

Leibniz Institute for Baltic Sea Research Warnemünde

Cruise Report

r/v "Prof. A. Penck"


Cruise- No. 07PE / 08 / 06


27 March – 4 April, 2008

Western and Central Baltic Sea

This report is based on preliminary data

Leibniz-Institut für Ostseeforschung Warnemünde
an der Universität Rostock
Seestraße 15
D-18119 Rostock- Warnemünde
GERMANY

 +49-381-5197-0

 +49-381-5197 440

1. **Cruise No.:** 07PE / 08 / 06
2. **Dates of the cruise:** from 27 March 2008 to 4 April 2008
3. **Particulars of the research vessel:**
Name: Prof. Albrecht Penck
Nationality: Germany
Operating Authority: IOW
4. **Geographical area in which ship has operated:**
western and central Baltic Sea
5. **Dates and names of ports of call**
6. **Purpose of the cruise**
Monitoring cruise in the framework of HELCOM programme
7. **Crew:**
Name of master: U. Scholz
Number of crew: 10
8. **Research staff:**
Chief scientist: Dr. R. Feistel
Scientists: B. Deutsch, C. Gottfried, B. Niesterok
Engineers: K.-P. Wlost
Technicians: J. Donath, S. Busch
9. **Co-operating institutions:**
10. **Scientific equipment**
CTDO bathysonde, plankton net

11. General remarks and preliminary results

The deep water masses formed during and after the 2002/2003 inflow succession are still present in the central Baltic Sea, after having turned mostly to anoxic conditions in the meantime, in particular in the Western Gotland Basin between the Landsort and the Karlsö Deeps. Weak baroclinic and barotropic inflow activity in 2006 and 2007 had temporarily eased the stagnating conditions in particular between the Stolpe Sill and the Eastern Gotland Basin, see the bottom oxygen concentration map, attached. They also warmed up further the deep water in the Eastern Gotland Basin, now showing temperatures between 6.0 °C at 100 m depth and 6.4 °C at the bottom. During the time of this cruise **a minor inflow process could be observed** in the Bornholm Basin (station 213) beneath 80 m depth, coined by temperatures higher than 6 °C and slightly oxic (about 3 ml/l) water properties.

The cruise was carried out under calm to moderate **wind conditions**. A stable blocking situation with a high-pressure cell (core pressure 1030 hPa) over the Balticum/Russia and intense cyclones located in a trough extending from the White Sea to the north-west of Ireland caused permanent southerly winds with 3-6 BF over the central Baltic. From 1 April onward, winds were further calming down to almost windless weather. This situation was responsible for **outflow conditions** from the Baltic to the Kattegat since the Baltic filling level at Landsort gauge was about 40 cm above normal at the beginning of the cruise. In the Fehmarn Belt and at the Darss Sill, strong surface currents were observed from the ship's drift.

During the cruise, the surface water temperatures varied from 4.5 °C in the Kiel Bight to 3.3 °C at Landsort Deep. The morning air temperatures varied between -1 °C at departure from Marienehe and 5 °C in the Gotland Sea, the air pressure ranged from 1003 to 1021 hPa. Clear sky conditions with some fog or haze and cirrus but without dense cloud cover or precipitation were observed all along the cruise.

In the Eastern Gotland Basin, a **mooring** registering current speed and temperature since March 2007 was successfully recovered and deployed again.

Search for the recently immigrated neozoon jelly fish ***Mnemiopsis leidyi*** was almost in vain, only 3 individuals of 0.5 mm size could be caught by net sampling in the Arkona Sea (TF 113).

In the **Kiel and Lübeck Bights** (TF 360 and TF 22), surface salinities of 15.6 and 12.5 psu (Table 1, attached) are fairly high and must be attributed to the local wind and wave

conditions. The SiO_4 concentrations of about $9 \mu\text{mol/l}$ are only about half of the very high values of 2006, when about $16 \mu\text{mol/l}$ were measured. PO_4 concentrations of $0.1 \mu\text{mol/l}$ are comparable to those of 2006. While in the Kiel Bight the nitrate is already exhausted ($0.04 \mu\text{mol/l}$), the Lübeck Bight still shows higher levels ($0.3 \mu\text{mol/l}$). The conditions in the near-bottom layers are similar to those at the surface but with even higher concentrations in the Lübeck Bight. The oxygen supersaturation is insignificant, if at all.

In the **Arkona Basin** (TF 113), the near-bottom layer below 44 m has the highest temperature (4.6°C), salinity (17.7 psu) and lowest oxygen content (4.5 ml/l). This bottom water is colder, saltier and better ventilated than that at the bottom of the Bornholm Deep. The water passing the **Bornholmsgat** (TF 140) at 68 m depth has similar properties (4.6°C , 16.0 psu , 6.9 ml/l) but is better ventilated.

In the **Arkona Basin** (TF 113), the near-bottom water is well oxygenated (6.7 ml/l) and has surface water temperatures (4.5°C). Nutrient concentrations are significantly higher than 2007 near the bottom, but lower in the surface layer.

In the **Bornholm Basin** (TF 213), temperatures are slightly increasing from the surface (6°C) to 50 m depth (6°C). Between 54 m and 65 m, a layer warmer than 8°C with 11.5 psu to 14.7 psu and 3.5 ml/l to 2.0 ml/l oxygen is found with strong thermal fluctuations up to 8.6°C . Below, temperature drops to 7°C at 66 m with 14.7 psu and 2.3 ml/l , rises again above 8°C at 70 m (15.2 psu , 1.5 ml/l) and then decreases below 7°C from 79 m downward, reaching 6.7°C and 16.3 psu , 3.0 ml/l near the bottom.

This indicates an actual outflow process of warm and slightly oxygenated water into the Stolpe Channel, caused by the Bornholm deep water uplift by the colder water interleaving near the bottom. The highly variable properties of the different layers hint on further inflow activity into the Bornholm Deep in the recent past. No traces of H_2S were found.

At the south-western flank of the Bornholm Basin another station (TF 214) was sampled for more details about the apparent inflow. The bottom layer there is thicker (76 to 92 m), colder (6.0°C) and more enriched with oxygen (up to 4.2 ml/l at 81 m). The vertical oxygen minimum with 2.7 ml/l at 75 m is only weakly pronounced. These findings underpin evidence for a currently proceeding inflow into the Bornholm Basin. Nitrate is high at the bottom ($7.7 \mu\text{mol/l}$) and lower at the surface ($1.0 \mu\text{mol/l}$). Phosphate is low at both levels.

In the **Stolpe Channel** (TF 222), from 62 m to 90 m depth, water with 8°C and salinities increasing from 12.4 to 14.4 psu and oxygen decreasing from 3.7 ml/l to 1.9 ml/l has been detected. These properties meet those of the water pushed out of the Bornholm Deep. Low temperatures $< 5^\circ\text{C}$ and high oxygen $> 7.7 \text{ ml/l}$ prevail above 50 m depth.

In the **south-eastern Gotland Basin** (TF 256), an oxygen minimum is found at 66 m (1.2 ml/l), and a maximum 2.8 ml/l at the bottom. Oxic conditions are encountered even though less pronounced than in March 2007. Temperature reaches its maximum near the bottom below 70 m with 7.7 °C, warmer than last year. Apparently an inflowing water layer is detected here. Further downstream (TF 0259), near the bottom still more than 1 ml/l oxygen is found, while at about 80 m there is an oxygen minimum below 0.3 ml/l.

In the **Gotland Basin** (TF 271), the layers beneath 100 m are rather homogeneous with temperatures gradually rising from 6 °C to 6.5 °C, salinity from 10.9 psu to 12.7 psu, and anoxic conditions, up to -6.6 ml/l near the bottom. Between 99 m and 125 m, there are very weak temperature extrema, possibly remnants of earlier interleaving inflows. In this layer, traces of oxygen were found by titration in one sample, otherwise traces of H₂S.

In the **Landsort Deep** (TF 284), the water column is homogeneous from 100 m depth to the bottom (5.3 °C, 10.1 psu to 5.6 °C, 10.9 psu), and anoxic up to -2.7 ml/l.

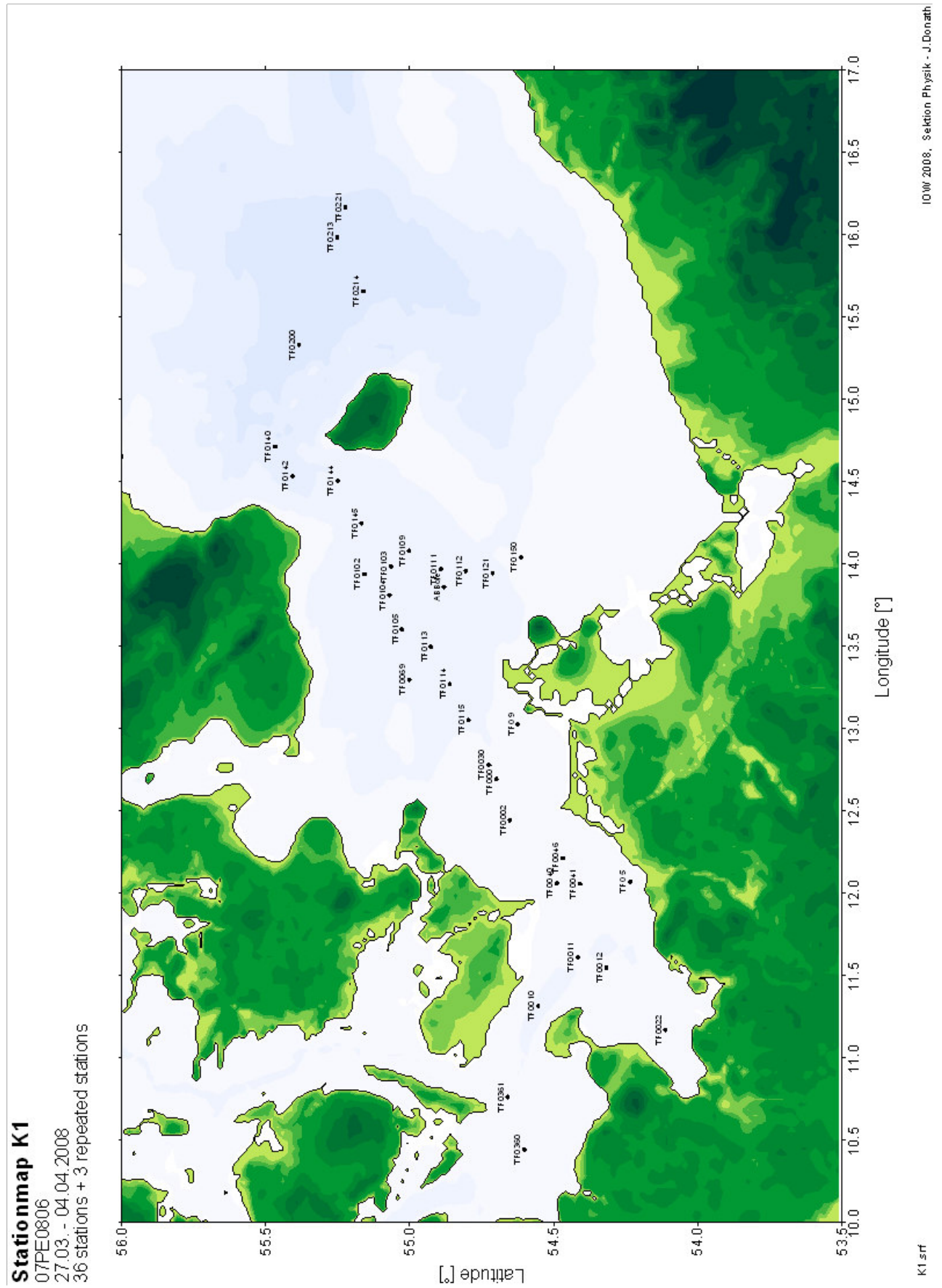
In the **Karlsö Deep** (TF 245), the T-S situation is rather similar below 100 m with 5.1 °C and 9.7 psu. No evidence of recent inflow activity was found, nonetheless, the water is ventilated down to the bottom and nitrate (1 µmol/l) could be found. Strong vertical mixing during the winter convection may be responsible for this unusual and unexpected observation.

Stagnant waters prevail in the deep water of all deeps visited in the northern Baltic Proper, while moderate ventilation is found in all southern basins. This again suggests some inflow activity in the recent past which is still in progress. Compared to 2007, the near-bottom H₂S concentrations have significantly increased in the Gotland, Farö and Landsort Deep. Weak ventilation found in the Karlsö Deep is likely by vertical transport from the winterly lowered pycnocline, rather than by lateral advection. A fairly good ventilation was measured between the Arkona Sea and station 259 north of Hel.

Rainer Feistel
scientist in charge

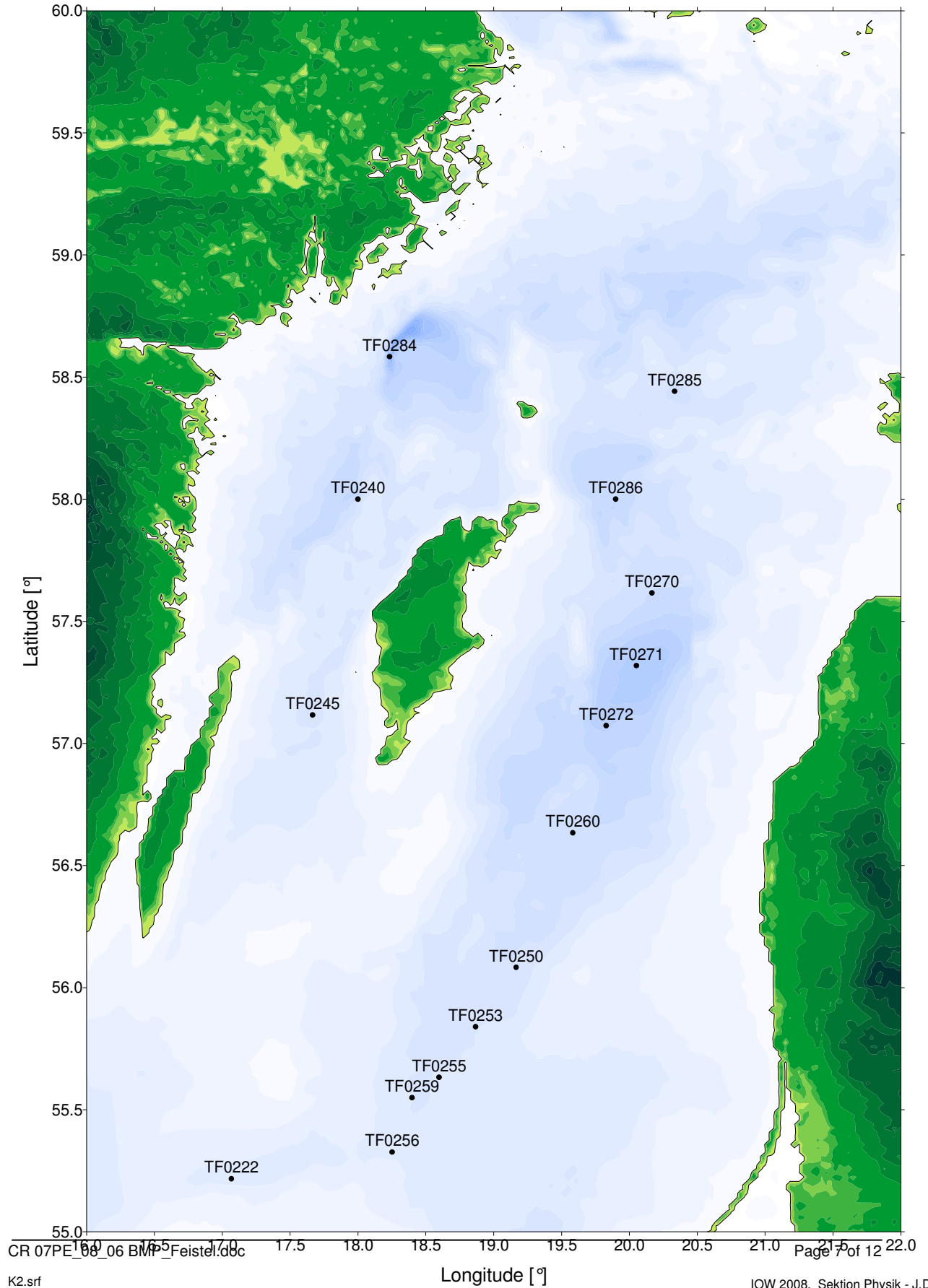
Attachments:

- station charts
- tables of preliminary results (surface layer and near bottom layer)
- transects of temperature and salinity between Kiel Bight and northern Gotland Sea
- map showing oxygen concentrations in the near bottom water layer
- preliminary map showing areas of near-bottom hydrogen sulphide and oxygen deficiency



Stationmap K2

07PE0806
27.03. - 04.04.2008
15 Stationen



**Table 1: Preliminary data of 2008 from the surface layer of selected regions.
Oxygen values from titration. In brackets, related data of March/April 2007.**

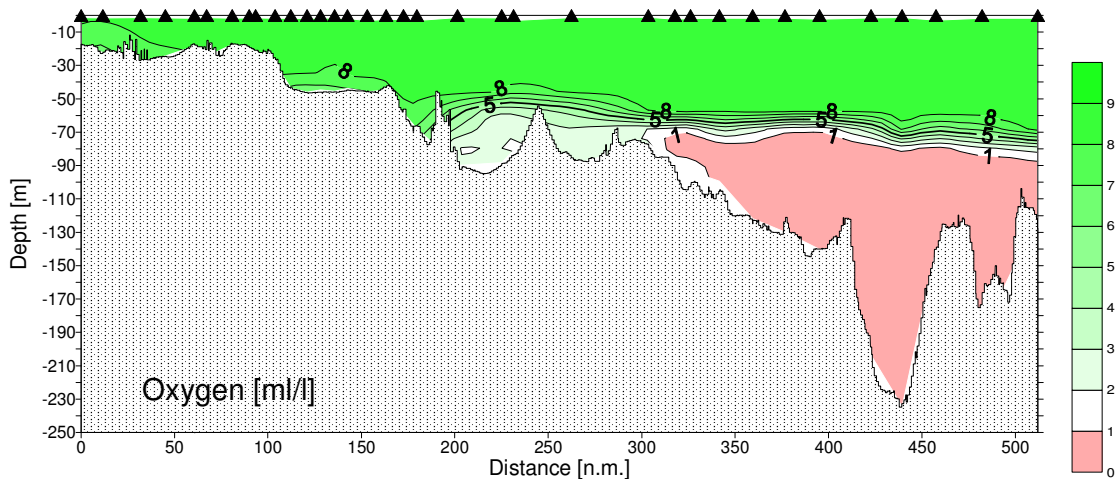
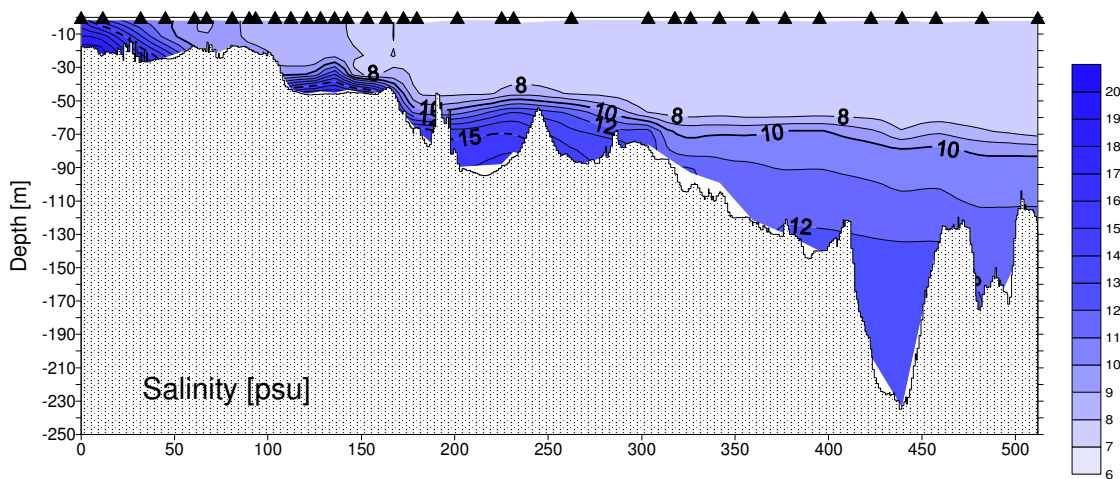
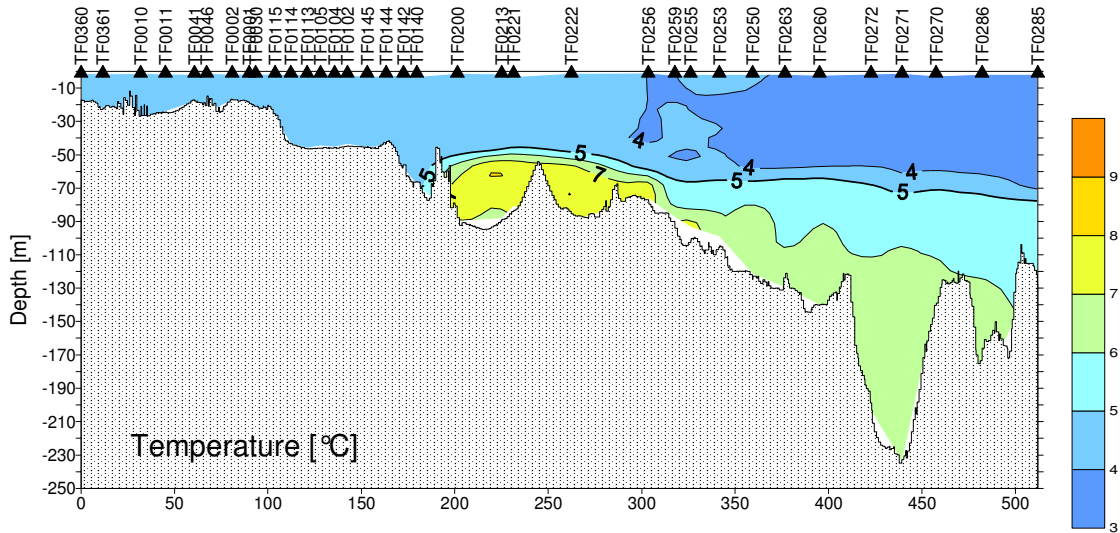
Location / Date	Station / Number	Temp. °C	Salinity psu	NO ₂₊₃ µmol/l	PO ₄ µmol/l	SiO ₄ µmol/l	O ₂ ml/l
Kiel Bight 27.03.2008	TF0360 5	4.53 (5.00)	15.60 (15.42)	0.04 (0.02)	0.14 (0.20)	9.20 (16.20)	8.23 (8.89)
Lübeck Bight 28.03.2008	TF0022 6	4.16 (5.04)	12.46 (14.92)	0.32 (3.24)	0.13 (0.19)	9.90 (16.00)	8.85 (8.28)
Arkona Basin 28.03.2008	TF0113 17	4.31 (4.45)	8.09 (8.59)	0.99 (3.34)	0.49 (0.75)	14.40 (16.20)	8.71 (8.59)
Bornholm Deep 29.03.2008	TF0213 26	4.13 (4.29)	7.63 (7.95)	0.11 (2.99)	0.55 (0.87)	16.40 (15.80)	8.92 (8.67)
SE Gotland Basin 30.03.2008	TF0259 30	3.98 (4.54)	7.41 (7.51)	0.91 (1.76)	0.60 (0.41)	15.40 (11.40)	8.88 (9.00)
Gotland Deep 31.03.2008	TF0271 37	3.95 (4.25)	7.41 (7.32)	1.67 (2.32)	0.56 (0.42)	12.80 (11.70)	8.97 (8.76)
Farö Deep 31.03.2008	TF0286 39	3.64 (3.56)	7.27 (6.85)	1.39 (2.26)	0.32 (0.58)	5.80 (15.90)	8.96 (9.14)
Landsort Deep 01.04.2008	TF0284 41	3.27 (2.42)	6.76 (6.46)	0.09 (1.45)	0.30 (0.41)	8.30 (15.90)	9.39 (9.45)
Karlsö Deep 02.04.2008	TF0245 43	3.67 (3.27)	7.25 (6.88)	1.15 (2.45)	0.35 (0.62)	7.20 (16.20)	8.78 (8.94)

**Table 2: Preliminary data of 2008 from the near-bottom layer of selected regions.
Oxygen values from titration. In brackets, related data of March/April 2007.**

Location / Date	Station / Number	Depth m	Temp. °C	Salinity psu	NO ₂₊₃ µmol/l	PO ₄ µmol/l	SiO ₄ µmol/l	O ₂ ml/l
Kiel Bight 27.03.2008	TF0360 5	18	4.91 (5.07)	20.00 (18.96)	0.32 (0.37)	0.13 (0.05)	6.80 (10.00)	7.35 (8.02)
Lübeck Bight 28.03.2008	TF0022 6	20	4.70 (4.38)	16.80 (17.81)	3.01 (14.03)	0.34 (0.67)	15.20 (24.50)	7.51 (5.12)
Arkona Basin 28.03.2008	TF0113 17	43	4.50 (4.98)	15.33 (19.43)	6.08 (1.79)	0.83 (0.36)	16.70 (5.50)	6.74 (7.52)
Bornholm Deep 29.03.2008	TF0213 26	85	6.75 (9.29)	16.19 (16.21)	7.74 (8.94)	1.59 (1.70)	36.30 (48.80)	3.09 (0.85)
SE Gotland Basin 30.03.2008	TF0259 30	84	6.52 (5.80)	11.23 (10.93)	5.96 (5.44)	2.47 (2.84)	47.80 (46.50)	1.18 (0.64)
Gotland Deep 31.03.2008	TF0271 37	232	6.45 (5.98)	12.69 (12.63)	0.00 (0.00)	4.55 (4.63)	68.60 (67.40)	-6.64 (-2.45)
Farö Deep 31.03.2008	TF0286 39	188	6.14 (6.01)	12.08 (12.18)	0.00 (0.00)	4.75 (3.75)	58.90 (57.30)	-4.77 (-0.95)
Landsort Deep 01.04.2008	TF0284 41	436	5.61 (5.68)	10.92 (11.06)	0.00 (0.00)	4.00 (3.55)	52.30 (54.30)	-2.73 (-0.45)
Karlsö Deep 02.04.2008	TF0245 43	104	5.11 (5.12)	9.67 (10.10)	1.02 (0.00)	2.07 (3.75)	24.20 (52.40)	+0.49 (-0.61)

Kiel Bight - Gotland Sea

monitoring 07PE0806 / 27.03. - 04.04.2008



Monitoring
07PE0806
27.03. - 04.04.2008
oxygen bottom
concentration [ml/l]

