ELISABETH MANN BORGESE-Berichte

Baltic Sea Long-term Observation Programme

Cruise No. EMB359

05.02.2025 – 19.02.2025
Rostock-Marienehe (Germany) – Rostock-Marienehe (Germany)
HELCOM /long-term obs

Michael Naumann, Jens Faber, Martin Sass, Anna-Adriana Anschütz, Jenny Jeschek, Ines Hand, Lars Kreuzer, Jonas Radisch, Christin Fechtel, Heike Benterbusch-Brockmöller, Anna Kujat, Caiyi Lu

Chief Scientist
Dr. Michael Naumann
Leibniz-Institute for Baltic Sea Research Warnemünde

2025

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1. Cruise summary

1.1 Summary in English

This campaign of measurements is the first one in a series of five annual cruises to study the spatial and temporal variations of the Baltic Sea ecosystem. The work programme consisted of field data acquisition for the national environmental monitoring in the German EEZ as contract work for the Federal Maritime Agency (BSH). The second work package is part of IOW's Baltic Sea long-term observation program. performed since 1969 by this institute and its predecessor. The data acquired are the back bone of research on the natural variability as well as anthropogenic influences and are used for the regular national and international assessments of the state of the Baltic Sea (HELCOM 2023, NAUMANN et al. 2024).

During this expedition 107 stations (125 CTD casts, water sampling for hydrochemical and hydrobiological parameters) were measured from the western to the central Baltic Sea. In addition, eight cores of surface sediments are extracted by the multicorer in the Kiel Bight and a BGC ArgoFloat was recovered in the Pomeranian Bight. The usually performed dense grid of vertical CTD casts along the so called "thalweg transect" was measured from Kiel Bight to the southern part of the Eastern Gotland Basin. Technical issues und phases of strong winds from northern direction hampered the completion to the Northern Gotland Basin. Only key stations could be measured in the Eastern, Northern and Western Gotland Basin. The cruise was performed in mostly windy weather conditions close to the working limit. Three phases of "waiting on weather" occurred. Around 70 % of the planned work programme were realised.

1.2 Zusammenfassung

Die Messkampagne ist die Erste von fünf jährlichen Expeditionen zur Erfassung der räumlich-zeitlichen Variabilität des Ökosystems Ostsee. Das wissenschaftliche Programm beinhaltet die Felddatenerfassung für die nationale Umweltüberwachung in der deutschen AWZ. basierend auf einem Vertrag mit dem Bundesamt für Seeschifffahrt und Hydrographie (BSH). Das zweite Arbeitspaket ist Teil des Ostsee-Langzeitbeobachtungsprogramms des IOW. das kontinuierlich seit 1969 vom Institut und seines Vorgängerinstituts durchgeführt wird. Die gewonnenen Daten bilden die Basis der Forschung zur natürlichen Variabilität sowie anthropogenen Einflüssen und werden für regelmäßige nationale und internationale Bewertungen des Umweltzustandes der Ostsee verwendet (HELCOM 2023, NAUMANN et al. 2024).

Im Verlauf der Expedition wurden 107 Stationen (125 CTD casts, Wasserbeprobung für hydrochemische und meeresbiologische Parameter) im Gebiet von der westlichen Ostsee bis in die zentrale Ostsee gemessen und beprobt. Zusätzlich wurden acht Sedimentkerne mit Eindringtiefen bis 60 cm mit dem Multicorer in der Kieler Bucht gebohrt und ein BGC ArgoFloat in der Pommerschen Bucht geborgen. Das „Thalweg Transekt" konnte nur von der Kieler Bucht bis in den südlichen Teil des östlichen Gotland Beckens mit einer dichten Abfolge von vertikalen CTD's erfasst werden. Technische Probleme und phasenweise starker Nordwind verhinderten das Transekt bis ins nördliche Gotland Becken zu messen, jedoch konnten die Schlüsselstationen gemessen werden. Die Expedition war hauptsächlich von windigen Witterungsverhältnissen am Limit der Arbeitsbedingungen geprägt. In drei windigen Phasen musste abgewettert werden. Nur etwa 70 Prozent des geplanten Arbeitsprogramms konnte umgesetzt werden.

2. Participants

2.1 Principal Investigators

Name	Institution
Naumann, Michael, Dr. (Physical Oceanography)	IOW
Mohrholz, Volker, Dr. (Physical Oceanography)	IOW
Kuss, Joachim, Dr. (Marine Chemistry – nutrients)	IOW
Waniek, Joanna J., Prof. (Marine Chemistry)	IOW
Kremp, Anke, Dr. (Marine Biology – phytoplankton)	IOW
Dutz, Jörg, Dr. (Marine Biology – zooplankton)	IOW

2.2 Scientific Party

Name	Discipline	Institution
Naumann, Michael, Dr.	Physical Oceanography/chief scientist	IOW
Faber, Jens, Dr.	Physical Oceanography	IOW
Anschütz, Anna-Adriana, Dr.	Physical Oceanography	IOW
Sass, Martin	Marine Observations	IOW
Jeschek, Jenny	Marine Chemistry	IOW
Hand, Ines	Marine Chemistry	IOW
Kreuzer, Lars	Marine Chemistry	IOW
Radisch, Jonas	Marine Chemistry	IOW
Fechtel, Christin	Biological Oceanography	IOW
Benterbusch-Brockmöller, Heike (5.-8.02.)	Biological Oceanography	IOW
Kujat, Anna (5.-8.02.)	Biological Oceanography	IOW
Caiyi, Lu (8.-20.02.)	Marine Chemistry	IOW

2.3 Participating Institutions

IOW Leibniz Institute for Baltic Sea Research Warnemünde. Germany

3. Research Program

3.1 Description of the Work Area

The area under investigation of the cruise EMB359 covered the western to central Baltic from the Kiel Bight to the Northern Gotland Basin. An overview of the locations of CTD stations and the cruise track is given in Figure 3.1. A station list is given in Table 7.1.

The majority of stations is located along the thalweg transect of the Baltic Sea (stations: EMB359_14 to EMB359_80) describing the hydrographic, hydrochemical and biological conditions in all basins on the pathway of saltwater inflows from the North Atlantic (Fig. 5.15 to Fig. 5.19). These inflows are the solely source for ventilation of the deep basins (MATTHÄUS et al. 2008). During this cruise the transect was interrupted due to technical problems after station EMB359_72 at the Eastern Gotland Basin. In the second part of the cruise this data gap of about 80 nautical miles to the Gotland Deep could not be measured. Stations farther north are as well sparse because of strong northerly winds. The planned perpendicular transects in the Western and Eastern Gotland Basin of scanfish measurements for the understanding of small-scale processes on the basin wide dynamics were skipped as well.

3.2 Aims of the Cruise

The performed meteorological. hydrographic. hydrochemical and hydrobiological sampling and measurements lead to an assessment of the actual autumn situation of the Baltic Sea ecosystem from Kiel Bight to the Northern Gotland Basin. EMB359 is the first cruise in the year 2025 of five annually expeditions.

In the frame of the COMBINE Programme of the Helsinki Commission (HELCOM), national monitoring demands to evaluate the status of Germany's coastal regions in North and Baltic Sea (BMLP) are conducted as contract work for the Federal Maritime and Hydrographic Agency (BSH) in German territorial waters and the Exclusive Economic Zone as well as bordering sea areas of Denmark and Sweden in the western Baltic Sea. Due to scientific interests, analysing variations and trends of the Baltic ecosystem as a whole, the IOW extends the investigated sites by its long-term observation programme. Stations in Danish, Swedish, Polish and Latvian territorial waters and their respective Exclusive Economic Zones are continuously sampled within this programme since the year 1969. From the year 2024 onwards, once a year IOW's long-term data programme is extended the northernmost parts of the Bothnian Bay to focus on the spring stage, focus on hydrographic conditions after ice melt.

The acquired data are used for regular national and international assessments of the state of the Baltic Sea (e.g. HELCOM 2023. NAUMANN et al. 2024), are analysed in numerous publications and provide the scientific basis for measures to be taken for the protection of the ecosystem Baltic Sea.

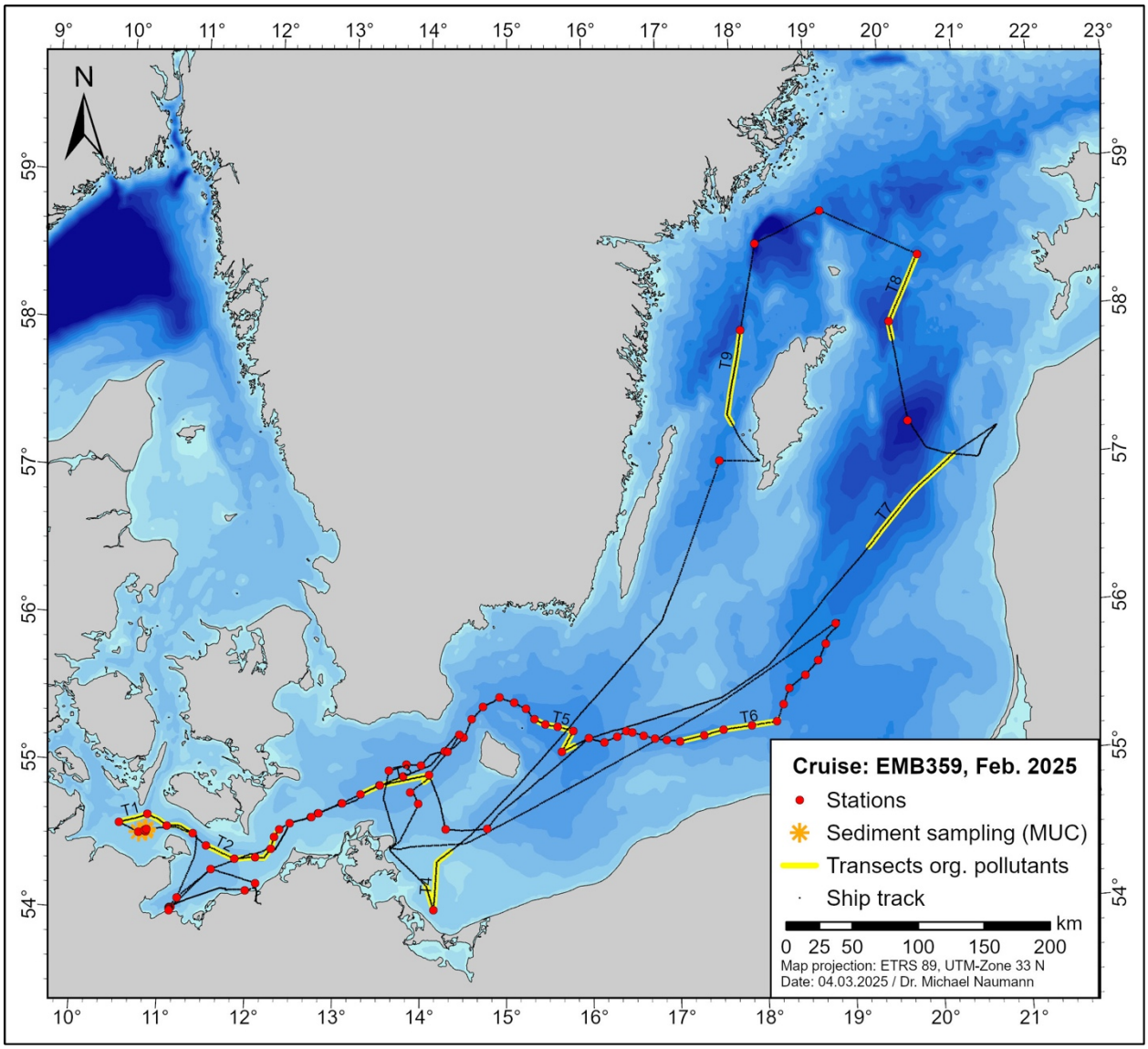


Fig. 3.1 Track chart of RV ELISABETH MANN BORGESE and map of stations of cruise EMB359 from 5. February – 19. February 2025. CTD stations are marked by red points, surface water transects for organic pollutants as yellow lines, sediment coring as orange asterisks and ship track as black line. The bathymetry basemap was interpolated as 200x200 m grid from the dataset SEIFERT et al. 2008).

3.3 Agenda of the Cruise

The work packages of the cruise were subsequently conducted. We started with the BSH environmental monitoring program in the western Baltic Sea and took first measurements and sampling at key stations of the Mecklenburg Bight, Lübeck Bight, Kiel Bight, Kadet Trench, Darss Sill, Arkona Basin and Oder Bank (February 5th – 8th, 18th). From February 8th onwards up to February 19th we continued with the IOW's Baltic Sea long-term observation program starting in the Arkona Basin to Bornholm Gatt and planned to turn anticlockwise around the isle of Gotland to follow the deepwater pathway of inflows through the central Basins. After a technical issue in the southern part of the Eastern Gotland Basin we were forced to move back to Sassnitz harbour. At February 12th we restarted our tour around Gotland. This time the strong winds from northerly direction forced us to turn first to the stations in the Western Gotland Basin. We restarted the thalweg transect from northern direction at station EMB359_80 at February 15th. An Argo float

was recovered at Pomeranian Bight at February 17th (station: EMB359_86). At the end of the cruise we measured a second CTD transect from the Bornholm Gatt to the Darss Sill and the key stations in the Arkona Basin, Darss Sill, Kadet Trench and Mecklenburg Bay a second time as repetitional sampling after more than a week as part of the national monitoring program (February 18th). Both programs consist mainly of CTD casts, water sampling for nutrient analysis, trace gas measurements and net sampling of phytoplankton and zooplankton, described below in detail.

The standard measurements

The work on the stations usually started with a CTD cast and programmed sampling during the down cast on standard depth levels for chemical and biological parameters. Manual releases in near-bottom waters and close to the sea surface completed the sampling. At key stations for example the Bornholm Deep, Gotland Deep and so on multiple CTD casts followed on demand to meet the additional water sample requirements. A detailed list of all CTD measurements are given in Table 7.1. At these key stations. water sampling was carried out for dissolved oxygen, basic dissolved inorganic nutrients, total nutrient concentrations, as well as net sampling for phytoplankton and zooplankton species were carried out. Moreover, determinations of chlorophyll and the depth of visibility by means of a Secci disk were also done. For the detailed list of sampling see Table 7.2.

Additional programme:

Long-term observation of the microbiological habitat of the redoxcline

Insights into the changes of the microbial food web of the redoxcline is obtained by well resolved sampling of the range of the redoxcline at Gotland Deep (TF0271) and Landsort Deep (TF0284) stations on each monitoring cruise. During this cruise TF0284 could not be sampled for reasons of permissions. 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. Klaus Jürgens).

Project MGF Ostsee – sediment sampling

At eight stations (EMB359_15 to EMB359_18) multicorer sediment cores of about 60 cm penetration depth into sea surface sediments were done in the Kiel Bight. They are analysed in the project: Exclusion of mobile bottom-contact fishimg in marine protected areasof the German EEZ of the Baltic Sea (Responsible scientist: Prof. Klaus Jürgens).

eDNA sampling

Sampling for building up an eDNA-archive of samples for analysis of metazoan and microorganisms. The water sampling was done at 11 stations in the western Baltic by Heike Benterbusch and Anna Kujat, supervised by Matthias Labrenz (IOW). Water samples were taken at the surface (2 l) and bottom (2 l) and filtered with mesh sizes of 0.45 µm Filter (Whatman). 0.45 µm filter from Sartorius and 0.2 µm (Isopore) and stored in Eppendorf safe-lock tubes and freeezed to -20 °C.

Sustainability and mitigation

The marine environment was less disturbed by performed scientific tasks during this cruise. No sampling in marine protected areas was done. Sensor measurements and water sampling in the water column for chemical and biological parameters were performed. Four sediment cores of 10 cm diameter and 60 cm penetration depth were taken in muddy sediments, with less changes at the sea floor habitat. No chemicals were released in the water column (e.g. tracer experiments), no devices were lost (marine trash) and no hydroacoustic measurements were performed (underwater noise).

Equipment

Data acquisition was carried out using the following devices and measuring platforms.

At stations and transects:

- CTD SBE 911+ with rosette water sampler (CTD)
- Multicorer (MUC)
- Phytoplankton net, 10 µm mesh size (PLA)
- Zooplankton Apstein net, 55 µm mesh size (APNET)
- Zooplankton net, 100 µm mesh size (WP2)
- Secci desk (SD)

Continuous measurements:

- Underway measurements of surface water properties
- Ship weather station

This ship based data set consists of one minute averages of: time (UTC), latitude and longitude, ships heading, depth, air pressure, wind direction, wind speed, air temperature, humidity, global radiation, infrared radiation, surface conductivity, surface salinity, surface water temperature, surface chlorophyll-a fluorescence, surface turbidity.

CTD sensors - configuration and calibration:

- SBE911plus/917plus
- Temperatures sensor 1: sonsor ID 55, serial number 4525, calibration date 17.12.2024
- Temperatures sensor 2: sonsor ID 55, serial number 6038, calibration date 17.12.2024
- Conductivity sensor 1: sonsor ID 3, serial number 3724, calibration date 17.12.2024
- Conductivity sensor 2: sonsor ID 3, serial number 4447, calibration date 17.12.2024
- Pressure sensor: sonsor ID 45, serial number 1385, calibration date 02.05.2019
- Oxygen sensor 1: sonsor ID 38, serial number 1741, calibration date 02.10.2024
- Oxygen sensor 2: sonsor ID 38, serial number 0157, calibration date 12.10.2024
- PAR Biospherical Licor Chelsea sensor: sonsor ID 42, serial number PAR_70256, uncalibrated
- Altimeter sensor: sonsor ID 0, serial number 10, uncalibrated
- FluoroWetlabECO AFL FL sensor: sonsor ID 20, serial number FL_22029_5V, uncalibrated
- TurbidityMeter sensor: sonsor ID 67, serial number NTU_2029_5V, uncalibrated
- SPAR sensor: sonsor ID 51, serial number 6307, calibration date 27.02.2017
- Rossette water sampler: 13x HYDRO-BIOS FreeFlow bottles, sampling at the downcast

4. Narrative of the Cruise

This paragraph is aimed to give an impression of the work on board during the campaign. It is a day by day report that includes the weather conditions and sea state. All times are given in UTC.

Tuesday, 4th February 2025: Loading and transport of equipment started at 06:00. Depacking was finished around 10:30 and all devices and laboratories were prepared at 15:30.

Day 1, Wednesday, 5th February 2025: Mecklenburg Bight – Lübeck Bight - Fehmarnbelt
Embarking of the scientific crew was done between 07:00, followed by safety instructions 07:00 to 07:30 and a first scientific meeting. Departure of the peer Rostock-Marienehe and start of the cruise was in time at 08:00 (9 Local). At 08:45 we passed the Warnow rivermouth and started at 09:15 the station work at TF005 two nautical miles northerly of Warnemünde. The weather situation in the Mecklenburg Bay was 3.7 °C air temperature, 1031 hPa air pressure, 90 % humidity, cloudy and nortnorthwesterly wind of 322°, 11-12 m/s (6 Bft) with a sea state of 0.5 m to 0.75 m swell. The sea surface temperature was around 4.2 °C and surface salinity of 8.9 g/kg. It followed a northwestward directed routeing for measurements at the key station TF0012 in the Mecklenburg Bay (12:00). During the late afternoon a CTD transect from North to South was measured at the Telemetry array in front of the cliff section at the northwestern coastline of Boltenhagen (17:00-18:30). The weather situation at Lübeck Bight (17:30) was 5.9 °C air temperature, slightly increased air pressure of 1036 hPa, decreased humidity to 79 %. A surface water temperature of 4.2 °C and salinity of 17.2 g/kg was measured by the ships fery box system. The wind decreased to 7.5 m/s (4 Bft) from 357 ° (North) and swell conditions were calm with 0.3-0.5 m. At 19:00 the key station TF0022 of the Lübeck Bight was measured. Afterwards we turned northwards to the Fehmarnbelt. At station TF0010 transect T1 of filtered surface water for analysis of organic pollutants was started (22:30).

Day 2, Thursday, 6th February 2025: Kiel Bight – Mecklenburg Bight – Kadet Trench
After midnight we reached the the stations in the Kiel Bight (TF0014, TF360). The key station Kiel Bight – TF0360 was measured and sampled for chemical parameters, phytoplankton and benthic fauna between 03:30 to 04:30. The surface water sampling transect T1 ended at this position. Later, from 06:30 onwards to 10:00 we sampled four stations in the west of Fehmarn by CTD and surface sediments up to 60 cm depth by multicorer cores for the BMBF project “MGF Ostsee”, before we went back to the Fehmarnbelt. Station TF0010 was measured by CTD and sampled for eDNA and PFAS (11:30). Afterwards we went eastwards. At Mecklenburg Bight the weather conditions stayed calm (12:30) with sunshine, air pressure of 1043 hPa, air temperature of 3 °C and 93 % humidity. The sea surface temperature showed 4.5 °C and surface salinity of 10.9 g/kg. Light winds of 2.5 m/s (2 Bft) blew from northnortheastern direction (24°) with a calm sea state of 0.3 m swell. The stations TF0013 and TF0017 were measured by CTD during the afternoon. Station TF0013 was the start of surface water filtering transect T2 – Mecklenburg Bight, which was done up to station TF0001. At 16:00 we reached the stations at the Kadet Trench and TF0041, key station TF0046 (sampling of several chemical, biological parameters), TF0083 and TF0033 were measured by CTD up to 20:00. At 20:30 we reached the Darss Sill and measured the stations TF0002, TF0001 and TF0030 (biological sampling) up to midnight. Next Station TF0001 is the position of the autonomous platform MARNET Darss Sill where we did a reference CTD

and dissolved oxygen samples for quality management of these platform, where sensor packages are mounted in seven discrete depths.

Day 3, Friday, 7th February 2025: Arkona Basin – Sassnitz harbour

We moved farther eastwards to the Arkona Basin and sampled during the night and early morning hours the stations TF0115, TF0114 (both nutrient parameters) and key station TF0113 (chemical and biological parameters). At 07:00 we reached key station TF0109 (chemical and biological parameters) at the southeastern slope of the Arkona Basin and then we turned southwestwards, reaching the MARNET aoutonomous platform "AB Boje" at 09:30. We did again CTD measurements and dissolved oxygen sampling for quality management of the sensor packages of the platform. A next surface water filtering transect (T3 – Arkona Basin) was done from station TF0115 to AB Boje. The weather conditions at 10:00 were cloudy, air temperature 4.7 °C, air pressure of 1040 hPa, 81 % humidity, 5.4 °C sea surface temperature, salinity of 8.0 g/kg, 10-11.6 m/s wind (5-6 Bft) from NO (60°) and a sea state of 0.5-1 m swell. Increasing easterly winds up to 7 Bft were forecasted for late afternoon up to Saturday. Originally it was planned to measure the Oder Bank station and then transit to Sassnitz harbor for personal exchange, quick delivery of the sediment cores and PFAS samples at Saturday lunchtime. The increasing wind and swell forecast led to the decision to skip the Oder Bank area and leaving directly to Sassnitz harbor.
On the transit to Sassnitz we sampled TF0112 at the southern slope of the Arkona Basin at 10:20 to 11:30. Afterwards we stopped the scientific programme and reached Sassnitz harbor at 14:30 to stay there overnight "waiting on weather". Last filtering and measuring of samples were done in the harbor.

Day 4, Saturday, 8th February 2025: Arkona Basin – Bornholm basin

Exchange of scientific crew at 12:00: H. Benterbusch-Brockmöller and A. Kujat left like planned and C. Lu came onboard for taking the water samples for trace gas analysis in the central basins as well as for reasons of sea going training. The multicorer sediment cores from the stations Bio FB1 to FB 4 as well as the water samples for PFAS analysis were taken from board.
Departure of Saßnitz harbour /Rügen island at 13:00 with routeing northwards back to the Arkona Basin. We had to delay the Oder Bank sampling up to the end of the cruise, that we spare some time. The goal was to sample the stations along the thalweg transect (Fig. 5.15 to 5.19) from the Bornholm Gat to the central Bornholm Basin relatively quickly, because Sunday evening the next strong wind phase was forecasted to hit the Bornholm Basin. The weather situation in the central Baltic was forecasted as relatively calm for the next 3-4 days. The plan was to reach this area as early as possible. The weather conditions at Arkona Basin (17:15): air temperature 3.0 °C, air pressure of 1032 hPa, 76 % humidity, 4.9 °C sea surface temperature, salinity of 8.3 g/kg, 10-11.3 m/s wind (5-6 Bft) from eastsoutheastern direction (109°) and a sea state of 1 m swell. At 17:00 we reached station TF0105 in the centre of the Arkona Basin in Swedish waters, measuring a CTD cast and water sampling of nutrient parameters. Statios TF0104 and TF103 followed. At 21:20 we reached the Bornholm Gat and measured the stations TF0145DK up to TF0140 in Danish waters up to midnight. At 22:00 the wind decreased slightly to 8.3 m/s (5 Bft) and turned southeastwards (150°). It formed intersecting sea around the northern part of Bornholm island and the ship was swinging awfully.

Day 5, Sunday, 9th February 2025: Bornholm basin – Slupsk Channel

During the morning hours we measured and sampled the western part of the Bornholm Basin. In the centre, the bottom water below 80 m was oxic and no hydrogen sulphide was found (stations TF0200, TF0214). The weather conditions at the central Bornholm Basin were at 11:30: cloudy, air temperature 2.0 °C, air pressure of 1035 hPa, 78 % humidity, 4.5 °C sea surface temperature, 8.6 m/s wind (5 Bft) from northeastern direction (65°) and a sea state of 1 m swell. The key station TF0213 – Bornholm Deep was reached at 13:00 for three CTD casts and intense sampling of nutrients and phytoplankton. Multiple net sampling was done in three different mesh sizes for sampling of zooplankton. Sampling was finished at 16:00 and we continued in eastward direction the thalweg transect of dense CTD measurements. At 19:00 we crossed the Slupsk Sill (station TF226) and measured TF0229 in the central Slupsk Channel close to midnight. Oxic bottom water of 110 µmol/l was found. The wind increased to 6 Bft and formed a swell of 1.5 m.

Day 6, Monday, 10th February 2025: Slupsk Channel – Eastern Gotland basin

After midnight we reached the key station of the Slupsk Channel - TF0222 a did CTD measurements and nutrient sampling. Stations TF0266, TF0267, TF0268, TF0256 followed in eastward direction. Then we left the Slupsk Channel and turned northeastwards reaching the southern part of the Eastern Gotland Basin. At 06:20 we measured TF0257 and later key station TF0259 at 07:30. The weather conditions at the southern Eastern Gotland Basin were at 11:30: cloudy, air temperature -0.5 °C, air pressure of 1040 hPa, 79 % humidity, 5.4 °C sea surface temperature, salinity of 7.6 g/kg, 8.3 m/s wind (5 Bft) from northeastern direction (64°) and a sea state of 0.75 m swell. At 12:40 we reached station TF0258 (93 m water depth) and the near bottom water was sampled for hydrogen sulphide, but it not appeared. Next stations in northeastern direction followed and at TF0265 the lowermost two meters showed inflowing water masses of slightly increased salinity and dissolved oxygen concentrations compared to anoxic water on top. The surface waters of the latest stations showed mixing and were homogenous up to 55 m water depth. At 15:00 both redundant navigation systems failed at the bridge. We stayed on position to fix this problem. Our location was in Swedish waters in the five nations corner Latvia, Lithuania, Russia, Poland, Sweden. We continued our route at 15:30, before at 16:15 a next fail of the navigation system occurred. We had to quit our work and leaving this area with transit to Rostock. Later on, a maintenance service was ordered to Sassnitz and we changed the routing. Navigation was done traditionally by GPS-positioning, compass and drawing our positions every 30 min into analog maps. The AIS system was working and we kept clear from major shipping routes.

Day 7, Tuesday, 11th February 2025: Bornholm Basin – Sassnitz harbour

The transit to Sassnitz harbour was continued. The weather in the Pommeranian Bight /Oder Bank at 11:45 was sunny, air pressure of 1034 hPa, air temperature of 1.5 °C and 71 % humidity. The sea surface temperature showed 4.0 °C and surface salinity of 7.9 g/kg. Strong winds from abaft of 11.4 m/s (6 Bft) blew from eastern direction (90°) with sea state of 1 m swell. At 14:45 we reached the harbour of Saßnitz and a service company came at 15:30 to repair the navigation system. Two hardware systems were exchanged up to 22:45.

Day 8, Wednesday, 12th February 2025: Sassnitz harbour – Oder Bank – Bornholm Basin
During the morning reinstallation of maps and system checks were finished. At 07:00 options for the scientific goals of the remaining eight cruise days were discussed, weather checked. We missed the calm weather phase in the central Baltic and easterly winds should turn to north with a high wind front forecasted for Thursday. We decided to finish the programme in the western Baltic Sea at the Oder Bank and then heading northwards to the Western Gotland Basin, that we have options to stay in the cover if the forecasted front hits us.
At 08:30 we left Sassnitz harbour and reached position TF0160 at the Oder Bank at 11:15 to start the surface water filtering transect T4 for organic pollutants. The weather conditions at the Oder Bank were at 09:00: cloudy, air temperature -4.0 °C, air pressure of 1027 hPa, 83 % humidity, 3.2 °C sea surface temperature, salinity of 7.8 g/kg, 8.3 m/s wind (5 Bft) from eastsoutheastern direction (106°) and a sea state of 0.75 m swell. The autonomous MARNET station OBBoje was measured at 12:45 and water sampling for nutrients and PFAS pollutants was done as well as a CTD validation. Afterwards we headed northeastwards to cross the Bornholm Basin.

Day 9, Thursday 13th February 2025: Western Gotland Basin
During the night we crossed the Bornholm Basin heading northwards into the Western Gotland Basin. Cloudy weather with Wind of 5-6 Bft occurred, forming a swell of 1-1.5 m. At 14:35 we reached the key station Karlsö Deep (TF0245) measuring a CTD with sampling of nutrient parameters as well as CTD Validation. The weather in the southern part of the Western Gotland Basin at 14:45 was cloudy to slightly rain, air pressure of 1022 hPa, air temperature of 0.9 °C and 86 % humidity. The sea surface temperature showed 3.8 °C and surface salinity of 7.2 g/kg. Medium winds of 7.1 m/s (4 Bft) blew from northern direction (5°) with sea state of 0.75-1 m swell. This was a short phase of lowered wind and to 15:10 it increased again to 10-12 m/s. A front of 7 Bft (up to 17 m/s) and swell up to 1.8 m passing us during the night was forecasted. After the station work we turned eastwards in the cover of the western coast of Gotland. We stayed anchored waiting on weather from 17:15 onwards.

Day 10, Friday, 14th February 2025: Western Gotland Basin
We stayed anchored up to 07:30 and we left in northern direction to the next station at the centre of the Western Gotland Basin. The weather at 11:45 reaching open water conditions are as follows: -0.8 °C air temperature, 1025 hPa air pressure and 67 % humidity, sunny to cloudy, 3.9 °C sea surface temperature and a salinity of 7.1 g/kg. The wind conditions were 12-13 m/s (6 Bft) from northnorthwestern direction (340°) with a sea state from last night's storm of 1.5 m. The intended plan of stations in the Western, Northern and Eastern Gotland Basin had to be reduced a lot, because we lost three days of shiptime by technical issues and now again a half day by "waiting on weather". The next strong winds from northern direction will arrive on Saturday afternoon. The adapted plan is with a reduced number of station and focus on key stations in these three basins to be at Gotland Deep at Saturday afternoon, before the next stronger occur. We reached out first station TF0240 at 14:50 and measured CTD, taking water samples for nutrients and hydrogen sulphide. Next station in northern direction was TF284 – the Landsort Deep of 460 m water depth, taking four CTD casts and several water samples from 19:10 to 22:00. The weather conditions at the Landsort Deep were at 19:10: air temperature -1.5 °C, air pressure of 1024 hPa, 68 % humidity, 3.9 °C sea surface temperature, salinity of 6.7 g/kg, 6.3 m/s wind speed (4 Bft) from

northnorthwestern direction (343°) and a sea state of 1 m swell. We continued in eastern direction reaching the Northern Gotland Basin around midnight.

Day 11, Saturday, 15th February 2025: Northern Gotland Basin – Eastern Gotland Basin
Station work at TF0283 – the northernmost station of this cruise began at 00:40. One CTD cast for sampling of hydrogen sulphide was done. Next station was TF0285 in southeastern direction. At 09:00 we reached the key station Farö Deep of 190 m water depth, the southern part of the Northern Gotland Basin. We took two CTD casts for water sampling of nutrients, hydrogen sulphide and trace gases. The surface water was well mixed up to 33 m and the halocline depth was in 60 m. The bottom near water of the lowest five meters showed signs of inflowing water. The salinity increased there of around 0.25 g/kg and a temperature increase of as well 0.25 °C was detected. At the Farö Deep the weather conditions were at 09:45: sunny, air temperature of -0.8 °C, air pressure of 1019 hPa and 51 % humidity. The sea surface temperature showed 4.5 °C and surface salinity of 7.2 g/kg. Moderate winds of 5.8 m/s (4 Bft) blew from northnorthwestern direction (336°) with sea state of 0.5-0.75 m swell. Afterwards we left this area heading southwards to the Eastern Gotland Basin around 10:00. The regular stations in the northern part of the Eastern Gotland Basin had to be skipped because of timely reasons. Before the next strong wind phase will hit us around 18:00, we want to finish the measurements and sampling at the key station Gotland Deep (TF0271). The weather conditions in the Eastern Gotland Basin were at 14:00: snowy to cloudy, air temperature -1.5 °C, air pressure of 1019 hPa, 75 % humidity, 5.0 °C sea surface temperature, salinity of 7.5 g/kg, 11-12.5 m/s wind speed (6 Bft) from northwestern direction (300°) and a sea state of 0.75 m to 1 m swell. At 14:15 we reached the Gotland Deep sampling the station with a reduced programme of four optimized CTD casts, where the water sampling depths and amount of water for several parameters were carefully selected. Normally it would have been planned seven casts. In Addition, net sampling for phytoplankton and a surface water filtering for organic pollutants were done. The six hours of in-situ pump filtering in the deep-water was skipped, as well as the intended six hours of microstructure CTD measurements. We finished the work at 17:10 and didn't continue southwards. The strong winds from the north arrived and we left eastwards to the Latvian coast, where wind strength and wave heights were forecasted on a lower level. The night we were waiting on weather close to the coast.

Day 12, Sunday, 16th February 2025: Eastern Gotland Basin – Bornholm Basin
We left this shadow at 02:00 in the morning, we turned southwestwards. A transect of surface water filtering was started at 03:00 at the eastern slope of the Eastern Gotland Basin. The finish was planned at TF0260, where we measure and sample to close the data gap at the thalweg transect between TF0265 in the southern part and TF0271 in the centre. At 03:30 our newly installed navigation systems failed again. Several trials of restarts failed and we had to quit the planned stationary work at TF0260 and other stations along the transect. The next wind phase was coming from northern direction and we left in southwestern direction. At the southern part of the Eastern Gotland Basin the weather conditions were at 11:45: sunny, air temperature of -1.4 °C, air pressure of 1024 hPa and 61 % humidity. The sea surface temperature showed 4.6 °C and surface salinity of 7.5 g/kg. Moderate winds of 10.5 m/s (5 Bft) blew from northnorthwestern direction (340°) forming a sea state of 1.5 m swell. In the afternoon used for scientific exchange. Anna Anschütz gave a talk about climate change and ocean acidification in the Baltic Sea, showing her latest

interdisciplinary model results (project RETAKE). Afterwards it resulted in a fruitful long discussion of multiple topics like geology, society aspects, geoengineering and some more. At 20:30 we crossed the Slupsk Sill and reached the Bornholm Basin. At the Slupsk Sill the weather conditions were: air temperature of -0.6 °C, air pressure of 1024 hPa and 45 % humidity. The sea surface temperature showed 4.5 °C and surface salinity of 7.8 g/kg. Strong winds of 11-12.5 m/s (6 Bft) blew from northwestern direction (300°) with sea state of 1.5 m swell.

Day 13, Monday, 17th February 2025: Bornholm Basin – Pomeranian Bight – Arkona Basin
At midnight we reached the Bornholm Deep (TF0213) again and did repetition measurements and sampling to compare the environmental changes within a week. Afterwards we headed southwestwards to the Pomeranian Bight to recover a BGC ArgoFloat with low batteries in the south of Bornholm island. The weather conditions in the Pomeranian Bight were at 09:00: sunny, air temperature -0.6 °C, air pressure of 1026 hPa, 62 % humidity, 4.8 °C sea surface temperature, salinity of 8.0 g/kg, 10 m/s wind speed (5 Bft) from northwestern direction (290°) and a sea state of 0.75 m swell. The drifting ArgoFloat was found at 09:25 and brought safely on deck with the dinghy at 10:00. Afterwards station TF0112 at the Adlergrund in the south of the Arkona Basin was measured by CTD (12:00). Out task to pick up a cardinal buoy of the MARNET Arkona Basin II platform in the harbour of Rönne /Bornholm was cancelled, because it was not found in the storage of the local maritime authority. The buoy was driftet away from the autonomous platform and stranded at the coastline of Bornholm after a storm at the beginning of the year.
We headed northwards to the Arkona Basin /Bornholm Gat. At the southeastern part of the Arkona Basin the weather conditions were at 15:00: sunny, air temperature of 0.5 °C, air pressure of 1025 hPa and 69 % humidity. The sea surface temperature showed 4.3 °C and surface salinity of 8.0 g/kg. The wind conditions had increased during the afternoon to 13-14 m/s (6-7 Bft) and blew from northwestern direction (320°) forming a sea state of 1-1.5 m swell.
The plan was to measure a second CTD transect from the Bornholm Gatt to the Darss Sill comparing the changes of hydrographic conditions to the beginning of the cruise. The stations TF0109, TF0145, TF0144 and TF0122 were measured. Close to midnight we reached the key station of the Arkona Basin TF0113 for repeated water sampling (biology).

Day 14, Tuesday, 18th February 2025: Darss Sill – Mecklenburg Bight
The CTD transect was continued, measuring the stations TF0114, TF0115, TF0030, TF0001 and TF0002 up to 08:00. Afterwards we did two stations for repetition of biological sampling at the Kadet Trench (TF0046) and in the Mecklenburg Bight (TF0012). The weather conditions at the Kadet Trench were at 10:15: cloudy, air temperature 0.3 °C, air pressure of 1030 hPa, 82 % humidity, 3.9 °C sea surface temperature, salinity of 9.1 g/kg, 6.3 m/s wind speed (4 Bft) from northwestern direction (310°) and a sea state of 0.5 m swell. During the late evening we repeated the CTD transect from North to South at the Telemetry array at the northwestern coastline of Boltenhagen (17:30-20:10) to have a second dataset for validation of the moored sensors. Afterwards cleaning and deinstallation of instruments started in the laboratories on our transit to Rostock harbour.

Day 15, Wednesday, 19th February 2025: Mecklenburg Bight – Rostock harbour

At 06:00 we measured our last CTD station of the cruise at NH-Boje for validation of moored sensors. A new permanent mooring of our IOW research group "S2B - Shallow water processes and transitions to the Baltic Sea" was deployed in 10 m water depth in January 2025. It is integrated in the Nienhagen platform "Digital Ocean Lab" (Ocean Technology Campus Rostock /Fraunhofer). Afterwards we had a short transit to the harbor Rostock-Marienehe (08:00). In the time frame 08:00 to 11:30 deinstallation, unloading of scientific equipment and disembarking of scientific crew was done. End of cruise EMB328 at 11:30. Later on, equipment was depacked and stored in the institute in Warnemünde and IOW storage at Marienehe up to 14:30 UTC.

5. Preliminary Results

The results presented in the following section are preliminary and not comprehensive, since they are based in most cases on unevaluated raw data. CTD data is quality checked and validated within two weeks after the cruise. The aim of this section is to give a first impression on the collected data set. An advanced data analysis will be integrated follow after all validated data sets are available.

5.1 Meteorological Conditions

The weather conditions during the cruise were generally between appropriate and the upper working limit. Time gaps of "waiting on weather" occurred at February 14th – 15th (14 hours) at the western coast of Gotland and at February 15th – 16th (9 hours) at the Latvian coast in the Eastern Gotland Basin. At February 7th we went a bit earlier into Sassnitz harbor for personal exchange due to increasing wind. We had a second stop at Sassnitz harbour from Frebuary 11th – 12th for maintenance of our navigation systems.

In chapter 4 are daily notes of the conditions described once or two times a day in the different subregions of the ship track.

The wind conditions are shown in figure 5.1 with a stick plot for an overview of the development windspeed and wind direction as well as a colour bar of the windspeed. Southeastern wind directions dominated (mean: 163° SSE) and wind strength was mostly below 7 Bft (Fig. 5.1 – blueish, greenish and yellow colours) with a mean windspeed of 8.7 m/s; 5 Bft). Only 6 hours of 7 Bft occurred in the Western Gotland Basin at February 13th – 14th and led to "waiting on weather".

The air temperature ranged between -4.4 °C at the Pomeranian Bight to 6 °C at the beginning, in the area Mecklenburg Bight (Fig. 5.2). The mean air temperature during the cruise was about 0.7 °C and the graph shows no larger fluctuations during the cruise.

Air pressure varied from 1017.5 hPa (February 15th) to 1043.9 hPa (February 6th) and the cruise was generally under high pressure conditions with a mean of 1029.5 (Fig. 5.3). The humidity was generally high with in mean 75.4 % and ranged between 42-100 % (Fig. 5.4).

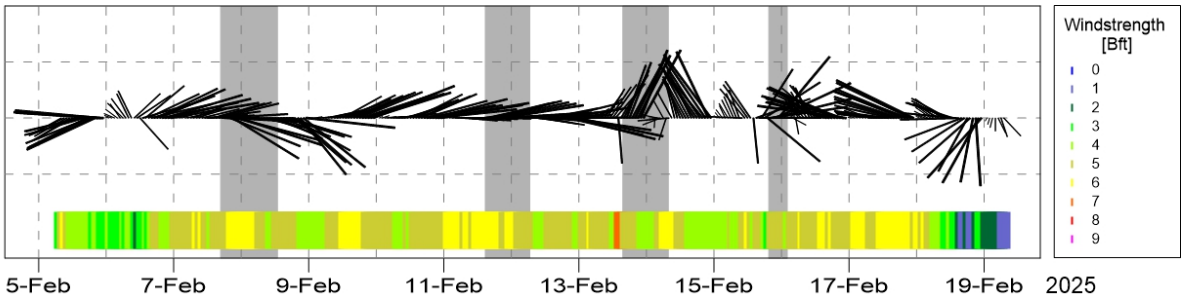


Fig. 5.1 Stick plot of wind vector measured by the ship weather station of RV ELISABETH MANN BORGESE (hourly mean values). The grey shaded areas indicate periods when the ship was in the harbour of Sassnitz or "waiting on weather".

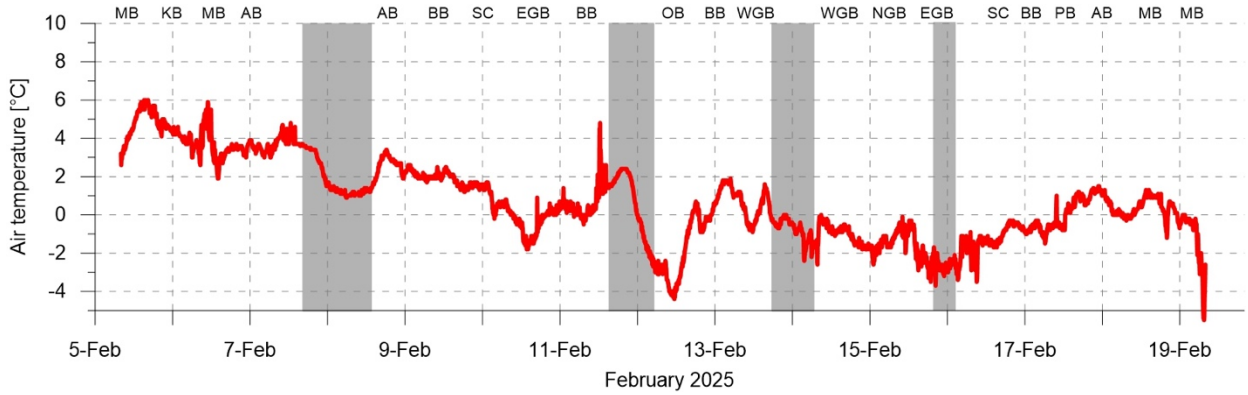


Fig. 5.2 Air temperature measured by the ship weather station of RV ELISABETH MANN BORGESE (5 min spot values). The grey shaded areas indicate periods when the ship was in the harbour of Sassnitz or "waiting on weather". Abbreviations for the main sea area of each day are marked on top (KB – Kiel Bight, MB – Mecklenburg Bight, AB – Arkona Basin, OB – Oder Bank, PB – Pomeranian Bight, BB – Bornholm Basin, SC – Slupsk Channel, EGB – Eastern Gotland Basin, NGB – Northern Gotland Basin, WGB – Western Gotland Basin).

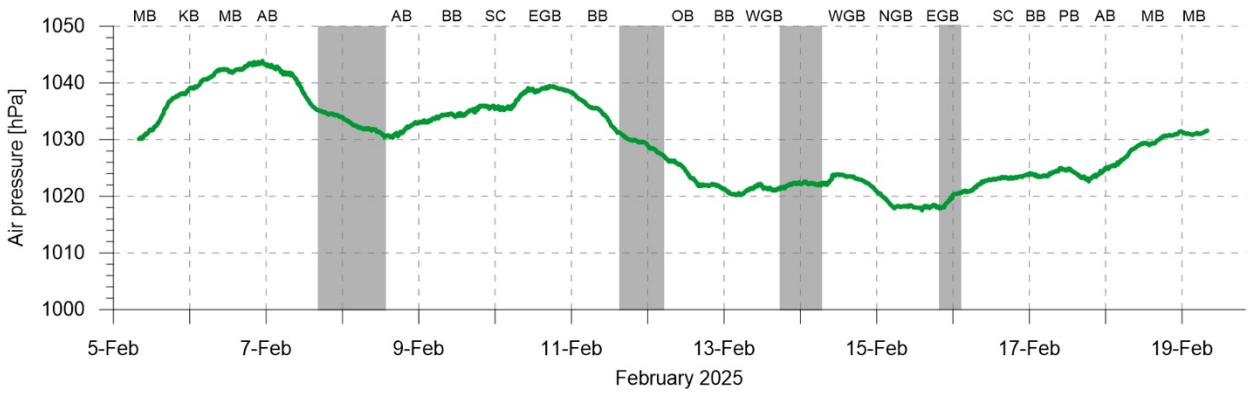


Fig. 5.3 Air pressure measured by the ship weather station of RV ELISABETH MANN BORGESE (5 min spot values). The grey shaded areas indicate periods when the ship was in the harbour of Sassnitz or "waiting on weather". Abbreviations for the main sea area of each day are marked on top.

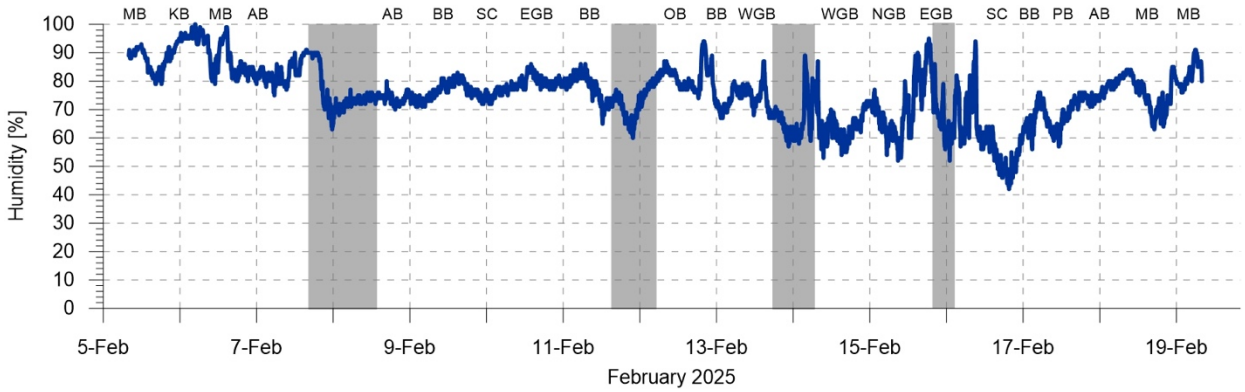


Fig. 5.4 Air humidity measured by the ship weather station of RV ELISABETH MANN BORGESE (5 min spot values). The grey shaded areas indicate periods when the ship was in the harbour of Sassnitz or "waiting on weather". Abbreviations for the main sea area of each day are marked on top.

5.2 Properties of Surface Waters

Sea surface temperature, salinity, chlorophyll-a fluorescence and turbidity distributions in the investigation area were compiled from data gathered with the Surface water Monitoring Box (JSMB). The distributions shown in Fig. 5.5 to Fig. 5.12 are based on unvalidated data.

The sea surface temperatures (SST) ranged during this February cruise between 2.0-5.5 °C. At the beginning of the cruise the western Baltic showed SST values 3.6 °C in the Kiel Bight, 4.4 °C in the Mecklenburg Bight and 4.1 °C in the Arkona Basin (Table 5.1), which is 1.5-2 K above the climatological mean (1900-2005) for this region. The southern and central Baltic showed SST values in the same magnitude with 4.2. °C at the Bornholm Deep, 3.3 °C at the Landsort Deep and 4.4 °C at the Gotland Deep. In comparison, the climatological means (1900-2005) at these key stations are as well much lower with 2.5 °C (Bornholm Deep), 1.5 °C (Landsort Deep) and 2.3 °C (Gotland Deep). To the end of the cruise the SST values in the Western Baltic cooled down to 2-4 °C (Fig. 5.7). The Warnow rivermouth showed slight icing of 2-5 cm thickness due to a cold spell at the mainland in the meantime.

The surface salinity (SSS) depicted its maximum of 15.5 g/kg (February 5th) in the Kiel Bight and Belt Sea west of Fehmarn in the transition zone to the North Sea. In the Mecklenburg Bight the SSS values decreased from the western part of the Lübeck Bight (16.4 g/kg) to 9.2 g/kg at the center (key station TF0012) and to 8.5 g/kg at the Darss Sill at the eastern boundary (Table 5.1). The measured values are below the climatological SSS mean values (1900-2005) of 17.02 g/kg at Kiel Bight and 14.28 g/kg Mecklenburg Bight. In the central Baltic the SSS values stayed below 8 g/kg (Fig. 5.6, Fig. 5.8). The lowest value of the cruise track was measured at the Landsort Deep with 6.6 g/kg, which is slightly below the climatological mean of 6.94 g/kg. The SSS at the Farö Deep (7.2 g/kg) and Gotland Deep (7,49 g/kg) is in the range of the long-term means. At the end of the cruise the maximum salinity decreased to 12 g/kg in the Mecklenburg Bight.

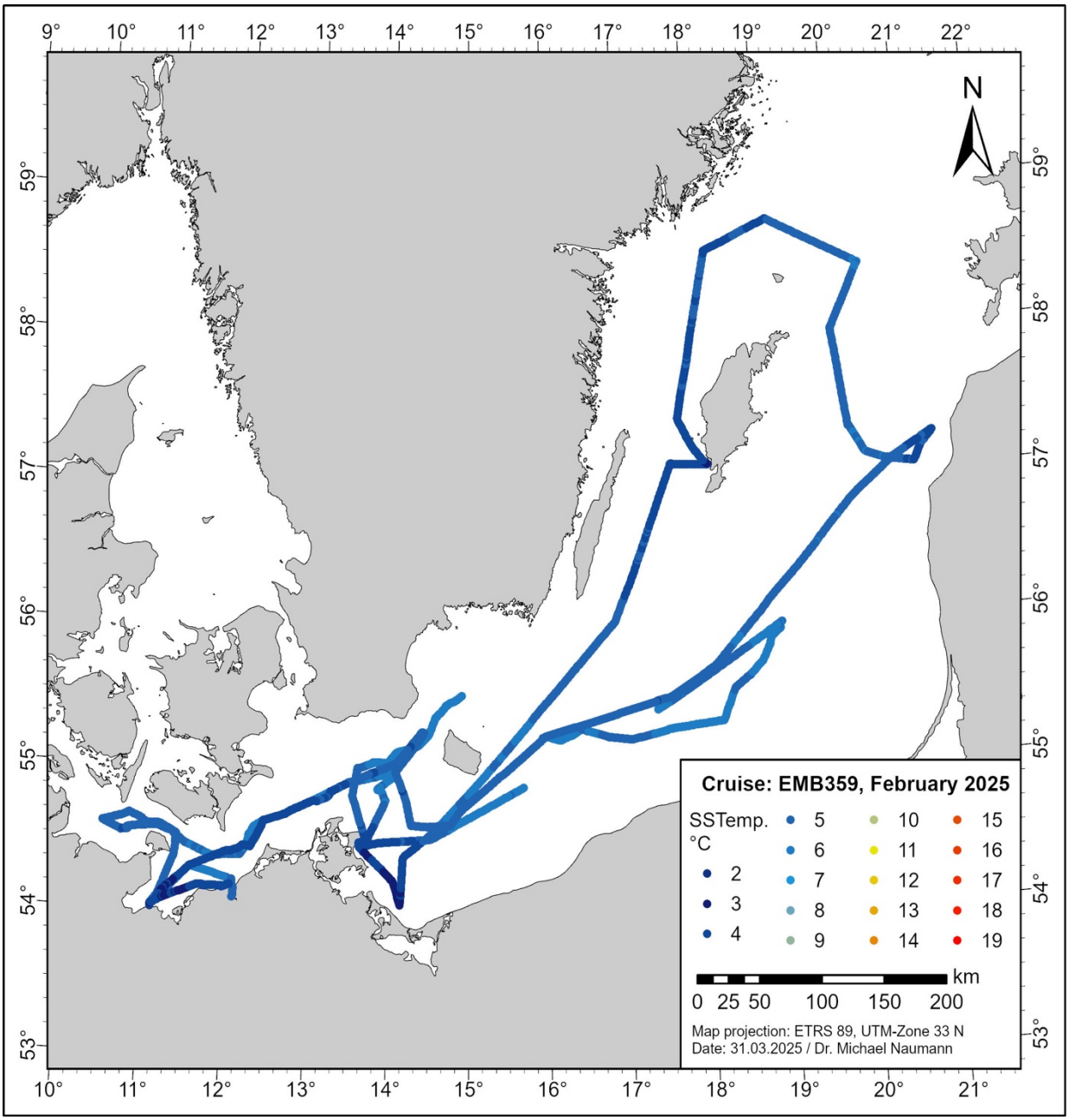


Fig. 5.5 Sea surface temperature distribution along the cruise track of EMB359 measured with the ship thermosalinograph (5 min spot values).

The surface distribution of chlorophyll-a fluorescence and turbidity depicts a sensory information about the biological activity of plankton in the surface water (Fig. 5.9. Fig. 5.10. Fig. 5.11. Fig. 5.12) despite our water sampling at key stations and extensive time-consuming laboratory analysis. The fluorescence sensor shows values between 0.1-0.9 along the cruise track. These generally low values are typical for low plankton activity during the winter season. The spring bloom have not started yet.

The surface turbidity distribution was as well generally low along the cruise track ranging from 0.2-3 ntu with some short peaks up to 20-39 ntu (Fig. 5.10, Fig. 5.12). The mean value was 1.3 ntu. A phase of values between 5-10 ntu occurred at February 12th at the Oder Bank, caused by easterly winds and resuspension of sea floor sediments in this region of shallow water depths (Fig. 5.10).

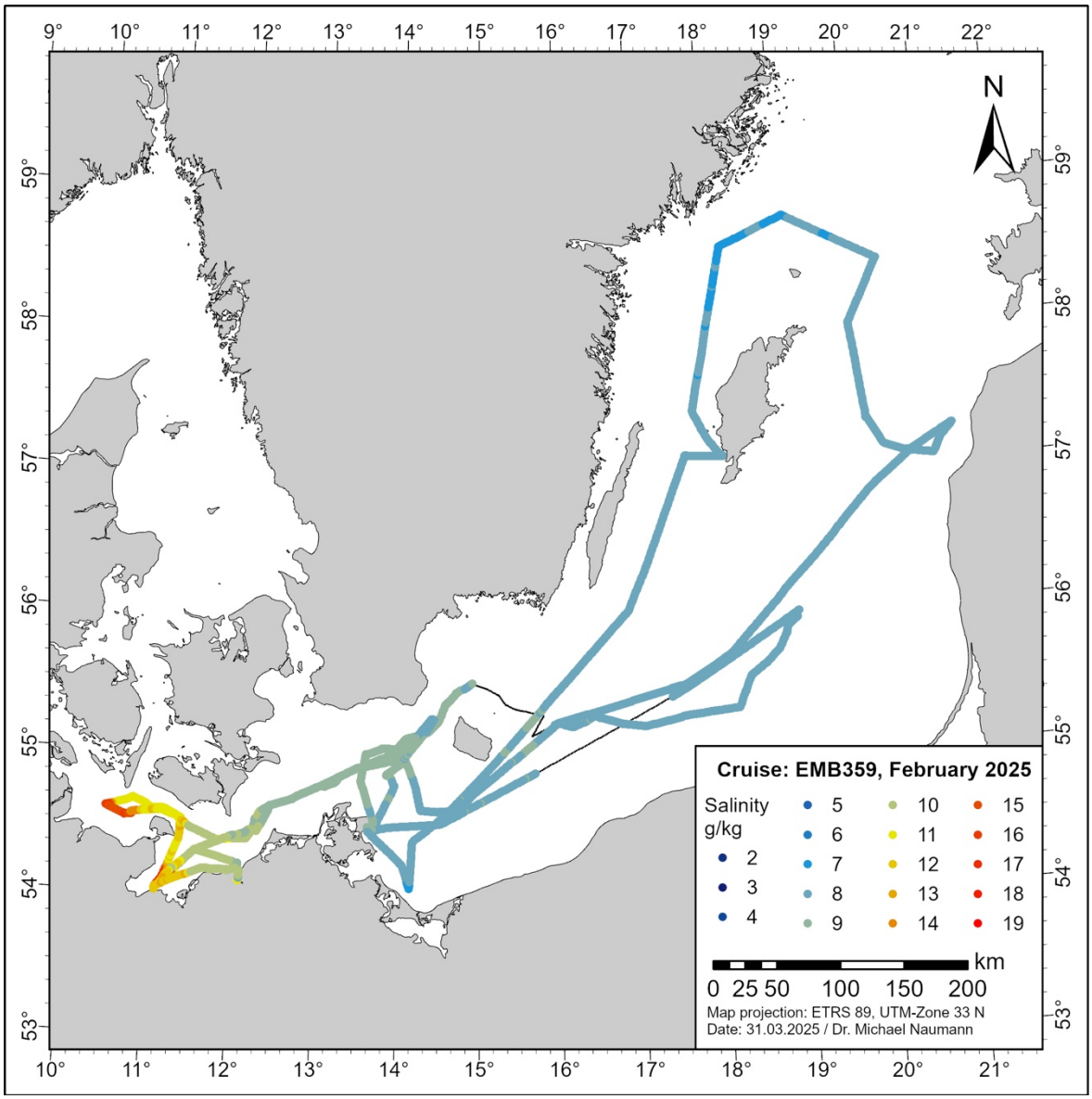


Fig. 5.6 Surface salinity distribution along the cruise track of EMB359 measured with the ship thermosalinograph (5 min spot values).

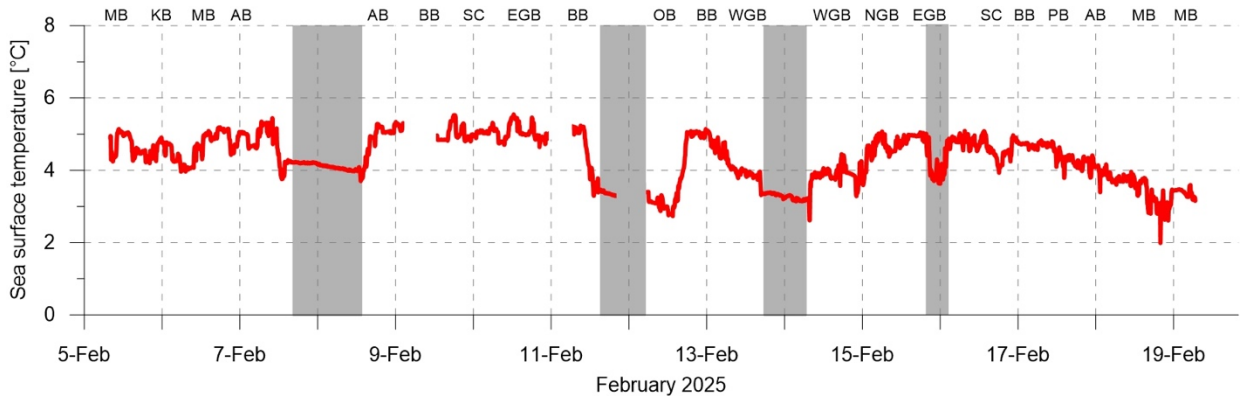


Fig. 5.7 Surface temperature measured with the ship thermosalinograph of RV ELISABETH MANN BORGESE (5 min spot values). The grey shaded area indicate periods when the ship was in the harbour of Sassnitz or “waiting on weather”. Abbreviations for the main sea area of each day are marked on top.

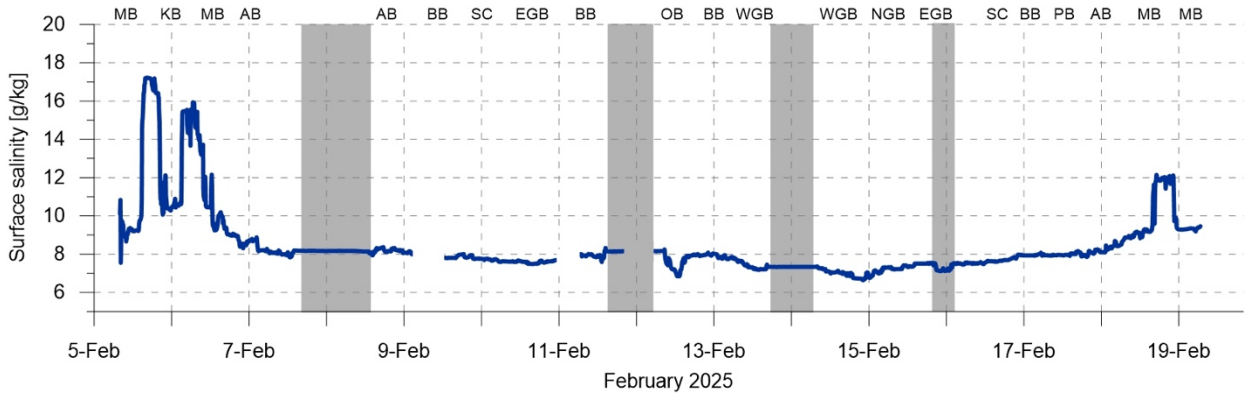


Fig. 5.8 Surface salinity measured with the ship thermosalinograph of RV ELISABETH MANN BORGESE (5 min spot values). The grey shaded area indicate periods when the ship was in the harbour of Sassnitz or "waiting on weather". Abbreviations for the main sea area of each day are marked on top.

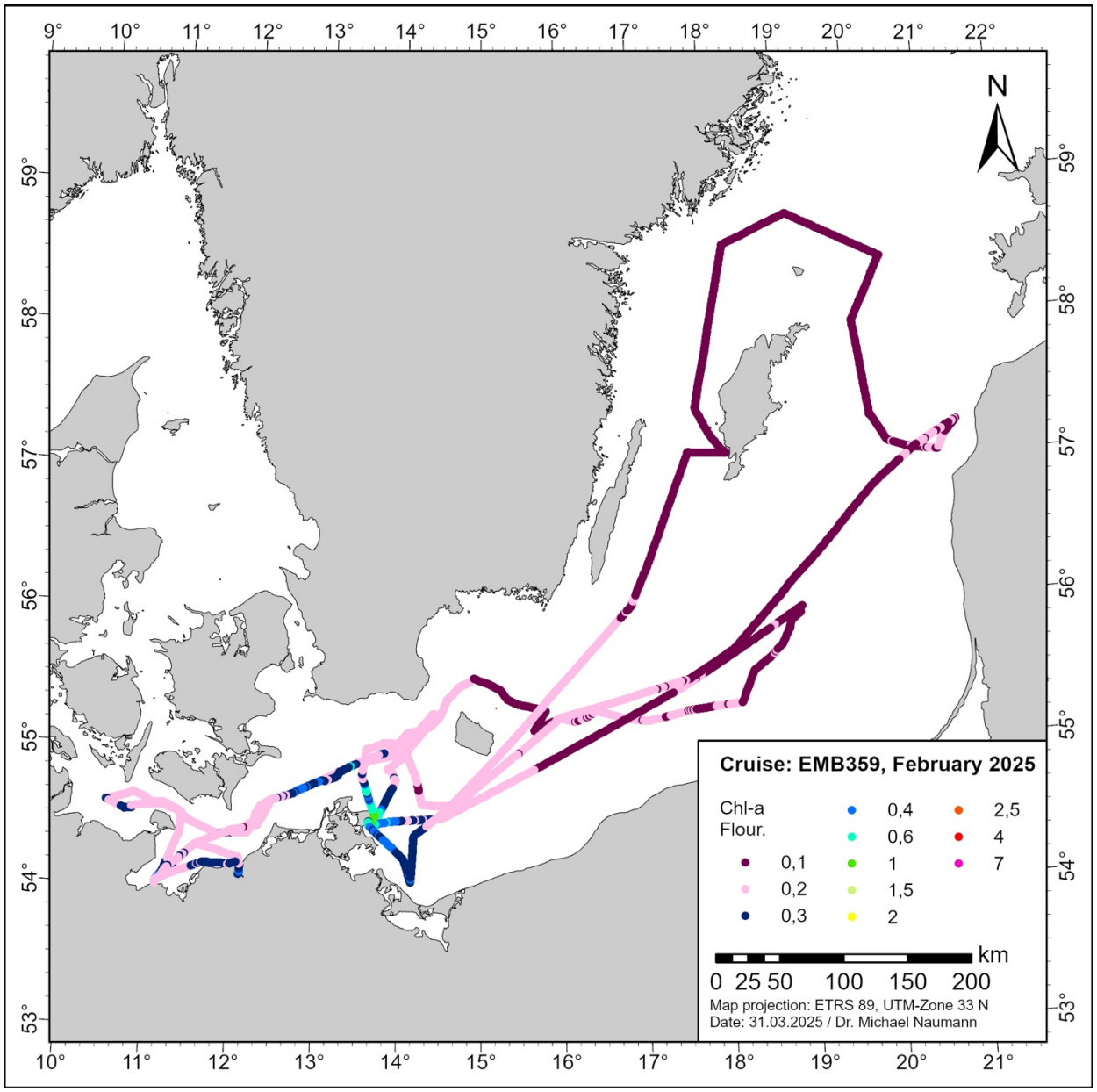


Fig. 5.9 Surface chlorophyll-a fluorescence along the cruise track of EMB359 measured with the ship thermosalinograph (5 min spot values).

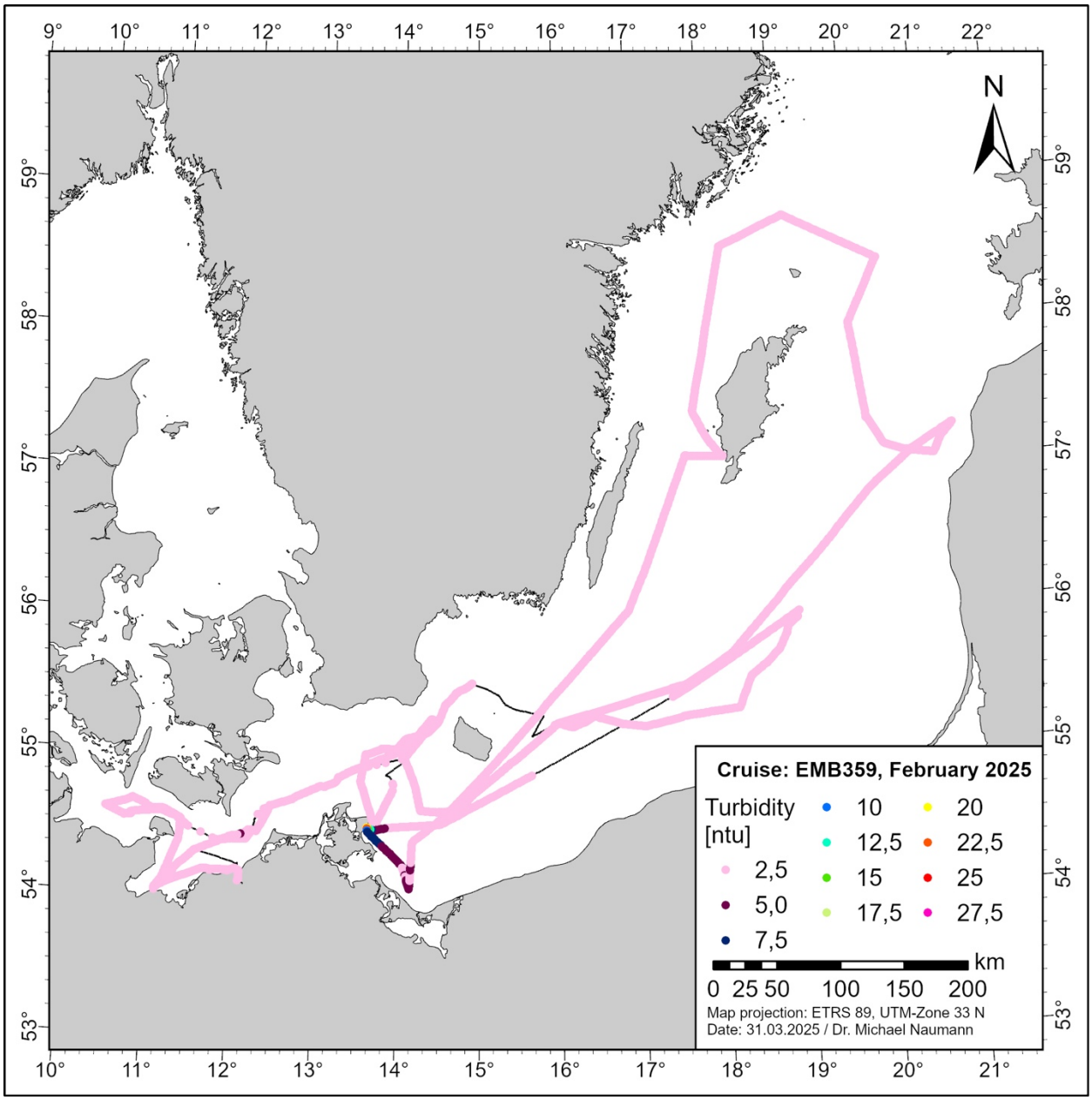


Fig.5.10 Surface turbidity along the cruise track of EMB359 measured with the ship thermosalinograph (5 min spot values).

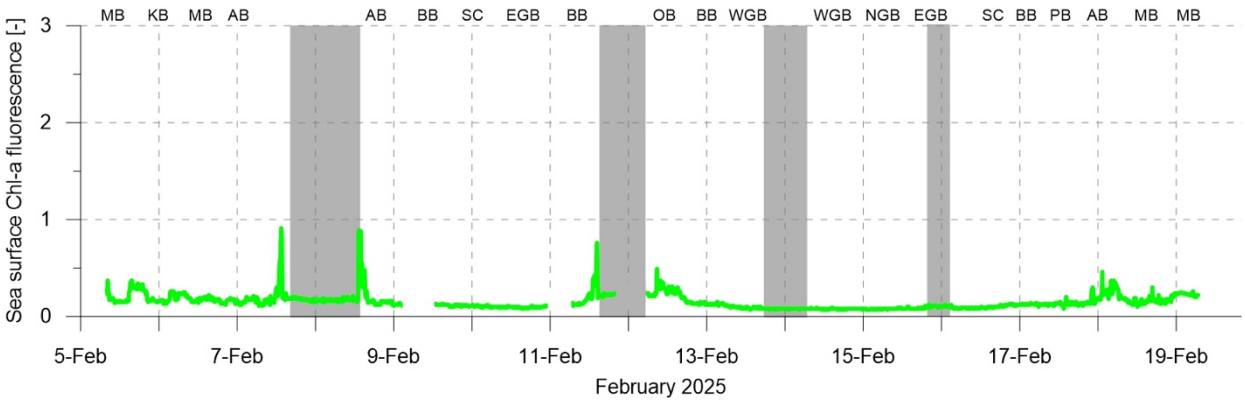


Fig.5.11 Surface chlorophyll-a fluorescence measured with the flow through fluorometer of RV ELISABETH MANN BORGESE (5 min spot values). The grey shaded area indicate periods when

the ship was in the harbour of Sassnitz or "waiting on weather". Abbreviations for the main sea area of each day are marked on top.

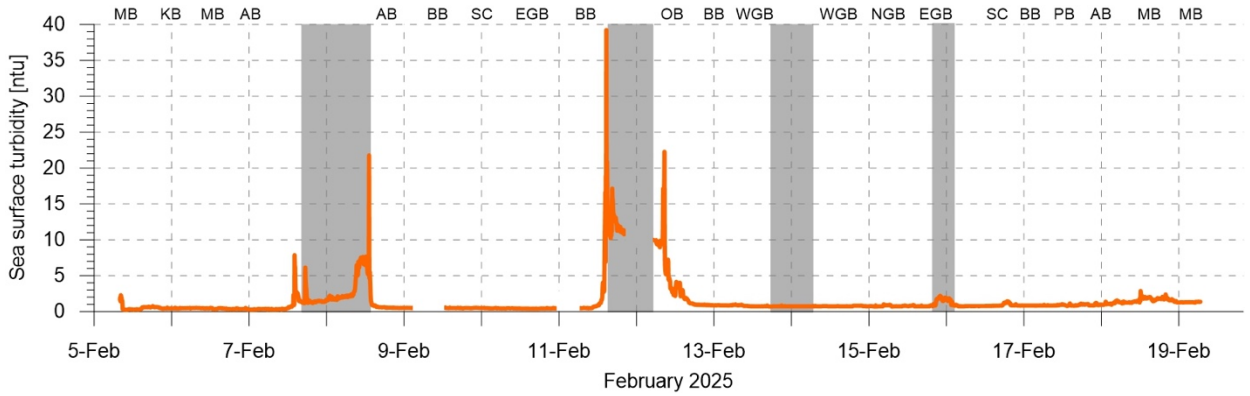


Fig.5.12 Surface turbidity measured with the flow through fluorometer of RV ELISABETH MANN BORGESE (5 min spot values). The grey shaded area indicate periods when the ship was in the harbour of Sassnitz or "waiting on weather". Abbreviations for the main sea area of each day are marked on top.

5.3 Observations at key Stations

The following tables list the surface (Table 5.1) and bottom values (Table 5.2) of the most important hydrographic and chemical parameters measured at the key stations of the Baltic long term observation program. The vertical profiles of the CTD measurements are plotted in comparison to long term values for some of these stations in Fig. 5.20. For positions of the particular stations refer to Fig. 5.13 and Table 7.1.

The physical conditions of the surface water layer are described in chapter 5.2 and dissolved oxygen showed in all subregions high concentrations and ranged between 373 µmol/l at Lübeck Bight and 390 µmol/l at the Darss Sill as well as Karlsö Deep. The nutrient concentrations depicted the typical for winter in the surface water and increased significantly due to less biological activity compared to the measurements in November 2024 (cf. cruise report EMB353, KUBE 2025) and low levels to the end of summer. The phosphate concentrations ranged between 0.48 µmol/l in the Arkona Basin to 0.85 µM at the Slupsk Channel and southern part of the Eastern Gotland Basin. In general, the measured values are in the same magnitude than winter values of the previous five years. Nitrate concentrations at the surface increased a lot since November 2024, ranging between 3.03-6.79 µmol/l and reaching usual winter maxima above 3.5 µmol/l. Silicate concentrations are at 60-80 % of the winter-maxima and ranged from 16.0 µmol/l (Gotland Deep) to 25.5 µmol/l (Lübeck Bight).

The bottom water concentrations of nutrients are controlled mainly by the vertical position of the redox cline and the oxygen conditions. In the subregions Kiel Bight to Mecklenburg Bight and Arkona Basin to Slupsk Channel the nitrate bottom concentrations were with values of 7.26-9.17 µmol/l much higher compared to values below one in the central basins (Table 5.2). The only exception was the Darss Sill with 3.90 µmol/l. In the central Baltic Basins around the isle of Gotland nitrate is zero in the near bottom layer and bound in the surface sediments due to hypoxic conditions in the deep water. Phosphate showed low values between 0.52-0.94 µmol/l in the western part, slight increased values up to 2.33 µmol/l in the Bornholm Basin and higher values of 2.85-6.25 µmol/l under hypoxic conditions in the central part. Silicate stayed nearly constant

under stagnation conditions in the bottom near water of the central basins compared to measurements in February 2024.

The spatial distribution of bottom oxygen conditions and hypoxia /hydrogen sulphide is derived from laboratory analysis from water samples and given in Fig. 5.13. The hydrographic highly dynamic conditions from Kiel Bight to Mecklenburg Bight, Darss Sill and Arkona Basin showed oxygen concentrations between 363-293 µmol/l in near bottom waters. The deep water conditions from Arkona Basin to the central basins are influenced by inflow activity from the North Sea or stagnation periods. The latest larger inflow activity was in December 2023 (1.7 Gt salt import), January 2024 (1.3 Gt) and December 2024 (1.1 Gt) and smaller inflow pulses delivered oxygenized water masses more frequent into the Arkona Basin. The oxygen concentration of 93 µmol/l is low and close to the hypoxic limit at the Bornholm Deep and in the same magnitude at the Slupsk Channel with 104 µmol/l. The southwestern part of the Eastern Gotland Basin oxygen concentrations fall below the hypoxic limit to zero and slight concentrations of hydrogen sulphide were detected (0.6 µmol/l H2S). The oxygen deficit increases to Gotland Deep with hydrogen sulphide concentrations of 193.5 µmol/l. Farther north 96.8 µmol were found in the Farö Deep /Northern Gotland Basin. In the Western Gotland Basin lower hydrogen sulphide concentrations of 32.3 µmol/l and 41.8 µmol were found in the Landsort Deep and Karlsö Deep.

Table 5.1 Sea surface water values (1-5 m water depths) of main hydrographic and hydrochemical properties at the key stations. Location of selected key stations see Fig. 5.13.

Area /Date	Station Name /No.*	Sampl. Depth [m]	Temp. [°C]	Sal. [g/kg]	$O_{2\,(tit)}$ [µmol/l]	PO4 [µmol/l]	NO3 [µmol/l]	SiO4 [µmol/l]
Kiel Bight / 2025-02-06	TF0360/014	0.75	3.62	15.46	376.5	0.68	5.59	22.50
Lübeck Bight / 2025-02-05	TF0022/010	0.97	3.75	16.41	373.1	0.75	6.79	25.50
Meckl.Bight /2025-02-05	TF0012/002	1.27	4.44	9.21	382.6	0.54	3.44	16.60
Darss Sill / 2025-02-06	TF0001/028	6.81	3.96	8.53	390.2	0.47	3.53	16.70
Arkona Basin / 2025-02-07	TF0113/033	1.39	4.08	8.19	384.1	0.48	3.60	16.40
Bornholm Deep / 2025-02-09	TF0213/053	1.5	4.24	7.79	382.5	0.80	3.18	21.20
Stolpe Channel / 2025-02-10	TF0222/061	0.82	4.40	7.75	378.9	0.85	3.38	21.00
SE Gotland Basin / 2025-02-10	TF0259/068	1.58	4.19	7.61	380.0	0.85	3.44	20.90
Gotland Deep / 2025-02-15	TF0271/083	2.94	4.37	7.49	377.1	0.58	3.42	16.00
Farö Deep / 2025-02-15	TF0286/082	1.01	3.92	7.21	380.6	0.57	3.56	16.50
Landsort Deep / 2025-02-14	TF0284/078	1.4	3.26	6.72	378.1	0.71	4.48	22.2
Karlsö Deep / 2025-02-13	TF0245/075	1.66	3.22	7.21	390.3	0.69	3.03	19.40

Table 5.2 Deep-water layer (near bottom depths) of main hydrographic and hydrochemical properties at the key stations. Location of selected key stations see Fig. 5.13.

Area /Date	Station Name /No.*	Sampl. Depth [m]	Temp. [°C]	Sal. [g/kg]	$O_{2\,(titration)}$ [µmol/l]	PO4 [µmol/l]	NO3 [µmol/l]	SiO4 [µmol/l]
Kiel Bight / 2025-02-06	TF0360/014	17.4	4.50	20.19	338	0.94	8.34	30.00
Lübeck Bight / 2025-02-05	TF0022/010	21.9	4.24	17.36	337	0.79	7.76	29.70
Meckl.Bight / 2025-02-05	TF0012/002	23.3	4.28	17.18	335	0.83	7.26	28.20
Darss Sill / 2025-02-06	TF0001/028	20.1	4.95	9.51	363	0.52	3.90	15.80
Arkona Basin / 2025-02-07	TF0113/033	45.2	6.12	14.20	293	0.77	7.52	23.80
Bornholm Deep / 2025-02-09	TF0213/053	87.8	9.01	16.25	93	2.33	8.50	52.20
Stolpe Channel / 2025-02-10	TF0222/061	89.0	9.53	13.24	104	1.54	9.17	44.00
SE Gotland Basin / 2025-02-10	TF0259/068	86.9	6.69	10.87	H2S: 0.6	2.85	0.00	59.30
Gotland Deep / 2025-02-15	TF0271/083	233.7	7.25	12.58	H2S: 193.5	6.25	0.00	109.50
Farö Deep / 2025-02-15	TF0286/082	189.4	7.31	12.11	H2S: 96.8	4.40	0.00	80.00
Landsort Deep / 2025-02-14	TF0284/078	436.2	6.65	10.75	H2S: 32.3	3.95	0.00	74.00
Karlsö Deep / 2025-02-13	TF0245/075	107.7	5.81	9.91	H2S: 41.8	4.40	0.00	77.50

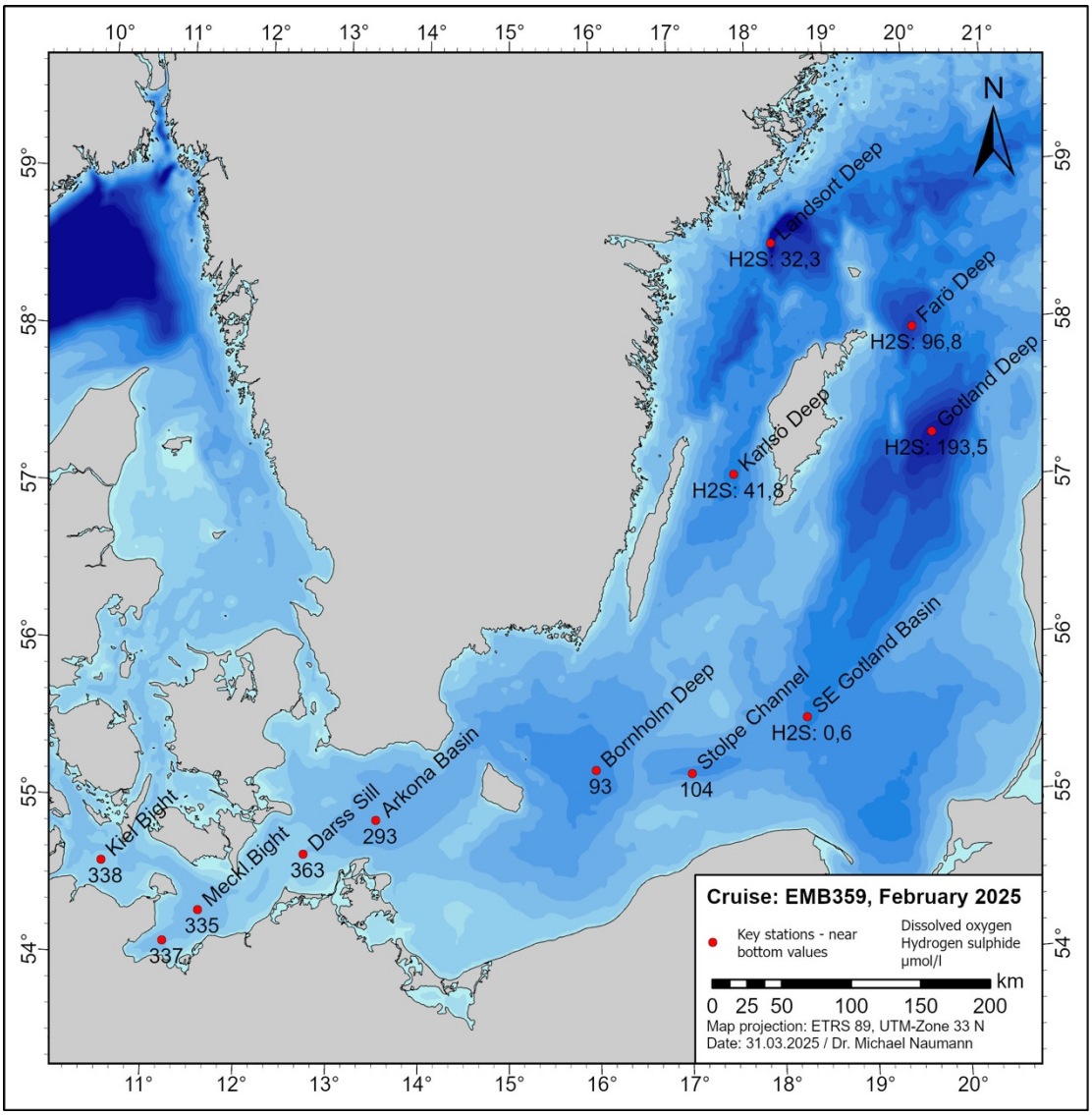


Fig. 5.13 Distribution of dissolved oxygen and hydrogen sulfide concentrations in the near bottom layer at key stations of the long-term observation program (table 5.2).

5.4 Baltic Thalweg Transect

During the cruise 75 CTD stations were aligned along the thalweg transect from the Mecklenburg Bight, in the western Baltic Sea, towards the central Baltic (Fig. 5.14). This transect supplies an excellent overview about the hydrographic and environmental state of the Baltic Sea. And thus, it is worked as standard transect of the IOW long term observation program. The CTD measurements were done as continuous sequence of stations during the first days of cruise, beginning at February 6th (TF0360 – Kiel Bight) to February 10th (TF0265 – southern Eastern Gotland Basin). A timely interruption of 5 days (February 10th-15th) occurred due to the technical defect and repairing of the navigation system. The transect was restarted in the Northern Gotland Basin (TF0285), but the dense grid of stations thinned out due to bad weather. A larger gap exists in the Eastern Gotland Basin from the Gotland Deep (Tf0271) to TF0265, which is blanked in the figures 5.15 to 5.19. The data supplies a quasi-synoptic picture of the hydrographic patterns along the thalweg.

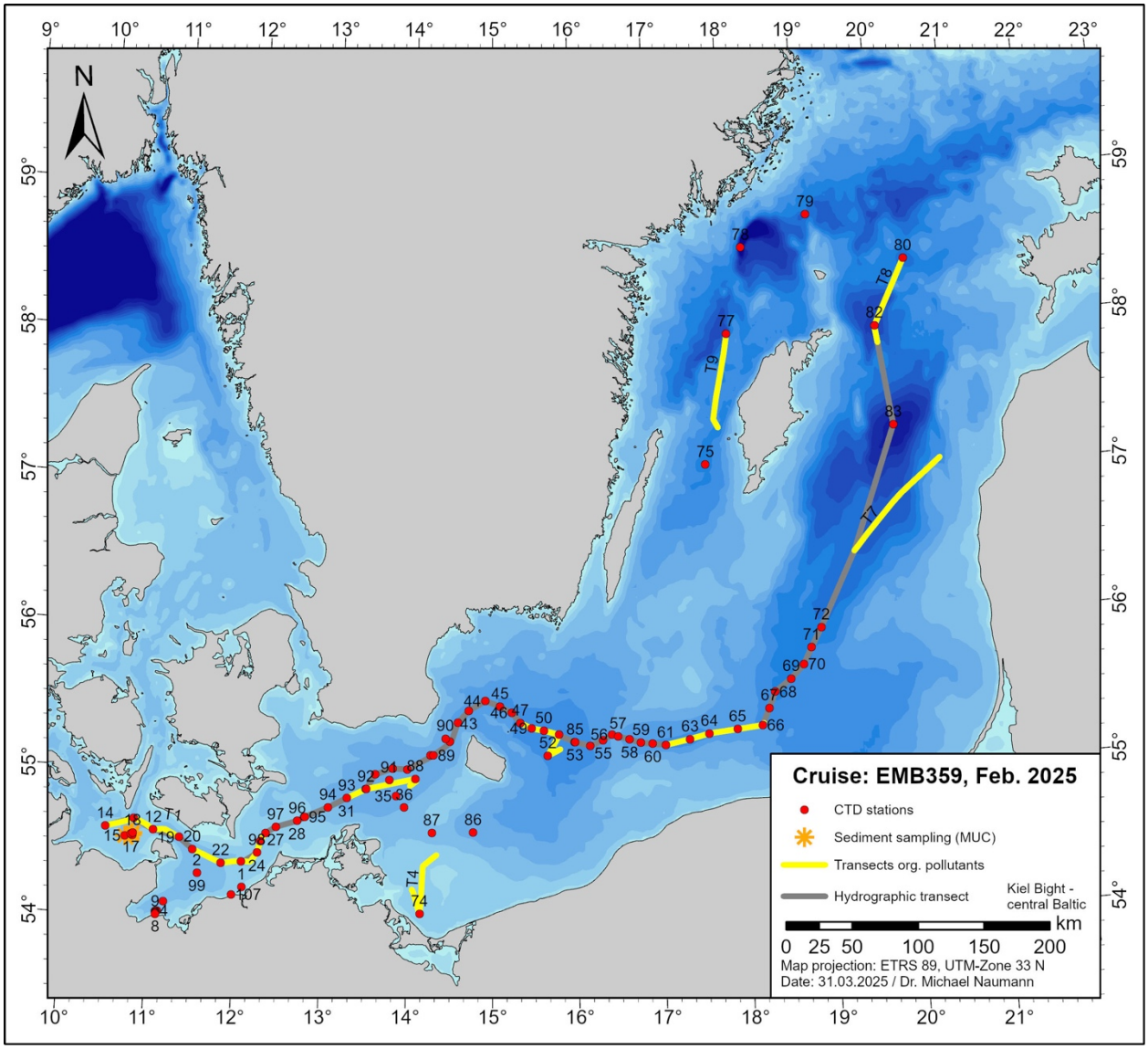


Fig. 5.14 Location of measured CTD stations (table 7.1) and the "Thalweg"-transect crossing all deep basins on the pathway of saltwater inflows (hydrographic parameters visualized as cross sections in Fig. 5.15 – 5.19).

The observations show the winter conditions in the western to central Baltic (Fig.5.15 to Fig. 5.19). The temperature in the upper layer (above the permanent halocline) depicted nearly constant values between 3.5-5.5 °C, showing no horizontal gradient. The situation in the uppermost part of the surface water layer (SST) was 1.5-2 K to warm (c.f. chapter 5.2), but the cross section figure 5.15 delivers a complete view of the water column. Below the halocline the deep water temperature showed as well increased values from the Western Baltic to the central basins. The deep water temperature curves of these recent measurements are on warm upper level compared to long term data at key stations (Fig. 5.20). The bottom near temperatures at the Bornholm Deep of 9.1 °C stayed constant compared to the November measurements as well as at the Gotland Deep (7.25 °C), Farö Deep (7.31 °C) and Landsort Deep (6.65 °C), indicating stagnant conditions in the bottom water of the central Baltic. Recent inflow activity of winter 2023/2024 and 2024/2025 have spreaded in upper water depths below the halocline. From the Bornholm Basin to the southern entrance of the Eastern Gotland Basin a warm water layer above 9 °C is propagating northwards.

The salinity distribution (Fig. 5.16) shows southwest-northeast gradients in the surface layer as well as in the deep water layer. In the surface water a horizontal gradiant 15.46 g/kg at Kiel Bight to 7.2 g/kg at the Northern Gotland Basin. The surface salinity reduction is driven by freshwater runoff with increasing influence to the Northeast, the most distal areas from the entrance to the North Sea / North Atlantic. In contrast the deep water conditions are steered by lateral inflow activity and shows the same horizontal gradiant, but on higher salinity level. In addition, a strong vertical salinity gradiant characterizes the Baltic Sea with its permanent halocline. In comparison to the deep water temperature (Fig. 5.15), the parameter salinity shows the same pattern of propagation of these warm inflows from the Bornholm Basin to the entrance of the Eastern Gotland Basin by salinities between 15-12 g/kg. The deep water salinities at key stations in central basins around Gotland were stagnant compared to the situation in Novemeber 2024 (cruise EMB328). For example, the Bornholm Deep showed a near bottom salinity 16.1 g/kg in November 2024 and 16.25 g/kg in February 2025 (Tab. 5.2), the Gotland Deep showed a salinity of 12.6 g/kg at both times. The recent inflow activity 2023-2024 have not reached the near bottom water of the central Baltic Sea. The inflow of December 2024 was detected as bottom layer of 5 m thickness with a salinity of 17-18 g/kg, a temperature around 8 °C and turbidity of 2 ntu in the Arkona Basin.

The oxygen distribution along the transect is shown in Fig. 5.17. The inflows ventilated the deep water of the Bornholm Basin and Slupsk Channel. In comparison to the measurements in November 2024 (KUBE 2025) the near bottom oxygen concentration increased from hypoxic 2.2 µmol/l to oxic 93 µmol/l at the Bornholm Deep and in the Slupsk Channel from hypoxic 60 µmol/l to oxic 104 µmol/l. Stagnation in the central basins was ongoing, but the near bottom waters showed a decrease, almost a bisection of hydrogen sulphide concentrations compared to November 2024. The Gotland Deep reduced from 294 µmol/l in November to 193.5 µmol/l H2S in February, the Farö Deep from 139.3 µmol/l to 96.8 µmol/l, the Landsort Deep from 66.3 µmol/l to 32.3 µmol/l and the Karlsö Deep from 75.9 µmol/l to 41.8 µmol/l. Figure 15.13 shows an aerial overview of near bottom dissolved oxygen and hydrogen sulphide concentrations.

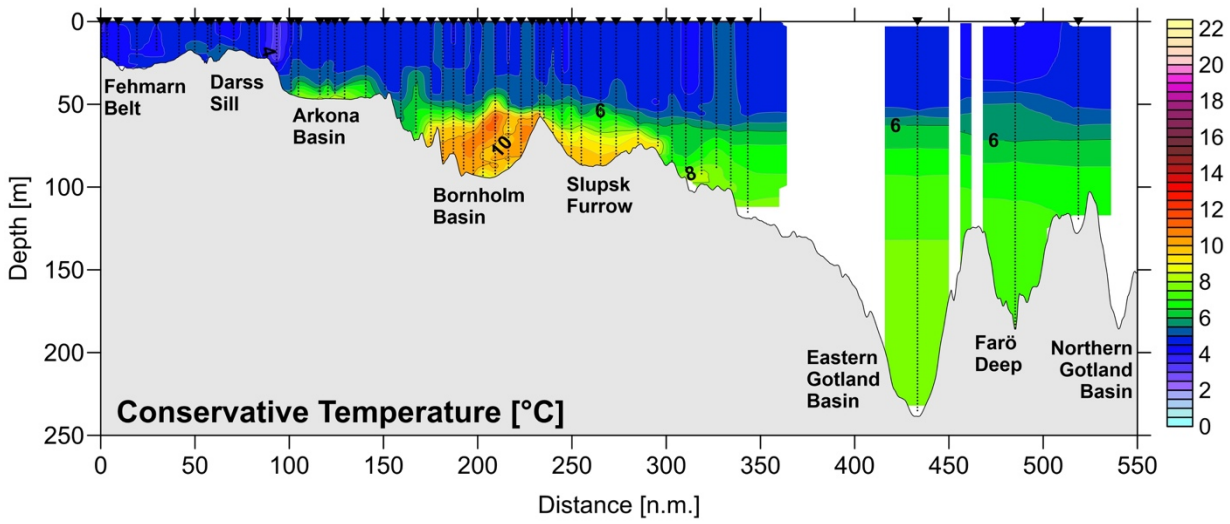


Fig. 5.15 Distribution of conservative temperature along the thalweg of the Baltic Sea from the Kiel bight to the Northern Gotland Basin. The figure is based on the preliminary CTD data gathered from 06.02.-18.02.2025. Data gaps due to technical issues and phases of strong winds are blanked.

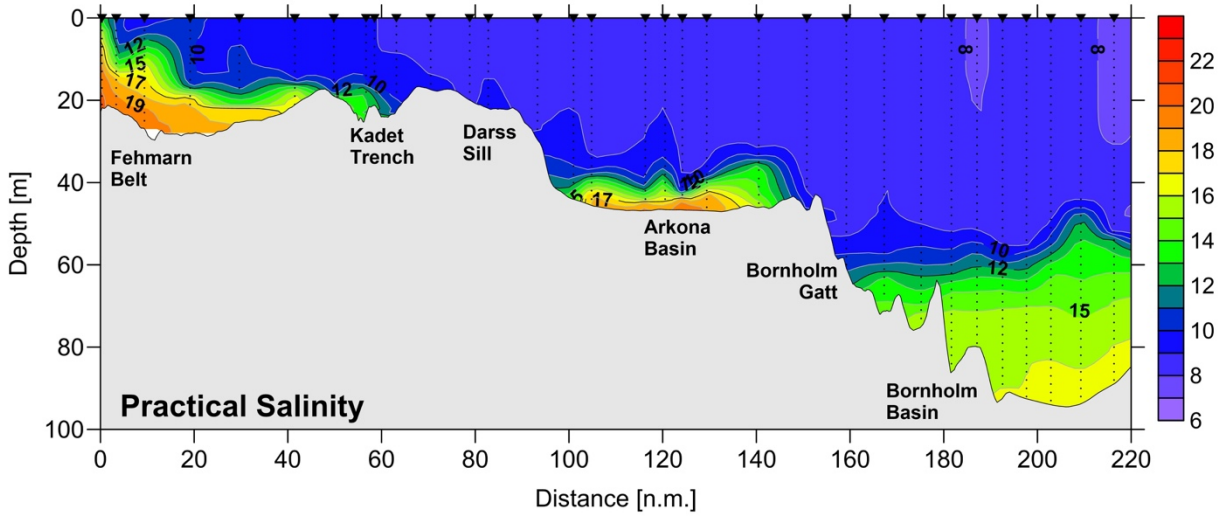


Fig. 5.16 Distribution of absolute salinity along the thalweg of the Baltic Sea from the Kiel bight to the Northern Gotland Basin. The figure is based on the preliminary CTD data gathered from 06.02.-18.02.2025. Data gaps due to technical issues and phases of strong winds are blanked.

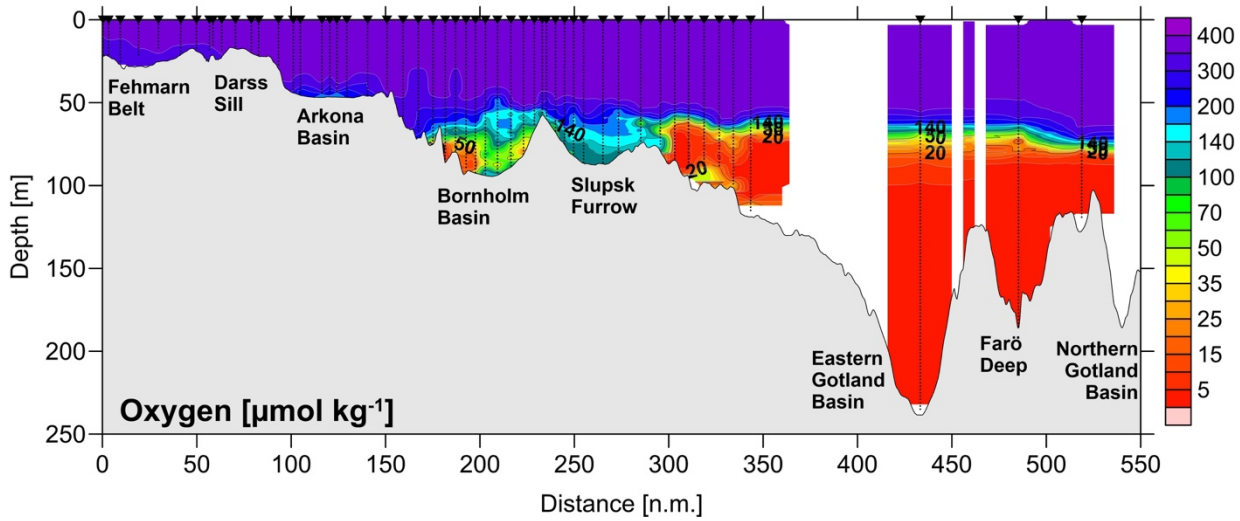


Fig. 5.17 Distribution of dissolved oxygen the thalweg of the Baltic Sea from the Kiel bight to the Northern Gotland Basin. The figure is based on the preliminary CTD data gathered from 06.02.-18.02.2025. Data gaps due to technical issues and phases of strong winds are blanked.

The chlorophyll-a fluorescence along the transect was very low in the deep water with values below 0.5 (Fig. 5.18). In the surface water in the central Baltic showed as well values below 0.5, already described in chapter 5.2. The Western Baltic showed higher fluctuations and values up to 2.0 from the surface to the halocline in around 15-20 m water depth. The sensor of the Surface water Monitoring Box (JSMB) measured lower values in this area with a maximum of 0.90 (cf. Fig 5.9, Fig. 5.11). In general, the primary production is low, usual for the winter season.

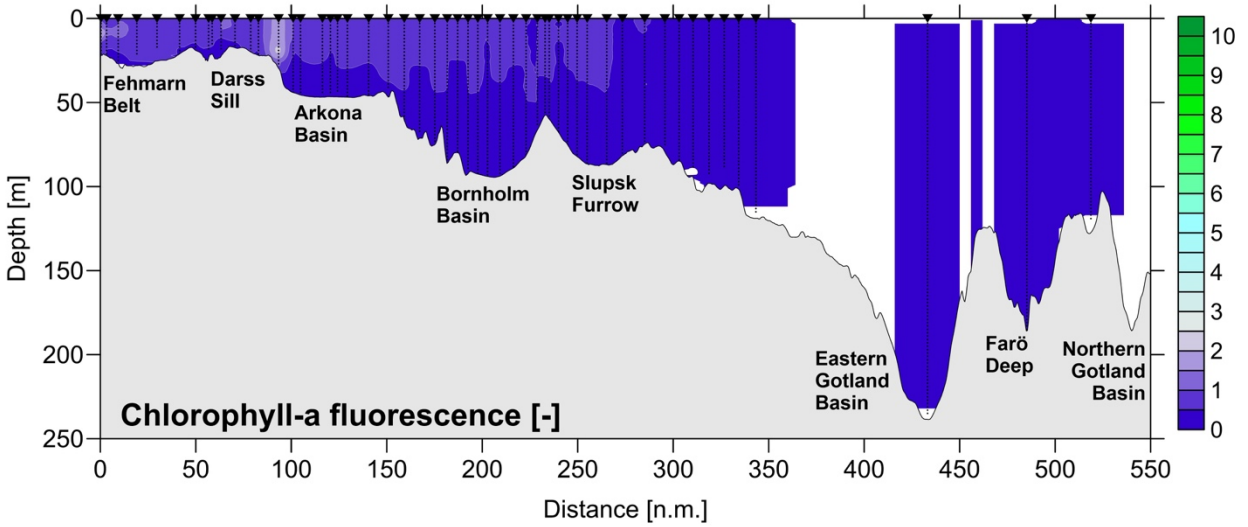


Fig. 5.18 Distribution of chlorophyll-a fluorescence along the thalweg of the Baltic Sea from the Kiel bight to the Northern Gotland Basin. The figure is based on the preliminary CTD data gathered from 06.02.-18.02.2025. Data gaps due to technical issues and phases of strong winds are blanked.

The turbidity distribution along the transect is shown in figure 5.19 and the surface water (upper 4 m) is shown in more detail in the figures 5.10 and 5.12. The surface values are changing between 0.2-3 ntu and short peaks up to 20-39 ntu (see chapter 5.2). The water layer below shows as well turbity values up to 3 ntu and but mostly below 0.4 ntu. Along the lowermost 5-10 m water depth

spans a layer of increased values of 1-2 ntu from the Mecklenburg Bight to the Arkona Basin, indicating the latest inflow activity of December 20024. In the Slupsk Channel such a bottom layer of increased values occurred as well, indicating propagation of water masses. In the Eastern to Northern Gotland Basin this layer of values between 0.8-2 ntu continues below the halocline in water depths from 90 m to 160 m, where redox processes take part (redoxcline depth). In contrast, in these central deep basins (Eastern Gotland Basin to Northern Gotland Basin) the near bottom layer shows very low levels below 0.6 ntu.

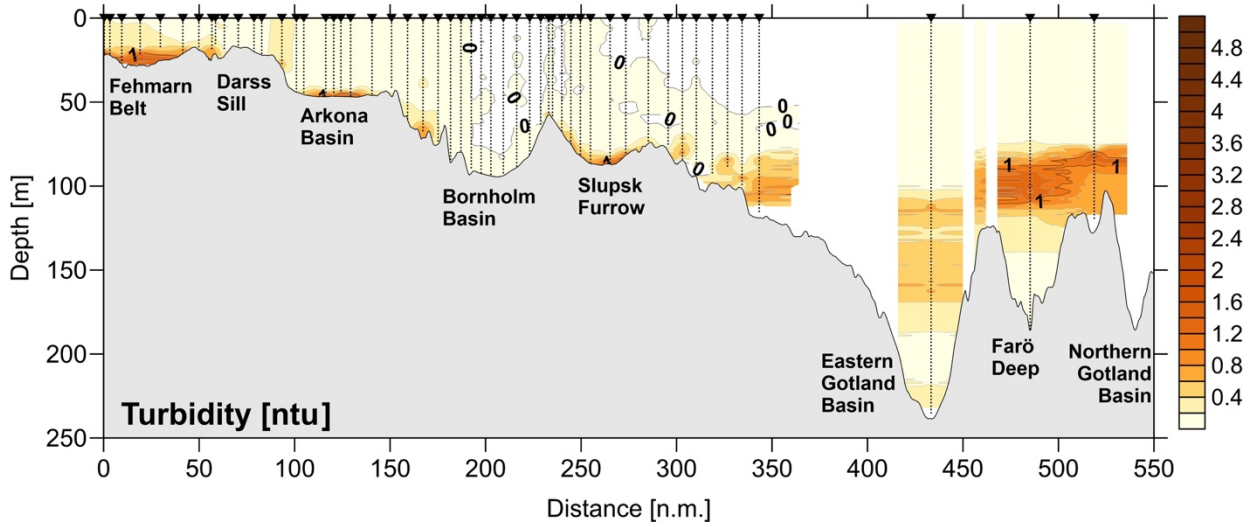
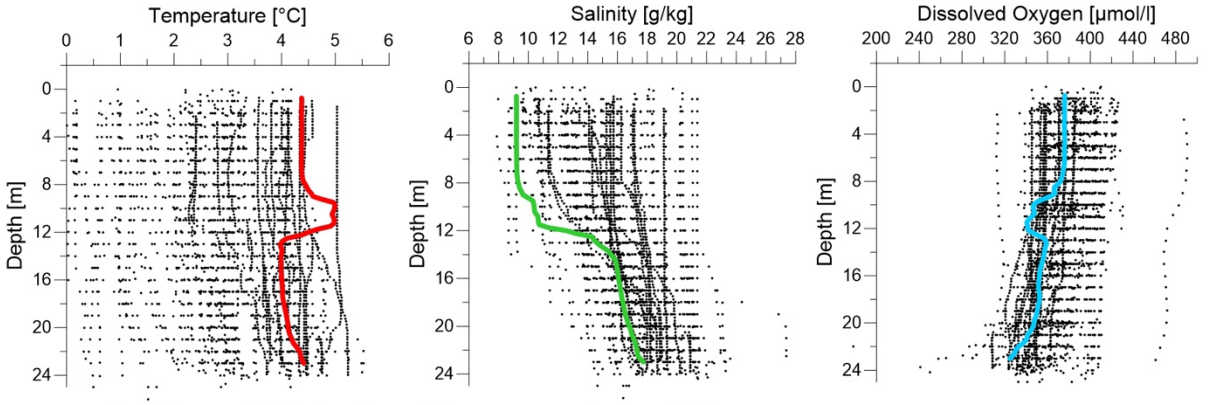


Fig. 5.19 Distribution of turbidity along the thalweg of the Baltic Sea from the Kiel bight to the Northern Gotland Basin. The figure is based on the preliminary CTD data gathered from 06.02.-18.02.2025. Data gaps due to technical issues and phases of strong winds are blanked.

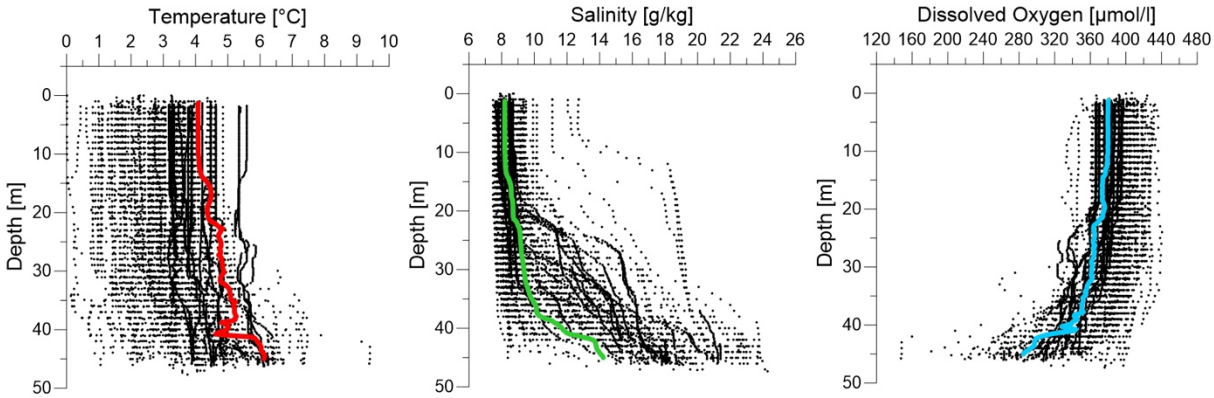
An overview of the hydrographic conditions at seven key stations spanning from the Mecklenburg Bight Basin to the central Baltic Sea is given by vertical profiles of temperature, salinity and dissolved oxygen concentration in figure 5.20. The recent measurements are compared to continues measurements at these stations in the time slot “late January to mid February - the winter situation” since the late 1960’s. These plots shows the main characteristics of the different subregions and the actual state very impressive. The temperature plot shows the comparatively very warm surface water temperatures of 3.5-4.5 °C in the entire investigation area in this winter season 2024-2025. The deep water temperatures are as well on the upper level compared to long term data and display the warm inflow water. The salinity plot shows the permanent stratified water column of lower values in the surface layer and higher salinity in the deep water very clear. In the Western Baltic Sea the surface and deep water salinity was comparatively low (stations TF0012, Tf0113). In the Arkona Basin the halocline depth at 40 m was on a very low level. Both findings mark an outflow situation in the Western Baltic Sea. The general oxygen deficiency and stagnant conditions of the central Baltic deep water is impressive shown at stations Gotland Deep, Farö deep, Landsort Deep and Karlsö Deep. The different water masses observed during the cruise can be clearly identified using its temperature, salinity and oxygen signature (Fig. 5.21). The left temperature – salinity plot shows the different subregions colour coded for a spatial overview, whereas in the right plot dissolved oxygen concentrations are marked by colour.

Station TF0012 - Mecklenburg Bight



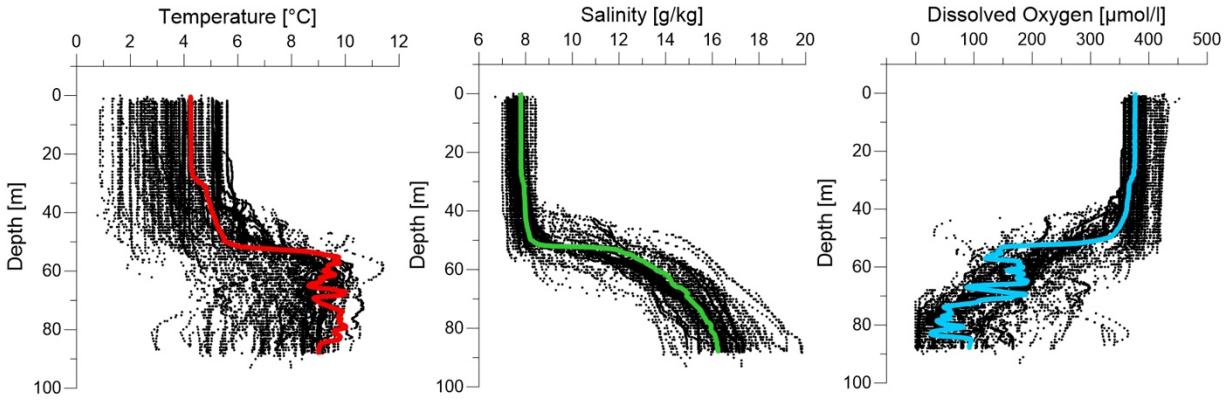
comparison February 2025 to long-term winter measurements since 1971

Station TF0113 - Arkona Basin

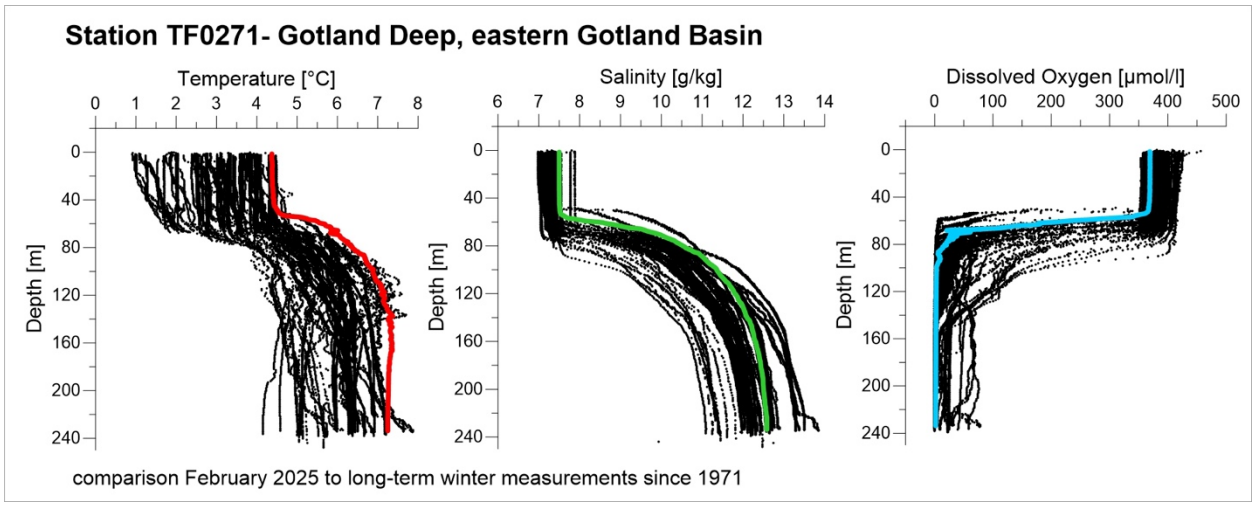


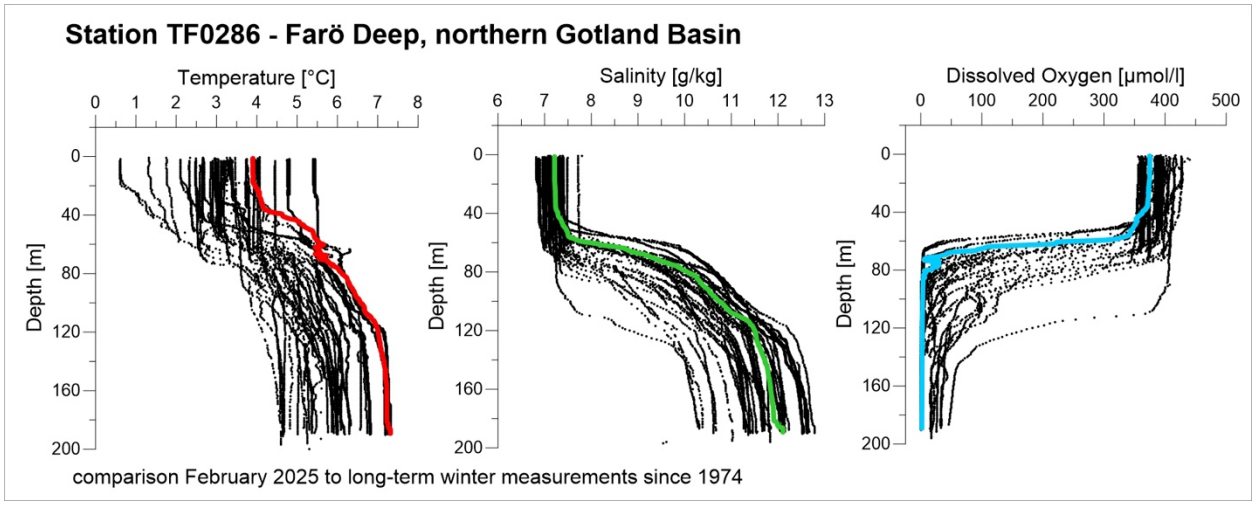
comparison February 2025 to long-term winter measurements since 1953

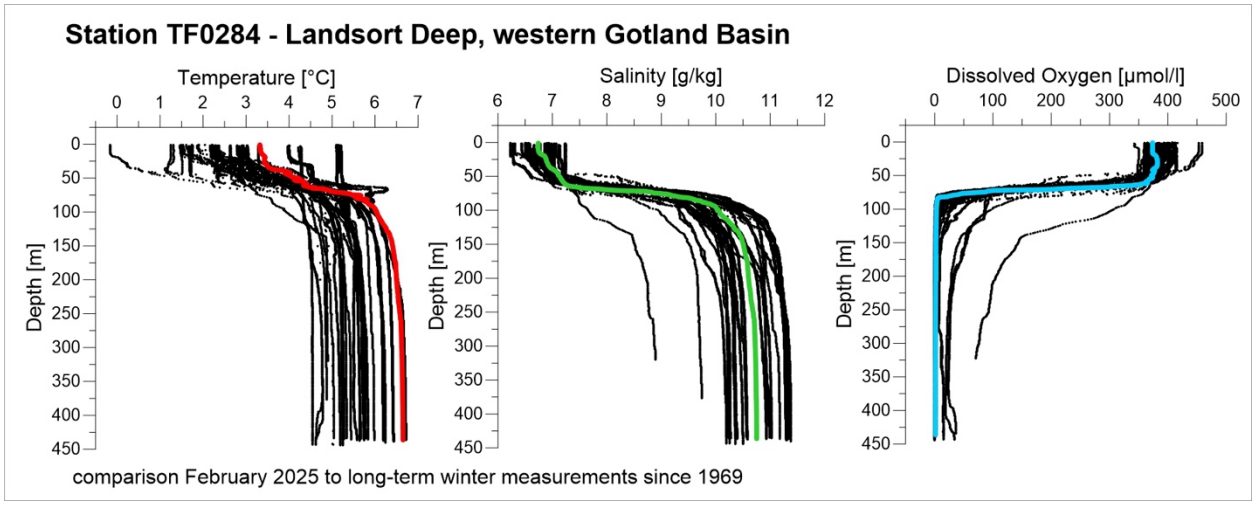
Station TF0213 - Bornholm Basin



comparison February 2025 to long-term winter measurements since 1971


Station TF0271- Gotland Deep, eastern Gotland Basin
Temperature [°C]
Salinity [g/kg]
Dissolved Oxygen [µmol/l]
Depth [m]
comparison February 2025 to long-term winter measurements since 1971


Station TF0286 - Farö Deep, northern Gotland Basin
Temperature [°C]
Salinity [g/kg]
Dissolved Oxygen [µmol/l]
Depth [m]
comparison February 2025 to long-term winter measurements since 1974


Station TF0284 - Landsort Deep, western Gotland Basin
Temperature [°C]
Salinity [g/kg]
Dissolved Oxygen [µmol/l]
Depth [m]
comparison February 2025 to long-term winter measurements since 1969

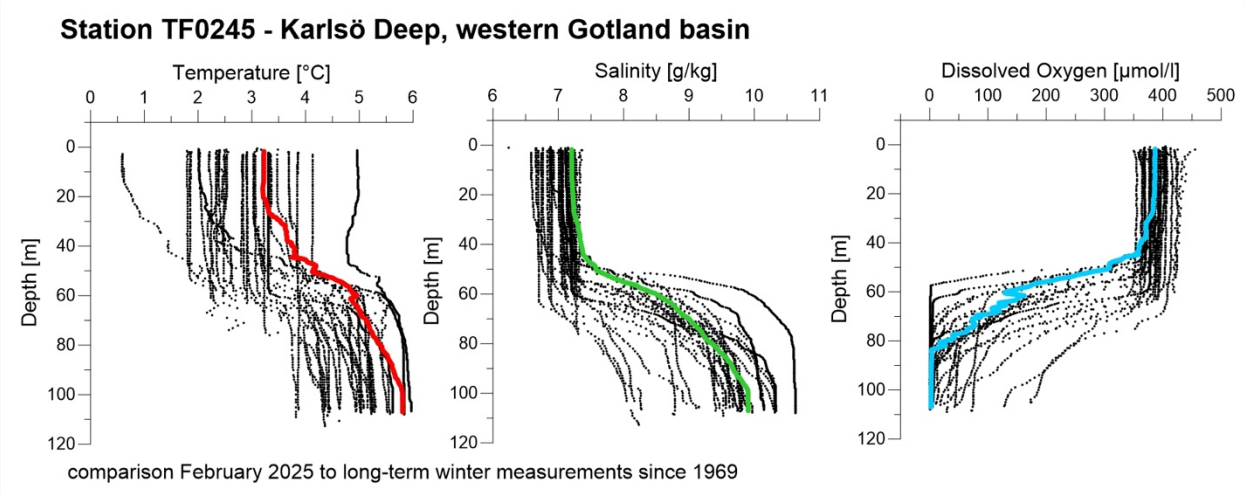


Fig. 5.20 Vertical profiles of temperature (red), salinity (green) and oxygen concentration (blue) at the main stations from the western to the central Baltic Sea compared to long-term observations. Mecklenburg Bight TF0012, Arkona Basin TF0113, Bornholm Deep TF0213, Gotland Deep TF0271, Farö Deep TF0286, Landsort Deep TF0284 and Karlsö Deep TF0245.

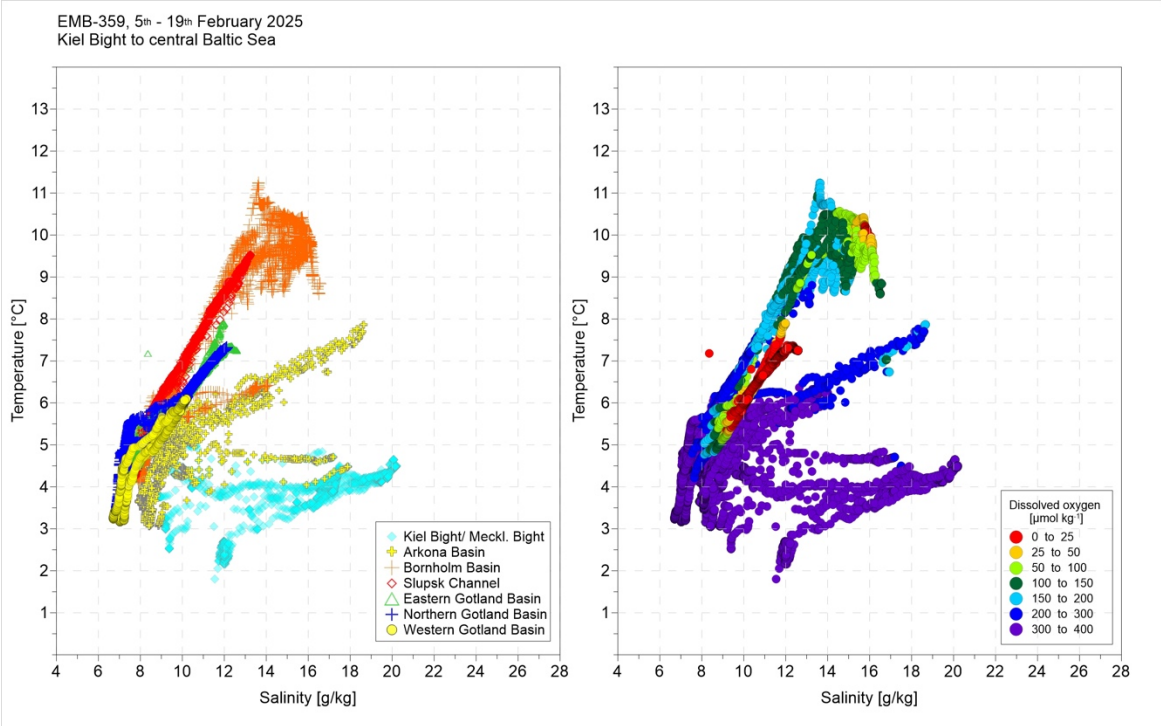


Fig. 5.21 Temperature-salinity diagram of all stations (left). Temperature – salinity values and dissolved oxygen classified in color [µmol/l].

5.5 Biological Investigations

Sampling for phytoplankton as well as chlorophyll analyses were collected from the rosette water sampler from different depths in the euphotic zone from surface to max. 20 m water depths. Additionally, phytoplankton net samples were taken. Phytoplankton samples were preserved for later microscopic analyses of the species composition and chlorophyll samples were filtered and deep frozen. The standard zooplankton WP2 net was used to sample mesozooplankton above and below the halocline. Additional Apstein net samples were collected for analyses of small

developmental stages of zooplankton. All samples were preserved for later microscopic analyses of the zooplankton community composition. Responsible scientists at IOW are Dr. Anke Kremp (phytoplankton) and Dr. Jörg Dutz (zooplankton).

Insights into the changes of the microbial food web of the redoxcline is obtained by vertical high resolution sampling of the range of the redoxcline at Gotland Deep (TF0271) and Landsort Deep (TF0284a) 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. The responsible scientist at IOW is Prof. Dr. Klaus Jürgens.

Water samples for eDNA extraction were taken with the aim of building up a microbiological DNA archive. Samples were taken in the southwestern Baltic Sea at 11 stations. This programme is done since 3 years and is planned to continue. The responsible scientist at IOW is Prof. Dr. Matthias Labrenz.

The analysis of all biological samples will be performed after the cruise. Thus, no preliminary results of this program are presented here.

6. Ship's Meteorological Station

Not applicable on EMB. The meteorological conditions during the cruise are described in section 5.1. based on data of the automatic weather station of the ship.

7. Station List EMB359

7.1 Overall Station List, 107 CTD Stations. 125 Casts

Date / Time	Station No.	Station Name	Depth	Latitude	Longitude	Gear
[UTC]	EMB	IOW	[m]			
5.2.25 9:19	EMB359_1-1	TF05	9	54° 13,8403' N	012° 04,5226' E	CTD
5.2.25 9:24	EMB359_1-2	TF05	9	54° 13,8333' N	012° 04,5268' E	SD
5.2.25 12:01	EMB359_2-1	TF0012	23	54° 18,9055' N	011° 32,9832' E	CTD
5.2.25 12:05	EMB359_2-2	TF0012	23	54° 18,9080' N	011° 32,9481' E	SD
5.2.25 12:06	EMB359_2-3	TF0012	23	54° 18,9051' N	011° 32,9482' E	4x PLA
5.2.25 12:20	EMB359_2-4	TF0012	21	54° 18,8667' N	011° 32,9420' E	WP2
5.2.25 12:34	EMB359_2-5	TF0012	21	54° 18,8536' N	011° 32,9714' E	WP2
5.2.25 12:43	EMB359_2-6	TF0012	1	54° 18,8619' N	011° 32,9874' E	CTD
5.2.25 13:12	EMB359_2-7	TF0012	1	54° 18,8719' N	011° 33,0016' E	CTD
5.2.25 15:53	EMB359_3-1	A3 Boltenhagen	22	54° 02,5561' N	011° 06,5162' E	CTD
5.2.25 16:20	EMB359_4-1	A1 Boltenhagen	21	54° 02,5493' N	011° 05,5748' E	CTD
5.2.25 16:53	EMB359_5-1	B1 Boltenhagen	17	54° 02,2939' N	011° 05,4461' E	CTD
5.2.25 17:14	EMB359_6-1	C1 Boltenhagen	12	54° 02,0199' N	011° 05,4293' E	CTD
5.2.25 17:34	EMB359_7-1	D1 Boltenhagen	9	54° 01,7418' N	011° 05,3946' E	CTD
5.2.25 17:53	EMB359_8-1	E1 Boltenhagen	7	54° 01,4968' N	011° 05,4675' E	CTD
5.2.25 18:15	EMB359_9-1	F1 Boltenhagen	6	54° 01,2270' N	011° 05,4467' E	CTD
5.2.25 19:16	EMB359_10-1	TF0022	21	54° 06,6068' N	011° 10,5717' E	CTD
5.2.25 22:45	EMB359_11-1	T1 start	2	54° 33,2003' N	011° 19,0746' E	Insitupump
5.2.25 22:45	EMB359_11-1	T1 end	2	54° 36,0217' N	010° 26,9578' E	Insitupump
6.2.25 0:11	EMB359_12-1	TF0014	25	54° 35,6611' N	011° 00,8784' E	CTD
6.2.25 1:40	EMB359_13-1	TF0361	23	54° 39,8780' N	010° 46,6018' E	CTD
6.2.25 3:34	EMB359_14-1	TF0360	16	54° 36,0036' N	010° 27,0266' E	CTD
6.2.25 3:39	EMB359_14-2	TF0360	16	54° 36,0047' N	010° 26,9987' E	PLA
6.2.25 3:47	EMB359_14-3	TF0360	10	54° 36,0185' N	010° 26,9744' E	CTD
6.2.25 4:28	EMB359_14-4	TF0360	15	54° 36,0141' N	010° 27,0078' E	WP2
6.2.25 5:52	EMB359_15-1	Bio FB2	21	54° 32,4999' N	010° 41,1879' E	CTD
6.2.25 6:54	EMB359_15-2	Bio FB2	25	54° 32,5016' N	010° 41,1638' E	MUC
6.2.25 7:32	EMB359_16-1	Bio FB1	22	54° 32,8774' N	010° 46,2170' E	CTD
6.2.25 7:49	EMB359_16-2	Bio FB1	24	54° 32,8979' N	010° 46,1078' E	MUC
6.2.25 8:12	EMB359_17-1	Bio FB3	22	54° 33,3970' N	010° 45,3170' E	CTD
6.2.25 8:32	EMB359_17-2	Bio FB3	25	54° 33,4218' N	010° 45,3046' E	MUC
6.2.25 9:01	EMB359_18-1	Bio FB4	22	54° 33,7746' N	010° 46,5056' E	CTD
6.2.25 9:17	EMB359_18-2	Bio FB4	25	54° 33,7984' N	010° 46,4571' E	MUC
6.2.25 11:39	EMB359_19-1	TF0010	27	54° 33,0975' N	011° 19,2191' E	CTD
6.2.25 12:50	EMB359_20-1	TF0013	25	54° 28,4704' N	011° 29,0402' E	CTD
6.2.25 13:03	EMB359_21-1	T2 start	2	54° 28,5202' N	011° 29,1117' E	Insitupump
6.2.25 13:03	EMB359_21-1	T2 end	2	54° 36,1526' N	012° 19,6407' E	Insitupump
6.2.25 14:36	EMB359_22-1	TF0017	21	54° 23,4516' N	011° 49,3763' E	CTD
6.2.25 15:54	EMB359_23-1	TF0041	17	54° 24,3914' N	012° 03,6628' E	CTD
6.2.25 17:18	EMB359_24-1	TF0046	27	54° 28,1918' N	012° 14,4673' E	CTD

6.2.25 17:19	EMB359_24-2	TF0046	22	54° 28,1982' N	012° 14,4704' E	3x PLA
6.2.25 17:40	EMB359_24-3	TF0046	22	54° 28,1979' N	012° 14,5135' E	WP2
6.2.25 18:28	EMB359_25-1	TF0083	24	54° 32,9858' N	012° 16,4618' E	CTD
6.2.25 19:16	EMB359_26-1	TF0033	18	54° 36,2766' N	012° 19,8330' E	CTD
6.2.25 20:11	EMB359_27-1	TF0002	16	54° 39,0051' N	012° 27,0084' E	CTD
6.2.25 21:32	EMB359_28-1	TF0001	19	54° 41,7421' N	012° 41,8624' E	CTD
6.2.25 22:21	EMB359_29-1	TF0030	21	54° 43,3989' N	012° 46,9408' E	CTD
6.2.25 22:22	EMB359_29-2	TF0030	21	54° 43,4000' N	012° 46,9421' E	3x PLA
6.2.25 22:46	EMB359_29-3	TF0030	5	54° 43,4076' N	012° 46,9444' E	CTD
7.2.25 0:18	EMB359_30-1	TF0115	28	54° 47,6919' N	013° 03,4766' E	CTD
7.2.25 1:42	EMB359_31-1	TF0114	43	54° 51,5956' N	013° 16,5362' E	CTD
7.2.25 1:48	EMB359_32-1	T3 start	2	54° 51,6005' N	013° 16,5504' E	Insitupump
7.2.25 1:48	EMB359_32-1	T3 end	2	54° 57,0416' N	014° 01,2330' E	Insitupump
7.2.25 3:11	EMB359_33-1	TF0113	44	54° 55,4897' N	013° 29,8997' E	CTD
7.2.25 3:20	EMB359_33-2	TF0113	44	54° 55,5102' N	013° 29,9866' E	3x PLA
7.2.25 3:55	EMB359_33-3	TF0113	25	54° 55,5077' N	013° 29,9628' E	CTD
7.2.25 4:13	EMB359_33-4	TF0113	44	54° 55,5124' N	013° 30,0270' E	WP2
7.2.25 4:21	EMB359_33-5	TF0113	44	54° 55,5134' N	013° 30,0283' E	WP2
7.2.25 7:11	EMB359_34-1	TF0109	46	54° 59,9778' N	014° 04,9218' E	CTD
7.2.25 7:13	EMB359_34-2	TF0109	46	54° 59,9772' N	014° 04,9301' E	3x PLA, SD
7.2.25 7:38	EMB359_34-3	TF0109	46	54° 59,9950' N	014° 05,0102' E	WP2
7.2.25 9:13	EMB359_35-1	ABBoje	44	54° 52,8118' N	013° 51,5833' E	CTD
7.2.25 10:25	EMB359_36-1	TF0112	38	54° 48,2078' N	013° 57,4227' E	CTD
7.2.25 10:57	EMB359_36-2	TF0112	5	54° 48,2219' N	013° 57,4760' E	CTD
8.2.25 16:55	EMB359_37-1	TF0105	44	55° 01,5193' N	013° 36,3778' E	CTD
8.2.25 18:16	EMB359_38-1	TF0104	44	55° 04,1143' N	013° 48,7609' E	CTD
8.2.25 19:31	EMB359_39-1	TF0103	45	55° 03,8163' N	013° 59,2735' E	CTD
8.2.25 21:23	EMB359_40-1	TF0145_DK	45	55° 09,6632' N	014° 15,6967' E	CTD
8.2.25 22:56	EMB359_41-1	TF0144	41	55° 15,4224' N	014° 29,2963' E	CTD
9.2.25 0:16	EMB359_42-1	TF0142DK	69	55° 23,0294' N	014° 34,9912' E	CTD
9.2.25 1:37	EMB359_43-1	TF0140	67	55° 27,9934' N	014° 42,9597' E	CTD
9.2.25 2:58	EMB359_44-1	TF0206	74	55° 31,9760' N	014° 54,8610' E	CTD
9.2.25 4:06	EMB359_45-1	TF0207	83	55° 29,7593' N	015° 05,4301' E	CTD
9.2.25 5:07	EMB359_46-1	TF0208	90	55° 27,1779' N	015° 13,8919' E	CTD
9.2.25 6:07	EMB359_47-1	TF0200	89	55° 22,9932' N	015° 19,9252' E	CTD
9.2.25 6:27	EMB359_48-1	T5 start	2	55° 22,9825' N	015° 20,1918' E	Insitupump
9.2.25 6:27	EMB359_48-1	T5 end	2	55° 12,1328' N	015° 48,5179' E	Insitupump
9.2.25 7:08	EMB359_49-1	TF0209	91	55° 20,8005' N	015° 27,9409' E	CTD
9.2.25 8:14	EMB359_50-1	TF0211	93	55° 19,7933' N	015° 36,7982' E	CTD
9.2.25 9:28	EMB359_51-1	TF0212	93	55° 18,1019' N	015° 47,6602' E	CTD
9.2.25 11:04	EMB359_52-1	TF0214	91	55° 09,5820' N	015° 39,5913' E	CTD
9.2.25 13:02	EMB359_53-1	TF0213	87	55° 15,0027' N	015° 58,9272' E	CTD
9.2.25 13:03	EMB359_53-2	TF0213	87	55° 14,9986' N	015° 58,9269' E	SD
9.2.25 13:03	EMB359_53-3	TF0213	87	55° 14,9963' N	015° 58,9661' E	3x PLA
9.2.25 13:23	EMB359_53-4	TF0213	85	55° 15,0034' N	015° 58,9780' E	WP2
9.2.25 13:33	EMB359_53-5	TF0213	85	55° 14,9982' N	015° 59,0024' E	WP2

9.2.25 13:44	EMB359_53-6	TF0213	51	55° 14,9963' N	015° 59,0144' E	WP2
9.2.25 13:51	EMB359_53-7	TF0213	85	55° 15,0062' N	015° 58,9886' E	WP2
9.2.25 14:04	EMB359_53-8	TF0213	25	55° 14,9993' N	015° 58,9886' E	CTD
9.2.25 14:26	EMB359_53-9	TF0213	25	55° 14,9960' N	015° 59,0167' E	CTD
9.2.25 14:43	EMB359_53-10	TF0213	88	55° 15,0052' N	015° 59,0031' E	APNET
9.2.25 15:09	EMB359_53-11	TF0213	87	55° 15,0104' N	015° 58,9813' E	APNET
9.2.25 15:32	EMB359_53-12	TF0213	87	55° 15,0134' N	015° 59,0071' E	APNET
9.2.25 16:59	EMB359_54-1	TF0221	80	55° 13,2804' N	016° 09,8802' E	CTD
9.2.25 17:59	EMB359_55-1	TF0225	63	55° 15,5195' N	016° 19,2265' E	CTD
9.2.25 18:52	EMB359_56-1	TF0226	56	55° 17,7932' N	016° 25,7289' E	CTD
9.2.25 19:36	EMB359_57-1	TF0224	60	55° 17,0247' N	016° 29,9649' E	CTD
9.2.25 20:36	EMB359_58-1	TF0227	66	55° 15,6846' N	016° 38,1544' E	CTD
9.2.25 21:40	EMB359_59-1	TF0228	75	55° 14,2434' N	016° 46,2865' E	CTD
9.2.25 22:35	EMB359_60-1	TF0229	83	55° 13,7047' N	016° 54,7107' E	CTD
9.2.25 23:32	EMB359_61-1	TF0222	89	55° 12,9849' N	017° 03,9130' E	CTD
9.2.25 23:50	EMB359_62-1	T6 start	2	55° 12,9894' N	017° 04,0255' E	Insitupump
9.2.25 23:50	EMB359_62-1	T6 end	2	55° 20,8320' N	018° 15,1609' E	Insitupump
10.2.25 1:02	EMB359_63-1	TF0266	86	55° 15,0958' N	017° 21,4857' E	CTD
10.2.25 2:22	EMB359_64-1	TF0267	81	55° 17,1262' N	017° 35,4935' E	CTD
10.2.25 3:57	EMB359_65-1	TF0268	72	55° 18,4528' N	017° 55,7254' E	CTD
10.2.25 5:21	EMB359_66-1	TF0256	75	55° 19,6006' N	018° 14,0134' E	CTD
10.2.25 6:28	EMB359_67-1	TF0257	84	55° 26,4747' N	018° 19,2304' E	CTD
10.2.25 7:55	EMB359_68-2	TF0259	91	55° 32,9844' N	018° 23,9460' E	3x PLA, SD
10.2.25 8:19	EMB359_68-1	TF0259	91	55° 33,0680' N	018° 24,0964' E	CTD
10.2.25 9:02	EMB359_68-3	TF0259	25	55° 33,1461' N	018° 24,3830' E	CTD
10.2.25 10:18	EMB359_69-1	TF0255	92	55° 38,0047' N	018° 36,0043' E	CTD
10.2.25 11:42	EMB359_70-1	TF0258	86	55° 43,6351' N	018° 45,7955' E	CTD
10.2.25 13:02	EMB359_71-1	TF0253	98	55° 50,3716' N	018° 51,8854' E	CTD
10.2.25 15:29	EMB359_72-1	TF0265	114	55° 58,3780' N	018° 59,8061' E	CTD
12.2.25 11:17	EMB359_73-1	T4 start	2	54° 14,7459' N	014° 03,5106' E	Insitupump
12.2.25 11:17	EMB359_73-1	T4 end	2	54° 28,9050' N	014° 20,5411' E	Insitupump
12.2.25 12:37	EMB359_74-1	OBBoje	13	54° 04,8316' N	014° 09,1436' E	CTD
13.2.25 14:40	EMB359_75-1	TF0245	107	57° 06,9840' N	017° 39,9548' E	CTD
14.2.25 9:30	EMB359_76-1	T9 start	2	57° 21,9706' N	017° 50,3938' E	Insitupump
14.2.25 9:30	EMB359_76-1	T9 end	2	58° 00,0252' N	017° 59,9947' E	Insitupump
14.2.25 14:56	EMB359_77-1	TF0240	164	57° 59,9371' N	017° 59,9418' E	CTD
14.2.25 19:11	EMB359_78-1	TF0284	439	58° 34,9390' N	018° 14,0073' E	CTD
14.2.25 20:20	EMB359_78-2	TF0284	130	58° 34,9887' N	018° 14,0209' E	CTD
14.2.25 21:00	EMB359_78-3	TF0284	13	58° 34,9990' N	018° 13,9548' E	CTD
14.2.25 21:21	EMB359_78-4	TF0284	105	58° 35,0134' N	018° 13,9483' E	CTD
15.2.25 0:41	EMB359_79-1	TF0283	120	58° 46,9703' N	019° 06,0896' E	CTD
15.2.25 5:16	EMB359_80-1	TF0285	119	58° 26,4899' N	020° 19,9758' E	CTD
15.2.25 5:17	EMB359_81-1	T8 start	2	58° 26,4937' N	020° 19,9517' E	Insitupump
15.2.25 5:17	EMB359_81-1	T8 end	2	57° 53,3273' N	019° 55,4572' E	Insitupump
15.2.25 8:51	EMB359_82-1	TF0286	190	57° 59,9555' N	019° 54,0418' E	CTD
15.2.25 9:28	EMB359_82-2	TF0286		58° 00,0006' N	019° 53,9660' E	SD

15.2.25 9:45	EMB359_82-3	TF0286	30	58° 00,0158' N	019° 53,9834' E	CTD
15.2.25 14:10	EMB359_83-1	TF0271 pollutants filter start	2	57° 19,2310' N	020° 03,1347' E	Insitupump
15.2.25 14:10	EMB359_83-1	TF0271 pollutants filter end	2	57° 19,1768' N	020° 02,9548' E	Insitupump
15.2.25 14:16	EMB359_83-2	TF0271	234	57° 19,0886' N	020° 02,9766' E	CTD
15.2.25 14:19	EMB359_83-3	TF0271		57° 19,0992' N	020° 02,9600' E	SD
15.2.25 15:00	EMB359_83-4	TF0271	104	57° 19,2153' N	020° 02,9720' E	CTD
15.2.25 15:45	EMB359_83-5	TF0271	28	57° 19,2103' N	020° 02,9817' E	CTD
15.2.25 15:54	EMB359_83-6	TF0271	30	57° 19,2279' N	020° 02,9914' E	3x PLA
15.2.25 16:22	EMB359_83-7	TF0271	120	57° 19,2158' N	020° 02,9308' E	CTD
16.2.25 2:16	EMB359_84-1	T7 start	2	57° 04,3015' N	020° 35,8013' E	Insitupump
16.2.25 2:16	EMB359_84-1	T7 end	2	56° 29,2492' N	019° 28,3567' E	Insitupump
17.2.25 0:02	EMB359_85-1	TF0213	86	55° 14,9980' N	015° 59,0507' E	CTD
17.2.25 0:07	EMB359_85-2	TF0213	30	55° 14,9924' N	015° 59,0445' E	1x PLA
17.2.25 0:53	EMB359_85-3	TF0213	86	55° 14,9698' N	015° 58,9922' E	WP2
17.2.25 1:05	EMB359_85-4	TF0213	86	55° 14,9776' N	015° 58,9606' E	WP2
17.2.25 1:16	EMB359_85-5	TF0213	49	55° 14,9583' N	015° 58,9524' E	WP2
17.2.25 1:24	EMB359_85-6	TF0213	86	55° 14,9559' N	015° 58,9519' E	WP2
17.2.25 1:46	EMB359_85-7	TF0213	87	55° 14,9812' N	015° 58,9497' E	APNET
17.2.25 2:14	EMB359_85-8	TF0213	87	55° 14,9706' N	015° 58,9533' E	APNET
17.2.25 2:35	EMB359_85-9	TF0213	87	55° 14,9047' N	015° 58,8319' E	APNET
17.2.25 9:54	EMB359_86-1	ARGO	1	54° 38,2511' N	014° 46,3136' E	WVGL
17.2.25 12:11	EMB359_87-1	TF0152	28	54° 37,9811' N	014° 17,1522' E	CTD
17.2.25 15:23	EMB359_88-1	TF0109	45	54° 59,9797' N	014° 05,0450' E	CTD
17.2.25 17:04	EMB359_89-1	TF0145_DK	43	55° 09,6046' N	014° 17,8124' E	CTD
17.2.25 18:22	EMB359_90-1	TF0144	39	55° 16,5810' N	014° 26,2169' E	CTD
17.2.25 22:13	EMB359_91-1	TF0122	44	54° 59,2867' N	013° 46,4893' E	CTD
17.2.25 23:47	EMB359_92-1	TF0113	45	54° 55,4868' N	013° 30,1552' E	CTD
17.2.25 23:48	EMB359_92-2	TF0113	20	54° 55,4780' N	013° 30,1379' E	PLA
18.2.25 0:16	EMB359_92-3	TF0113	44	54° 55,4508' N	013° 29,9753' E	WP2
18.2.25 0:26	EMB359_92-4	TF0113	33	54° 55,4744' N	013° 29,9682' E	WP2
18.2.25 0:33	EMB359_92-5	TF0113	44	54° 55,4625' N	013° 29,9472' E	WP2
18.2.25 2:06	EMB359_93-1	TF0114	42	54° 51,5719' N	013° 16,6880' E	CTD
18.2.25 3:32	EMB359_94-1	TF0115	27	54° 47,6572' N	013° 03,5754' E	CTD
18.2.25 5:03	EMB359_95-1	TF0030	20	54° 43,3863' N	012° 47,0970' E	CTD
18.2.25 5:50	EMB359_96-1	TF0001	19	54° 41,7643' N	012° 42,1400' E	CTD
18.2.25 7:21	EMB359_97-1	TF0002	15	54° 38,9721' N	012° 27,0012' E	CTD
18.2.25 11:04	EMB359_98-1	TF0046	26	54° 28,2029' N	012° 14,5172' E	CTD
18.2.25 11:05	EMB359_98-2	TF0046	15	54° 28,2039' N	012° 14,5090' E	PLA
18.2.25 11:05	EMB359_98-3	TF0046		54° 28,2040' N	012° 14,5072' E	SD
18.2.25 11:22	EMB359_98-4	TF0046	22	54° 28,1949' N	012° 14,4696' E	WP2
18.2.25 14:32	EMB359_99-1	TF0012	22	54° 18,9089' N	011° 33,0565' E	CTD
18.2.25 14:34	EMB359_99-2	TF0012		54° 18,9058' N	011° 33,0368' E	SD
18.2.25 14:40	EMB359_99-3	TF0012	15	54° 18,8966' N	011° 33,0234' E	PLA
18.2.25 14:57	EMB359_99-4	TF0012	22	54° 18,9052' N	011° 33,0172' E	WP2
18.2.25 17:33	EMB359_100-1	A3 Boltenhagen	21	54° 02,5850' N	011° 06,4899' E	CTD
18.2.25 18:01	EMB359_101-1	A1 Boltenhagen	21	54° 02,5331' N	011° 05,5222' E	CTD

18.2.25 18:23	EMB359_102-1	B1 Boltenhagen	16	54° 02,2765' N	011° 05,3825' E	CTD
18.2.25 18:47	EMB359_103-1	C1 Boltenhagen	12	54° 02,0410' N	011° 05,3931' E	CTD
18.2.25 19:09	EMB359_104-1	D1 Boltenhagen	8	54° 01,7826' N	011° 05,3532' E	CTD
18.2.25 19:29	EMB359_105-1	E1 Boltenhagen	7	54° 01,5112' N	011° 05,4316' E	CTD
18.2.25 19:51	EMB359_106-1	F1 Boltenhagen	6	54° 01,2449' N	011° 05,4034' E	CTD
19.2.25 5:52	EMB359_107-1	NH-Boje	9	54° 10,6943' N	011° 57,5452' E	CTD

7.2 Water Sampling – Parameters and Number of Samples

Station No. EMB359_xxx	Station name	O2	H2S-Best.	PO4	NO3	NO2	SIO4	NH4	P-Total	CH4_N2O	CO2	SPM	CKW/PAK	DNA-Filter	FISH Filter	P+G	Phyto-net	APSTE1 net	Chlorophyll	Phytoplankton	Zooplankton + Zoo.-DNA	PFAS
1	TFO5	1		3	3	3	3	3	2													1
2	TF0012	4		4	4	4	4	4	3					3			3		6	2	2	1
3	A3 Boltenhagen																					
4	A1 Boltenhagen																					
5	B1 Boltenhagen																					
6	C1 Boltenhagen																					
7	D1 Boltenhagen																					
8	E1 Boltenhagen																					
9	F1 Boltenhagen																					
10	TF0022	4		4	4	4	4															1
11	T1											4	2									
12	TF0014																					
13	TF0361																					
14	TF0360	11		3	3	3	3	3	3					3			3		4	3	1	1
15	Bio FB2																					
16	Bio FB1																					
17	Bio FB3																					
18	Bio FB4																					
19	TF0010	1		4	4	4	4															1
20	TF0013																					
21	T2											6	1									
22	TF0017																					
23	TF0041	1		3	3	3	3															
24	TF0046	1		4	4	4	4							3			3		6	2	2	1
25	TF0083																					
26	TF0033																					
27	TF0002	3		3	3	3	3															
28	TF0001	3		3	3	3	3															
29	TF0030																3		5	2		
30	TF0115	13		4	4	4	4															
31	TF0114	1		5	5	5	5															
32	T3											6	1									
33	TF0113	7		7	7	7	7	7	4	7	7			3			3		6	2	2	1
34	TF0109	1		5	5	5	5	5	4					3			3		5	2	1	1
35	ABBoje	2																				
36	TF0112	1		4	4	4	4															
37	TF0105	1		5	5	5	5															
38	TF0104	1		5	5	5	5															
39	TF0103	1		5	5	5	5															
40	TF0145_DK	1		5	5	5	5															

41	TF0144																					
42	TF0142_DK	10		5	5	5	5															
43	TF0140	1		6	6	6	6															
44	TF0206																					
45	TF0207																					
46	TF0208																					
47	TF0200	2		7	7	7	7															
48	T5											4	2									
49	TF0209																					
50	TF0211																					
51	TF0212																					
52	TF0214	1		7	7	7	7															
53	TF0213	10		10	10	10	10	10	6	10	10						3	3	6	2	4	
54	TF0221																					
55	TF0225																					
56	TF0226																					
57	TF0224																					
58	TF0227																					
59	TF0228																					
60	TF0229																					
61	TF0222	7		7	7	7	7	7														
62	T6											5	1									
63	TF0266	9																				
64	TF0267																					
65	TF0268																					
66	TF0256																					
67	TF0257		3																			
68	TF0259	6	2	7	7	7	7	7									3		5	2		
69	TF0255																					
70	TF0258	2	1																			
71	TF0253																					
72	TF0265	2	2																			
73	T4											9	1									
74	OBBoje	11		2	2	2	2															1
75	TF0245	15	2	8	8	8	8	8														
76	T9											6	1									
77	TF0240	5	5	10	10	10	10	10														
78	TF0284	11	20	29	29	29	29	29	10					52	26	52						
79	TF0283	1	3																			
80	TF0285	1	3																			
81	T8											6	1									
82	TF0286	9	8	16	16	16	16	16	6	16	16											
83	TF0271	21	19	34	34	34	34	34	12	24	21	3	1	52	26	52	3		5	2		
84	T7											6	1									
85	TF0213	16		7	7	7	7										1	3	6		4	
86	ARGO																					
87	TF0152																					
88	TF0109																					
89	TF0145_DK																					

90	TF0144																					
91	TF0122																					
92	TF0113															1		5		1		
93	TF0114																					
94	TF0115																					
95	TF0030																					
96	TF0001																					
97	TF0002																					
98	TF0046															1		6		1		
99	TF0012															1		5		1		
100	A3 Boltenhagen																					
101	D1 Boltenhagen																					
102	E1 Boltenhagen																					
103	F1 Boltenhagen																					
104	NHBoje																					
	Samples	54	68	231	231	231	231	143	50	57	54	55	12	119	52	104	31	6	70	19	19	9
	Stations	38	32	32	32	32	32	13	9	4	4	10	10	7	2	2	11	2	11	9	8	9
		O2	**H2S-Best.**	**PO4**	**NO3**	**NO2**	**SIO4**	**NH4**	**P-Total**	**CH4_N2O**	**CO2**	**SPM**	**CKW/PAK**	**DNA-Filter**	**FISH Filter**	**P+G**	**Phyto-net**	**APSTEI net**	**Chlorophyll**	**Phytoplankton**	**Zooplankton + Zoo.-DNA**	**PFAS**

7.3 List – Surface water transects of organic pollutants

Station No.	Profile Name	Start [UTC]	Latitude [WGS84]	Longitude [WGS84]	End [UTC]	Latitude [WGS84]	Longitude [WGS84]
EMB359_11-1	T1 - Kiel Bight	5.2.25 22:45	54° 33,2003' N	011° 19,0746' E	5.2.25 22:45	54° 36,0217' N	010° 26,9578' E
EMB359_21-1	T2 - Mecklenbug Bight	6.2.25 13:03	54° 28,5202' N	011° 29,1117' E	6.2.25 13:03	54° 36,1526' N	012° 19,6407' E
EMB359_32-1	T3 - Arkona Basin	7.2.25 1:48	54° 51,6005' N	013° 16,5504' E	7.2.25 1:48	54° 57,0416' N	014° 01,2330' E
EMB359_48-1	T5 - Bornholm Basin	9.2.25 6:27	55° 22,9825' N	015° 20,1918' E	9.2.25 6:27	55° 12,1328' N	015° 48,5179' E
EMB359_62-1	T6 - Slupsk Channel	9.2.25 23:50	55° 12,9894' N	017° 04,0255' E	9.2.25 23:50	55° 20,8320' N	018° 15,1609' E
EMB359_73-1	T4 - Oder Bank	12.2.25 11:17	54° 14,7459' N	014° 03,5106' E	12.2.25 11:17	54° 28,9050' N	014° 20,5411' E
EMB359_76-1	T9 - Western Gotland Basin	14.2.25 9:30	57° 21,9706' N	017° 50,3938' E	14.2.25 9:30	58° 00,0252' N	017° 59,9947' E
EMB359_81-1	T8 - Northern Gotland Basin	15.2.25 5:17	58° 26,4937' N	020° 19,9517' E	15.2.25 5:17	57° 53,3273' N	019° 55,4572' E
EMB359_83-1	TF0271 - stationary filtering	15.2.25 14:10	57° 19,2310' N	020° 03,1347' E	15.2.25 14:10	57° 19,1768' N	020° 02,9548' E
EMB359_84-1	T7 - Eastern Gotland Basin	16.2.25 2:16	57° 04,3015' N	020° 35,8013' E	16.2.25 2:16	56° 29,2492' N	019° 28,3567' E

7.4 List – Sediment coring

Date Time [UTC]	Station No.	Station Name	Depth [m]	Latitude	Longitude	Gear	Sampling
6.2.25 6:54	EMB359_15-2	Bio FB2	25	54° 32,5016' N	010° 41,1638' E	MUC	2 cores
6.2.25 7:49	EMB359_16-2	Bio FB1	24	54° 32,8979' N	010° 46,1078' E	MUC	2 cores
6.2.25 8:32	EMB359_17-2	Bio FB3	25	54° 33,4218' N	010° 45,3046' E	MUC	2 cores
6.2.25 9:17	EMB359_18-2	Bio FB4	25	54° 33,7984' N	010° 46,4571' E	MUC	2 cores

8. Data and Sample Storage and Availability

All data gathered will be stored 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). 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. Date from German waters will be stored additionally in the BSH MUDAB data base.

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 any 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 8.1 Data availability and responsible scientists.

Type	Database	Available	Free Access	Contact
Hydrographic measurements	IOW DB, MUDAB, HELCOM, ICES	January 2024	December 2025	Naumann. Michael. Dr. michael.naumann@io-warnemuende.de
Nutrient measurements	IOW DB, MUDAB, HELCOM, ICES	March 2024	January 2027	Kuss. Joachim. Dr. joachim.kuss@io-warnemuende.de
Phytoplankton measurements	Personal contact	June 2024	February 2027	Kremp. Anke. Dr. anke.kremp@io-warnemuende.de
Zooplankton measurements	Personal contact	June 2024	February 2027	Dutz. Jörg. Dr. joerg.dutz@io-warnemuende.de

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11. Abbreviations

Defined in the text.

12. Appendices

No appendices.