science studies.

Trainees were introduced to various communication tactics and hands-on practical exercises to develop better communication skills. These included using cameras, microphones, and editing software to create quality videos and an audio piece (podcast), as well as writing, photography, and oral presentations. Each student group was given a task tailored to a specific audience, thereby enhancing their understanding of the goals and strategies behind effective science communication (Tab. 5.19; Fig. 5.15).

Group A gave an oral presentation about the big picture of the North Atlantic transect that was covered by comparing the results from the transects to a global view. They brought together all results from the entire transect and developed a scientific storyline in the context of global ocean observations and climate change.

In Group B, each trainee wrote a short article aimed at a lay audience, focusing on the importance of oceanic research and engagement. Their target audiences included students, scientists, and the general public. They were asked to share their perspectives on photography, image capturing, and the role of social media in sharing ocean-related content. Each trainee then ventured out to take pictures of subjects that resonated with them. Later, they gathered with the instructors to explain their choices and the stories behind their photographs. Following this discussion, each trainee selected a unique topic and wrote an individual piece. These topics included “Empowering Young African Researchers Through Science and Collaboration”, “The Wondrous World of Plankton”, “The Work That Goes Unseen”, and “Instructors and students on board the research vessel *Polarstern*, mutual Relations, team spirit, and oceanographic discovery”. Each trainee’s article was crafted to engage a broad audience and communicate the significance of their chosen theme in an accessible and compelling way.

Group C utilized various interview formats to engage with trainees and instructors on board. They developed a storyline to help instructors understand the deeper motivations behind their work. Voices of the Ocean serves as a platform where individuals share their thoughts on the ocean and their role in its protection. Through interviews with students, scientists, and crew members, the platform offers a valuable opportunity to learn from each participant's unique perspective. Crew members, having spent extended periods onshore or at sea, bring insights distinct from those of scientists. Their experiences provide a fresh lens through which to understand ocean exploration and conservation. Scientists, in contrast, view the ocean through a research-driven and environmental preservation perspective, which may differ from the outlook of students or trainees who are just beginning to immerse themselves in ocean studies. This platform is dedicated to amplifying diverse voices and fostering a deeper understanding of the ocean's significance, ensuring that every experience and perspective is heard.

Tab. 5.10: The table below highlights the various groups, and the themes worked on

Groups	Mode of communication	Members	Title of Tasks under Science Communication
A	Oral scientific presentation	Akote M'kawata Ahounga, Ayodele Gbla, Somyida Denis Sawadogo, Aly Diallo	Understanding the biogeochemical regimes along the PS147/2 transect
B	Writing and photography	Débora Da Luz Coelho Hannah Ukamaka Dennis Titus Tempel Drissa Alfousseyeni Coulibaly	Empowering Young African Researchers Through Science and Collaboration; and A Journey of Dreams, Science and Courage (accessible on oceanblogs.org) The Wondrous World of Plankton The Work that goes Unseen Instructors and students on board the research vessel <i>Polarstern</i> , mutual relations, team spirit, and oceanographic discovery
C	Audio/podcast	Joachim Laham, Patience Adjei Mensah, Souleymane Maman Nouri Souley, Josefa Beyer	Voices of the Ocean, as part of the Wellenbrecher podcast in the episode "WASCAL Floating University: Voices of an Ocean Community"
D	Film/video	N'guessan Cesaïre Kouadio, Nogaye Dia, Khevine Robaverge Mahougnon Djogli	A transformative journey on <i>Polarstern</i>



Fig. 5.15: Various group situations during scientific communication module on PS147/2: Interview phase for the video of Group D (top left), oral presentation of scientific results during PS147/2 of Group A (top right), presentation of writing articles of Group B (bottom left), and preparation of interviews for the audio format of Group C (bottom right)

Using video production techniques, Group D explored the purpose of the cruise, their expectations for each module, and how the experience deepened their understanding of the ocean. They learned the basic tools of storyboarding, and developed a framework for the video based on this. The importance of carrying a storyline through the video, keeping a main message while adding detail, and editing to stay within time constraints, could all be implemented on the storyboard. They then went out and filmed the scenes needed, practicing different interview formats and filming methods. Finally, they used freely available software to edit the final video.

Additionally, the cruise experience highlights how oceanic phenomena influence lifestyle choices by raising awareness of environmental challenges affecting various countries in West Africa, particularly in terms of flooding risks and natural disasters. The unique experience gained from this module was the confidence, ability to give a main message, and identify a target audience, which facilitates communication in the scientific world and beyond. Overall, the module is a powerful tool that can be applied anywhere because it equips you with the essential skills needed to convey a message easily.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (<https://www.pangaea.de>) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

Any other data will be submitted to an appropriate long-term archive that provides unique and stable identifiers for the datasets and allows open online access to the data.

This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 2, Subtopic Ocean and Cyrosphere in Climate Change, and Topic 6, Subtopic Marine and Polar Life.

In all publications based on this expedition, the **Grant No. AWI_PS147_03** will be quoted and the following publication will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. <http://dx.doi.org/10.17815/jlsrf-3-163>.

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Roesler C (2020) Extractive Fluorometric Chlorophyll analysis. March, 10–12.

https://misclab.umeoce.maine.edu/OceanOpticsClass2021/wp-content/uploads/2021/07/July23_Chlorophyll_Extracted_Fluorometric_Analysis_2020.pdf

APPENDIX

- A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTES**
- A.2 FAHRTTEILNEHMER:INNEN / CRUISE PARTICIPANTS**
- A.3 SCHIFFSBESATZUNG / SHIP'S CREW**
- A.4 STATIONSLISTE / STATION LIST**
- A.5 STATION COORDINATES ALONG THE CRUISE TRANSECT FOR THE
WASCAL FLOATING UNIVERSITY**

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTES

Affiliation	Address
BR.CHM	Marinha do Brasil Centro de Hidrografia da Marinha Rua Barão de Jaceguai, s/n Ponta da Armação 24048-900 Niterói Brazil
CV.UTA	Universidade Técnica do Atlântico Institute of Engineering and Marine Sciences CP.163 – Campus de Ribeira de Julião Mindelo, São Vicente Cabo Verde
DE.AWI	Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung Postfach 120161 27515 Bremerhaven Germany
DE.CAU	Kiel University Christian-Albrechts-Platz 4 24118 Kiel Germany
DE.GEOMAR	GEOMAR Helmholtz Centre for Ocean Research Kiel Wischhofstr. 1-3 24148 Kiel Germany
DE.ECOP	ECOP-Germany, Austria, Switzerland (DACH) Coordination Unit National Node Germany https://www.ecopdecade.org/germany/
DE.IOW	Leibnitz Institute for Baltic Sea Research Warnemünde Seestraße 15 18119 Rostock-Warnemünde Germany
DE.JAG	Johannes-Althusius-Gymnasium Emden Früchteburger Weg 28 26721 Emden Germany
DE.TI	Institute of Sea Fisheries Herwigstraße 31 27572 Bremerhaven Germany

Affiliation	Address
DE.UNI-Potsdam	University of Potsdam Am Neuen Palais 10 14469 Potsdam Germany
DK.SDU	University of Southern Denmark Campusvej 55 5230 Odense M Denmark
NL.UU	Utrecht University Heidelberglaan 8 3584 CS Utrecht The Netherlands
SN.CRODT	Centre de Recherche Océanographique de Dakar Thiaroye (CRODT-ISRA) B.P. 2241, Rte des Hydrocarbures Dakar République du Sénégal

A.2 FAHRTTEILNEHMER:INNEN / CRUISE PARTICIPANTS

PS147/1 Stanley – Mindelo				
Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	Fachrichtung/ Discipline
On board				
Fernandes	Marcella	BR.CHM	Observer	Hydrology
Köhler	Laura Elisabeth	DE.AWI	Scientist	Physics
Künzig	Sophia Hannah Celina	DE.UNI-Potsdam	Student	Geo Sciences
Müller	Mario	DE.GEOMAR	Engineer	Oceanography
Müller	Tim	DE.GEOMAR	Student	Data
Schulze Tenberge	Yvonne	DE.AWI	Scientist	Geophysics
Not on board				
Brandt	Peter	DE.GEOMAR	Scientist	Oceanography
Dorschel	Boris	DE.AWI	Scientist	Geophysics
Dreutter	Simon	DE.AWI	Scientist	Geophysics

PS147/2 Mindelo – Bremerhaven				
Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	Fachrichtung/ Discipline
On board				
Ahounga	Akotè M'kawata	CV.UTA	Student	Marine Sciences
Almeida	Corrine	CV.UTA	Scientist	Biology
Antia	Avan	DE.CAU	Scientist	Biology
Baierlein	Paula	DE.GEOMAR	Student	Outreach
Beyer	Josefa	NL.UU	Student	Law of the Sea
Bittig	Henry	DE.IOW	Scientist	Chemistry
Chouksey	Manita	DE.IOW	Scientist	Physics
Coelho	Débora da Luz	CV.UTA	Student	Marine Sciences
Coulibaly	Drissa Alfousseyni	CV.UTA	Student	Marine Sciences
Dennis	Hannah Ukamaka	CV.UTA	Student	Marine Sciences
Dia	Nogaye	CV.UTA	Student	Marine Sciences
Diallo	Aly	CV.UTA	Student	Marine Sciences

PS147/2 Mindelo – Bremerhaven				
Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	Fachrichtung/ Discipline
On board				
Djogli	Khevine Robaverge Mahougnon	CV.UTA	Student	Marine Sciences
Fiedler	Björn	DE.GEOMAR	Scientist	Chemistry
Fock	Heino	DE.TI	Scientist	Biology
Gbla	Ayodele	CV.UTA	Student	Marine Sciences
Hahn	Tobias	DE.GEOMAR	Scientist	Chemistry
Javidpour	Jamileh	DK.SDU	Scientist	Biology
Kache	Sophie	DE.IOW	Scientist	Biology
Köhler	Laura	DE.AWI	Scientist	Physics
Kouadio	N'guessan Cesaire	CV.UTA	Student	Marine Sciences
Künzig	Sophia Hannah Celina	DE.UNI-Potsdam	Student	Geo Sciences
Lamah	Joachim	CV.UTA	Student	Marine Sciences
Mensah	Patience Adjei	CV.UTA	Student	Marine Sciences
Sarré	Abdoulaye	SN.CRODT	Student	Biology
Sawadogo	Somyida Denis	CV.UTA	Student	Marine Sciences
Schulze Tenberge	Yvonne	DE.AWI	Scientist	Geophysics
Souley	Souleymane Maman Nouri	CV.UTA	Student	Marine Sciences
Tempel	Titus	DE.JAG	Pupil	Marine Sciences
Not on board				
Dorschel	Boris	DE.AWI	Scientist	Geophysics
Dreutter	Simon	DE.AWI	Scientist	Geophysics
Schütte	Florian	DE.GEOMAR	Scientist	Physics
Körtzinger	Arne	DE.GEOMAR	Scientist	Chemistry

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

No	Dienstgrad	Rank	Nachname / Last name	Vorname / First name
1	Kapitän	Master	Kentges	Felix
2	1. Offizier	Chief Mate	Langhinrichs	Jacob
3	1. Offizier Ladung	Chief Mate Cargo	Janik	Michael
4	2. Offizier	2nd Mate	Hering	Igor
5	2. Offizier	2nd Mate	Rathke	Wulf Jannik
6	Schiffsärztin	Doctor	Gößmann-Lange	Petra
7	Leitender Ingenieur	Chief Engineer	Grafe	Jens
8	2. Ingenieur	2nd Engineer	Ehrke	Tom
9	2. Ingenieur	2nd Engineer	Brose	Thomas Christian Gerhard
10	2. Ingenieurin	2nd Engineer	Bähler	Stefanie
11	Schiffselektrotechniker Maschine	Ship Electrotechnical Officer Engine	Redmer	Jens
12	Schiffselektrotechniker Maschine	Ship Electrotechnical Officer Engine	Zivanov	Stefan
13	Elektroniker Winden	Electrotechnical Engineer Winches	Jäger	Vladimir
14	Elektroniker Netzwerk/Brücke	Electrotechnical Engineer Network/Bridge	Frank	Gerhard Ansgar Leon
15	Elektroniker Labor	Electrotechnical Engineer Labor	Hüttebräucker	Olaf
16	Elektroniker System	Electrotechnical Engineer System	Pliet	Johannes
17	Bootsmann	Bosun	Sedlak	Andreas
18	Zimmermann	Carpenter	Neisner	Winfried
19	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Klee	Philipp

No	Dienstgrad	Rank	Nachname / Last name	Vorname / First name
20	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Burzan	Gerd-Ekkehard
21	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Fischer	Sascha
22	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Klähn	Anton
23	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Kryszkiewicz	Maciej Waldemar
24	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Cornelsen	Robert
25	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Bäcker	Andreas
26	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Röth	Benedikt
27	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Rhau	Lars-Peter
28	Decksmann/Matrose	Able Seaman	Ackenhausen	Hendrik
29	Lagerhalter	Storekeeper	Preußner	Jörg
30	Schiffsmechaniker Maschine	Multi Purpose Rating Engine	Rolofs	Nils Christian Timo
31	Schiffsmechaniker Maschine	Multi Purpose Rating Engine	Hänert	Ove
32	Schiffsmechanikerin Maschine	Multi Purpose Rating Engine	Klinger	Dana
33	Schiffsmechaniker Maschine	Multi Purpose Rating Engine	Plehn	Marco Markus
34	Schiffsmechaniker Maschine	Multi Purpose Rating Engine	Münzenberger	Börge
35	1. Koch	1st Cook	Hofmann	Werner
36	2. Köchin	2nd Cook	Hammelman	Louisa
37	2. Köchin	2nd Cook	Dietrich	Emilia Felizitas Ilse Lieselotte
38	1. Steward	1st Steward	Pieper	Daniel
39	2. Stewardess / Krankenschwester	2nd Stewardess / Nurse	Schwantes	Andrea
40	2. Stewardess	2nd Stewardess	Brändli	Monika
41	2. Steward	2nd Steward	Dibenau	Torsten
42	2. Stewardess	2nd Stewardess	Möhle	Steffi

No	Dienstgrad	Rank	Nachname / Last name	Vorname / First name
43	2. Steward / Wäscherei	2nd Steward / Laundry	Arendt	Rene
44	2. Steward / Wäscherei	2nd Steward / Laundry	Cheng	Qi
45	2. Steward / Wäscherei	2nd Steward / Laundry	Chen	Dansheng
46	Auszubildender Schiffsmechaniker	Apprentice Ship Mechanic	Glawe	Jonathan Elias

A.4 STATIONSLISTEN / STATION LISTS PS147/1 AND PS147/2

Station list of expedition PS147/1 from Stanley – Mindelo; the list details the action log for all stations along the cruise track.

See <https://www.pangaea.de/expeditions/events/PS147/1> to display the station (event) list for expedition PS147/1.

This version contains Uniform Resource Identifiers for all sensors listed under <https://sensor.awi.de>. See <https://www.awi.de/en/about-us/service/computing-centre/data-flow-framework.html> for further information about AWI's data flow framework from sensor observations to archives (O2A).

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/1-track		2025-03-13T00:00:00	-51.69000	-57.81200		CT	Station start	Stanley - Mindelo
PS147/1-track		2025-04-01T00:00:00	16.88610	-24.99760		CT	Station end	Stanley - Mindelo
PS147/1_0_Underway-1		2025-03-13T19:44:00	-48.25998	-56.01588	2335	GRAV	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-1		2025-04-01T08:00:00	16.89711	-25.01921	33.9	GRAV	Station end	Profiles stopped within Brazilian EEZ and ECS zones

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/1_0_Underway-2		2025-03-13T19:45:00	-48.25789	-56.01466	2342.4	MAG	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-2		2025-04-01T08:00:00	16.89711	-25.01921	33.9	MAG	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-3		2025-03-13T19:46:00	-48.25662	-56.01395	2349.8	SWEAS	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-3		2025-04-01T08:00:00	16.89711	-25.01921	33.9	SWEAS	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-4		2025-03-13T19:47:00	-48.25398	-56.01256	2376	NEUMON	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-4		2025-04-01T08:00:00	16.89711	-25.01921	33.9	NEUMON	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-5		2025-03-13T19:48:00	-48.24844	-56.00955	2423.6	MYON	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-5		2025-04-01T08:00:00	16.89711	-25.01921	33.9	MYON	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-6		2025-03-13T19:57:00	-48.22315	-55.99541	2731.8	ADCP	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-6		2025-04-01T08:00:00	16.89799	-25.02029	35.6	ADCP	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-7		2025-03-13T19:51:48	-48.23900	-56.00400	2514.3	MBES	Station start	Profiles stopped within Brazilian EEZ and ECS zones; Event shows start/end point (date/time & coordinates) of first/last data reco...

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/1_0_Underway-7		2025-04-01T07:38:25	16.89370	-25.08200	46	MBES	Station end	Profiles stopped within Brazilian EEZ and ECS zones; Event shows start/end point (date/time & coordinates) of first/last data reco...
PS147/1_0_Underway-8		2025-03-13T19:54:00	-48.23235	-56.00067	2520.7	FBOX	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-8		2025-04-01T08:00:00	16.89711	-25.01921	33.9	FBOX	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-11		2025-03-13T19:57:00	-48.22315	-55.99541	2731.8	SNDVELPR	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-11		2025-04-01T08:00:00	16.89799	-25.02029	35.6	SNDVELPR	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-10		2025-03-13T19:57:00	-48.22315	-55.99541	2731.8	pCO2	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-10		2025-04-01T08:00:00	16.89799	-25.02029	35.6	pCO2	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-15		2025-03-14T20:30:00	-44.31296	-53.89782	5703.9	PAMOS_003	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-15		2025-04-01T08:00:00	16.89711	-25.01921	33.9	PAMOS_003	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-14		2025-03-14T20:30:00	-44.31296	-53.89782	5703.9	PAMOS_001	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-14		2025-04-01T08:00:00	16.89711	-25.01921	33.9	PAMOS_001	Station end	Profiles stopped within Brazilian EEZ and ECS zones

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/1_0_Underway-12	TSK1	2025-03-13T19:56:00	-48.22561	-55.99689	2632.3	TSG	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-12	TSK1	2025-04-01T08:00:00	16.89711	-25.01921	33.9	TSG	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-13	TSK2	2025-03-13T19:57:00	-48.22426	-55.99608	2695.4	TSG	Station start	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_0_Underway-13	TSK2	2025-04-01T08:00:00	16.89711	-25.01921	33.9	TSG	Station end	Profiles stopped within Brazilian EEZ and ECS zones
PS147/1_1-1		2025-03-14T16:49:00	-44.82031	-54.15503	5736.8	CTD-RO	max depth	
PS147/1_2-1		2025-03-15T15:49:00	-41.21906	-52.33537	5535.8	CTD-RO	max depth	
PS147/1_3-1		2025-03-16T15:36:00	-37.55192	-50.57755	4810.3	CTD-RO	max depth	
PS147/1_4-1	TRIATLAS tall mooring	2025-03-17T10:00:00	-34.49621	-49.50221	3509.6	MOOR	Station start	recovery, aborted
PS147/1_4-1	TRIATLAS tall mooring	2025-03-17T12:13:00	-34.49663	-49.50067	0	MOOR	Station end	recovery, aborted
PS147/1_5-1		2025-03-19T10:52:00	-30.29548	-40.88211	3679.6	CTD-RO	max depth	
PS147/1_6-1		2025-03-21T10:11:00	-24.29868	-34.17800	4494.9	SVP	Station start	
PS147/1_6-1		2025-03-21T11:54:00	-24.29880	-34.17820	4497.4	SVP	Station end	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/1_7-1		2025-03-23T14:58:00	-15.66075	-31.61360	9237.3	SVP	Station start	
PS147/1_7-1		2025-03-23T16:18:00	-15.66019	-31.61414	4746.9	SVP	Station end	
PS147/1_8-1		2025-03-24T14:41:00	-12.14823	-30.14439	5471.6	CTD-RO	max depth	
PS147/1_9-1		2025-03-25T14:41:00	-8.48372	-28.63247	5521.1	CTD-RO	max depth	
PS147/1_10-1		2025-03-26T14:39:00	-4.91325	-27.17954	5563.9	CTD-RO	max depth	
PS147/1_11-1		2025-03-27T14:37:00	-1.37372	-25.79671	4703.7	CTD-RO	max depth	
PS147/1_12-1		2025-03-28T14:44:00	2.42577	-25.03458	4083.0	CTD-RO	max depth	
PS147/1_13-1		2025-03-29T14:39:00	6.11956	-25.08742	4072.7	CTD-RO	max depth	
PS147/1_14-1		2025-03-30T14:34:00	9.97283	-25.15426	5477.3	CTD-RO	max depth	

*Comments are limited to 130 characters. See <https://www.pangaea.de/expeditions/events/PS147/1> to show full comments in conjunction with the station (event) list for expedition PS147/1.

Abbreviation	Method/Device
ADCP	Acoustic Doppler Current Profiler
CT	Underway cruise track measurements
CTD-RO	CTD/Rosette
FBOX	FerryBox
GRAV	Gravimetry
MAG	Magnetometer
MBES	Multibeam echosounder
MOOR	Mooring
MYON	DESY Myon Detector
NEUMON	Neutron monitor
PAMOS_001	Atmospheric measurement box PAMOS 1
PAMOS_003	Atmospheric measurement box PAMOS 3
SNDVELPR	Sound velocity probe
SVP	Sound velocity profiler
SWEAS	Ship Weather Station
TSG	Thermosalinograph
pCO2	pCO2 sensor

Station list of expedition PS147/2 from Mindelo – Bremerhaven; the list details the action log for all stations along the cruise track.

See <https://www.pangaea.de/expeditions/events/PS147/2> to display the station (event) list for expedition PS147/2.

This version contains Uniform Resource Identifiers for all sensors listed under <https://sensor.awi.de>. See <https://www.awi.de/en/about-us/service/computing-centre/data-flow-framework.html> for further information about AWI's data flow framework from sensor observations to archives (O2A).

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/2-track		2025-04-01T00:00:00	16.88610	-24.99760		CT	Station start	Mindelo - Bremerhaven
PS147/2-track		2025-04-14T00:00:00	53.56750	8.55480		CT	Station end	Mindelo - Bremerhaven
PS147/2_0_Underway-1		2025-04-01T08:09:00	16.88993	-25.00761	10.9	ADCP	Station start	
PS147/2_0_Underway-1		2025-04-13T11:48:00	53.48275	5.07118	15.7	ADCP	Station end	
PS147/2_0_Underway-2		2025-04-01T12:54:50	16.94730	-24.98000	10.7	MBES	Station start	Event shows start/end point (date/time & coordinates) of first/last data record using Atlas Hydrographic Hydrosweep DS 3 multibeam...
PS147/2_0_Underway-2		2025-04-11T04:00:07	47.90720	-6.43810	121.6	MBES	Station end	Event shows start/end point (date/time & coordinates) of first/last data record using Atlas Hydrographic Hydrosweep DS 3 multibeam...

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/2_0_Underway-3		2025-04-01T08:08:00	16.88977	-25.00761	10.7	PAMOS_001	Station start	
PS147/2_0_Underway-3		2025-04-13T11:49:00	53.48393	5.07630	15.2	PAMOS_001	Station end	
PS147/2_0_Underway-4		2025-04-01T08:08:00	16.88977	-25.00761	10.7	PAMOS_003	Station start	
PS147/2_0_Underway-4		2025-04-13T11:49:00	53.48393	5.07630	15.2	PAMOS_003	Station end	
PS147/2_0_Underway-6		2025-04-01T08:08:00	16.88977	-25.00761	10.7	MYON	max depth	no end was logged
PS147/2_0_Underway-7		2025-04-01T08:08:00	16.88977	-25.00761	10.7	FBOX	Station start	
PS147/2_0_Underway-7		2025-04-13T11:49:00	53.48393	5.07630	15.2	FBOX	Station end	
PS147/2_0_Underway-9		2025-04-01T08:08:00	16.88977	-25.00761	10.7	MAG	Station start	
PS147/2_0_Underway-9		2025-04-13T11:49:00	53.48393	5.07630	15.2	MAG	Station end	
PS147/2_0_Underway-10		2025-04-01T08:08:00	16.88977	-25.00761	10.7	GRAV	Station start	
PS147/2_0_Underway-10		2025-04-13T11:49:00	53.48393	5.07630	15.2	GRAV	Station end	
PS147/2_0_Underway-11		2025-04-01T08:08:00	16.88977	-25.00761	10.7	NEUMON	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/2_0_Underway-11		2025-04-13T11:50:00	53.48531	5.08217	14.9	NEUMON	Station end	
PS147/2_0_Underway-13		2025-04-01T08:09:00	16.88993	-25.00761	10.9	pCO2	Station start	
PS147/2_0_Underway-13		2025-04-13T11:48:00	53.48275	5.07118	15.7	pCO2	Station end	
PS147/2_0_Underway-18		2025-04-01T08:09:00	16.88993	-25.00761	10.9	SNDVELPR	Station start	
PS147/2_0_Underway-18		2025-04-13T11:48:00	53.48275	5.07118	15.7	SNDVELPR	Station end	
PS147/2_0_Underway-22		2025-04-01T08:08:00	16.88977	-25.00761	10.7	SWEAS	Station start	
PS147/2_0_Underway-22		2025-04-13T11:49:00	53.48393	5.07630	15.2	SWEAS	Station end	
PS147/2_0_Underway-25		2025-04-01T08:08:00	16.88978	-25.00761	10.7	EK60_EK80	Station start	
PS147/2_0_Underway-25		2025-04-13T11:49:00	53.48393	5.07630	15.2	EK60_EK80	Station end	
PS147/2_0_Underway-19	TSK1	2025-04-01T08:08:00	16.88977	-25.00761	10.7	TSG	Station start	
PS147/2_0_Underway-19	TSK1	2025-04-13T11:49:00	53.48393	5.07630	15.2	TSG	Station end	
PS147/2_0_Underway-20	TSK2	2025-04-01T08:08:00	16.88977	-25.00761	10.7	TSG	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/2_0_Underway-20	TSK2	2025-04-13T11:49:00	53.48393	5.07630	15.2	TSG	Station end	
PS147/2_1-1		2025-04-01T19:31:00	17.58253	-24.28566	3595.3	CTD-RO	max depth	
PS147/2_1-2		2025-04-01T20:49:00	17.58341	-24.28448	3596.3	MSN	Station start	
PS147/2_1-2		2025-04-01T22:34:00	17.58208	-24.28504	3596.0	MSN	Station end	
PS147/2_1-3		2025-04-01T21:32:00	17.58329	-24.28486	3594.3	HN	Station start	
PS147/2_1-3		2025-04-01T21:41:00	17.58313	-24.28494	3595.3	HN	Station end	
PS147/2_2-1	AWI004	2025-04-02T10:31:00	19.25373	-22.97378	3869.6	MSN	Station start	
PS147/2_2-1	AWI004	2025-04-02T11:52:00	19.25372	-22.97372	3870.9	MSN	Station end	
PS147/2_2-2		2025-04-02T12:31:00	19.25372	-22.97396	3872.1	CTD-RO	max depth	
PS147/2_2-3		2025-04-02T13:12:00	19.25394	-22.97315	3873.5	HN	Station start	
PS147/2_2-3		2025-04-02T13:17:00	19.25423	-22.97292	3872.7	HN	Station end	
PS147/2_3-1	AWI004	2025-04-03T05:04:00	21.57898	-21.35606	4358.3	MSN	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/2_3-1	AWI004	2025-04-03T06:29:00	21.57932	-21.35518	4358.3	MSN	Station end	
PS147/2_3-2		2025-04-03T05:49:00	21.57937	-21.35535	4359.5	HN	Station start	
PS147/2_3-2		2025-04-03T05:57:00	21.57968	-21.35520	4359.9	HN	Station end	
PS147/2_3-4		2025-04-03T06:55:00	21.57896	-21.35575	4357.7	HN	Station start	
PS147/2_3-4		2025-04-03T06:59:00	21.57901	-21.35587	4359.3	HN	Station end	
PS147/2_3-3		2025-04-03T07:18:00	21.57861	-21.35518	4358.5	CTD-RO	max depth	
PS147/2_4-1		2025-04-04T19:36:00	26.54005	-17.33941	3609.3	CTD-RO	max depth	
PS147/2_4-2	AWI004	2025-04-04T20:06:00	26.53971	-17.34015	3609.5	MSN	Station start	
PS147/2_4-2	AWI004	2025-04-04T21:27:00	26.54009	-17.33977	3609.8	MSN	Station end	
PS147/2_4-3		2025-04-04T20:32:00	26.54021	-17.33979	3612.0	HN	Station start	
PS147/2_4-3		2025-04-04T20:39:00	26.54025	-17.33982	3601.1	HN	Station end	
PS147/2_4-4		2025-04-04T20:40:00	26.54025	-17.33984	3611.8	HN	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/2_4-4		2025-04-04T20:43:00	26.54024	-17.33987	3612.4	HN	Station end	
PS147/2_4-5	P53337-20FR001	2025-04-04T21:28:00	26.54008	-17.33979	3611.3	ARGOFL	max depth	
PS147/2_5-1	AWI004	2025-04-05T15:30:00	29.16680	-15.49898	3612.8	MSN	Station start	
PS147/2_5-1	AWI004	2025-04-05T16:45:00	29.16662	-15.49978	3613.1	MSN	Station end	
PS147/2_5-2		2025-04-05T16:01:00	29.16666	-15.49936	3612.5	APN	max depth	
PS147/2_5-3		2025-04-05T16:12:00	29.16655	-15.49934	3612.8	APN	max depth	
PS147/2_5-4		2025-04-05T18:21:00	29.16657	-15.49990	3614.0	CTD-RO	max depth	
PS147/2_5-5	AWI004	2025-04-05T19:42:00	29.16583	-15.50005	3614.3	MSN	Station start	
PS147/2_5-5	AWI004	2025-04-05T21:05:00	29.16514	-15.50033	3614.2	MSN	Station end	
PS147/2_5-6		2025-04-05T20:26:00	29.16559	-15.50103	3614.5	APN	max depth	
PS147/2_5-7		2025-04-05T20:39:00	29.16552	-15.50101	3614.3	APN	max depth	
PS147/2_6-1		2025-04-06T10:07:00	31.24533	-14.70047	3983.5	CTD-RO	max depth	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/2_6-2	AWI004	2025-04-06T10:42:00	31.24503	-14.70098	3981.5	MSN	Station start	
PS147/2_6-2	AWI004	2025-04-06T12:05:00	31.24474	-14.69999	3986.1	MSN	Station end	
PS147/2_6-3		2025-04-06T11:02:00	31.24525	-14.70082	3984.7	APN	max depth	
PS147/2_6-4		2025-04-06T11:12:00	31.24520	-14.70074	3985.2	APN	max depth	
PS147/2_7-1	AWI004	2025-04-07T04:30:00	33.98988	-13.62257	4441.6	MSN	Station start	
PS147/2_7-1	AWI004	2025-04-07T05:53:00	33.98934	-13.61602	4439.5	MSN	Station end	
PS147/2_7-2		2025-04-07T06:39:00	33.98911	-13.61446	4440.9	CTD-RO	max depth	
PS147/2_7-3		2025-04-07T06:45:00	33.98912	-13.61442	4441.9	APN	max depth	
PS147/2_7-4		2025-04-07T06:53:00	33.98956	-13.61451	4440.7	APN	max depth	
PS147/2_8-1		2025-04-08T08:30:00	38.20237	-11.57272	5063.2	CTD-RO	max depth	
PS147/2_8-2	AWI004	2025-04-08T09:42:00	38.20218	-11.57243	5064.0	MSN	Station start	
PS147/2_8-2	AWI004	2025-04-08T10:58:00	38.20233	-11.57278	5067.4	MSN	Station end	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/2_8-3		2025-04-08T10:11:00	38.20220	-11.57248	5062.3	APN	max depth	
PS147/2_8-4		2025-04-08T10:23:00	38.20214	-11.57275	5062.6	HN	Station start	
PS147/2_8-4		2025-04-08T10:27:00	38.20215	-11.57278	5066.1	HN	Station end	
PS147/2_9-1	AWI004	2025-04-09T03:29:00	40.92898	-10.09316	3656.5	MSN	Station start	
PS147/2_9-1	AWI004	2025-04-09T05:00:00	40.93144	-10.09277	3662.7	MSN	Station end	
PS147/2_9-2		2025-04-09T03:58:00	40.93021	-10.09311	3659.4	APN	max depth	
PS147/2_9-3		2025-04-09T04:13:00	40.93041	-10.09291	3658.3	APN	max depth	
PS147/2_9-4		2025-04-09T05:47:00	40.93409	-10.09068	3676.7	CTD-RO	max depth	
PS147/2_10-1	WMO3902588	2025-04-09T09:02:00	41.32774	-10.33750	3471.7	ARVORFL	max depth	
PS147/2_11-1	AWI004	2025-04-11T04:04:00	47.90704	-6.43891	149.1	MSN	Station start	
PS147/2_11-1	AWI004	2025-04-11T04:28:00	47.90634	-6.43922	148.7	MSN	Station end	
PS147/2_11-2		2025-04-11T04:50:00	47.90677	-6.44006	148.4	CTD-RO	max depth	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS147/2_11-3		2025-04-11T05:06:00	47.90689	-6.43978	148.4	APN	max depth	
PS147/2_11-4		2025-04-11T05:12:00	47.90662	-6.43959	148.0	APN	max depth	

*Comments are limited to 130 characters. See <https://www.pangaea.de/expeditions/events/PS147/2> to show full comments in conjunction with the station (event) list for expedition PS147/2.

Abbreviation	Method/Device
ADCP	Acoustic Doppler Current Profiler
APN	Apstein plankton net
ARGOFL	Argo float
ARVORFL	ARVOR I Profiling Float (NKE Instrumentation)
CT	Underway cruise track measurements
CTD-RO	CTD/Rosette
EK60_EK80	Fish finder echolot, EK60 / EK80
FBOX	FerryBox
GRAV	Gravimetry
HN	Hand net
MAG	Magnetometer
MBES	Multibeam echosounder
MSN	Multiple opening/closing net
MYON	DESY Myon Detector
NEUMON	Neutron monitor
PAMOS_001	Atmospheric measurement box PAMOS 1
PAMOS_003	Atmospheric measurement box PAMOS 3
SNDVELPR	Sound velocity probe
SWEAS	Ship Weather Station
TSG	Thermosalinograph
pCO2	pCO2 sensor

A.5 STATION COORDINATES ALONG THE CRUISE TRANSECT FOR THE WASCAL FLOATING UNIVERSITY

Station	Latitude	Longitude
1	17.581	24.285
2	19.254	22.974
3	21.579	21.355
4	26.541	17.338
5	29.166	15.500
6	31.245	14.701
7	33.989	13.616
8	38.202	11.573
9	40.932	10.092
11	47.907	6.440

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ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG

BREMERHAVEN

Am Handelshafen 12
27570 Bremerhaven
Telefon 0471 4831-0
Telefax 0471 4831-1149
www.awi.de

HELMHOLTZ