

Leibniz Institute for Baltic Sea Research Warnemünde

Cruise Report


r/v "Elisabeth Mann Borgese"


Cruise-No. EMB 078

Monitoring Cruise
19 July – 30 July 2014
Kiel Bight to Northern Baltic Proper

This report is based on preliminary data

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1. **Cruise No.:** EMB 078
2. **Dates of the cruise:** from 19 July to 30 July 2014
3. **Particulars of the research vessel:**
Name: "Elisabeth Mann Borgese"
Nationality: Germany
Operating Authority: Leibniz Institute for Baltic Sea Research (IOW)

4. **Geographical area in which ship has operated:**
Kiel Bight to Northern Baltic Proper

5. **Dates and names of ports of call**
No port of call

6. **Purpose of the cruise**
Baltic monitoring in the frame of the COMBINE Programme of HELCOM

7. **Crew:**
Name of master: Volker Ziegner
Number of crew: 11

8. **Research staff:**
Chief scientist: Dr. Wasmund, Norbert

Scientists: Dr. David Meier
Elvita Eglite

Engineers: Jan Donath
Ingo Schuffenhauer

Technicians: Lars Kreuzer
Susanne Lage
Michael Pöttsch
Andrea Tschakste

Students Diane Enkelmann
Mattis Karle,
Celina Lehnert

9. **Co-operating institutions:**
All institutions dealing with HELCOM monitoring programmes.

10. **Scientific equipment**

CTD + Rosette water samplers, Phytoplankton net (Apstein), Zooplankton net (WP2), Secchi disk, nutrient analyser Evolution III from Alliance, oxygen analyser Titrino from Metrohm. ScanFish.

11. General remarks and preliminary results

This cruise is part of the German contribution to the HELCOM COMBINE program and contributes to IOW's long term data series in the central Baltic Sea. The area under investigation extended from Kiel Bight to the Northern Gotland Sea (station map see Figs. 1-3). On the way back, selected HELCOM stations in the Bornholm Sea (stat. TFO213), Arkona Sea (stat. TFO113, TFO030) and Mecklenburg Bight (TFO046, TFO012) were sampled a second time for nutrient, phytoplankton and zooplankton data. The hydrographical, chemical and biological investigations were performed according to the Manual of the COMBINE Programme of HELCOM.

Weather conditions

The weather situation was mainly characterized by high air pressure of over 1017 hPa. Only during the first two days of the cruise and after the 27.7.2014, air pressure decreased from 1017 hPa to 1012 hPa. This decrease was accompanied during the first two days by cloudy conditions and increase of the wind speed up to 17 m/s during the night from the 20.7. to the 21.7.2014. Because of this wind and high waves we interrupted our transect in the Arkona Sea on station TFO069, moved to station OB in the Pomeranian Bight and continued with the short "Ystad transect" towards station TFO113. After the 21.7.2014, with air pressure between 1017 and 1022 hPa, wind speed decreased to < 11 m/s and it became sunny and warm. Wind direction was east to north-east until the 26 July and changed to different directions on 27 July when the wind calmed further down to below 7 m/s. Rain occurred in the night from 26 July to 27 July.

Water temperature and salinity

The shallow Kiel Bight and Mecklenburg Bight are characterized by shallow pycnoclines, with strong salinity and temperature gradients below 5 to 9 m. In the deepest (45 m) parts of the Arkona Sea (e.g. stat. TFO104, TFO105, TFO113), the thermocline and halocline are starting at depths of 15 and 42 m, respectively. It is known that the depth of the halocline decreases with the depth of the Baltic basins. It started in the western part of the Bornholm Basin at a depth of 50 m, in the Stolpe Channel (stat. TFO222) at 55 m and in the Eastern Gotland Basin at 60-70 m depth (Fig. 5). As in previous reports, data of surface temperature and salinity are compiled in Table 1.

The surface water temperatures (0-10 m; °C) of selected stations of this cruise are compared with early long-term mean values (1971-1990, station numbers in brackets) collected during our summer cruises (end of July-beginning of August) in the 1970s and 1980s and in the last 4 years in the table below. They reflect that the summer 2014 was still warmer than the warm summer 2013 due to strong sunshine before and during the cruise and the formation of a warm surface layer above a secondary thermocline.

Area:	2014	2013	2012	2011:	2010:	1971-1990:	
Mecklenburg Bight (stat. TFO012)	18.8	17.3	17.2	19.0	17.7		
Arkona Sea (stat. TFO113)	19.4	19.4	19.1	17.3	22.6	17.0	
Bornholm Sea (stat. TFO213)	19.4	20.3	18,4	18.5	18.4	17.6	
Eastern Gotland Sea (stat. TFO271)	19.8	19.4	16.9	19.1	22.0	17.1	
Farö Deep (stat. TFO286)	20.4	18.9	17.1	19.4	20.9	17.7	
Landsort Deep (stat. TFO284)		21.8	19.0	15.9	17.9	19.4	18.2
Karlsö Deep (stat. TFO245)	21.9	20.4	17.7	17.3	20.9	16.9	

A better indicator for long-term temperature trends is the deep water as it is not influenced by short-term changes of the weather situation but integrates over longer periods. The long-term trend of water temperature [°C] in the deep water layers in the western and northern deeps is shown in the following table. The temperatures declined since 2010, but nevertheless recent deep-water temperatures are still higher than the mean values of the 1970s and 1980s in the deepest basins.

	July <u>2014</u>	Aug. <u>2013</u>	July <u>2012</u>	July <u>2010</u>	July <u>2007</u>	July <u>2005</u>	July <u>2003</u>	Mean <u>1971-1990</u>
Bornholm Deep	5.9	4.9	6.6	7.5	8.8	7.0	3.7	6.1
Gotland Deep	6.0	6.4	6.4	6.4	6.8	6.0	4.6	5.6
Farö Deep	5.9	5.9	6.2	6.8	6.1	6.0	6.0	5.2
Landsort Deep	5.2	5.4	5.4	6.1	5.7	5.8	5.9	4.8
Karlsö Deep	5.0	5.2	5.3	5.5	5.1	5.3	4.9	4.2

Oxygen

The oxygen minimum in Kiel Bight and Mecklenburg Bight can be found above the bottom with minimum concentrations of almost 5 ml O₂/l and about 3 ml O₂/l, respectively. In the deep central parts of the Arkona Sea (e.g. stat. TFO104, TFO105, TFO113), oxygen minima of less than 1 ml O₂/l occurred above the bottom. In the shallower (29 m) part south-east of this area, at stations TFO121 and TFO152, oxygen concentrations near the bottom are still higher (4 ml O₂/l). The deep exit from the Arkona Sea to the Bornholm Basin (Bornholmgat; stat. TFO145, TFO144, TFO142, TFO140) has relatively high oxygen concentrations near the bottom (1.5 – 4 ml O₂/l).

The Bornholm Basin, which was anoxic in the deepest layers in 2011, recovered after some smaller inflows of oxygenated deep water. Oxygen concentrations in the deep water were 3.46 ml O₂/l in May 2014, but have decreased to 1.58 ml O₂/l during our cruise (Table 2, Fig. 4).

In the south-eastern Gotland Basin (Stat. TFO259), even 4.1 ml O₂/l were recorded in May 2014, whereas oxygen concentrations decreased to 3.3 ml O₂/l (Table 2). However, at stations TFO259 and TFO255, a narrow oxygen intrusion with about 6 ml O₂/l was noticed within the halocline from 80-82 m depth. Intrusions of oxygenated water with about 3 ml O₂/l extended from 88 m to the bottom at station TFO253, from 102 m to the bottom (2.5 ml O₂/l) at station TFO250 and from 120 m to the bottom with up to 1.8 ml O₂/l at station TFO263. This is an indication of a deep water inflow reaching up to this station. Only at stations TFO260 and TFO272, hydrogen sulphide was found in the water layers below about 120 m depth down to the bottom. A similar situation occurred at station TFO271 in the morning of the 24 July 2014. However, oxygenated water reached this station in the course of the day in a cooler layer between 197 and 200 m depth and at the bottom below 227m depth. These layers increased in width and oxygen concentration during the night, reaching oxygen maxima of 1.3 ml O₂/l at 194 m depth in the morning of the 25 July. A repetition of the CTD cast on the 27 July showed a completely oxygenated water column below 200 m depth with maxima at the bottom of 0.5 ml O₂/l. This inflow was also indicated by a decrease in deep water temperature from 6.02 °C (Table 2) to 5.69 °C and an increase in salinity from 12.25 to 12.30 within three days. Such far-reaching inflows are rare and this is probably the largest after that of 2003.

At the stations north of the Gotland Deep (Stat. Tfo270, Tfo286), oxygen concentrations were zero below a depth of approximately 120 m. At stations Tfo285, Tfo284 and Tfo240, oxygen concentrations were zero even below 85 m and at station Tfo245 below 80m depth. Hydrogen sulphide concentrations increased further in the Farö Deep, Landsort Deep and Karlsö Deep in comparison with the previous summer cruise. The oxygen concentrations in the bottom layer of the basins can be looked up in Table 2. An oxygen demand is expressed by negative oxygen data.

Nutrients

The nutrient data of surface water and bottom-near water of selected stations are compiled in Tables 1 and 2. The relatively high phosphate concentrations in the surface water of the Bornholm Basin and south-eastern Gotland Basin may indicate that a cyanobacteria bloom has still not occurred in this area. After an inflow event, nutrient data in the deep water layers are of special interest as the introduced oxygen oxidises the ammonium and binds the phosphorus. Indeed, the phosphate concentrations decreased in the Bornholm Deep and the Gotland Deep in comparison with data from May 2014.

Biological data

Samples for phyto- and zooplankton were collected for later analysis in the laboratory. Therefore, data cannot be presented yet. However, visual observations allowed statements on the state of cyanobacteria blooms. A small bloom of cyanobacteria, drifting at the surface, was already noticed on front of Warnemünde. In the western Mecklenburg Bight, cyanobacteria were suspended in the water but not floating at the surface. Kiel Bight was free of cyanobacteria. In the Arkona Basin, Bornholm Basin and south-eastern Gotland Basin, no blooms occurred, but at some places cyanobacteria were suspended in the water (stat. Tfo030, Tfo112). Starting from station Tfo271, lots of cyanobacteria aggregates were clearly visible in the water. Large fields of surface accumulations were present between stations Tfo270 and Tfo286. During the further cruise track down to the Bornholm Sea, cyanobacteria were still there but not in these dense surface accumulations.

Appendix

- Tables 1& 2: Preliminary results for selected parameters in the surface layer and the near-bottom layer (unvalidated results)
- Figs. 1-3: Station grid (total grid and two sub-maps)
- Fig. 4: Oxygen /hydrogen sulphide concentrations in the near-bottom layer for selected stations
- Fig. 5: Transsect from the Kiel Bight to the Farö Deep for temperature, salinity and oxygen (unvalidated data)

Dr. Norbert Wasmund
Scientist in charge

Table 1: Surface layer (0 - 10m)

Area	Station	Temperature	Salinity	PO ₄ ³⁻	NO ₂₃ ^{-*}
Date	Name/ No. **	°C	PSU	μmol/dm ³	μmol/dm ³
Kiel Bight 19.7.2014	TF0360/ 005	20.58	13.46	0.03	0.91
Meckl. Bight 20.7.2014	TF0012/ 007	18.85	10.86	0.00	0.63
Lübeck Bight 20.7.2014	TF0022/ 006	20.19	12.93	0.00	0.85
Arkona Basin 21.7.2014	TF0113/ 024	19.38	7.72	0.01	0.04
Bornholm Deep 22.7.2014	TF0213/ 037	19.43	4.42	0.22	0.85
Stolpe Channel 23.7.2014	TF0222/ 039	19.26	7.35	0.24	0.92
SE Gotland Basin 23.7.2014	TF0259/ 041	19.82	7.11	0.22	0.14
Gotland Deep 24.7.2014	TF0271/ 048) ^a	19.85	6.68	0.03	0.09
Fårö Deep 25.7.2014	TF0286/ 050	20.42	6.61	0.03	0.00
Landsort Deep 26.7.2014	TF0284/ 052	21.80	6.70	0.14	0.11
Karlsö Deep 26.7.2014	TF0245/ 054	21.91	7.07	0.18	0.50

* $\Sigma \text{NO}_2^- + \text{NO}_3^-$; NO₂ was present only in traces in most areas under investigation

** Station name see maps (Fig. 1 - 3)

)^a This was the first cast at that station

Table 2: Bottom-near water layer

Area	Station	Sampl. Depth	Temp.	Salinity	O ₂	PO ₄ ³⁻	NO ₂₃ ⁻ *
Date	Name/ No. **	m	°C	PSU	cm ³ /dm ³	µmol/dm ³	µmol/dm ³
Kiel Bight 19.7.2014	TF0360/ 005	17	13.56	20.10	4.95	0.09	0.71
Meckl. Bight 20.7.2014	TF0012/ 007	23	11.35	25.20	2.83	0.69	1.61
Lübeck Bight 20.7.2014	TF0022/ 006	22	10.64	21.64	1.52	0.76	0.71
Arkona Basin 21.7.2014	TF0113/ 024	45	8.89	16.58	0,26	1.23	7.55
Bornholm Deep 22.7.2014	TF0213/ 037	87	5.92	16.63	1.58	1.17	11.24
Stolpe Channel 23.7.2014	TF0222/ 039	88	6.16	14.51	2.03	1.54	6.49
SE Gotland Basin 23.7.2014	TF0259/ 041	86	5.72	12.46	3.34	1.38	5.32
Gotland Deep 24.7.2014	TF0271/ 048) ^a	232	6.02	12.25	0.37	2.51	0.00
Fårö Deep 25.7.2014	TF0286/ 050	187	5.87	11.58	-5.33	4.30	0.00
Landsort Deep 26.7.2014	TF0284/ 052	433	5.19	10.41	-3.29	3.25	0.00
Karlsö Deep 26.7.2014	TF0245/ 054	106	5.00	9.58	-2.44	3.05	0.00

* $\Sigma \text{NO}_2^- + \text{NO}_3^-$; NO₂ was present only in traces in most areas under investigation

** Station name see maps (Fig. 1 - 3)

)^a This was the first cast at that station

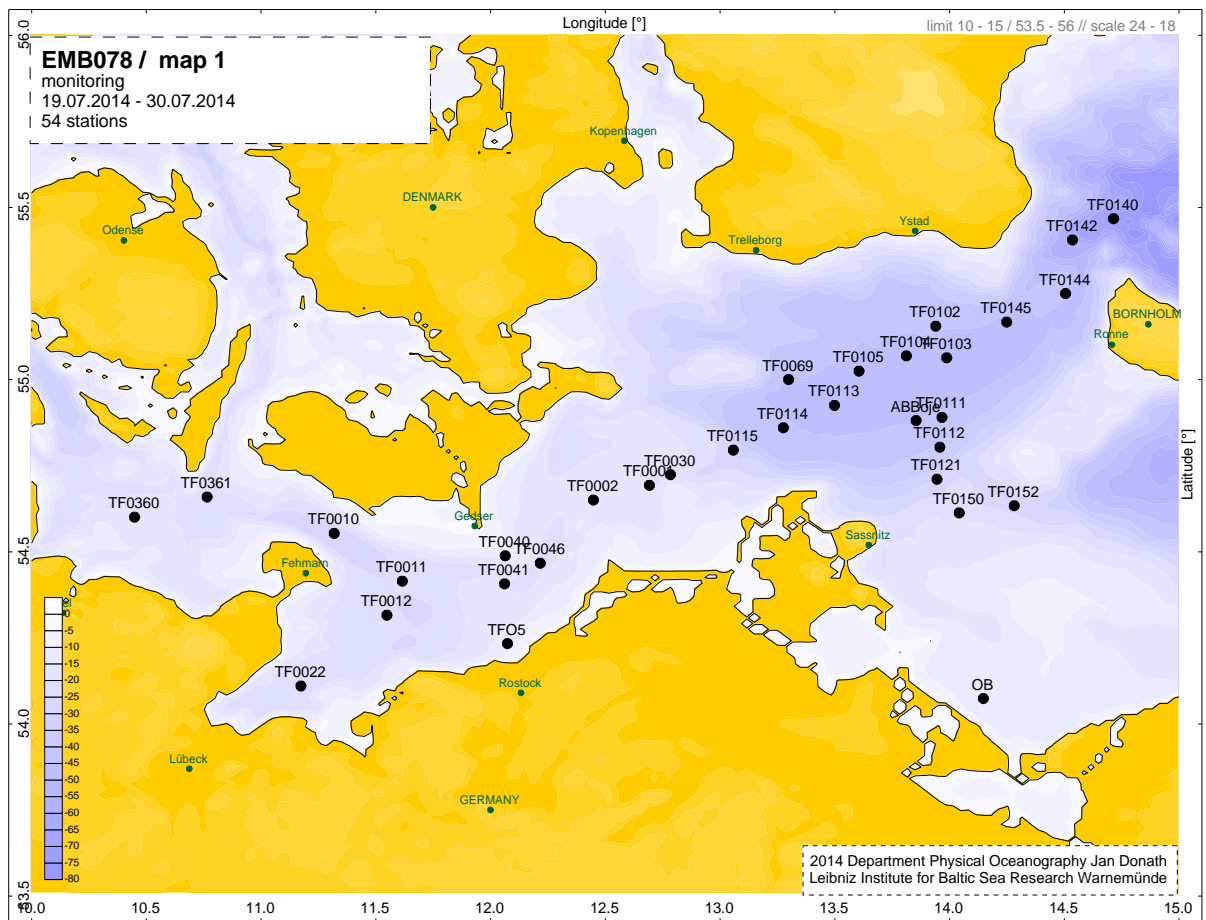
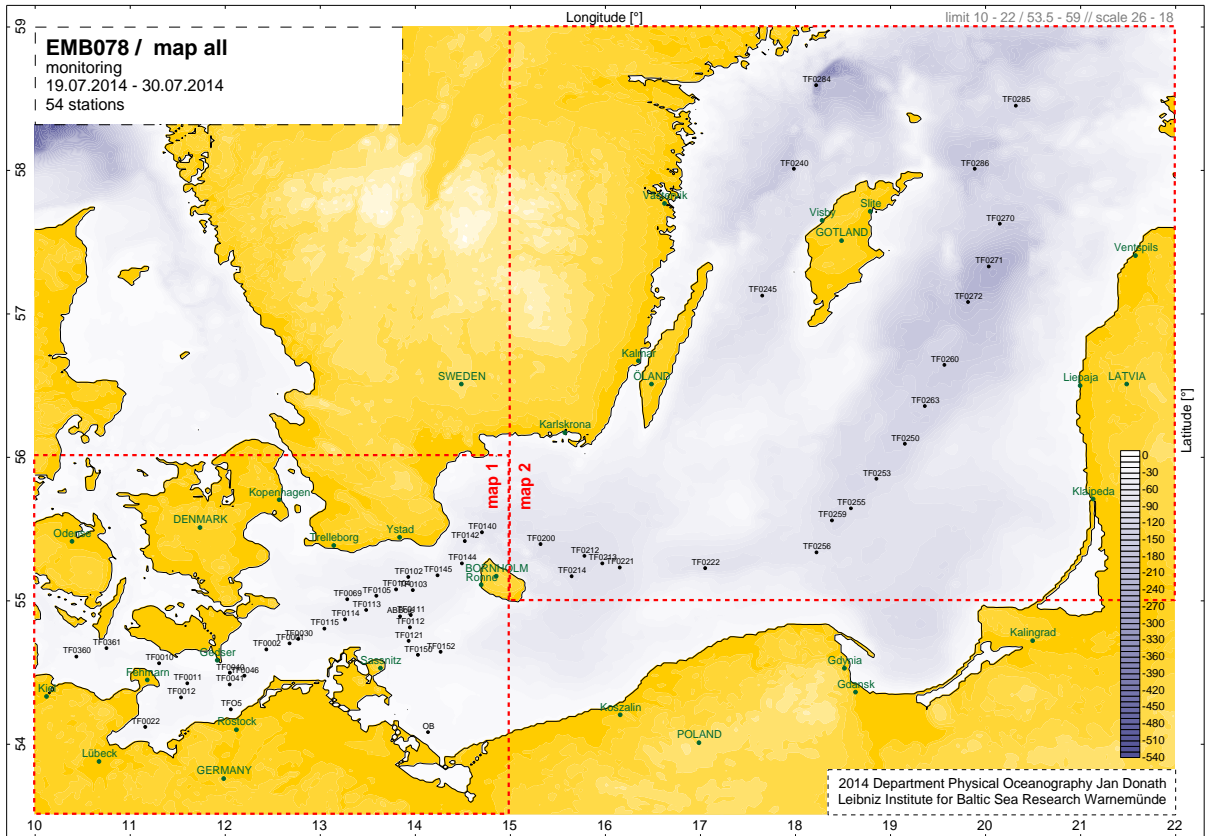


Fig.1 and 2: Total station map and detailed map of the western Baltic Sea .

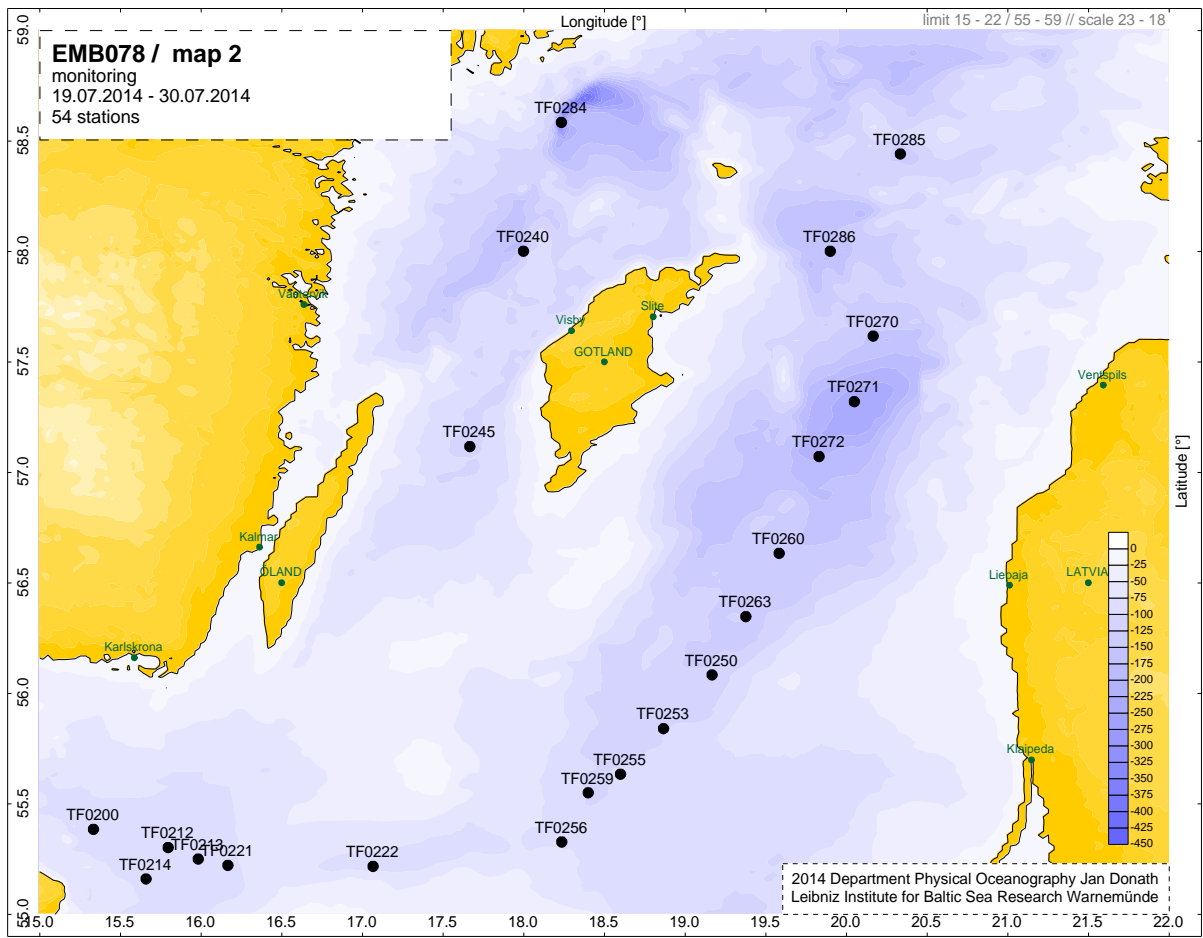


Fig. 3: Map of monitoring stations in the Baltic Proper.

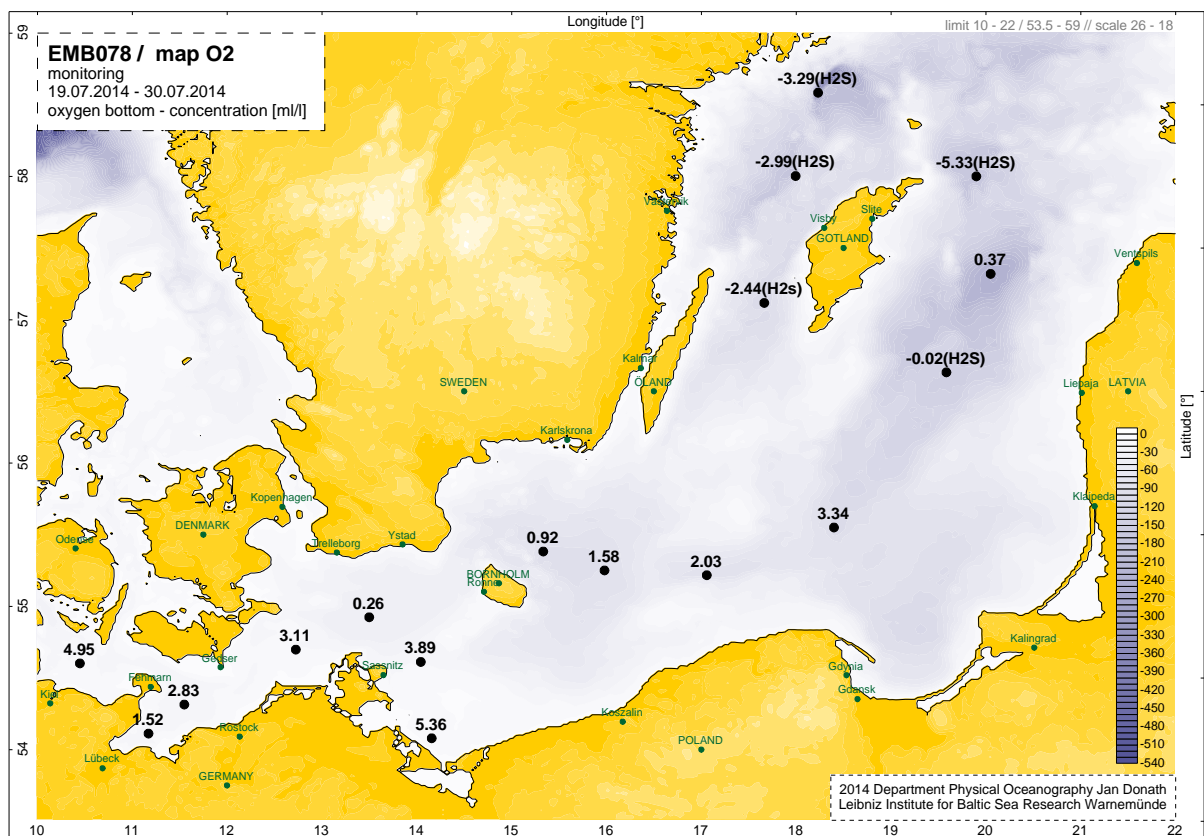


Fig. 4: Oxygen/hydrogen sulphide concentrations in the near-bottom layer (selected stations)

Monitoring EMB078

Kiel Bight - Gotland Sea
19.07.2014 09:59 - 25.07.2014 20:05 UTC

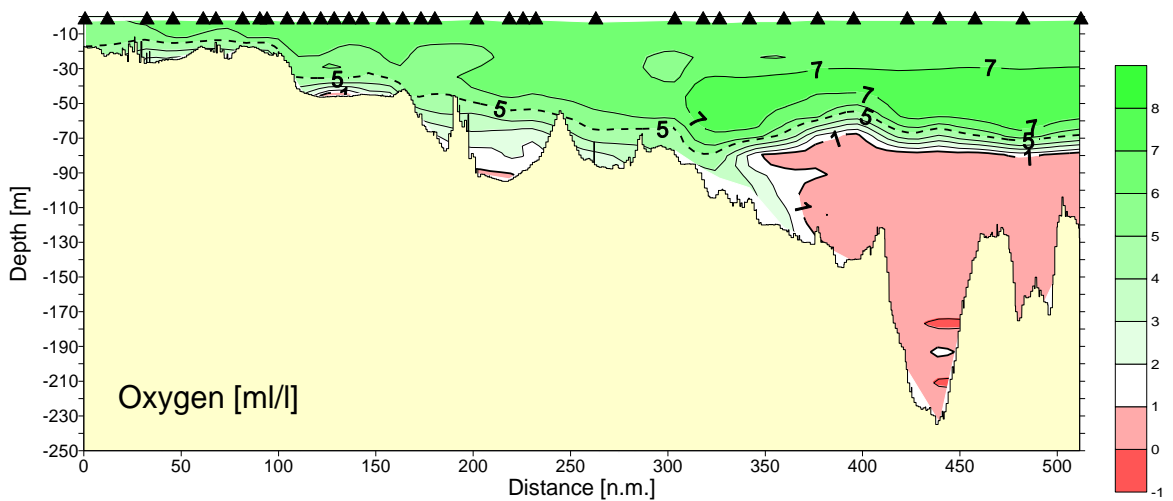
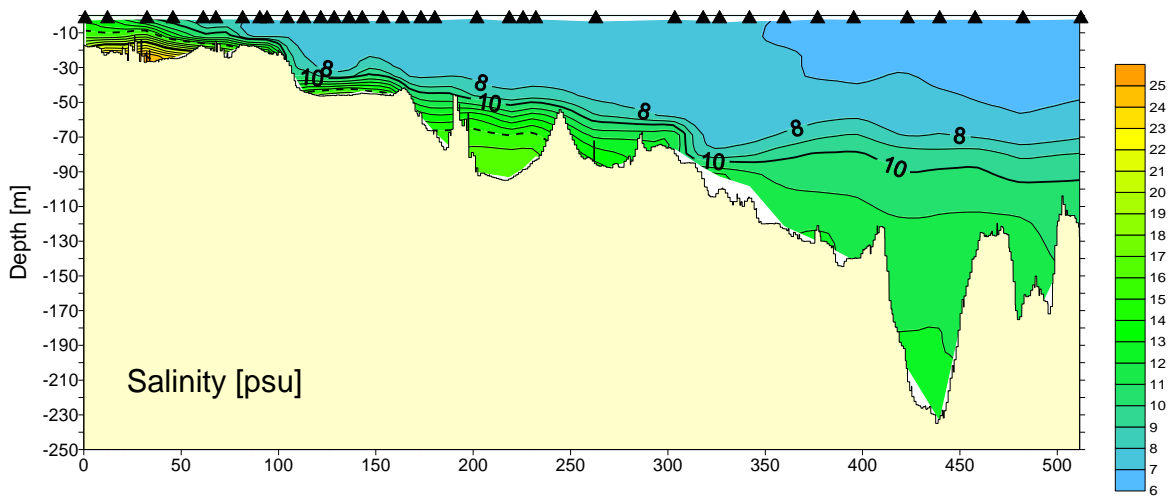
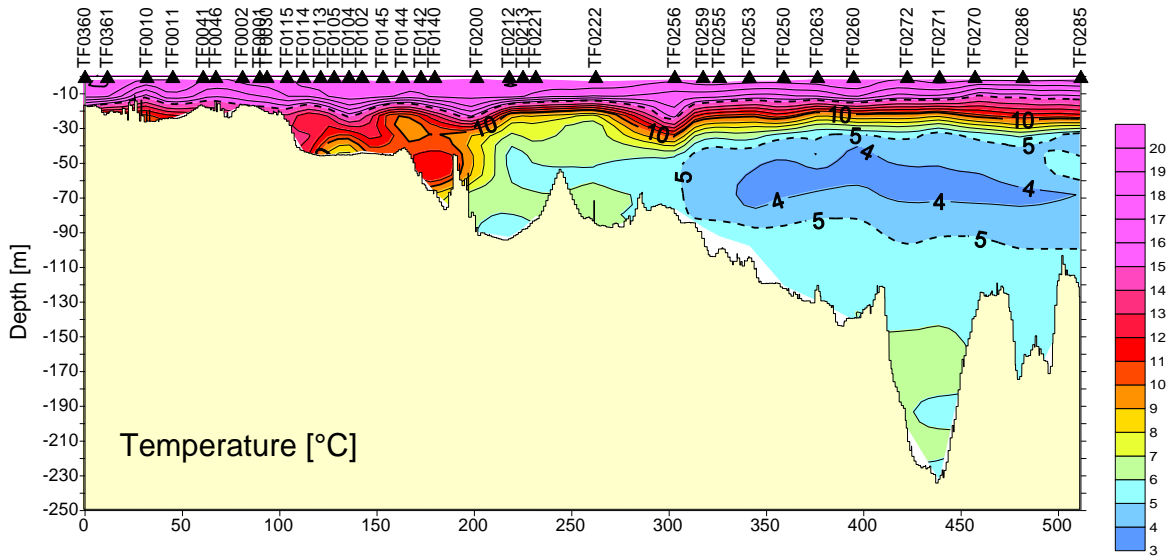


Fig. 5: Transect from the Kiel Bight to the Farø Deep for temperature, salinity and oxygen.