ELISABETH MANN BORGESE – Berichte

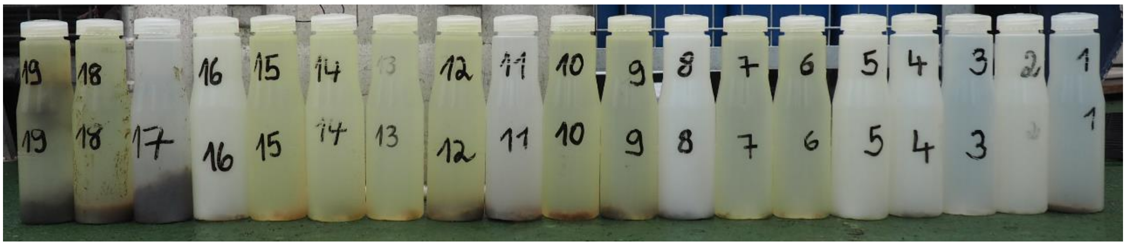
Baltic Monitoring Programme (BMP) of HELCOM and IOW's long-term observations, western Baltic to central Baltic Proper

Cruise No. EMB-251

2020-11-11 – 2020-11-25

Rostock-Marienehe to Rostock-Warnemünde (Germany)

ACRONYM: HELCOM/long-term



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2020

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1 Cruise Summary

1.1 Summary

This campaign of measurements continues the regulary cruises to study the spatial and temporal variability of the Baltic Sea on annual and interannual time scale. It is conducted in the frame of the COMBINE Programme of the Helsinki Commission (HELCOM) as well as part of the IOW's long term data programme, performed since 1969. Some measurements during this cruise are related to an ongoing cooperation with the DTU. Moorings and autonomous platforms, used in key areas to get higher temporal resolution of data are maintained during this cruises. 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 ecosystem Baltic Sea.

During this expedition hydrographic measurements were carried out in an area between the Kiel Bight and the central Baltic Sea. From water samples macro-nutrients and pollutants were determined, but also zooplankton and phytoplankton samples were taken. In the western Baltic sediment samples where taken to assess species decomposition and abundance of the macro-zoobenthos. Two mooring were maintained in the Gotland Basin, the mooring "Gotland – central" equipped with sediment trap and hydrographic sensors and the hydrographic mooring "Gotland - SW" were recovered and deployed again.

The cruise was characterised by notoriosly stormy weather. Most stations planned for the Gotland Basin had to be skipped. The towed CTD SCANfish could not be deployed and the mooring maintenance "Gotland – NE" was not possible. An unvoluntary stay in Slite harbour was necessary, which however could be used for repairing ships gyro compass. Ships thermosalinigraph was not usable.

1.2 Zusammenfassung

Die Messkampagne ist eine von fünf jährlichen Expeditionen zur Erfassung der räumlich-zeitlichen Variabilität des Ökosystems Ostsee mit einer Vielzahl hydrographischer, chemischer und biologischer Parameter. Die Arbeiten sind in das COMBINE Programme der Helsinki Kommission (HELCOM) zur Überwachung der Meeresumwelt eingebettet und setzen das IOW Langzeitdatenprogramm für Messungen außerhalb der deutschen Territorialgewässer fort, das seit 1969 fortlaufend durchgeführt wird. Während der Reise werden auch Verankerungen und autonome Messplattformen gewartet, die an Schlüsselstationen in den tiefen Ostseebecken eingesetzt werden, um die zeitliche Datenauflösung zu verbessern. Die gewonnenen Daten gehen in die regelmäßige nationale und internationale Bewertungen des Umweltzustandes der Ostsee ein und bilden die wissenschaftliche Basis für zu ergreifende Maßnahmen zum Schutz der Meeresumwelt.

Zur Aufnahme des aktuellen Zustandes im Gebiet der westlichen bis zentralen Ostsee wurden an 63 Stationen 77 CTD Einsätze gefahren. Für die Messung einer Vielzahl an Nährstoff- und Schadstoffgrößen wurden dabei Wasserproben genommen. An Schlüsselstationen wurde außerdem das Zoo- und Phytoplankton beprobt. In der westlichen Ostsee wurde die jährlich Untersuchung des Makrozoobenthos vorgenommen. Die Verankerungen Gotland Zentral (Sedimentfalle, hydrographische und Strömungsmessungen) und die hydrographische Verankerung Gotland SW konnten geborgen und erneut verankert werden.

Die Expedition war von permanent windigen Witterungsverhältnissen geprägt, fast alle geplanten Stationen in der Gotlandsee konnten nicht beprobt werden. Es kam zu einem ungeplanten Hafenaufenthalt in Slite (Gotland), der jedoch zu einer Reparatur des defekten Kreiselkompasses genutzt werden konnte. Auch der Einsatz des geschleppten CTD SCANfish

und die Wartung der Verankerung Gotland NO waren wegen der widrigen Witterungsbedingungen nicht möglich. Der Thermosalinograph des Schiffes war nicht nutzbar.

2 Participants

2.1 Principal Investigators

Name	Institution
Bittig, Henry, Dr. (Sensor technology)	IOW
Dutz, Jörg, Dr. (Zooplankton)	IOW
Schulz-Bull, Detlef, Prof. Dr. (Marine Chemistry)	IOW
Kremp, Anke, Dr. (Phytoplankton)	IOW
Jürgens, Klaus, Prof. Dr. (Microbiology)	IOW
Otto, Stefan, Dr. (Carbon cycle)	IOW
Schmidt, Martin, Dr. (Hydrography)	IOW
Zettler, Michael, Dr. (Bethos)	IOW

2.2 Scientific Party

Name	Discipline	Institution
Schmidt, Martin, Dr.	Physical Oceanography/chief scientist	IOW
Donath, Jan	Physical Oceanography	IOW
Schöne, Susanne	Marine Chemistry	IOW
Sadkowiak, Birgit	Physical Oceanograpy	IOW
Heene, Toralf (15.15.-25.11.2020)	Marine Chemistry	IOW
Hehl, Uwe	Marine Biology	IOW
Pötzsch, Michael	Marine Geology	IOW
Kreuzer, Lars	Marine Chemistry	IOW
Schubert, Stefanie (11.11.-15.11.2020)	Marine Biology	IOW

2.3 Participating Institutions

IOW Leibniz Institute for Baltic Sea Research Warnemünde, Germany

Name	Rank
Kasch, Gunnar	Master

3 Research Program

3.1 Aims of the Cruise

The aim of the cuise is continuation of regular meteorological, hydrographic, hydrochemical and hydrobiological sampling in the Baltic Sea between Kiel Bight to the northern Gotland Basin. These measurements are combined with a microbiological sampling in the Gotland Basin and Landsort Deep to investigate the specific microbial communities in view of the varying redox-conditions in the deep water of these areas. Another task is annual sampling of the macrozoobenthos in the German EEZ, carried out on behalf of the Federal Maritime and Hydrographic Agency (BSH) Hamburg und Rostock. Finally, maintainance of moorings in the Central Gotland Basin is carried out.

The acquired data are needed to detect and understand long-term variations and trends in the Baltic Sea ecosystem (IOW's long-term data programme 1969-2019). In addition, they will be used for regular national and international assessments of the state of the Baltic Sea (e.g. HELCOM 2018, NAUMANN et al. 2018) carried out in the frame of the COMBINE Programme of the Helsinki Commission (HELCOM) and for national monitoring demands. This data analysis provides a scientific basis for measures for the protection of the ecosystem Baltic Sea. The hydrographic and biochemical data are essential for modelling and understanding the variability of the Baltic Sea ecosystem on synoptic and climate time scales.

Long term series of N_2O and CH_4 contribute to the investigation of the gas dynamics in the Baltic Sea. The gas samples are taken at key stations in the major Basin, TF0113, TF0213, TF0271 and TF0286. In the Gotland Basin, the methane release from the metabolic activity of the zooplankton over the year is investigated, (Stawiarski, B. et al., 2019). The CO_2 samples in the Gotland Basin is used to study mineralization kinetics and stoichiometry, (Schneider et al., 2019). The determination of relevant CO_2 parameters (total CO_2, pH, and alkalinity) is extended to the stations TF0113, TF0213 and TF0286.

In the frame of the DArgo2025-project (DArgo2025) and the C-SCOPE-project (C-SCOPE), optical nitrate sensors and pCO_2 sensors are tested with the aim of a routinely sensor application in the long term data programme. The validity of analysis algorithms for the specific optical properties of DOM rich Baltic Sea waters in investigated and refined algorithms are designed.

3.2 Equipment and Methods

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

At stations and transects:

- CTD SBE 911+ with rosette water sampler equipped with 13 free-flow bottles (5l) Double sensors packages
- In situ video camera attached to the CTD
- Nitrate sensor, OPUS-DS (TriOS) attached to the CTD
- Nitrate sensor SUNA V2 (Seabird) attached to the CTD
- pCO2-Sensor (Contros HydroC CO2) attached to the CTD
- Oceanographic moorings (GODESS, Gotland central)
- Phytoplankton nets
- Zooplankton net (WP2)
- Secci desk
- Autoanalyser, ALLIANCE INSTRUMENTS Flowsys

- UV-VIS Spektrophotometer, Shimadzu UVmini 1204
- Metrohm 794 Basic Titrino IV
- Van Veen grab, dredge

Each station work starts with a **CTD cast**. The sea state compensating winch allows a constant veering velocity of 0.3 m/s, which avoids “looping” of the CTD. 5m above the sea floor, veering speed was reduced to 0.1 m/s. Data are stored directly on a PC. Free flow bottles are closed automatically during the down-cast in predefined depth, at the bottom and at the sea surface. Only in a few cases of sampling additional specific depth, bottles are closed during up-cast after stopping the CTD winch and waiting about 1 min.

To ensure high quality data, doubled conductivity, temperature and oxygen sensors are used in parallel. The common drift of all sensor values by a possibly drifting quartz normal of the CTD probes analog-digital transformers was excluded by observing the quartz oscillation frequency. In addition, at least once a day at selected stations intercomparison measurements are carried out. Salinity samples are taken in homogeneous water bodies to be measure later with an AUTOSAL 5400 in the laboratory. In the same depth, temperature is controlled with a high precision thermometer SBE35. The zero point of the pressure sensor is controlled by means of a registration on deck, whereby the CTD probe was hanging in order to reduce the influence ship vibrations. At almost every station an oxygen sample was taken from a homogeneous layer. The zero of the oxygen sensors was controlled prior the cruise by filling the sensor tube with dry pure dinitrogen gas. Measurements in anoxic and sulfidic deep waters in the Gotland Basin provide an additional control of the oxygen sensor stability.

Macronutrients (nitrate, nitrite, phosphate and silicate) are determined simultaneously from sea water samples using an autoanalyser Flowsys from ALLIANCE INSTRUMENTS.

Nitrite is measured by the reaction with Sulfanilamid in acid environment followed by coupling with N-(1-Naphthyl)ethylendiamindihydrochlorid.
Accuracy: ± 0.05 µmol/L

Nitrate is reduced to nitrite on copper covered cadmium granulate at pH-Bereich 7.5 bis 8.4. Subsequently the nitrite concentration measured as described above.
Accuracy: ± 0.5 µmol/L

Phosphate is determined via ist reaction with molybdate in strongly acid environment (pH<1) to a heteropolymolybdato-phosphoracid to be reduced by ascorbin acid to molybdanum blue.
Accuracy: ± 0.06 µmol/L

Silicate is detected via the reaction (pH 1.4 bis 1.6) with molybdate to yellow Heteropolymolybdato-silicate, to be reduced to molybdanum blue.
Accuracy: ± 0.23 µmol/L

Ammonium is determined by a colorimetric method based on the formation of blue indophenol from phenol and hypochlorite in the presence of ammonium. The accuracy is ± 0.5 µmol/kg. Samples are diverted from the nutrient samples, and are opened as short as possible to add reagents. A spectral photometer UV-mini 1240 is used for the optical determination of the ammonium concentration.

Almost every station **dissolved oxygen** is determined in selected homogeneous water bodies with the Winkler method. With a hose, calibrated oxygen bottles are filled bubble with seawater, fixed with potassium iodide, shaked at least 30 s and stored cool in the dark. Latest after 12 h, oxygen concentration is measured with a TITRINO with tiamo software. These measurements allow an accuracy of 0.2 ml/l and help to control the drift of the oxygen sensor.

Hydrogen sulphide samples are taken bubble free in glas bottles with help of a hose with an overflow of more than three times the bottle volume. The method is based on the transformation of p-aminodimethylanilin with hydrogen sulphide to methylenblue under the influence of iron(III)chloride in an acid environment. After shaking the bottle it is stored in the dark. At least after 24 h the hydrogen sulphide concentration is determined with a spectralphotometer UV-mini 1240. The accuracy is ± 3%.

The **nitrate sensors** OPUS-DS (TriOS) and SUNA V2 (Seabird) attached to the CTD gain a vertical UVvis spectrum profile stored on a PC harddrive. The applicability of inverse models (DArgo2025) for the nitrate/nitrite concentration originally designed for oceanic water is extended to high CDOM waters in the Baltic Sea.

The **pCO_2-Sensor** (Contros HydroC CO2) attached to the CTD gains a vertical IR-absorption spectrum profile stored on a PC harddrive. The inverse models for pCO_2, pH and alkalinity calculation are refined (C-SCOPE). The sensor requires at least 5 min equilibration (Fietzek) time after deployment that needs strict consideration in the general CTD deployment strategy.

For the **CH_4** and **N_2O** measurement sample bottles are filled from the CTD bottles and poisoned with mercury chloride. In the laboratory, the dynamic "headspace" method is used. The separation and analysis of the components is realized by gas chromatography, which is coupled with a flame ionization detector (for CH4) and an electron capture detector (for N2O), (Wilson et al, 2018)

Data on **Chlorophyll *a*** and **phytoplankton** biomass and community composition as key parameters for the ecological status of the Baltic Sea reflect major ecosystem functions such as primary production and nutrient uptake/draw-down. Samples collected during regular monitoring cruises provide data for the calculation of indicators such as Chl-a concentrations, the Dia/Dino Index, cyanobacteria biomass and seasonal succession of groups that support status assessment and the tracing of ecosystem change.

Samples for the determination of chlorophyll a concentrations are collected together with phytoplankton samples at standard depths of 1 m, 5 m, 10 m, 15 m and 20 m. 200-500 ml of water are filtered through glass-fiber filters (Whatman GF/F) that are flash-frozen in liquid nitrogen (-196°C) and stored until analysis according to standard procedures (HELCOM 2017).

As a rule, two phytoplankton samples are taken at each station: a composite sample is mixed from equal parts of surface water and from depths of 1 m, 2.5 m, 5 m, 7.5 m and 10 m; in addition, a sample is taken from below the upper pycnocline (usually from a depth of 20 m). Samples (200 ml) are fixed with 1 ml of acid Lugol's solution and are stored until analysis (6 months at most). The biomass of individual phytoplankton species is analysed microscopically using the standard method according to UTERMÖHL (1958). During counting, individuals are classified not just according to taxa, but also size classes in line with HELCOM guidelines (Olenia et al. 2006; HELCOM 2017). Annually updated biovolume lists (e.g.PEG_BIOVOL2019, http://ices.dk/data/Documents/ENV/PEG_BVOL.zip) are used to calculate biomasses based on abundances for each species.

Secci depth is determined at stations representative for the major Baltic Sea stations for comparison with historical data.

For **zooplankton** assessment, net catches using a WP-2 net equipped with a TSK flowmeter and 100 µm mesh size were conducted at selected monitoring stations. To support the analysis of the long-term changes in the population dynamics of key copepod species in the Bornholm Basin, zooplankton nets (Apstein, mesh size 50 µm, WP-2 mesh size 100 µm) were deployed to quantitatively sample nauplii and copepodites (responsible scientist Dr. Jörg Dutz, IOW)

For **macrozoobenthos** sampling, at 8 stations ranging from the Kiel Bay in the West to the Pomeranian Bay in the East in water depths between 20 and 50 m a van Veen grab was used for sampling. For quantitative analysis three replicates at each station and one grab for sediment surface analysis was deployed. Additionally a dredge was used for qualitative aspects. Following the HELCOM guidelines, after 3 month of waiting for weight stability, further processing of samples will be undertaken in the laboratory. After rinsing each haul, taxa will be sorted under a binocular microscope at 10-20 x magnification.

Continuous measurements:

Ships weather station

These data are compiled into a data set comprising the following data on hourly basis: time (UTC), latitude and longitude, depth, air pressure, air temperature, humidity, global radiation, infrared radiation, PAR, surface water temperature, wind direction and wind speed. Data are converted to netcdf files.

Since the thermosalinograph was inoperative, sea surface temperature from the ships weather station was used. The sensors are located inside the ship and have a positive offset. Comparing with the CTD based surface temperature an offset was found and a correction of -0.3 deg was applied.

Moorings:

The Gotland - SW mooring is a hydrographic mooring. It consists of an upward directed Doppler current meter near the sea floor and of several temperature and conductivity loggers and oxygen sensors. The mooring was recovered and laid out again.

The Gotland - Central mooring is a hydrographic mooring combined with a sediment trap.

3.2 Description of the Work Area

The area under investigation covers the western and central Baltic Sea from the Kiel Bight to the northern Gotland Basin (Fig. 3.1). Most stations were located along the so called thalweg transect of the Baltic Sea. This section follows the pathway of saltwater inflowing from the North Atlantic through the Arkona Sea, Bornhom Gatt, Bornholm Basin into the Central Gotland Basin. Additional deep Basins as Farö Deep, the Landsort Deep and Karlsö Deep are also included in the programme, but could not be reached because of stormy weather. Also the zonal sections across the Gotland Basin needed for a more accurate determination of the size of anoxic areas in the Central Gotland Basin had to be cancelled. The stations in the Western Baltic and the Pommeranian Bight are serving also as data baseline for the Baltic Sea monitoring of BSH.

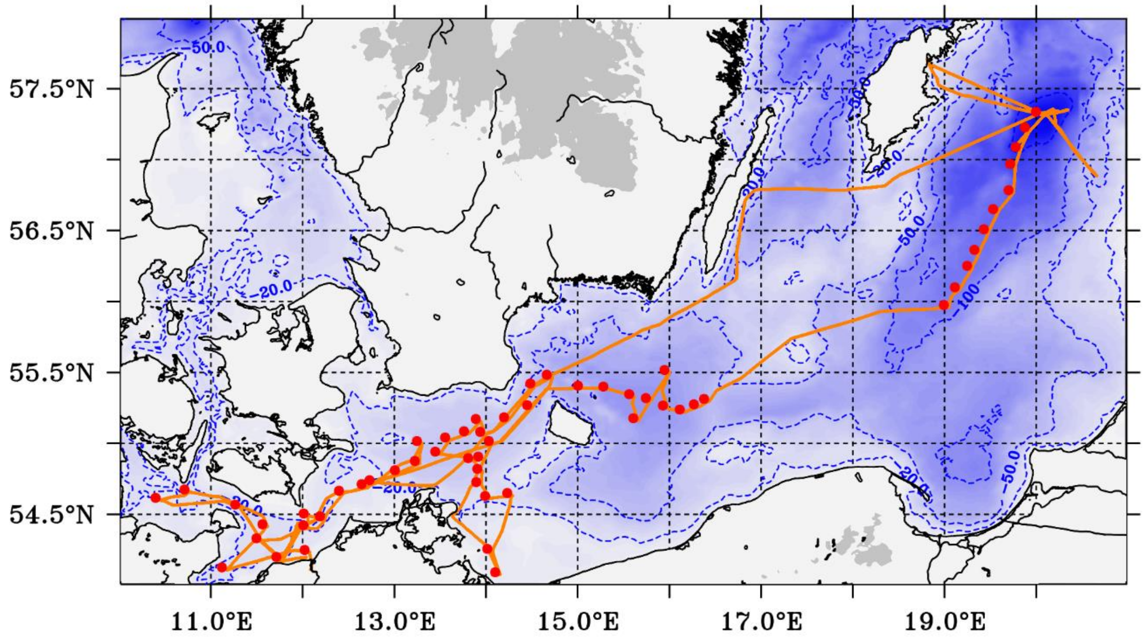


Fig. 3.1 Track chart of R/V ELISABETH MANN BORGESE of cruise EMB-251. For station names see Section 7.

4 Narrative of the Cruise

The cruise started Nov. 11th in Rostock-Marienehe. Several days before the cruise, all participants were in self isolation and were tested against the corona virus. Before loading the equipment, they were checked again against corona infection. The cruise was organized in two legs with a crew exchange in Saßnitz Nov. 15th. Slite on Gotland was an unplanned port of call. Here the ships gyro was repaired, which permitted continuation of the cruise. Moderate westerly winds and low sea state allowed for continuous station work during the first leg of the cruise. However, long lasting stormy conditions prohibited maintenance of one mooring and the deployment of the towed CTD (ScanFish) as well. The hydrographic stations in Polish waters could not even be reached, since high sea state limited maximum ship speed to 3 knots. Only some stations in the western Baltic Sea could be worked later, since the land shelter limited the wave height during the last day of the cruise.

Date	Time [UTC]	Task
2020-11-11	08:00-10:00	Testing for corona infection, loading of equipment, preparing devices for the cruise
2020-11-11	16:30 17:30 18:00 - 24:00	Departure from port Rostock-Marienehe, weather: cloudy, no wind, bad visibility First station, Station work towards Mecklenbur Bight
2020-11-12	00:00 - 24:00	Station work in Mecklenburg Bight, Darss Sill, stations TF360 – TF0001, Benthos sampling
2020-11-13	00:00 – 24:00	Station work in the Arkona Basin, stations TF069 - TF144
2020-11-14	00:00 - 15:00	Station work in the Arkona Basin and Bornholms Gat, East of Rügen. social event

2020-11-15	00:09 - 09:30 16:00 – 24:00	Crew exchange in Saßnitz. Stefanie Schubert, Toralf Heene Station work through Bornholms Gatt towards Bornholm Basin
2020-11-16	02:00 - 05:00 06:00 – 24:00	Station work on TF213, Transit and station work into the Gotland Basin
2020-11-17	00:80 - 09:00 10:00 - 13:00	Maintenance mooring GOSW Maintenance mooring Central Gotland See, Sediment trap Partial blackout – no gyro for several hours, stop of station work SCANfish deployment cancelled because of bad weather
2020-11-18	06:15	Gyro still inoperative, Slite harbour
2020-11-19	00:00 - 16:00 16:00 - 18:00	Slite harbour, Gyro maintenance Gyro becomes operative again
2020-11-20	00:00-14:00 14:00-22:00 22:00-00:00	Slite harbor Transit to TF0271 Station work at TF0271 with high priority.
2020-11-21	07:00 11:00-24:00	Interruption of station work Waiting for better conditions off Öland
2020-11-22	08:00 - 24:00	Transit to Bornholm Basin, gale force winds, 2kn speed only. Skipping TF0213
2020-11-23	00:00 -12:00 12:00 - 20:00	Bornholms Gatt, 3kn speed Transit to Arkona Basin, Skipping TF0113
2020-11-24	00:80 - 24:00	Station work in the western Baltic Sea
2020-11-25	08:80 -12:00	Arrival at port Rostock-Marienehe
	08:00 - 11:00	Deinstallation, unloading of scientific equipment, disembarking
	11:00	Disembarking of scientific crew, end of cruise EMB-251

5 Preliminary Results

The results presented in the following section are preliminary and not comprehensive. They are based in most cases on unevaluated raw data. The analysis of biological samples in the laboratory is outstanding. The assessment of the Baltic Sea ecosystem status will be presented elsewhere.

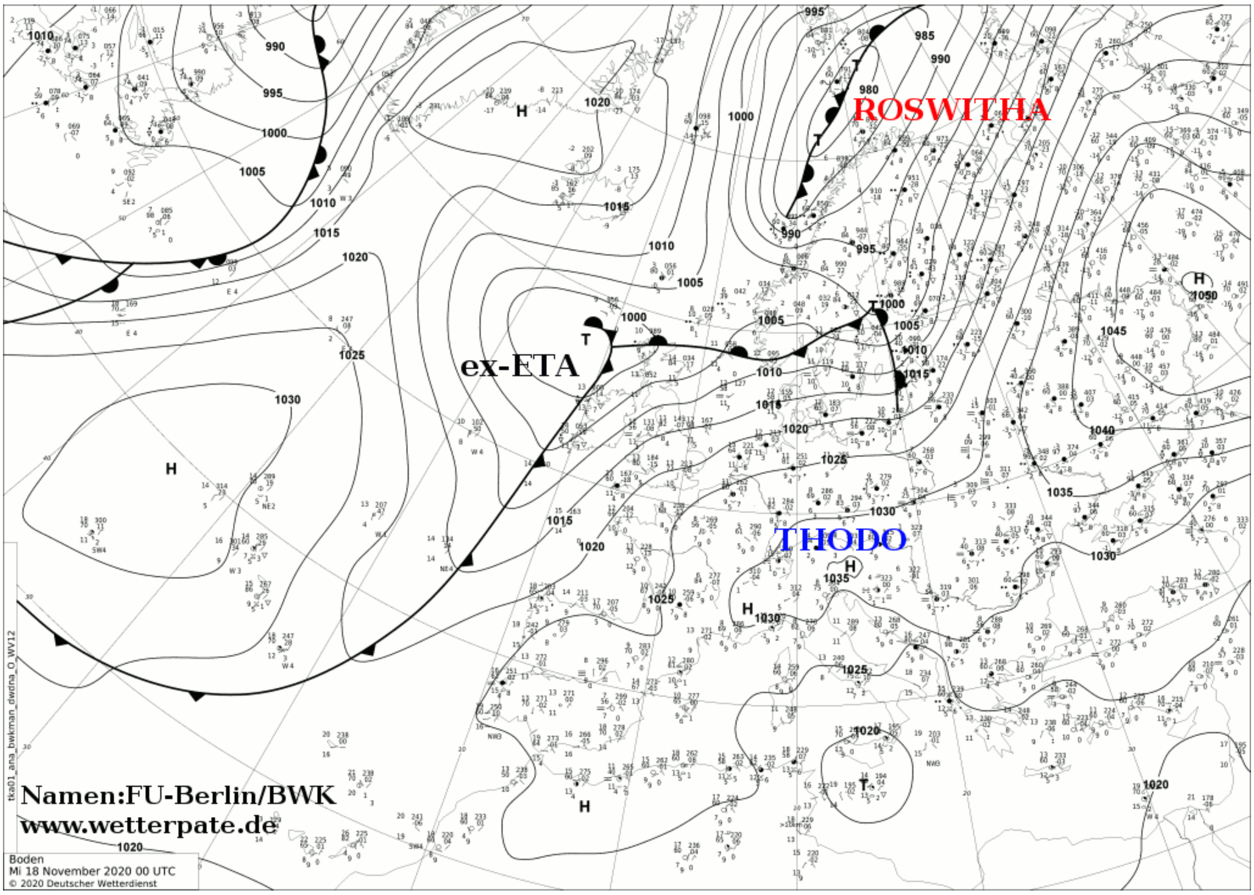


Fig. 5.1 Typical bottom pressure distribution during the time of the cruise. (With kind permission from http://www.met.fu-berlin.de/de/wetter/bodenanalyse/)

5.1 Meteorological Conditions

Governed by a stagnant high pressure system over central Europe the cruise started with prevailingly little wind, cloud covered skies and bad visibility. This calm weather was replaced later by contrary weather with moderate westerly winds.

Later, after 15 November, permanent high pressure over southern and central Europe in combination with a sequence of low pressure areas over northern Scandinavia went along with long lasting stormy conditions. Fig. 5.1 shows a typical air pressure distribution with high isobar density over the Baltic Sea area. 20 November a short pause allowed for station work in the central Gotland Sea. However, during the following days strong south-westerly or westerly winds with a long fetch and related high sea state allowed for slow ship speed only and prohibited any station work.

Figure 5.2 shows time series of the global and thermal radiation, air temperature and sea surface temperature and stick plots of hourly winds. At some days solar radiation is not exceeding 200 Wm^{-2} at noon. The high thermal radiation at 16 November should be an artifact. An instrument error cannot be excluded as reason, but this day the ship was in transit to the Gotland Basin and had permanently the same heading.

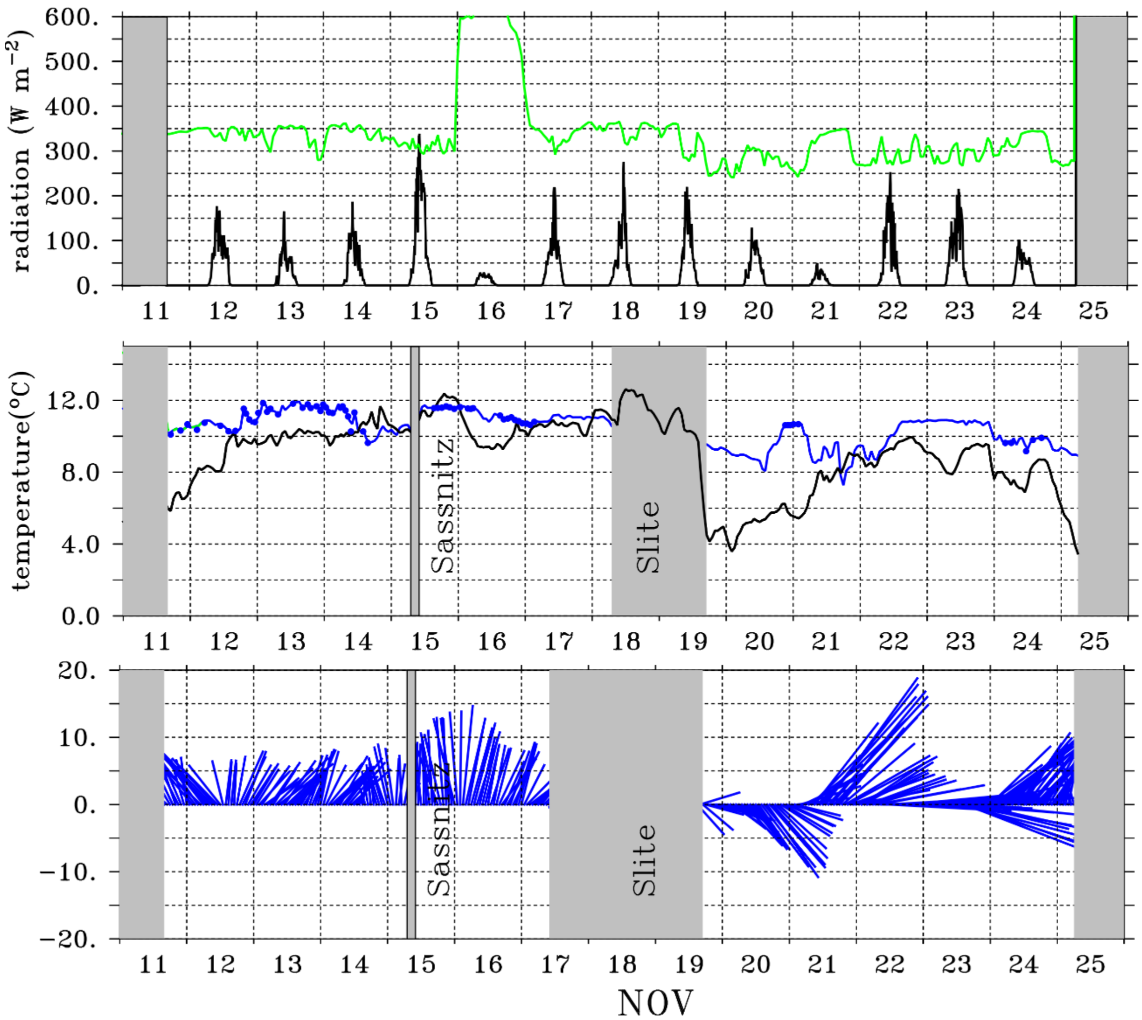


Fig. 5.2 Solar (black) and thermal (green) radiation, air temperature (black) and sea surface temperature (blue) and stick-plots of the wind speed measured by ships weather station during the cruise. Weather station SST was corrected by an offset of (-0.3 deg.) after comparison with CTD surface data. Blue dots depict surface temperature from the CTD, the green line Nov. 11th marks the sea surface temperature from the thermosalinograph before it failed permanently.

5.2 Surface conditions

On the cruise track, surface temperatures varied between 10°C and 12°C. The sea surface temperature was permanently well above the air temperature. Hence, the water heat budget was negative and a mixing surface layer with entrainment of heat and nutrients from subsurface layer low can be expected. The satellite based SST (Fig. 5.3, right panel) shows an overall cooling during the time of the cruise. Lower SST at west coasts can be understood as upwelling of cold subsurface water driven by southerly wind. At the southern tip and at the east coast of Gotland both lower SST and enhanced cooling suggest upwelling and mixing down to the winter water layer. See also the CTD profile from station TF0271, where the surface layer is perfectly mixed and entrains into the cold winter water layer. In turn, the warming in the Hanö Bight is most probably related to the upwelling of warmer (more saline) water.

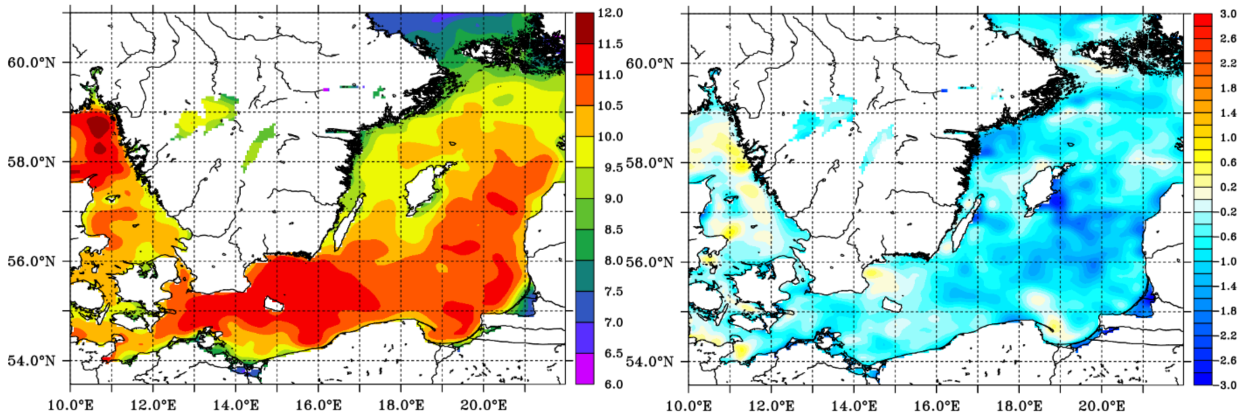


Fig. 5.3 Sea surface temperature distribution during the time of the cruise. Left figure: snapshot from GHRSST Level 4 OSTIA (https://podaac.jpl.nasa.gov/dataset/OSTIA-UKMO-L4-GLOB-v2.0) for 17.11.2020.Right figure: Change of the SST between 12 November and 22 November.

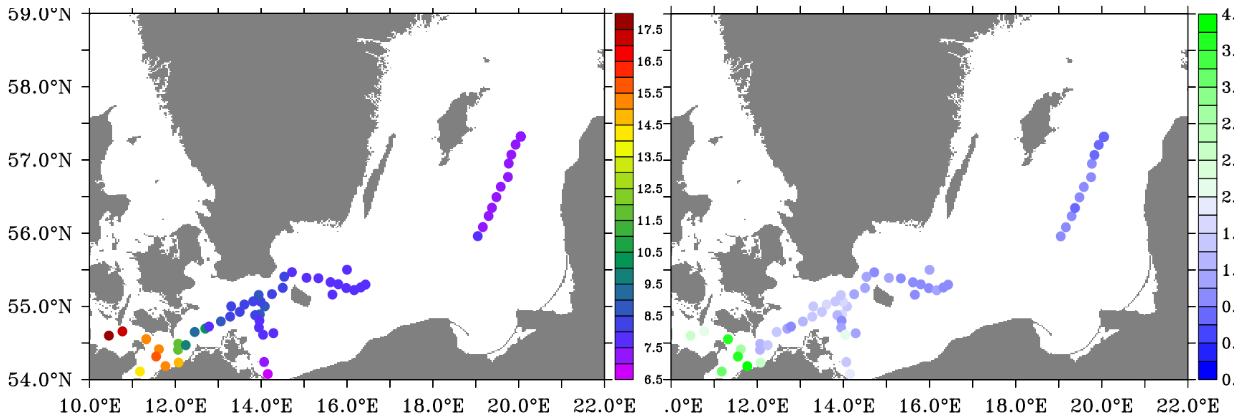


Fig. 5.4 Practical salinity (left figure) and fluorescence (right figure) from CTD surface data. Fluorescence (maximum value in the upper 10m) is given in chlorphyll-a units, mg m^{-3}.

Chlorophyll-a represented by fluorescence is generally small and well below 2 mg m^{-3} in the Baltic proper. It corresponds to a typical Secci depth of about 6 m. Only in the Arkona Basin and west of Darss Sill still some enhanced fluorescence is met.
At the surface, both the nutrients phosphorus and nitrogen are elevated again, especially near Darss Sill nitrate is available. Silicate concentration varies between 13µM and 18µM. At some stations more than half of the nitrogen is available as ammonium. For a summary for key stations see Table 6.1.

5.3 Specific situation in Mecklenburg Bight

The conditions in the Mecklenburg Bight deserve detailed attention, since this area is an important fishery (plaice) ground, is a touristic area but is also surrounded by land with intense agricultural activity and has two cities in its neighborhood. Differently from 2019, when bottom water was suboxic, the whole water column at stations TF0012 and TF0022 is well oxygenated.

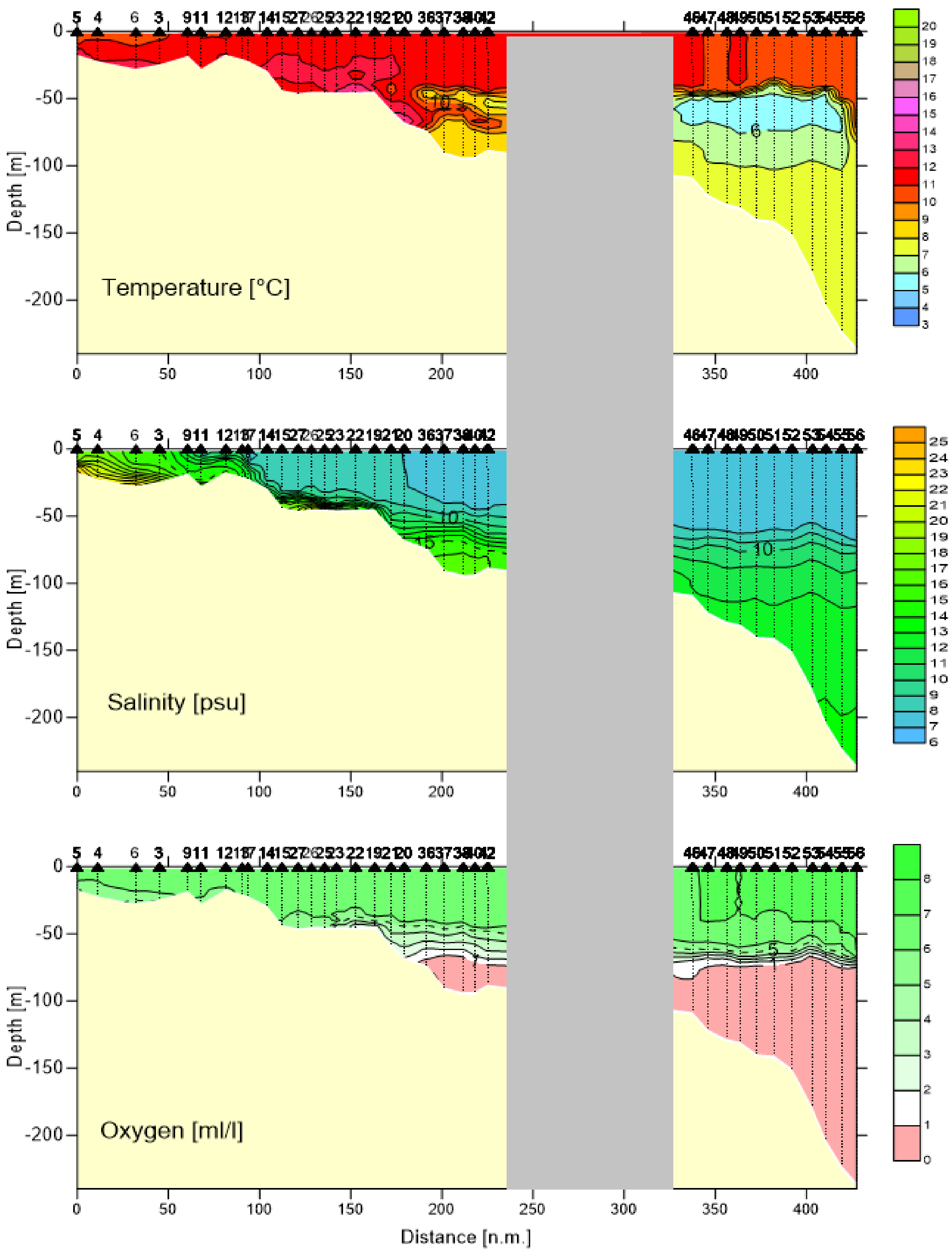


Fig. 5.5 Cross section from Kiel Bight to eastern Gotland Basin showing the temperature, salinity and oxygen on the "thalweg" of Major Baltic Inflows (for location see map Fig. 3.1). Stations in the grey area could not be reached because of stormy weather. Stations were worked from 11 November to 21November. (Figure: J. Donath, IOW)

5.4 Hydrographic Conditions along the Thalweg

Fig. 5.5 shows in situ temperature, salinity and oxygen concentration along the thalweg between Kiel Bight and the Gotland Basin. The hydrographic conditions along this thalweg cover the transition from oceanic to brackish waters. Under oceanic conditions with high salinity, stratification is governed mostly by potential temperature that is monotonically decreasing with depth. In brackish waters of the Baltic Proper stratification is strongly influenced by salinity and potential temperature is not monotonic. In the west, the seasonal thermocline is already dissolved by autumn cooling, the surface water is cooler than the more saline warmer bottom water. A similar warm and saline bottom water mass is also found in the Arkona Basin and in the Bornholm Gatt. Fig. 5.5 suggests this layer is intruding into the Bornholm Basin stratifying below the winter water layer and above a stagnant (almost anoxic) colder bottom layer. Parts of the water body propagate also through Słupsk Furrow and is losing slowly its salinity-temperature characteristics when descending into the Gotland Basin.

A typical feature on the thalweg is a permanent halocline at about 50m depth in the Bornholm Basin and 70 m depth in the Gotland Basin. Within the halocline there resides a cold water mass called winter water that is formed by surface cooling and convection during the winter time and stays present over all seasons.

Within the Gotland Basin the winter water layer exhibits a more pronounced temperature minimum than in the Bornholm Basin. The temperature minimum is located at about 45m depth. The minimum temperature is usually well below 4°C but exceeds 5.5°C in the Gotland Basin in 2020. Below the winter water layer both, temperature and salinity are monotonically increasing. Bottom temperature at station TF0271 is 7.3°C practical salinity is 13.3.

Downward from the center of the winter water layer oxygen concentration is decreasing rapidly. In the Bornholm Basin the intruding warmer water stratifying below the winter water causes some oxygenation. In Gotland Basin at the base of the winter water layer at 60m depth, oxygen concentration falls rapidly well below 1 ml l^{-1}. Between 60m and 120m depth oxygen concentration is varying indicating mixing and some ventilation from inflowing water stratifying into this depth horizon. Below 120m depth, the water becomes fully anoxic and hydrogen sulphide gives water samples its typical smell. Generally, at the redoxcline a strong pronounced turbidity maximum is met.

5.5 Hydrographic Profiles in the Bornholm Basin and the Gotland Basin

Fig.s 5.6 and 5.7 show the development of the vertical structure of water bodies from conditions before (2013) and after the major inflow event (2015) and rapid reestablishing anoxic conditions in the years 2018 and 2019. Compared with per-inflow conditions, the salinity profile below the halocline stays shifted towards higher values, the temperature is permanently elevated. The winter water minimum temperature is rising to 5.5°C in 2020. In the Bornholm Basin the winter water warming is even more pronounced. At station TF0271, the partial erosion of the winter water by strong mixing during the storm before the station was worked is obvious.

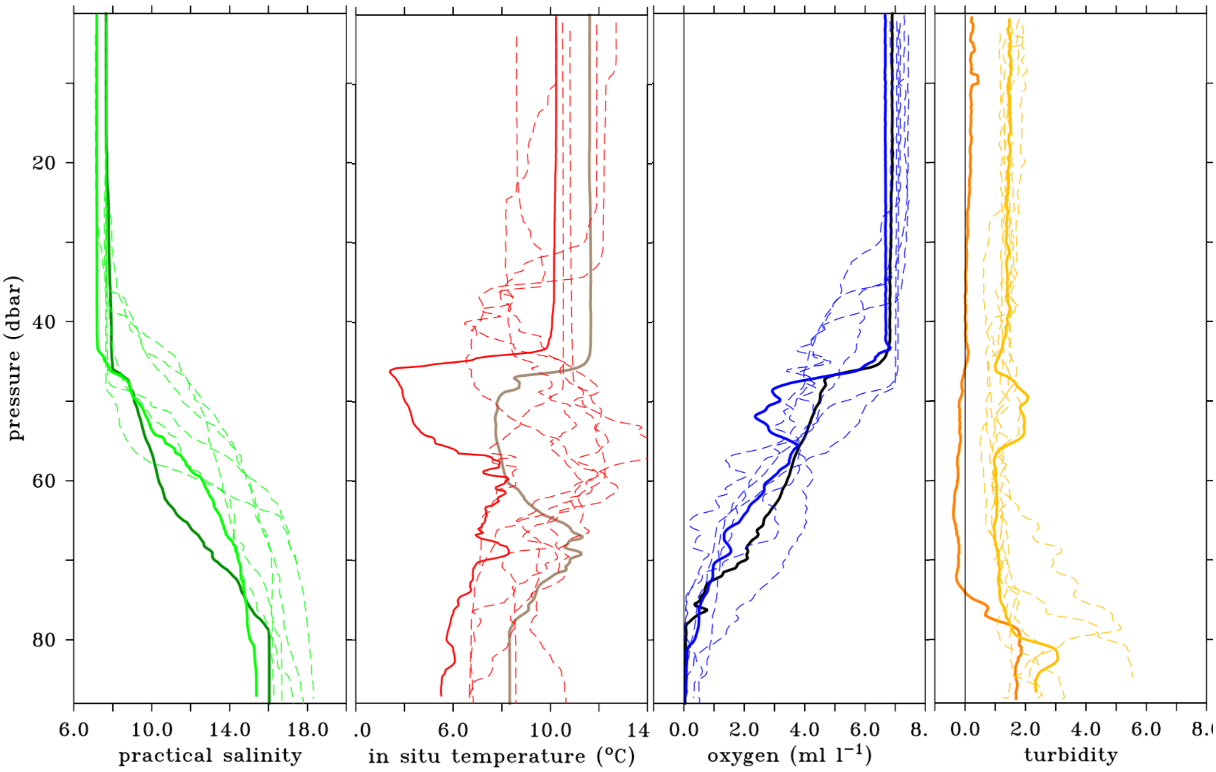


Fig. 5.6 Profiles of in situ temperature, practical salinity, oxygen concentration and turbidity at **TF0213** in the Bornholm Basin. The graphs with distinct color (dark green, tan, black, orange) depict the situation in Nov. 2020. The other graphs correspond to the stagnant conditions in November 2013 (thick full lines) and the variable hydrographic situation after the last major Baltic inflows 2015 (thin dotted lines) and during following reestablishing anoxic conditions.

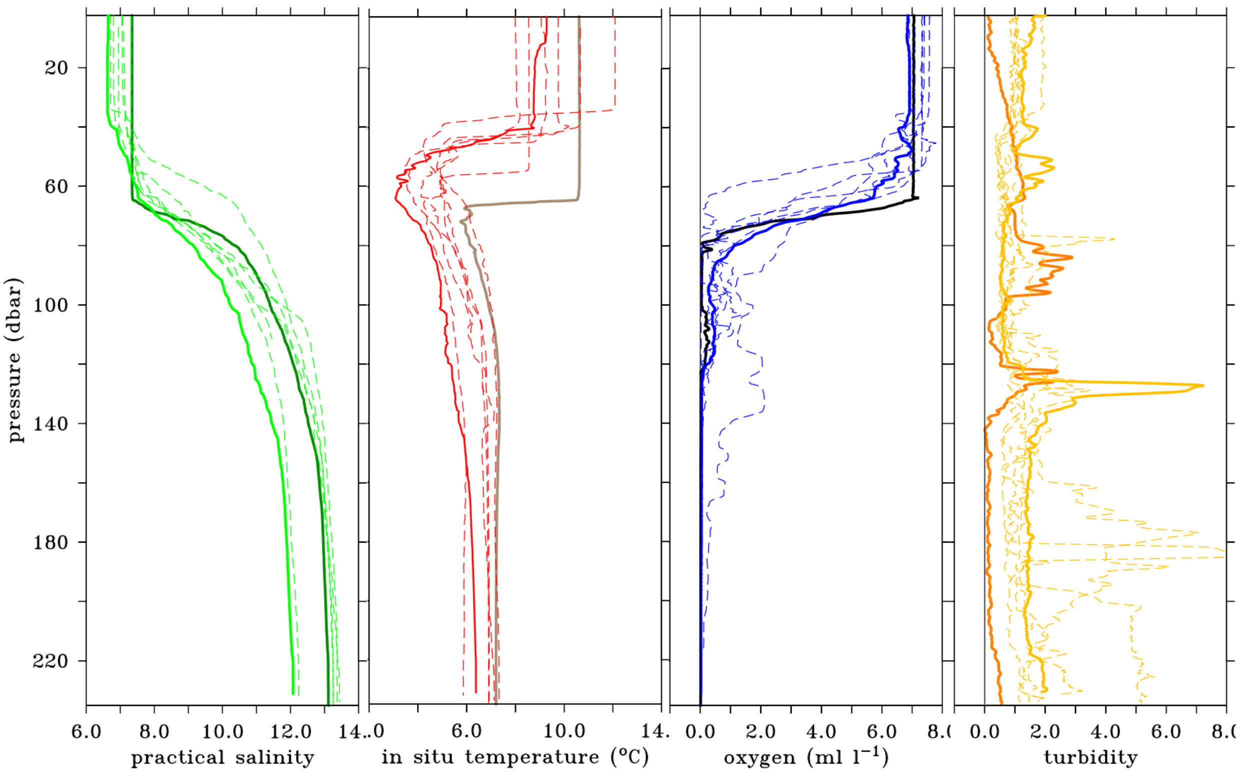


Fig. 5.7 Profiles of in situ temperature, practical salinity, oxygen concentration and turbidity at **TF0271** in the Gotland Basin. The graphs with distinct color (dark green, tan, black, orange) depict the situation in Nov. 2020. The other graphs correspond to the stagnant conditions in November 2013 (thick full lines) and the variable hydrographic situation after the last major Baltic inflows 2015 (thin dotted lines) and during following reestablishing anoxic conditions.

Also the upper bound of the oxygen depleted layer is shifted upwards to 80m depth. There is only a minor intrusion of hypoxic water at about 110m depth. This is a remarkable loss of habitat for organisms depending on oxygenated waters.

5.6 Long Term Development in the Gotland Basin Bottom Water

The major Baltic inflow from December 2014 and the following inflow events up to 2018

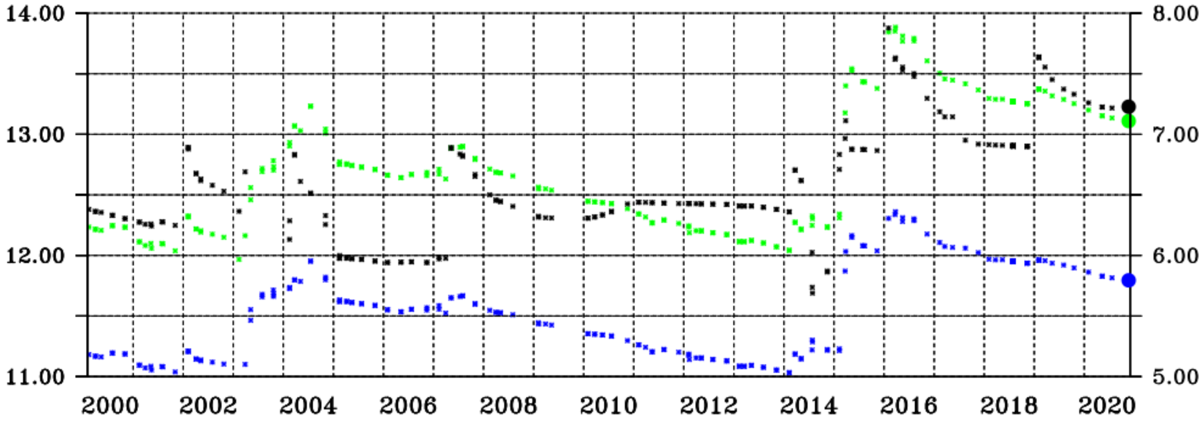


Fig. 5.8 Time series of temperature (black, right axes) and practical salinity (green, left axes) in the deep water of station **TF0271** in the Gotland Basin. The rightmost points are related to the cruise EMB-251. The blue dots mark in-situ density in kg m^{-3} (subtracted 1000.5 kg m^{-3} to fit to the left axes).

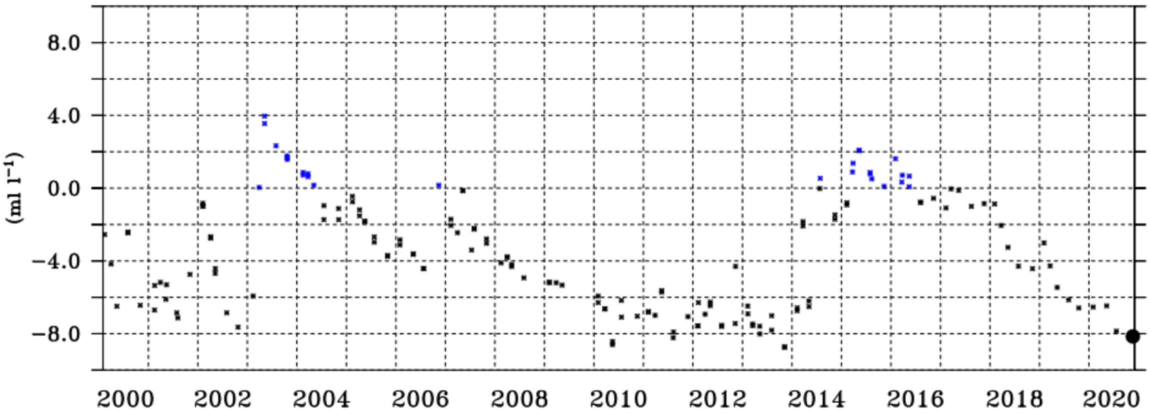


Fig. 5.9 Time series of oxygen concentration (blue) and hydrogen sulphide concentration (black, negative oxygen equivalent) in the deep water of station **TF0271** in the Gotland Basin. The rightmost points are related to the cruise EMB-251.

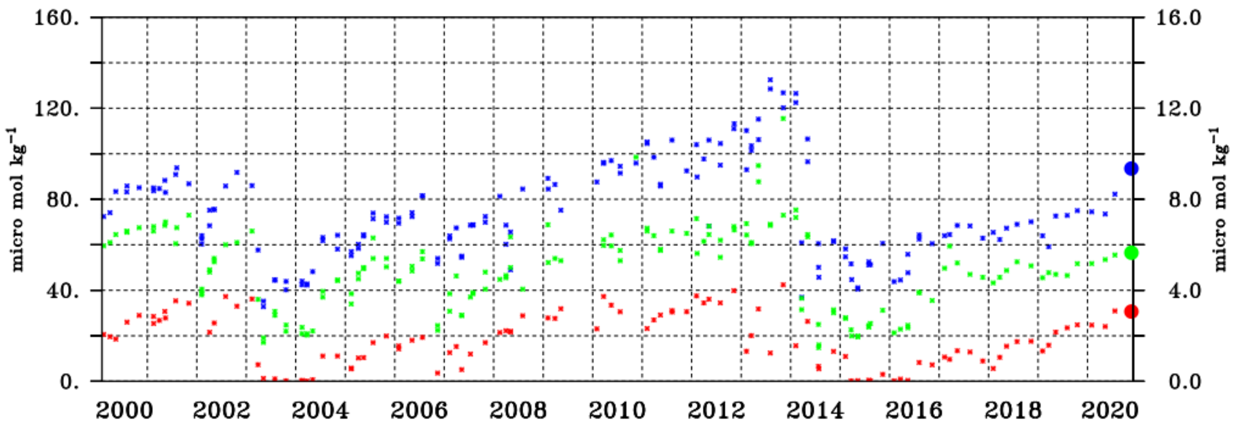


Fig. 5.10 Time series of macronutrient concentration in the deep water of station **TF0271** in the Gotland Basin. The rightmost points are related to the cruise EMB-251. Blue and left axes: silicate concentration, red and left axes: ammonium concentration, green and right axes: phosphate concentration.

elevated the salinity in the bottom layer in the central Baltic Proper rapidly to a maximum of 13.84 at the Gotland Deep in February 2016. Afterwards, it is slowly decreasing interrupted by a slight increase April 2017 and January 2019. The in-situ temperature shows a similar behavior, after a significant cooling from the major inflow and a step-wise warming from subsequent minor inflows, temperature relaxes towards some steady state. This process continues 2020. Oxygen (negative hydrogen sulphide equivalent) concentration is almost on the same level than it was before the inflow. The rising of the nutrient pool (ammonium, phosphate, silicate) in the Gotland Basin is continuing over 2020. As a result, the current status of the Gotland Basin bottom water is characterized by potential density still elevated compared to pre-inflow conditions and is comparable to values after the inflow 2004. Replacement of this bottom water would require high density water and minor inflows stratify in intermediate layers. On the other hand, hydrogen sulphide concentration is already elevated to typical stagnant conditions. Anoxic conditions start at 80m depth. This makes warm inflows into intermediate depth more likely, which in turn may sustain the uplift of overlaying water masses especially of the winter water layer. The compression of the ventilated habitats in the Gotland Basin continues.

5.7 Hydrographic Conditions for Surface and Bottom Waters at Key Stations

Tab. 5.1 Surface water layer (about 3 m depth) - hydrographic and hydrochemical properties

Area /Date	Station Name/No.	Temp. °C	Prac. Sal.	O_2 ml/l	NH_4 µM	PO_4 µM	NO_{2+3} µM	SiO_4 µM
Kiel Bight /2020-11-12	TF0360/05	10.74	17.83	6.67	0.27	0.71	0.17	18.7
Meckl.Bight /2020-11-12	TF0012/07	10.28	15.61	7.07	0.16	0.68	0.48	16.5
Darss Sill /2020-11-13	TF0030/17	11.22	7.95	6.96		0.58	3.69	18.5
Arkona Basin /2020-11-14	TF0113/27	11.29	8.06	6.87	0.32	0.51	1.14	15.8
Bornholm Deep /2020-11-16	TF0213/42	11.61	7.65	6.91	0.21	0.45	1.97	15.7
Gotland Deep /2020-11-20	TF0271/56	10.62	7.34	7.06	0.15	0.37	2.16	13.7

Tab. 5.2 Deep water layer (bottom near depths) - hydrographic and hydrochemical properties

Area /Date	Station Name /No.*	Temp. °C	Prac. Sal.	$O_2/2H_2S$ ml/l	NH_4 µM	PO_4 µM	NO_{2+3} µM	SiO_4 µM
Kiel Bight /2020-11-12	TF0360/05	12.08	24.47	4.83	0.86	0.82	2.86	21.6
Meckl.Bight /2020-11-12	TF0012/07	12.13	22.13	5.12	1.59	0.91	3.30	24.3
Darss Sill /2020-11-13	TF0030/17	11.95	12.64	6.14		0.81	3.42	20.8
Arkona Basin /2020-11-14	TF0113/27	11.81	19.30	5.41	1.43	0.74	2.77	17.4
Bornholm Deep /2020-11-16	TF0213/42	8.33	16.04	0.00	0.89	3.80	0.00	69.0
Gotland Deep /2020-11-20	TF0271/56	7.20	13.11	-8.15	30.65	5.63	0.00	93.2

* hydrogen sulphide was converted into negative oxygen equivalents

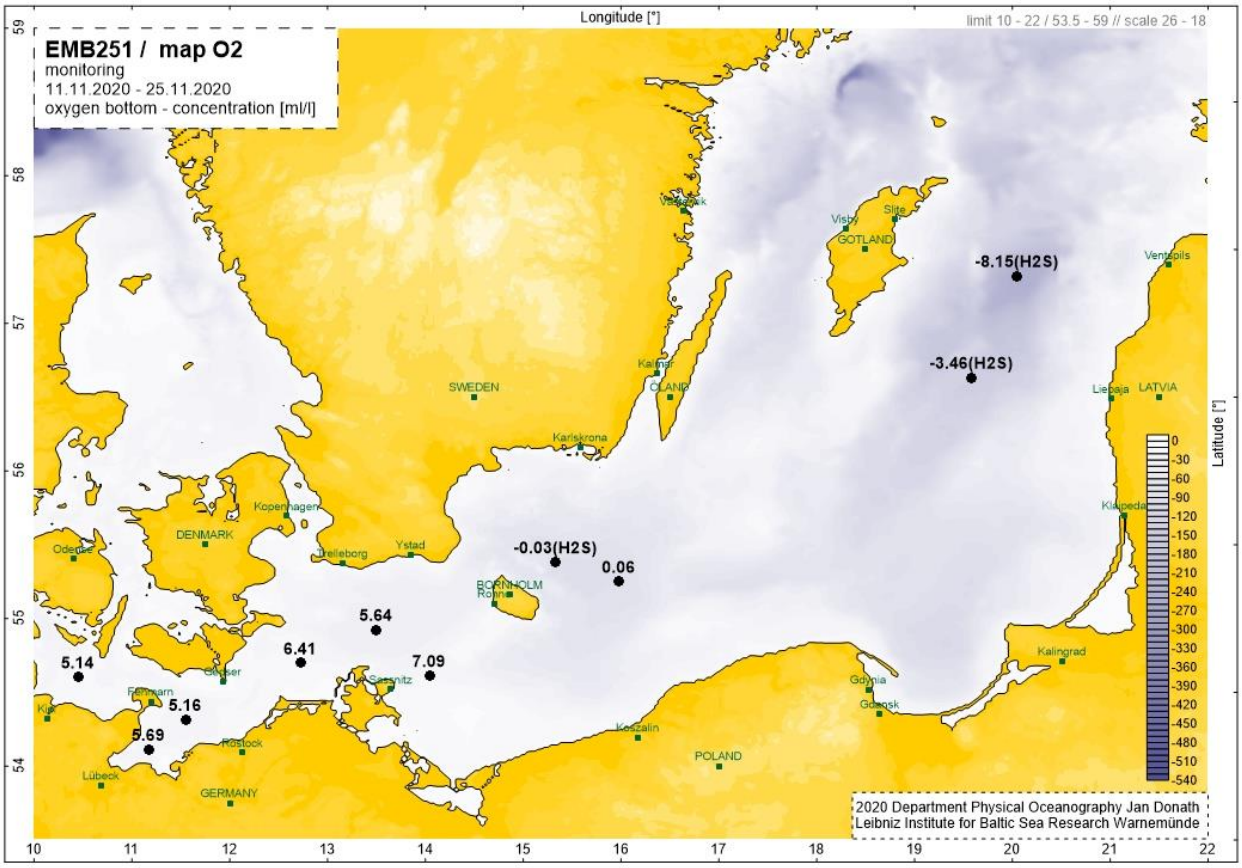


Fig. 5.11 Oxygen/hydrogen sulphide conditions in the bottom near layer for selected key stations (hydrogen sulphide was converted into negative oxygen equivalents).

7 Station Lists EMB251

7.1 Station List – CTD Measurements

Number EMB-251-	Name (IOW)	Begin	Date	Latitude	Longitude	Depth [dB]
0001	TFO5	16:37:06	11-NOV-20	54 13.9601N	12 04.5638E	13.12
0002	TF0022	20:20:39	11-NOV-20	54 06.6079N	11 10.4110E	23.43
0003	TF0011	22:52:44	11-NOV-20	54 24.7942N	11 36.9470E	25.43
0004	TF0361	02:18:07	12-NOV-20	54 39.5091N	10 45.9290E	23.24
0005	TF0360	04:59:20	12-NOV-20	54 35.9927N	10 27.0137E	18.47
0006	TF0010	10:41:39	12-NOV-20	54 33.1091N	11 19.1497E	28.61
0007	TF0012	13:33:44	12-NOV-20	54 18.8891N	11 33.0172E	25.03
0008	TF0018	16:05:09	12-NOV-20	54 11.0097N	11 46.0471E	20.71
0009	TF0041	19:03:37	12-NOV-20	54 24.4196N	12 03.6950E	19.52
0010	TF0040	19:51:38	12-NOV-20	54 29.3527N	12 03.9437E	12.32
0011	TF0046	21:03:40	12-NOV-20	54 28.1770N	12 14.5603E	28.35
0012	TF0002	23:02:27	12-NOV-20	54 38.9847N	12 27.0265E	18.20
0013	TF0001	00:15:43	13-NOV-20	54 41.7641N	12 41.8339E	21.23
0014	TF0115	01:57:16	13-NOV-20	54 47.6436N	13 03.5786E	30.43
0015	TF0114	03:24:24	13-NOV-20	54 51.5881N	13 16.6487E	45.03

0016	TF0069	04:35:37	13-NOV-20	54 59.9860N	13 18.0201E	46.73
0017	TF0030	07:20:56	13-NOV-20	54 43.4428N	12 46.9837E	23.17
0018	TF0109	12:41:28	13-NOV-20	54 59.9939N	14 05.0444E	48.05
0019	TF0144	16:10:38	13-NOV-20	55 15.1787N	14 30.1373E	45.90
0020	TF0140	17:58:30	13-NOV-20	55 28.0217N	14 42.9886E	69.25
0021	TF0142	19:02:10	13-NOV-20	55 24.3326N	14 32.2388E	60.34
0022	TF0145	21:11:18	13-NOV-20	55 10.0279N	14 15.0264E	46.59
0023	TF0103	22:31:15	13-NOV-20	55 03.8825N	13 59.4217E	47.25
0024	TF0102	23:29:41	13-NOV-20	55 09.3100N	13 56.5487E	45.05
0025	TF0104	00:28:58	14-NOV-20	55 04.1428N	13 48.8321E	46.42
0026	TF0105	01:34:52	14-NOV-20	55 01.4965N	13 36.4923E	46.33
0027	TF0113	02:55:36	14-NOV-20	54 55.5107N	13 30.0158E	47.13
0028	TF0111	05:39:45	14-NOV-20	54 53.4022N	13 58.1107E	44.79
0029	ABBoje	06:27:27	14-NOV-20	54 52.7696N	13 51.5542E	45.79
0030	TF0112	07:31:09	14-NOV-20	54 48.2428N	13 57.5527E	40.80
0031	TF0121	08:27:08	14-NOV-20	54 42.6361N	13 56.8398E	30.29
0032	TF0150	09:26:55	14-NOV-20	54 36.7444N	14 02.6378E	21.65
0033	TF0152	10:40:09	14-NOV-20	54 38.0149N	14 17.1402E	31.31
0034	TF0160	13:46:52	14-NOV-20	54 14.4233N	14 04.0930E	14.72
0035	OBBoje	15:30:41	14-NOV-20	54 04.5261N	14 09.2290E	29.73
0036	TF0205	15:15:12	15-NOV-20	55 23.4073N	15 03.4259E	75.38
0037	TF0200	16:35:51	15-NOV-20	55 23.0109N	15 20.0080E	91.50
0038	TF0211	18:06:15	15-NOV-20	55 19.8017N	15 36.9307E	95.53
0039	TF0214	19:30:34	15-NOV-20	55 09.6533N	15 39.6107E	93.84
0040	TF0212	20:50:32	15-NOV-20	55 18.1604N	15 47.8264E	95.60
0041	TF0220	22:28:53	15-NOV-20	55 30.0350N	16 00.0199E	81.08
0042	TF0213	00:35:01	16-NOV-20	55 15.0212N	15 58.9951E	89.87
0043	TF0221	03:20:47	16-NOV-20	55 13.3121N	16 10.0034E	82.32
0044	TF0225	04:23:06	16-NOV-20	55 15.5245N	16 19.2532E	67.24
0045	TF0226	05:18:36	16-NOV-20	55 17.8244N	16 25.8814E	58.38
0046	TF0265	14:53:59	16-NOV-20	55 57.5326N	19 02.8128E	111.93
0047	TF0250	16:09:52	16-NOV-20	56 05.0036N	19 10.0001E	124.31
0048	TF0262	17:38:52	16-NOV-20	56 14.0798N	19 18.0490E	130.93
0049	TF0263	18:56:21	16-NOV-20	56 20.8388N	19 22.7698E	133.37
0050	TF0261	20:14:08	16-NOV-20	56 29.5589N	19 28.9704E	142.99
0051	TF0260	21:31:40	16-NOV-20	56 38.0535N	19 35.0741E	144.02
0052	TF0274	22:57:48	16-NOV-20	56 46.0515N	19 45.1214E	153.60
0053	TF0273	00:22:52	17-NOV-20	56 57.1242N	19 46.2293E	181.98
0054	TF0272	01:39:02	17-NOV-20	57 04.3100N	19 49.8149E	205.74
0055	TF0275	03:07:54	17-NOV-20	57 12.6051N	19 55.8140E	226.40
mooring	GOSW	08:16:28	17-NOV-20	57 07.0480N	19 48.5246E	222.42
mooring	GOC	10:00:00	17-NOV-20	57 18.3750N	20 04.8540E	250.00
0058	TF0271	21:05:15	20-NOV-20	57 19.1781N	20 03.0449E	237.63
0059	TF0030	03:51:37	24-NOV-20	54 43.4032N	12 47.0251E	22.51
0060	TF0002	06:00:27	24-NOV-20	54 39.0122N	12 27.0295E	18.25
0061	TF0018	11:22:07	24-NOV-20	54 11.0261N	11 46.0304E	20.82

0062	TF0012	13:44:40	24-NOV-20	54 18.8836N	11 33.0524E	24.59
0063	TF0046	16:50:26	24-NOV-20	54 28.1971N	12 14.5171E	28.58

7.2 Station List – Plankton Sampling

Phytoplankton is filtered from water samples, zooplankton is sampled with WP2 net. See Section 3.2

Number EMB-251-	Name (IOW)	Begin	Date	Latitude	Longitude	Depth [dB]
0005	TF0360	04:59:20	12-NOV-20	54 35.9927N	10 27.0137E	18.47
0006	TF0010	10:41:39	12-NOV-20	54 33.1091N	11 19.1497E	28.61
0011	TF0046	21:03:40	12-NOV-20	54 28.1770N	12 14.5603E	28.35
0017	TF0030	07:20:56	13-NOV-20	54 43.4428N	12 46.9837E	23.17
0018	TF0109	12:41:28	13-NOV-20	54 59.9939N	14 05.0444E	48.05
0027	TF0113	02:55:36	14-NOV-20	54 55.5107N	13 30.0158E	47.13
0042	TF0213	00:35:01	16-NOV-20	55 15.0212N	15 58.9951E	89.87
0058	TF0271	21:05:15	20-NOV-20	57 19.1781N	20 03.0449E	237.63
0059	TF0030	03:51:37	24-NOV-20	54 43.4032N	12 47.0251E	22.51
0060	TF0002	06:00:27	24-NOV-20	54 39.0122N	12 27.0295E	18.25
0063	TF0046	16:50:26	24-NOV-20	54 28.1971N	12 14.5171E	28.58

7.3 Station List – Benthos Sampling

Number EMB-251-	Name (IOW)	Begin	Date	Latitude	Longitude	Depth [dB]
0005	TF0360	04:59:20	12-NOV-20	54 35.9927N	10 27.0137E	18.47
0006	TF0010	10:41:39	12-NOV-20	54 33.1091N	11 19.1497E	28.61
0007	TF0012	13:33:44	12-NOV-20	54 18.8891N	11 33.0172E	25.03
0008	TF0018	16:05:09	12-NOV-20	54 11.0097N	11 46.0471E	20.71
0009	TF0041	19:03:37	12-NOV-20	54 24.4196N	12 03.6950E	19.52
0017	TF0030	07:20:56	13-NOV-20	54 43.4428N	12 46.9837E	23.17
0018	TF0109	12:41:28	13-NOV-20	54 59.9939N	14 05.0444E	48.05
0033	TF0152	10:40:09	14-NOV-20	54 38.0149N	14 17.1402E	31.31
0034	TF0160	13:46:52	14-NOV-20	54 14.4233N	14 04.0930E	14.72
0061	TF0018	11:22:07	24-NOV-20	54 11.0261N	11 46.0304E	20.82

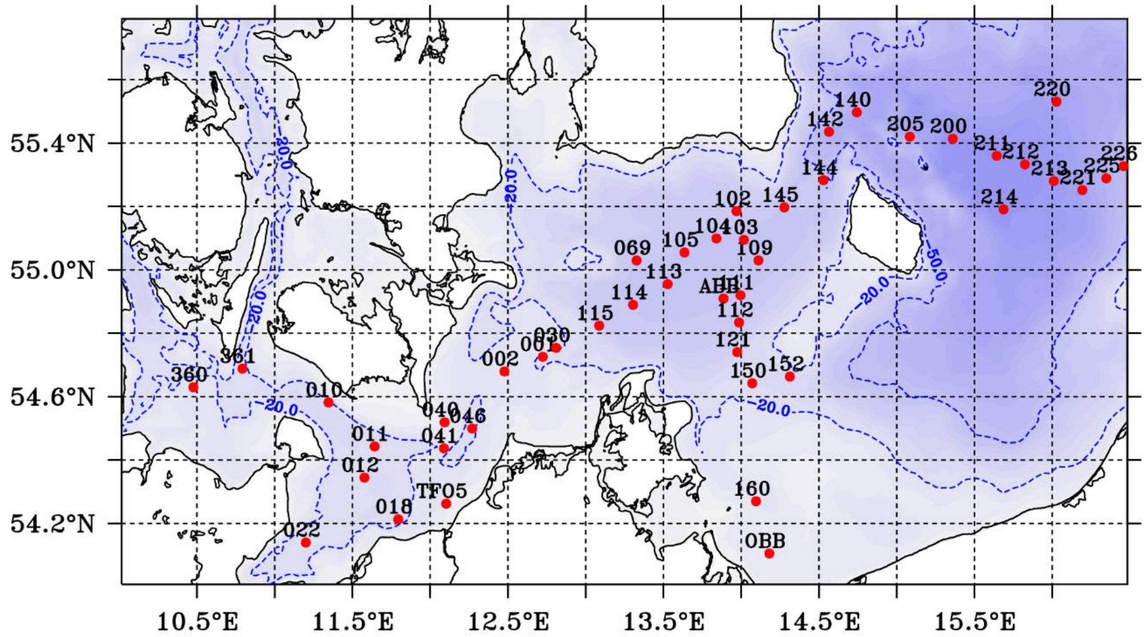


Fig. 7.1 Hydrographic stations in the western Baltic Sea, Arkona Basin and Bornholm Basin. Station names are abbreviated, read 213 as TF0213.

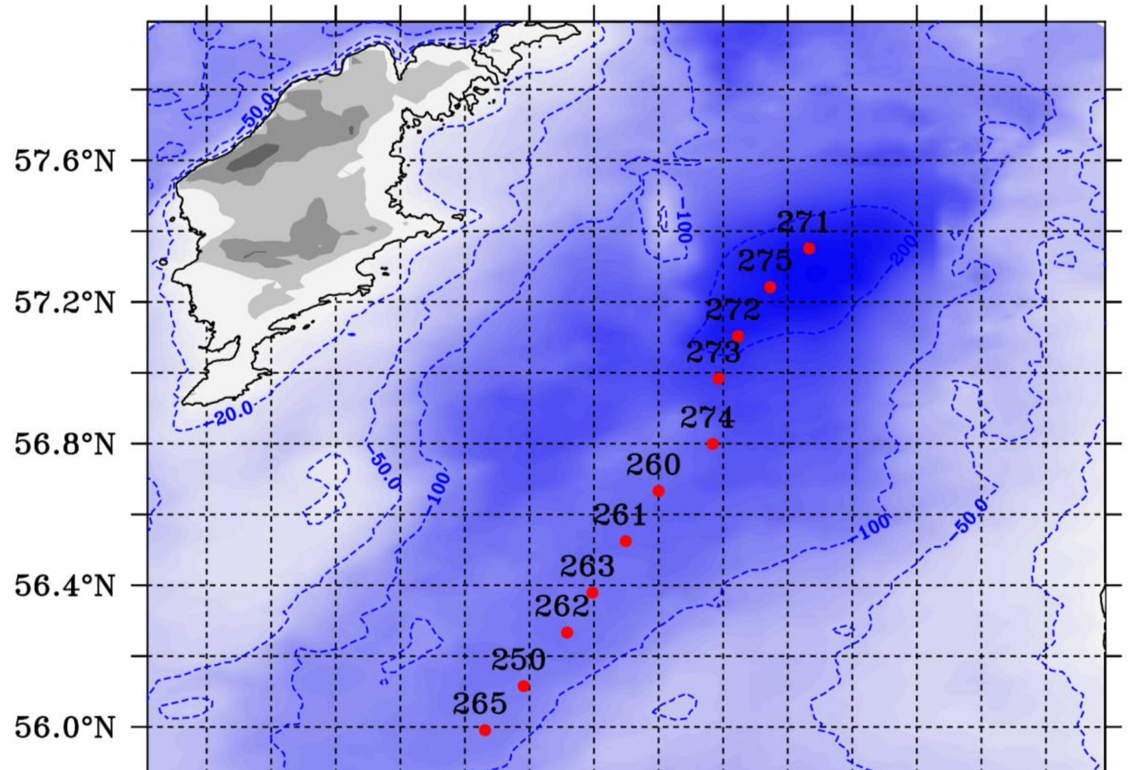


Fig. 7.2 Hydrographic stations in the “thalweg” to the Gotland Basin. Station names are abbreviated, read 271 as TF0271.

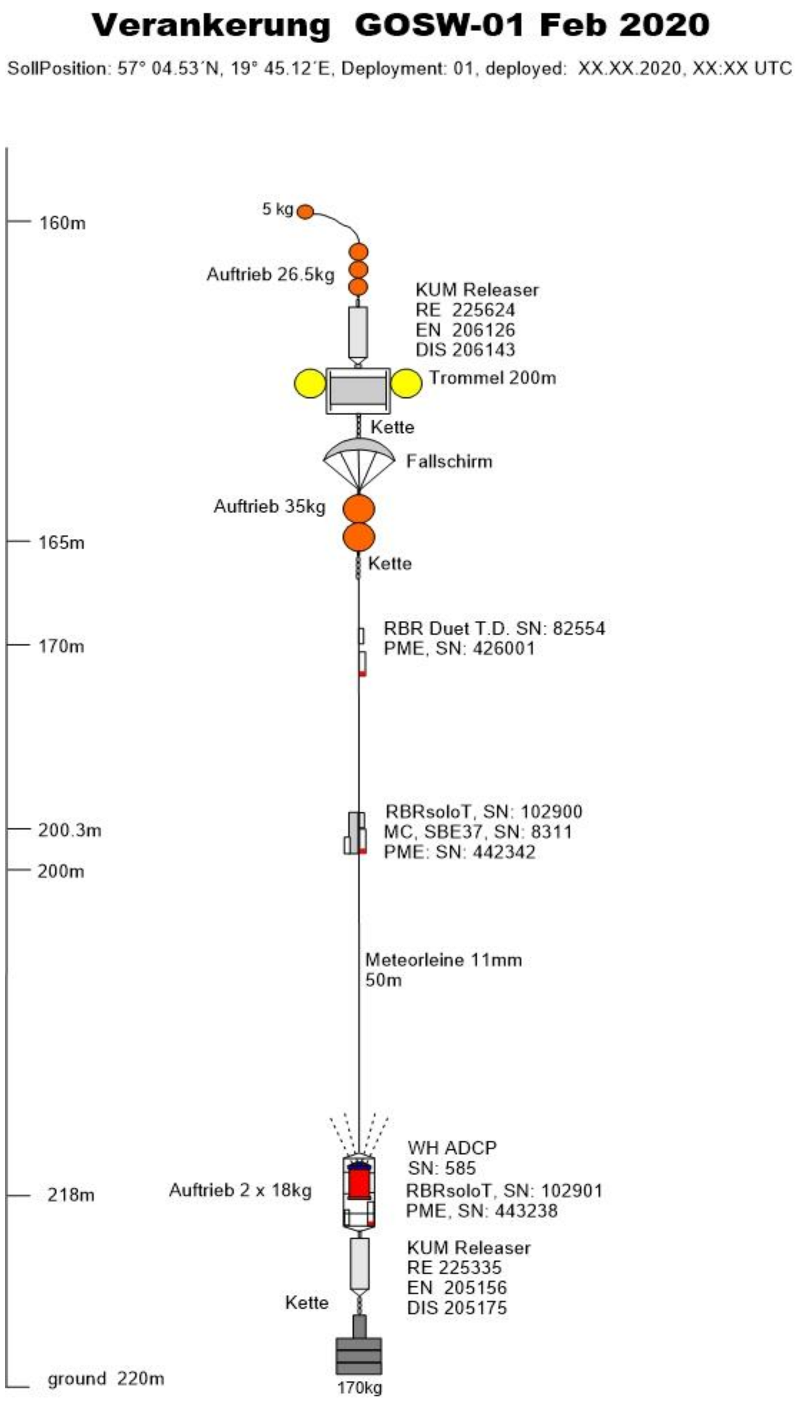
7.4 Water Sampling Inventory – Quantities and Number of Samples

Stationsbez..	Stationsnr.	Meteorologie	T-Boden	S-Boden	T-Profil	S-Profil	O2-Profil	Flurometer	Sauerstoff	PO4	** NO3	** NO2	** SIO4	NH4	P-Total	** N-Gesamt	** POM+DOM	Phyto-Netz	Chlorophyll	Phytoplankton	H2S-Best.	Sichttiefe (m)	DNA-Filter	CH4	CO2	Zooplankton	P+G, Betain	SECCHI (m)
TFO5	**1**	x	x	x	x	x	x	x	1	3	3	3	3	3	2	2	2											
TF0022	**2**	x	x	x	x	x	x	x	1	4	4	4	4	-		-	-											
TF0011	**3**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											
TF0361	**4**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											
TF0360	**5**	x	x	x	x	x	x	x	2	3	3	3	3	3	3	3	3	1	5	3						2		5,0
TF0010	**6**	x	x	x	x	x	x	x	1	4	4	4	4	-		-	-											
TF0012	**7**	x	x	x	x	x	x	x	2	4	4	4	4	4	3	3	3	1	6	2						2		5,0
TF0018	**8**	x	x	x	x	x	x	x	2		-	-	-	-		-	-											
TF0041	**9**	x	x	x	x	x	x	x	1	3	3	3	3	-		-	-											
TF0040	**10**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											
TF0046	**11**	x	x	x	x	x	x	x	1	4	4	4	4	-		-	-	1	5	2						2		
TF0002	**12**	x	x	x	x	x	x	x	1	3	3	3	3	-		-	-											
TF0001	**13**	x	x	x	x	x	x	x	3	2	2	2	2	-		-	-											
TF0115	**14**	x	x	x	x	x	x	x	10	4	4	4	4	-		-	-											
TF0114	**15**	x	x	x	x	x	x	x	1	5	5	5	5	-		-	-											
TF0069	**16**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											8,0
TF0030	**17**	x	x	x	x	x	x	x	1	4	4	4	4	-		-	-	1	6	2								9,0
TF0109	**18**	x	x	x	x	x	x	x	1	5	5	5	5	5	4	4	4	1	5	2						2		
TF0144	**19**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											
TF0140	**20**	x	x	x	x	x	x	x	1	6	6	6	6	-		-	-											
TF0142	**21**	x	x	x	x	x	x	x	1	5	5	5	5	-		-	-											
TF0145	**22**	x	x	x	x	x	x	x	1	5	5	5	5	-		-	-											
TF0103	**23**	x	x	x	x	x	x	x	1	5	5	5	5	-		-	-											
TF0102	**24**	x	x	x	x	x	x	x			-	-	-	-		-	-											
TF0104	**25**	x	x	x	x	x	x	x	1	5	5	5	5	-		-	-											
TF0105	**26**	x	x	x	x	x	x	x	9	5	5	5	5	-		-	-											
TF0113	**27**	x	x	x	x	x	x	x	7	7	7	7	7	7	4	4	4	2	6	2				7	7	2		
TF0111	**28**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											
ABBoje	**29**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											

TF0112	**30**	x	x	x	x	x	x	x	1	4	4	4	4	-		-	-											
TF0121	**31**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											
TF0150	**32**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											
TF0152	**33**	x	x	x	x	x	x	x	4	4	4	4	4	-		-	-											
TF0160	**34**	x	x	x	x	x	x	x	3	3	3	3	3	-		-	-											
OBBoje	**35**	x	x	x	x	x	x	x	2	2	2	2	2	-		-	-											
TF0205	**36**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											
TF0200	**37**	x	x	x	x	x	x	x	1	7	7	7	7	-		-	-				2							
TF0211	**38**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											
TF0214	**39**	x	x	x	x	x	x	x	1	7	7	7	7	-		-	-				2							
TF0212	**40**	x	x	x	x	x	x	x			-	-	-	-		-	-											
TF0220	**41**	x	x	x	x	x	x	x	1		-	-	-	-		-	-				1							
TF0213	**42**	x	x	x	x	x	x	x	19	10	10	10	10	10	6	6	6	1	5	2	2			10	10	4		
TF0221	**43**	x	x	x	x	x	x	x			-	-	-	-		-	-				1							
TF0225	**44**	x	x	x	x	x	x	x	1		-	-	-	-		-	-											
TF0226	**45**	x	x	x	x	x	x	x			-	-	-	-		-	-											
TF0265	**46**	x	x	x	x	x	x	x	1		-	-	-	-		-	-				1							
TF0250	**47**	x	x	x	x	x	x	x			-	-	-	-		-	-				1							
TF0262	**48**	x	x	x	x	x	x	x	1		-	-	-	-		-	-				1							
TF0263	**49**	x	x	x	x	x	x	x			-	-	-	-		-	-				1							
TF0261	**50**	x	x	x	x	x	x	x	1		-	-	-	-		-	-				1							
TF0260	**51**	x	x	x	x	x	x	x	7	9	9	9	9	-		-	-				2							
TF0274	**52**	x	x	x	x	x	x	x	1		-	-	-	-		-	-				1							
TF0273	**53**	x	x	x	x	x	x	x	1		-	-	-	-		-	-				1							
TF0272	**54**	x	x	x	x	x	x	x			-	-	-	-		-	-				4							
TF0275	**55**	x	x	x	x	x	x	x			-	-	-	-		-	-				1							
TF0271	**56**	x	x	x	x	x	x	x	22	21	21	21	21	21	12	12	12	2	6	2	8		50	21	21		52	
TF0030	**59**	x	x	x	x	x	x	x	1		-	-	-	-		-	-	2	5	2								
TF0002	**60**	x	x	x	x	x	x	x	2		-	-	-	-		-	-											
TF0018	**61**	x	x	x	x	x	x	x	2		-	-	-	-		-	-											
TF0012	**62**	x	x	x	x	x	x	x	1		-	-	-	-		-	-	2	6	2						1		**4,0**
TF0046	**63**	x	x	x	x	x	x	x	1		-	-	-	-		-	-	2	5	2						1		**5,0**
									134	153	153	153	153	53	34	34	34	16	60	23	30		50	38	38	16	52	**6**
		61	61	61	61	61	61	61	53	29	29	29	29	7	7	7	7	11	11	11	16		1	3	3	8	1	

7.5 Mooring Work

Date	Latitude [decimal]	Longitude [decimal]	Begin [UTC]	End [UTC]	Water Depth [m]	Action
2020-11-17	57.12N	19.81E	06:50	07:30	220	Mooring Gotland - SW, recovery, maintenance, deployment
2020-11-17	57.32N	20,13E	09:40	13:30	240	Mooring Gotland - central, recovery, maintenance, deployment



8 Data and Sample Storage and Availability

After validation data will be freely available in the IOW DB online via ODIN2 (https://odin2.io-warnemuende.de/#/). The data will be imported into national and international databases (MUDAB, HELCOM, ICES, ENA).

8.1 CTD Sensors and Handling

The CTD SBE911+ is equipped with pairs of temperature, conductivity and oxygen sensors. This allows to control the data quality during the cruise and to identify sensor malfunction.

variable	Sensor type	Sensor ID	Date of calibration	
temperature	SBE-3	5491	2020-01-23	ITS-90
		1700	2020-10-13	
conductivity	SBE-4	4006	2020-01-23	
		2907	2020-10-13	
Oxygen conc.	SBE-43	3826	2019-08-08	Sea-Bird equation
	SBE-43	3619	2020-08-08	Sea-Bird equation
pressure	digiquarz	1385	2020-03-11	
fluorescence	WETlabs ECO Afl/fl	FL_22029_5V	2010-09-28	
turbidity	WETLAB ECO NTU	NTU_2029_10V	2010-09-28	
PAR	Biospherical Licor Chelsea	PAR_70256_5V	2009-08-12	
temperature	SBE-35			

To evaluate a possible drift of the CTD normal quartz, its frequency if observed during the cruise.

The deviation between the two sensor packages is monitored in homogeneous water layers. The deviation between the two SBE-3 thermometers in homogeneous layers did not exceed 2mK , the deviation between the conductivity sensors SBE-4 did not exceed 2mS.

The quality of the temperature sensors is also monitored with a high precision thermometer RT-35.

To control the conductivity sensors, salt samples are taken in homogeneous layers to be measured later with an AUTOSAL in the laboratory against standard seawater.

A temperature correction of about 1mk and no conductivity correction was applied.

Prior the cruise the zero point of the oxygen sensors is verified by filling the sensors with oxygen free nitrogen gas. The sensor slope is calibrated during the cruise with oxygen samples taken in homogeneous water layers (3 bottles, 3 samples from each bottle).

CTD profiles are loaded into the IOW data base ODIN2 (https://odin2.io-warnemuende.de/#/).

8.2 Oxygen, Nutrient, CO_2 and Hydrogen Sulphide Data Handling

After validation, data are merged with hydrographic and geographic references and are stored in IOW data base ODIN2 (https://odin2.io-warnemuende.de/#/).

Data from the experimental nitrate and CO_2 sensors are validated against bottle data and will be used to prepare routinely sensor usage for the specific Baltic Sea waters. Responsible Dr. Henry Bittig, henry.bittig@io-warnemuende.de.

Microbiology- samples for cell counts and nucleic acid analysis of bacteria/ archaea are held at the Institute for Baltic Sea Research in Warnemünde (Dept. Biological Oceanography, Prof. Dr. Klaus Jürgens). Samples are being processed and analyzed by scientific and technical staff under the supervision of Prof. Dr. Klaus Jürgens in order to monitor microbial composition in the oxygen-deficient basins. Obtained data (mainly sequences) are being deposited in standard data bases (EMBL, NCBI, ENA).

hydrography	Jan 2021	free	ODIN**	markus.meier@io-warnemuende.de
hydrographic mooring	Jun 2021	Nov 2023	ODIN	volker.mohrholz@io-warnemuende.de
Sediment trap	Jun 2021	Free	ODIN, MUDAB***	anke.kremp@io-warnemuende.de
nutrients	Apr 2021	free	ODIN, MUDAB	detlef.schulz-bull@io-warnemuende.de
microbiology		free	ENA*	klaus.juergens@io-warnemunde.de
Phytoplankton	Jun 2021	free	MUDAB	anke.kremp@io-warnemuende.de
Zooplankton	Jun 2021	free	MUDAB	joerg.dutz@io-warnemuende.de
Macrozoobethos	Jun 2021	free	ODIN	michael.zettler@io-warnemuende.de
carbon cycle				stefan.otto@io-warnemuende.de

* ENA: https://www.ebi.ac.uk/ena
** ODIN2: https://odin2.io-warnemuende.de.
*** MUDAB https://seadata.bsh.de/csr/retrieve/dod_index.html

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The title photo shows a time series of the detritus precipitation seen in the sample bottles of the sediment trap in the Central Gotland Basin. Photo: M. Schmidt.

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