



Baltic Sea Research Institute Warnemünde

Cruise Report

r/v "Gauss"

Cruise- No. 11 / 05 / 03

1 – 11 April, 2005

Western and Central Baltic Sea

This report is based on preliminary data

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1. **Cruise No.:** 11 / 05 / 03
2. **Dates of the cruise:** from 1 April 2005 to 11 April 2005
3. **Particulars of the research vessel:**
Name: Gauss
Nationality: Germany
Operating Authority: Bundesamt für Seeschifffahrt und Hydrographie (BSH)
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: J. Schütt
Number of crew: 20
8. **Research staff:**
Chief scientist: R. Feistel
Scientists: F. Schaeffer, E. Simon
Engineers: S. Weinreben
Technicians: J. Donath, A. Welz, B. Buuk, B. Sadkowiak
9. **Co-operating institutions:**
10. **Scientific equipment**
CTDO bathysonde, plankton net

11. General remarks and preliminary results

This monitoring cruise was still under the impression of a cold, oxygen-rich salt water **inflow from the Kattegat in January 2003** and a subsequent warm, oxygen-poor **baroclinic summer inflow in August 2003**, and their possibly lasting effects on the deep water ventilation state, the deep water temperature distribution, and the salt budget in central Baltic Sea. The previous year 2004 was coined by very low inflow activity through the Danish Straits, although in the deep layers by progressing of water substitution processes, extending from the Bornholm Basin to the Karlsö Deep. In 2004, salinity at 200 m depth in the Eastern Gotland Basin became the highest of the entire 27-years period since the heavy inflow events of 1976/77, thus underlining the continuing importance of the recent 2002/2003 inflow succession.

The cruise was carried out under calm to moderate **wind conditions**, in the beginning from easterly, later turning to westerly directions. An extended high pressure cell persisted over central Europe, while Atlantic cyclones passed over northern Scandinavia with fronts touching the Baltic Sea region. Wind speeds of BF6 were exceeded in gusts only infrequently, and station work was never suspended during the whole cruise. The good conditions allowed some additional profiles of CTD and hydrochemistry to be taken in the Eastern Gotland Basin for a more detailed picture of the actual transition from an inflow-controlled to a stagnation regime. Air pressure varied between 1033 and 998 hPa, morning air temperature between 7°C and 4°C. Water surface temperatures were found between 2.4°C in the north and 3.1°C in the south, in part with formation of a shallow daily thermocline and nightly convection. Algal bloom was already pronounced with reduced Secchi depth and oxygen supersaturation in the surface layer up to 12.6 ml/l (titration) resp. 10.4 ml/l (O₂ sensor raw data) at station TF0011.

In the deep water of the central Baltic Sea, higher salinities with increased temperatures have propagated as far as the Farö to the Karlsö Deep. H₂S was mainly found in the near bottom layers of the Bornholm and the Eastern Gotland Basin, as well as in the Farö Deep and intermediate layers about 150 m of the Landsort Deep, but not in the South-eastern Gotland Basin. Karlsö Deep, on the opposite, is currently subject to ongoing, rather delayed ventilation. Surface salinities have generally increased compared to March 2004. These features may be attributed to the lift-up of old stagnant, deep waters to the halocline by the inflows of 2003, and their subsequent erosion and advection during winter.

In following report text, O₂ data in the graphs are still raw CTD sensor values, which at high concentrations are likely too low by a factor of about 1.2 compared to bottle titration.

In the **western Baltic**, down to 50 m depth, temperatures were rather homogeneous at 2-3°C, comparable to the values found in the previous year in this area. Surface and bottom salinities were lower this year as no inflow situation was encountered. The salinity stratification west of the Darss Sill is pronounced with values between 8 and 16 psu. Surface silicate was even higher this year than in 2004, namely 17.7 µmol/l in the **Arkona Basin** and even 52.0 µmol/l in the Oder Bight. Correspondingly, the Arkona Basin bottom salinity at station TF0113 was found to be only 12 psu on April 3, compared to 14 psu in March 2004 and 21 psu in the inflow situation of March 2003. High oxygen values (sensor) beyond 9 ml/l (titration) resp. 10 ml/l (O₂ sensor raw data) are found down to 40 m depth.

In the **Bornholm Basin**, at station TF0212 the warmest layer with 7.8°C is located at 72 m depth just below the halocline. Its salinity is 15.2 psu, its oxygen (sensor raw data) of 2.5 ml/l (resp. titration 2.6 ml/l at 70 m) is found within a strong vertical gradient. A similar warm layer (60 – 70 m depth) with temperatures even exceeding 8°C was found in spring 2004. Further down, temperature drops to 6.7°C, salinity increases only slowly to 16.6 psu, and oxygen disappears. At some stations (TF0212, TF0211), even H₂S up to -0.4 ml/l oxygen equivalent was measured. Thus, bottom oxygen concentrations continue the trend to stagnation after March 2004 (0.5 ml/l) which were already significantly reduced compared to March 2003 (5 ml/l). Values above 9 ml/l oxygen (titration) are measured throughout the surface mixed layer down to 50 m depth. The almost horizontal salinity stratification suggests the absence of currently intense advection and exchange processes.

In the **Pomeranian Bight**, very high concentrations of NO₃ (64 µmol/l) and SiO₄ (52 µmol/l) were measured, along with low PO₄ (0.08 µmol/l), the latter is only about 10% of the surface phosphate found in the Arkona and Bornholm Basins. High plankton concentrations were apparent in the Oder Bight region. At the time of measurement, windless and sunny conditions permitted the temporary formation of a thin (2 m) warm surface layer with up to 5.6°C and oxygen 10.0 ml/l (titration).

In the **Stolpe Channel** the near-bottom oxygen concentration is about 3 ml/l (titration), gradually increasing towards the surface. This value is about the same what had been measured there in March 2004, is comparable with that of the actual 70m-layer in the Bornholm Basin, but remarkably higher than that found in the bottom layer there. Bottom salinity is now 13.5 psu, slightly lower than previous year. Highest temperature is found at the bottom, just exceeding 7°C. There is no sign of any cold inflow water overcoming the Stolpe Sill during the past winter.

From the Bornholm Deep through the Stolpe Channel the fading and disrupted warm water tongue ($> 6^{\circ}\text{C}$) continues beyond the south-western (station TF0250: 6.7°C and 12.3 psu near the bottom) into the central Gotland basin in levels between 90 and 170 m depth. The **South-eastern Gotland Basin** appears to be weakly ventilated (O_2 titration values mostly at or higher than 1 ml/l at the bottom) by apparently occasional overflow processes over the Stolpe Sill with Bornholm Basin water from just below the halocline, perhaps carrying some oxygen taken up from the winter water layer above.

The **Gotland Deep** station TF0271 had no anoxic levels in March 2003 but has now very low oxygen levels below 90 m and H_2S below 220 m. A weak oxygen maximum of 0.55 ml/l (titration) is found in the deep water at 125 m depth, close to the local temperature maximum of 6.4°C (at salinity 11.8 psu), which may be influenced by interleaving water from the SE Gotland Basin. The vertical temperature distribution below 125 is decreasing to an extended, shallow minimum of 5.9°C around 200 m depth and increasing again towards nearly 6.0°C (12.76 psu) at 233 m. This near-bottom temperature is lower than the values before (March 2004: 6.8°C , March 2003: 6.7°C) and is the same found there in February 2005. The temperature and salinity decrease near the ground is perhaps due to diapycnal mixing within the basin, indicating the end of renewal processes in the Gotland Deep water and a transition to a new stagnation period. The still obvious fine structure in the vertical temperature profile has not yet been erased completely by diffusion, however.

The **Farö Deep** TF0286 entire water column was found no longer completely oxygenated as it was in March 2004, but only at 190 m depth H_2S of -0.24 ml/l oxygen equivalent was found. Near-bottom temperature of currently 6.0°C has gradually increased again and almost reached the value of 6.4°C in March 2003. Salinity 12.22 psu is only slightly higher than last year (12.18 psu), suggesting a reducing overflow from the Gotland Basin.

While the **Landsort Deep** was first influenced in March 2004 by the cold January 2003 inflow, when the near-bottom values had changed remarkably down to 5.49°C and up to 10.74 psu. This time, temperature there has returned to high values (5.71°C) and salinity has increased further (10.98 psu). Thus, the warm summer inflow of 2003 has even reached this remote basin, continuing the trend seen already in February 2005. Down to 100 m depth and again from 300 m depth to the bottom, no H_2S is found but oxygen in concentrations about 0.14 ml/l (titration) in the bottom water, similar to 2004. At 125 - 200 m depth an anoxic layer is persisting with maximum hydrogen sulphide concentration of -0.38 ml/l oxygen equivalent.

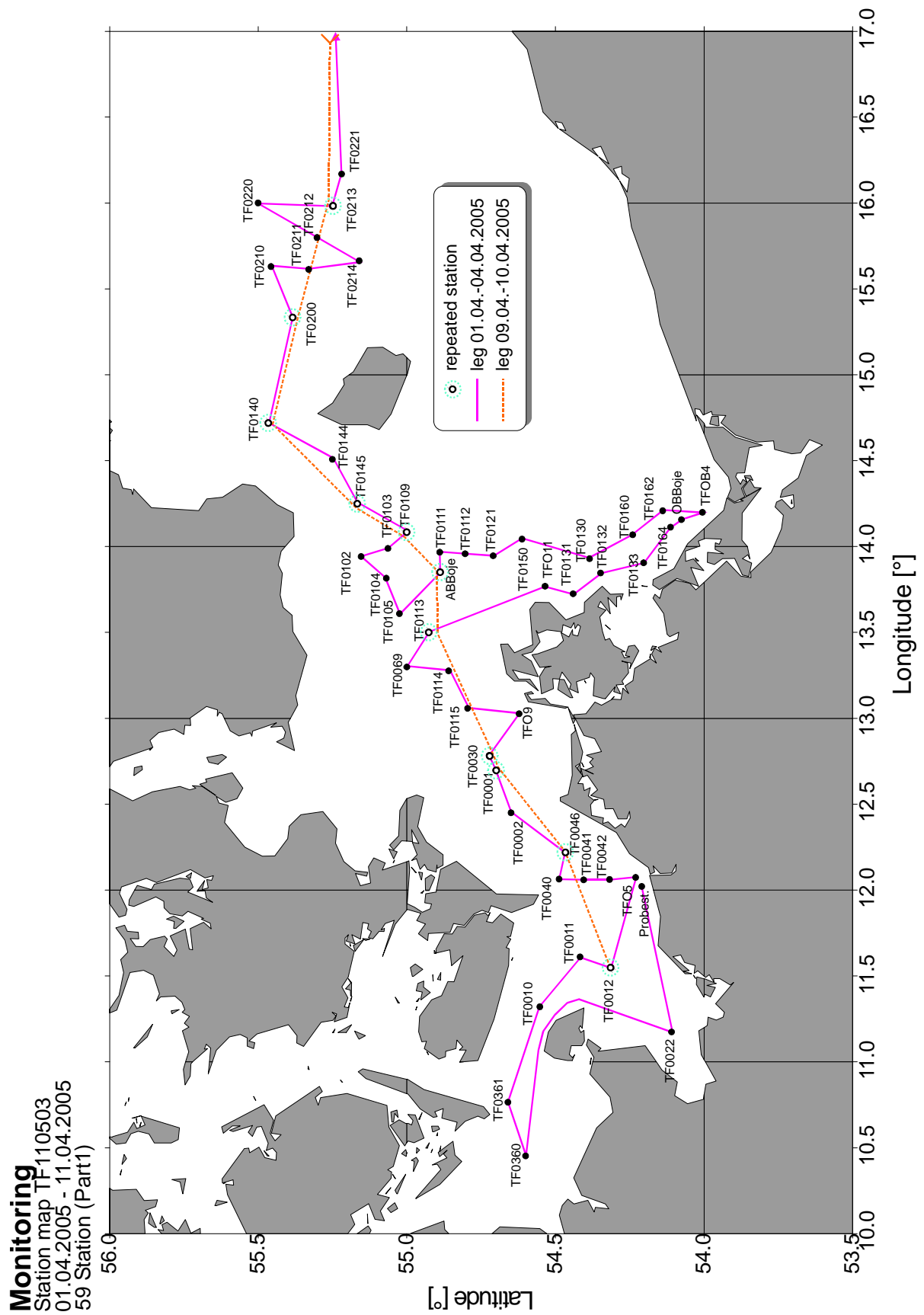
Karlsö Deep near-bottom H_2S concentrations have improved subsequently from -1.2 ml/l O_2 equivalent in March 2003 to -0.34 ml/l in March 2004 and have toggled now to +0.29 ml/l

oxygen (titration) content. No H₂S was found in the entire water column. This lasting trend is opposite to the one observed before 2003 and indicates an increasing ventilation effect due to the January 2003 inflow in this remote basin. Compared to last year, both bottom temperature from 4.98 to 5.12°C and salinity from 9.56 to 9.95 psu have increased significantly. The corresponding values in February 2005 were 5.02°C, 9.81 psu and < 0.1 ml/l O₂, so the inflow process here seems to be in rapid progress actually.

Rainer Feistel
scientist in charge

Attachments:

- track 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



IOW 2005, Sektion Physik - J.Donath

K1.srf

Monitoring

Station map TF110503
01.04.2005 - 11.04.2005
33 Station (Part2)

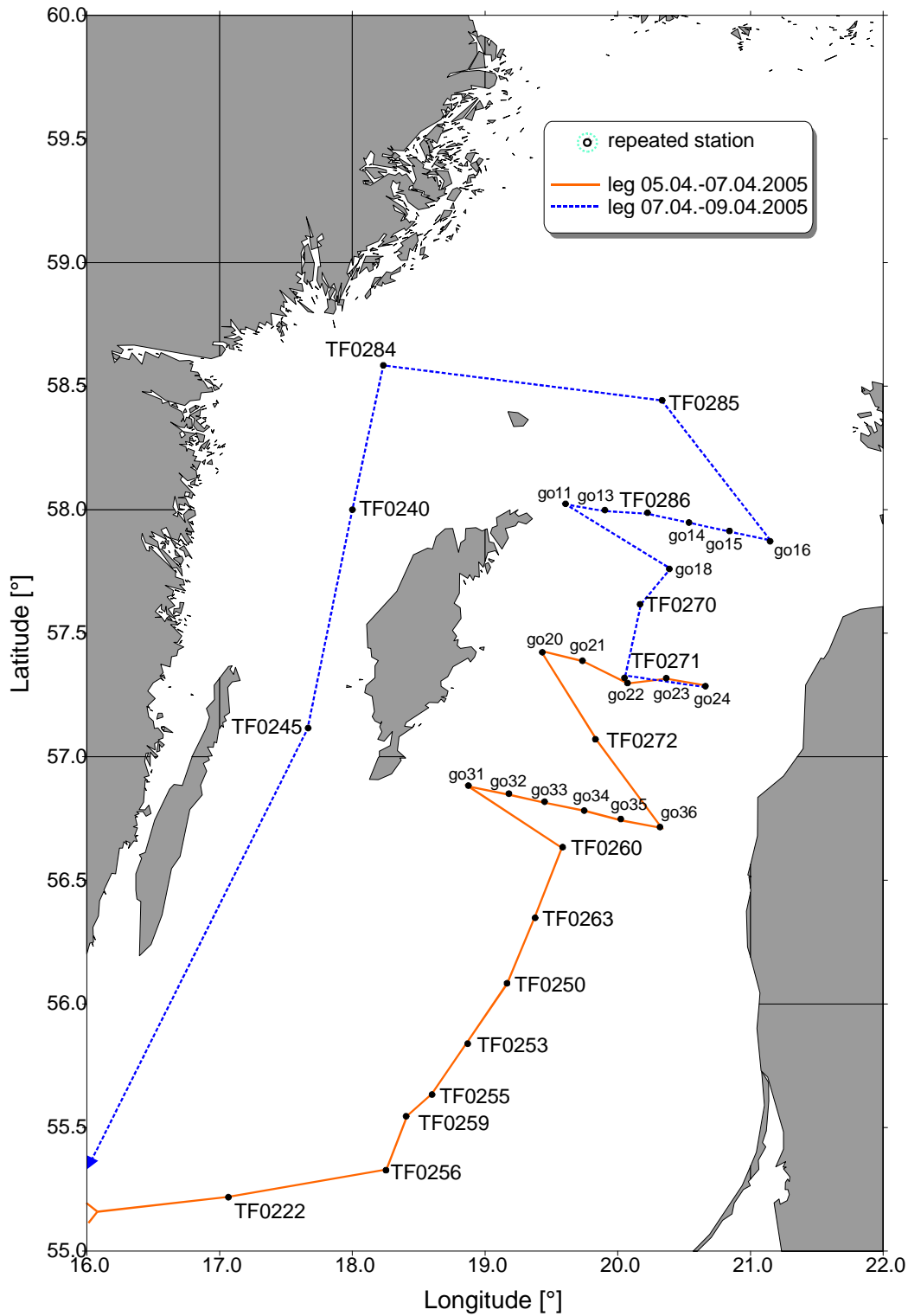


Table 1: Preliminary data from the surface layer of selected regions

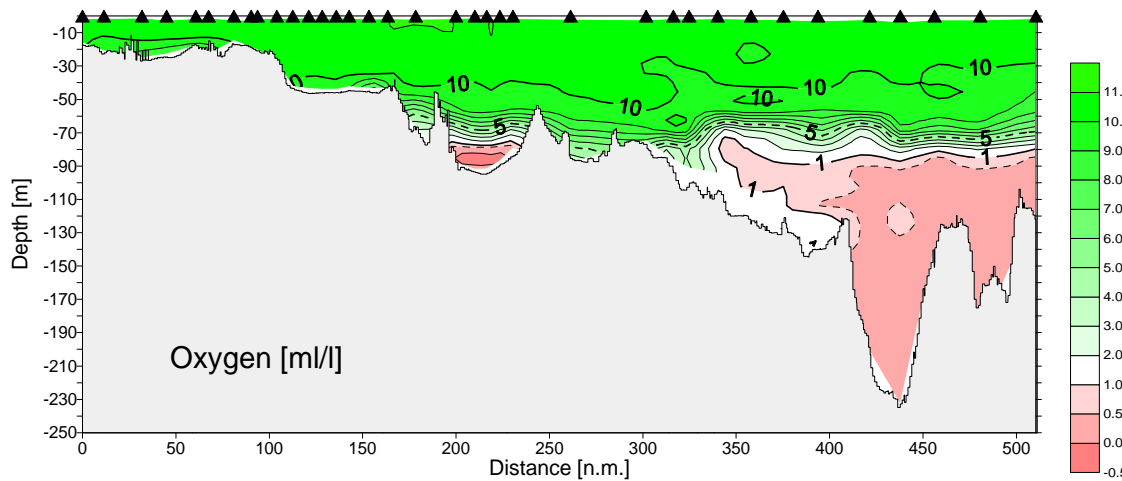
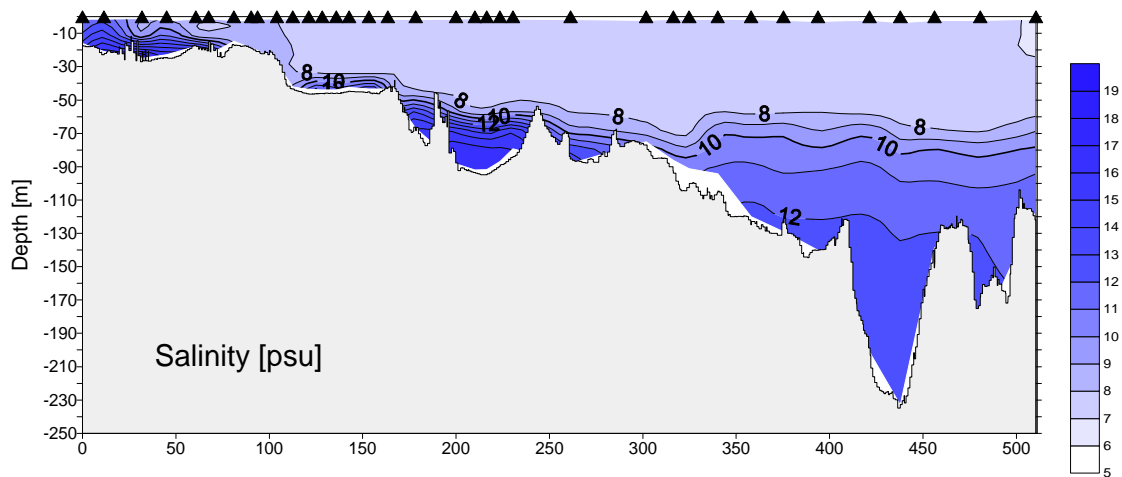
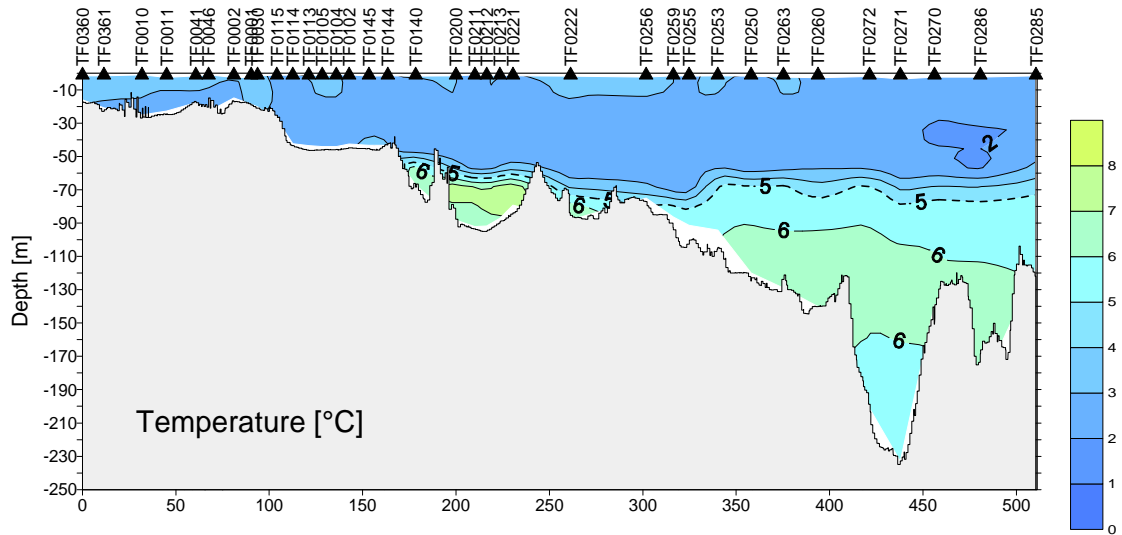
Location / Date	Station / Number	Temp. °C	Salinity psu	NO ₂₊₃ µmol/l	PO ₄ µmol/l	SiO ₄ µmol/l	O ₂ ml/l
Kiel Bight 02.04.2005	TF0360 3	3.48	10.40	0.04	0.17	3.70	9.46
Mecklenburg Bight 02.04.2005	TF0012 7	3.32	9.30	0.41	0.43	10.80	9.29
Lübeck Bight 01.04.2005	TF0022 2	4.00	11.40	0.07	0.06	1.30	9.77
Arkona Basin 03.04.2005	TF0113 20	2.91	7.76	1.37	0.84	17.70	9.27
Oder Bight 03.04.2005	OB4 27	5.41	5.43	64.05	0.08	52.00	9.96
Bornholm Deep 04.04.2005	TF0213 50	2.99	7.59	0.04	0.75	15.50	9.81
SE Gotland Basin 05.04.2005	TF0259 54	3.02	7.38	1.00	0.61	14.40	9.54
Gotland Deep 07.04.2005	TF0271 72	2.68	7.39	0.75	0.61	12.60	9.58
Farö Deep 07.04.2005	TF0286 76	2.43	7.07	1.62	0.48	12.60	9.52
Landsort Deep 08.04.2005	TF0284 82	2.55	6.77	0.16	0.43	13.20	9.73
Karlsö Deep 09.04.2005	TF0245 84	2.79	7.23	0.08	0.67	16.60	9.59

Table 2: Preliminary data from the near-bottom layer of selected regions

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 02.04.2005	TF0360 3	16	3.04	13.99	0.05	0.07	1.30	9.27
Mecklenburg Bight 02.04.2005	TF0012 7	22	2.47	15.67	6.72	0.60	15.90	6.73
Lübeck Bight 01.04.2005	TF0022 2	20	2.72	12.75	0.36	0.09	2.00	9.33
Arkona Basin 03.04.2005	TF0113 20	43	2.47	11.98	3.81	0.69	14.30	8.12
Oder Bight 03.04.2005	OB4 27	12	2.57	7.80	10.51	0.30	12.00	9.36
Bornholm Deep 04.04.2005	TF0213 50	87	6.78	16.51	1.65	11.00	62.40	0.00
SE Gotland Basin 05.04.2005	TF0259 54	86	5.56	10.67	6.14	2.77	44.50	1.39
Gotland Deep 07.04.2005	TF0271 72	233	5.98	12.76	0.16	4.75	58.40	-1.52
Farö Deep 07.04.2005	TF0286 76	189	6.03	12.22	0.17	3.32	51.70	-0.24
Landsort Deep 08.04.2005	TF0284 82	433	5.71	10.98	5.39	2.98	46.90	0.14
Karlsö Deep 09.04.2005	TF0245 84	106	5.12	9.95	2.43	3.40	53.60	0.29

Kiel Bight - Gotland Sea

TF110503
02.04.2005 00:47 - 08.04.2005 05:51 UTC



Monitoring
TF110503
01.04.2005 - 11.04.2005
Oxygen bottom concentration [ml/l]

