ELISABETH MANN BORGESE - Reports

Baltic Sea Long-term Observation Programme

Cruise No. EMB209

15. – 27. March 2019
Rostock – Rostock
HELCOM/long-term

V. Mohrholz, J. Donath, M. Dierken, F. Pohl, I. Schuffenhauer

Chief Scientist – Dr. Volker Mohrholz
Leibniz-Institute for Baltic Sea Research Warnemünde

2019

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1 Cruise Summary

1.1 Summary in English

The cruise EMB209 was carried out in frame of the Baltic Sea long term observation program. It consisted of field data acquisition for the national environmental monitoring in the German EEZ, which is performed in context with the Helsinki Commission (HELCOM) and federal programs to evaluate the status of coastal regions in North and Baltic Sea (BMLP). This work package is based on contract between the Federal Maritime Agency (BSH) and IOW as administrative agreement since 1991. The second work package is part of IOW's Baltic Sea long-term observation program, related to the institutes research foci "changing ecosystems", "basin-scale ecosystem dynamics" and to a smaller extent for "small- and mesoscale processes". The central task is a continuously ongoing data collection of time series at key stations spanning from the western to central Baltic Sea, initiated since 1969. Since 1997 it is complemented by permanent moorings in key areas. The gathered data are the back bone of research on the natural variability of the ecosystem, anthropogenic influences and the impact of climate change on the Baltic Sea. Despite of the unusual strong wind conditions the full scientific program of EMB209 was successful completed. The observed temperatures in the upper water column were high for the early spring season. The SST ranged between 3.2 and 4°C which was about 1.0K above the long term mean. There were no signs of larger inflow events that may lead to a ventilation of deep water layer in the eastern Gotland basin.

1.2 Zusammenfassung

Die Expedition EMB209 wurde im Rahmen des Ostsee Langzeitbeobachtungsprogramms durchgeführt. Das wissenschaftliche Programm beinhaltet die Felddatenerfassung für die nationale Umweltüberwachung in der deutschen AWZ, die im Rahmen der Helsinki-Kommission (HELCOM) und des nationalen Programmes zur Zustandsbewertung von Küstenregionen in Nord- und Ostsee (BMLP) durchgeführt wird. Dieses Arbeitspaket basiert auf einem Vertrag zwischen dem Bundesamt für Seeschifffahrt und Hydrographie (BSH) und dem IOW als Verwaltungsvereinbarung seit 1991. Das zweite Arbeitspaket der Expedition ist Teil des Ostsee-Langzeitbeobachtungsprogramms des IOW, das Teil der IOW Forschungsschwerpunkte "Ökosysteme im Wandel", "Ökosystemdynamik im Beckenmaßstab" und in geringerem Umfang "kleine und mesoskalige Prozesse" ist. Zentrales Element des Programmes ist eine seit 1969 initiierte, kontinuierlich durchgeführte Datenerhebung von Schlüsselparametern an Stationen in der westlichen und zentralen Ostsee. Seit 1997 wird das Programm durch permanente Verankerungen in der Gotland See ergänzt. Die gewonnenen Daten bilden die Basis der Forschung zur natürlichen Variabilität des Ostsee-Ökosystems, zu anthropogenen Einflüssen und zu den Auswirkungen des Klimawandels auf die Ostsee. Trotz der ungewöhnlichen starken Windverhältnisse konnte das gesamte wissenschaftliche Programm des EMB209 erfolgreich abgeschlossen werden. Die beobachteten Temperaturen in der oberen Wassersäule waren für die zeitige Frühjahrssaison relativ hoch. Die SST lag zwischen 3.2 und 4°C, was etwa 1,0K höher als der langjährige Mittelwert ist. Es gab keine Anzeichen für größere Einstromereignisse, die zu einer Belüftung der Tiefwasserschicht im östlichen Gotlandbecken führen könnten.

2 Participants

2.1 Principal Investigators

Name	Program	Institution
Mohrholz, Volker, Dr.	Hydrography	IOW
Kuss, Joachim, Dr.	Marine Chemistry	IOW
Dutz, Jörg, Dr.	Biology	IOW

2.2 Scientific Party

Name	Discipline	Institution
Mohrholz, Volker, Dr.	Phys. Oceanogr. / Chief Scientist	IOW
Herran, Natalia, Dr	Phys. Oceanogr.	IOW
Nascimento, Fernanda, Dr.	Phys. Oceanogr.	IOW
Schuffenhauer, Ingo	Phys. Oceanogr.	IOW
Donath, Jan	Phys. Oceanogr.	IOW
Pohl, Frank	Biology	IOW
Dierken, Madleen	Marine Chemistry	IOW
Reineccius, Jannika	Marine Chemistry	IOW

2.3 Participating Institutions

IOW Leibniz-Institute for Baltic Sea Research Warnemünde

2.4 Crew

Name	Rank
Scholz, Uwe	Kapitän / Master
Kaufmann, Tino	Chief mate
Kasch, Gunnar	2nd NO
Nehls, Rainer	Chief Eng.
Renken, Bernd	Electrician
Nevermann, Hartmut	Decksmen
Wagner, Knut	Bosun
Martens, Ulf	Decksmen
Becker Braunschweig, Detlef-Ulrich	Deckmen
Wurm, Wolfgang	Decksmen
Langhof, Maik	Cook

3 Research Program

3.1 Aims of the Cruise

The cruise EMB209 was carried out as a joined cruise of the environmental monitoring program of the Federal Maritime and Hydrographic Agency (BSH) and the Baltic Sea long term observation program of the Leibniz-Institute for Baltic Sea Research Warnemünde (IOW). It was the second cruise in a series of five expeditions performed annually.
The data acquired 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.
A special focus of the cruise was on the impact of the subsequent warm baroclinic inflows, observed in summer and autumn 2018, on the environmental conditions in the central Baltic.

3.2 Agenda of the Cruise

The three main work packages were subsequently conducted. Work package one was the BSH environmental monitoring program in the western Baltic. Work package two was the IOW's Baltic Sea long term observation program in the central Baltic Sea. The third optional work package was the high resolution observations of the saline overflow at the Slupsk Sill.

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)
- Oceanographic moorings (GONE)
- Towed CTD ScanFish (SCF)
- Phytoplankton nets
- Zooplankton net (WP2)
- Secci desk (SD)

Continuous measurements:

- Vessel mounted ADCP 150kHz Ocean Surveyor
- Vessel mounted ADCP 250kHz Signature mounted in the moon pool
- Underway measurements of surface water properties
- Ship weather station

3.3 Description of the Work Area

Data collection covered the western and central Baltic from the Kiel Bight to the northern Gotland Basin. The majority of stations is located along the talweg transect of the Baltic Sea. The possible western pathway of saline water from the Bornholm Basin to the western Gotland Basin was not sampled, since there were no indications of a spreading of saline waters through this trench.

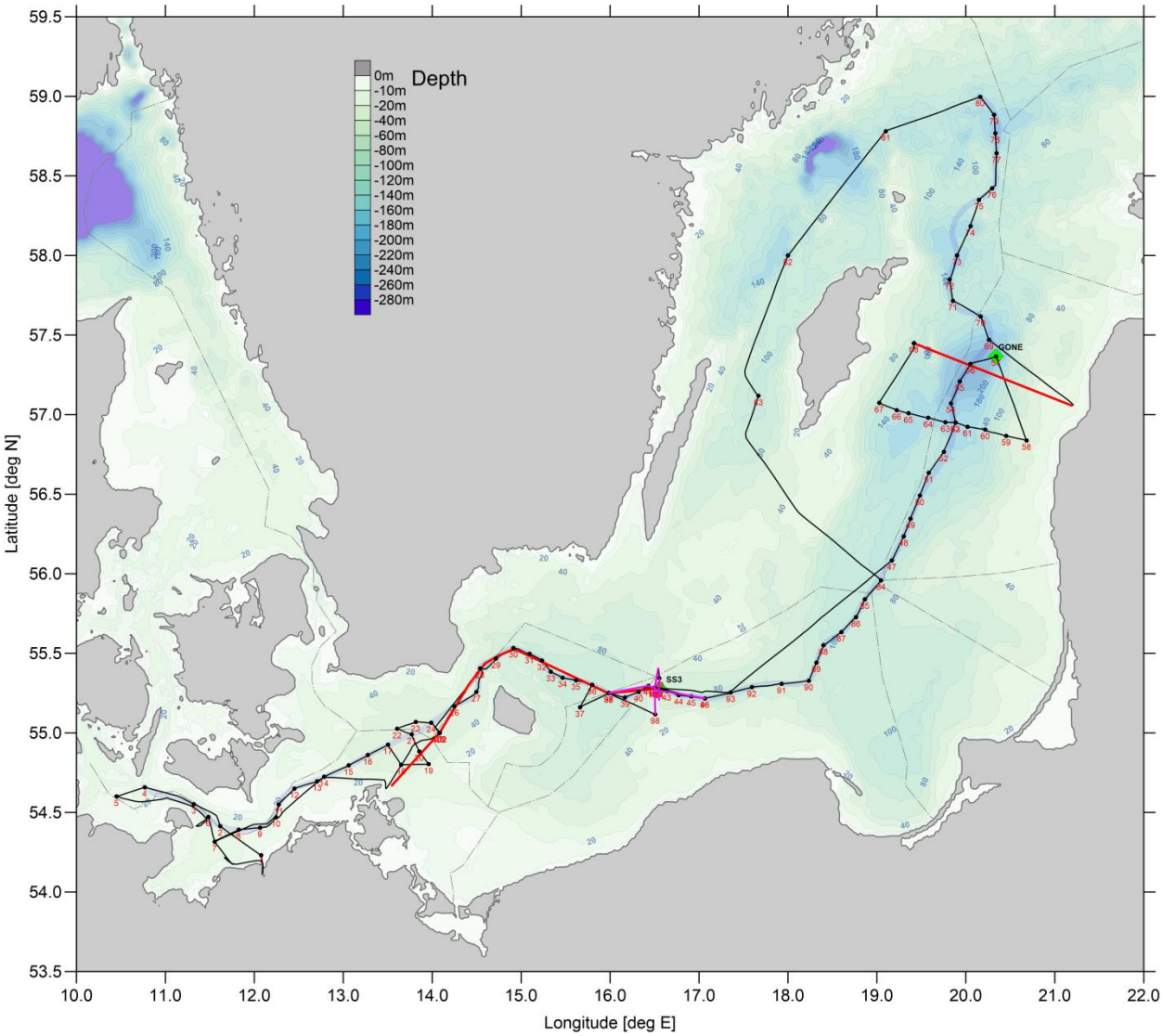

Figure 3.1 Map of stations and ship track of cruise EMB209 from 15. – 27. March 2019. Black dots and red labels indicate the positions and names of CTD stations. The red and magenta lines depict the ScanFish and MSS transects, respectively. Green diamonds mark the location of mooring GONE in the eastern Gotland basin, and SS3 at the Slupsk Sill.

Along the southern rim of the eastern Gotland Basin an east-west transect of CTD stations was worked, in order to gather information about the cross basin distribution of hydrographic parameters in the main basin of the Baltic proper. Additionally, a number of CTD casts were carried out at stations aside the main transects, especially in the western Gotland Basin. The ScanFish undulating CTD was deployed in the eastern Gotland Basin and on the way back to Rostock from the Slupsk Sill to the Arkona Basin. The saline overflow at the Slupsk Sill was covered with three MSS transects. Additionally, a short term mooring was deployed here for the period of the MSS observations. An overview of the locations of CTD stations, mooring positions, and the cruise track is given in Figure 3.1. A station list is given in Table 8.1.

4 Narrative of the Cruise

Date	***Time [UTC]***	***Task***
14.03.2019		Loading of equipment, preparing devices for the cruise
15.03.2019	06:00	Embarking of scientific crew
	06:30	Safety instructions
	07:00	Departure from port Rostock-Marienehe, weather predictions for the next two days are bad.
	08:10	Start of station work in the western Baltic, with station TF_O5 off Warnemünde.
	15:45	Station work at western most station TF0360, wind has increased to 8Bft, Zooplankton net was canceled due to heavy weather, wind gusts up to 25m/s
	20:00	Wind reached Bft 11. The station work was stopped. Station TF0014 was canceled. The ship was going for shelter behind Fehmarn island.
16.03.2019	02:00	Continuation of station work at station TF0013, after wind speed decreased to Bft 7
	08:38	Start of continuous VMADCP 150kHz measurements at the Darss Sill on station TF0002
	11:00	Start station work at the MarNET station Darss Sill, performing comparison measurements for oxygen concentration.
		Station work in the Arkona Basin
	15:22	Start of station work at the central station in the Arkona Basin, moderate wind conditions of Bft 5
	19:25	working at the MarNET station Arkona Buoy, performing comparison measurements for oxygen concentration.
	20:30	Leaving German EEZ
17.03.2019		Continuation of station in Danish and Swedish EEZ, ongoing strong wind conditions
	05:00	Passing the Bornholmgat, Wind conditions still high of Bft 6-7
	07:00	The mooring deployment at the Slupsk Sill, planned for the evening, was canceled due to strong wind and high sea state.
	11:40	Restart of the measuring device for surface water properties, after a failure on 16.03.2019 14:18 UTC
	16:20	Start of station work at the central station in the Bornholm Basin, medium wind conditions of Bft 5-6
	22:20	Passing the Slupsk Sill, wind speed is increasing to 6-7 Bft
18.03.2019	02:30	Stop of station work due to high wind speed and sea state
	06:00	Steaming to station TF250 in the southern Gotland Basin. Working is still not possible, wind speed increased to 7-8 Bft
	12:55	Configuration of VMADCP changed from 4m to 8m bin size for the conditions in the OMZ of the central Baltic. Wind speed is still at 7 Bft

Date	***Time [UTC]***	***Task***
	18:30	Restart station work in the southern Gotland basin at station TF0260. Wind decreased to 6 Bft
19.03.2019		Continuation of station work, wind was decreasing during the night to 5 to 6 Bft
	06:46	Start of station work at the central station TF0271 in the eastern Gotland Basin, medium wind conditions of Bft 5-6
	10:00	First trial to release the long-term mooring at Gotland NE. The communication with the releaser was successful established, but after release of the mooring, it does not appear at the surface. Also two further repetitions of the release procedure failed.
	11:30	Second trial to release the long-term mooring at Gotland NE, using the spare releaser. The release was successful.
	12:30	Deployment of the long-term mooring at Gotland NE, No. 37
	15:30	Cross basin transect through the southern Gotland Basin, Configuration of VMADCP changed from 8m to 4m bin size
20.03.2019	01:50	End of cross basin transect through the southern Gotland Basin, steaming to start position of ScanFish Transect 1
	05:00	Configuration of VMADCP changed from 4m to 8m bin size
	05:45	Start of cross basin ScanFish transect through the central Gotland Basin,
	16:00	End of cross basin ScanFish transect through the central Gotland Basin. Steaming to station TF0276, Wind increased to 7 Bft
	21:50	Start station work on the thalweg transect in the northern Gotland Basin, Wind decreased to 6 Bft
21.03.2019		Continuation of station work on the thalweg transect in the northern Gotland Basin.
	13:45	Northern end of thalweg transect, station work at TF0288
		Steaming to the first station in the western Gotland Basin
	17:45	Start station work in the western Gotland Basin.
22.03.2019	05:38	End of station work in the western Gotland Basin. Wind decreased to 3 Bft.
		Steaming to the southern Gotland Basin
	13:49	Continuation of station work in the southern Gotland Basin along the thalweg transect. Weak winds, cloud free sky.
23.03.2019	01:17	End of station work in the southern Gotland Basin along the thalweg transect. Steaming to the mooring position at the Slupsk Sill
	04:50	Failure of the ships waste water system
	06:00	CTD at the mooring position at the Slupsk Sill
	06:15	Stop of scientific work to fix the failure of the ships waste water system, steaming to central station TF0213 of the Bornholm Basin.
	08:22	waste water system was fixed
	08:25	Start station work at TF0213, heavy fog. Wind speed 5 Bft

Date	***Time [UTC]***	***Task***
	12:00	Mooring deployment of the short term mooring SS19/3 at the Slupsk Sill.
		Still failures of the ships waste water system
	13:40	Start of first MSS transect across the Slupsk Sill
24.03.2019		Continuation of MSS transect across the Slupsk Sill, Wind speed 4-5 Bft
	13:50	End of first MSS transect across the Slupsk Sill
	14:00	CTD deployment at station TF0213, steaming to start position of second MSS transect
	16:30	Start of second MSS transect along crest of the Slupsk Sill
25.03.2019	03:15	End of second MSS transect along crest of the Slupsk Sill, steamning to the third MSS transect
	03:50	Start of third MSS transect downstream the crest of the Slupsk Sill
	08:45	End of third MSS transect downstream the crest of the Slupsk Sill
	09:30	Mooring recovery of the short term mooring SS19/3 at the Slupsk Sill. Recovered with first release, calm wind condition. All sensors gathered the intended data
	11:00	Start of the second ScanFish transect from the Slupsk Sill through the Bornholm Basin, towards Arkona Basin
	22:30	Passing the Bornholmgat
26.03.2019	03:20	Interruption of the second ScanFish transect at station TF0109 for CTD measurements
	03:50	Continuation of the second ScanFish transect in the Arkona Basin, increasing wind speeds
	05:00	The wind speed reached 7 Bft, wave height increased
	07:00	Heading towards the Tromper Wiek for a save recovery of the ScanFish, Wind speed still at Bft
	09:40	End of second ScanFish transect.
	10:15	Work on station TF0113 was cancelled due to bad weather conditions, steaming to station TF0030
	12:10	Start station work at the Darss Sill
	18:16	Last station of the cruise TF0012
	19:00	End of scientific work of cruise EMB209
		Heading towards Rostock port
27.03.2019	07:00	Arrival at port Rostock-Marienehe
	08:00	Unloading of scientific equipment
	11:00	Disembarking of scientific crew, end of cruise EMB209

5 Data Processing and Quality Assurance

A station name and a station number were assigned to all stations, where scientific equipment was used. The station name identifies a geographical position. The station number is an alphanumerical value that is incremented for each new station and gear. The station number was applied according the station number rules of the ship. For the cruise EMB209 the first station number is EMB209_1.

5.1 CTD

The CTD-system "SBE 911plus", SN-09P43260-0853, (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 (683nm)
- Turbidity
- PAR
- SPAR

To minimize salinity spiking, temperature- (SBE 3), conductivity (SBE 4) and oxygen sensors (SBE 43) are arranged within a tube system, where seawater is pumped through with constant velocity. The CTD was equipped with a redundant sensor system sensor system for temperature, conductivity and oxygen. The temperature is given in ITS-90 temperature scale. Salinity is calculated from the Practical Salinity Scale (1978) equations. Fluorescence and turbidity are measured with a downward looking WET Labs fluorimeter. Pressure is determined with a Paroscientific Digiquartz pressure sensor, maximum range 2058 dbar.
Data were monitored during the casts and stored on hard disk with Seasave Version 7. For each station a configuration file (stationname.con) was written which contains the complete parameter set, especially sensor coefficients used for the conversion of raw data (frequencies) to standard output format.

Additionally, the CTD-probe was equipped with a Rosette water sampler with 13 Free Flow bottles of 5l volume each. This design allows for closing of bottles automatically at predefined depths during down-casts. Closing depth and sensor values are aligned by appropriate choice of parameters of the CTD software generating the “bottle files”. The CTD is attached to a heave-compensating winch, enabling the CTD during a cast to be nearly completely decoupled from the ships heave and roll movements.

Sampling

A CTD cast was started below the sea surface with the pressure sensor usually at about 5m depth to prevent a contamination of the CTD pumping system with air bubbles. Data were collected down to 1m above the bottom at all stations. An attached altimeter and a down-facing

underwater camera including LED spotlights and laser were used to determine the bottom distance. Sampling rate of the CTD probe was 24Hz. Data were displayed online to determine appropriate sampling depth and stored on a PC hard drive.
The probe sheds water in its wake over a long distance. Hence, only downcast registration was reliable. Upcast registration was used only for water sampling, if the closing depth was determined during the downcast. At downcast bottles were closed while fiering in an auto-fire mode. For sampling during upcast, the CTD was stopped and bottles closed manually after a 30 second adjustment period. When the device was back on deck oxygen samples were taken first, followed by water samples for salinity, nutrients and water for several biological and geochemical techniques.

Sensor check

The CTD sensors were checked during the cruise by comparison measurements.
At stations with well mixed water layers temperature was measured with a high precision thermometer SBE 35. Salinity samples were taken every day. The samples were stored in white glass bottles and will be analyzed after the cruise by means of a salinometer AUTOSAL Model 8400B (accuracy of 0.002). Most samples were taken from near surface layers, only a few deep well mixed layers could be found.

Slope and offset of the oxygen sensors SBE 43 were determined by help of water samples. Oxygen content of the samples was determined with a titration set (Winkler method, accuracy of 0.02ml/l). Oxygen concentration is calculated using Seasoft, oxygen formula "1",

$$ox = Soc * (V + Voffset) * (1 + A*T + B*T^2 + C*T^3) * OXSAT * \exp(E*P/k)$$

The pressure sensor was checked by measuring pressure on deck before the cast.
Calibration measurements for the fluorometer data have not been done, since no quantitative phytoplankton analysis was performed during the cruise.

Table 5.1: Type and serial numbers of mounted CTD sensors

Sensor	***Type***	***SN***	***Last calibration***
Pressure	Digiquartz	100070	16.05.2006
Temperature 0	SBE 3	5491	17.01.2017
Temperature 1	SBE 3	5492	17.01.2017
Conductivity 0	SBE 4	4006	17.01.2017
Conductivity 1	SBE 4	4007	17.01.2017
Oxygen 0	SBE 43	1733	17.10.2018
Oxygen 1	SBE 43	1735	17.10.2018
Chl-a fluorescence / Turbidity	WET Labs - FLNTURTD	2484	11.01.2012
PAR sensor	Biospherical Licor Chelsea	70256	08.12.2009
SPAR	SPAR/Surface Irradiance	20364	27.02.2017

5.2 VMADCP 150kHz

A 150kHz Acoustic Doppler Current Profiler (VMADCP) Ocean Surveyor (frequency 150 kHz, beam angle 30deg), manufactured by RD-Instruments, was mounted downward looking at the ship hull. The data output of the ADCP was merged online with the corresponding navigation data and stored on the hard disc using the program VMDAS. Pitch, roll and heading data are converted from TCPTIP to UDP protocol with an own program, running on the VMADCP control PC. Current data are collected in beam coordinates to apply all corrections during post processing. The VMADCP was operated continuously during the entire cruise. The following configurations were used for data acquisition in the western and central Baltic..

Table 5.2: Configuration of 150kHz VMADCP

Command	***Parameter***	***Value (western Baltic)***	***Value (central Baltic)***
WP	Broad band pings	1 ping/ens	1 ping/ens
WN	number of depth cells	65	35
WS	bin length	4m	8m
WF	blank after transmit	4m	4m
WV	Ambigiuity velocity	6.5m/s	6.5m/s
BP	bottom track	1 ping/ens	1 ping/ens
BX	max bottom distance	280m	280m
WD	data output	u, corr, amp, PG	u, corr, amp, PG
TP	time between pings	0	0
EZ	sensor source	temp	temp
EX	co-ordinates (ENX)	beam	beam
ED	transducer depth	4m	4m
ES	salinity	15	15
Data option dialog of VMDAS software	heading source	Ext. Gyro	Ext. Gyro
	pitch / roll source	Ext. Phins	Ext. Phins
	navigation source	Ext. GPS	Ext. GPS
	time per ensemble	2s	2s
	time between pings	1s	1s
	heading alignment	0 deg	0 deg
	heading bias	0 deg	0 deg
	short term average	60s	60s
	long term average	300s	300s
	data screening	off	off

Post-processing of the VMADCP data was carried out using the Matlab® ADCP toolbox of IOW. The final profiles are 120s and 300s averages of the single ping profiles. At sections where bottom tracking was available the heading bias of the instrument was calculated. This value and the magnetic deviation were applied during post processing.

5.3 ScanFish towed CTD

High resolution hydrographic transects with the ScanFish towed CTD (SF) were performed in the eastern Gotland Basin and along the western part of Baltic talweg transect.
The ScanFish consists of a Seabird 911+ CTD mounted on a wing shaped body undulating between sea surface and about 130m depth when towed behind the ship. Additionally to the usual CTD sensors, the probe is equipped with sensors for dissolved oxygen concentration, turbidity and Chlorophyll-a fluorescence. The details of the used sensors are given in Table 5.3. Hydrographic data are transmitted via a multi-conductor cable and stored in the lab on a computer disc. The instrument will be deployed over the stern of the ship. The cable is operated from a separate winch to be mounted at the aft deck. The cable is guided by a pulley block mounted below the A-crane. The A-crane will be used for deployment and recovery. The device is towed with 5-7 knots, the undulation depth is steered from the lab. Control commands are transmitted via the cable.

Table 5.3: Type and serial numbers of CTD sensors mounted on ScanFish

Sensor	***Type***	***SN***	***Last calibration***
Pressure	Digiquartz	70963	17.04.2018
Temperature 0	SBE 3	5356	09.07.2018
Conductivity 0	SBE 4	1390	04.07.2018
Oxygen 0	SBE 43	0523	01.12.2018
Chl-a fluorescence / Turbidity	WET Labs - FLNTURTD	2029	28.09.2010

5.4 Moorings

GONE (Long Term Mooring Gotland Northeast)

Main purpose of the GONE mooring is obtaining hydrographic time series of temperature, salinity, oxygen and currents from the deep water range in the eastern Gotland Basin, the central basin of the Baltic Sea. The data are used for long term observation of environmental conditions in the deep water of the Baltic and for detecting the impact of saline inflow events. The mooring is operated since 1997 and provides also the data basis for the "Hagen-Curve" of deep water temperatures in the eastern Gotland basin. The GONE mooring consists of a bottom mounted ADCP 300kHz, 1 MicroCat thermosalinometer SBE37, three RBR temperature recorders, and 3 PME oxygen optodes. The sketch of the mooring is depicted in left panel of Figure 5.1.
On 19.03.2017 11:30 UTC the GONE mooring (deployment NE36) was successful recovered after five month of operation. Since the release of the main mooring failed, the spare release at the end of ground rope was used for recovering. During the deployment NE36 all devices delivered data for the entire measuring period. The mooring (deployment NE37) was redeployed after maintenance on the afternoon of 19.03.2019 at 12:30 UTC (compare Table 8.3).

SS19/3 (Slupsk Sill High Resolution Mooring)

The SS19/3 was used to gather high resolution current measurement in the center of the MSS transect at the Slupsk Sill. The right panel of Figure 5.1 depicts the sketch of the mooring. It consists of a 1200kHz WH-ADCP, and twelve RBR temperature loggers to cover the bottom water column. The mooring was deployed at noon of 23.03.2013 (12:00 UTC). After finishing

the MSS observations the mooring was successful recovered on 25.03.2015 at 09:30 UTC (see Table 8.3).

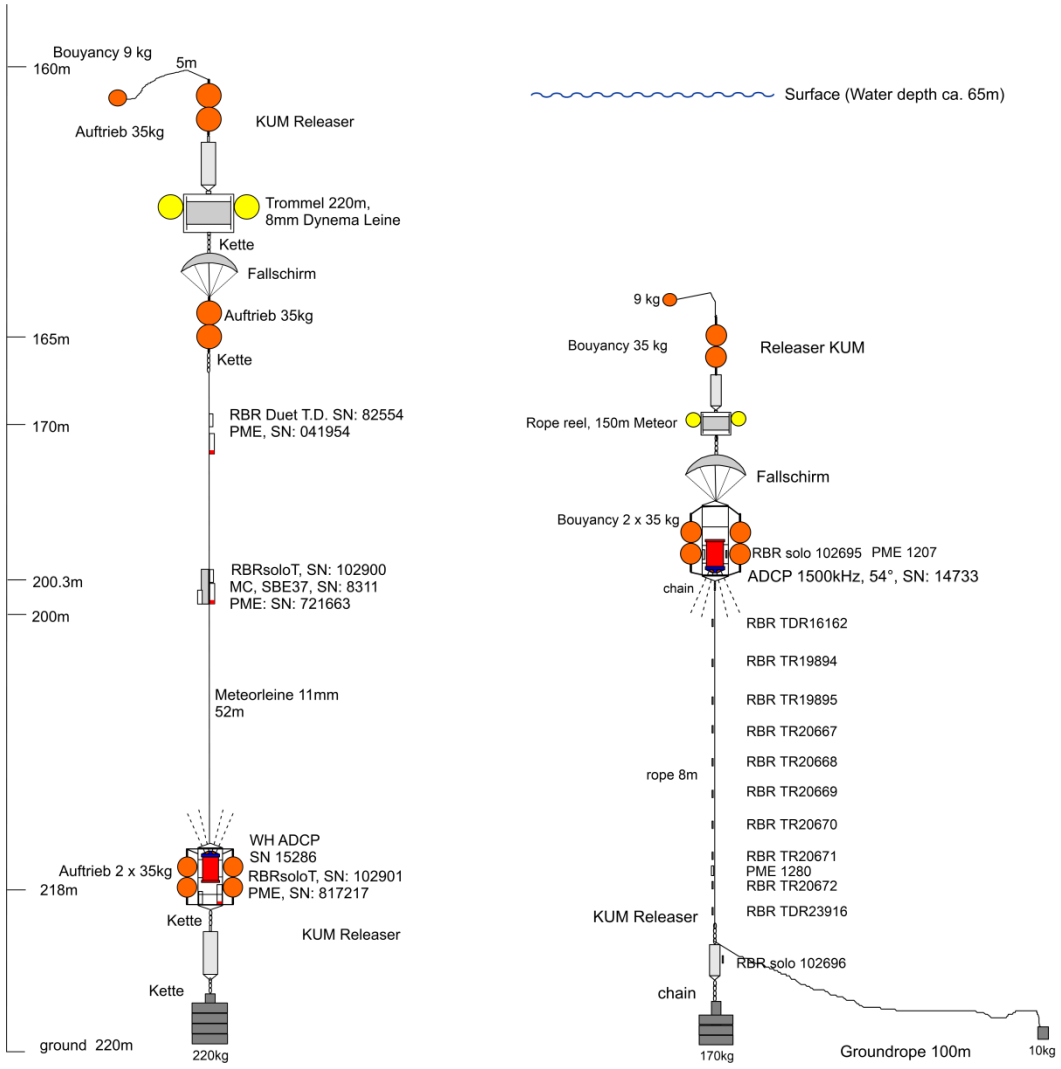

Figure 5.1 Sketch of the GONE mooring deployment 37 (left), and Slupsk Sill short term mooring deployment SS19/3 (right).

5.5 Microstructure Profiler (MSS)

From 23rd to 25th March three MSS transects were carried at the Slupsk Sill, to observe the overflow of saline water from the Bornholm Basin into the Slupsk Furrow. Here about 500 MSS profiles were performed.

The MSS 90-S (Serial number 038) is an instrument for simultaneous microstructure and precision measurements of physical parameters in marine waters. The MSS profiler was equipped with 2 velocity microstructure shear sensors (for turbulence measurements), a microstructure temperature sensor, standard CTD sensors for precision measurements, a turbidity sensor, and a vibration control sensor.

All sensors are mounted at the measuring head of the profiler, the microstructure ones being placed about 150 mm in front of the CTD sensors. The sampling rate for all sensors was 1024 samples per second. The profiler was balanced with negative buoyancy, which gave it a sinking

velocity of about 0.6 m/s. It was deployed with a winch at the reeling. The profiler was operated from the stern of FS Elisabeth Mann Borgese. Disturbing effects caused by cable tension (vibrations) and the ship's movement were excluded by a slack in the cable. After the deployment the sensors were flushed with pure water to prevent fouling.
The dissipation rate of turbulent kinetic energy was calculated by fitting the shear spectrum to the theoretical Nasmyth spectrum in a variable wave number range from 2 to maximum 30 cycles per meter (cpm). The low wave number cut off at 2 cpm is to eliminate contributions from low frequent tumbling motions of the profiler. The MSS sensors were calibrated before the cruise in the IOW calibration lab.

5.6 Plankton Sampling

Plankton sampling was performed by means of a rosette sampler (combined with CTD) as well as with a small phytoplankton net (PLA) and a zooplankton net (WP2). Samples were taken from different depths in order to get representative data from the euphotic zone. Additionally, samples for micro biological analyses were taken at some stations in the central Baltic.

5.7 Long Term Investigations of CH_4, N_2O and CO_2 Distribution

Sampling for simultaneous CH_4 and N_2O observation was carried out in frame of an extension to the long term data collection program. The sampled stations are indicated in Table 8.1 with the abbreviation "TG". One complete depth profile was sampled at station TF0271 for the long term data collection of CT, AT, and pH.
These samples were fixed with 500 µL saturated $HgCl_2$-solution to prevent microbiological activity and stored dark.

5.8 Underway Measurements

The FS Elisabeth Mann Borgese is equipped with numerous sensors, which continuously provide important environmental and navigation parameters. The available data set consists of weather parameters, surface water properties, navigation information, rope length, winch speed and more. The data are collected by a data acquisition system DSHIP3 manufactured by WERUM. All data are stored in a data base and can be extracted by a web interface. A description of all collected parameters is given in the ship specific DSHIP3 manual. All data are snapshots taken and stored every second. After the cruise the full data set was extracted. During the cruise a subset of the parameters was processed.

This data set consists of ten minutes averages of:

- time (UTC)
- latitude and longitude
- ships heading
- depth
- air pressure
- air temperature
- humidity
- global radiation

- infrared radiation
- Surface conductivity
- Surface salinity (SSS)
- Surface water temperature (SST)
- Surface chlorophyll-a fluorescence
- Surface turbidity
- Wind direction
- Wind speed

Due to a failure in the measuring system for surface water properties no data on SST, SSS, Chlorophyll-a fluorescence and turbidity are available for the period 16.03.2019 14:18 UTC to 17.03.2019 11:53 UTC.

6 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! The aim of this section is to give a first impression on the collected data set. An advanced data analysis will follow after all validated data sets are available.

6.1 Meteorological Conditions

The general meteorological conditions during the cruise were characterized by a continuous chain of low pressure systems, rapidly moving eastward over the Baltic. This caused fast changes in wind and cloud coverage. The cruise started with medium wind conditions. During the afternoon of 15th March the wind speed increased rapidly to gale force strength from westerly directions. In the Evening of that day the station work was interrupted due to the high sea state and a wind speed of 23ms^{-1}. On the next day the wind speed decreased to 5 to 6 Bft, and remained at that level also on the 17th March. During the night from 17th to 18th March the wind reached gale force again, but decreased soon in the afternoon of the 18th March. During the following days the wind speed alternated between 4 and 6 Bft with westerly directions. After a calm day on 22nd March, the wind speed remained at a level of about 10ms^{-1} (Figure 6.1 and Figure 6.2).

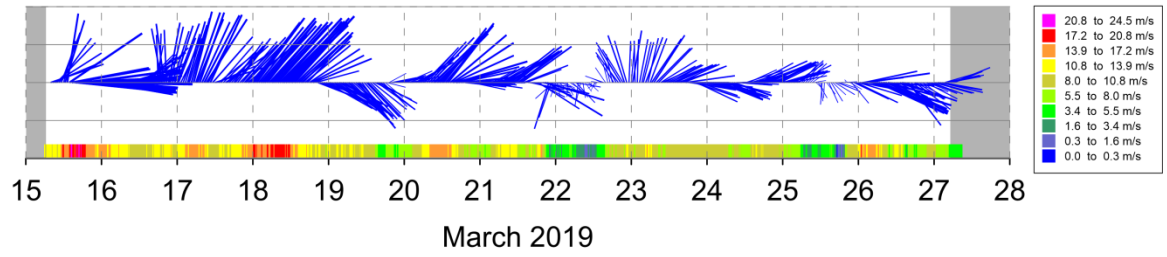

Figure 6.1 Stick plot of wind vector measured by the ship weather station of FS Elisabeth Mann Borgese. The grey shaded areas indicate periods when the ship was in port.

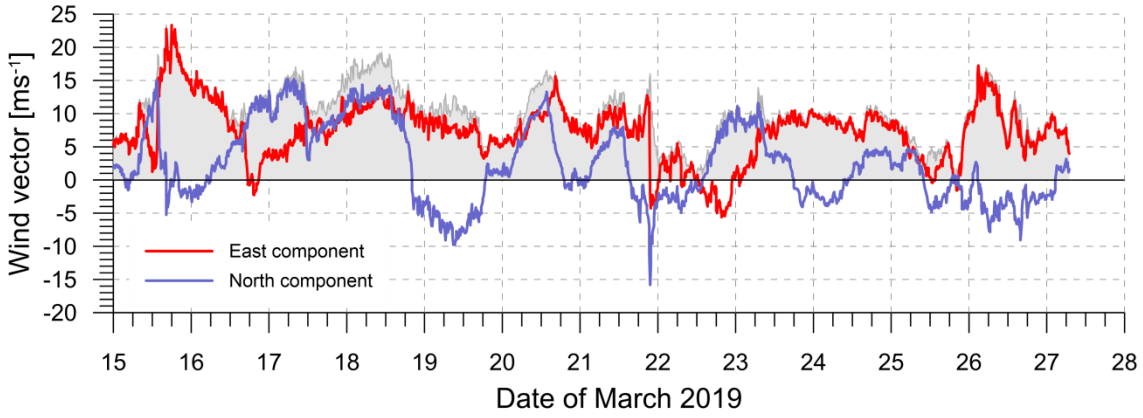

Figure 6.2 Wind vector east and north measured by the ship weather station of FS Elisabeth Mann Borgese (10 min averaged values).

The air temperature was well above the long term average for the early spring season. From 15th to 18th March the air temperature was about 5 to 6°C. After the passage of the storm low pressure system on 19th March the air temperature dropped to 2°C, and increased during the following two days to about 4°C. For the rest of the cruise the air temperature remained at the level of 4 to 5°C.

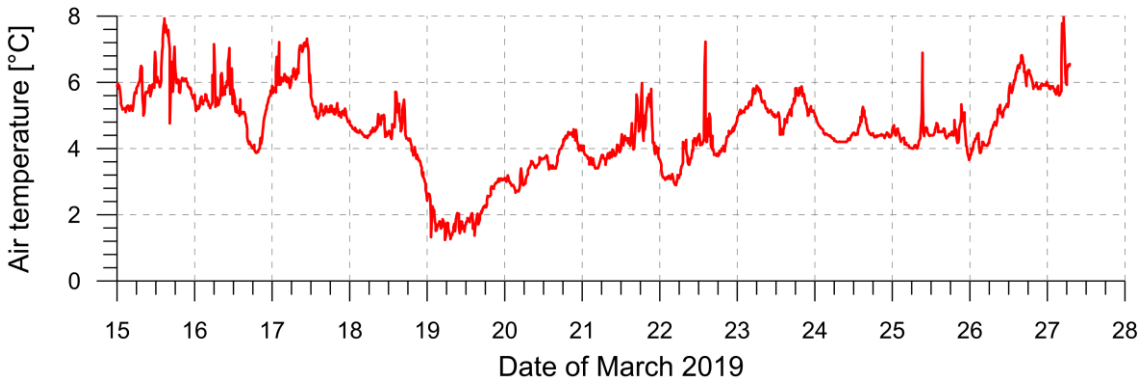

Figure 6.3 Air temperature measured by the ship weather station of FS Elisabeth Mann Borgese (10 min averaged values).

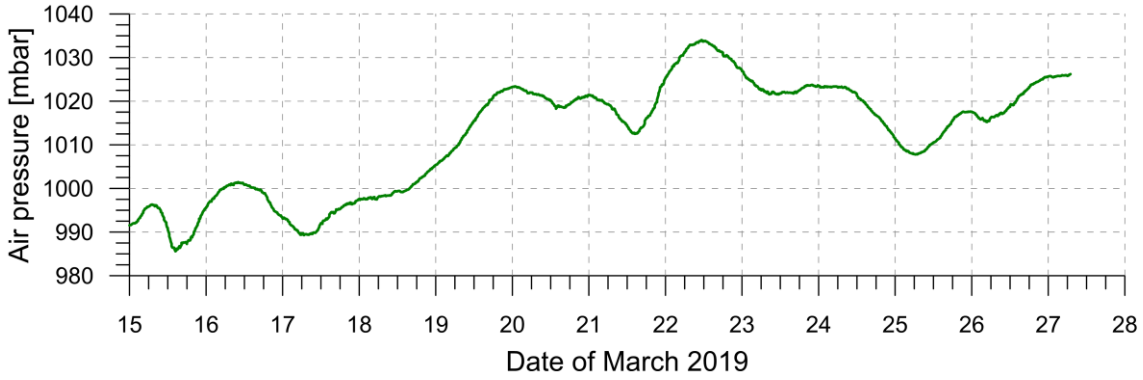

Figure 6.4 Air pressure measured by the ship weather station of FS Elisabeth Mann Borgese (10 min averaged values).

The air pressure variations during the cruise show the typical time scale of passing low and high pressure systems of 1 to 3 days duration. During the first two days of the cruise the air pressure

ranged between 985 and 1000mbar. An overall increasing trend was observed from 18th till the 22th March. Afterwards the chain of small low pressure system over the central Baltic caused minor fluctuations of air pressure from 1010 to 1030mbar. The air pressure remained at around 1020mbar till the end of cruise.

The humidity was relatively high, but typical for the spring season varying between 70 and nearly 100%. On 23rd March low winds and cooling by the cool surface water caused the formation of sea fog. The global radiation was strongly related to the cloud coverage. In the first half of the cruise the high cloud coverage caused very low values of global radiation, which were mostly below the long wave radiation. Maximum value, at noon on the sunny 22nd March, was about 600 Wm^{-2}. From 24th March onwards the daily global radiation maxima were about 500 to 600 Wm^{-2}. The long wave radiation ranged between 240 and 340 Wm^{-2}.

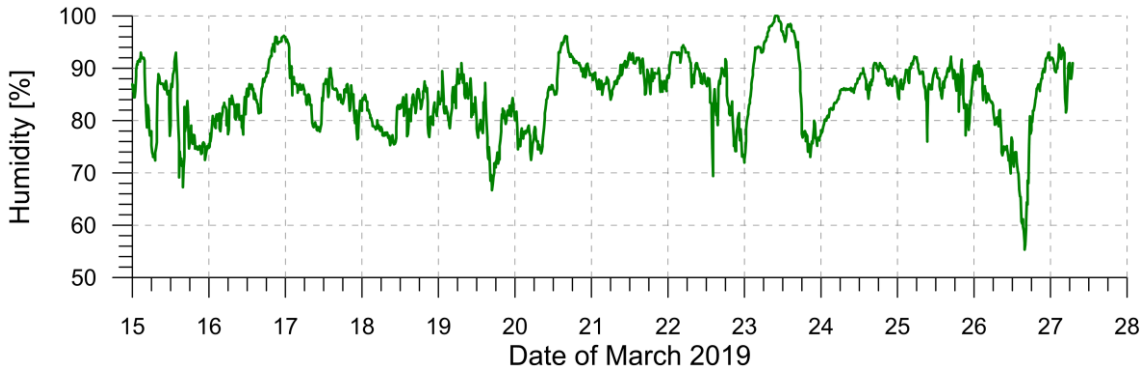

Figure 6.5 Air humidity measured by the ship weather station of FS Elisabeth Mann Borgese (10 min averaged values).

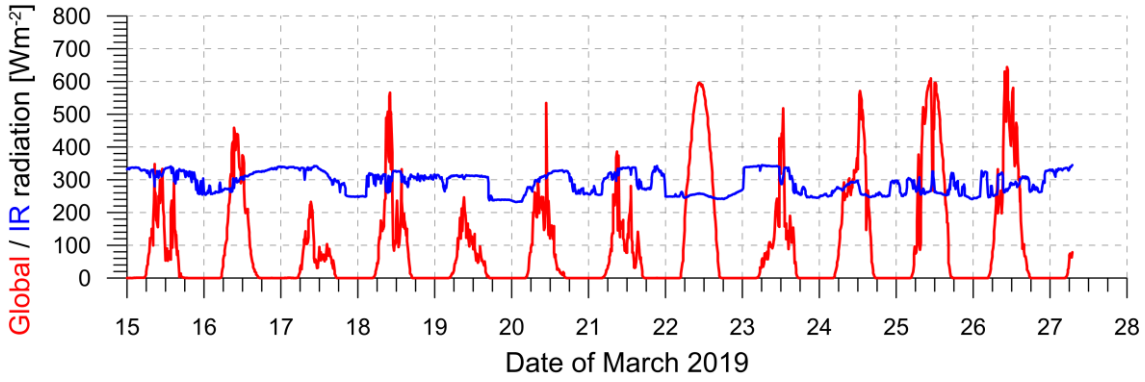

Figure 6.6 Global and infrared radiation measured by the ship weather station of FS Elisabeth Mann Borgese (10 min averaged values).

6.2 Sea Surface Temperature, Salinity and Chlorophyll-a Distribution

Sea surface temperature and surface salinity distributions in the investigation area were compiled from data gathered with the ships thermosalinograph. The distributions shown in Figure 6.7 are based on unvalidated data.

Due to the extremely mild winter 2018/2019 the sea surface temperatures (SST) in the entire Baltic were well above the climatological mean value for March. In the Kiel Bight and the Mecklenburg Bight the SST was about 5.0 to 5.5°C. Here, the observed saline surface waters

indicate the transition zone between Baltic and North Sea (Figure 6.7). Generally, the salinity (SSS) decreases from west to east. In the Arkona Basin SSTs were about 4.0°C and SSS about 8.0 in the beginning of the cruise on 15th March. The SST remained at about 4.0°C till the 26th March due to low air temperatures and the high cloud coverage during the cruise. Along the thalweg the SST and SSS decreased towards the central Baltic. In the western Gotland Basin a SST and SSS of 3.2°C and 7.4 were observed, respectively. Further north and west the decrease of SST and SSS continued. The minimum SST of 1.8°C and SSS of 6.5 were observed at station TF0283 in the western Gotland basin (Figure 6.8 and Figure 6.9). In contrast to the southern and central Baltic, in the western Gotland basin the SST was partly the density maximum, which is important for the onset of stratification and spring bloom. On the way back towards the western Baltic only the SST in the southern Gotland Basin was slightly higher than in the beginning of the cruise.

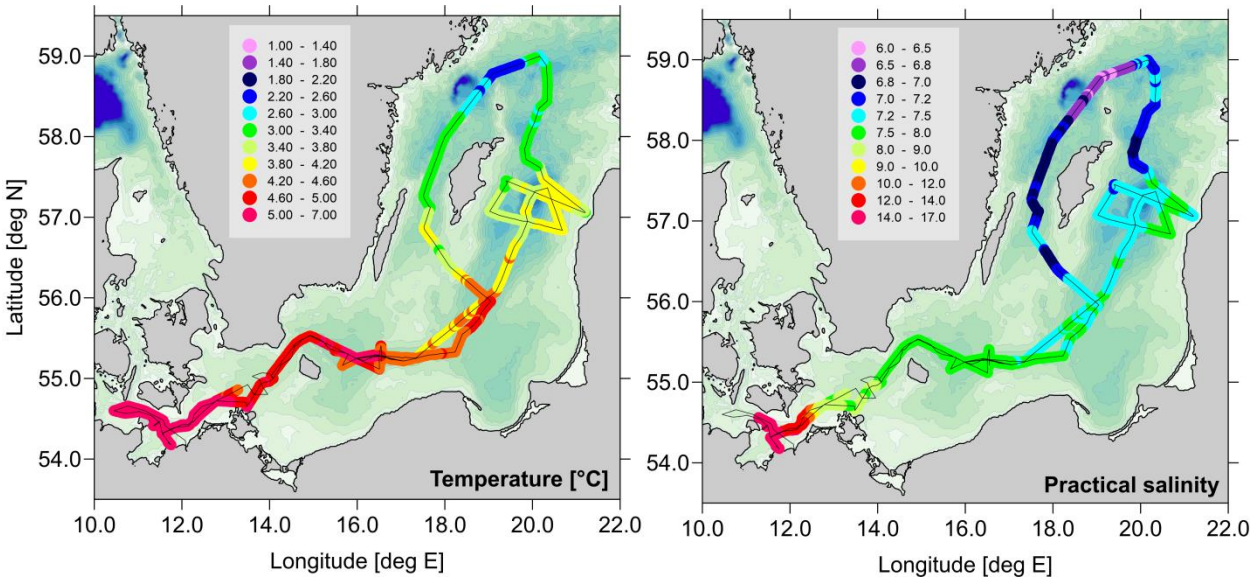

Figure 6.7 Surface temperature (left) and surface salinity distribution (right) along the cruise track of EMB209 in the western and central Baltic (10 min averaged values).

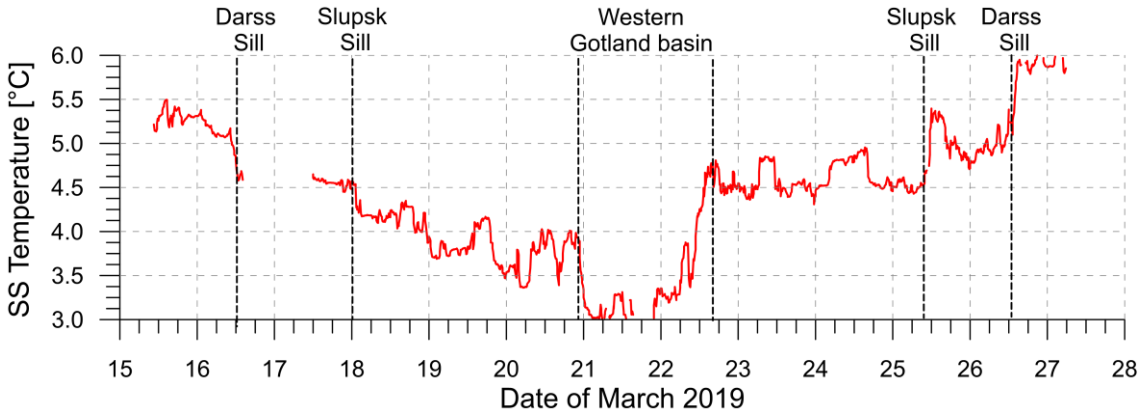

Figure 6.8 Surface temperature measured with the ship thermosalinograph of FS Elisabeth Mann Borgese. The gray shaded area indicates the range below the density maximum at the sea surface.

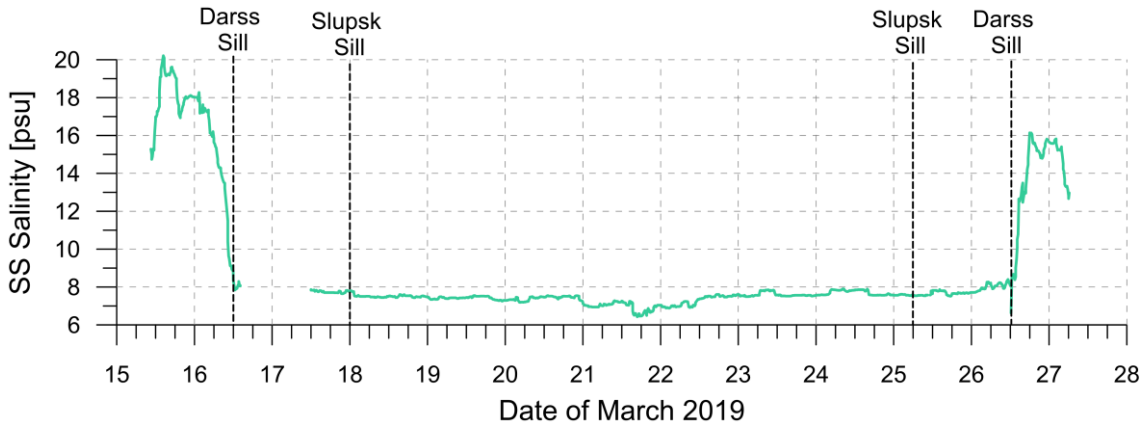

Figure 6.9 Surface salinity measured with the ship thermosalinograph of FS Elisabeth Mann Borgese.

The surface distribution of Chlorophyll-a fluorescence supplied information about the beginning spring bloom (Figure 6.11). In the first days of the cruise the Chlorophyll-a fluorescence was elevated west of the Darss Sill in the Kiel and the Mecklenburg Bight, indicating that the spring bloom has already started here. During the work in the Arkona Bight no continuous surface water sampling was performed due to a failure of the measuring device. However, there was some indication of increased Chlorophyll-a fluorescence in the eastern Bornholm Basin (Figure 6.10). East of the Slupsk Sill towards the eastern and central Gotland Basin the Chlorophyll-a fluorescence was very low. In contrast, higher Chlorophyll-a fluorescence was observed in the western Gotland Basin, and partly on the way back in the southern Gotland basin. Here the start of the spring bloom was triggered by the onset of stable shallow surface stratification. The highest values of Chlorophyll-a fluorescence were observed in the western Bornholm Basin and in the Arkona Basin during the return to Rostock on the 26th March.

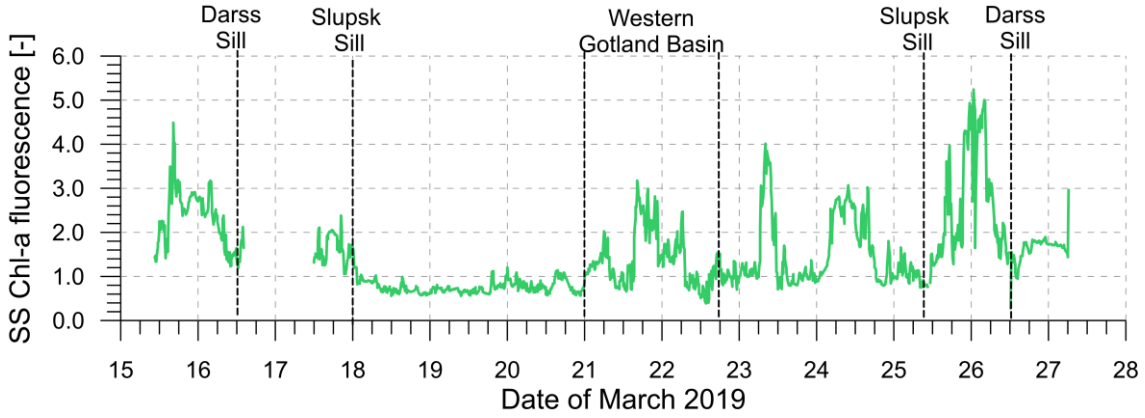

Figure 6.10 Surface chlorophyll-a fluorescence measured with the flow through fluorometer of FS Elisabeth Mann Borgese.

The surface distribution of turbidity correlates in most regions with the chlorophyll-a fluorescence pattern. Higher turbidity was observed in regions where the spring bloom has started. However, the lowest turbidity in surface water was observed in the western Bornholm basin at higher chlorophyll-a fluorescence values (Figure 6.11).

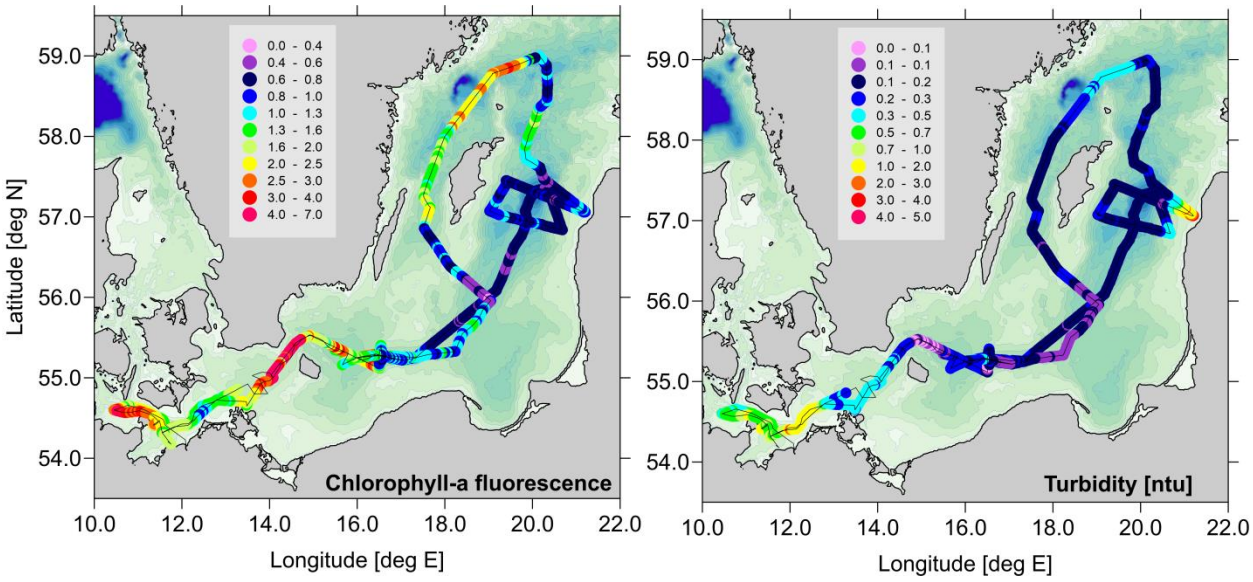

Figure 6.11 Surface chlorophyll-a fluorescence (left) and surface turbidity distribution (right) along the cruise track of EMB209 in the western and central Baltic (10 min averaged values).

6.3 Observations at Main Stations

The following tables list the surface (Table 6.1) and bottom values (Table 6.2) of the most important hydrographic and chemical parameters measured at the main stations of the monitoring program. For positions of the particular stations refer to Figure 3.1 and Table 8.1. In the depth-column the italic number in brackets shows the BottleID of the corresponding sample. Blue colored values in the oxygen column are hydrogen sulfide concentrations. The italic oxygen values in brackets depict the raw readings of the CTD oxygen sensor 0.

Conversion factors: µmol l^{-1} H_2S * -0.0448 = negative oxygen equivalent ml l^{-1} O_2
µmol l^{-1} O_2 * 0.0224 = ml l^{-1} O_2

Table 6.1 Surface values of main hydrographic parameters at the main stations.

Area ***Date***	***St. name*** ***St. no.***	***Depth*** ***[m]***	***Temp*** ***[°C]***	***Sal*** ***[psu]***	***O_2 / H_2S*** ***[µmol l^{-1}]***	***PO_4*** ***[µmol l^{-1}]***	***NO_3*** ***[µmol l^{-1}]***	***SiO_4*** ***[µmol l^{-1}]***
Kiel Bight 15.03.2019	TF0360 EMB209_5	2 *(110)*	4.71	19.21	351 *(344)*	0.10	0.0	1.8
Meckl. Bight 16.03.2019	TF0012 EMB209_7	3 *(210)*	4.60	17.28	347 *(341)*	0.19	0.0	3.1
Darss Sill 16.03.2019	TF0030 EMB209_14	2 *(377)*	4.27	8.88	379 *(372)*	0.38	0.55	14.3
Arkona Basin 16.03.2019	TF0113 EMB209_17	3 *(458)*	3.99	7.97	385 *(380)*	0.41	0.58	15.0
Bornholm Deep 17.03.2019	TF0213 EMB209_38	3 *(1027)*	4.00	7.69	388 *(379)*	0.52	1.03	14.4
Slupsk Furrow 18.03.2019	TF0222 EMB209_46	2 *(1302)*	3.71	7.51	385 *(377)*	0.60	2.30	15.8
SE Gotland Basin 22.03.2019	TF0259 EMB209_87	2 *(2602)*	3.88	7.52	- *(377)*	0.55	2.25	15.4

SC Gotland Basin 18.03.2019	TF0260 EMB209_51	2 *(1427)*	3.40	7.48	384 *(375)*	0.59	2.69	15.8
Gotland Deep 19.03.2019	TF0271 EMB209_56	4 *(1627)*	3.25	7.43	386 *(375)*	0.64	2.79	15.6
Farö Deep 21.03.2019	TF0286 EMB209_72	2 *(2177)*	2.46	6.94	397 *(388)*	0.68	3.11	18.7
Landsort Deep Not measured	TF0284	-	-	-	-	-	-	-
W Gotland Basin 21.03.2019	TF0240 EMB209_81	2 *(2402)*	2.80	7.04	395 *(385)*	0.64	2.44	19.1
Karlsö Deep 22.03.2019	TF0245 EMB209_82	2 *(2477)*	2.74	6.97	397 *(387)*	0.66	2.63	19.2

Table 6.2 Bottom values of main hydrographic parameters at the main stations.

Area ***Date***	***St. name*** ***St. no.***	***Depth*** ***[m]***	***Temp*** ***[°C]***	***Sal*** ***[psu]***	***O_2 / H_2S*** ***[µmol l^{-1}]***	***PO_4*** ***[µmol l^{-1}]***	***NO_3*** ***[µmol l^{-1}]***	***SiO_4*** ***[µmol l^{-1}]***
Kiel Bight 15.03.2019	TF0360 EMB209_5	17 *(113)*	5.05	22.19	- *(299)*	0.26	0.60	4.4
Meckl. Bight 16.03.2019	TF0012 EMB209_7	23 *(213)*	4.65	17.53	- *(338)*	0.20	0.09	3.4
Darss Sill 16.03.2019	TF0030 EMB209_14	22 *(380)*	4.12	9.72	- *(360)*	0.40	1.10	14.3
Arkona Basin 16.03.2019	TF0113 EMB209_17	46 *(464)*	4.94	16.28	266 *(257)*	0.89	7.42	24.3
Bornholm Deep 17.03.2019	TF0213 EMB209_38	88 *(1036)*	8.58	17.12	63 *(60)*	2.73	8.07	46.1
Slupsk Furrow 18.03.2019	TF0222 EMB209_46	89 *(1308)*	7.85	14.12	- *(163)*	1.71	7.41	30.7
SE Gotland Basin 22.03.2019	TF0259 EMB209_87	88 *(2608)*	6.70	11.68	12 / **0.4** *(17)*	2.90	0.0	45.0
SC Gotland Basin 18.03.2019	TF0260 EMB209_51	140 *(1435)*	7.18	12.78	**38** *(11)*	3.95	0.0	47.0
Gotland Deep 19.03.2019	TF0271 EMB209_56	234 *(1614)*	7.55	13.36	**96** *(0)*	4.78	0.0	59.2
Farö Deep 21.03.2019	TF0286 EMB209_72	190 *(2164)*	6.83	12.58	**68** *(0)*	3.97	0.0	56.6
Landsort Deep Not measured	TF0284	-	-	-	-	-	-	-
W Gotland Basin 21.03.2019	TF0240 EMB209_81	160 *(2411)*	5.78	10.62	**44** *(1)*	3.35	0.0	52.4
Karlsö Deep 22.03.2019	TF0245 EMB209_82	198 *(2484)*	5.69	10.47	**47** *(1)*	3.40	0.0	47.8

The spatial distribution of bottom oxygen conditions derived from water bottle samples is given in Figure 6.12. Nearly the entire central Baltic, east of the Slupsk Furrow was covered by anoxic bottom waters, enriched with free hydrogen sulphide. Only at the entrance to the eastern Gotland Basin oxic bottom water was observed in a small plume of inflowing saline water, originated from the baroclinic summer inflows in 2018.

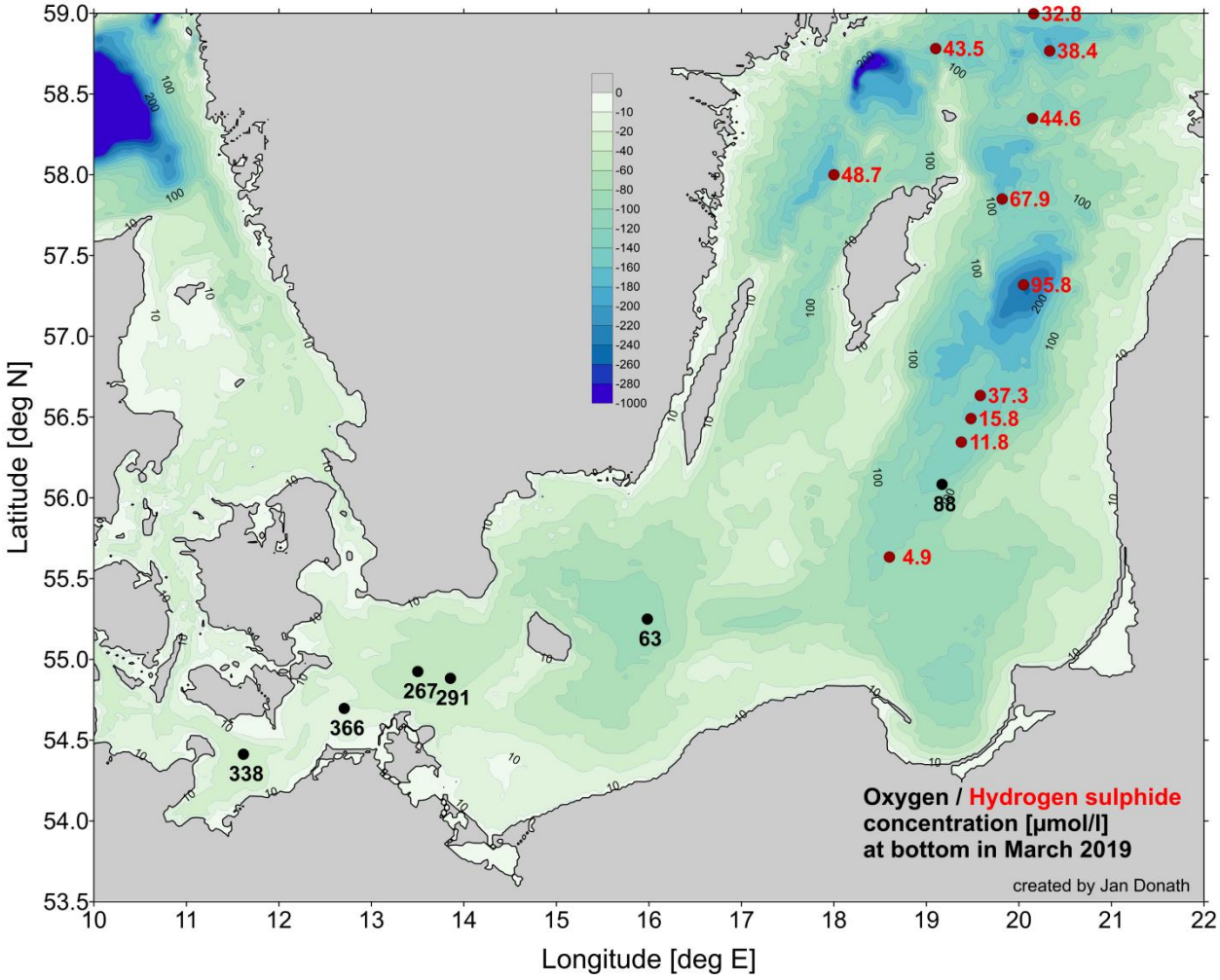

Figure 6.12 Distribution of oxygen (black labels) and hydrogen sulphide concentrations (red labels) near bottom at main stations of the long term observation program.

6.4 Baltic Thalweg Transect

The majority of the stations worked during the cruise EMB209 were aligned along the thalweg transect from the Danish straits, through the western Baltic Sea, and further towards the northern Gotland basin. This transect supplies an excellent overview about the hydrographic and environmental state of the entire Baltic Sea. Due to the weather conditions the transect could not worked as a continuous sequence of stations. The stations were worked in three sections. The first section from the Danish straits to the Slupsk Sill was performed from 15th to early morning of 18th March. The transect was continued in the southern Gotland basin in the evening of 18th March. The northern most station of the transect was reached on 21st March. On the way back to the Slupsk Sill, the remaining stations in the southern Gotland basin and Slupsk Furrow were coverd on 22nd March. The transect depict the typical patterns of early spring conditions and the signatures of eastward spreading saline waters between the Bornholm Basin and the entrance to the eastern Gotland Basin (Figure 6.13 and Figure 6.14).

The temperatures in the surface layer of the western Baltic were extremely high at about 4.7°C in the Belt Sea and 4.0°C in the Arkona Basin. Slightly lower SST's of about 3.2°C were found in

the Eastern Gotland basin. The lowest SST along the transect was detected at the northernmost station with of 2.3°C. The thickness of the well mixed upper water layer increases eastward from about 45 m in the Bornholm Basin to nearly 70m in the southern Gotland basin. In the northern Gotland basin the surface mixed layer thickness slightly decreases to about 60m. Along the entire transect the surface temperatures were above the temperature of maximum density. Thus, the start of heating of surface layer during spring will stabilize the surface water by the onset of thermal stratification. Below the thermocline the water temperature increased to 6 to 8°C. The highest temperature of 8.9°C was observed in the deep water of the western Bornholm Basin. Also the intermediate layer between 100 and 150m depth in the eastern Gotland basin depicted a temperature maximum, with some water patches warmer than 8°C. The bottom water temperature in the Gotland deep was 7.55°C.

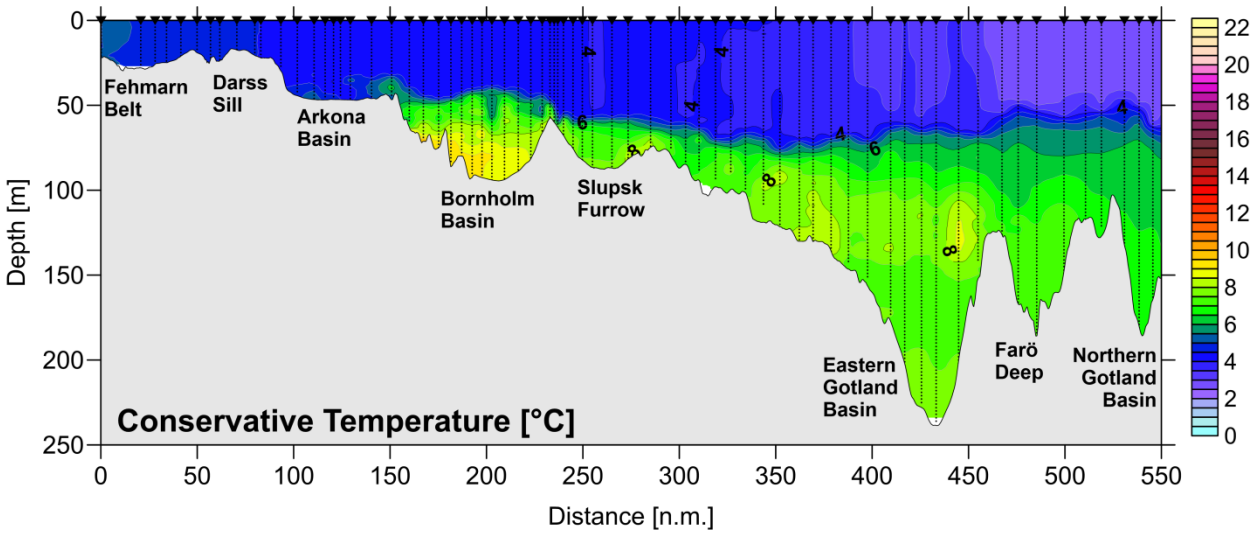

Figure 6.13 Distribution of conservative temperature along the talweg of the Baltic Sea from the Kiel bight to the eastern Gotland Basin. The figure is based on the preliminary CTD data gathered from 15.03. - 23.03.2019.

In summer and autumn 2018 a series of baroclinic and weak barotropic inflows was observed in the western Baltic. These inflow events transported significant amounts of warm saline water into the Baltic. The mean salinity of the inflowing water was high enough to replace the deep and bottom water of the Bornholm Basin. Due to their distinct temperature, the warm waters of the inflows are seen in the temperature distribution (Figure 6.13). The inflow waters filled the the Bornholm Basin below the sill depth of the Slupsk Sill. The upper parts of this water has passed the eastern sill of Slupsk Furrow and spreading eastward to the eastern Gotland Basin. The event like overflow of the sill formed several plumes. Due to their low salinity around 12 g/kg this water is sandwiched in the intermediate water layer of the eastern Gotland basin at a depth range between 100 and 150m. The deep water layers of the Slupsk Furrow has been flushed by cooler water from the halocline layer of the Bornholm Basin. The deep and bottom layer of the eastern Gotland basin is still covered by high saline waters from the recent inflow series started with the exceptional Major Baltic Inflow in December 2014. In the Gotland Deep the bottom temperature and salinity of 7.55°C and 13.36gkg^{-1} are still close to the ever observed maximum.

The spatial distribution of salinity along the thalweg transect (Figure 6.14) depicted similar features as the temperature distribution. Additionally, a beginning inflow of saline water is seen

in the Fehmarn Belt area with salinities above 22gkg^{-1} at the westernmost station of the transect. Another patch of dense saline water covered a 10 to 15m thick bottom layer in the Arkona basin. The low temperature of the water body indicates that it originates from an small inflow in February. The halocline in the central Baltic was found at a depth between 70 and 80m. Its vertical salinity gradient decreases towards northern end of the transect.

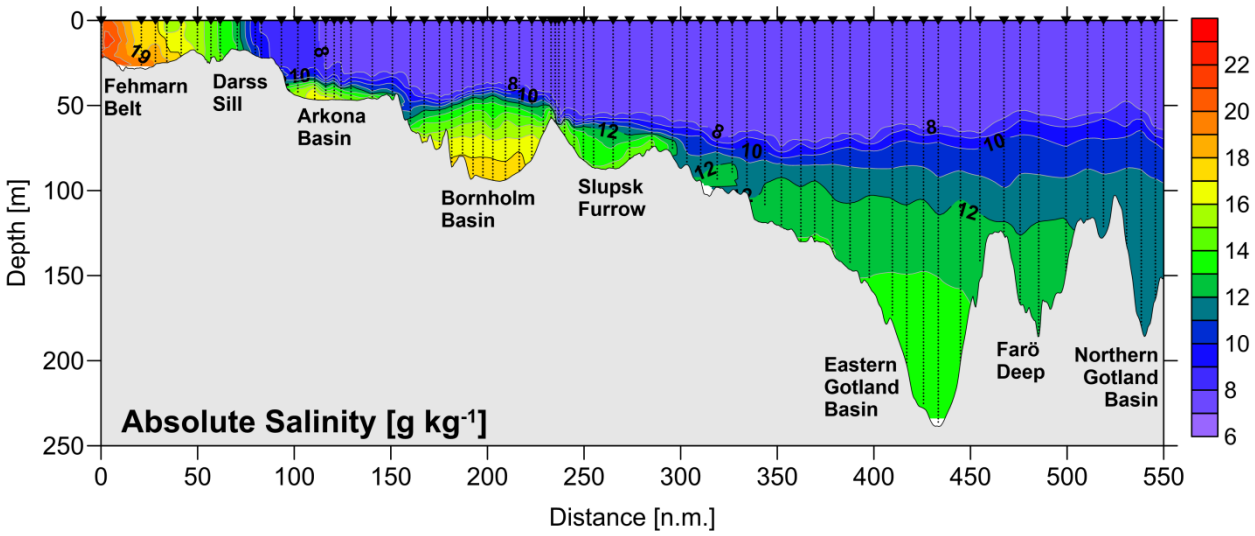

Figure 6.14 Distribution of Absolute salinity along the talweg of the Baltic Sea from the Kiel bight to the eastern Gotland Basin. The figure is based on the preliminary CTD data gathered from 15.03. - 23.03.2019.

The oxygen distribution along the central transect is shown in Figure 6.15. Due to the series of minor inflow events the western Baltic is well ventilated. The density of the inflow water was high enough to replace also the deep water in the Bornholm basin. However, due to mixing with former oxygen depleted deep water the bottom oxygen concentration was reduced. At station TF0213 a bottom oxygen concentration of 60 µmol kg^{-1} was observed.

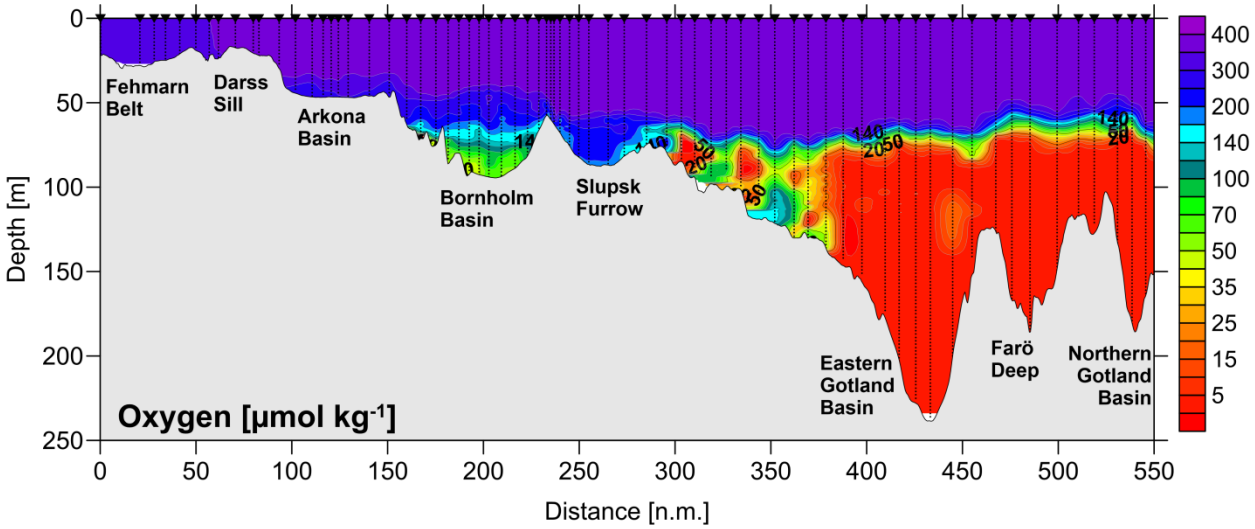

Figure 6.15 Distribution of oxygen concentration along the talweg of the Baltic Sea from the Kiel bight to the eastern Gotland Basin. The figure is based on the preliminary CTD data gathered from 15.03. - 23.03.2019.

The Slupsk Furrow depicted deep water oxygen concentrations of about 160 µmol kg^{-1}. This was caused by the nearly complete flushing of the furrow by well oxygenated halocline waters from

the Bornholm Basin. Between the eastern outlet of the Slupsk Furrow and the eastern Gotland Basin (EGB) the plumes of warm saline inflow water are also visible in the oxygen distribution. Their high oxygen concentration was in big contrast to the ambient anoxic water. Generally, in the eastern Gotland Basin the oxygen concentrations below the halocline decreased rapidly to values below 10 µmol kg^{-1}. In the northern part of the EGB a patch with slightly enhanced oxygen concentration coincides with the warm patch in temperature (Figure 6.13), indicating remains of water from the warm summer inflows. In the major part of the EGB the dissolved oxygen concentrations below the halocline were close to 0. At depth below 150m oxygen was exhausted, and free hydrogen sulfide was detected in water samples. In the Faro deep and the northern Gotland Basin the anoxic waters start at the lower halocline at about 80m depth.
The surface layer of the Baltic is well ventilated, mainly due to wind induced deep mixing during the winter season. The beginning spring bloom and the low temperatures lead to enhanced oxygen concentrations above 400 µmol kg^{-1} in the surface layer.

The chlorophyll-a fluorescence data gathered along the transect indicate that the spring bloom has already started in the Danish Straits and the Arkona Basin, where the highest chlorophyll-a fluorescence was observed (Figure 6.16). Enhanced chlorophyll-a fluorescence was also detected in the eastern Bornholm Basin and the Faro Deep. In the Slupsk Furrow and the eastern Gotland Basin the chlorophyll-a fluorescence values were still low. There the deep mixed layer hampered the fast development of the spring bloom.

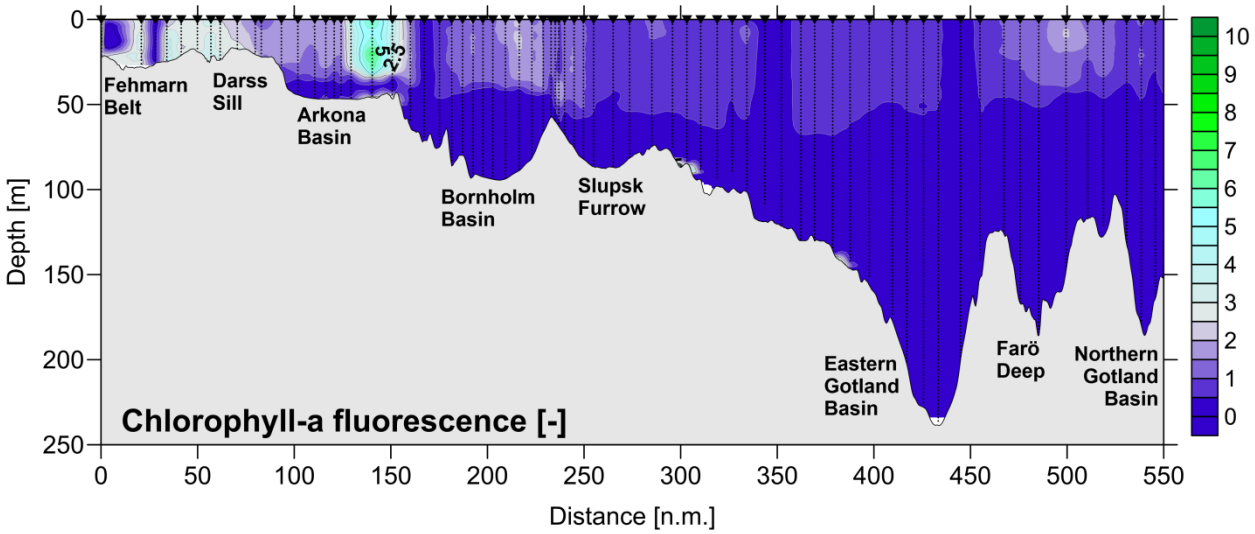

Figure 6.16 Distribution of Chlorophyll-a fluorescence along the talweg of the Baltic Sea from the Kiel bight to the eastern Gotland Basin. The figure is based on the preliminary CTD data gathered from 15.03. - 23.03.2019.

The turbidity in surface water of the Fehmarn Belt and Darss Sill area is correlated to the pattern of the Chlorophyll-a fluorescence. Below the thermocline the turbidity depicts enhanced values in the bottom waters of the Arkona Basin and the eastern Slupsk Furrow, where the highest turbidity values were observed. In the eastern Gotland Basin the patches of higher turbidity indicate the depth level of the redoxcline between 80 and 160m. Partly two turbid layers are visible at the upper and lower limit of the warm inflow water layer (Figure 6.17).

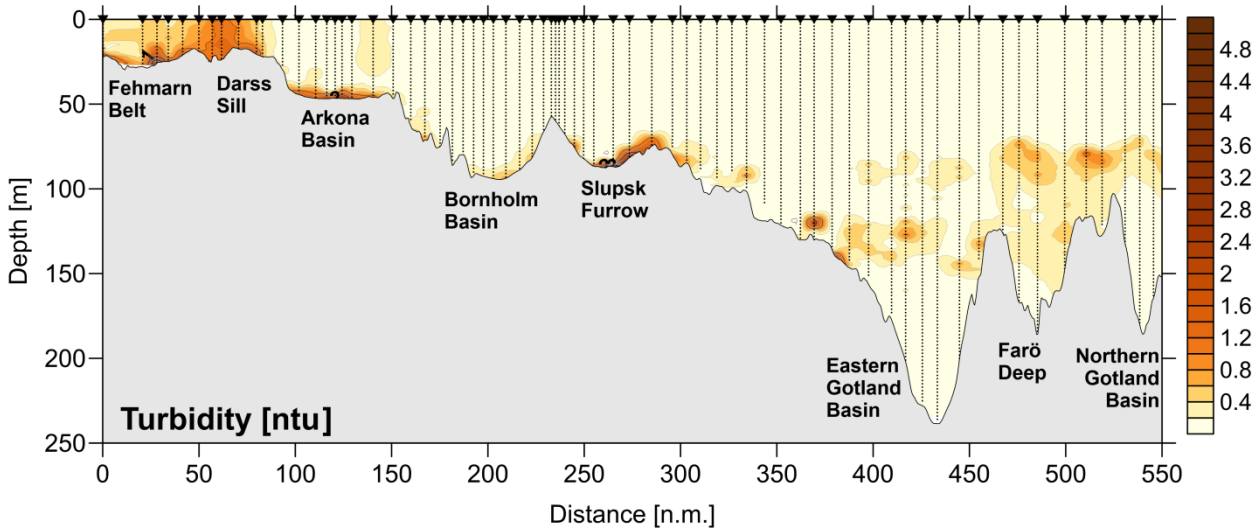

Figure 6.17 Distribution of turbidity along the talweg of the Baltic Sea from the Kiel bight to the eastern Gotland Basin. The figure is based on the preliminary CTD data gathered from 15.03. - 23.03.2019.

The different water masses observed during the cruise can be clearly identified using its temperature, salinity and oxygen signature. Figure 6.18 gives an overview about the different water masses in two state diagrams. The following water bodies were identified and depicted in the figure:

A - Western Baltic surface water
B – Fehmarn Belt bottom water
C - Central Baltic surface water
D - Bornholm Basin bottom water
E - Bornholm Basin halocline water
F - Slupsk Furrow bottom water
G - EGB halocline water
H - EGB deep water
I - EGB bottom water

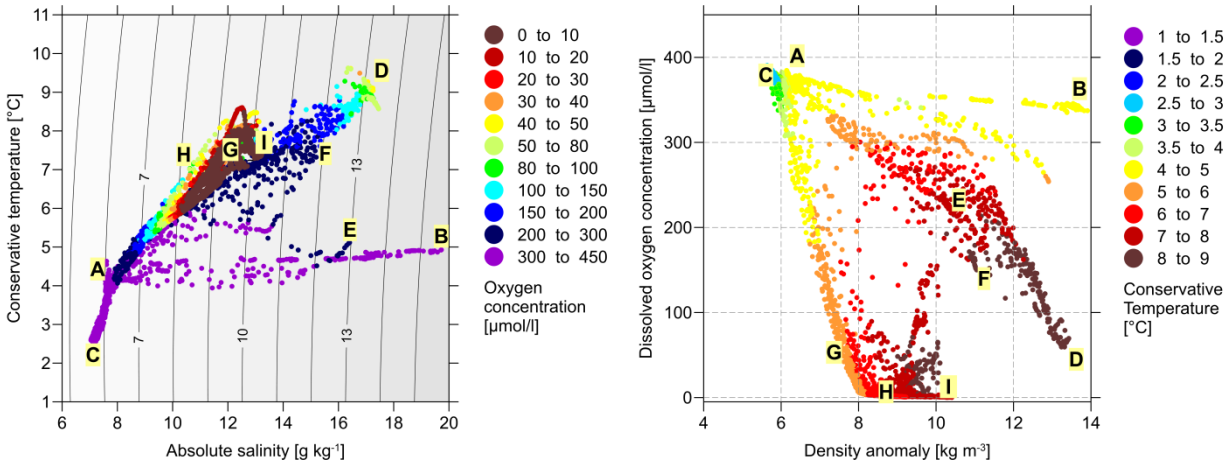

Figure 6.18 TS-diagram (left) and Oσ-diagram (right) of the Baltic transect. The capital letters indicate the different water masses (see text).

6.5 Southern Gotland Basin Transect

A zonal transect at the southern rim of the Eastern Gotland Basin (compare Figure 3.1) was performed between 19th and 20th March. It depicts the conditions at the entrance of the Eastern Gotland Basin. The surface water depicts nearly uniform properties separated from the deep water by a pronounced pycnocline, which was established by the deep convection during late winter (Figure 6.19). The inflowing saline water from the summer/autumn inflows 2018 enters the Basin at the eastern slope, visible as a patch of higher temperature between 100 and 150m depth. The temperature in the core of the inflow water exceeded 8°C. The bottom salinity along the section was well above 13 gkg^{-1}. In the surface water the salinity depicted a weak horizontal gradient from west to east.

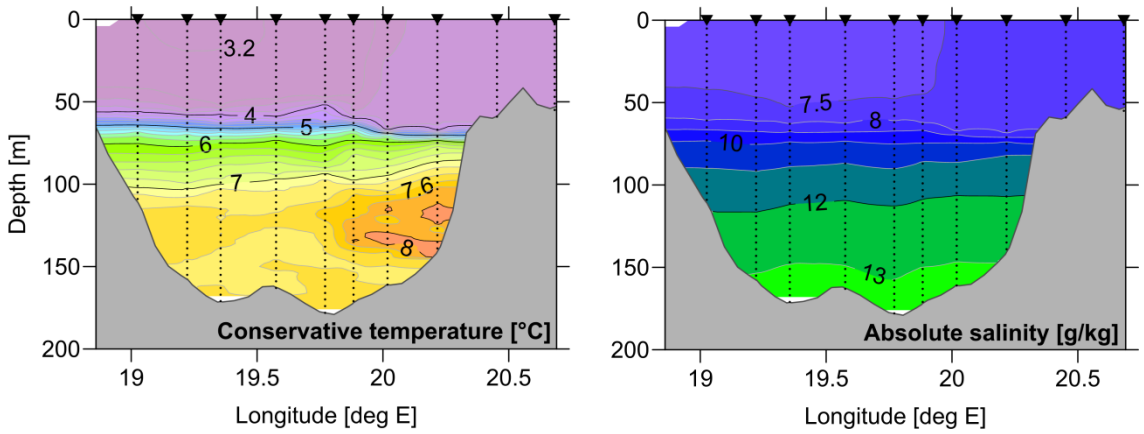

Figure 6.19 Temperature and salinity distribution along the zonal transect at the southern rim of the Eastern Gotland Basin (based on preliminary CTD data, 19.03. and 20.03.2019).

Below the halocline at about 65m depth the oxygen concentration decreased rapidly to values below 10 µmol kg^{-1} at 90m. Except the inflow water patch at the eastern rim, the deep water was anoxic below 100m depth. The Chlorophyll-a fluorescence values were generally low. Slightly enhanced values in the surface layer may indicate a very early sate of the spring bloom.

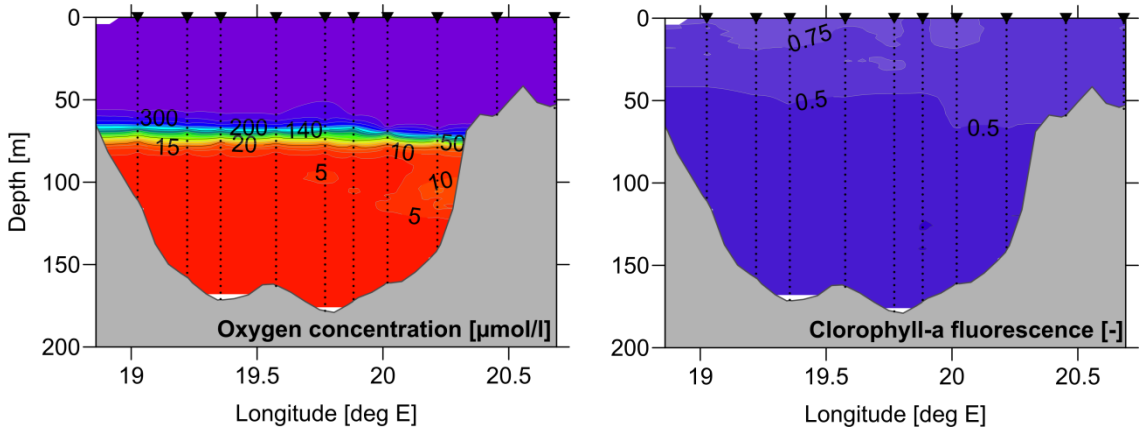

Figure 6.20 Dissolved oxygen and Chlorophyll-a fluorescence distribution along the zonal transect at the southern rim of the Eastern Gotland Basin (based on preliminary CTD data, 19.03. and 20.03.2019).

7 Ship's Meteorological Station

Not applicable on EMB. The meteorological conditions during the cruise are described in section 6.1, based on data of the automatic weather station of the ship.

8 Station Lists EMB209

8.1 Overall Station List

Table 8.1 list all stations and deployments carried out during the cruise EMB209. Standard sampling consisted of a single CTD cast. Nutrient samples at fixed standard depth were taken at selected station, indicated by N. At some stations a number of additional chemical and biological samplings were performed. These tasks are indicated in the last column of Table 8.1.

Used gears:

CTD	- CTD probe with rosette water sampler
SD	- Secci disk
PLA	- Phytoplankton net
WP2	- WP2 net for Zooplankton sampling
APNET	- Appstein net for Zooplankton sampling
MSS	- Microstructure profiler for turbulence and mixing study
SCF	- ScanFish undulating CTD deployment

Additional sampling program on selected stations:

CC	- Comparison measurements for CTD data quality assurance
Moor	- Mooring maintenance for IOW long term observation program
N	- Nutrient sampling (NO_3, NO_4, NH_4, PO_4, SiO_4)
Ox	- Oxygen and if necessary also H_2S sampling
TG	- Trace gas sampling (CH_4 and N_2O)

Table 8.1: List of stations and gears

Station No.	Station name	Gear	Date/Time	Latitude	Longitude	Water Depth	Remarks
EMB	IOW		[UTC]			[m]	
EMB209_1-1	TFO5	CTD	15.03.2019 08:10	54° 13.87'N	012° 04.53'E	12.8	N
EMB209_2-1	TF0011	CTD	15.03.2019 10:16	54° 24.81'N	011° 37.03'E	25.9	N
EMB209_3-1	TF0010	CTD	15.03.2019 11:52	54° 33.12'N	011° 19.18'E	29.2	N
EMB209_4-1	TF0361	CTD	15.03.2019 14:05	54° 39.51'N	010° 46.05'E	50.0	
EMB209_5-1	TF0360	CTD	15.03.2019 15:36	54° 36.02'N	010° 27.00'E	19.7	N
EMB209_5-2	TF0360	SD	15.03.2019 15:46	54° 36.02'N	010° 27.05'E	19.1	
EMB209_5-3	TF0360	PLA	15.03.2019 15:48	54° 36.02'N	010° 27.04'E	19.2	
EMB209_6-1	TF0013	CTD	16.03.2019 01:50	54° 28.38'N	011° 28.97'E	27.3	CC, Ox
EMB209_7-1	TF0012	CTD	16.03.2019 03:25	54° 18.92'N	011° 33.23'E	25.3	N
EMB209_7-2	TF0012	PLA	16.03.2019 03:27	54° 18.91'N	011° 33.22'E	25.0	
EMB209_7-3	TF0012	CTD	16.03.2019 03:31	54° 18.90'N	011° 33.21'E	25.8	
EMB209_7-4	TF0012	WP2	16.03.2019 03:52	54° 18.90'N	011° 33.04'E	25.0	
EMB209_8-1	TF0017	CTD	16.03.2019 05:18	54° 23.50'N	011° 49.45'E	22.6	
EMB209_9-1	TF0041	CTD	16.03.2019 06:22	54° 24.26'N	012° 03.81'E	19.9	N
EMB209_10-1	TF0046	CTD	16.03.2019 07:37	54° 28.19'N	012° 14.57'E	29.3	N

Station No.	Station name	Gear	Date/Time	Latitude	Longitude	Water Depth	Remarks
EMB	IOW		[UTC]			[m]	
EMB209_10-2	TF0046	WP2	16.03.2019 07:56	54° 28.19'N	012° 14.47'E	29.6	
EMB209_11-1	TF0083	CTD	16.03.2019 08:37	54° 33.00'N	012° 16.53'E	26.7	
EMB209_12-1	TF0002	CTD	16.03.2019 09:45	54° 39.01'N	012° 27.05'E	18.6	Ox
EMB209_13-1	TF0001	CTD	16.03.2019 11:00	54° 41.78'N	012° 42.39'E	22.3	Ox
EMB209_14-1	TF0030	CTD	16.03.2019 11:41	54° 43.43'N	012° 47.04'E	23.6	N
EMB209_15-1	TF0115	CTD	16.03.2019 12:02	54° 43.78'N	012° 48.37'E	24.0	
EMB209_16-1	TF0114	CTD	16.03.2019 14:10	54° 51.61'N	013° 16.64'E	46.8	Ox
EMB209_17-1	TF0113	CTD	16.03.2019 15:22	54° 55.52'N	013° 30.11'E	49.0	N, TG
EMB209_17-2	TF0113	SD	16.03.2019 15:26	54° 55.51'N	013° 30.06'E	49.2	
EMB209_17-3	TF0113	PLA	16.03.2019 15:27	54° 55.51'N	013° 30.07'E	49.0	
EMB209_17-4	TF0113	WP2	16.03.2019 15:42	54° 55.48'N	013° 30.03'E	49.1	
EMB209_17-5	TF0113	WP2	16.03.2019 15:49	54° 55.46'N	013° 30.04'E	48.9	
EMB209_18-1	TF0123	CTD	16.03.2019 17:03	54° 47.98'N	013° 39.12'E	45.5	
EMB209_19-1	TF0112	CTD	16.03.2019 18:28	54° 48.23'N	013° 57.57'E	42.2	N
EMB209_20-1	ABBoje	CTD	16.03.2019 19:25	54° 53.00'N	013° 51.32'E	47.5	N, Ox
EMB209_21-1	TF0122	CTD	16.03.2019 20:36	54° 59.45'N	013° 46.19'E	49.2	
EMB209_22-1	TF0105	CTD	16.03.2019 21:30	55° 01.52'N	013° 36.38'E	48.4	N
EMB209_23-1	TF0104	CTD	16.03.2019 22:33	55° 04.14'N	013° 48.85'E	48.2	N
EMB209_24-1	TF0103	CTD	16.03.2019 23:30	55° 03.84'N	013° 59.34'E	49.3	N
EMB209_25-1	TF0109	CTD	17.03.2019 00:25	55° 00.07'N	014° 05.01'E	50.5	N
EMB209_25-2	TF0109	PLA	17.03.2019 00:30	55° 00.03'N	014° 05.01'E	50.6	
EMB209_25-3	TF0109	WP2	17.03.2019 00:47	55° 00.02'N	014° 05.02'E	49.9	
EMB209_26-1	TF0145	CTD	17.03.2019 02:19	55° 10.06'N	014° 15.03'E	48.9	CC, N, Ox
EMB209_27-1	TF0144	CTD	17.03.2019 03:49	55° 15.44'N	014° 29.75'E	47.1	
EMB209_28-1	TF0142	CTD	17.03.2019 05:21	55° 24.31'N	014° 32.27'E	62.9	N
EMB209_29-1	TF0140	CTD	17.03.2019 06:33	55° 28.03'N	014° 43.07'E	73.2	N
EMB209_30-1	TF0206	CTD	17.03.2019 07:44	55° 32.01'N	014° 54.84'E	79.0	
EMB209_31-1	TF0207	CTD	17.03.2019 08:50	55° 29.78'N	015° 05.63'E	88.6	
EMB209_32-1	TF0208	CTD	17.03.2019 09:49	55° 27.24'N	015° 13.99'E	96.0	
EMB209_33-1	TF0200	CTD	17.03.2019 10:44	55° 23.02'N	015° 20.02'E	88.8	N
EMB209_34-1	TF0209	CTD	17.03.2019 11:34	55° 20.82'N	015° 27.95'E	97.0	
EMB209_35-1	TF0211	CTD	17.03.2019 12:25	55° 19.81'N	015° 36.98'E	98.3	
EMB209_36-1	TF0212	CTD	17.03.2019 13:22	55° 18.12'N	015° 47.87'E	98.6	
EMB209_37-1	TF0214	CTD	17.03.2019 14:41	55° 09.63'N	015° 39.69'E	97.4	
EMB209_38-1	TF0213	CTD	17.03.2019 16:20	55° 14.96'N	015° 59.04'E	93.6	N
EMB209_38-2	TF0213	SD	17.03.2019 16:38	55° 15.01'N	015° 59.00'E	92.7	
EMB209_38-3	TF0213	PLA	17.03.2019 16:39	55° 15.01'N	015° 59.00'E	93.2	
EMB209_38-4	TF0213	CTD	17.03.2019 17:02	55° 15.03'N	015° 59.01'E	92.5	TG
EMB209_38-5	TF0213	WP2	17.03.2019 17:22	55° 15.04'N	015° 59.02'E	93.0	
EMB209_38-6	TF0213	WP2	17.03.2019 17:30	55° 15.04'N	015° 59.02'E	93.4	
EMB209_38-7	TF0213	WP2	17.03.2019 17:39	55° 15.05'N	015° 59.01'E	92.6	
EMB209_38-8	TF0213	WP2	17.03.2019 17:47	55° 15.04'N	015° 59.01'E	92.7	
EMB209_38-9	TF0213	WP2	17.03.2019 17:52	55° 15.03'N	015° 59.02'E	92.6	
EMB209_38-10	TF0213	APNET	17.03.2019 18:07	55° 15.01'N	015° 59.04'E	93.7	
EMB209_38-11	TF0213	APNET	17.03.2019 18:15	55° 15.02'N	015° 59.05'E	92.6	
EMB209_38-12	TF0213	APNET	17.03.2019 18:22	55° 15.02'N	015° 59.09'E	92.9	
EMB209_39-1	TF0221	CTD	17.03.2019 19:51	55° 13.32'N	016° 10.05'E	85.6	
EMB209_40-1	TF0225	CTD	17.03.2019 20:46	55° 15.46'N	016° 19.26'E	69.5	
EMB209_41-1	TF0226	CTD	17.03.2019 21:32	55° 17.77'N	016° 25.78'E	60.5	
EMB209_42-1	TF0224	CTD	17.03.2019 22:17	55° 17.01'N	016° 30.08'E	64.4	
EMB209_43-1	TF0227	CTD	17.03.2019 23:10	55° 15.73'N	016° 38.27'E	71.0	Ox
EMB209_44-1	TF0228	CTD	17.03.2019 23:59	55° 14.23'N	016° 46.36'E	80.7	

Station No.	Station name	Gear	Date/Time	Latitude	Longitude	Water Depth	Remarks
EMB	IOW		[UTC]			[m]	
EMB209_45-1	TF0229	CTD	18.03.2019 00:46	55° 13.73'N	016° 54.78'E	88.7	CC, Ox
EMB209_46-1	TF0222	CTD	18.03.2019 01:50	55° 13.00'N	017° 04.04'E	94.7	N
EMB209_47-1	TF0250	CTD	18.03.2019 18:28	56° 04.99'N	019° 10.07'E	128.6	Ox
EMB209_48-1	TF0262	CTD	18.03.2019 19:51	56° 14.06'N	019° 18.12'E	135.7	
EMB209_49-1	TF0263	CTD	18.03.2019 20:58	56° 20.76'N	019° 22.69'E	137.9	Ox
EMB209_50-1	TF0261	CTD	18.03.2019 22:18	56° 29.46'N	019° 28.94'E	148.3	Ox
EMB209_51-1	TF0260	CTD	18.03.2019 23:36	56° 38.01'N	019° 35.04'E	149.3	N
EMB209_52-1	TF0274	CTD	19.03.2019 00:55	56° 45.96'N	019° 45.09'E	159.2	CC, Ox
EMB209_53-1	TF0407	CTD	19.03.2019 02:39	56° 56.96'N	019° 53.09'E	181.9	
EMB209_54-1	TF0272	CTD	19.03.2019 03:58	57° 04.28'N	019° 49.86'E	213.6	Ox
EMB209_55-1	TF0275	CTD	19.03.2019 05:21	57° 12.55'N	019° 55.85'E	236.4	
EMB209_56-1	TF0271	CTD	19.03.2019 06:46	57° 19.12'N	020° 03.02'E	246.1	N, TG
EMB209_56-2	TF0271	WP2	19.03.2019 07:21	57° 19.19'N	020° 03.00'E	246.4	
EMB209_56-3	TF0271	WP2	19.03.2019 07:29	57° 19.19'N	020° 02.93'E	245.2	
EMB209_56-4	TF0271	CTD	19.03.2019 07:51	57° 19.20'N	020° 02.99'E	246.5	N, TG
EMB209_56-5	TF0271	CTD	19.03.2019 08:31	57° 19.19'N	020° 02.99'E	246.5	
EMB209_57-1	MoorGONE	CTD	19.03.2019 10:25	57° 21.97'N	020° 20.33'E	224.7	Moor
EMB209_58-1	TF0411	CTD	19.03.2019 15:39	56° 50.27'N	020° 40.96'E	59.5	Ox
EMB209_59-1	TF0410	CTD	19.03.2019 16:53	56° 51.98'N	020° 27.20'E	64.1	
EMB209_60-1	TF0409	CTD	19.03.2019 18:06	56° 54.30'N	020° 13.03'E	150.2	
EMB209_61-1	TF0408	CTD	19.03.2019 19:13	56° 55.40'N	020° 01.19'E	171.1	
EMB209_62-1	TF0407	CTD	19.03.2019 20:14	56° 57.00'N	019° 53.02'E	181.7	
EMB209_63-1	TF0273	CTD	19.03.2019 21:10	56° 57.10'N	019° 46.26'E	188.9	
EMB209_64-1	TF0406	CTD	19.03.2019 22:20	56° 58.79'N	019° 34.62'E	172.3	
EMB209_65-1	TF0405	CTD	19.03.2019 23:30	57° 00.48'N	019° 21.32'E	182.1	Ox
EMB209_66-1	TF0404	CTD	20.03.2019 00:22	57° 01.69'N	019° 13.35'E	167.4	
EMB209_67-1	TF0403	CTD	20.03.2019 01:24	57° 04.39'N	019° 01.55'E	118.6	CC, Ox
EMB209_68-1	SF_1c	SCF	20.03.2019 05:35	57° 26.97'N	019° 25.00'E	101.5	
EMB209_69-1	TF0276	CTD	20.03.2019 21:51	57° 28.20'N	020° 15.65'E	213.3	Ox
EMB209_70-1	TF0270	CTD	20.03.2019 23:16	57° 37.01'N	020° 10.10'E	148.6	
EMB209_71-1	TF0287	CTD	21.03.2019 00:41	57° 42.90'N	019° 51.28'E	132.1	Ox
EMB209_72-1	TF0290	CTD	21.03.2019 01:50	57° 51.01'N	019° 49.11'E	174.6	
EMB209_73-1	TF0286	CTD	21.03.2019 03:20	57° 59.98'N	019° 54.09'E	200.6	N, Ox
EMB209_73-2	TF0286	CTD	21.03.2019 04:26	57° 59.97'N	019° 54.06'E	200.6	
EMB209_74-1	TF0277	CTD	21.03.2019 05:50	58° 11.01'N	020° 03.18'E	167.4	
EMB209_75-1	TF0278	CTD	21.03.2019 07:23	58° 20.97'N	020° 08.86'E	125.7	
EMB209_76-1	TF0285	CTD	21.03.2019 08:18	58° 25.30'N	020° 17.63'E	126.2	Ox
EMB209_77-1	TF0279	CTD	21.03.2019 10:15	58° 38.51'N	020° 20.77'E	169.3	
EMB209_78-1	TF0289	CTD	21.03.2019 11:24	58° 46.04'N	020° 19.88'E	207.9	
EMB209_79-1	TF0282	CTD	21.03.2019 12:30	58° 53.04'N	020° 19.04'E	169.3	Ox
EMB209_80-1	TF0288	CTD	21.03.2019 13:45	58° 59.82'N	020° 09.64'E	149.3	Ox
EMB209_81-1	TF0283	CTD	21.03.2019 17:45	58° 46.88'N	019° 06.10'E	131.4	Ox
EMB209_82-1	TF0240	CTD	21.03.2019 23:28	57° 59.98'N	018° 00.02'E	171.5	N
EMB209_83-1	TF0245	CTD	22.03.2019 05:21	57° 07.05'N	017° 40.11'E	114.6	N
EMB209_84-1	TF0265	CTD	22.03.2019 13:49	55° 57.50'N	019° 02.79'E	115.4	Ox
EMB209_85-1	TF0253	CTD	22.03.2019 15:03	55° 50.34'N	018° 51.95'E	104.2	
EMB209_86-1	TF0258	CTD	22.03.2019 16:15	55° 43.58'N	018° 45.88'E	94.3	
EMB209_87-1	TF0255	CTD	22.03.2019 17:25	55° 38.01'N	018° 35.99'E	98.9	Ox
EMB209_88-1	TF0259	CTD	22.03.2019 18:38	55° 33.01'N	018° 23.96'E	94.1	
EMB209_88-2	TF0259	PLA	22.03.2019 18:41	55° 32.99'N	018° 24.01'E	93.6	CC, N, Ox
EMB209_89-1	TF0257	CTD	22.03.2019 19:50	55° 26.51'N	018° 19.15'E	90.6	
EMB209_90-1	TF0256	CTD	22.03.2019 21:02	55° 19.63'N	018° 14.04'E	80.7	Ox

Station No.	Station name	Gear	Date/Time	Latitude	Longitude	Water Depth	Remarks
EMB	IOW		[UTC]			[m]	
EMB209_91-1	TF0268	CTD	22.03.2019 22:26	55° 18.49'N	017° 55.72'E	77.8	
EMB209_92-1	TF0267	CTD	22.03.2019 23:49	55° 17.21'N	017° 35.65'E	87.9	CC, Ox
EMB209_93-1	TF0266	CTD	23.03.2019 01:05	55° 15.21'N	017° 21.41'E	92.4	
EMB209_94-1	SSmoor	CTD	23.03.2019 06:01	55° 16.63'N	016° 33.10'E	69.7	
EMB209_95-1	TF0213	CTD	23.03.2019 08:24	55° 15.02'N	015° 59.13'E	93.1	N
EMB209_95-2	TF0213	WP2	23.03.2019 08:47	55° 14.97'N	015° 59.05'E	92.9	
EMB209_95-3	TF0213	WP2	23.03.2019 08:56	55° 14.96'N	015° 59.03'E	93.0	
EMB209_95-4	TF0213	WP2	23.03.2019 09:05	55° 14.94'N	015° 59.02'E	93.0	
EMB209_95-5	TF0213	WP2	23.03.2019 09:11	55° 14.94'N	015° 59.00'E	92.9	
EMB209_96-1	TF0222	MSS	23.03.2019 13:41	55° 13.01'N	017° 04.03'E	95.0	001-292
EMB209_97-1	TF0213	CTD	24.03.2019 13:54	55° 14.99'N	015° 59.05'E	93.1	N
EMB209_97-2	TF0213	CTD	24.03.2019 14:17	55° 14.94'N	015° 59.01'E	93.2	CC, Ox
EMB209_98-1	ss_ct1	MSS	24.03.2019 16:30	55° 07.01'N	016° 30.47'E	53.6	293-448
EMB209_99-1	ss_ct3	MSS	25.03.2019 03:50	55° 20.60'N	016° 33.15'E	63.4	449-517
EMB209_100-1	SSmoor	CTD	25.03.2019 10:11	55° 16.96'N	016° 30.38'E	65.0	Moor
EMB209_101-1	TF0224	SCF	25.03.2019 11:05	55° 16.99'N	016° 29.88'E	64.2	
EMB209_102-1	TF0109	CTD	26.03.2019 03:31	55° 00.01'N	014° 05.15'E	50.0	N
EMB209_103-1	TF0109	SCF	26.03.2019 03:50	54° 59.87'N	014° 04.70'E	50.2	
EMB209_104-1	TF0030	CTD	26.03.2019 12:10	54° 43.39'N	012° 47.02'E	23.6	Ox
EMB209_104-2	TF0030	SD	26.03.2019 12:12	54° 43.39'N	012° 47.02'E	23.6	
EMB209_104-3	TF0030	WP2	26.03.2019 12:28	54° 43.38'N	012° 47.02'E	23.5	
EMB209_104-4	TF0030	WP2	26.03.2019 12:32	54° 43.38'N	012° 47.01'E	23.9	
EMB209_105-1	TF0046	CTD	26.03.2019 15:07	54° 28.19'N	012° 14.52'E	29.9	Ox
EMB209_105-2	TF0046	SD	26.03.2019 15:07	54° 28.19'N	012° 14.52'E	29.9	
EMB209_105-3	TF0046	PLA	26.03.2019 15:09	54° 28.19'N	012° 14.52'E	30.0	
EMB209_105-4	TF0046	WP2	26.03.2019 15:20	54° 28.20'N	012° 14.50'E	29.7	
EMB209_106-1	TF0012	CTD	26.03.2019 18:00	54° 18.91'N	011° 33.19'E	25.9	Ox
EMB209_106-2	TF0012	SD	26.03.2019 18:04	54° 18.90'N	011° 33.17'E	25.7	
EMB209_106-3	TF0012	PLA	26.03.2019 18:06	54° 18.89'N	011° 33.17'E	25.9	
EMB209_106-4	TF0012	WP2	26.03.2019 18:16	54° 18.89'N	011° 33.08'E	25.9	

8.2 VMADCP Deployment List

Table 8.2 List of VMADCP deployments during the cruise EMB209

ADCP	Deployment name	Start time	End time	STA Ens.	Bin size	Remarks
		[UTC]	[UTC]	No.	[m]	
VMADCP Ocean surveyor 150kHz	EMB209__001	16.03.2019 09:38:47	18.03.2019 12:51:49	3074	4	BB-EGB thalweg
	EMB209__002	18.03.2019 12:53:17	19.03.2019 15:31:17	1599	8	EGB thalweg south
	EMB209__003	19.03.2019 15:32:20	20.03.2019 04:56:22	805	4	EGB south cross tr.
	EMB209__004	20.03.2019 05:00:00	20.03.2019 16:07:00	668	8	EGB central cross tr.
	EMB209__005	20.03.2019 16:07:20	21.03.2019 13:44:22	1298	8	EGB north
	EMB209__006	21.03.2019 13:46:26	23.03.2019 08:53:27	2588	4	EGB west/Slupsk F.
	EMB209__007	23.03.2019 08:55:14	25.03.2019 10:43:14	2989	4	Slupsk Sill
	EMB209__008	25.03.2019 10:44:50	26.03.2019 14:50:51	1687	4	Bornholm Basin
VMADCP Signature 250kHz	egb1	19.03.2019 15:59:26	19.03.2019 16:01:24	0.1M	4	Device test
	egb2	19.03.2019 16:03:04	20.03.2019 04:44:59	40M	4	EGB south cross tr.
	egb3	20.03.2019 05:03:33	20.03.2019 16:06:25	19M	8	EGB central cross tr.
	ssf1	22.03.2019 15:54:00	23.03.2019 05:12:14	0.5M	8/2	Slupsk Furrow
	ssf2	23.03.2019 09:01:12	25.09.2015 10:47:07	158M	2	Slupsk Sill
	bbt1	25.03.2019 10:51:49	26.03.2019 07:12:51	50M	4/2	Bornholm Basin

8.3 Mooring deployment list

Table 8.3 List of mooring deployments during the cruise EMB209

Name	Latitude	Longitude	Deployed [UTC]	Recovered [UTC]	Depth [m]	Remarks
GONE36	57°21.999‘N	20°20.499‘E	*20.11.2018 11:00*	19.03.2019 11:30	210	Main release failed, Spare release was successful
GONE37	57°21.988‘N	20°20.503‘E	19.03.2019 12:30	*October 2019*	210	Two releaser, no ground rope
SS19/3	55°16.673’N	16°33.328’E	23.03.2019 12:00	25.03.2019 09:30	56	Two releaser, and ground rope

9 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.
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 9.1 Overview of data availability

Type	Database	Available	Free Access	Contact
Hydrographic data	ODIN	01.05.2019	01.05.2022	volker.mohrholz@io-warnemuende.de
Nutrient samples	ODIN	01.05.2019	01.05.2022	joachim.kuss@io-warnemuende.de
Biological samples	ODIN	01.09.2019	01.05.2022	joerg.dutz@io-warnemuende.de

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11 References

Nausch, G., Naumann, M., Umlauf, L., Mohrholz, V., Siegel, H., 2015. Hydrographic-hydrochemical assessment of the Baltic Sea 2014. – Meereswissenschaftliche Berichte (Marine Science Reports) 96, 91p.

Nausch, G., Naumann, M., Umlauf, L., Mohrholz, V., Siegel, H., Schulz-Bull, D., 2016. Hydrographic-hydrochemical assessment of the Baltic Sea 2015. – Marine Science Reports, 101: 91p.

Naumann, M., Umlauf, L., Mohrholz, V., Kuss, J., Siegel, H., Waniek, J.J., Schulz-Bull, D., 2017. Hydrographic-hydrochemical assessment of the Baltic Sea 2016. – Marine Science Reports, 104: 90p.