ELISABETH MANN BORGESE – Berichte

Baltic Sea Long-term Observation Programme

Cruise No. EMB 242

14 July – 28 July 2020,

Rostock – Rostock (Germany)

HELCOM/long-term

BALTIC SEA LONG-TERM OBSERVATION PROGRAMME
OF THE
LEIBNIZ INSTITUTE FOR
BALTIC SEA RESEARCH
WARNEMÜNDE

EMB 242

iow

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2020

Table of Contents

1 Cruise Summary

1.1 Summary in English

The cruise of r/v Elisabeth Mann Borgese No. 242 from July 14th to 28th July 2020 was done in the frame of the HELCOM monitoring and the IOW long-term observation of the Baltic Sea. During fair weather conditions with moderate winds and mostly around 17°C the workplan was fulfilled. Only from 18th-20th July air temperature reached pleasurable 20°C that suddenly ended on 21st July by elevated wind speed of up to 7 bft. The different parts with a total of 94 stations (4 repetitions included) comprise the hydrographic, hydrochemical and biological monitoring in German territorial waters and bordering sea areas as well as on the thalweg transect, from the Belt Sea to northern and western Gotland Sea with three transverse ScanFish transects to additionally provide data for hydrographic modelling purposes. In addition, sediment and water from a few near-coastal sites were sampled including the Pomeranian Bay and the Gulf of Riga for analysis of contaminants of emerging concern (BaltPoll).

Preliminary results show that inorganic nitrogen nutrients were almost depleted in the upper water column, whereas remains of phosphate were still available, also in surface waters. The oxygen concentration in bottom waters of the western Baltic Sea was still good, the Bornholm Sea and the southern Gotland Sea bottom waters were not anoxic at the time of measurement, whereas the deep eastern and western Gotland Basins showed a strong oxygen deficit. Accordingly, nitrate was not found in the bottom waters of the Gotland, Fårö, Landsort, and Karlsö Deeps in July 2020 like in previous years. For the weakly oxic Bornholm Deep a high nitrate concentration of 7.2 µM was determined. Thereby, phosphate showed an increasing tendency in the Gotland Deep bottom waters but almost stable conditions on different levels in the Fårö, Landsort, and Karlsö Deeps in summers of recent years.

In the frame of BaltPoll 44 PPCPs (pharmaceuticals and personal care products) were systematically investigated in the Baltic Sea's water column and sediments during the cruise. Preliminary results of the water column display increased concentrations in the near coastal waters with a decreasing trend towards the open Baltic Sea. Results show that PPCPs are transported into the open Baltic Sea. Furthermore, PPCPs were detected in the vertical profile of the water column with slightly higher concentrations in the near bottom layer than in the surface water.

1.2 Zusammenfassung

Die Reise des F/S Elisabeth Mann Borgese Nr. 242 vom 14. bis 28. Juli 2020 wurde im Rahmen des HELCOM Monitorings und der IOW Langzeit Überwachung der Ostsee durchgeführt. Bei angenehmen Wetterbedingungen mit mäßigen Winden und Temperaturen um 17°C wurde das Arbeitsprogramm geschafft. Nur vom 18.-20. Juli stieg die Lufttemperatur auf angenehme 20°C, was dann aber plötzlich durch stärkere Winde bis zu 7 Bft am 21. Juli beendet wurde. Die verschiedenen Aufgaben mit insgesamt 94 Stationen (mit 4 Wiederholstationen) umfassten das hydrographische, chemische und biologische Monitoring in den deutschen Territorialgewässern und angrenzender Meeresgebiete sowie auf dem Talweg Schnitt von der Beltsee bis in die nördliche und westliche Gotlandsee mit 3 ScanFish Querschnitten, die weitere Daten für die hydrographische Modellierung liefern sollen. Darüber hinaus wurden Sediment- und Wasserproben von einigen küstennahen Stationen genommen, so auch von der Pommernbucht und dem Rigaischen Meerbusen, für die Analyse von neuen Schadstoffen (BaltPoll).

Erste Ergebnisse zeigen, dass anorganische Stickstoffnährstoffe in der oberen Wassersäule nahezu verbraucht, wogegen Phosphatreste noch vorhanden waren, oft sogar im Oberflächenwasser. Die Sauerstoffkonzentration im Bodenwasser der westlichen Ostsee war noch gut, das Bodenwasser der Bornholm- und südlichen Gotlandsee war noch nicht anoxisch, wogegen die tiefen östlichen und westlichen Gotlandbecken einen ausgeprägten Sauerstoffmangel aufwiesen. Entsprechend konnte im Bodenwasser der Gotland-, Fårö-, Landsort-, und Karlsötiefs im Juli 2020 kein Nitrat nachgewiesen werden, wie auch schon in den vergangenen Jahren. Für das schwach oxische Bodenwasser des Bornholmtiefs wurde eine Nitratkonzentration von 7.2 µM bestimmt. Für die Phosphatkonzentration wurde eine ansteigende Tendenz im Gotlandtief Bodenwasser, aber in etwa stabile Konzentrationen auf unterschiedlichen Niveaus für das Bodenwasser im Fårö-, Landsort-, und Karlsötief für die Sommer der letzten Jahren ermittelt.
Im Rahmen von BaltPoll wurden 44 PPCPs (Produkte der pharmazeutischen und der Kosmetikindustrie) in der Wassersäule und in den Sedimenten der Ostsee während der Fahrt systematisch untersucht. Vorläufige Ergebnisse von der Wassersäule zeigen erhöhte Konzentrationen in den küstennahen Gewässern mit einem abnehmenden Trend zur offenen Ostsee. Die Ergebnisse zeigen, dass PPCPs in die offene Ostsee transportiert werden. Darüber hinaus wurden PPCPs im vertikalen Profil der Wassersäule mit etwas höheren Konzentrationen in der bodennahen Schicht als im Oberflächenwasser nachgewiesen.

2 Participants

2.1 Principal Investigators

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

2.2 Scientific Party

Name	Discipline	Institution
Kuss, Joachim, Dr.	Marine Chemistry, Chief Scientist	IOW
Kolbe, Martin	Phys. Oceanography, CTD	IOW
Donath, Jan	Phys. Oceanography, CTD	IOW
Dierken, Madleen	Marine Chemistry, Nutrients	IOW
Fisch, Kathrin, Dr.	Marine Chemistry, Organic pollutants	IOW
Schöne, Susanne	Marine Chemistry, Oxygen	IOW
Pötzsch, Michael	Biol. Oceanogr., Plankton and Microbiol.	IOW

2.3 Participating Institutions

IOW Leibniz Institute for Baltic Sea Research Warnemünde

3 Research Program

3.1 Description of the Work Area

The working area for IOW's contribution to the HELCOM monitoring comprized German territorial waters with the German Exclusive Economic Zone and bordering sea areas. Therefore, basic hydrographic data, major nutrients, phyto- and zooplankton parameters were determined. Moreover, the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) extends the investigated sites by its long-term observation programme of the Baltic Sea. This contributes with station work in parts of the Belt Sea, the Arkona Sea, and the Bornholm Sea, as well as the eastern and western Gotland Sea. Project work about modern contaminants was included into the cruise's work programme. Therefore, near coastal sites in Kiel Fjord, Mecklenburg Bight, Odra Bight, Pomeranian Bay and the Gulf of Riga were sampled. A major focus is always on the thalweg transect, which reflects the main path of inflowing North Sea water via the Belt Sea, Arkona Sea along the Słupsk channel (Bornholm Sea) in the eastern Gotland Sea Basin and further to the northern Gotland Sea, bringing episodically haline oxygen rich water to the central basins. These work was supplemented by three west-east ScanFish transects and one from the Karlsö Deep to the Bornholm Deep to provide data for hydrographic modelling purposes. An overview of the location of CTD stations and ScanFish transects are shown in Fig. 3.1. In addition, the list of stations is given in Chapter 6.

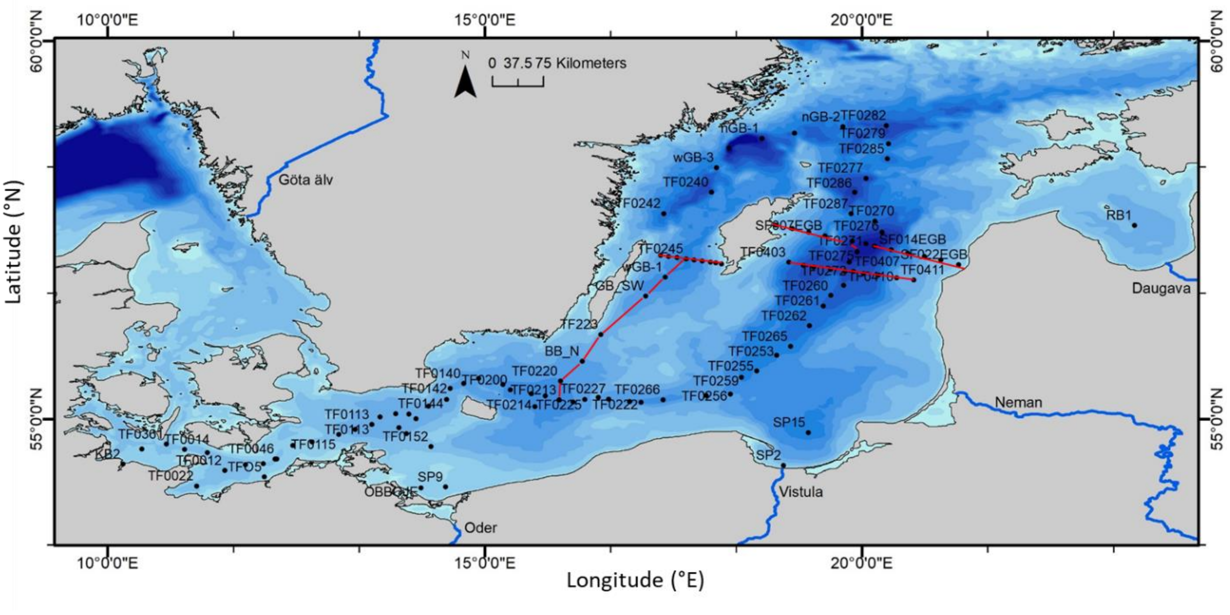

Fig. 3.1 Map of stations (black dots) and the Scan fish transects (red lines) of the cruise EMB 242 from 14th – 28th July 2020; for clarity, a couple of station names are not shown; for the details of the sampled stations the reader is referred to the list of stations in Chapter 6.

3.2 Aims of the Cruise

The cruise EMB 242 was carried out as a joined cruise of the environmental monitoring programme of the Federal Maritime and Hydrographic Agency (BSH) and the Baltic Sea long-term observation programme of the IOW. It was the third cruise in 2020 as one of usually five expeditions performed annually, however the March monitoring cruise was cancelled due to the pandemic Covid-19.

The acquired data are used for the regular national and international assessments of the state of the Baltic Sea, and provide the scientific basis for measures to be taken for the protection of the Baltic Sea ecosystem. The hydrographic and hydrochemical conditions as well as the development of phyto- and zooplankton populations are investigated. Microbiological aspects, acidification, trace gases were additionally studied in the frames of the long-term observation of the Baltic Sea and of projects. A special focus of the long-term observation is always the occurrence or absence of inflow events that both have major consequences for the state of the Baltic Sea hydrochemistry and the ecosystem. The oxygen entrained by the Major Baltic Inflows that occurred between 2014 and 2016 vanished and euxinic conditions prevail in deep waters. Baroclinic inflows of warm water of summer 2018 caused a record high bottom water temperature in the Gotland Deep in 2019 but did not improve the oxygen situation significantly. Some inflow events of weak intensity during 2019 layered in the intermediate waters of the eastern Gotland Sea basin (Naumann et al., 2020 subm.), but these had no effect on bottom waters.

For the **BaltPoll** project, the aim during this cruise was to investigate the occurrence of contaminants of emerging concern in the Baltic Sea. The acquired samples will be used to investigate the distribution patterns of pharmaceuticals and personal care products in the Baltic Sea and their distribution between the water and sediment phase. The investigation of these contaminants will allow to display the current degree of pollution in the Baltic Sea. Furthermore, the near shore and off-shore samples will provide us with more knowledge about their potential off-shore transport and their behaviour in the marine environment. The comparison of water and sediment samples will further point towards potential sinks and even possible accumulation regions in the Baltic Sea.

3.3 Agenda of the Cruise

3.3.1 Station work

The work on the stations usually started with a CTD cast and already programmed sampling on standard depth levels and manual releases in near-bottom waters and close to the sea surface. Then other CTD casts follow to meet the additional water sample requirements on the respective stations. Net sampling and depth of visibility determinations by means of a Secci disk were done on selected stations. The project on modern contaminants required a couple of multicorer hauls to sample surface sediment. For details see list of stations in Chapter 6.

CTD and Sampling

The CTD-system "SBE 911plus" (SEABIRD-ELECTRONICS, USA) was used to measure the variables: Pressure, Temperature (2x SBE 3), Conductivity (2x SBE 4), Oxygen concentration (2x SBE 43), Chlorophyll-a fluorescence (683 nm), Turbidity, Photosynthetic active radiation in water (PAR), and above the sea (SPAR).

The Rosette water sampler was equipped with 13 Free Flow bottles of 5 L volume each. The CTD sensors were checked during the cruise by comparison measurements. In detail, for temperature a high precision thermometer SBE RT35 was used. Salinity samples were taken for measurement after the cruise by means of a salinometer. Slope and offset of the oxygen sensors SBE 43 are determined by daily comparison with Winkler titration.

Nutrients

Nitrate, nitrite, phosphate, and silicate were analyzed using standard colorimetric methods by means of an autoanalyser (FlowSys, Alliance-Instruments, Ainring, Germany) and ammonium was determined manually as indophenole blue (Grasshoff et al., 1999) from unfiltered water on-board. Total and total dissolved nitrogen and phosphorous samples as well as particulate and dissolved organic matter samples were prepared and stored deep frozen for digestion and analysis in the IOW nutrients and natural organic matter labs, respectively.

Oxygen and hydrogen sulphide

Oxygen was analyzed by Winkler titration and hydrogen sulphide was determined spectrophotometrically by the methylene blue reaction (Grasshoff et al., 1999). To continue the oxygen profiles in anoxic waters and for comparison, H_2S concentration was converted to negative oxygen values according to its reduction capacity: $H_2S + 2\ O_2 \text{ -> } H_2SO_4$. During CTD casts the SBE 43 oxygen sensor (duplicate installation) recorded oxygen values that are validated by daily Winkler titration of triplicate samples from 3 water sampling bottles released according to a specific time-regime.

Plankton sampling

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

Long-term observation of the microbiological habitat of the redoxcline

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

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

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

Methane production in the oxic water body (OxiMeth)

For the preparation of an incubation experiment in the frame of the study OxiMeth, water samples from surface water (5 m: 15 x 1 L and 15 x ca. 160 ml) and of the sub-thermocline range (40 m, 15 x 1 L und 15 x 160 ml) were taken on station TF0213 Bornholm Deep. It is investigated which substrates are used during methane production in different zones of the oxic water body. Moreover, water samples were taken in the thermocline range for a high resolution methane profile in oxic waters. (Responsible scientists: Dr. Oliver Schmale, Dr. Marion Kanwischer).

*Contaminants of emerging concern (pharmaceuticals and personal care products) as anthropogenic indicators in the Baltic Sea (**BaltPoll**)*

To investigate the distribution patterns of contaminants of emerging concern such as pharmaceuticals and personal care products (PPCPs) and polar pesticides (Glyphosate) in the Baltic Sea, water samples were taken at 18 stations during this cruise. For the PPCPs analysis, 1 L water samples were taken at different depths (surface, Chl_a maximum, and bottom). Each sample was acidified (pH=3), spiked with an internal standard, and enriched on OASIS HLB® solid-phase extraction column and then stored at -20°C. Samples for Glyphosate analysis were frozen at -20°C. The samples will be analysed for PPCPs (**BaltPoll**) and for Glyphosate at IOW laboratories. Surface sediment (0-1cm) was sampled on 11 stations by multicorer hauls. Two cores (up to 34 cm) were taken at SP15 and RB1 (Fig. 3.1). These will be analyzed for PPCPs and POPs (persistent organic pollutants). All sediment samples were stored at -20°C for further analysis in the IOW laboratories.

The acquired PPCPs samples will be analysed to investigate the horizontal (off-shore) and vertical transport of PPCPs in the water column. The data set will be the basis to determine possible sinks for PPCPs in the Baltic Sea and to study their partitioning between the water and sediment phase. (Responsible scientists: Dr. Kathrin Fisch, Prof. Detlef Schulz-Bull).

Self-cleaning monitoring box (SMB)

The SMB (4H-Jena) system (Leibniz Institute for Baltic Sea Research4H-Jena, 2020) is aimed to improve standard thermosalinograph measurements by regular cleaning intervals. Therefore, the shape of the sensor enclosure is constructed to enable effective automatic cleaning. The measurement ranges, the accuracy or alternatively the sensitivity of the measurements are as follows: conductivity with a range of 0 to 70 mS/cm, and an accuracy of 0.003 mS/cm, temperature (-3 to 35 °C, 0.002 °C), salinity (2 to 42, 0.005), sound velocity (1375 to 1625 m/s, 0.025 m/s), turbidity (0 to 25 NTU, 0.013 NTU sensitivity), and chlorophyll_a (0 to 50 µg/L, 0.025 µg/L sensitivity). The system was used during transect for recording of these parameters in surface water that was pumped from below the ship’s hull. Preliminary data of temperature, salinity, chlorophyll_a and turbidity are shown in Figure 5.2 (Responsible scientists: Siegfried Krüger, Johann Ruickoldt).

Scan fish

An undulating CTD-system with fluorometer and oxygen sensor was tugged on 4 transects. The transverse transects versus the thalweg, two in the eastern and on in the western Gotland Basin and on along the route from the central western Gotland Basin to the Bornholm Basin.

The ScanFish is a towed platform in wing shape allowing to accumulate CTD data of the water column in an undulating manner from surface to about 200 m maximum depth. It offers a payload to accommodate a pumped Seabird CTD application consisting of a Seabird SBE911+ probe, temperature (SBE3), conductivity (SBE4) (salinity) and oxygen (SBE43) sensor. Additionally, a Wetlabs FLNTU is installed for chlorophyll and turbidity recording. The central ScanFish controller supports DSL data transfer protocols and speed, making it very flexible to interface with additional sensors and devices (Responsible scientists: Siegfried Krüger, Martin Kolbe).

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 forecasted weather and sea condition as predicted by the Deutscher Wetterdienst (DWD)(2020) for the respective days.
Tuesday, 14 July 2020: The weather forecast for the day was wind of first variable directions of 2 to 4 Bft, then westerly winds 3 to 4 Bft, locally misty and a sea of 0.5 m wave height. The start of the working program was scheduled for 15:30 o'clock on station TFO5. A certain delay was caused by missing Covid-19 test results of crew members. We left the pier at 15:00 o'clock with about one-hour delay. Some problems occurred in the very beginning with the "dship" server that was offline. Usually it provides the GPS data for the stations protocol. TFO5 was completed successfully with the sampling for oxygen, the nutrients nitrate, nitrite, phosphate, silicate, ammonium, total nitrogen and total phosphorous as well as for the dissolved and particulate natural organic matter analyses. In this way the TFO5 served as a test station for all chemical parameters. Then TF0012 followed with first plankton net hauls and an early oxygen inter-comparison measurement here. The "dship" was fully in operation again. We did a final CTD cast as well as a multicorer haul on TF0022 in the Lübeck Bight in the evening of the first day.
Wednesday, 15 July: For the Belts and Sound westerly winds of about 3 Bft were forecasted with some mist and later local thunderstorms at a sea below 0.5 metre wave height. Early in the morning we sampled TF0010 for nutrients and about one hour later the TF0014. A CTD cast followed by a multicorer haul were then done after breakfast on KB2 in the Kiel fjord close to the lighthouse of "Friedrichsort". The weather was calm and the sea flat, partly sunny but hazy. The Kiel Bight stations TF0360 with an extensive work programme and TF0361 were completed next. On the way back to the east we sampled TF0017, TF0041, and TF0046, the latter again with the comprehensive parameter set and a multicorer haul. Finally, TF0002, a hydrographic station with oxygen and inorganic nutrient determinations was completed.
Thursday, 16 July: The weather on Thursday was expected to be fine again, with northerly winds of 3 to 4 Bft and light and variable winds later. Local shower squalls some mist from time to time at a calm sea of 0.5 metre allowed undisturbed work. We started at 2:15 o'clock on TF0001, from the Darss Sill via TF0115, TF0114, TF0113, TF0105, TF0104, TF0103, TF0109, ABBoje, TF0112, in the central Arkona Sea round the Island of Rügen and then far south close to the mouth of river Odra for station OBBoje during a sunny day with light winds, to cover basically the HELCOM monitoring obligations on behalf of BSH. On station OBBoje close to the MARNET discus-buoy, we took samples for oxygen inter-comparison measurements according to Winkler at the depth levels 3 m and 12 m of the oxygen sensors of the buoy. In a distance of about 12 n.m.

east of the Odra Bank buoy, already in Polish territorial waters, we had a multicorer haul and again a CTD cast with sampling for new organic pollutants on station SP9.

Friday, 17 July: The weather forecast for the western Baltic Sea: wind from northwest of 3 to 4 Bft with a decreasing tendency at a sea 0.5 m wave height. During the night we went back in northern direction to the central Arkona Basin. We started the work programme early in the morning at 3:20 o'clock on TF0152. Then TF0145 was completed with standard nutrient and oxygen measurements like on the station before, but additionally, with a multicorer haul. Stations TF0144, TF0142, TF0140 followed and around noon we reached the Bornholmsgat between Bornholm and Sweden, where the transfer of deep waters from the Arkona Basin to the Bornholm Basin could happen, but not at the time of our cruise. Then TF0206, TF0208, TF0200, TF0211, TF0214, TF0212, were completed with basically hydrographic investigations, i.e., CTD-casts. In the evening the wind calmed down and the sea looked shimmering and colourful in the sundown. As the last station of the day, the busy station Bornholm Deep (TF0213) was scheduled for the late evening but was completed well before midnight.

Saturday, 18 July: For the Southern Baltic wind was forecasted at first, light and variable and then easterly winds of 2 to 3 Bft. Early in the morning we had fog and a flat sea surface. The first stations were completed as pure CTD-casts without water sampling at TF0221, TF0225, TF0224, TF0227, TF0229, along the thalweg transect. After breakfast the TF0222, TF0266, TF0268, TF0256, on an already sunny morning. Then we moved far south into the Pomeranian Bight to fulfil the multicorer sampling and water sampling for new pollutants on SP2 and SP15. The transit time over dinner was used for a barbeque. This social event was done on the working deck for the crew and the scientists together at nice weather conditions. The subsequent water and sediment sampling close to the Vistula River estuary contributed again to the BaltPoll study on pharmaceuticals and personal care products (PPCPs).

Sunday, 19 July: On this sunny Sunday with light and variable winds at a sea of 0.5 m wave height, we started at 8:00 o'clock on station TF0259 with sampling for standard nutrients and ammonium and additional for hydrogen sulphide analysis. The following hydrographic station TF0255 was completed by a CTD-cast without water sampling. TF0253 was the selected reference site for the PPCPs investigation that included multicorer sediment and water sampling. Then TF0265, TF0262, TF0261, TF0260, and finally TF0274 late in the evening were fulfilled along the thalweg, heading further north.

Monday, 20 July: For the central Baltic Sea southerly winds of 2 to 3 Bft with an increasing tendency were expected for the day. Later thundery gusts at a calm sea of 0.5 m wave height were forecasted. For this day, mainly the ScanFish transect transversely to the thalweg transect at about 57°N was scheduled. It was started after midnight in the east with a CTD cast and oxygen measurements for comparison purposes with the ScanFish sensors. The ScanFish transect was done until about 6:00 o'clock in the morning, when a data transmission failure occurred. An exchange of the winch with the spare winch that provided a new cable connector solved the problem. For comparison again a CTD cast was done at already more than 180 m depth at station TF0407. At light rain the ScanFish was deployed again. The ScanFish transect could subsequently be completed without problems. A CTD cast with an oxygen comparison measurement in the afternoon finalized the transect. For the evening the stations TF0272, TF0275, and the central station of the Baltic Sea monitoring TF0271 Gotland Deep were scheduled. The latter required many CTD casts with water sampling from selected depths distributed on a 240 m water column for most parameters investigated during the cruise. The foci were the redoxcline that is of major importance with respect microorganisms living in niches of gradients and doing specialized metabolic processes and the oxygen/hydrogen sulphide situation in the deep waters. The preparation of the samples stretched until about 2:00 am. Then the transit to the second ScanFish transect was done, which was scheduled to start close to the coast of the Island of Gotland that enabled recovery for most of the members of the scientific crew.

Tuesday, 21 July: The weather forecast for the day predicted westerly winds of 4 to 5 Bft and locally even 6 Bft for the study area. Shower squalls and thunderstorms were expected at a sea of 1.5 m wave height. However, the ScanFish transect was started at 6:00 o'clock in the morning on SF01EGB far in the west of the eastern Gotland Basin, close to the Island of Gotland. The transect guided about 85 n.m. along the "SF_EGB" station chain. Also this transect is orientated transversely to the thalweg from west-northwest to east-southeast with the Gotland Deep station in the centre of the chain. The transect took about 14 hours at a speed of almost 6 kn. However, in the deeper parts of below 200 m it appeared that the energy needs of the steering flaps were too high to reach the close bottom range. So the next stations SF12EGB (244 m deep) in the Gotland Deep and SF14EGB (146 m deep) were done by CTD casts. After the CTD cast on SF14EGB, the ScanFish was deployed again and the transect was continued. At the final station of the transect a CTD cast and an oxygen comparison measurement was done. Then we headed North and the long transit into the Gulf of Riga began. The transit took about 12 hours plus 10 hours back of valuable ship time, but indeed brought us to an interesting site influenced by the large River Daugava. The Gulf of Riga was rarely investigated by IOW research groups.

Wednesday, 22 July: For the Gulf of Riga also a bit stronger wind from west to northwest of 4 to 5 Bft partly even higher was forecasted, but the sea state of 1 metre wave height wouldn't cause any problems for the scheduled work. The long transit to the station RB1 in the Gulf of Riga was continued in the morning at calm sea conditions in the enclosed sea area. It was a rainy day with less than 15°C in the morning, rather cold for end of July. At about 9:00 o'clock in the morning we reached RB1 and started with a CTD cast followed by a multicorer haul again for new pollutants like PPCPs. A 10-hour transit brought us back to the thalweg. In the evening, we completed CTD casts on TF0276 and TF0270.

Thursday, 23 July: The forecast for the day was elevated wind from northwest of 4 to 5 Bft with local shower- or thundery gusts that turned out to be up to 7 Bft at a sea of 1.5 metre wave height. Early in the morning on the hydrographic station TF0287 just a CTD cast was done. After breakfast the station Fårö Deep (TF0286) was investigated by two CTD casts with water sampling and filtration for nutrients with total nitrogen as well as total phosphorus and ammonium, oxygen, the greenhouse gases methane and dinitrogen oxide. The hydrographic stations TF0277, TF0285, TF279, TF282, the mooring station nGB-2, TF0283, and the mooring station nGB-1 in the northern part of the Gotland Basin were subsequently completed by CTD casts only.

Friday, 24 July: The wind calmed down over night and was forecasted to about 4 Bft changing its direction from west to southwest, but temporarily increasing to 6-7 Bft at a sea of 2 meter. We started in the morning at the deepest site in the Baltic Sea, the Landsort Deep station (TF0284). As one of the main monitoring stations, all nutrient parameters as well as oxygen and hydrogen sulphide were sampled and analysed. Secci depth was determined and net hauls were done as well as water from the redoxcline range was taken and filtrated for final microbiological analyses on the collected particles in the IOW labs. Over noon the weather changed from partly-cloudy and

sunny to misty and rainy. Until the next ScanFish transect the hydrographic stations wGB-3, TF0240, TF0242 were completed just by CTD casts and a few oxygen comparison measurements to observe the stability of the oxygen sensor and potentially to correct the readings.
Saturday, 25 July: After midnight the ScanFish transect in the western Gotland Sea was started on station SF032WGB. Like the other transects, it was orientated transversally to the thalweg that is assumed to continue in the western basin after passing north of the Island of Gotland. The ScanFish was recovered on SF025WGB at 6:00 o'clock near the island of Öland. Then we went back for one hour along the ScanFish transect to reach the Karlsö Deep station TF0245 again (Fig. 3.1), also one of the main station in IOW monitoring for a CTD cast with water sampling for standard parameters. Then we deployed the ScanFish again and continued to go further south to reach the mooring station wGB-1. The weather was fine with light and variable winds and some sunshine, but the wind was forecasted to increase to 4 Bft with shower squalls at a sea of 1 m wave height. The work over night was then the recovery of the ScanFish, a CTD-cast and deployment of the ScanFish afterwards on each of the next four stations GB_SW, TF223, BB_N, TF0220.
Sunday, 26 July: On station Bornholm Deep (TF0213), the ScanFish was finally recovered for this cruise in the late morning. Overall it worked pretty well. A few problems could be solved rapidly. The weather forecast was again suitable for the final activities at westerly winds of 4 Bft, shifting south to southeast thereby decreasing to 3 Bft. A calm sea state was forecasted with an expected wave height of 0.5 meters only. The station work began at noon. Several CTD casts were done to meet the water requirement for the nutrient measurements, phytoplankton species composition determination, and for a detailed inspection of the methane concentration distribution across the thermocline. Moreover, water sampling was done for an incubation experiment on the differences between the above and below thermocline methane production. Zooplankton net hauls, Secci depth determination, and of course the salinity, temperature and oxygen profiles were also completed. We left the station at about 15:00 o'clock heading west-southwest to the central Arkona Basin.
Monday, 27 July: The weather was forecasted to be fine that day with south-westerly winds of 2 to 3 Bft, shifting southeast that could increase to 5 Bft at a sea of up to 1 metre wave height. We reached the central Arkona Sea on the sunny morning and started with the repetition station TF0113, and afterwards the repetition stations TF046 as well as TF0012 followed, already in the Belt Sea and close to Rostock harbour.
Tuesday, 28 July: We entered the harbour and dock at the pier at about 7:00 o'clock in the morning. All the equipment was removed from board and carried on trucks and in vans back to the institute or to the nearby storage depot. The large amount of valuable sample material, either sediments, water or frozen filters were taken in cooling boxes that these could be subjected to further analyses as far as possible unaffected by transport and handling in the IOW labs.

5 Preliminary Results

The results presented in the following section are preliminary and many samples taken are to be analysed and interpreted during the next weeks and months. The aim of this section is to give a first impression on the collected data set. An advanced data analysis will follow when the validated data sets are available.

5.1 Meteorological conditions

The development of the on-board measured wind speed, the air temperature and the surface water temperature (upper panel) as well as the wind direction and humidity (lower panel) during the cruise are shown in Fig. 5.1. Wind was mainly weak (from easterly directions) to moderate (westerly directions), only between 21st to 23rd July an elevated wind speed of up to 6-7 bft was observed in the Gulf of Riga and the northern Gotland Sea. Air temperature was relatively low for end of July and was often around 17°C (12.5-23.5 °C). During 18th-20th July it was a bit warmer with an air temperature of about 20°C. The surface water temperatures were between 15 and 23°C (Fig. 5.1).

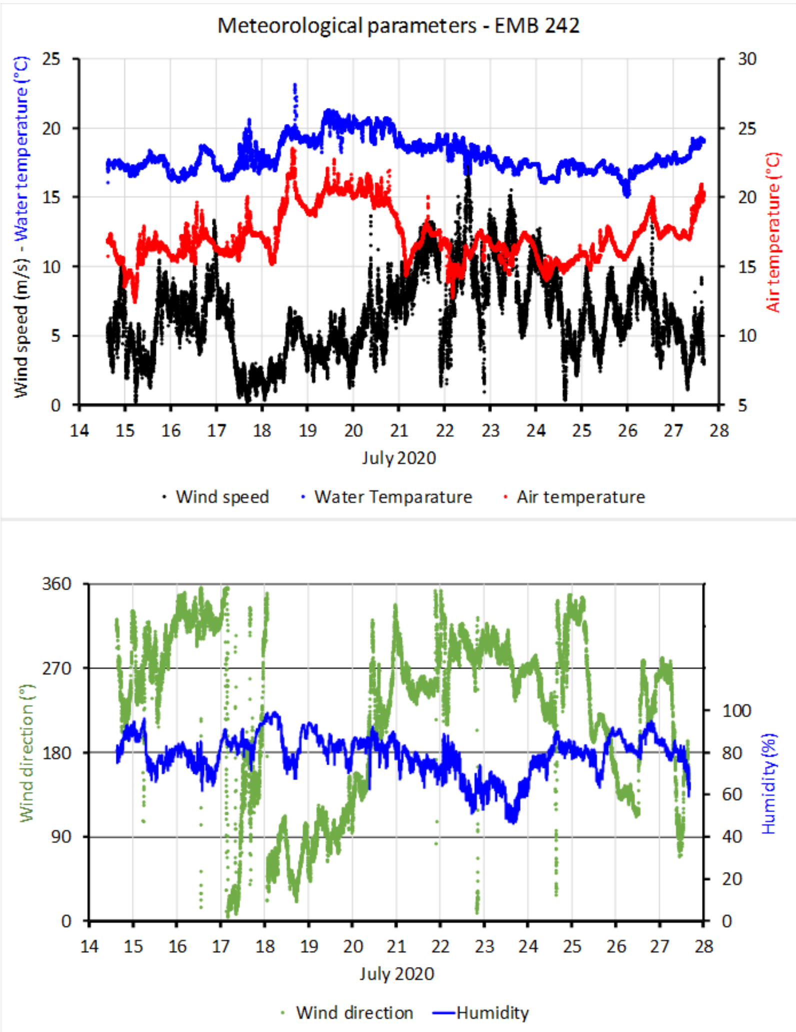

Fig. 5.1 Surface water temperature, air temperature, and wind speed (upper panel) as well as humidity and wind direction measured on-board by the automatic weather station of the DWD; surface water temperature was measured by the SMB-thermosalinograph.

Likely the imprint of freshwater caused elevated chlorophyll_a concentration in the Pomeranian Bay and the Gulf of Riga (Fig. 5.2), but also in the northern Gotland Sea and the transition area between the Bornholm Sea and the Arkona Sea higher chlorophyll_a concentrations were determined by surface water sensor measurements in July 2020. Increased turbidity appeared to be linked to shallower areas at least in the eastern Gotland Sea (Fig. 5.2, upper panel, orange).

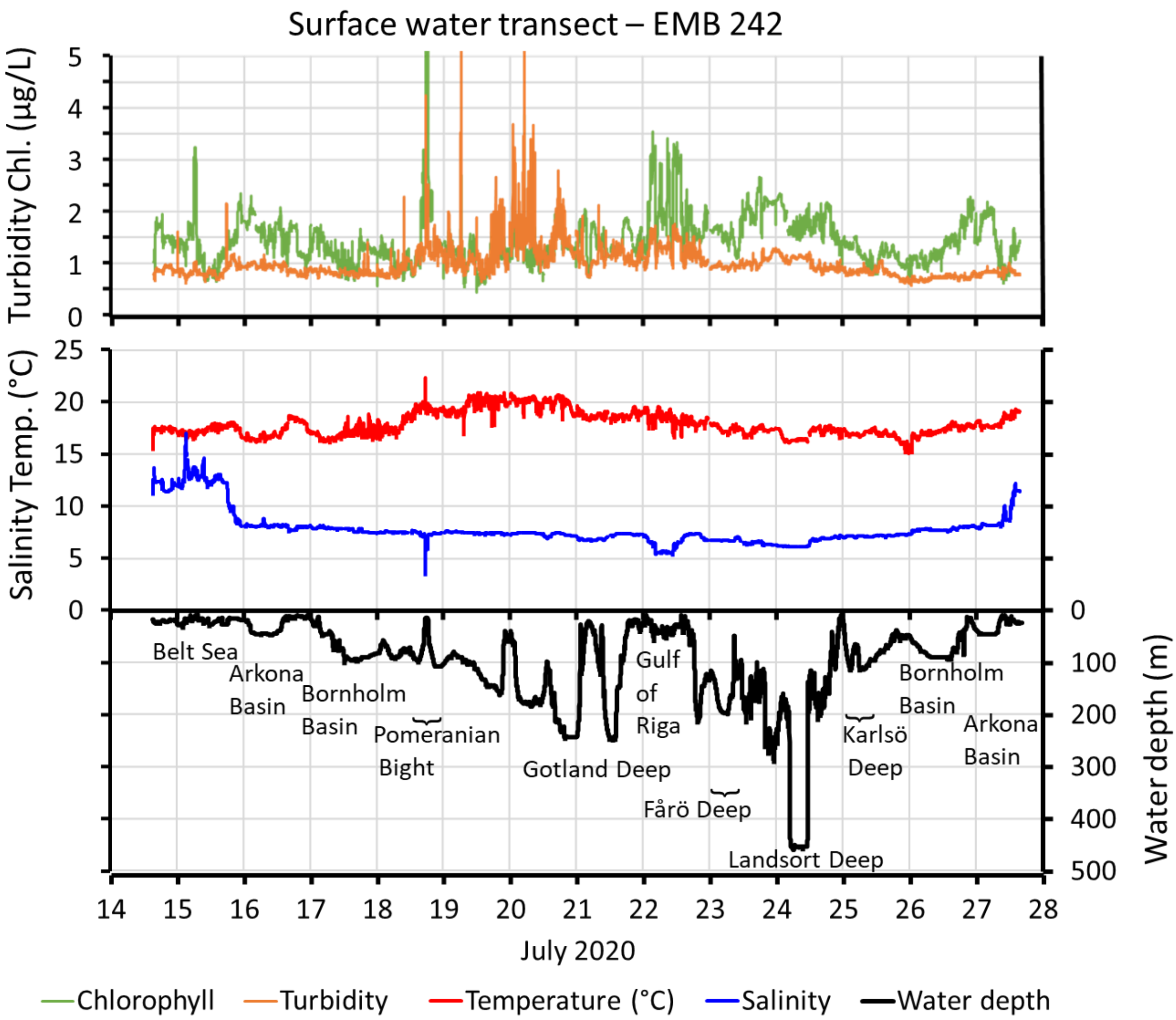

Fig. 5.2 Recording of data not finally validated of chlorophyll, turbidity, temperature, and salinity in surface waters with the corresponding water depth and sea area during the cruise EMB 242 of r/v Elisabeth Mann Borgese from July 14th to July 28th.

5.2 Nutrient situation in the western Baltic Sea in Summer 2020

In the western Baltic Sea, the nutrient situation was characterized by depletion of nitrate and significant residues of phosphate in surface waters. Only in the large central eastern and western Gotland Basin both nutrients were mostly depleted as expected for late July. Also below the thermocline, nitrate was only present in minor amounts (< 0.5 µmol/L) in the shallow western Baltic Sea. An exception reflected the deeper Fehmarn Belt station (TF0010). Bottom waters sampled at 28 m depth showed 2.4 µmol/L nitrate and ~ 0.8 µmol/L phosphate. However, the phosphate concentration of 0.2 to 0.4 µmol/L determined between 10 and 25 m depth was still elevated. In bottom waters of the Lübeck Bight (TF0022) at 20 and 23 m depth, a phosphate concentration of about 0.7 µmol/L was measured. In the Arkona Sea nitrate was depleted until about 40 m depth where concentrations suddenly reached concentrations of 1 to 6 µmol/L in the near-bottom range. Also nitrite contributed significantly to the oxidized nitrogen species with 0.1 to 0.5 µmol/L below about 30 m depth. Phosphate was on average 0.53 µmol/L in 29-35 m, and about 1 µmol/L in 40-47 m which represented the bottom water layer. This reflected a clear excess of phosphate over nitrate considering a Redfield ratio of 16:1 as the favourite N:P uptake ratio in phytoplankton. Thus in case of upwelling, a clear advantage for diazotrophic cyanobacteria is preformed in the deeper waters.

5.3 Baltic thalweg transect

The profiles of the stations between the Kiel Bight along the thalweg to the northern Gotland Sea were combined to contour plots with isolines of salinity, temperature and oxygen for an overview of the hydrographic and the hydrochemical state of the Baltic Proper during the cruise EMB 242 in July 2020 (Fig. 5.3). The Belt Sea (TF0010) showed a temperature range of 17-12°C, a salinity between 12 and 23, and oxygen of 6.3-3.3 mL/L from surface to bottom waters (Fig. 5.3, left side). In the North of the eastern Gotland Sea (TF0286) salinity was from 6.7 to 12.5 at temperatures between about 17 and 7.3°C from surface to bottom waters. The oxygen concentration was 6.3 mL/L in surface waters, a maximum in the winter water of 7.2 at about 50 m and oxygen remained undetectable below about 80 m (Fig. 5.3, right side).

Cold water of down to 10.5 °C situated between 30 and 40 m in the Arkona Sea. This winter water zone stretched all the way to the northern Gotland Sea. In the Bornholm Sea it showed up between 30-60 m depth with approximately 7 °C (TF0221). Further on, the cold winter water of 6.3 °C was between 55-65 m depth in the Słupsk channel area (TF0266) and resided between 40 and 65 m at temperatures around 5.5 °C in the eastern Gotland Basin.

Bottom water salinity was roughly 23 in the Belt Sea at TF0010, 18 in the Arkona Sea, 16 in the Bornholm Sea, almost 14 in the Słupsk channel, 12.5 in the eastern Gotland Sea around the Gotland Deep that showed a salinity of 13.1 in its centre. A brackish water body with a salinity of below 8 stretched between the surface and 30 m depth at the Bornholmsgat (TF0144), deepening to 60 m further east until the southern Gotland Sea and remains almost between the surface and this depth throughout the eastern Gotland Sea (Fig. 5.3, upper panel).

The mixed layer oxygen concentration was close to the equilibrium with the atmosphere, at the respective surface water temperature. By comparison of the plot for temperature and oxygen, it was obvious that a large cold (< 6°C) and oxygen rich (> 7 mL/L) water body was situated between the mixed layer and the halocline in the eastern Gotland Sea. Below this cold water mass, the oxygen concentration decreased sharply within the halocline to mostly an undetectable level. However, a water body that reflected slightly positive oxygen values of above ~ 1 mL/L (white area at 360 n.m.), which apparently moved down the southern slope of the eastern Gotland Sea basin (Fig. 5.3, bottom panel). The origin of the water body is likely the Bornholm Basin that frequently obtains water from the western Baltic Sea with elevated salinity to be episodically released to the eastern Gotland Basin. It is mostly intruded at a depth interval of 80 to 140 m in the central Eastern Gotland Basin, but at low temperatures in winter it could reach deeper levels. It should be mentioned that H_2S is ignored in this figure since the oxygen sensor is unable to record "negative oxygen".

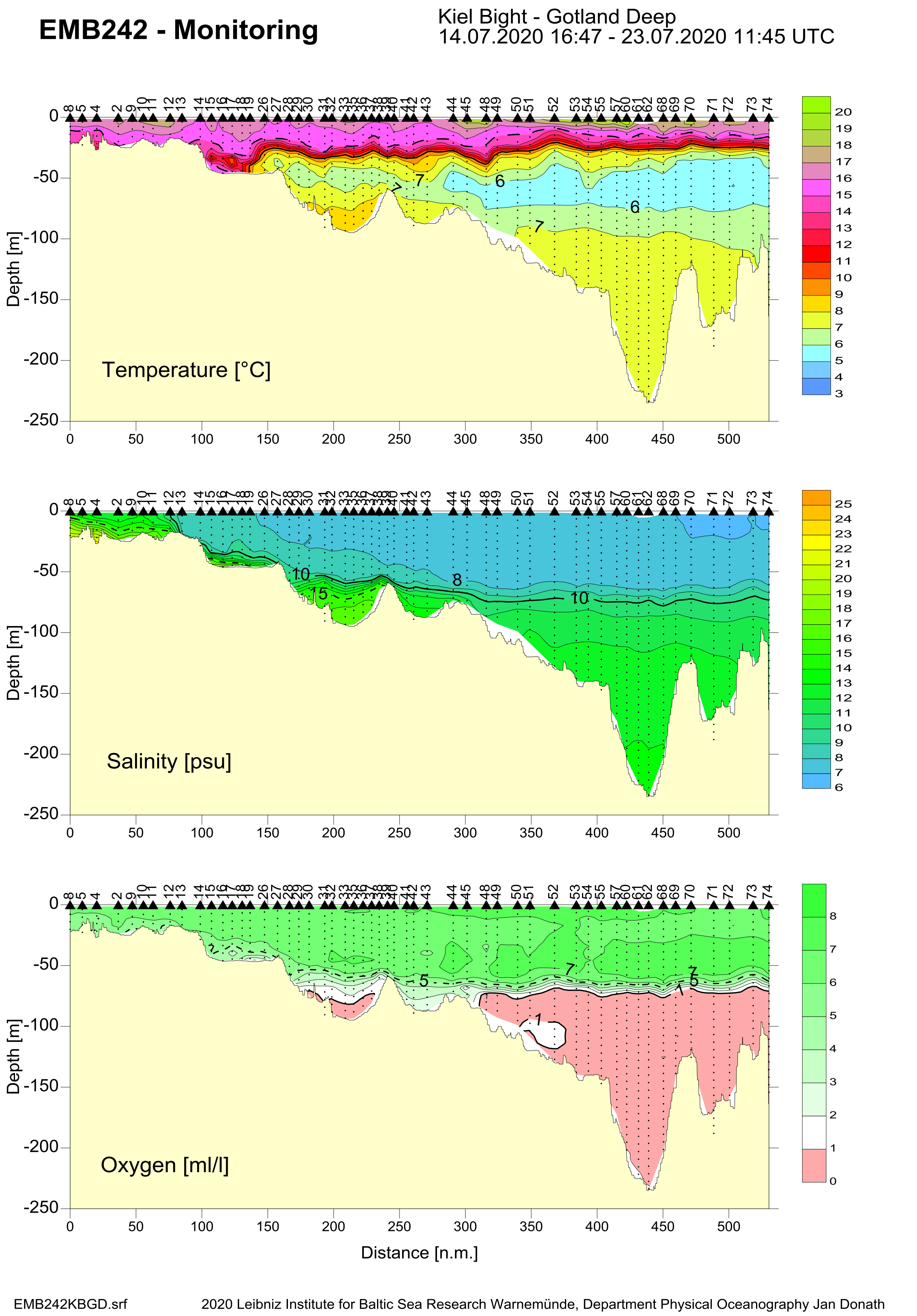

Fig. 5.3 Distribution of temperature, salinity and oxygen along the thalweg of the Baltic Sea from the Kiel bight to the northern Gotland Basin. The figure is based on the preliminary CTD data, measured between July 14th and July 23rd.

5.4 Development of Baltic Sea water masses – comparison to previous cruises

5.4.1 Surface water temperature

The surface water temperatures during the cruise EMB 242 were already shown (Fig. 5.2). Here we compare the values determined at selected Baltic Sea monitoring stations to the temperatures of the last summers from 2015 to 2019 and the long-term mean values 1971-1990 measured during the respective July/August cruises in the 1970ies and 1980ies (Table 5.1). Surface water temperatures in July 2020 appear generally at the lower end compared to recent years, except for the Gotland Deep station, where 19.1 °C almost reflect an average of recent years. These temperatures were again clearly lower than the exceptionally high temperatures measured in summer 2018. The surface water temperatures of this year were well in the range of the long term averages of the chosen two decades of the last century or even a bit lower, with the already mentioned exception of the Gotland Deep station that was 2 K warmer. So on average it was 0.6 K (+ 2.0 K to -2.1 K) colder in 2020 than the long-term averages determined for 1971-1990.

Table 5.1 Surface water temperature (°C) of Baltic Sea areas of this cruise (Aug-19) compared to the last two years and to a former long-term average.

Temperature (°C)	Jul-15	Aug-16	Aug-17	Aug-18	Aug-19	**Jul-20**	1971-1990
Mecklenb. Bight (TF0012)	18.3	19.3	18.2	22.5	18.9	**17.1**	17.7
Arkona Basin (TF0113)	16.3	18.8	17.3	21.7	19.9	**16.0**	17.0
Bornholm Deep (TF0213)	15.6	19.2	17.6	22.0	18.9	**16.0**	17.6
Gotland Deep (TF0271)	16.2	18.9	17.5	23.0	17.8	**19.1**	17.1
Fårö Deep (TF0286)	16.8	-	18.2	23.1	16.9	**16.9**	17.0
Landsort Deep (TF0284)	15.2	18.0	16.8	23.1	18.5	**16.1**	18.2
Karlsö Deep (TF0245)	16.7	18.4	16.9	24.5	18.6	**16.3**	16.9

5.4.2 Deep water salinity and temperature

The salinity of the bottom water layer measured in July 2020 is shown in comparison to data from the cruises in July 2015 to August 2019 (Table 5.2). It appears that the salinity is still decreasing in the Gotland and the Fårö Deeps since the strong inflow in 2014/2015 that led to a maximum in the Gotland Deep in 2016 and in the Fårö Deep as well as in the Landsort Deep in 2017. However, no data were available for the Fårö Deep in August 2016. In the Landsort Deep salinity had increased in July 2020 in summer since August 2017. In contrast, the bottom water salinity showed no clear trend in the Karlsö Deep and seemed to episodically receive slightly saltier water, but salinity basically had scattered around 10.5 in recent summers.

The salinity of the Gotland Deep bottom water decreased significantly from August 2019 to July 2020 by 0.15. Lower salinity would improve the chance of water of a certain density to reach the bottom water layer. But with regard to the strong oxygen deficits, the salinity of 13.13 was still high in July 2020 in comparison to pre-inflow time in August 2014 when the salinity was 12.25 (Kuss, 2019).

Table 5.2 Bottom water salinity of Baltic Sea deeps of this cruise (Jul-20) compared to the last 5 years.

Salinity	Jul-15	Aug-16	Aug-17	Aug-18	Aug-19	**Jul-20**
Gotland Deep	13.42	13.80	13.47	13.27	13.28	**13.13**
Fårö Deep	12.23	(12.66)*	12.82	12.75	12.63	**12.55**
Landsort Deep	10.86	11.26	11.54	11.46	11.38	**11.53**
Karlsö Deep	9.65	10.32	10.39	10.70	10.45	**10.59**

* Value measured in May 2016

The temperatures in the bottom waters of the Fårö, Landsort, and Karlsö Deeps were 0.11, 0.39, 0.29 K higher compared to summer last year (Table 5.3). The Bornholm Deep and Gotland Deep bottom waters reflected lower temperatures by -0.23 K and -0.15 K, respectively, compared to August 2019. The bottom water temperatures of July 2020 confirm the finding that temperatures in recent years are clearly above the long-term averages of 1971-1990. In July 2020 the deviation ranged between 1.60 and 2.19 K with an average of 1.96 K higher temperatures in bottom waters.

Table 5.3 Bottom water temperature (°C) of Baltic Sea deeps of this cruise (Jul-20) compared to the last 5 years and to a former long-term average.

Temperature (°C)	Jul-15	Aug-16	Aug-17	Aug-18	Aug-19	**Jul-20**	1971-1990
Bornholm Deep	7.01	6.56	6.97	6.97	8.54	**8.31**	6.12
Gotland Deep	6.87	7.50	6.95	6.90	7.37	**7.22**	5.62
Fårö Deep	6.58	-	6.98	6.76	7.19	**7.30**	5.20
Landsort Deep	5.68	6.02	6.36	6.28	6.50	**6.89**	4.76
Karlsö Deep	5.02	5.43	5.58	5.83	5.68	**5.97**	4.18

5.4.3 Oxygen

The oxygen concentration in the bottom water clearly worsen since August 2017 in the Gotland Deep to -7.88 mL/L and the Karlsö Deep to -3.48 mL/L. For the Fårö Deep with -4.17 mL/L and the Landsort Deep with -1.74 mL/L oxygen equivalents (Table 5.4) a slight improvement of a decreased hydrogen sulphide concentration was determined (Fig. 5.4). The Fårö Deep might has received some oxygen by smaller inflows in 2019 that reached the northern rim of the Gotland Basin in October 2019 with a salinity that likely allowed a contribution to the deep waters there (Naumann et al., 2020 subm.).

Table 5.4 Bottom water oxygen concentration (mL/L) of Baltic Sea deeps during this cruise (Jul-20) compared to the summer values of the last five years.

Oxygen (mL/L)	Jul-15	Aug-16	Aug-17	Aug-18	Aug-19	**Jul-20**
Gotland Deep	0.86	-0.79	0.06	-4.29	-6.15	**-7.88**
Fårö Deep	-1.54	-	< d.l.	-3.52	-4.68	**-4.17**
Landsort Deep	-0.88	-0.92	< d.l.	-0.82	-2.08	**-1.74**
Karlsö Deep	-1.22	-1.82	< d.l.	-3.10	-2.93	**-3.48**

d.l.: detection limit

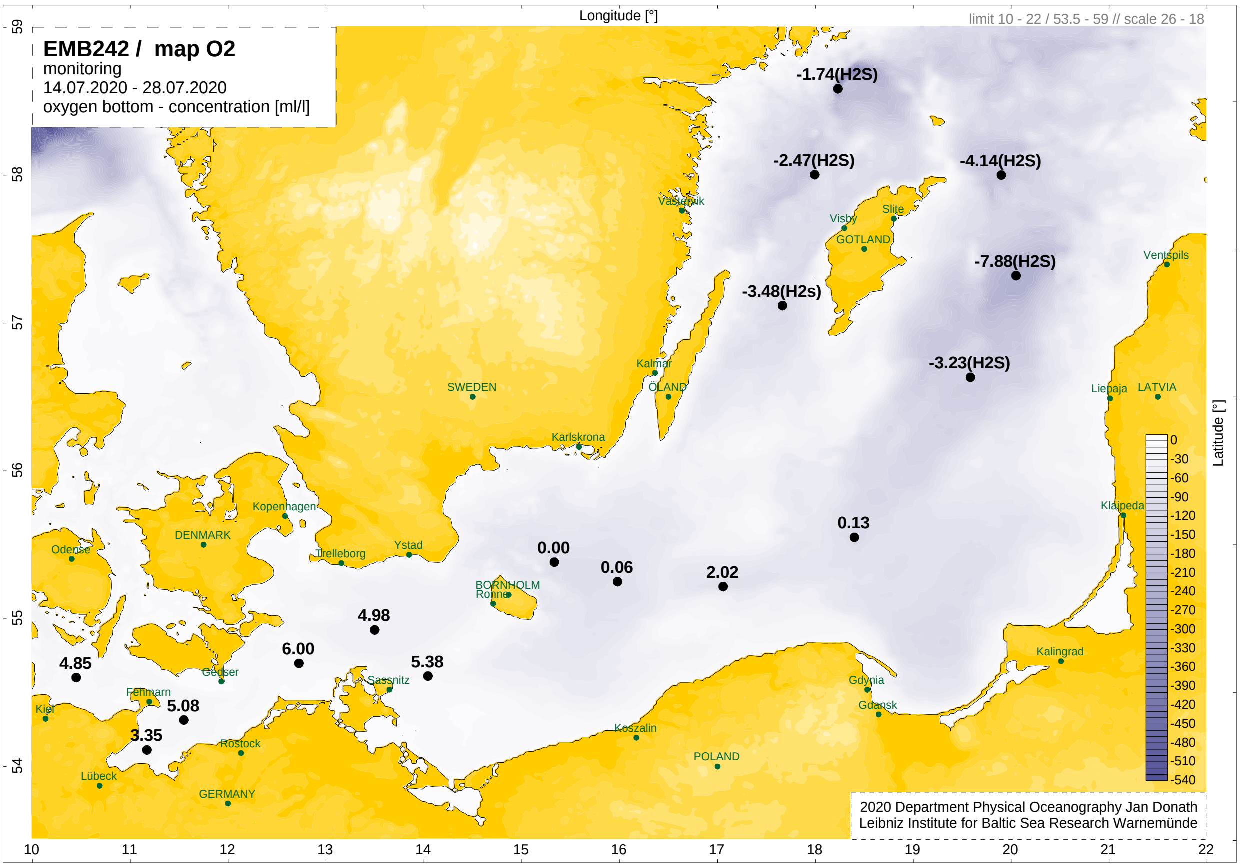

Fig. 5.4 Oxygen concentration (mL/L) in bottom waters of selected Baltic Sea stations (H_2S is included as negative oxygen).

The oxygen concentration in bottom waters of the western Baltic Sea was still good on the sampled stations at the time of sampling, showing values between 3.35 and 6 mL/L. Only the Lübeck Bight bottom water was close to the ~3 mL/L (4 mg/L) threshold value for a good status according to the German evaluation scheme for stratified waters. The Bornholm Sea and the southern Gotland Sea bottom waters were not sulphidic at the time of measurement and showed an oxygen concentration of up to 2.02 mL/L. However, the deep eastern and western Gotland Basin showed a strong oxygen deficit with up to -7.88 mL/L oxygen equivalents in bottom waters.

Moreover, it was interesting to investigate the turbidity zones in intermediate and deeper waters in comparison to low oxygen waters, as it was observed that turbidity often marks the mixing or diffusion zones between sulphidic and oxygenated waters. Partly this is caused by precipitation of fine particles of elemental sulphur (Kamyshny et al., 2013) and likely manganese(IV) and iron(III) oxyhydroxides and phosphates play a role too (Dellwig et al., 2010). The thalweg transect from the Belt Sea to the eastern Gotland Sea Basin reflected low oxygen zones on EMB 242 that were surrounded by waters of elevated turbidity (Fig. 5.5), marking the transition zone to the sulphidic waters. It remains unclear, if the strong turbidity layers in the Northern Gotland Sea - beyond 1100 km of the transect - were produced by the same mechanism, or were caused by resuspension of nearby plateau areas at that depth level.

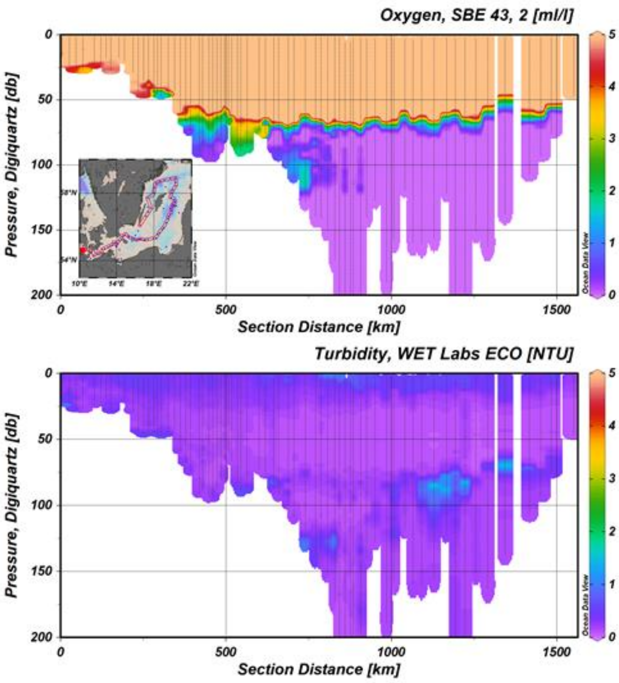

Fig. 5.5 Sensor measurements of oxygen (mL/L; without H_2S) and turbidity in the upper 200 m of the water column between the Belt Sea and the western Gotland Sea along the thalweg. The plot was done by using ODV 5 (Schlitzer, 2018).

5.4.4 Nutrients

Inorganic nitrogen nutrients are almost depleted in the upper water column of the Baltic Proper in summer situations, whereas remains of phosphate were often still available in mid-summer in recent years. Due to the relative deficit of nitrogen compared to phosphorus according to the Redfield ratio, diazotrophic cyanobacteria are favoured by this nutrient composition. In the near-bottom layer, the situation had changed strongly because of the inflow of oxygenated water in the Gotland Deep in the year 2014-2016. Thus the nitrate concentration had increased in deep water layers intermittently. Because of the new stagnation phase and subsequent oxygen depletion and increase of hydrogen sulphide in deep waters, nitrate was also depleted and phosphate was accumulated there again (Table 5.5). Anoxic condition lead on one side to remineralisation of organic matter until the oxidation state of ammonium only, and on the other side remaining nitrate is used as oxidant until its depletion. Thus nitrate is usually at its detection limit under anoxic condition. So nitrate was not found in July 2020 in the bottom waters of the Gotland, Fårö, Landsort, and Karlsö Deeps like in previous years. Thereby, the phosphate concentration showed some variability with an increasing tendency in the Gotland Sea bottom waters and almost stable conditions on different levels in the Fårö, Landsort, and Karlsö Deeps in recent years. In contrary, Bornholm deep was weakly oxic with a nitrate concentration of 7.2 µM – more than 3 times higher - and a phosphate concentration of 2.6 µM – almost 3 times lower - than in August last year (Table 5.5).

Table 5.5 Bottom water Nitrate (upper part) and phosphate (lower part) concentrations (µM) of Baltic Sea deeps of this cruise (Aug-19) compared to the last 5 years.

Nitrate (µM)	Jul-15	Aug-16	Aug-17	Aug-18	Aug-19	**Jul-20**
Bornholm Deep	13.8	10.7	1.1	< d.l.	2.25	**7.2**
Gotland Deep	12.3	< d.l.	< d.l.	< d.l.	< d.l.	**< d.l.**
Fårö Deep	< d.l.	-	< d.l.	< d.l.	< d.l.	**< d.l.**
Landsort Deep	< d.l.	< d.l.	< d.l.	< d.l.	< d.l.	**< d.l.**
Karlsö Deep	< d.l.	< d.l.	< d.l.	< d.l.	< d.l.	**< d.l.**

Phosphate (µM)	Jul-15	Aug-16	Aug-17	Aug-18	Aug-19	**Jul-20**
Bornholm Deep	2.0	2.2	2.7	8.3	7.0	**2.6**
Gotland Deep	2.4	3.9	4.7	5.3	4.7	**5.6**
Fårö Deep	3.0	-	3.4	4.4	4.6	**4.4**
Landsort Deep	3.3	3.1	2.8	3.0	3.4	**3.3**
Karlsö Deep	3.6	4.3	3.8	3.8	3.8	**3.8**

5.5 Pharmaceuticals and Personal Care Products (BaltPoll)

Pharmaceuticals and personal care products (PPCPs) were detected in the water phase at all 18 sampled stations. Of 44 analysed compounds 14 compounds could be determined: 6 pharmaceuticals, 7 UV-filters, 1 phenolic compound. The anticonvulsant carbamazepine (CBM), the metabolite nonylphenoxyacetic acid, the UV-stabilizer avobenzone (BMDBM) and caffeine (CAF) were the most detected compounds (detection frequency = 100%). The antibiotic sulfamethoxazole was only detected antibiotic in the water phase (station SP2). Furthermore, the non-steroidal anti-inflammatory drug diclofenac was also only detected at station SP2. The nonylphenoxyacetic acid was the compounds with the broadest concentration range from 17.8 ng/L (TFF0012) to 177.5 ng/L (SP2). The UV-filter octocrylene (OC) displayed the second broadest range from not detected to 138.1 ng/L (TFO5). At the stations TFO5, SP2, TF0012, and SP9 the highest total PPCPs concentrations were detected in the surface waters (462.7 ng/L, 298.4 ng/L, 135.1 ng/L, 91.4 ng/L, respectively) (Fig. 5.6). The distribution pattern shows that higher PPCPs concentrations occurred at the near coastal stations and that the concentrations decrease towards the open Baltic Sea. However, as PPCPs could be detected at all stations, it demonstrates that PPCPs can be transported in to off-shore/open sea regions.

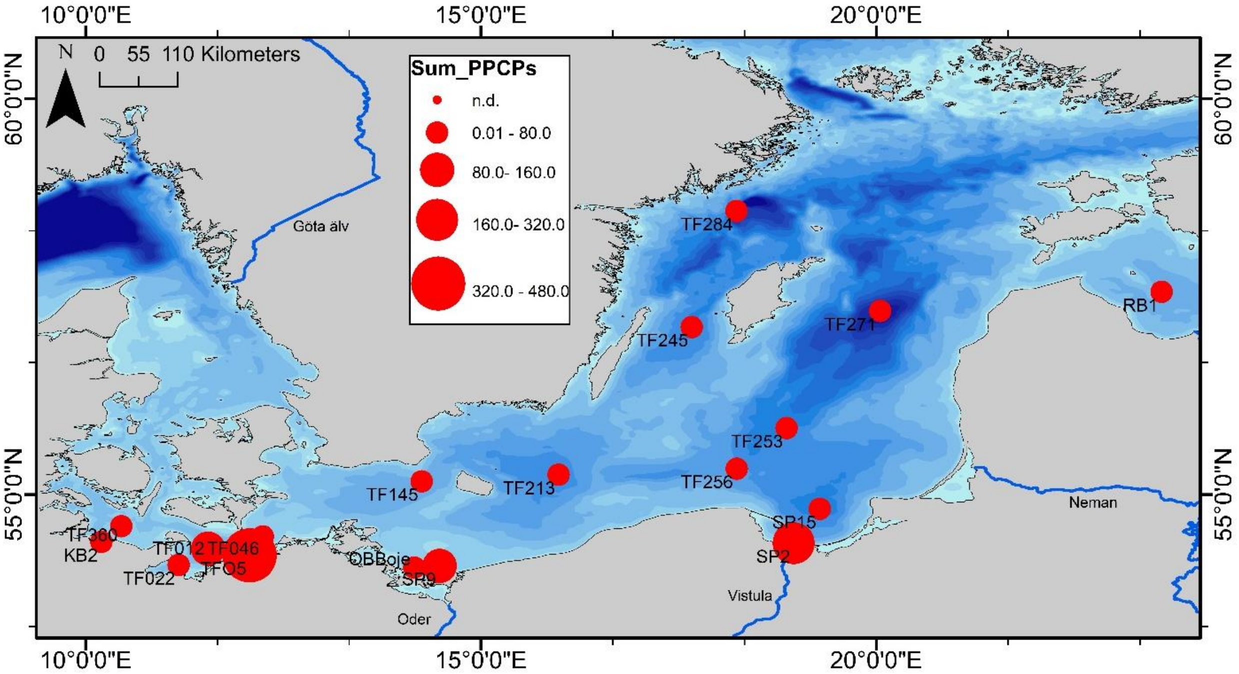

Fig. 5.6 Total concentration [ng/L] of detected PPCPs in the surface water of the Baltic Sea (Preliminary results).

At all PPCP-stations, samples were taken at different depth to investigate the PPCPs distribution in the water column. The UV-filters PBSA, OC, and BMDBM display similar distribution patterns along the water column at different stations (Fig. 5.7). The concentrations decrease from the surface towards lower water layers than however slightly increase in the near bottom layers. It could be possible that the more hydrophobic compounds OC and BMDBM adsorb onto particles and are re-suspended in the near bottom layer. To get a better understanding of the distribution between the water phase and the sediments, the sediment samples have yet to be analysed. However, this is a first indicator that the near bottom layer and the sediment phase could play an important role in understanding the environmental behaviour of UV-filters. Only at station KB2 OC and BMDBM display a different pattern. The biological parameters of the water phase at 11m have to be inspected and compared to the biological parameters at the other stations.

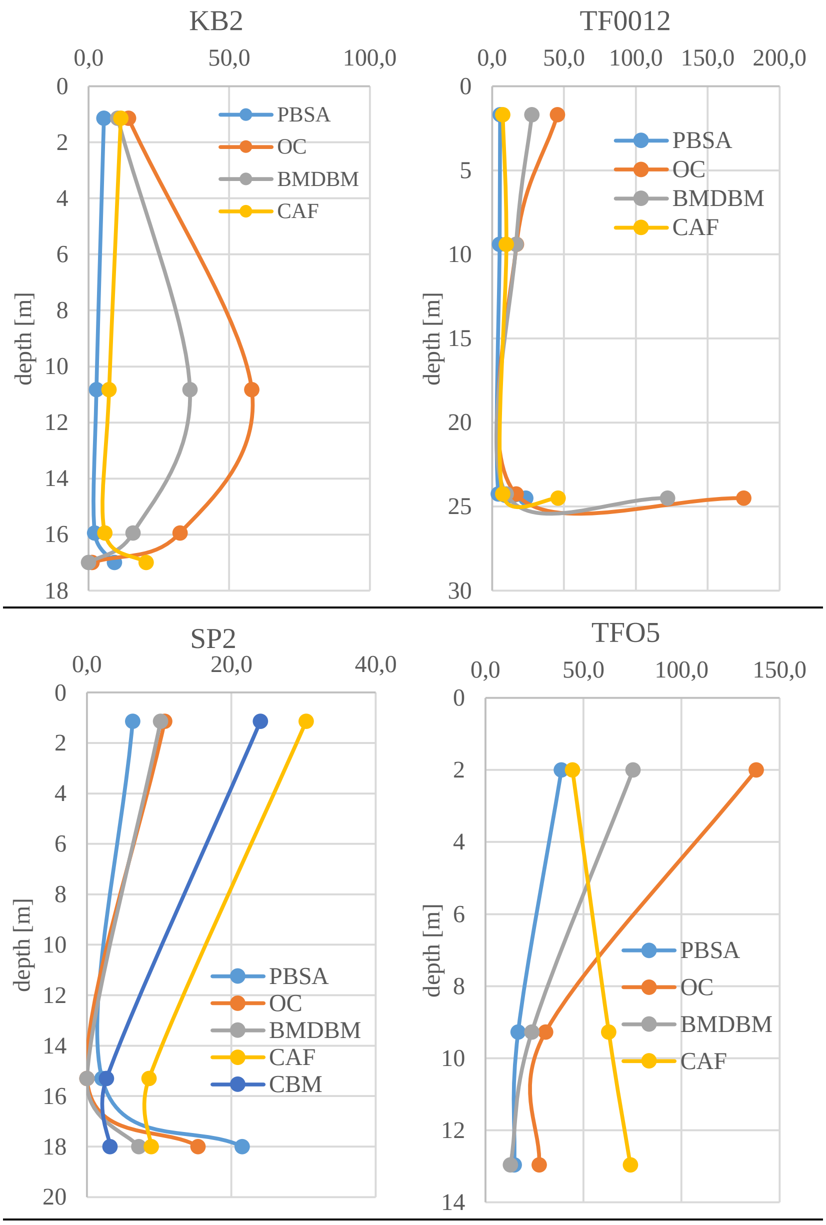

Fig. 5.7 Concentration [ng/L] profiles of the major detected compounds at selected stations from west (Kiel Bay, KB2) to east (Bay of Gdansk, SP9). PBSA – Phenylbenzimidazole sulfonic acid, OC - octocrylene, BMDBM - avobenzone, CAF-Caffeine, CBM - carbamazepine.

6 Station List EMB242

6.1 Overall Station List

Station No.		Date	Gear	Time	Latitude	Longitude	Water Depth	Remarks/ Recovery
Elisabeth Mann Borgese	IOW	2020		[UTC]	[°N]	[°E]	[m]	Max sampl. depth
EMB242_1-1	TFO5	14 July	CTD	14:16	54.2317	12.0750	14	SLmax: 11 m
EMB242_1-2	TFO5	14 July	Multi Corer	14:37	54.2317	12.0750	14	SLmax: 12 m
EMB242_2-1	TF0012	14 July	CTD	16:41	54.3150	11.5500	21.5	SLmax: 23 m
EMB242_2-2	TF0012	14 July	Secchi disk	16:42	54.3150	11.5499	21.6	
EMB242_2-3	TF0012	14 July	WP-2 Plank. net	16:43	54.3151	11.5499	21.6	

EMB242_2-4	TF0012	14 July	CTD	17:17	54.3151	11.5495	21.6	SLmax: 23 m
EMB242_2-5	TF0012	14 July	Multi Corer	17:37	54.3152	11.5491	21.6	SLmax: 25 m
EMB242_2-6	TF0012	14 July	WP-2 Plank. net	17:49	54.3152	11.5500	21.4	Depth 22 m
EMB242_3-1	TF0022	14 July	CTD	19:48	54.1103	11.1760	20.3	Depth 21 m
EMB242_3-2	TF0022	14 July	Multi Corer	20:12	54.1098	11.1750	20.1	Depth 23 m
EMB242_4-1	TF0010	15 July	CTD	00:55	54.5520	11.3194	25.1	Depth 26 m
EMB242_5-1	TF0014	15 July	CTD	02:16	54.5955	11.0142	25	SLmax: 26 m
EMB242_6-1	KB2	15 July	CTD	05:55	54.4024	10.1988	13.2	Depth 14 m
EMB242_6-2	KB2	15 July	Multi Corer	06:13	54.4019	10.1982	13	Depth 16 m
EMB242_7-1	TF0360	15 July	CTD	08:05	54.6001	10.4511	14.9	Depth 16 m
EMB242_7-2	TF0360	15 July	Secchi disk	08:07	54.6001	10.4509	14.9	
EMB242_7-3	TF0360	15 July	WP-2 Plank. net	08:15	54.6000	10.4507	14.9	
EMB242_7-4	TF0360	15 July	Multi Corer	08:27	54.6000	10.4504	14.9	Depth 19 m
EMB242_7-5	TF0360	15 July	Plank. net	08:40	54.6000	10.4503	14.9	Depth 15 m
EMB242_8-1	TF0361	15 July	CTD	10:10	54.6652	10.7760	21.1	Depth 23 m
EMB242_8-2	TF0361	15 July	Secchi disk	10:14	54.6651	10.7762	21.1	
EMB242_9-1	TF0017	15 July	CTD	14:17	54.3919	11.8231	19	SLmax: 20 m
EMB242_10-1	TF0041	15 July	CTD	15:27	54.4067	12.0636	16	SLmax: 17 m
EMB242_11-1	TF0046	15 July	CTD	16:32	54.4702	12.2409	25.5	SLmax: 26m
EMB242_11-2	TF0046	15 July	CTD	17:05	54.4700	12.2415	25.6	SLmax: 27 m
EMB242_11-3	TF0046	15 July	Multi Corer	17:26	54.4700	12.2414	25.4	SLmax: 29 m
EMB242_11-4	TF0046	15 July	WP-2 Plank. net	17:40	54.4698	12.2411	25.4	SLmax: 15 m
EMB242_11-5	TF0046	15 July	WP-2 Plank. net	17:47	54.4698	12.2412	25.4	Depth 25 m
EMB242_12-1	TF0002	15 July	CTD	19:21	54.6495	12.4514	14.8	Depth 16 m
EMB242_13-1	TF0001	16 July	CTD	00:21	54.6972	12.6968	18	Depth 19 m
EMB242_14-1	TF0115	16 July	CTD	02:05	54.7948	13.0577	26.9	SLmax: 28 m
EMB242_15-1	TF0114	16 July	CTD	03:16	54.8597	13.2761	41.8	SLmax: 43 m
EMB242_15-2	TF0114	16 July	CTD	03:31	54.8604	13.2766	42.1	SLmax: 40 m
EMB242_16-1	TF0113	16 July	CTD	04:42	54.9241	13.5002	44.3	SLmax: 45 m
EMB242_16-2	TF0113	16 July	Secchi disk	04:58	54.9248	13.5001	44.6	
EMB242_16-3	TF0113	16 July	Plank. net	04:59	54.9248	13.5001	44.3	
EMB242_16-4	TF0113	16 July	CTD	05:24	54.9250	13.5002	44.3	SLmax: 45 m
EMB242_16-5	TF0113	16 July	WP-2 Plank. net	05:43	54.9250	13.5001	44.3	Depth 43 m
EMB242_17-1	TF0105	16 July	CTD	06:40	55.0248	13.6074	43.6	Depth 44 m
EMB242_18-1	TF0104	16 July	CTD	07:46	55.0680	13.8157	43.2	Depth 44 m
EMB242_19-1	TF0103	16 July	CTD	08:45	55.0626	13.9905	44.3	Depth 45 m
EMB242_20-1	TF0109	16 July	CTD	09:44	54.9997	14.0838	45.4	Depth 46 m
EMB242_20-2	TF0109	16 July	Secchi disk	09:54	54.9997	14.0835	45.4	
EMB242_20-3	TF0109	16 July	Plank. net	09:54	54.9997	14.0835	45.7	
EMB242_20-4	TF0109	16 July	WP-2 Plank. net	10:07	54.9999	14.0834	45.4	Depth 26 mj
EMB242_20-5	TF0109	16 July	WP-2 Plank. net	10:12	55.0000	14.0833	45.5	Depth 45 m
EMB242_21-1	ABBoje	16 July	CTD	11:33	54.8800	13.8600	42.9	Depth 44 m
EMB242_22-1	TF0112	16 July	CTD	12:32	54.8031	13.9574	37.7	
EMB242_22-2	TF0112	16 July	CTD	12:41	54.8031	13.9576	37.5	Depth 38 m
EMB242_23-1	OBBoje	16 July	CTD	17:14	54.0775	14.1550	11.7	SLmax: 2x13m
EMB242_23-2	OBBoje	16 July	CTD	18:00	54.0772	14.1558	11.9	Depth 13 m
EMB242_23-3	OBBoje	16 July	Multi Corer	18:16	54.0778	14.1553	11.9	Depth 16 m
EMB242_24-1	SP9	16 July	CTD	19:36	54.0979	14.4767	10.3	Depth 11 m
EMB242_24-2	SP9	16 July	Multi Corer	19:52	54.0981	14.4756	10.2	Depth 15 m
EMB242_25-1	TF0152	17 July	CTD	01:20	54.6327	14.2832	28.1	Depth 29 m
EMB242_25-2	TF0152	17 July	CTD	01:44	54.6334	14.2833	27.9	
EMB242_26-1	TF0145	17 July	CTD	05:32	55.1663	14.2500	44.3	SLmax: 45 m
EMB242_26-2	TF0145	17 July	Multi Corer	05:56	55.1670	14.2500	44.4	Depth 47 m
EMB242_27-1	TF0144	17 July	CTD	07:14	55.2571	14.4899	41.8	Depth 42 m
EMB242_28-1	TF0142	17 July	CTD	08:40	55.4040	14.5364	58.2	Depth 58 m
EMB242_29-1	TF0140	17 July	CTD	09:53	55.4668	14.7167	67.5	Depth 67 m
EMB242_30-1	TF0206	17 July	CTD	11:02	55.5330	14.9154	74.4	Depth 74 m
EMB242_31-1	TF0208	17 July	CTD	12:30	55.4536	15.2338	91.1	Depth 90 m
EMB242_32-1	TF0200	17 July	CTD	13:24	55.3834	15.3333	90.4	Depth 90 m
EMB242_33-1	TF0211	17 July	CTD	14:46	55.3301	15.6141	94.4	SLmax: 94m
EMB242_34-1	TF0214	17 July	CTD	16:08	55.1605	15.6602	92.5	SLmax:17m; 92m
EMB242_35-1	TF0212	17 July	CTD	17:46	55.3016	15.7960	94.3	Depth 93 m
EMB242_36-1	TF0213	17 July	CTD	18:50	55.2501	15.9829	88.6	Depth 88 m
EMB242_36-2	TF0213	17 July	Secchi disk	18:55	55.2500	15.9834	88.6	

EMB242_36-3	TF0213	17 July	Plank. net	18:56	55.2500	15.9835	88.8	
EMB242_36-4	TF0213	17 July	WP-2 Plank. net	19:22	55.2500	15.9830	88.5	Depth 28 m
EMB242_36-5	TF0213	17 July	WP-2 Plank. net	19:28	55.2501	15.9829	88.6	Depth 86 m
EMB242_36-6	TF0213	17 July	WP-2 Plank. net	19:37	55.2502	15.9830	88.6	Depth 50 m
EMB242_36-7	TF0213	17 July	WP-2 Plank. net	19:47	55.2503	15.9830	88.6	Depth 86 m
EMB242_36-8	TF0213	17 July	WP-2 Plank. net	19:59	55.2503	15.9827	88.6	Depth 86 m
EMB242_36-9	TF0213	17 July	CTD	20:19	55.2503	15.9833	88.6	Depth 88 m
EMB242_37-1	TF0221	18 July	CTD	00:39	55.2216	16.1663	81.1	Depth 81 m
EMB242_38-1	TF0225	18 July	CTD	01:36	55.2585	16.3202	64.3	Depth 64 m
EMB242_39-1	TF0224	18 July	CTD	02:34	55.2832	16.4992	59.6	SLmax: 60 m
EMB242_40-1	TF0227	18 July	CTD	03:24	55.2616	16.6385	66.5	SLmax: 66 m
EMB242_41-1	TF0229	18 July	CTD	04:45	55.2290	16.9134	84	SLmax: 84 m
EMB242_42-1	TF0222	18 July	CTD	05:41	55.2169	17.0660	90	Depth 89 m
EMB242_43-1	TF0266	18 July	CTD	07:10	55.2519	17.3596	87.9	Depth 87 m
EMB242_44-1	TF0268	18 July	CTD	09:22	55.3079	17.9294	72.5	Depth 73 m
EMB242_45-1	TF0256	18 July	CTD	10:44	55.3265	18.2347	76.1	Depth 76 m
EMB242_45-2	TF0256	18 July	Multi Corer	11:06	55.3267	18.2348	75.7	Depth 79 m
EMB242_46-1	SP2	18 July	CTD	17:34	54.3855	18.9553	13.8	Depth 14 m
EMB242_46-2	SP2	18 July	Multi Corer	18:01	54.3851	18.9556	12.9	Depth 16 m
EMB242_47-1	SP15	18 July	CTD	21:05	54.8181	19.2847	106.4	Depth 105 m
EMB242_47-2	SP15	18 July	Multi Corer	21:35	54.8180	19.2854	106.4	Depth 105 m
EMB242_48-1	TF0259	19 July	CTD	05:59	55.5501	18.3999	88.6	Depth 87 m
EMB242_48-2	TF0259	19 July	Plank. net	06:27	55.5504	18.4006	88.6	
EMB242_49-1	TF0255	19 July	CTD	07:25	55.6332	18.5981	94.6	Depth 93 m
EMB242_50-1	TF0253	19 July	CTD	10:03	55.8400	18.8665	100.7	
EMB242_50-2	TF0253	19 July	CTD	10:16	55.8401	18.8666	100.7	Depth 99 m
EMB242_50-3	TF0253	19 July	Multi Corer	10:37	55.8401	18.8666	100.7	Depth 102 m
EMB242_51-1	TF0265	19 July	CTD	11:53	55.9588	19.0464	110.7	Depth 109 m
EMB242_52-1	TF0262	19 July	CTD	14:04	56.2350	19.3007	131.4	SLmax: 129 m
EMB242_53-1	TF0261	19 July	CTD	15:58	56.4915	19.4801	142.9	SLmax: 140 m
EMB242_54-1	TF0260	19 July	CTD	17:23	56.6333	19.5827	144.3	SLmax: 141m
EMB242_54-2	TF0260	19 July	CTD	18:03	56.6331	19.5829	144.8	Depth 141 m
EMB242_55-1	TF0274	19 July	CTD	19:28	56.7677	19.7510	153.6	Depth 150 m
EMB242_56-1	TF0411	19 July	CTD	22:41	56.8385	20.6813	54.3	Depth 54 m
EMB242_56-2	TF0411	19 July	ScanFish	23:05	56.8384	20.6837	54.3	SF 23:20 on Deck
EMB242_56-3	TF0411	19 July	ScanFish	23:31	56.8425	20.6500	56.8	
EMB242_57-1	TF0407	20 July	CTD	04:33	56.9491	19.8845	177	SF 4:13 on Deck
EMB242_58-1	X_0058	20 July	ScanFish	05:30	56.9420	19.9240	174.3	SF 5:45 on Deck
EMB242_58-2	X_0058	20 July	ScanFish	06:55	56.9449	19.9099	174.7	SF 5:45 on Deck
EMB242_58-3	X_0058	20 July	ScanFish	10:15	56.9920	19.4833	173.6	SF 9:48 on Deck
EMB242_59-1	TF0403	20 July	CTD	13:57	57.0729	19.0262	114.2	SF 13:25 on Deck
EMB242_60-1	TF0272	20 July	CTD	16:49	57.0714	19.8299	208.6	SLmax: 205m
EMB242_61-1	TF0275	20 July	CTD	18:40	57.2108	19.9310	230	Depth 225 m
EMB242_62-1	TF0271	20 July	CTD	20:00	57.3202	20.0517	241.4	Depth 235 m
EMB242_62-2	TF0271	20 July	Plank. net	20:02	57.3202	20.0512	241.4	
EMB242_62-3	TF0271	20 July	CTD	20:59	57.3201	20.0505	241.4	Depth 109 m
EMB242_62-4	TF0271	20 July	CTD	21:43	57.3201	20.0504	241.4	Depth 21 m
EMB242_62-5	TF0271	20 July	CTD	22:19	57.3199	20.0500	241.4	Depth 20 m
EMB242_62-6	TF0271	20 July	CTD	23:05	57.3198	20.0499	241.4	
EMB242_63-1	SF001EGB	21 July	CTD	04:00	57.5621	18.8531	20	SLmax: 21m
EMB242_63-2	SF001EGB	21 July	ScanFish	04:37	57.5606	18.8569	21.6	
EMB242_64-1	SF012EGB	21 July	CTD	13:23	57.2852	20.1656	244.3	SF 12:00 on Deck
EMB242_65-1	SF014EGB	21 July	CTD	14:48	57.2391	20.3846	146.6	SLmax: 143 m
EMB242_65-2	SF014EGB	21 July	ScanFish	15:10	57.2387	20.3798	147.8	
EMB242_66-1	SF022EGB	21 July	CTD	20:55	57.0393	21.2951	15.7	SF 20:35 on Deck
EMB242_67-1	RB1	22 July	CTD	07:27	57.5612	23.6101	51.3	Depth 50 m
EMB242_67-2	RB1	22 July	Multi Corer	07:50	57.5620	23.6078	50.4	Depth 53 m
EMB242_68-1	TF0276	22 July	CTD	19:42	57.4700	20.2614	207.3	Depth 202 m
EMB242_69-1	TF0270	22 July	CTD	21:15	57.6167	20.1678	144.5	Depth 140 m
EMB242_70-1	TF0287	22 July	CTD	23:09	57.7148	19.8541	128.6	Depth 127 m
EMB242_71-1	TF0286	23 July	CTD	05:15	58.0004	19.8989	195.8	SLmax: 190 m
EMB242_71-2	TF0286	23 July	CTD	06:10	58.0015	19.8962	196.9	Depth 43 m
EMB242_72-1	TF0277	23 July	CTD	07:41	58.1831	20.0525	162.9	Depth 157 m
EMB242_73-1	TF0285	23 July	CTD	09:57	58.4416	20.3344	122.5	Depth 119 m

EMB242_74-1	TF0279	23 July	CTD	11:41	58.6414	20.3457	164.3	Depth 160 m
EMB242_75-1	TF0282	23 July	CTD	13:45	58.8833	20.3169	165.5	SLmax: 160 m
EMB242_76-1	nGB-2	23 July	CTD	15:55	58.8656	19.7467	157.1	SLmax: 156 m
EMB242_77-1	TF0283	23 July	CTD	18:17	58.7837	19.1008	113.6	Depth 122 m
EMB242_78-1	nGB-1	23 July	CTD	20:02	58.7124	18.6710	241.4	Depth 238 m
EMB242_79-1	TF0284	24 July	CTD	05:26	58.5834	18.2333	452.8	Depth 443 m
EMB242_79-2	TF0284	24 July	Secchi disk	05:47	58.5837	18.2318	455.6	
EMB242_79-3	TF0284	24 July	Multi Corer	06:32	58.5831	18.2341	452.8	Depth 270 m
EMB242_79-4	TF0284	24 July	CTD	07:27	58.5827	18.2331	452.8	Depth 133 m
EMB242_79-5	TF0284	24 July	CTD	08:14	58.5835	18.2328	452.8	Depth 18 m
EMB242_79-6	TF0284	24 July	CTD	09:59	58.5835	18.2335	452.8	Depth 98 m
EMB242_80-1	wGB-3	24 July	CTD	12:43	58.3265	18.0687	150.7	Depth 151 m
EMB242_81-1	TF0240	24 July	CTD	15:13	58.0015	18.0018	165.7	Depth 163 m
EMB242_82-1	TF0242	24 July	CTD	18:05	57.7168	17.3701	140.7	Depth 137 m
EMB242_83-1	SF032WGB	24 July	ScanFish	23:44	57.0521	18.1305	10.6	
EMB242_84-1	SF025WGB	25 July	CTD	04:43	57.1615	17.3246	67.5	SF 4:30 on Deck
EMB242_85-1	TF0245	25 July	CTD	06:10	57.1158	17.6680	109.7	Depth 106 m
EMB242_86-1	wGB-1	25 July	ScanFish	06:52	57.1072	17.6585	109.5	
EMB242_86-2	wGB-1	25 July	CTD	10:01	56.8766	17.3896	95	SF 9:45 on Deck
EMB242_87-1	GB_SW	25 July	ScanFish	10:30	56.8765	17.3894	95	
EMB242_87-2	GB_SW	25 July	CTD	13:37	56.6256	17.1309	76.8	SF 13:25 on Deck
EMB242_88-1	TF223	25 July	ScanFish	14:25	56.6186	17.1248	77.7	
EMB242_88-2	TF223	25 July	CTD	20:52	56.1171	16.5346	46.8	SF 20:28 on Deck
EMB242_89-1	TF223	25 July	ScanFish	21:25	56.1102	16.5288	48.9	
EMB242_89-2	TF223	26 July	CTD	01:32	55.7624	16.2899	60.7	SF 1:19 on Deck
EMB242_90-1	BB_N	26 July	ScanFish	01:50	55.7627	16.2907	60.5	
EMB242_90-2	BB_N	26 July	CTD	05:04	55.5005	16.0007	79.2	SF 4:55 on Deck
EMB242_91-1	TF0220	26 July	ScanFish	05:30	55.4967	15.9998	79.2	
EMB242_91-2	TF0220	26 July	CTD	10:01	55.2502	15.9829	88.6	Depth 88 m
EMB242_91-3	TF0213	26 July	Secchi disk	10:02	55.2502	15.9830	88.6	SF 08:07 on Deck
EMB242_91-4	TF0213	26 July	Plankton Net	10:03	55.2502	15.9830	88.6	
EMB242_91-5	TF0213	26 July	Plankton Net	10:05	55.2502	15.9831	88.6	
EMB242_91-6	TF0213	26 July	CTD	10:32	55.2501	15.9835	88.6	Depth 57 m
EMB242_91-7	TF0213	26 July	WP-2 Plank. net	10:51	55.2500	15.9834	88.6	Depth 25 m
EMB242_91-8	TF0213	26 July	WP-2 Plank. net	10:55	55.2500	15.9832	88.6	Depth 25 m
EMB242_91-9	TF0213	26 July	WP-2 Plank. net	11:00	55.2500	15.9834	88.6	Depth 55 m
EMB242_91-10	TF0213	26 July	WP-2 Plank. net	11:09	55.2500	15.9834	88.6	Depth 86 m
EMB242_91-11	TF0213	26 July	WP-2 Plank. net	11:18	55.2499	15.9832	88.6	Depth 86 m
EMB242_91-12	TF0213	26 July	CTD	11:33	55.2500	15.9833	88.6	Depth 39 m
EMB242_91-13	TF0213	26 July	WP-2 Plank. net	11:47	55.2500	15.9834	88.6	Depth 86 m
EMB242_91-14	TF0213	26 July	Apstein Net	11:59	55.2499	15.9836	88.6	Depth 86 m
EMB242_91-15	TF0213	26 July	CTD	12:31	55.2499	15.9836	88.6	Depth 47 m
EMB242_92-1	TF0113	27 July	CTD	05:30	54.9248	13.4998	44.2	SLmax: 45 m
EMB242_92-2	TF0113	27 July	Secchi disk	05:34	54.9248	13.4998	44.3	
EMB242_92-3	TF0113	27 July	Plank. net	05:35	54.9248	13.4998	44.3	
EMB242_92-4	TF0113	27 July	CTD	05:55	54.9249	13.4996	44.3	Depth 45 m
EMB242_92-5	TF0113	27 July	WP-2 Plank. net	06:27	54.9244	13.4981	44.3	Depth 43 m
EMB242_93-1	TF0046	27 July	CTD	11:44	54.4697	12.2393	24.9	Depth 26 m
EMB242_93-2	TF0046	27 July	Secchi disk	11:45	54.4697	12.2394	25	
EMB242_93-3	TF0046	27 July	Plank. net	11:46	54.4697	12.2395	25.1	
EMB242_93-4	TF0046	27 July	Plank. net	11:50	54.4697	12.2399	25.1	
EMB242_93-5	TF0046	27 July	WP-2 Plank. net	11:59	54.4695	12.2404	25	Depth 25 m
EMB242_94-1	TF0012	27 July	CTD	14:39	54.3151	11.5508	21.5	SLmax: 23 m
EMB242_94-2	TF0012	27 July	Secchi disk	14:43	54.3150	11.5502	21.4	
EMB242_94-3	TF0012	27 July	Plank. net	14:45	54.3150	11.5502	21.5	
EMB242_94-4	TF0012	27 July	WP-2 Plank. net	14:54	54.3151	11.5504	21.5	SLmax: 23 m

SLmax: Maximum rope/cable length
Multi Corer: Multi Corer with 4 tubes
Secchi disk: Defined white disk with bore holes to determine water transparency
WP-2 Plank. net: Plankton net with closing mechanism and removable net bucket
Plank. net: Small Apstein net
CTD: CTD rosette system with Fluorimeter, Oxygen Sensor, Water Sampler, and Camera
SF (ScanFish): Undulating CTD with Fluorimeter and Oxygen Sensor mounted in a wing

7 Data and Sample Storage and Availability

All data gathered are saved on a data repository in the IOW immediately after the cruise. The processed and validated data will be stored in the ODIN data base (https://odin2.io-warnemuende.de) in due time after the cruise. According to the IOW data policy and to facilitate the international exchange of data, all metadata will be made available under the international ISO 19115 standards for georeferenced metadata.
The access to the data itself will be restricted for three years after data acquisition to protect the research process, including scientific analysis and publication. After that period the data becomes openly available to any person or 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 7.1 Overview of data availability

Type	**Database**	**Available**	**Free Access**	**Contact**
Hydrographic data	ODIN	01.10.2020	01.10.2023	volker.mohrholz@io-warnemuende.de
Nutrient data	ODIN	01.08.2021	01.08.2024	joachim.kuss@io-warnemuende.de
Biological results	ODIN	01.08.2021	01.08.2024	joerg.dutz@io-warnemuende.de

8 Acknowledgements

We thank the captain and the crew of the r/v Elisabeth Mann Borgese for their efforts and support during the cruise, as well as the cruise participants of the Leibniz Institute for Baltic Sea Research in Warnemünde (IOW), who carried out the measurements as part of the HELCOM’s Baltic Sea monitoring program and the IOW’s long-term measuring program. We are grateful to all people who helped to prepare, conduct and finalize the cruise, especially Johann Ruickoldt. The cruise was funded by IOW and the Federal Maritime and Hydrographic Agency in Hamburg and Rostock.

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