ELISABETH MANN BORGESE–Berichte

Baltic Sea Long-term Observation Programme

Cruise No. EMB337

19 March – 3 April 2024,

Rostock – Sassnitz – Visby (Sweden) – Rostock

HELCOM/long-term

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2024

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1 Summary

1.1 Summary in English

The cruise of r/v Elisabeth Mann Borgese No. 337 was done in the frame of the HELCOM monitoring and the IOW long-term observation of the Baltic Sea from March 19th to April 3rd 2024. The weather was characterized by mostly calm, partly moderate wind and near gale conditions on the last day at sea, air temperatures of usually 2 to 8 °C, often misty or even foggy conditions and sometimes sunny. The sea showed a low wave height and was frequently even flat. We completed 94 stations with a mooring recovery, refurbishment and re-deployment on one station. We completed a route of almost 2000, with 380 n.m. used for four ScanFish transects. We stopped in Sassnitz for a disembarkation of three scientists and in Visby harbour to supplement foodstuffs. At a water temperature of 3.5 to 6.4 °C, the spring bloom was clearly developed in the western and southern Baltic Sea, as the chlorophyll_a concentration showed. The development was also noticeable in the partial decline of the major nutrients nitrate, phosphate and also silicate in surface water of that area. Moreover, an elevated chlorophyll_a concentration was widely spread in the Northern and the Western Gotland Sea at temperatures of around 2 °C. The deep water of the southern Baltic Sea is affected by the recent medium size Major Baltic Inflow of December 2023 that meanwhile proceeded until the southern part of the eastern Gotland Basin (~56.3 °N) and oxygenated bottom water so far. The inflow changed not only the concentrations of oxygen/hydrogen sulphide but also of major nutrients in deep water of a large area.

1.2 Zusammenfassung

Die Reise des F/S Elisabeth Mann Borgese Nr. 337 wurde im Rahmen des HELCOM Monitorings und der IOW Langzeit Überwachung der Ostsee vom 19. März bis 4. April 2024 durchgeführt. Das Wetter während der Reise war durch schwache, zum Teil mäßige Winde, sowie stürmische Bedingungen am letzten Tag auf See und Lufttemperaturen von normalerweise zwischen 2 und 8 °C gekennzeichnet, oft war es diesig oder sogar nebelig und zeitweise sonnig. Die See zeigte nur niedrige Wellenhöhen und war häufig sogar glatt. Es wurden 94 Stationen absolviert, wobei eine der Bergung, Überarbeitung und Wiederverankerung einer Verankerung diente. Dabei wurde eine Strecke von insgesamt fast 2000 Seemeilen zurückgelegt, wovon wir 380 n.m. für 4 ScanFish Schnitte genutzt haben. Um einem Wissenschaftler und zwei Wissenschaftlerinnen, die ihr Arbeitsprogramm abgeschlossen hatten, das Absteigen in Sassnitz zu ermöglichen, und in Visby, um Nahrungsmittel für den Rest der Reise nachzukaufen, wurde jeweils ein Halt eingerichtet. Bei einer Wassertemperatur von 3.5 bis 6.4 °C war die Frühjahrsblüte in weiten Teilen der westlichen und südlichen Ostsee gut entwickelt, wie aus den Chlorophyll_a Konzentrationen zu erkennen war. Die fortgeschrittene Blüte war auch an dem partiellen Verbrauch der Hauptnährstoffe Nitrat, Phosphat und Silikat zu erkennen. Darüber hinaus wurden auch erhöhte Konzentrationen von Chlorophyll_a in einem großen Gebiet der nördlichen und westlichen Gotlandsee bei etwa 2 °C Wassertemperatur vorgefunden. Das Tiefenwasser der südlichen Ostsee war deutlich durch den mittelgroßen Einstrom von salzreichem Wasser aus dem Dezember 2023 bestimmt, der inzwischen bis in den südlichen Teil des östlichen Gotlandbeckens (~56.3 °N) vorgedrungen war und das Bodenwasser belüftet hatte. Dabei wurden nicht nur die Konzentrationen von Sauerstoff/ Schwefelwasserstoff, sondern auch von den Hauptnährstoffen im Tiefenwasser über ein weites Gebiet verändert.

2 Participants

2.1 Principal Investigators

Name	Institution
Kuss, Joachim, Dr. (Marine Chemistry)	IOW
Mohrholz, Volker, Dr. (Hydrography)	IOW
Dutz, Jörg, Dr. (Zooplankton)	IOW
Kremp, Anke, Dr. (Phytoplankton)	IOW

2.2 Cruise Participants

Name	Discipline	Institution
Kuss, Joachim, Dr.	Marine Chemistry, Chief Scientist	IOW
Michels, Emil	Phys. Oceanography, CTD & ScanFish	IOW
Köhn, Josef	Phys. Oceanography, CTD & ScanFish	IOW
Hemmecke, Norwin	Biol. Oceanogr., CTD support	IOW
Kreuzer, Lars	Marine Chemistry, Nutrients	IOW
Dierken, Madleen	Marine Chemistry, Nutrients	IOW
Schöne, Susanne	Marine Chemistry, Oxygen	IOW
Fechtel, Christin	Biol. Oceanogr., Plankt. and Microbiol.	IOW
Sakpal, Harshada	Ökologische Chemie, Organic pollutants	JKI
Xie, Rongrong (PhD)	Marine Chemistry, Organic pollutants	IOW
Kloska, Leonard	Microbiology	MPI-MM

2.3 Participating Institutions

IOW	Leibniz Institute for Baltic Sea Research Warnemünde
JKI	Julius-Kühn-Institut
MPI-MM	Max Planck Institute for Marine Microbiology

3 Research Programme

3.1 Description of the Work Area

The working area for IOW's contribution to the HELCOM monitoring comprised German territorial waters with the German Exclusive Economic Zone and bordering sea areas. Therefore, basic hydrographic data, major nutrients, phyto- and zooplankton parameters were determined. Moreover, the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) extends the investigated sites by its long-term observation programme of the Baltic Sea. This contributes with additional stations in the Belt Sea, the Arkona Sea, and the Bornholm Sea, as well as with station work in the eastern and western Gotland Sea. Sampling in the frame of the project for "Identification of UV Filter enrichment areas in the Baltic Sea" and a DAM (Deutsche Allianz Meeresforschung) initiative to establish an archive of eDNA samples was added to the cruise's work programme. Therefore, additional CTD-rosette casts were done to provide water samples for the projects. However, a major focus is always on the Thalweg transect, which reflects the main

path of inflowing North Sea water via the Belt Sea, Arkona Sea, Bornholm Sea, along the Słupsk Furrow to the eastern Gotland Basin and further to the northern and western Gotland Sea, bringing episodically haline oxygen rich water to the central basins. This happened in December 2023 and was additionally investigated by a long transect with a ScanFish (towed undulating CTD) to realize a higher resolution of data. The ScanFish was used to obtain data of salinity, temperature, oxygen, chlorophyll and turbidity at high resolution along the Thalweg, in addition to the regular transverse transects in the western and eastern Gotland Sea. CTD stations and ScanFish transects are shown in the map (Fig. 3.1). The list of stations and activities is given in Chapter 6.

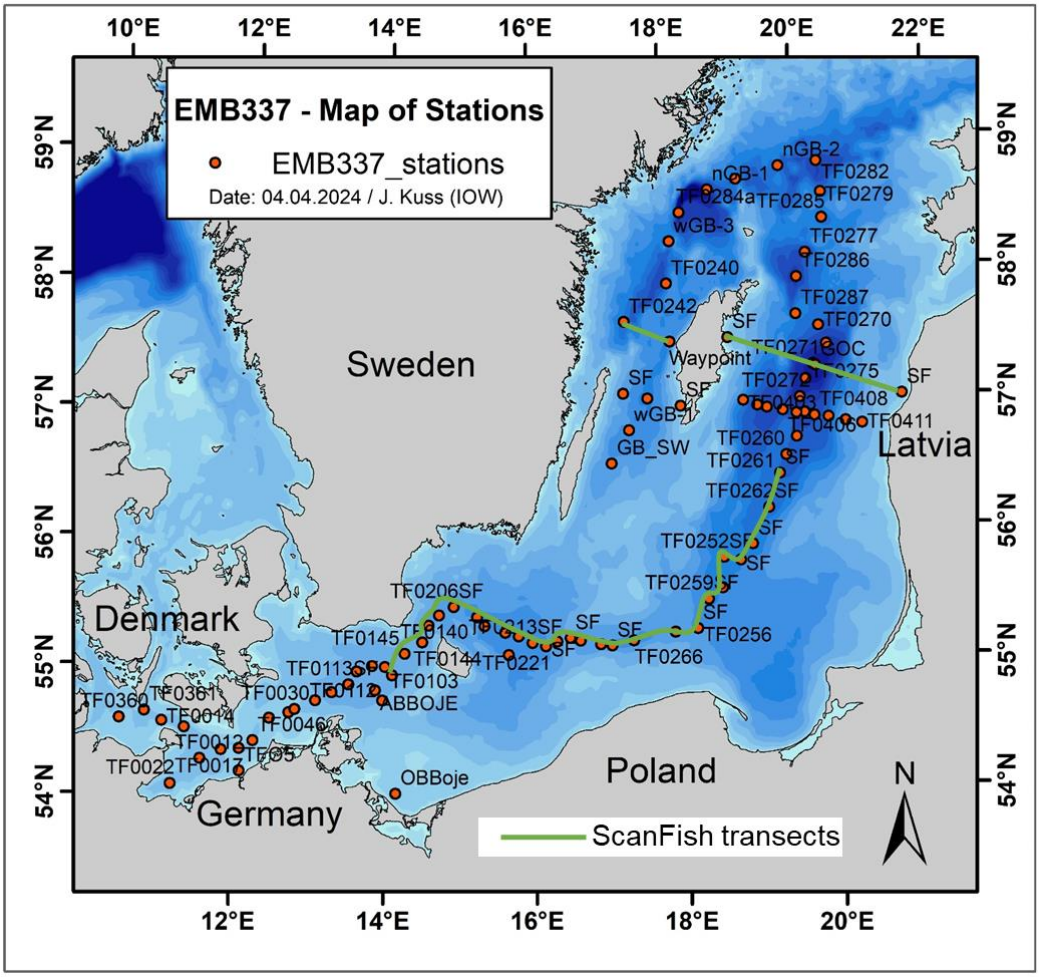

Fig. 3.1 Map of stations (red dots) and ScanFish transects (SF waypoints, green lines) of the cruise EMB337 from 19th March – 3rd April 2024; for clarity, a couple of station names are not shown; for the details of the sampled stations see list of stations in Chapter 6.

3.2 Aims of the Cruise

The cruise EMB337 was carried out as a joined cruise of the environmental monitoring programme of the Federal Maritime and Hydrographic Agency (BSH) and the Baltic Sea long-term observation programme of the IOW. It was the second cruise in 2024 as one of five expeditions performed annually. The acquired data are used for the regular national and international assessments of the state of the Baltic Sea, and provide the scientific basis for measures to be taken for the protection of the Baltic Sea ecosystem. The hydrographic and hydrochemical conditions as well as the development of phytoplankton and zooplankton abundances are investigated. Microbial

habitats, ocean acidification and greenhouse gases were additionally studied in the frames of the long-term observation of the Baltic Sea and by projects. A special focus of the long-term observation is always the occurrence or absence of inflow events that both have major consequences for the state of the Baltic Sea hydrochemistry and the ecosystem. The oxygen entrained by a medium size Major Baltic Inflow (MBI) that occurred in December 2023 and brought large amounts of salt as well as oxygen in the Bornholm Basin, in the Słupsk Furrow and further on (Mohrholz, 2024) that was important to investigate.

3.3 Agenda of the Cruise

The work on the stations usually started with a CTD cast and already programmed sampling on standard depth levels and manually released samplings in near-bottom and surface waters. Then other CTD casts were carried out to meet the additional water sample requirements on the respective stations. Net sampling and depth of visibility determinations by means of a Secci disk were done on selected stations. For details see list of stations in Chapter 6.
The project UV Filter to investigate their enrichment areas, transport processes and long-term sinks in water and sediment required many additional water samples mainly in the western Baltic Sea. Moreover, water from three selected water layers was sampled in German territorial and EEZ waters for a DAM initiative to establish an eDNA sample archive and to investigate the metabolic pathways of microorganisms and metazoans by a metagenomic and metaproteomic approach.
Measures are taken to conduct responsible marine research to protect species, habitats, threatened and declining features. Our sampling in the Baltic Sea does not cause any noticeable changes in the ecosystem. No intentional sampling of any threatened features of the marine ecosystem takes place. The amount of sampled biota is small and the sampling strategy is designed to answer a number of questions on the same samples. Our working program will not affect any other research conducted concurrently in the same region. No toxic or harmful substances are released into the environment. All chemical waste is collected on-board and brought back to the home laboratory for disposal.

CTD and Sampling
The CTD-system "SBE 911plus" (Seabird-Electronics, USA) was used to measure the variables: Pressure, Temperature (2x SBE 3), Conductivity (2x SBE 4), Oxygen concentration (2x SBE 43), Chlorophyll-a fluorescence (683 nm), Turbidity, Photosynthetic active radiation in water (PAR), and above the sea (SPAR). The Rosette water sampler was equipped with 13 Free Flow bottles of 5 L volume each. The CTD sensors were checked during the cruise by comparison measurements. In detail, for temperature a high precision thermometer SBE RT35 was used. Salinity samples were taken for measurement after the cruise by means of a salinometer. Slope and offset of the oxygen sensors SBE 43 are determined by daily comparison with Winkler titration.

Nutrients
Nitrate, nitrite, phosphate, and silicate were analysed using standard colorimetric methods by means of an autoanalyser (FlowSys, Alliance-Instruments, Ainring, Germany) and ammonium was determined manually as indophenole blue (Grasshoff *et al.*, 1999) from unfiltered water on-board. Total and total dissolved nitrogen and phosphorous samples as well as particulate and

dissolved organic matter samples were prepared and stored deep frozen for digestion and analysis in the IOW nutrients and natural organic matter labs, respectively.

Oxygen and hydrogen sulphide

Oxygen was analysed by Winkler titration and hydrogen sulphide was determined by spectrophotometry after its conversion to methylene blue (Grasshoff *et al.*, 1999). To continue the oxygen profiles in anoxic waters and for comparison, H_2S concentration was converted to negative oxygen values according to its reduction capacity: $H_2S + 2\ O_2 \rightarrow H_2SO_4$. During CTD casts the SBE 43 sensors (duplicate installation) recorded oxygen values that are validated by daily Winkler titration from 3 water sampling bottles released according to a specific time-regime, each by triplicate analysis.

Plankton sampling

Plankton sampling was performed by means of the rosette sampler (combined with CTD) as well as with a small phytoplankton net and the zooplankton nets WP2 and Apstein. Samples were taken in a tight follow up of depths levels in order to get representative data from the water column. The traditional method to estimate water transparency/primary production by means of a Secci disk is also applied here. (Responsible scientists: Dr. Anke Kremp, Dr. Jörg Dutz).

Long-term observation of the microbial habitat of the redoxcline

Insights into the redoxcline microbial food web is obtained by well resolved sampling in the range of the redoxcline at Gotland Deep and Landsort Deep stations on each monitoring cruise. Therefore, in the redoxcline as well as 6 depths above and below, respectively, in depth intervals of 2 m, samples were taken by CTD/water sampling bottles and prepared for microbiological analysis (FISH and DNA) and determination of pigments. (Responsible scientist: Prof. Dr. Klaus Jürgens)

Long-term investigations of CH_4, N_2O, CO_2 and the marine carbonate system

Sampling for simultaneous CH_4 and N_2O observation is carried out on 4 stations (TF0113, TF0213, TF0271, TF0286) in the frame of an accompanying project for long term data collection. All samples were taken in septum-sealed 250 mL water bottles and fixed with 200 µL saturated $HgCl_2$-solution to prevent microbiological activity and stored dark. On the same stations and depths also samples were taken for the analyses of carbon dioxide, total inorganic carbon, total alkalinity and pH for their long-term observation. These samples were fixed by the same method and were also stored dark. In case of hydrogen sulphide presence, these samples were fixed with 500 µL saturated $HgCl_2$-solution. (Responsible scientist: Prof. Dr. Gregor Rehder).

Establishment of an eDNA-archive and Metaproteogenomic analyses (DAM project)

For a bio-archive of microorganisms and metazoans in the North and the Baltic Sea, biomass is collected by filtering seawater either through a 0.2 µm or a 0.45 µm filter to obtain respectively bacterial and metazoan DNA (CREATE project). All samples are frozen directly and stored at -20 °C and are available for further processing like DNA extraction and sequencing.

For metaproteogenomic analyses, surface water samples of 60 L were taken by a CTD-Rosette system. Subsequently, the water was filtered through 10 µm, 3 µm and 0.2 µm filters, respectively. Filters were stored at -80 °C. Macro- and microalgae were found on the 10 µm and 3 µm filters and bacteria were harvested on the 0.2 µm filter for metagenomic and metaproteomic analyses and furthermore for the determination of bacterial metabolic activity. (Responsible scientists: Prof. Dr. Matthias Labrenz, IOW, Dr. Norma Welsch, Uni-Greifswald, Dr. Anneke Heins, MPI-Bremen).

Identification of UV Filter enrichment areas in the Baltic Sea - Investigation of transport processes and long-term sinks in water and sediment

The primary objective of this study is to contribute to a better understanding of UV Filter distribution and fate in the marine environment. This project aims to help identify enrichment areas where UV Filters were significantly contaminating, as well as, which transport processes contribute to the introduction of UV Filters into the open Baltic Sea.

Aim for EMB337 monitoring cruise: The sampling strategy focuses on the identification of enrichment areas for homogeneous or heterogeneous distribution of UV Filters across the coastal areas, bays and the open Baltic Sea, and on the transport processes for the occurrence of UV Filters in the Baltic Sea. Given the importance of seasonal variations in concentrations of UV Filters in the Baltic Sea, this spring cruise will aid in providing complementary information. A considerable high prominence of UV Filters is expected in summer (Responsible Scientists: Harshada Sakpal and Dr. Kathrin Fisch, JKI Berlin, Dr. Marion Kanwischer and Prof. Detlef Schulz-Bull, IOW).

Just a Surface water Monitoring Box (JSMB)

The JSMB system (Krüger and Ruickoldt, 2021) is used for continuous measurements of temperature, salinity, conductivity, calculated sound velocity, real sound velocity, Chl_a, turbidity and optional many more parameters in a seawater flow pumped from below the ship's hull. The measurement ranges, the accuracy or alternatively the sensitivity of the measurements are as follows: conductivity with a range of 0 to 70 mS/cm, and an accuracy of 0.003 mS/cm, temperature (-3 to 35 °C, 0.002 °C), salinity (2 to 42, 0.005), sound velocity (1375 to 1625 m/s, 0.025 m/s), turbidity (0 to 25 NTU, 0.013 NTU sensitivity), and chlorophyll_a (0 to 50 µg/L, 0.025 µg/L sensitivity). The system was used during transect for recording of these parameters in surface water that was pumped from below the ship's hull. Preliminary data of temperature, salinity, chlorophyll_a and turbidity are shown in Figure 5.2 (Responsible scientists: Robert Mars, Johann Ruickoldt).

ScanFish

An undulating CTD-system with fluorometer and oxygen sensor was tugged on selected transects. The ScanFish is a towed platform in wing shape allowing to accumulate CTD data of the water column in an undulating manner from the surface close to the bottom. It offers a payload to accommodate a pumped Seabird CTD application consisting of a Seabird SBE911+ probe, temperature (SBE3), conductivity (SBE4) (salinity) and oxygen (SBE43) sensor. Additionally, a Wetlabs FLNTU is installed for chlorophyll and turbidity recording. The central ScanFish controller supports DSL data transfer protocols and speed, making it very flexible to interface with additional sensors and devices (Responsible scientists: Martin Kolbe, Emil Michels).

4 Narrative of the Cruise

This paragraph aims at giving an impression of the work on board during the campaign. It is a day by day report that includes the forecasted weather and sea condition as predicted by the Deutscher Wetterdienst, DWD (2024) for the respective days.

Tuesday, 19 March 2024: According to the weather forecast, wind was expected from southeast of 4 to 5 bft, shifting slowly southwest, decreasing to 2-3 bft. Later in the western part, locally misty conditions are projected at a flat sea of 0.5-meter wave height. We left Rostock harbour at a sunny and bright day at temperatures around the freezing point. The first station was shifted a bit, because of dredging work at the waterway near the exact location of TFO5. The station was accomplished by a CTD cast with sensor measurements of conductivity, temperature, depth, oxygen, fluorescence and turbidity and water sampling for the determination of several chemical parameters. It was used as a test station for the CTD and the lab work. After ending the station work, a successful security exercise followed, because all were well prepared by the instructions they had received after breakfast. Then we headed northwest to reach the TF0012 with a major programme of water sampling by three CTD casts for oxygen Winkler determinations, the nutrients nitrate, nitrite, phosphate, silicate, ammonium, total nitrogen and total phosphorous as well as for the dissolved and particulate natural organic matter, and UV filter analyses. The depth of visibility was determined by the traditional Secci disk. As well, net catches for phytoplankton and zooplankton samples were done. Moreover, sampling for an eDNA archive as well as to investigate bacteria's metabolic activity by examination of metagenomics and metaproteomics was subsequently performed. The TF0010 in the Fehmarn Belt was used for intercomparison measurements of oxygen, salinity, temperature, and pressure to secure the correctness and stability of the sensors or in case of deviations, to adjust the sensor reading after the cruise. The stations TF0014, the laborious TF0360 with many water samples for chemical parameters, and the TF0361 just for a CTD cast followed. The long transit to the station TF0022 in the Lübeck Bight was done overnight.

Wednesday, 20 March 2024: The weather forecast predicted southerly wind of about 3 bft in eastern parts, in the other areas of the western Baltic Sea, light wind, temporarily misty with fog patches at a sea 0.5-meter wave height. Later, westerly wind of about 4 bft was expected. Early in the morning the TF0022 was completed by a CTD cast with Winkler oxygen measurements and inorganic nutrient determinations. Moreover, an intercomparison measurement for the CTD parameters was done. Then just a CTD profile without water sampling followed on TF0017 and a cast with sampling for inorganic nutrients and a Winkler oxygen determination on TF0041. In the morning the weather was characterized by calm winds, about 6 °C air and water temperature and cloud covered sky. On the TF0046 in the Kadet Channel two CTD casts for nutrients, chlorophyll enrichment on filters, net hauls for phytoplankton and zooplankton samples were carried out before lunch, as well as sampling for UV filter determinations and microbiological analyses in the frame of project work. The shallow stations between the western Baltic Sea and the Baltic Proper TF0002 and TF0001 were done next. On TF0001 at the autonomous MARNET station *Darss Sill*, sampling for nutrients and oxygen is done in respective sensor depths of the pile, to use Winkler oxygen determinations as comparison for the sensors. The biological work at station TF0030 comprises phytoplankton net hauls and sampling for chlorophyll in combination with inorganic nutrients

determination and oxygen samples for Winkler titration on selected depths. The depth of visibility was determined by the traditional Secci disk. Similarly, on TF0115 and TF0114 in the evening, CTD casts with inorganic nutrients and oxygen measurements were on the schedule. The final station of the day was the major station TF0113 later in the evening. Water sampling for the inorganic nutrients including ammonium, total nitrogen and total phosphorous as well as for the dissolved and particulate natural organic matter analyses was done. Water samples were also taken for the enrichment of particulate UV Filters on filters and subsequently dissolved UV Filter substances on organic adsorbents. Moreover, sampling for an eDNA archive as well as to investigate bacteria's metabolic activity was subsequently carried out. Then we headed south in direction of the MARNET station *Odra Bank*.

Thursday, 21 March 2024: The weather was forecasted with wind from southwest of 3 bft, for a time shifting northwest to north and increasing slowly to 4-5 bft. At times misty with local fog in the morning, later the sea was expected to increase to 1-meter wave height. After the long transit from the Odra buoy to the central Arkona Sea, first the TF0112 was completed after breakfast by two CTD casts for oxygen and inorganic nutrients and the microbiological samples for the eDNA archive, and a complete rosette of 60 L water for the bacterial metabolic activity determinations was taken. Then the TF0109 was completed by a CTD cast with water sampling for inorganic nutrients and oxygen, as well for UV filter analysis. Then the biological programme of 3 net hauls with the small phytoplankton net and two casts with a WP2 net for zooplankton samples followed. Afterwards we headed south-east to reach Sassnitz harbour in the afternoon to take three of the scientific party who had finished their work to the harbour by the work dinghy. They left the ship at a quarter to four. The sea was flat and fog patches were everywhere. Then we headed north-east to the third MARNET station *Arkona Basin*. At the semi-submersible platform comparison measurements for oxygen by Winkler were done on water samples from 7 and 40 m depth for the respective sensors mounted at the platform. On stations TF0105, TF0104, and TF0103, a CTD with water sampling for inorganic nutrients and oxygen were done late in the evening.

Friday, 22 March 2024: The weather forecast for the Southern Baltic expected wind from southwest to west of 4 to 5 bft, at times misty at a sea of 1.5-meter wave height. After midnight the TF0145, TF0144, and the TF0142 between Bornholm and Sweden followed early in the morning by a respective CTD cast on each and sampling for Winkler oxygen and inorganic nutrients. Further on the TF0140 and TF0206 north of Bornholm came next with a CTD cast and just one oxygen determination. The weather was rainy and misty at 5 to 6 bft wind, and the waves were clearly a bit higher compared to previous days. Many stations with just a CTD followed after breakfast and Winkler oxygen determinations of bottom water on selected stations as well as from the 10 m-references depth for stability checks on TF0208, TF0200, TF0211, TF0214, and TF0212. Then one of the major stations, Bornholm Deep TF0213 was completed in the afternoon with sampling for nutrient parameters, nitrate, nitrite, phosphate, silicate, ammonium, total and total dissolved nitrogen and phosphorus, as well as oxygen. Hydrogen sulphide was clearly not present in bottom waters after the ventilation by the inflow from December 2023 and subsequent smaller inflows during January/February 2024. Up to now it was unclear how far the water reached into the deep eastern Gotland basin, but the next days would bring some more information about this. As well water sampling for greenhouse gases carbon dioxide, methane, dinitrogen oxide (CO_2,

CH_4, and N_2O), and for dissolved and particulate natural organic matter was done. Subsequently, further CTD casts with oxygen samples on selected locations and depths, followed on stations TF0221, TF0225, TF0224, and finally TF0227 late in the evening.

Saturday, 23 March 2024: Wind of about 4 bft from west to southwest was forecasted in the Southern Baltic, temporarily decreasing a little. Partly misty was expected at a sea reaching 1.5-meter wave height. After midnight the CTD on TF0229 was completed and early in the morning we continued with the TF0222, the central station of the Słupsk channel with a CTD cast and sampling for inorganic nutrients with ammonium, as well as a Winkler oxygen profile. Then we headed further east through the waters of the Polish exclusive economic zone for CTD casts on the stations TF0266, TF0268, TF0256, TF0259, TF0255, TF0252, and TF0253 at a still cloud covered sky with moderate wind. Thereby, the important station TF0259 at the southern end of the eastern Gotland Basin was carried out with sampling for inorganic nutrients and phytoplankton by net hauls, as well as Secci depth determination. Then we reached the deep eastern Gotland Basin and completed the stations TF0265, TF0262 at that time the inflow of November/December 2023 was still noticeable on TF0262 with a bottom water oxygen concentration of 58 µmol/L (1.3 mL/L). The inflow appeared not to have reached the TF0261 the next station further north along the Thalweg, which showed no signs of oxygen or at least increased turbidity as an indication of elemental sulphur from hydrogen sulphide oxidation.

Sunday, 24 March 2024: The weather for the Central Baltic was forecasted with south-westerly wind of 3 to 4 bft, later showing variable directions of 2 to 4 bft, locally misty at a sea of 1-meter wave height. After midnight we completed the TF0260 and TF0274 by CTD casts and subsequently headed east for a transversal section from Latvia in direction of the southern tip of the island of Gotland (Sweden) by CTD casts on the stations TF0411 to TF0403 with the Thalweg station TF0274 in the middle. In the evening we moved in north-eastern direction to centre of the basin. We reached TF0272 after dinner for a CTD cast with bottom water H_2S profile and later in the evening TF0275 to complete a final pure CTD cast of the day.

Monday, 25 March 2024: The weather forecast was wind with variable directions of 2 to 4 bft, with local fog patches at a sea of 0.5-meter wave height. After breakfast the recovery of the mooring *Gotland Central* with a time-series sediment trap was on the schedule. The releaser was activated 7:54 and a few minutes later, a buoy package was visible at the sea surface nearby the ship. The buoys were hooked up and pulled on-board. After the long recovery line, the releaser, a couple of meters mooring rope with sensor packages and the sediment trap were on deck at 8:41 o'clock. Finally, an ADCP and the mooring weight were on deck right before 8:47 o'clock. The redeployment was planned for the afternoon after exchange of the instruments and some refurbishment. The nearby Gotland Deep station was then foreseen for determination and sampling for hydrographic, chemical and biological parameters by CTD casts. We started with the deep CTD to cover the near-bottom range with sampling for inorganic nutrients, nitrate, nitrite, phosphate, silicate, ammonium, as well for total nitrogen and total phosphorus and hydrogen sulphide. The second and third cast were for sampling of intermediate and finally the upper water with sampling for oxygen instead of hydrogen sulphide was done. The samples for natural organic matter, total nitrogen, total phosphorus were prepared and stored deep frozen for analysis in the

home laboratory. Greenhouse gases were sampled as well and several phytoplankton net hauls and water sampling for chlorophyll determinations were done. Then we moved back to the mooring station Gotland Central for redeployment. Already at 15:03 o'clock, we started with the mooring weight, then at 15:13 the time-series sediment trap was introduced in the mooring rope and several sensor packages for temperature salinity, depth and oxygen were attached to the mooring rope. Finally, the mooring was released at 15:29 by a special hook and the mooring weight could sink to the sea bed and the instruments were kept upright in the water by attached floats. Then we headed in the direction of Gotland to start a ScanFish transect across the eastern Gotland Basin from station SF0001EGB to the station SF0022EGB close to the Latvian coast. After the deployment it quickly became obvious that the instrument turned and was upside down. So it was recovered again and properly deployed in the surface water to let it undulate between the surface and the near-bottom range. The instrument was tugged until the next morning.

*Tuesday, 26 March 2*024: The weather for the Central Baltic was forecasted with wind of variable direction of 2 to 4 bft, shifting southeast and increasing to 4-5 bft. At times misty conditions with fog patches are projected at a sea of swelling waves up to 1.5-meter wave height. The morning showed dense fog at calm winds and 3 °C air temperature. After a comparison measurement with the CTD, the ScanFish was recovered at 11:15. Another 4.5 hours' transit to the centre of the basin was needed, followed by CTD casts on the stations TF0276 in the afternoon and TF0270 in the evening, respectively. The latter was used for a Winkler oxygen measurement in 10 m depth as comparison value, and a bottom water hydrogen sulphide profile to monitor the current oxygen/hydrogen sulphide status of the bottom water of the region. Moreover, in the evening the TF0287 was done by a CTD cast and subsequently the major station Fårö Deep TF0286 followed with all nutrient parameters, sampling for natural organic matter and greenhouse gases analyses. The necessary conservation of the gas samples and the filtration for dissolved organic and total matter determinations of carbon, nitrogen, and phosphorus stretched almost until midnight.

Wednesday, 27 March 2024: The weather forecast for the Central Baltic Sea was southeast of 4 to 5 bft at a sea of 1.5-meter wave height. Still in the night the TF0277, TF0285, and early in the morning TF0279 as well as TF0282, nGB-2, TF0283, nGB-1 in the northern Gotland Basin were completed by CTD casts and samples for hydrogen sulphide and oxygen measurements on selected depths. The morning was sunny but later a thin layer of clouds covered the sky. The air temperature raised from 3 to 4 °C but was still relative low. Finally, the TF0284a a substitute of the Landsort Deep station outside Swedish territorial waters was done from the afternoon to the evening, as it is still the deepest station of the cruise with an ambitious sampling schedule and many parameters of nutrients and oxygen/hydrogen sulphide, as well as microbiological sample in the redoxcline range, and a Secci depth determination. Station wGB-3 was late in the evening by a CTD cast only.

Thursday, 28 March 2024: The weather forecast for the Central Baltic expected wind from south-eastern direction of 4 to 5 bft, shifting southwest, at times misty, and a wave height of 1-meter. After midnight the TF0240 and half an hour later the TF0242 followed by just recording a CTD profile, before we headed to Visby port to refill our food storage. The weather was sunny but

a bit dizzy and relatively warm compared to recent days. In the port we had temperatures above 10 °C and had a walk through the old town and other explored the nature north of Visby. However, also some data compilation and report writing was on the schedule.

Friday, 29 March 2024: The weather forecast for the Central Baltic was with south-westerly winds of 4 to 5 bft, later decreasing a little, at times misty and sea of 1.5-meter wave height. We left the sunny port shortly after noon and headed south-west to reach SF032WGB after leaving and re-entering the Swedish territorial waters further South. The first station of the next ScanFish transect, this time across the western Gotland Basin, was reached at about 18:00 o'clock. The waves appeared a bit higher than the days before, but still acceptable working conditions were present. We deployed the ScanFish for about 3 hours before we arrived at the Karlsö Deep station TF0245, where it was recovered for two CTD casts with water sampling for inorganic nutrients with ammonium included, and an oxygen Winkler sample and hydrogen sulphide samples in the bottom water. Afterwards, the ScanFish was redeployed to proceed the transect. At the last station SF025WGB of the transect, the ScanFish was recovered for a CTD cast and was redeployed afterwards for comparison measurements with the CTD and finally secured on deck.

Saturday, 30 March 2024: The weather forecast for the Central Baltic expected light and variable winds that would later shift east and increase to 4 bft at a sea of 1-meter wave height. At times misty conditions with fog patches were expected. The next CTD casts were done on stations wGB-1 and GB_SW before we headed east to enter the eastern Gotland Basin again.

In the afternoon we arrived on station TF0261, first we did a CTD cast with four bottom water samples (138.6 m right above the bottom, 135 m, 130 m and 125 m) that showed clearly elevated hydrogen sulphide concentrations and no indication of oxygen. Then we started the Thalweg transect by ScanFish in reversed direction, so to say uphill along TF0262, TF0265 to TF0253 and further on. Then we had to adjust the time on-board to the Central Europe summer time.

Sunday, 31 March 2024: Weather forecast for the Southern Baltic proposed early local winds from east to northeast of 4 bft, otherwise light and variable winds, at times misty settings with fog patches at a sea of 0.5-meter wave height. Some Chocolate Easter bunnies, Easter eggs and other sweets for the scientific party and the crew appeared in the morning. Reaching the southern transect of the Thalweg at station TF0256 we headed west to reach the next waypoints of stations in the Słupsk Furrow TF0222 and subsequently TF0224. Finally, we arrived at the Bornholm Deep station TF0213 the first station which is mandatory to be sampled again on the way back home. Therefore, the ScanFish was recovered. The water sampling was done in 7 depth layers for oxygen and inorganic nutrients and in case of the presence of anoxic conditions, two samples for hydrogen sulphide analysis were prepared but not needed. Chlorophyll was sampled in 7 surface layers and several net hauls for zooplankton and phytoplankton samples were also done. Then we decided to deploy again the ScanFish to continue the reversed Thalweg transect until the Arkona Basin via station TF0206 and the route north of Bornholm to the second repetition station TF0113 in the central Arkona Sea. We fulfilled a comparison between CTD and ScanFish around midnight, then the ScanFish was deployed again for a long transect of about 90 n.m..

Monday, 01 April 2024: For the Western Baltic Sea, first light and variable winds were expected from northeast to east of about 4 bft. Later variable directions of 4 to 6 bft were forecasted, at times misty or foggy, later shower- with locally thundery gusts and a sea with increasing wave height to 1-meter. We continued the ScanFish transect until the evening and recovered it as scheduled on TF0113, after completing a comparison measurement of the ScanFish sensors with the sensors of the rosette system. Some net hauls for phytoplankton and zooplankton samples and a final comparison measurement for the CTD with Winkler oxygen, salinity, temperature and pressure determinations. The last duties on the schedule would be the repetition stations TF0046 and TF0012 already near to Rostock harbour. However, strong wind first from eastern direction, later from the west required to look for a sheltered place, which we found near the island of Fehmarn.

Tuesday, 02 April 2024: The weather forecast expected wind from south-west to west of about 6 bft that was expected to shift north later and to decrease. The weather was misty and the waves were still 1.5-meter high. So the TF0012 was preliminary scheduled for the afternoon and the TF0046 near Darss Sill in the evening, because the latter was still influenced by strong winds of up to 8 bft until the afternoon. Both were completed by CTD casts and net hauls for phytoplankton as well as for zooplankton samples at about 16:00 and 19:00 o'clock, respectively. Then we headed south-west to reach a place near the mouth of the River Warnow to stay overnight.

Wednesday, 03 April 2024: Early in the morning we entered Rostock harbour and docked at the pier of Rostock-Marienehe at about 8 o'clock in the morning. After the customs clearance, all the lab stuff that was stowed in a small container was carried from board at once and loaded on the Institute's lorry. Also the valuable samples and data were taken from board to the IOW.

5 Preliminary Results

The results presented in the following sections are preliminary and many samples taken are to be analysed and interpreted during the next weeks and months. The aim of this section is to give a first impression of the actual state of the western and central Baltic Sea in the second half of March and beginning of April 2024. An advanced data analysis will follow when the validated data set is available.

5.1 Meteorological Conditions

In the beginning of the cruise (17^{th}-20^{th} March) the weather situation was characterized by an anticyclonic weather pattern with a Fennoscandian high (DWD) (2024; 2024). During the winter months, the stable high pressure zone had often extended over northern Russia. Further to the west, there was a blocking wedge of high pressure, sometimes also a closed high-altitude high over Norway. Central Europe was influenced by the anticyclonic setting on the southern edge of the high pressure. Then the weather pattern changed to a cyclonic Western setting. From 23^{rd} to 25^{th} March individual disturbances moved with embedded intermediate highs or high pressure wedges in a normal orientated frontal zone from the North Sea and Baltic Sea to Eastern Europe, where it was deflected to the north-east. Then the weather regime changed to a low pressure system over the British Isles. From 23^{rd} to 25^{th} March the low pressure system at the British Isles steered

individual disturbances in a circle from the mid-Atlantic via the Bay of Biscay, northern France and western Central Europe to the north. Occasional peripheral lows on the northern flank of the low moved westwards again. From the 1st to 2nd April, a low of 995 hPa over the Black Forest moved towards Zealand while deepening somewhat and influenced the weather over the southern Baltic until 2nd April by building up a second core of 992 hPa over the south-eastern Baltic Sea.

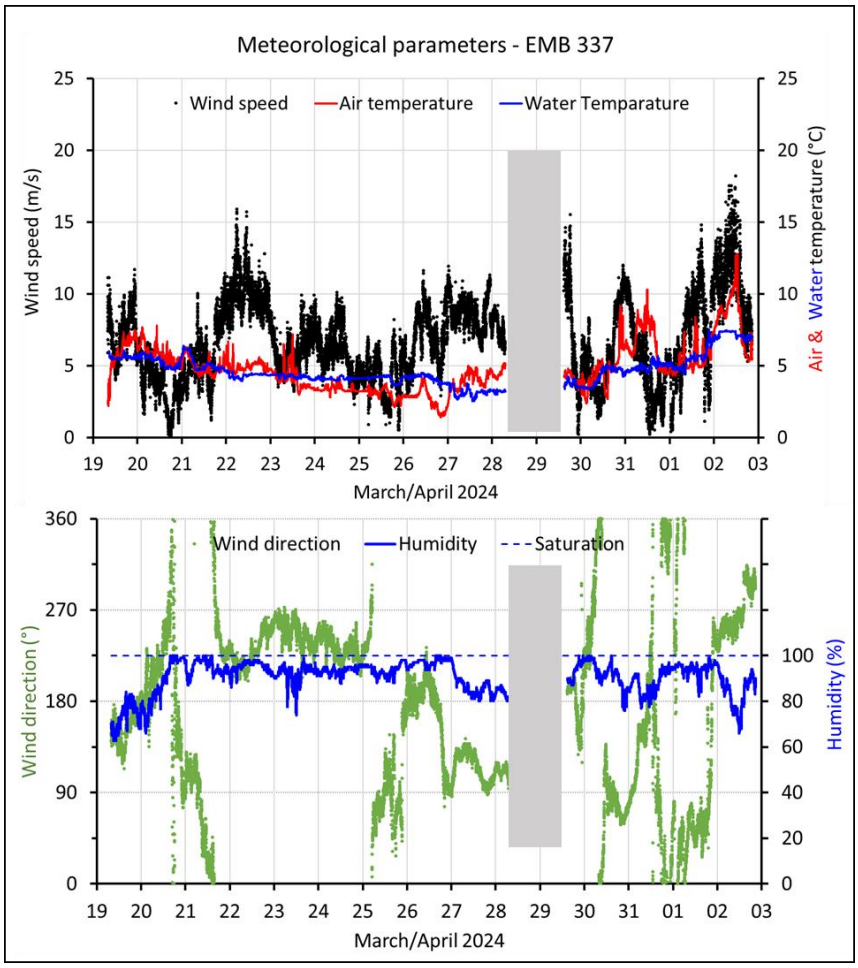

Fig. 5.1 Surface water temperature (JSMB-thermosalinograph), air temperature, and wind speed (upper panel) as well as humidity and wind direction (lower panel) measured on-board by the automatic weather station of the DWD; the time period of the stay in Visby (Sweden) and adjacent territorial waters is shaded grey.

In the harbour we still had winter conditions with temperatures below the freezing point on the ground, but after reaching the open sea, the air temperature had adapted to the water temperature of about 5 °C. The first three days were characterized by a light to fresh breeze, an average water temperature of 4.7 ± 1.0 °C, and an air temperature of 4.8 ± 1.7 °C. After a short stop at Sassnitz, we headed to the northern Arkona Sea and further to the Bornholm Sea at a fresh breeze and near gale gusts from south-western direction. However, the stronger wind didn't cause significant higher waves. Between the 22nd to 16th March, being in the Bornholm Sea and the eastern Gotland Sea the conditions were clearly colder with average air temperatures of 3.6 ± 1.0 °C and surface water temperatures of 4.2 ± 0.2 °C. But the wind calmed down to a moderate breeze with small waves only. From the 27th to the noon of the 30th March we were in the northern and western Gotland Sea at cold and foggy weather at an almost flat sea. However, the water temperatures of around 3.4 °C and of air of 4.1 °C caused an uncomfortable coldness. Thereby, a brief stay in

Visby provided some sunshine and temperatures clearly above 10 °C. Then we moved again to the southern part of the eastern Gotland Basin and the Bornholm Sea to proceed with another ScanFish transect along the thalweg in southern direction. The area is affected by the recent medium size MBI and more actual data in higher resolution would be useful for understanding and interpretation of the status. The start was put on the station TF0261 that was north of the oxygenation by the inflow, based on the CTD recordings of 23rd March and was still correct on 30th March which was shown by a couple of hydrogen sulphide analyses in the bottom water range.

Surface water processes are often closely coupled to prevailing weather conditions. Strong winds normally hamper the development of blooms by deep mixing, but sunny periods with low wind cause warming and stabilization of surface water that usually help to start the spring bloom. The elevated chlorophyll_a concentration in western Baltic Sea and the Bornholm Sea waters indicated the ongoing spring bloom at low water temperatures. This was also visible in the partial decline of major nutrients in surface water that will be discussed later (paragraph 5.3.1). Moreover, the spring bloom had further developed in some areas between the beginning of the cruise and the last few days (Fig. 5.2). The advanced spring bloom and its patchiness in the western Baltic Sea, as well as the low chlorophyll_a concentration in the Gotland Basin are also illustrated in the Thalweg panel (Fig. 5.5, middle).

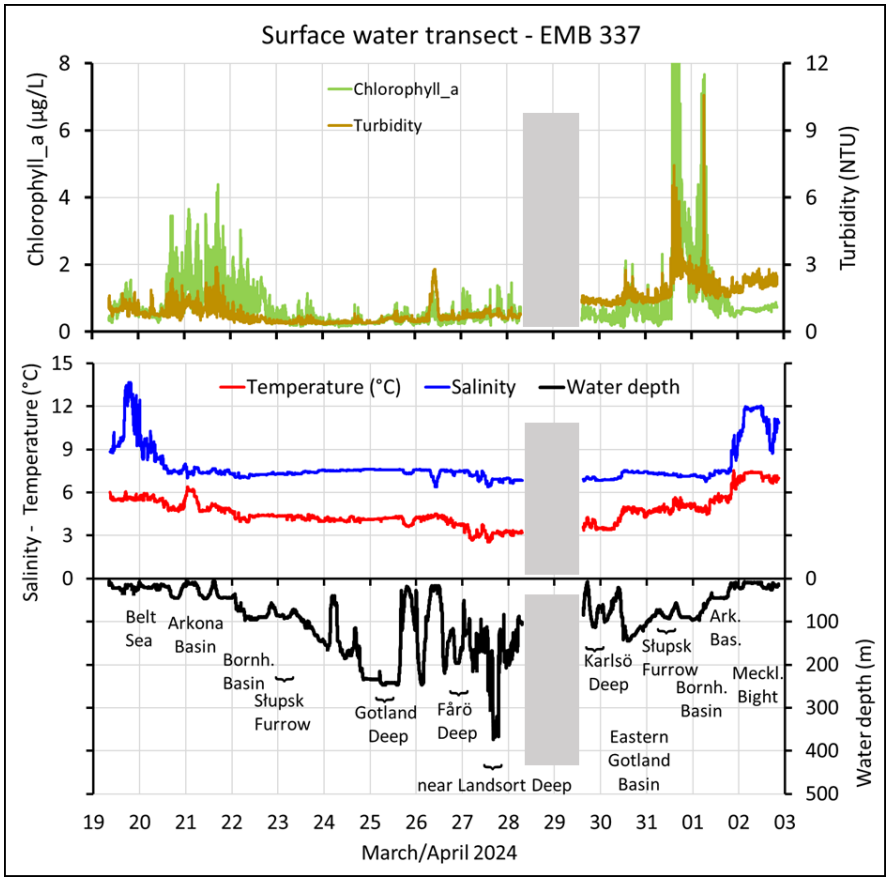

Fig. 5.2 Recording of chlorophyll and turbidity data (upper panel, drift corrected), compared to temperature and salinity in surface waters with the corresponding water depth and sea area during the cruise EMB337 of r/v *Elisabeth Mann Borgese* from March 19th to April 3rd 2024; the time period of the stay in Visby (Sweden) and adjacent territorial waters is shaded grey.

5.2 Baltic Thalweg Transect

For an overview of the hydrographic and the hydrochemical state of the Baltic Proper during the cruise EMB337, data of the CTD casts along the Thalweg from the Kiel Bight to the eastern, via the northern to the western Gotland Sea were combined to contour plots of salinity, temperature and oxygen for the time span of the cruise (Fig. 5.3, with a small map of the selected stations in the lowest panel). In addition, two transects were transverse versus the thalweg in the eastern and western Gotland Basins, with the Gotland Deep and the Karlsö Deep stations, respectively, in their centres. Moreover, a ScanFish Thalweg transect in reverse direction – uphill – was done on the way back to the Arkona Sea. It was divided in two parts by a brief recovery at the Bornholm Deep station (see map, Fig. 3.1).

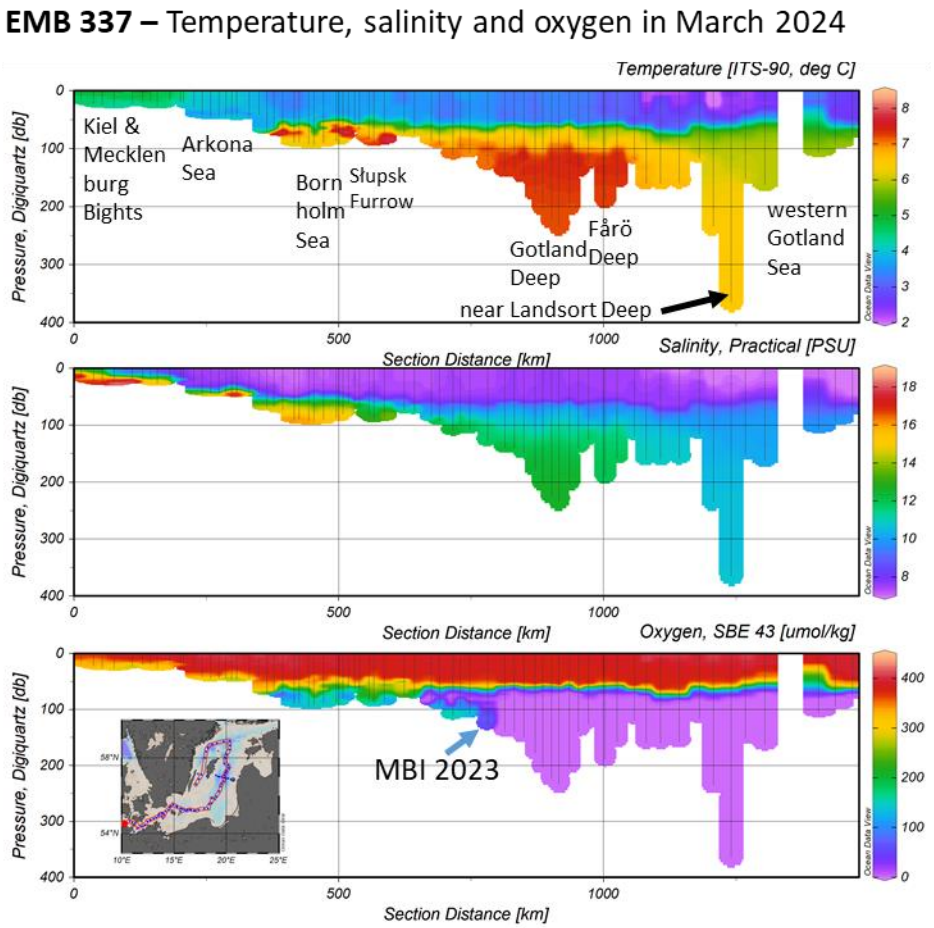

Fig. 5.3 Temperature, salinity and oxygen (without H_2S) along the Thalweg of the Baltic Sea from the Kiel Bight via the Arkona Sea, the Bornholm Sea, the eastern and northern to the western Gotland Sea (19 Mar – 30 Mar 2024). The gap is caused by the stay in Visby (Sweden). The elevated oxygen concentration in the bottom water of the Bornholm Sea, the Słupsk Furrow and the southern part of the eastern Gotland Basin is indicated the blue-greenish colour. The figure is based on the preliminary data of the CTD casts (vertical grey lines) by using ODV 5 (Schlitzer, 2018).

The weather conditions strongly influence the surface water conditions and the mixed layer depth. In the Belt Sea, strong salinity gradients between 9 to 12 in surface water and 14 to 18 in bottom water hindered a complete mixing to the bottom at the time of the cruise. Similarly, in the Arkona Basin that showed a salinity of about 7.5 in the surface mixed layer and near the bottom

of 16 to 17. Corresponding temperatures were higher in the mixed layer of the Belt Sea of about 4.8-4.9 °C compared to about 4.0 °C in the Arkona Basin. The bottom water temperatures were a few tenths of a degree below the mixed layer temperatures. The mixed layer in the Arkona Basin is restricted to 25-30 m and the bottom water to 5-10 m thickness. Further east in the Bornholm Sea a deeper mixed layer of about 50 m depth prevailed with a temperature of 3 to 4 °C until the southern part of the eastern Gotland Basin. Then the mixed layer depth increased clearly in northern direction and reaches a depth of about 75 m in the northern Gotland Basin. In the northern part of the western Gotland Basin some cold water patches of about 1.8 °C and a salinity of 7.2 were noticeable. Further south in the western basin, the temperature reached 3.3 °C at a salinity of about 7.0. A relative warm water persisted in the halocline range of the Bornholm Sea that continued as bottom water in the Słupsk Furrow between 7 and 8 °C, at a salinity of about 14. It is attributed to a mixture of the inflow of especially warm water in summer 2023 and the medium size MBI of December 2023 (Mohrholz, 2024). The relative warm deep water of the Gotland and Fårö Deeps of 7.4 °C at a salinity of 12 is noticeable. In the Landsort Deep area, the temperature of deep water is between 6 and 6.5 °C at a salinity of about 10.5.

5.3 Development of Baltic Sea Water Masses – Comparison to Previous Cruises

5.3.1 Surface Water Salinity, Temperature and Nutrients

The surface water temperature and salinity during the cruise EMB337 along the transect was already shown in an overview (Fig. 5.2). However, on selected stations that are assumed to represent certain Baltic Sea areas, surface water CTD measurements are given and compared to the values from March 2023 (Table 5.1). For comparison of temperature and salinity the data of EMB314 March 2023 and for nutrients additionally data of EMB356 February 2024 are given (Mohrholz, 2023, 2024). The western part of the study area, Kiel Bight and Mecklenburg Bight until Darss Sill showed an elevated temperature at lower Salinity compared to 2023 and usually reduced major nutrient concentrations. The Bornholm Sea showed lower temperatures and salinity in 2024 compared to 2023. Considering the dynamic of surface water, the temperature and salinity of the Gotland Sea surface water was similar as in March of the previous year. The nutrient concentrations confirm that the seasonality is also further developed in the western Baltic Sea, where nutrients were stronger declined since February 2024 as in the surface water of the central basins. A strong decline since February (> 50%) of phosphate was measured in the Kiel Bight and Mecklenburg Bight, and of nitrate further until the Słupsk Furrow. Whereas for silicate only in Kiel Bight surface water a strong decline was found and somehow indication of silicate uptake in the Mecklenburg Bight. The silicate concentration is also coupled to salinity that makes the decline more difficult to interpret as salinity is variable in the western Baltic Sea. The average nitrate/phosphate ratio was 6.3 based on the selected stations in Table 5.1, which is clearly below the Redfield uptake ratio (Redfield *et al.*, 1963). Nitrate is thus the limiting nutrient of the spring bloom. So the proceeding is clearly visible in the nitrate consumption and indicates that spring bloom was just started the Gotland Sea, but was well developed in the Belt Sea, Arkona Sea and the Bornholm Sea.

Table 5.1 Surface water temperature, salinity and major nutrients of Baltic Sea areas during this cruise (March 2024) are compared to March last year and the winter values of February 2024 (nutrients only).

Area \ Year	Temperature [°C]		Salinity [psu]		Phosphate [µmol L^{-1}]			Nitrate [µmol L^{-1}]			Silicate [µmol L^{-1}]		
	2023	**2024**	**2023**	**2024**	**Mar 2023**	**Feb 2024**	**Mar 2024**	**Mar 2023**	**Feb 2024**	**Mar 2024**	**Mar 2023**	**Feb 2024**	**Mar 2024**
Kiel Bight (TF0360)	4.14	4.95	18.7	13.3	0.02	0.52	0.06	0.00	4.55	0.11	12.4	10.6	5.1
Meckl. Bight (TF0012)	3.58	4.74	13.2	9.23	0.37	0.63	0.22	1.98	6.43	0.21	16.7	16.3	12.0
Darss Sill (TF0030)	4.01	4.50	8.95	7.64	0.42	0.59	0.32	1.55	3.52	1.37	16.6	15.7	16.6
Arkona Basin (TF0113)	3.99	4.01	8.73	7.45	0.40	0.60	0.37	1.30	3.29	1.22	15.5	16.6	18.8
Bornh. Deep (TF0213)	4.23	3.68	7.91	7.26	0.54	0.61	0.41	1.55	3.05	0.64	15.6	15.9	16.7
Slupsk Furrow (TF0222)	3.86	3.66	7.56	7.27	0.60	0.63	0.49	1.85	3.01	1.40	15.8	16.9	17.2
SE Gotl. Basin (TF0259)	3.43	3.62	7.40	7.31	0.62	0.68	0.54	2.83	3.65	3.24	16.7	17.3	18.1
SC Gotl. Basin (TF0260)	3.37	3.30	7.37	7.56	0.51	0.75	0.64	2.43	3.88	3.02	15.2	17.9	18.1
Gotland Deep (TF0271)	3.26	3.47	7.38	7.60	0.56	0.72	0.61	2.84	3.76	3.04	15.0	17.7	17.3
Fårö Deep (TF0286)	3.13	3.02	7.38	7.46	0.54	0.70	0.61	3.01	4.82	3.48	17.1	17.9	17.7
Landsort Deep (TF0284)	2.20	2.43	6.55	6.91	0.63	0.70	0.60	3.27	4.94	3.42	20.7	18.9	18.6
W Gotl. Basin (TF0240)	2.59	2.51	6.87	6.99	0.55	0.70	0.60	3.05	4.66	3.60	17.8	18.7	19.2
Karlsö Deep (TF0245)	2.94	3.33	7.08	7.07	0.59	0.70	0.65	2.89	4.53	3.00	16.9	18.5	20.0

5.3.2 Deep Water Salinity, Temperature and Oxygen

The salinity, temperature and the oxygen concentration of the bottom water layer measured in March 2024 is shown in comparison to data from the cruises in March 2023 (Table 5.2). The medium MBI 2023 that still showed its passage in the Arkona basin with a salinity of 21.2 in February (Mohrholz, 2024) moved further to the Bornholm and Southern Gotland Sea. The remaining bottom water of a salinity of 14 represented a relative low value that indicated the replacement of the MBI water in that area. The inflow is best identified by the oxygen concentration of deep water, because salinity and temperature are in the meantime well in the range of March last year. Based on the selected stations the elevated oxygen concentration in the near bottom range is documented until the TF0259 in 87 m bottom water depth with 5 µmol L^{-1}. Further on the TF0260, oxygen equivalents of hydrogen sulphide increased from -238 to -45 µmol L^{-1}, 76 n.m. further north. However, oxic bottom water of 60 µmol L^{-1} is shown on the map (Fig. 5.4) and by the CTD profiles until TF0262 (Fig. 5.3).

Table 5.2 Bottom water temperature, salinity and oxygen of Baltic Sea deeps of this cruise (March 2024) compared to the cruise in March 2023.

	Depth	Temperature [°C]		Salinity [psu]		Oxygen/H_2S* [µmol L^{-1}]	
Area \ Year	[m]	**2023**	**2024**	**2023**	**2024**	**2023**	**2024**
Kiel Bight (TF0360)	17	4.23	4.54	19.81	17.73	352	350
Meckl. Bight (TF0012)	23	4.33	4.30	17.91	18.18	326	290
Darss Sill (TF0030)	22	3.79	4.17	9.52	10.12	-	332
Arkona Basin (TF0113)	46	4.78	3.75	18.64	14.14	289	318
Bornh. Deep (TF0213)	87	8.67	6.24	16.57	15.76	82	161
Slupsk Furrow (TF0222)	89	9.15	7.54	13.86	13.42	118	129
SE Gotl. Basin (TF0259)	87	6.59	6.75	10.77	10.69	-34	5
SC Gotl. Basin (TF0260)	141	7.22	7.32	12.31	12.33	-238	-45
Gotland Deep (TF0271)	235	7.23	7.23	12.81	12.68	-306	-753[§]
Fårö Deep (TF0286)	189	7.17	7.30	12.05	11.97	-238	-272
Landsort Deep (TF0284)	437**	6.47	6.46	10.79	10.72	-90	-138
W Gotl. Basin (TF0240)	161	6.08	6.01	10.31	10.18	-96	-117
Karlsö Deep (TF0245)	107	5.95	5.85	10.13	9.95	-124	-104

* The hydrogen sulphide values are given as negative oxygen equivalents

** Values measured in 2024 on 284a in bottom water at 359 m depth

[§] The concentration of H_2S in the Gotland Deep was unprecedented high and require verification.

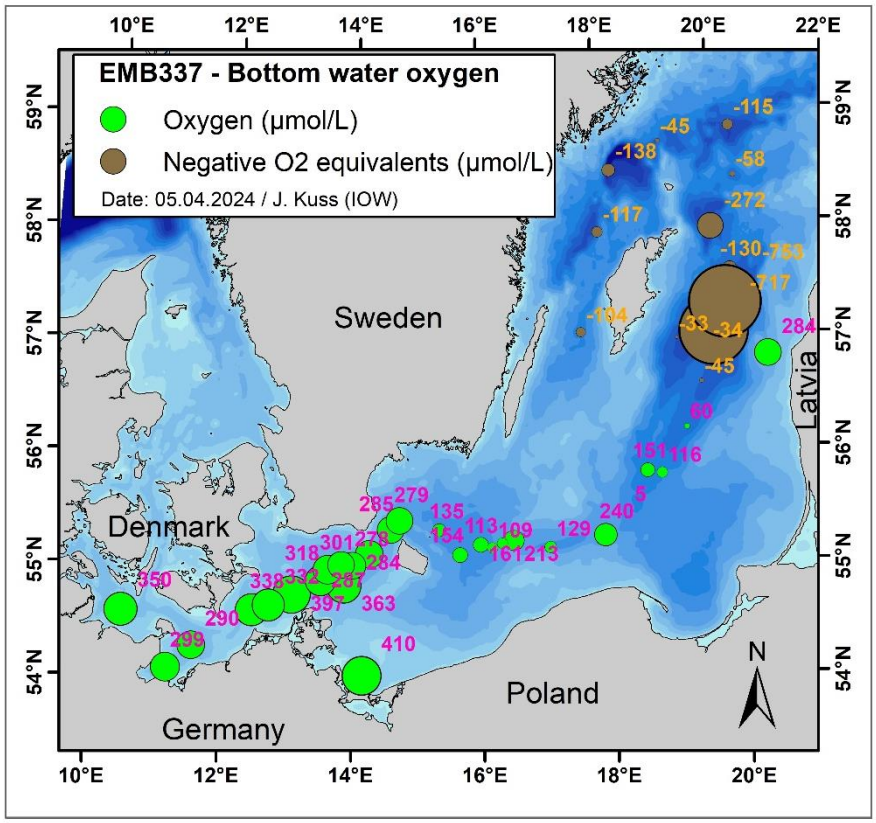

Fig. 5.4 Oxygen (green circles and concentration in µmol/L, magenta) and hydrogen sulphide concentrations (as negative oxygen concentration equivalents as brown circles in µmol/L, values are given in orange) in bottom waters of selected Baltic Sea stations.

The oxygen concentration in bottom waters of the western Baltic Sea (Kiel Bight to the Arkona Basin with Odra Bight) ranged from 278 to 410 µmol L^{-1} for 15 selected station (Fig. 5.4 map). This shallow sea area was well oxygenated during March. During summer the region could be partly affected by low oxygen concentration. Further on in the Bornholm Sea, the Słupsk Furrow and the southern part of the eastern Gotland Sea that is frequently affected by anoxic/euxinic conditions was oxygenated after the medium size MBI in December 2023. The Winkler oxygen measurements were between 240 µmol L^{-1} to 5 µmol L^{-1} with a clear decreasing tendency to deeper waters in north-eastern direction, until the already mentioned 60 µmol L^{-1} on station TF0262. Especially high hydrogen sulphide concentrations were determined at that time in the Gotland Deep of more than 350 µmol L^{-1} hydrogen sulphide, which corresponded to more than 700 µmol L^{-1} negative oxygen equivalents that still require verification. In the bottom water of the Fårö Deep also strong euxinic conditions with -272 µmol L^{-1} oxygen equivalents were measured, but further north and in the western Gotland Basins on the 6 investigated stations, the concentration equivalents were between -45 and -138 µmol L^{-1} oxygen equivalents (Fig. 5.4).

In this context, it was interesting to also investigate the turbidity zones in intermediate and deeper waters in comparison to low oxygen waters, as it was observed that turbidity often marks the mixing or diffusion zones between sulphidic and oxygenated waters (Fig. 5.5, lower panel). Partly this is caused by precipitation of fine particles of elemental sulphur (Kamyshny *et al.*, 2013) and likely manganese(IV) and iron(III) oxyhydroxides and phosphates play a role too (Dellwig *et al.*, 2010). The elevated turbidity in the bottom waters of the Mecklenburg and Kiel Bights and in the Arkona Sea are likely linked to resuspension of bottom sediments. However, in bottom waters

of the Bornholm Basin and the Słupsk Furrow already the sulphur precipitation from hydrogen sulphide oxidation could have contributed to turbidity maxima. Especially the deep water turbidity maxima however confirm the reach of the medium size MBI of December 2023 until stations TF0261 and TF0260 and the decrease of hydrogen sulphide concentration by entrained oxygenated waters, as shown by the data of Table 5.2. Interesting in this circumstance is the occurrence of elevated turbidity in the area of the Landsort Deep around 100 m depth, clearly below the halocline. No clear signs of different salinity or temperature marks this water of elevated turbidity. However, some oxygen could be entrained from above or laterally.

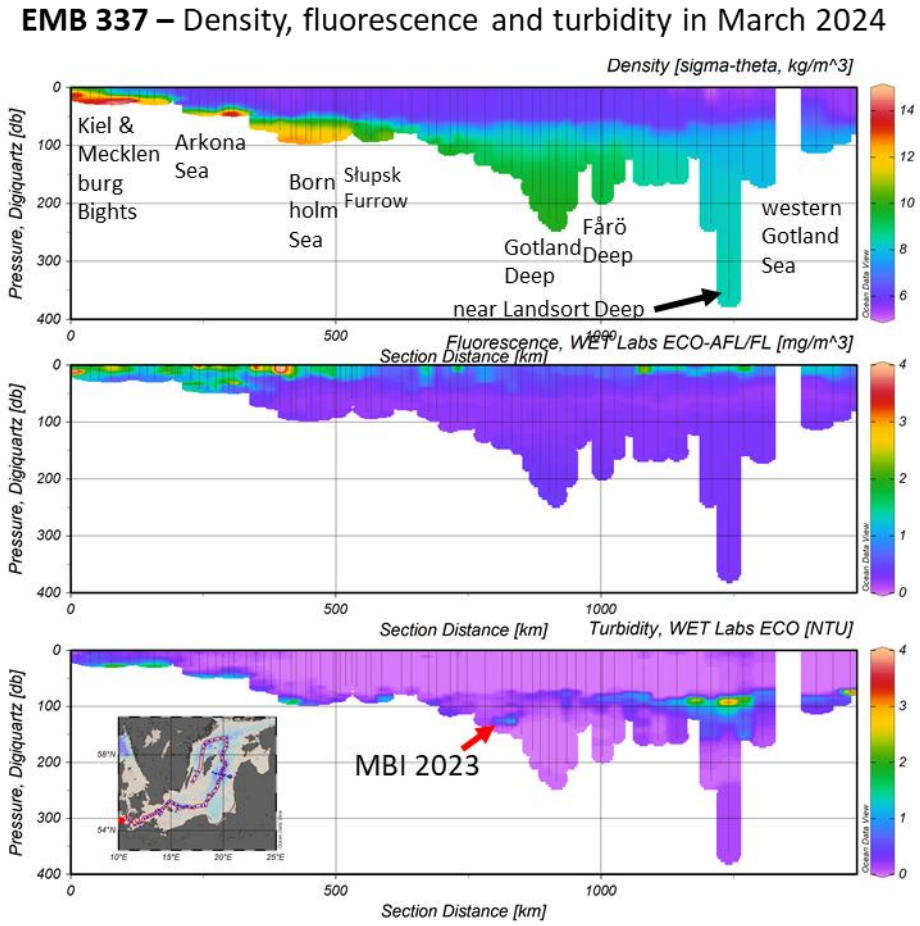

Fig. 5.5 Sensor measurements of density, fluorescence and turbidity along the Thalweg transect (see Fig. 5.3). The figure is based on the preliminary data of the CTD casts (vertical grey lines) by using ODV 5 (Schlitzer, 2018).

The density distribution (Fig. 5.5, upper panel) is basically determined by salinity (Fig. 5.3, middle panel), as temperature was low in upper waters in March and did not cause a stabilizing effect on the water column. Interestingly, the turbidity maximum on stations TF0261 at 124 m depth and on TF0262 at 128 m depth (red arrow in Fig. 5.5) was likely caused by the inflow of December 2023 that caused oxygenation on TF0262 of slightly above 70 µmol/kg at 115 m depth (see Fig 5.3).

The chlorophyll_a fluorescence in upper waters is well visible from the Kiel Bight to the Bornholm Sea but faded away further northeast to the southern Gotland Sea. It should be noted

that elevated chlorophyll_a concentration was widely spread in the Northern and the Western Gotland Sea at temperatures around 2 °C (Fig. 5.5, middle panel).

5.3.4 Deep water Nutrients

The nutrient concentration in bottom water of the western Baltic Sea is determined by the changes caused by remineralisation and consumption processes in combination with mixing, inflow and outflow. So the concentrations of phosphate, nitrate and silicate are basically similar to the March of the previous year for the selection of stations from Kiel Bight to the Arkona Basin. In deep basins, the prevailing oxygen/hydrogen sulphide concentration determines the accumulation or removal of phosphate and the presence or absence of nitrate. Phosphate showed on-going accumulation in the central Eastern Gotland Basin by elevated values in March 2024 compared to March 2023. In the northern and western Gotland Sea the nutrient concentrations were quite similar compared to March last year. Whereas in the southern part of the Eastern Gotland Basin the inflow caused some removal of phosphate, as measured on TF0259 after the recent oxygenation there. Similarly, the conditions changed for nitrate as oxygenation enabled remineralization of organic nitrogen until nitrate. So the presence of nitrate in March 2024 on this station in the south-eastern Gotland Basin is certainly enabled by the recent inflow. Silicate seemed as well to be accumulated in the central and northern part of the Eastern Gotland Basin that are subjected to ongoing stagnation in March 2024.

Table 5.3 Bottom water Phosphate, Nitrate and Silicate concentrations (µmol L^{-1}) of selected Baltic Sea areas of this cruise (March 2024) compared to the cruise in March 2023.

		Phosphate		Nitrate		Silicate	
	Depth	[µmol L^{-1}]		[µmol L^{-1}]		[µmol L^{-1}]	
Area \ Year	[m]	**2023**	**2024**	**2023**	**2024**	**2023**	**2024**
Kiel Bight (TF0360)	17	0.06	0.15	0.0	1.0	12.3	5.0
Meckl. Bight (TF0012)	23	0.62	0.74	5.2	6.6	21.2	17.0
Darss Sill (TF0030)	22	0.41	0.44	1.5	2.8	14.8	14.6
Arkona Basin (TF0113)	46	0.81	0.78	4.2	8.8	17.4	25.5
Bornh. Deep (TF0213)	87	1.19	1.50	8.6	7.2	46.7	38.5
Slupsk Furrow (TF0222)	89	1.97	1.73	6.9	7.1	44.1	44.7
SE Gotl. Basin (TF0259)	87	3.48	2.94	0.0	1.4	59.0	58.4
SC Gotl. Basin (TF0260)	141	5.30	5.65	0.0	0.0	81.5	95.5
Gotland Deep (TF0271)	235	6.50	6.78	0.0	0.0	100.5	111.3
Fårö Deep (TF0286)	189	4.00	5.03	0.0	0.0	68.5	84.0
Landsort Deep (TF0284)*	437	4.90	3.85	0.0	0.0	67.5	64.8
W Gotl. Basin (TF0240)	161	4.00	3.93	0.0	0.0	71.5	69.0
Karlsö Deep (TF0245)	107	3.95	4.00	0.0	0.0	69.0	69.5

* Values measured in 2024 on 284a in bottom water at 359 m depth

6 Station List EMB337

6.1 Overall Station List

Station No.		Date	Gear	Time	Latitude	Longitude	Water Depth	Remarks/ Recovery
r/v *Elisabeth Mann Borgese*	IOW	2023		[UTC]	[°N]	[°E]	[m]	Max sampl. depth
EMB337_1-1	TFO5	19 Mar	CTD	08:53	54.2219	12.0527	11	CLmax: 12m
EMB337_1-2	TFO5	19 Mar	SD	08:50	54.2220	12.0526	11	CLmax: 5.5m
EMB337_2-1	TF0012	19 Mar	CTD	11:15	54.3150	11.5500	22	CLmax: 22m
EMB337_2-2	TF0012	19 Mar	PLA	11:20	54.3151	11.5503	22	3 hauls
EMB337_2-6	TF0012	19 Mar	SD	11:21	54.3151	11.5503	22	CLmax: 5.5m
EMB337_2-3	TF0012	19 Mar	WP2	11:34	54.3150	11.5499	22	CLmax: 21m
EMB337_2-4	TF0012	19 Mar	WP2	11:40	54.3147	11.5500	22	CLmax: 21m
EMB337_2-5	TF0012	19 Mar	WP2	11:49	54.3146	11.5500	22	CLmax: 21m
EMB337_2-7	TF0012	19 Mar	CTD	12:10	54.3150	11.5506	22	CLmax: 22m
EMB337_2-8	TF0012	19 Mar	CTD	12:34	54.3141	11.5495	22	CLmax: 5m
EMB337_3-1	TF0010	19 Mar	CTD	14:42	54.5528	11.3195	25	CLmax: 26m
EMB337_4-1	TF0014	19 Mar	CTD	16:17	54.5949	11.0133	25	CLmax: 25m
EMB337_5-1	TF0360	19 Mar	CTD	18:36	54.5991	10.4499	15	CLmax: 16m
EMB337_5-2	TF0360	19 Mar	PLA	18:39	54.5992	10.4498	15	3 hauls
EMB337_5-3	TF0360	19 Mar	WP2	18:52	54.5993	10.4504	15	CLmax: 15m
EMB337_6-1	TF0361	19 Mar	CTD	20:39	54.6658	10.7762	21	CLmax: 22m
EMB337_7-1	TF0022	20 Mar	CTD	02:50	54.1095	11.1750	20	CLmax: 21m
EMB337_7-2	TF0022	20 Mar	CTD	03:21	54.1092	11.1754	20	CLmax: 1.2m
EMB337_8-1	TF0017	20 Mar	CTD	06:53	54.3917	11.8237	19	CLmax: 20m
EMB337_9-1	TF0041	20 Mar	CTD	08:09	54.4062	12.0635	16	CLmax: 17m
EMB337_10-1	TF0046	20 Mar	CTD	09:26	54.4693	12.2403	26	CLmax: 26m
EMB337_10-2	TF0046	20 Mar	PLA/SD	09:30	54.4691	12.2397	26	3 hauls/Clmax: 7m
EMB337_10-3	TF0046	20 Mar	WP2	09:46	54.4696	12.2400	25	CLmax: 24m
EMB337_10-4	TF0046	20 Mar	CTD	10:06	54.4695	12.2406	26	CLmax: 22m
EMB337_11-1	TF0002	20 Mar	CTD	11:51	54.6492	12.4490	15	CLmax: 15m
EMB337_12-1	TF0001	20 Mar	CTD	13:15	54.6972	12.7055	18	CLmax: 19m
EMB337_13-1	TF0030	20 Mar	CTD	14:05	54.7235	12.7815	20	CLmax: 20m
EMB337_13-2	TF0030	20 Mar	SD	14:00	54.7237	12.7812	20	CLmax: 7m
EMB337_13-3	TF0030	20 Mar	PLA	14:10	54.7233	12.7819	20	3 hauls
EMB337_13-4	TF0030	20 Mar	CTD	14:30	54.7233	12.7834	20	CLmax: 5m
EMB337_14-1	TF0115	20 Mar	CTD	15:54	54.7944	13.0582	27	CLmax: 27m
EMB337_15-1	TF0114	20 Mar	CTD	17:12	54.8604	13.2763	43	CLmax: 42m
EMB337_16-1	TF0113	20 Mar	CTD	18:29	54.9261	13.4997	45	CLmax: 45m
EMB337_16-2	TF0113	20 Mar	PLA	18:33	54.9263	13.4999	45	3 hauls
EMB337_16-3	TF0113	20 Mar	WP2	18:46	54.9259	13.5002	45	CLmax: 33m
EMB337_16-4	TF0113	20 Mar	WP2	18:54	54.9259	13.4998	45	CLmax: 45m
EMB337_16-5	TF0113	20 Mar	WP2	19:08	54.9252	13.5001	45	CLmax: 45m
EMB337_16-6	TF0113	20 Mar	CTD	19:29	54.9251	13.5005	45	CLmax: 21m
EMB337_17-1	OBBoje	21 Mar	CTD	02:19	54.0834	14.1528	12	CLmax: 13m
EMB337_17-2	OBBoje	21 Mar	CTD	02:37	54.0843	14.1509	12	CLmax: 13m
EMB337_18-1	TF0112	21 Mar	CTD	07:34	54.8032	13.9583	38	CLmax: 38m
EMB337_18-2	TF0112	21 Mar	CTD	08:02	54.8033	13.9578	38	CLmax: 5m
EMB337_19-1	TF0109	21 Mar	CTD	09:53	55.0007	14.0835	46	CLmax: 45m
EMB337_19-2	TF0109	21 Mar	PLA/SD	10:00	55.0002	14.0833	46	3 hauls/CLmax: 8m
EMB337_19-3	TF0109	21 Mar	WP2	10:09	54.9998	14.0830	46	CLmax: 31m
EMB337_19-4	TF0109	21 Mar	WP2	10:17	55.0000	14.0833	46	CLmax: 46m
EMB337_19-5	TF0109	21 Mar	CTD	10:43	55.0002	14.0836	46	CLmax: 25m
EMB337_20-1	ABBOJE	21 Mar	CTD	17:52	54.8797	13.8594	44	CLmax: 43m
EMB337_21-1	TF0105	21 Mar	CTD	19:31	55.0250	13.6070	44	CLmax: 44m
EMB337_22-1	TF0104	21 Mar	CTD	20:45	55.0680	13.8133	44	CLmax: 44m

EMB337_23-1	TF0103	21 Mar	CTD	21:53	55.0635	13.9893	45	CLmax: 44m
EMB337_24-1	TF0145	21 Mar	CTD	23:40	55.1672	14.2519	45	CLmax: 44m
EMB337_25-1	TF0144	22 Mar	CTD	01:17	55.2570	14.4903	42	CLmax: 42m
EMB337_26-1	TF0142_DK	22 Mar	CTD	02:36	55.3873	14.5737	70	CLmax: 68m
EMB337_26-2	TF0142_DK	22 Mar	CTD	02:52	55.3874	14.5735	70	CLmax: 5m
EMB337_27-1	TF0140	22 Mar	CTD	04:11	55.4665	14.7172	68	CLmax: 67m
EMB337_28-1	TF0206	22 Mar	CTD	05:25	55.5329	14.9153	75	CLmax: 73m
EMB337_29-1	TF0208	22 Mar	CTD	07:16	55.4530	15.2345	92	CLmax: 90m
EMB337_30-1	TF0200	22 Mar	CTD	08:21	55.3830	15.3330	91	CLmax: 89m
EMB337_31-1	TF0211	22 Mar	CTD	09:58	55.3301	15.6153	95	CLmax: 93m
EMB337_32-1	TF0214	22 Mar	CTD	11:31	55.1599	15.6596	94	CLmax: 92m
EMB337_33-1	TF0212	22 Mar	CTD	13:01	55.3017	15.7969	95	CLmax: 92m
EMB337_34-1	TF0213	22 Mar	CTD	14:16	55.2504	15.9837	89	CLmax: 87m
EMB337_34-2	TF0213	22 Mar	SD	14:07	55.2506	15.9841	89	CLmax: 8m
EMB337_34-3	TF0213	22 Mar	PLA	14:19	55.2502	15.9832	89	3 hauls
EMB337_34-4	TF0213	22 Mar	WP2	14:35	55.2498	15.9827	89	CLmax: 86m
EMB337_34-5	TF0213	22 Mar	WP2	14:46	55.2499	15.9822	90	CLmax: 86m
EMB337_34-6	TF0213	22 Mar	WP2	14:56	55.2501	15.9831	89	CLmax: 40m
EMB337_34-7	TF0213	22 Mar	WP2	15:06	55.2499	15.9834	89	CLmax: 86m
EMB337_34-8	TF0213	22 Mar	CTD	15:31	55.2500	15.9835	89	CLmax: 22m
EMB337_34-9	TF0213	22 Mar	APNET	15:46	55.2501	15.9833	91	CLmax: 87m
EMB337_34-10	TF0213	22 Mar	APNET	16:09	55.2499	15.9833	89	CLmax: 87m
EMB337_34-11	TF0213	22 Mar	APNET	16:57	55.2500	15.9833	90	CLmax: 87m
EMB337_34-12	TF0213	22 Mar	Float	17:22	55.2498	15.9829	90	ARGO float depl.
EMB337_34-13	TF0213	22 Mar	APNET	17:35	55.2504	15.9801	89	CLmax: 87m
EMB337_35-1	TF0221	22 Mar	CTD	18:54	55.2217	16.1669	82	CLmax: 80m
EMB337_36-1	TF0225	22 Mar	CTD	19:57	55.2586	16.3221	65	CLmax: 63m
EMB337_37-1	TF0224	22 Mar	CTD	21:05	55.2826	16.5003	60	CLmax: 59m
EMB337_38-1	TF0227	22 Mar	CTD	22:03	55.2614	16.6378	68	CLmax: 66m
EMB337_39-1	TF0229	22 Mar	CTD	23:33	55.2288	16.9137	85	CLmax: 83m
EMB337_40-1	TF0222	23 Mar	CTD	03:43	55.2165	17.0666	91	CLmax: 88m
EMB337_40-2	TF0222	23 Mar	CTD	04:02	55.2165	17.0667	91	CLmax: 8m
EMB337_41-1	TF0266	23 Mar	CTD	05:36	55.2520	17.3599	88	CLmax: 86m
EMB337_42-1	TF0268	23 Mar	CTD	08:00	55.3076	17.9318	76	CLmax: 73m
EMB337_43-1	TF0256	23 Mar	CTD	09:28	55.3267	18.2362	76	CLmax: 74m
EMB337_44-1	TF0259	23 Mar	CTD	11:21	55.5499	18.4011	89	CLmax: 87m
EMB337_44-2	TF0259	23 Mar	SD	11:13	55.5502	18.4011	90	CLmax: 8m
EMB337_44-3	TF0259	23 Mar	PLA	11:24	55.5498	18.4009	90	3 hauls
EMB337_45-1	TF0255	23 Mar	CTD	12:45	55.6333	18.5991	96	CLmax: 93m
EMB337_46-1	TF0252	23 Mar	CTD	14:42	55.8643	18.6409	114	CLmax: 111m
EMB337_47-1	TF0253	23 Mar	CTD	15:57	55.8400	18.8668	101	CLmax: 98m
EMB337_48-1	TF0265	23 Mar	CTD	17:21	55.9587	19.0472	111	CLmax: 108m
EMB337_49-1	TF0262	23 Mar	CTD	19:44	56.2342	19.3021	132	CLmax: 128m
EMB337_50-1	TF0261	23 Mar	CTD	21:56	56.4915	19.4823	144	CLmax: 139m
EMB337_51-1	TF0260	23 Mar	CTD	23:22	56.6334	19.5837	146	CLmax: 141m
EMB337_52-1	TF0274_	24 Mar	CTD	00:58	56.7677	19.7524	155	CLmax: 150m
EMB337_53-1	TF0411	24 Mar	CTD	04:50	56.8381	20.6817	55	CLmax: 53m
EMB337_54-1	TF0410	24 Mar	CTD	06:10	56.8666	20.4555	60	CLmax: 58m
EMB337_55-1	TF0409	24 Mar	CTD	07:38	56.9052	20.2164	146	CLmax: 141m
EMB337_56-1	TF0408	24 Mar	CTD	09:07	56.9229	20.0185	166	CLmax: 161m
EMB337_57-1	TF0407	24 Mar	CTD	10:14	56.9498	19.8837	178	CLmax: 172m
EMB337_58-1	TF0273	24 Mar	CTD	11:19	56.9515	19.7702	184	CLmax: 179m
EMB337_59-1	TF0406	24 Mar	CTD	12:37	56.9799	19.5770	169	CLmax: 163m
EMB337_60-1	TF0405	24 Mar	CTD	13:58	57.0081	19.3547	177	CLmax: 172m
EMB337_61-1	TF0404	24 Mar	CTD	15:03	57.0286	19.2211	163	CLmax: 158m
EMB337_62-1	TF0403	24 Mar	CTD	16:20	57.0733	19.0260	114	CLmax: 111m
EMB337_63-1	TF0272	24 Mar	CTD	19:36	57.0715	19.8296	210	CLmax: 204m
EMB337_64-1	TF0275	24 Mar	CTD	21:10	57.2100	19.9304	231	CLmax: 225m

EMB337_65-1	GOC	25 Mar	MOOR	06:54	57.3057	20.0768	246	Released
EMB337_65-1	GOC	25 Mar	MOOR	06:55	57.3057	20.0770	246	At surface
EMB337_65-1	GOC	25 Mar	MOOR	07:41	57.3073	20.0820	246	Sediment trap recov.
EMB337_65-1	GOC	25 Mar	MOOR	07:47	57.3072	20.0819	246	Complete recovery
EMB337_66-1	TF0271	25 Mar	CTD	08:34	57.3201	20.0499	241	CLmax: 235m
EMB337_66-2	TF0271	25 Mar	SD	08:19	57.3204	20.0495	241	CLmax: 12m
EMB337_66-3	TF0271	25 Mar	CTD	09:28	57.3202	20.0501	241	CLmax: 156m
EMB337_66-4	TF0271	25 Mar	CTD	10:11	57.3196	20.0503	241	CLmax: 85m
EMB337_66-5	TF0271	25 Mar	CTD	10:41	57.3197	20.0499	242	CLmax: 30m
EMB337_66-6	TF0271	25 Mar	CTD	11:12	57.3199	20.0501	242	CLmax: 20m
EMB337_66-7	TF0271	25 Mar	PLA	11:16	57.3200	20.0499	242	3 hauls
EMB337_66-8	TF0271	25 Mar	CTD	11:30	57.3201	20.0499	241	CLmax: 49m
EMB337_66-9	TF0271	25 Mar	CTD	12:27	57.3202	20.0504	241	CLmax: 95m
EMB337_67-1	GOC	25 Mar	MOOR	14:03	57.3072	20.0803	246	Weight in water
EMB337_67-1	GOC	25 Mar	MOOR	14:13	57.3069	20.0815	246	Trap in water
EMB337_67-1	GOC	25 Mar	MOOR	14:23	57.3069	20.0818	247	Releaser in water
EMB337_67-1	GOC	25 Mar	MOOR	14:29	57.3069	20.0814	247	Deployed
EMB337_68-1	SF001EGB	25 Mar	CTD	19:14	57.5622	18.8503	19	CLmax: 18m
EMB337_68-2	SF001EGB	25 Mar	SCF	19:45	57.5599	18.8629	24	Start profiling
EMB337_68-2		26 Mar	SCF	01:39	57.3479	19.8828	219	CLmax: 500m
EMB337_68-2	SF022EGB	26 Mar	SCF	09:50	57.0405	21.2792	19	End profiling
EMB337_69-1	SF022EGB	26 Mar	CTD	10:08	57.0402	21.2839	18	CLmax: 18m
EMB337_69-2	SF022EGB	26 Mar	SCF	10:25	57.0393	21.2833	18	CLmax: 18m
EMB337_70-1	TF0276	26 Mar	CTD	15:18	57.4695	20.2605	209	CLmax: 203m
EMB337_71-1	TF0270	26 Mar	CTD	16:52	57.6165	20.1675	145	CLmax: 140m
EMB337_72-1	TF0287	26 Mar	CTD	18:39	57.7153	19.8536	130	CLmax: 127m
EMB337_73-1	TF0286	26 Mar	CTD	21:04	58.0005	19.9005	196	CLmax: 190m
EMB337_73-2	TF0286	26 Mar	CTD	21:58	58.0001	19.9001	196	CLmax: 190m
EMB337_74-1	TF0277	26 Mar	CTD	23:52	58.1834	20.0505	164	CLmax: 158m
EMB337_75-1	TF0285	27 Mar	CTD	02:24	58.4420	20.3333	124	CLmax: 119m
EMB337_76-1	TF0279	27 Mar	CTD	04:31	58.6413	20.3446	166	CLmax: 160m
EMB337_77-1	TF0282	27 Mar	CTD	06:31	58.8834	20.3168	167	CLmax: 160m
EMB337_78-1	nGB-2	27 Mar	CTD	09:03	58.8661	19.7444	163	CLmax: 158m
EMB337_79-1	TF0283	27 Mar	CTD	11:45	58.7833	19.1007	122	CLmax: 114m
EMB337_80-1	nGB-1	27 Mar	CTD	13:55	58.7126	18.6699	243	CLmax: 235m
EMB337_81-1	TF0284a	27 Mar	CTD	16:32	58.5451	18.2350	333	CLmax: 367m
EMB337_81-2	TF0284a	27 Mar	SD	16:06	58.5454	18.2344	352	CLmax: 9m
EMB337_81-3	TF0284a	27 Mar	CTD	17:19	58.5449	18.2344	345	CLmax: 128m
EMB337_81-4	TF0284a	27 Mar	CTD	17:53	58.5452	18.2353	328	CLmax: 11m
EMB337_81-5	TF0284a	27 Mar	CTD	18:37	58.5447	18.2347	336	CLmax: 109m
EMB337_82-1	wGB-3	27 Mar	CTD	20:45	58.3263	18.0686	154	CLmax: 152m
EMB337_83-1	TF0240	27 Mar	CTD	23:28	58.0001	18.0003	168	CLmax: 162m
EMB337_83-2	TF0242	27 Mar	CTD	23:53	58.0000	18.0002	168	CLmax: 10m
EMB337_84-1	Visby	28 Mar	CTD	03:26	57.7171	17.3669	143	CLmax: 137m
EMB337_85-1	SF032WGB	29 Mar	CTD	17:02	57.0525	18.1358	8	CLmax: 8m
EMB337_85-2	SF032WGB	29 Mar	SCF	17:20	57.0515	18.1285	10	Start profiling
EMB337_85-2		29 Mar	SCF	19:07	57.0970	17.8112	94	CLmax: 450m
EMB337_85-2	SF025WGB	29 Mar	SCF	22:58	57.1623	17.3243	68	End profiling
EMB337_86-1	TF0245	29 Mar	CTD	20:35	57.1165	17.6661	111	CLmax: 106m
EMB337_87-1	TF0245	29 Mar	CTD	23:45	57.1620	17.3233	68	CLmax: 67m
EMB337_87-2	SF025WGB	29 Mar	SCF	23:55	57.1623	17.3229	69	CLmax: vertikel
EMB337_87-2	SF025WGB	30 Mar	SCF	00:04	57.1619	17.3225	69	CLmax: 67m
EMB337_88-1	wGB-1	30 Mar	CTD	02:32	56.8771	17.3885	97	CLmax: 94m
EMB337_88-2	wGB-1	30 Mar	CTD	02:41	56.8771	17.3888	97	CLmax: 14m
EMB337_89-1	GB_SW	30 Mar	CTD	05:04	56.6249	17.1305	78	CLmax: 76m
EMB337_90-1	TF0261	30 Mar	CTD	14:25	56.4925	19.4717	143	CLmax: 139m
EMB337_90-2	TF0261	30 Mar	SCF	14:49	56.4812	19.4716	143	Start Profiling
EMB337_90-2		30 Mar	SCF	16:30	56.3247	19.3638	133	CLmax: 650m

EMB337_90-2	TF0213	31 Mar	SCF	18:05	55.2517	15.9737	90	End profiling
EMB337_91-1	TF0213	31 Mar	CTD	18:37	55.2502	15.9823	90	CLmax: 87m
EMB337_91-2	TF0213	31 Mar	PLA	18:29	55.2501	15.9820	90	1 haul
EMB337_91-3	TF0213	31 Mar	WP2	19:12	55.2502	15.9828	90	CLmax: 86m
EMB337_91-4	TF0213	31 Mar	WP2	19:24	55.2507	15.9822	90	CLmax: 86m
EMB337_91-5	TF0213	31 Mar	WP2	19:34	55.2503	15.9827	90	CLmax: 50m
EMB337_91-6	TF0213	31 Mar	WP2	19:45	55.2504	15.9834	90	CLmax: 86m
EMB337_91-7	TF0213	31 Mar	APNET	20:05	55.2499	15.9830	90	CLmax: 87m
EMB337_91-8	TF0213	31 Mar	APNET	20:28	55.2501	15.9837	90	CLmax: 87m
EMB337_91-9	TF0213	31 Mar	APNET	20:50	55.2502	15.9837	90	CLmax: 87m
EMB337_91-10	TF0213	31 Mar	CTD	21:27	55.2502	15.9835	90	CLmax: 87m
EMB337_91-11	TF0213	31 Mar	SCF	22:02	55.2499	15.9856	90	CLmax: 88m
EMB337_91-12	TF0213	31 Mar	SCF	22:23	55.2526	15.9753	90	Start Profiling
EMB337_91-12		31 Mar	SCF	22:36	55.2618	15.9415	91	CLmax: 380m
EMB337_91-12	TF0113	1 Apr	SCF	15:10	54.9274	13.5078	45	End profiling
EMB337_92-1	TF0113	1 Apr	PLA	15:37	54.9253	13.4971	45	3 hauls
EMB337_92-2	TF0113	1 Apr	CTD	15:50	54.9252	13.4994	45	CLmax: 45m
EMB337_92-3	TF0113	1 Apr	SD	15:48	54.9250	13.4993	46	CLmax: 6.5m
EMB337_92-4	TF0113	1 Apr	SCF	16:13	54.9256	13.4977	45	Comparison meas.
EMB337_92-5	TF0113	1 Apr	WP2	16:41	54.9251	13.4989	45	CLmax: 27m
EMB337_92-6	TF0113	1 Apr	WP2	16:49	54.9249	13.4991	46	CLmax: 45m
EMB337_93-1	TF0012	2 Apr	CTD	13:23	54.3150	11.5499	22	CLmax: 23m
EMB337_93-2	TF0012	2 Apr	SD	13:15	54.3147	11.5501	23	CLmax: 6.5m
EMB337_93-3	TF0012	2 Apr	PLA	13:19	54.3148	11.5498	22	3 hauls
EMB337_93-4	TF0012	2 Apr	WP2	13:40	54.3147	11.5490	22	CLmax: 11m
EMB337_93-5	TF0012	2 Apr	WP2	13:44	54.3146	11.5487	22	CLmax: 21m
EMB337_94-1	TF0046	2 Apr	CTD	16:54	54.4698	12.2421	26	CLmax: 27m
EMB337_94-2	TF0046	2 Apr	PLA	16:50	54.4697	12.2422	26	1 hauls
EMB337_94-3	TF0046	2 Apr	SD	16:52	54.4698	12.2422	26	CLmax: 6m
EMB337_94-4	TF0046	2 Apr	WP2	17:06	54.4699	12.2418	26	CLmax: 8m
EMB337_94-5	TF0046	2 Apr	WP2	17:12	54.4699	12.2416	26	CLmax: 25m

CLmax:	Maximum rope/cable length
PLA:	Small plankton net for manual catches
WP2:	Plankton net with closing mechanism and removable net bucket
APNET:	Apstein net with cone
CTD:	CTD rosette system with Fluorimeter, Oxygen Sensor, Water Sampler, and Camera
SD:	Secci disk to determine the depth of visibility
SCF:	Undulating CTD with sensor package (ScanFish)
Float:	Drifting CTD with sensor package (ARGO float)

7 Data and Sample Storage and Availability

All data gathered are saved on a data repository in the IOW immediately after the cruise. The processed and validated data will be stored in the ODIN data base (https://odin2.io-warnemuende.de) in due time after the cruise. According to the IOW data policy and to facilitate the international exchange of data, all metadata will be made available under the international ISO 19115 standards for georeferenced metadata.

The access to the data itself will be restricted for three years after data acquisition to protect the research process, including scientific analysis and publication. After that period the data becomes openly available to any person or organization who requests them, under the international Creative Commons (CC) data license of type CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/). For further details, refer to the IOW data policy document.

Table 7.1 Overview of data availability

Type	Database	Available	Free Access	Contact
Hydrographic data	ODIN	01.06.2024	01.06.2027	volker.mohrholz@io-warnemuende.de
Nutrient data	ODIN	01.10.2024	01.10.2027	joachim.kuss@io-warnemuende.de
Zooplankton data	ODIN	01.04.2025	01.04.2028	joerg.dutz@io-warnemuende.de
Phytoplankton data	ODIN	01.04.2025	01.04.2028	anke.kremp@io-warnemuende.de

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