

# **Baltic Sea Research Institute Warnemünde**

## **C r u i s e R e p o r t**

r/v "ALKOR"

Cruise- No. AK06 / 07 / 03

Monitoring Cruise  
26 October – 03 November 2007  
Kiel Bight to northern Gotland Sea

This report is based on preliminary data

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1. **Cruise No.:** AK06 / 07 / 03
2. **Dates of the cruise:** from 26 October to 03 November 2007
3. **Particulars of the research vessel:**
  - Name: "ALKOR"
  - Nationality: Germany
  - Operating Authority: IfM Geomar Kiel
4. **Geographical area in which ship has operated:**  
Kiel Bight to Northern Gotland Sea
5. **Dates and names of ports of call**  
none
6. **Purpose of the cruise**  
Baltic monitoring in the frame of the COMBINE Programme of HELCOM
7. **Crew:**
  - Name of master: Lass
  - Number of crew: 11
8. **Research staff:**
  - Chief scientist: Dr. M. Schmidt
  
  - Participants:
    - Glockzin, Ines
    - Sadkowiak, Birgit
    - Heene, Toralf
    - Hehl, Uwe
    - Lehnert, Gerhard
    - Dankert, Jutta
    - Weinreben, Stefan
    - Hand, Ines
9. **Co-operating institutions:**  
All institutions dealing with HELCOM monitoring programmes.
10. **Scientific equipment**
  - CTD SBE 911+ with Dr. Haard Fluorometer
  - Autosal 8400B,
  - SBE 35 Deep Sea Thermometer
  - rosette with water samplers
  - plankton nets WP2, filtration set
  - van Veen grab, dredge
  - autoanalyser, 716 DMS Titrino, DMA 5000
  - ships weather station

## 11. General remarks and preliminary results

The area of investigation covers the Baltic Sea from Kiel Bight to northern Gotland Sea, (see the attached station maps). The meteorological, hydrographical, chemical and biological investigations were performed according to the COMBINE Programme of HELCOM. Quality control of the hydrographic data was guaranteed by daily comparison measurements. 62 hydrographic stations were worked. Each station started with a CTD cast measuring pressure, temperature, conductivity (salinity), oxygen concentration, fluorescence, phycoerythrin and turbidity, at most stations combined with water sampling for oxygen and nutrient determination. At the first 4 stations fluorometer data are invalid because of an instrument malfunction, after station 5 (TF0010) data from a replacement instrument are reasonable.

At several stations plankton was sampled with WP2 nets, sample depth are chosen according to the measured temperature and salinity profiles. Chlorophyll-a samples are filtrated and frozen, other phytoplankton samples are conserved with Lugol. To estimate abundance and size distribution of the Jellyfish *Mnemiopsis leidyi* additional hauls were carried out with the WP2 net.

To investigate the density anomaly of Baltic seawater, density was estimated of samples from different stations with help of a density meter DMA 5000 to be compared with the density calculated from the equation of state of seawater from temperature and salinity, measured with a salinometer AUTOSAL 8400 B. Samples were taken from the surface and from 50 m depth.

Near station TF0271 the moored sediment trap in combination with an oxygen sensor and a current meter was recovered and deployed again.

Comparing underway measurements with the thermosalinograph with CTD surface data the instrument output revealed as irrelevant. After cleaning the device and de-aerating the instrument tank in the evening of 28<sup>th</sup> October the results are reasonable with an accuracy of +/- 0.05 degrees for temperature and +/- 0.04 for salinity. Both temperature and salinity show a significant offset and drift and the instrument needs attendance.

The cruise started with moderate winds under the influence of high pressure areas over the Gulf of Biskaya and Russia. Air temperature was below sea surface temperature favouring convective mixing. Accordingly, the seasonal thermocline was already dissolved in the area of investigation. In the evening of 28<sup>th</sup> of October wind turned to south-west and a front belonging to a strong cyclone over northern Scandinavia passed through. Strong winds stirred the thermally instable surface layer down to the halocline. Due to the high sea state the large CTD could not be handled safely and a CTD with a smaller rosette with sampler had to be used instead. This way, most hydrographic stations could be worked. Only stations TF0284 and TF0240 could not be reached because of the ships low speed against waves with more then 2 m height. The remaining stations as well as the repeated stations in the Bornholm Sea and in the western Baltic could be worked safely under the calm conditions in the intermediate height pressure area before the next storm started at 3<sup>th</sup> of November.

**West of Darß Sill, in the Lübeck Bight (TF0022) and the entrance to Kiel Bight (TF0360)** the surface water is well mixed, its temperature is horizontally uniform about 11°C. The cruise started after a long outflow period with falling average sea level (Landsort). Accordingly, surface water stems from outflowing Arkona Sea water and salinity is very low from 15 to 8.3 between Kiel Bight and Darß Sill. There is a bottom layer with enhanced temperature and salinity. In the Mecklenburg Bight it is about 5 m thick but it vanishes near Darß Sill. Bottom water salinity is also low between 17.9 to 8.5, which indicates, that outflowing water governs also the bottom waters in the western Baltic Sea. Bottom water oxygen concentration is below 5 ml/l. The minimum is found in the Lübeck Bight at TF0022 and also at TF0361 with about 3 ml/l. Bottom nitrate (phosphate) concentration is elevated here to about 6 µmol/l (1.5 µmol/l) at TF0022 and 9.8 µmol/l (2.4 µmol/l) at TF0361 respectively.

**East of Darß Sill** surface salinity is uniformly below 8. In the **Arkona Basin** surface layer thickness amounts about 32 m. Bottom water is warmer and more saline, temperature is partly above 14°C but bottom water salinity rarely exceeds 15. Patches of water with oxygen concentration less than 2 ml/l indicate, that this water originates from warm summer inflow and stagnates over the sediment. The intermediate layer of Bornholm Sea winter water found in November 2006 at stations TF0144, TF0145 and TF0140 is missing. Remarkably, in the bottom water at station TF0140 hydrogen sulphide is found. At stations shallower than 30 m (TF0150, TF0152, TFO11) the water body is uniform with salinity about 8, temperature about 11 °C and oxygen concentration 7 ml/l. An exception is station TF0160. Here salinity in the upper 6 m is slightly reduced and stratification is stable. The less saline water body carries twice the chlorophyll (fluorescence) as in the ambient waters, here also the highest values of phycoerythrin concentration are found during this cruise.

In **Bornholm Sea** the typical main water bodies are found, i) a well mixed about 37 m thick surface layer with a temperature of 11 °C and salinity of 7.5, ii) a cold winter water layer with temperature of 6.6 °C and salinity of 8, iii) intrusions of warm more saline water, which lift up the winter water, iv) a slightly colder bottom layer with maximum salinity of 16.1. Compared with the monitoring cruise from November 2006 winter water temperature is enhanced (a consequence of the warm winter 2006-2007?) and bottom salinity is slightly reduced. Oxygen content in the bottom layer below 70 m is lower than 1 ml/l. Bottom water at station TF0213 is anoxic, inorganic nitrogen present as ammonium amounts 9.24 µmol/l, whereas in the oxic water five meters above ammonium concentration is low but about the same amount of nitrate/nitrite is found. Phosphate concentration is about 6 µmol/l at the bottom, but is much smaller in the water mass above.

In **Stolpe Channel** the well mixed surface layer has salinity of 7.5. Its thickness amounts 45 m and because of the larger heat capacity the surface layer it is still warmer than in the Bornholm Basin. Through **Stolpe Channel** and **Eastern Gotland Sea**, from station TF0258 to TF0250 the bottom water contains oxygen, which reveals some permanent but weak eastward near bottom transport through Stolpe Channel.

In the central **Gotland Sea**, i.e. in the **Gotland Deep** and **Farö Deep** area surface temperature is not horizontally uniform but varies around 11°C with the thickness of the surface layer. Surface salinity amounts from 7.3 at TF0259 to 6.7 at Farö Deep. Remarkably the winter water is about 2 degrees warmer than 2006. At station TF0271 minimum temperature in the winter water is about 4.6°C in 65 m depth. In the winter water layer a pool with nitrite/nitrate of more than 6.7 µmol/l and phosphate of 2.0 µmol/l is found. Nitrate concentration is increasing downward to a maximum of 7.35 µmol/l in 112 m depth. Below, the water column is suboxic, the redoxcline is at about 130 m depth. Here both nitrate/nitrite and ammonium concentration is low, which indicates some denitrification. Below the redoxcline, H<sub>2</sub>S is found, nitrate concentration is zero and ammonium and phosphate are increasing to 17 µmol/l and 4.8 µmol/l respectively. Compared with November 2006 temperature and salinity are enhanced in the whole water column, which can be understood as result of several weak warm and saline inflows. However, the concentration of H<sub>2</sub>S in the bottom water is doubled compared with 2006. At station TF0270 H<sub>2</sub>S extended from the bottom to 125 m depth, suboxic water is found below 80 m depth.

At Farö Deep (TF0286) similar conditions are met. H<sub>2</sub>S is already found below 90 m depth, but there is an intrusion of oxic water at depth between 110 to 120 m.

Compared with November 2006 the nutrient pool in the anoxic water is further elevated. The N/P ratio is mostly well below 3.5. Together with the substantially warmer winter water, which makes deep convection more likely, this situation favours high nutrient supply into the surface water and because

of the low N/P ratio it has the potential for pronounced cyanobacteria development during summer 2008.

At **Karlsö Deep** surface temperature is lower than in the Gotland Deep, surface salinity is 6.7 and nitrate concentration is still low. The core of winter water is found at about 55 m depth with temperature of 3.7 °C and nitrate of 4.16 µmol/l. At depth below 80 m the water is suboxic; below 90 m H<sub>2</sub>S is found. This water mass contains no nitrate but ammonium concentration up to 10.48 µmol/l and phosphate concentration of about 4.3 µmol/l. Here the nutrient content in the suboxic and anoxic water is enhanced also compared with November 2006.

In the area from Kiel Bight to the Bornholm Basin (TF0360, TF0012, TF0010, TF0018, TF0030, TF0109, TF0152, TF0160, TF0213) benthos is sampled with a grab and by dredging. At each station three parallel grab samples are taken supplemented by an additional sample for sediment type determination (fine sand, sand with silt and silt). Compared with previous years, nothing special could be noticed. Shallow stations had oxic bottom water and exhibit a wide spectrum of species. Typical species frequently found are *Mytilus edulis*, *Macoma baltica*, *Crangon crangon*, *Arctica islandica*, *Asterias rubens* and *Ophiura albida*. At station TF0213 the bottom water is anoxic and no benthic specimen could be detected.

At several stations (TF0012, TF0046, TF0013, TF0113, TF0213, TF0259, TF0271) also abundance and size distribution of the Jellyfish *Mnemiopsis leidyi* were estimated. A significant gradient in abundance between the western Baltic and the eastern Baltic was found. West of Darß Sill the number of individuals (20 m<sup>-3</sup>) was two orders of magnitude higher than those found east of Darß Sill. Also in the Bornholm Sea and in the central Gotland Sea several individuals were found, but only below the halocline.

## Attachments

- Tables 1and 2: Preliminary results for selected parameters in the surface layer and the near bottom layer (unvalidated results)
- Figs. 1-2: Station grid and cruise track
- Fig. 3: Transect from the Kiel Bight to the northern Gotland Basin for temperature, salinity and oxygen (unvalidated data)
- Fig. 4: Meridional transect from Ystad to Odra Bight for temperature, salinity and oxygen (unvalidated data)
- Fig. 5: Oxygen /hydrogen sulphide concentrations in the bottom near layer for selected stations

Dr. Martin Schmidt  
Scientist in charge

**Table 1: Surface layer (0 - 10m)**

Area	Station	Temp.	Salinity	NO <sub>23</sub> <sup>-</sup> *	NH <sub>4</sub>	PO <sub>4</sub> <sup>3-</sup>	SiO <sub>4</sub>
Date	Name/ No. **	°C		μmol/l	μmol/l	μmol/l	μmol/l
Kiel Bight 27.10.07	TF0360/ 008	11.33	15.04	0.96	0.86	0.64	18.8
Meckl. Bight 26.10.07	TF0012/ 003	10.96	11.18	0.37	0.48	0.49	14.2
Lübeck Bight 26.10.07	TF0022/ 006	11.49	12.60	0.41	NA	0.50	21.9
Arkona Basin 28.10.07	TF0113/ 020	11.21	7.85	0.06	0.23	0.37	10.3
Pom. Bight 28.10.07 (0-6m)	TF0160/ 027	10.55	7.48	0.06	NA	0.37	19.3
Bornholm Deep 29.10.07	TF0213/ 040	11.08	7.23	0.17	0.25	0.31	10.5
Stolpe Channel 29.10.07	TF0222/ 042	12.39	7.46	0.67	NA	0.26	6.0
SE Gotland Basin 30.10.07	TF0259/ 044	11.79	7.27	0.46	0.25	0.25	8.2
Gotland Deep 30.10.07	TF0271/ 051	10.92	7.17	0.24	0.22	0.08	3.0
Fårö Deep 31.10.07	TF0286/ 053	10.27	6.90	0.52	NA	0.06	2.8
Landsort Deep	TF0284/	NA	NA	NA	NA	NA	NA
Karlsö Deep 01.11.07	TF0245/ 055	9.23	6.70	0.16	0.13	0.23	12.9

\*  $\Sigma \text{NO}_2^- + \text{NO}_3^-$ ; NO<sub>2</sub> was present only in traces in most areas under investigation

\*\* Station name see maps (Fig. 1 und 2)

**Table 2: Bottom-near water layer**

Area	Station	Sample Depth	Temp.	Sali- nity	O <sub>2</sub>	NO <sub>23</sub> <sup>-*</sup>	NH <sub>4</sub>	PO <sub>4</sub> <sup>3-</sup>
Date	Name/ No. **	m	°C		ml/l	µmol/l	µmol/l / dm <sup>3</sup>	µmol/l
Kiel Bight 27.10.07	TF0360/ 008	17	12.50	17.54	5.22	0.58	0.46	0.78
Meckl. Bight 36.10.07	TF0012/ 003	21	14.07	15.75	4.12	2.36	1.14	0.97
Lübeck Bight 26.10.07	TF0022/ 006	23	14.10	15.79	2.99	6.38	NA	1.55
Arkona Basin 28.10.07	TF0113/ 020	45	12.19	15.21	5.06	2.75	1.32	0.92
Pom. Bight 28.10.07	TF0160/ 027	14	10.70	7.77	6.91	0.06	NA	0.33
Bornholm Deep 29.10.07	TF0213/ 040	87	8.62	15.92	-1.01	0.00	9.24	6.00
Stolpe Channel 29.10.07	TF0222/ 042	88	7.52	12.99	1.87	8.73	NA	2.00
SE Gotland Basin 30.10.07	TF0259/ 044	86	7.55	11.37	3.14	7.95	0.48	1.60
Gotland Deep 30.10.07	TF0271/ 051	233	6.65	12.79	-4.9	0.00	17.0	4.80
Fårö Deep 31.10.07	TF0286/ 053	189	6.15	12.16	-3.14	0.00	NA	4.35
Landsort Deep	TF0284/	436	NA	NA	NA	NA	NA	NA
Karlsö Deep 01.11.07	TF0245/ 055	106	5.26	10.32	-2.94	0.00	10.48	4.33

\*  $\Sigma \text{NO}_2^- + \text{NO}_3^-$ ; NO<sub>2</sub> was present only in traces in most areas under investigation

\*\* Station name see maps (Fig. 1 und 2)



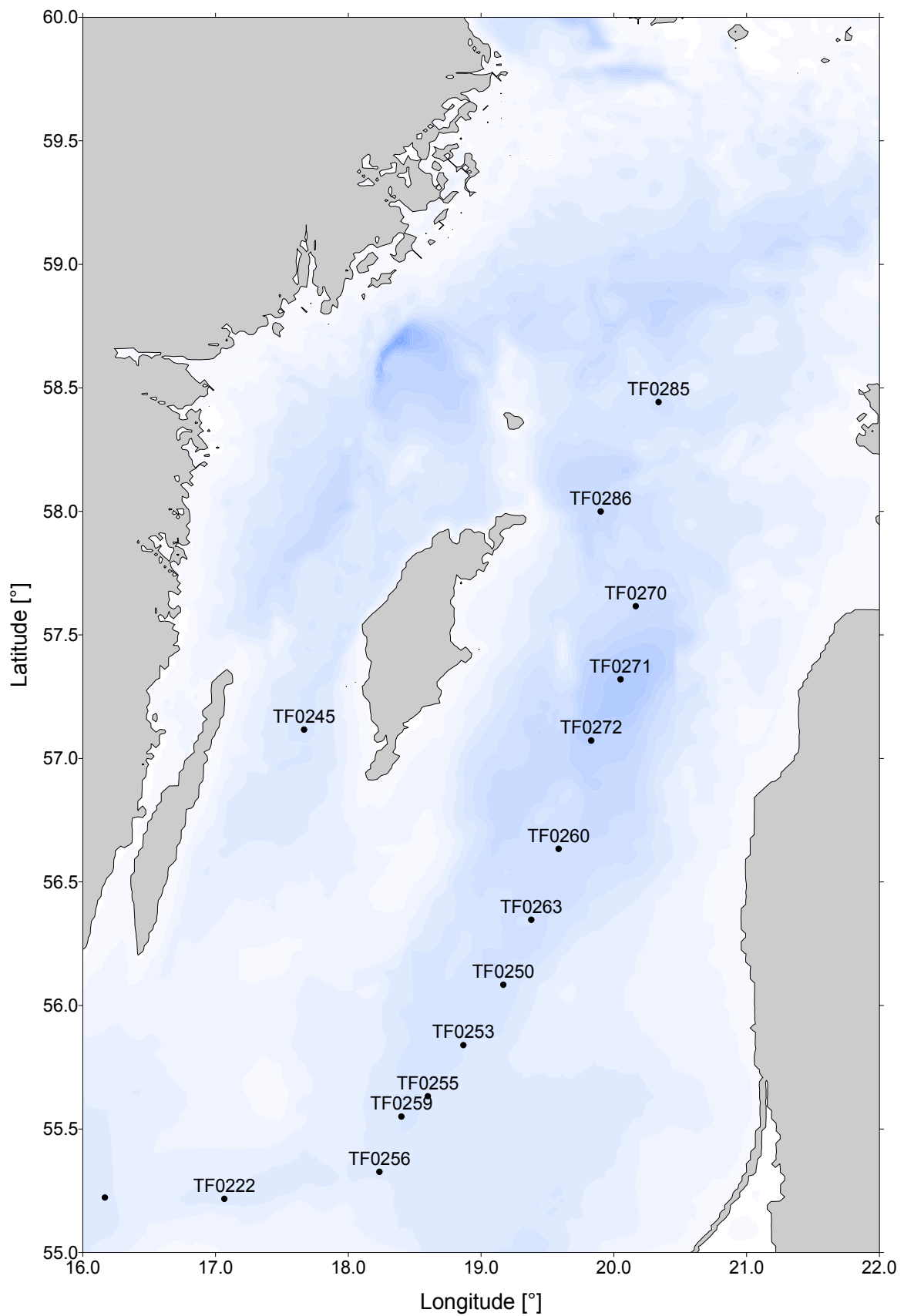


# 07PE0718 monitoring

stationmap

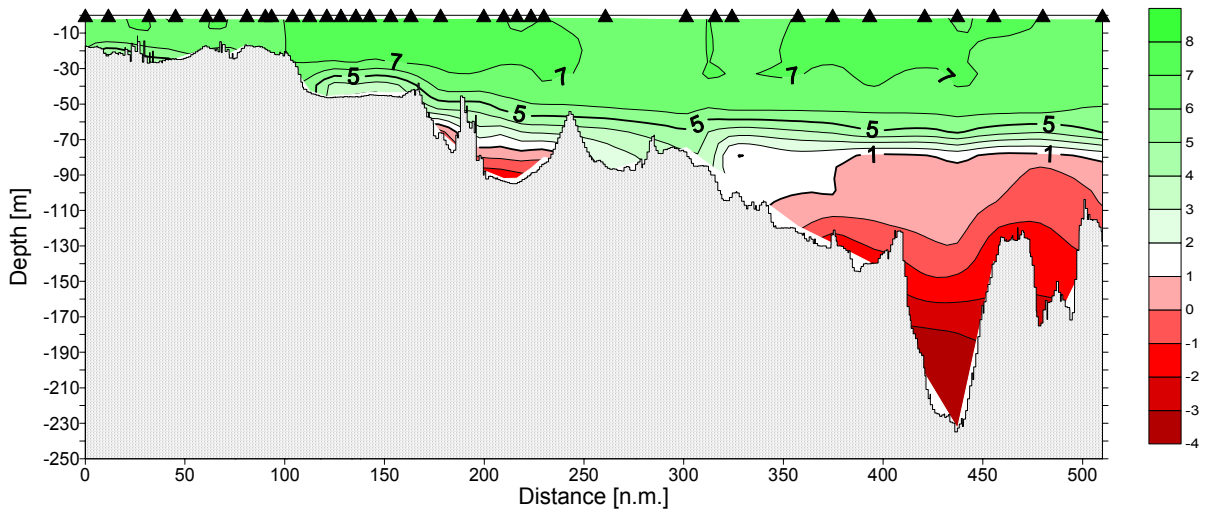
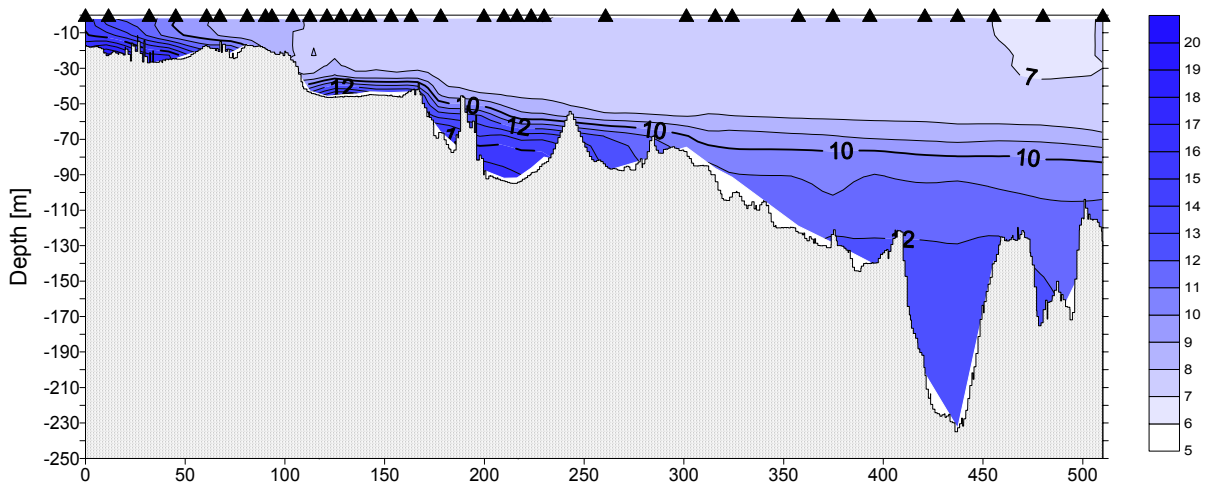
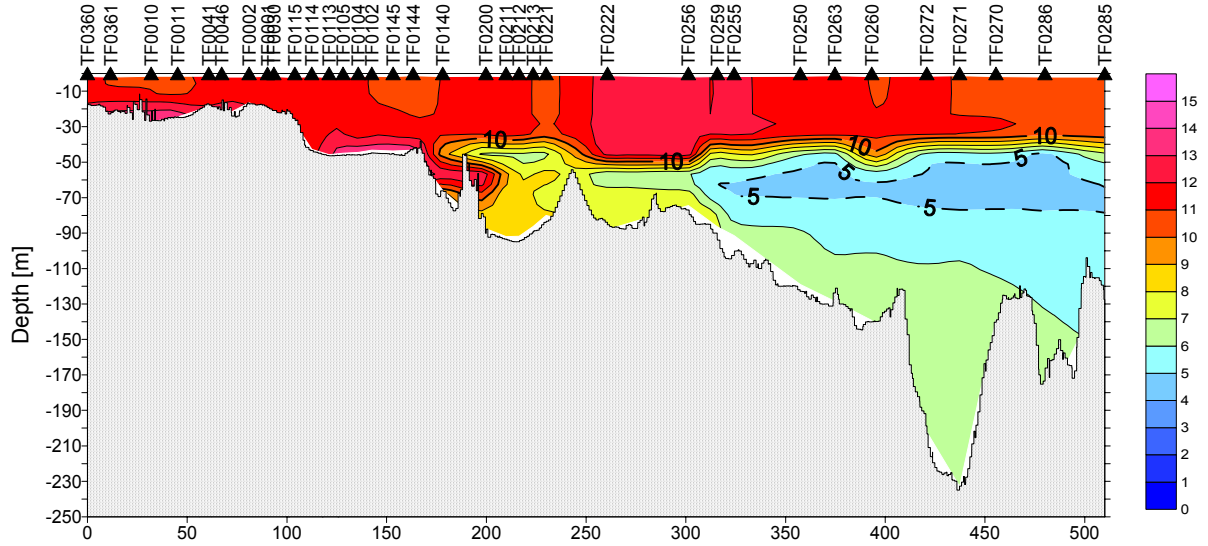
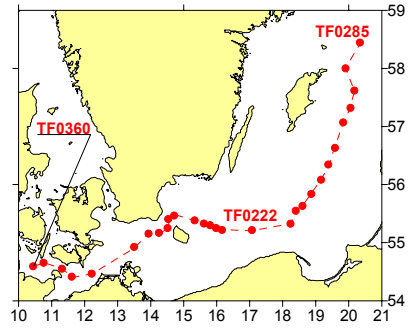
26.10.2007 - 03.11.2007

14 Stationen



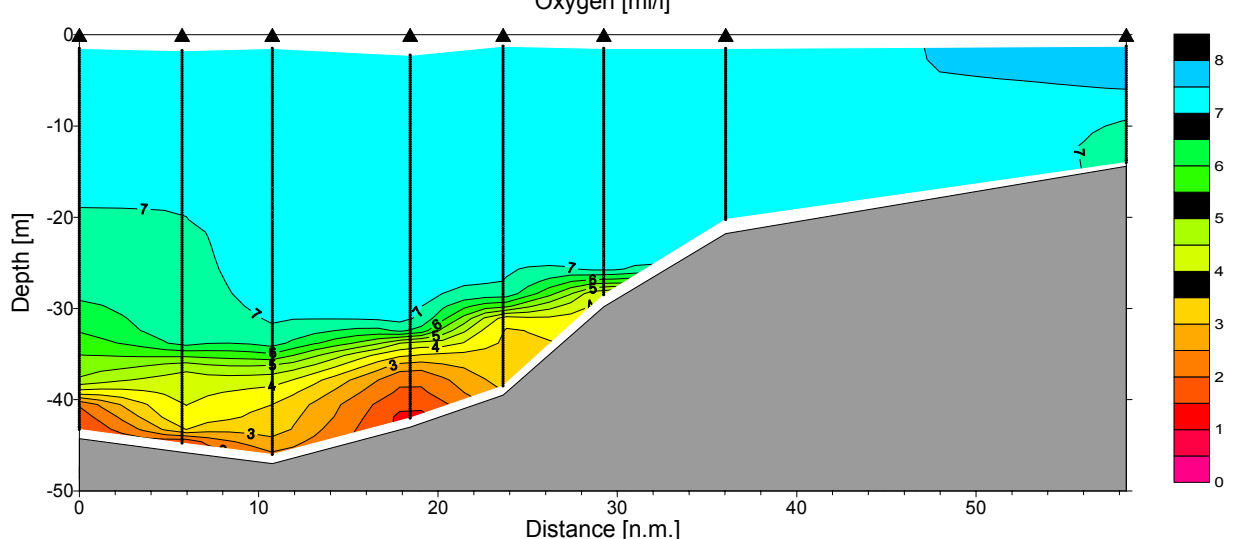
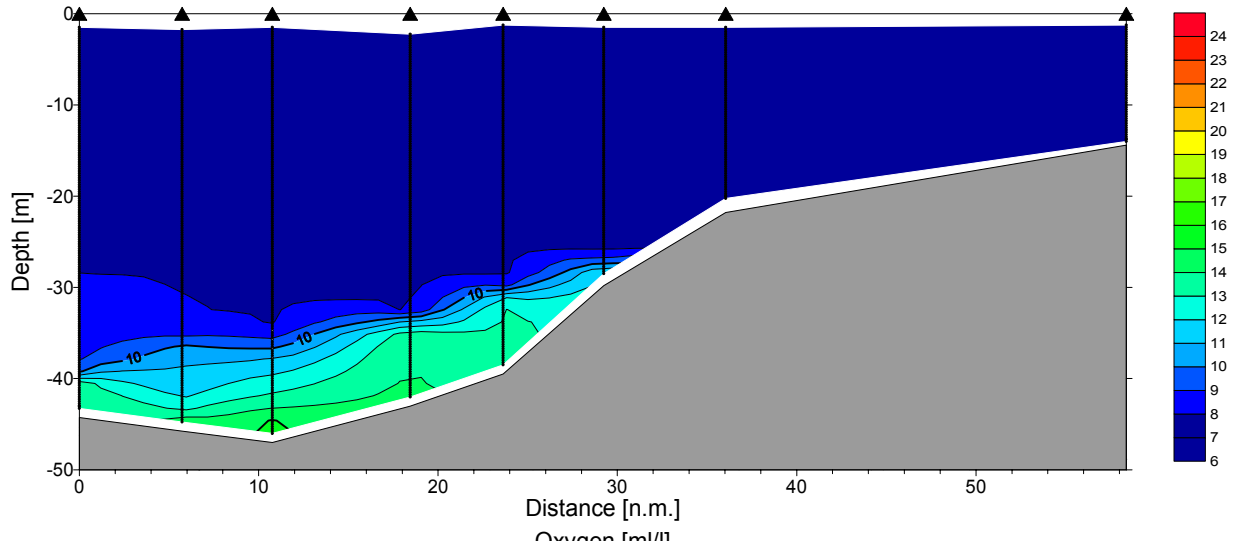
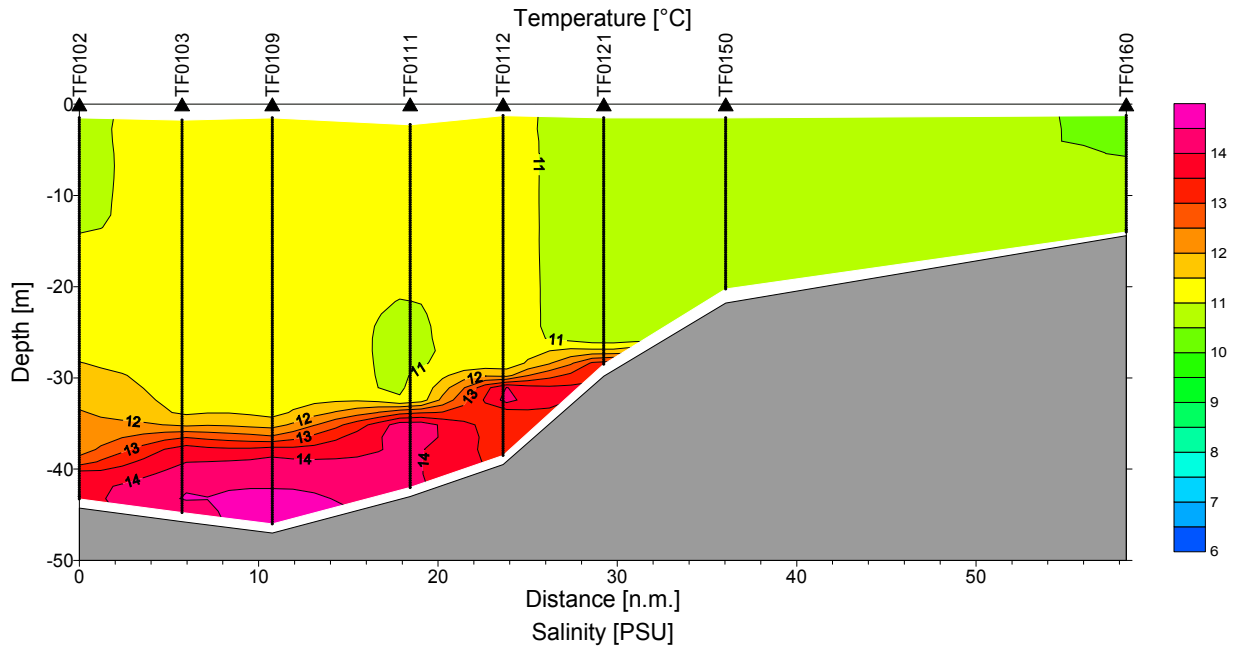
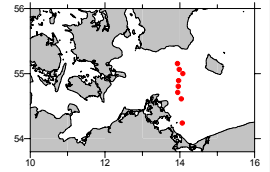
# 06AK0703 monitoring

Kiel Bight - Gotland Sea  
 26.10.2007 12:45 - 31.10.2007 19:52 UTC



# Terminfahrt, AK310

Schnitt 2  
28.10.2007 05:33 - 23:42 UTC



# Monitoring

06AK0703

26.10. - 03.11.2007

oxygen bottom  
concentration [ml/l]

