INSTITUT FÜR OSTSEEFORSCHUNG WARNEMÜNDE
an der Universität Rostock BALTIC SEA RESEARCH INSTITUTE

Baltic Sea Research Institute Warnemünde

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

r/v "Gauss"

Cruise- No. 11 / 04 / 03

16st – 27st March, 2004

Western and Central Baltic Sea

This report is based on preliminary data

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1. **Cruise No.:** 11 / 04 / 03

2. **Dates of the cruise:** from 16 March 2004 to 27 March 2004

3. **Particulars of the research vessel:**
   Name: Gauss
   Nationality: Germany
   Operating Authority: Bundesamt für Seeschiffahrt 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: K.P.Walde
   Number of crew: 20

8. **Research staff:**
   Chief scientist: R.Feistel
   Scientists: H. Burchard, F. Schaeffer
   Engineers: H. Huth
   Technicians: G.Plüschke, J. Donath, A. Welz, S. Busch

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 an oxygen-rich salt water **inflow from the Kattegat in January 2003** and its possibly lasting effects on the deep water ventilation state in central Baltic basins. The previous monitoring cruise in February 2003 had found the renewal front progressed up to Farö Deep.

The cruise was carried out under changing **weather conditions** with low winds between 5 and 10 m/s for most of the time, in the beginning from W to SW, in the second half from N to NE. On the 20th and 21st of March no station work could be carried out due to strong westerly winds exceeding 30 m/s. Work was also suspended due to rough sea conditions on March 25th. Air pressure varied between 1025 and 983 hPa, morning air temperatures between 2 and 9°C. Water surface temperatures have been measured between 2.6°C in the northern and 4.8°C in the western Baltic.

In following report text, O_2 data in the graphs are still raw CTD sensor values, different by a factor of 1.1 compared to bottle titration.

In the **western Baltic**, down to 50 m depth, temperatures were rather homogeneous at 2-3°C, about 0.5 - 1°C warmer than the values found in the previous year in this area. Surface and bottom salinities were lower this year as no inflow situation was encountered in the beginning of the cruise. Surface silicate was much higher this year, even by a factor 10 in the Mecklenburg Bight. Correspondingly, the **Arkona Basin** bottom salinity at station TF0113 was found to be 14 psu on March 18th compared to 21 psu in the inflow situation of March 2003.
Caused by the severe storm on March 20th and 21st, highly saline waters from the Kattegat passed the Sound until March 23rd. A second visit at the Arkona Deep station TF0113 on March 25th showed the existence of a new near-bottom layer of 5 m thickness there with salinity > 17 psu which is likely due to the short inflow phase. A similar observation was made at the Arkona Basin buoy which is equipped with CTD sensors down to 40 m depth. Our ship-borne measurements revealed the recent formation of a salty bottom layer below 40 m in between the two visits:

Depth m	18 Mar PSU	25 Mar PSU
40	11.4	13.7
41	11.5	17.4
42	11.6	18.5
43	11.8	18.6
44	13.3	18.6

Further east, towards the Bornholmsgat and beyond, no certain traces of this inflow splash could be identified.

In the **Bornholm Basin**, bottom oxygen concentrations found below 0.5 ml/l are lower than in February 2004 (about 1 ml/l) and significantly reduced now compared to March 2003 (5 ml/l). Values above 7.5 ml/l are measured throughout the surface mixed layer down to 50 m depth. The almost horizontal salinity stratification suggests the absence of currently active exchange processes. Bottom salinity with nearly 18 psu is lower than one year ago (> 19 psu). The most pronounced signal is the very warm intermediate layer (60 – 70 m depth) with temperatures exceeding 8°C, which is probably a remainder of the warm summer inflow 2003. Even bottom temperatures are higher than 4°C where waters colder than 4°C were found after the January 2003 inflow.

In the **Stolpe Channel** the near-bottom oxygen concentration is about 3 ml/l, gradually increasing towards the surface. This value is remarkably higher than that found in the Bornholm Basin, but only half of what had been measured there in March 2003. Bottom salinity is now 14.8 psu, comparable to the previous year. There is a sharp thermocline at 60 m depth with t about 7°C over all the layer below, but only 2.5°C at the surface. In 2003, the January inflow had brought about only 4.5°C above the ground.

From the Bornholm Deep through the Stolpe Channel the striking warm water tongue continues to the south-western (station TF0259: 6.1°C near the bottom) and central Gotland basin. The **Gotland Deep** station 271 was mostly anoxic below 120 m depth in March 2003 but has no anoxic levels now. The oxygen minimum at the bottom is now 0.79 ml/l (February 2004: 0.86 ml/l), a second minimum below the halocline is 0.7 ml/l at 98 m depth, in between a maximum is observed with 1.3 ml/l at 142 m. The vertical temperature distribution below the pycnocline is rather homogeneous, 6.1°C is found at 110 and 121 m depth, at 171 m is a minimum with 5.4°C, rising again to 6°C at 218 m and to even 6.8°C at 233 m depth. This

near-bottom temperature is even higher than the value before the cold inflow (March 2003: 6.7°C, August 2003: 4.4°C) and also exceeds notably the value of 6.1°C found there in February 2004. The salinity increase near the ground is continuous but less pronounced, from 12.2 psu (March 2003) to 12.7 (August 2003), 12.9 (Febr. 2004) and 13.1 psu now, indicating ongoing renewal processes at the Gotland Deep water.
These findings suggests a still continuing significant inflow of warm summer 2003 water into the Gotland Deep with unexpected strength and density.

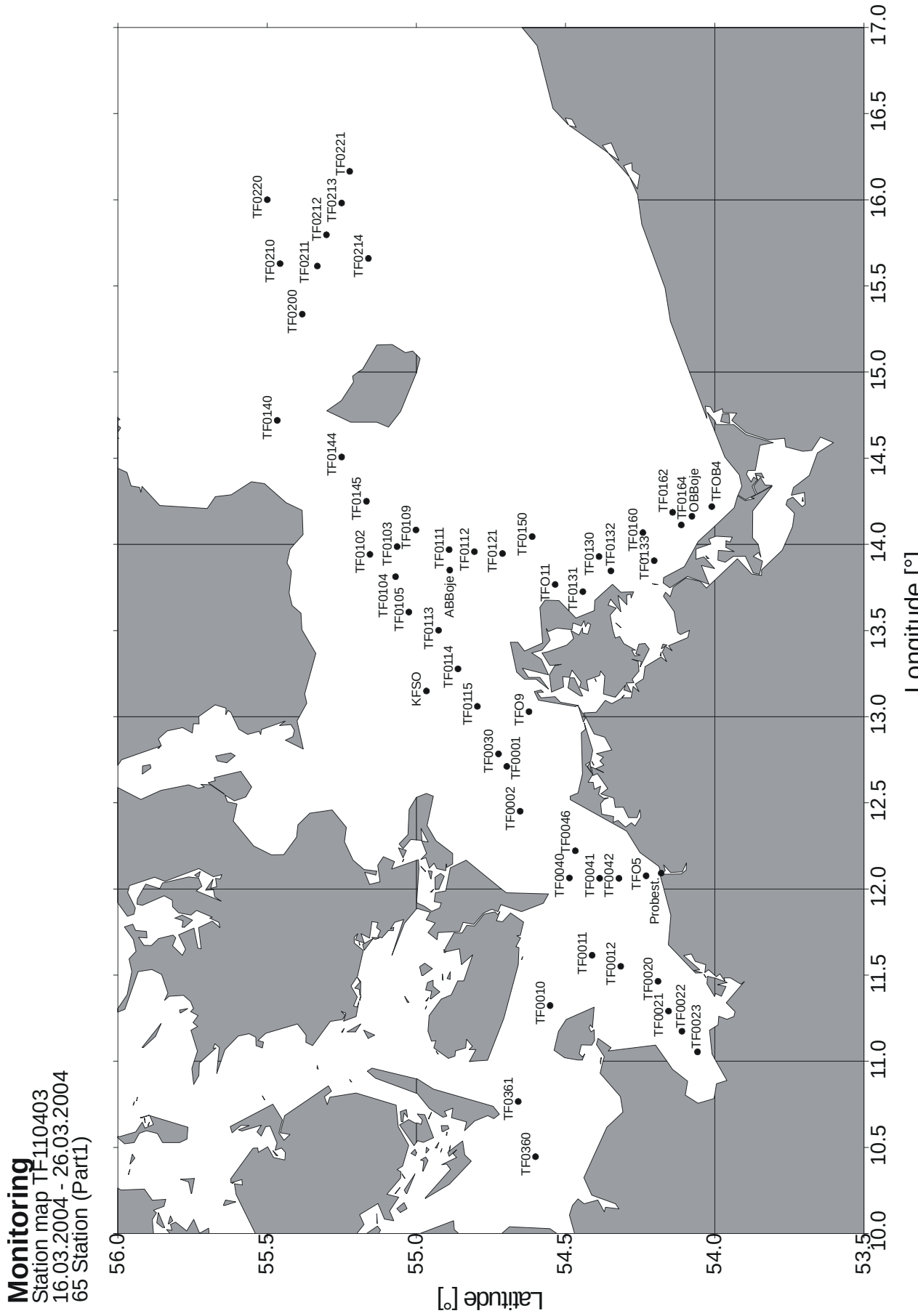
The **Farö Deep** entire water column was found completely oxygenated as it also was already in February 2004. Near-bottom temperature of 5.7°C is slightly higher again than in February 2004 (5.4°C) but still much lower than last year, 6.4°C in March 2003.

Somewhat surprisingly, even the **Landsort Deep** is clearly influenced now by the cold January 2003 inflow, which was not yet observed one month ago. Down to 100 m depth and again from 300 m depth to the bottom, no H_2S is found any more but oxygen in concentrations about 0.05 ml/l in the bottom water. At 150 m depth an anoxic layer is persisting with maximum hydrogen sulphide concentration of -0.87 ml/l oxygen equivalent. Near-bottom temperatures have fallen from 5.64°C in February 2004 to 5.49°C now, along with a salinity increase from 10.58 to 10.74 psu.

Karlsö Deep near-bottom H_2S concentrations have improved subsequently from -1.2 ml/l O_2 equivalent in March 2003 to -0.73 ml/l in February 2004 and -0.34 ml/l now. This trend is opposite to the one observed until 2003 and indicates an increasing ventilation effect due to the January 2003 inflow in this remote basin, even though no turning to oxygenated conditions could be observed so far.

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



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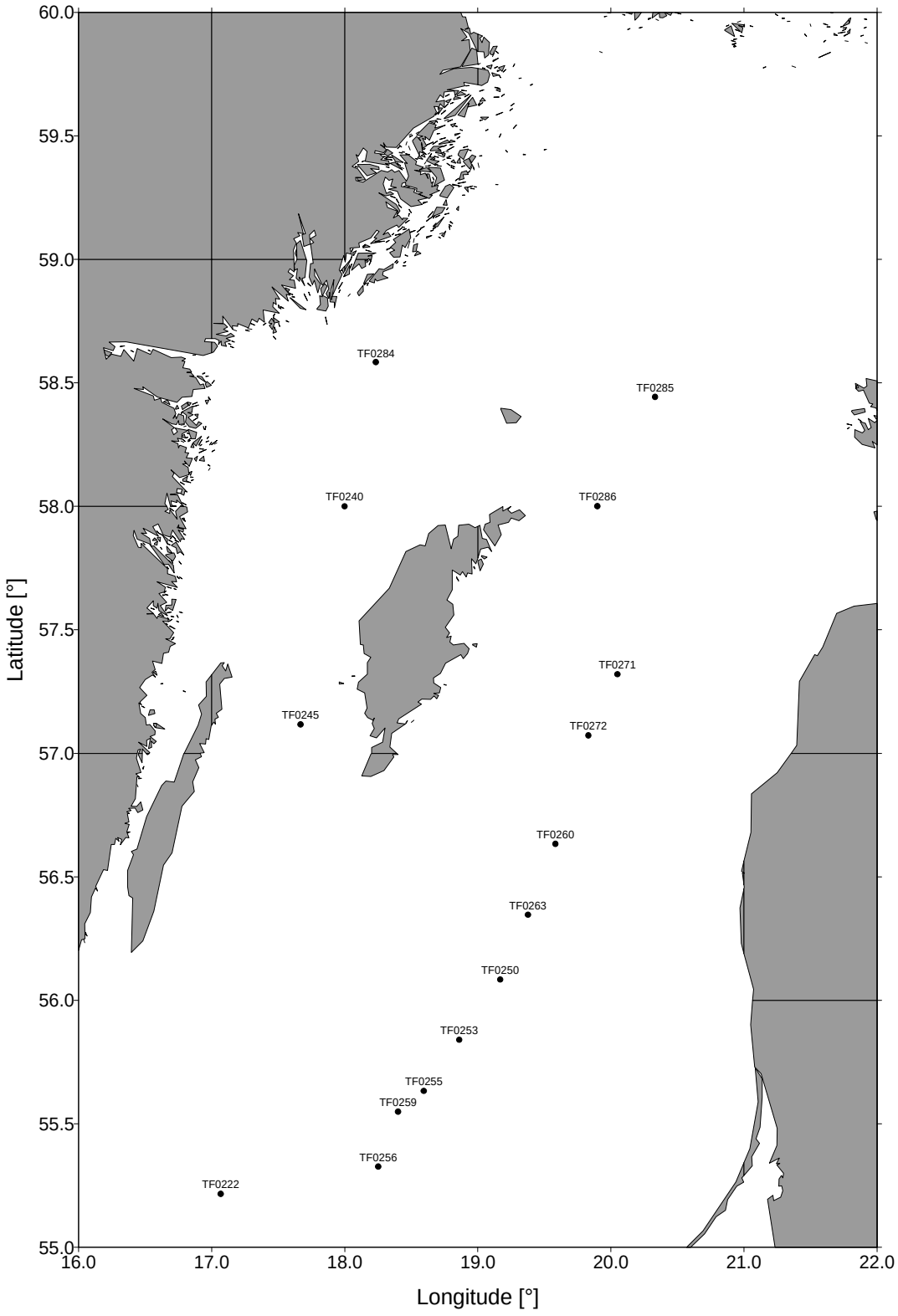
Monitoring

Station map TF110403
16.03.2004 - 26.03.2004
15 Station (Part2)



K2.srf

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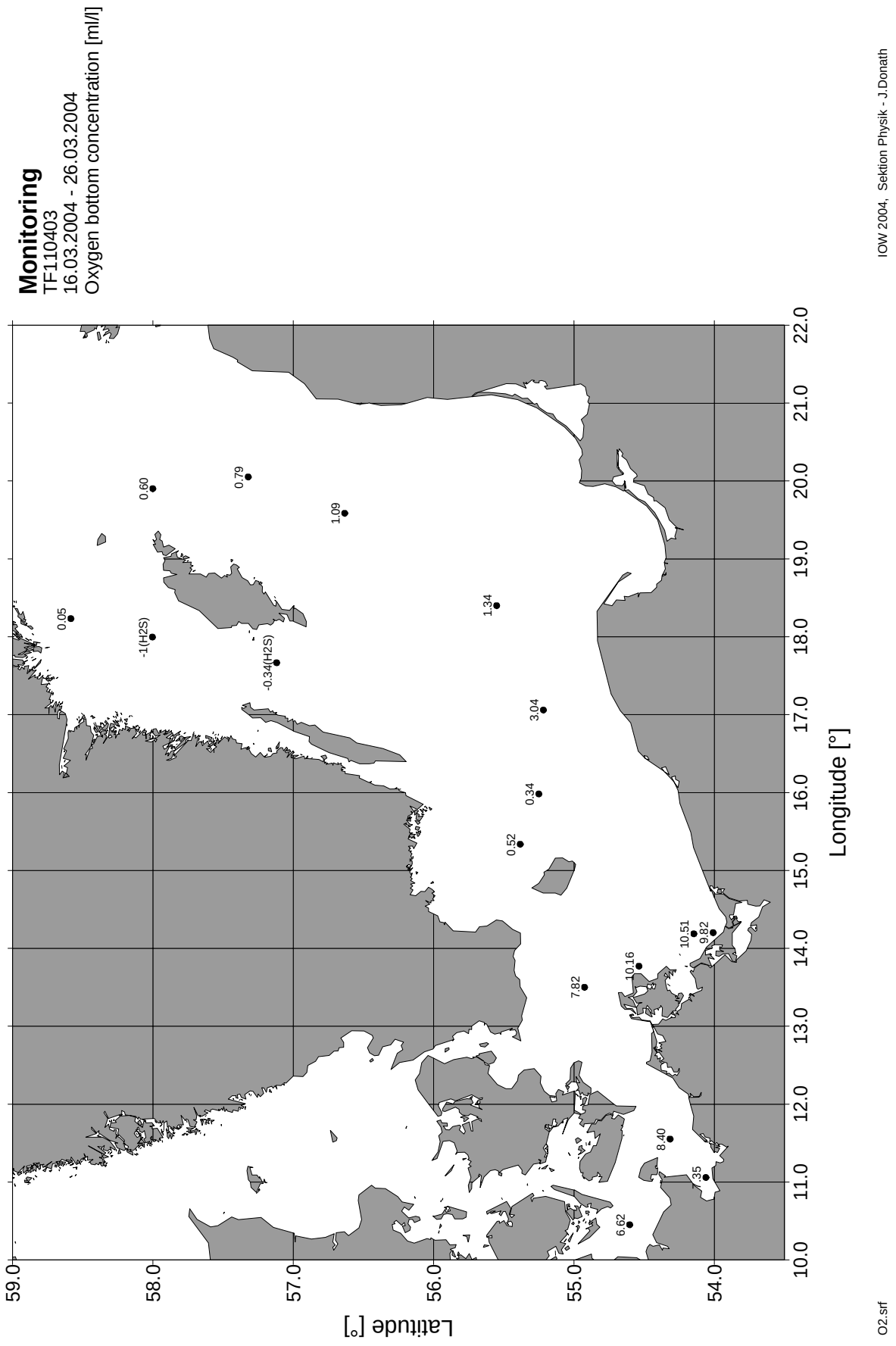
Table 1: Preliminary data from the surface layer of selected regions

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 17.03.2004	TF0360 10	2.97	14.53	0.32	0.01	1.8	9.18
Mecklenburg Bight 16.03.2004	TF0012 5	3.34	9.88	1.3	0.15	9.0	9.31
Lübeck Bight 16.03.2004	TF0023 9	2.65	11.62	0.27	0.01	3.0	9.74
Arkona Basin 17.03.2004	TF0113 22	2.47	7.87	1.26	0.33	9.0	9.38
Oder Bight 18.03.2004	OB4 29	2.80	6.16	36.43	0.08	40.4	10.82
Bornholm Deep 19.03.2004	TF0213 52	2.64	7.33	1.85	0.59	11.9	9.18
SE Gotland Basin 20.03.2004	TF0259 56	2.45	7.29	2.84	0.66	13.3	8.93
Gotland Deep 22.03.2004	TF0271 57	2.41	7.26	2.62	0.58	12.1	9.00
Farö Deep 23.03.2004	TF0286 59	1.97	7.04	3.31	0.75	15.2	9.22
Landsort Deep 23.03.2004	TF0284 61	1.36	6.49	1.47	0.65	16.1	9.75
Karlsö Deep 24.03.2004	TF0245 63	1.89	6.98	2.70	0.83	16.8	9.2

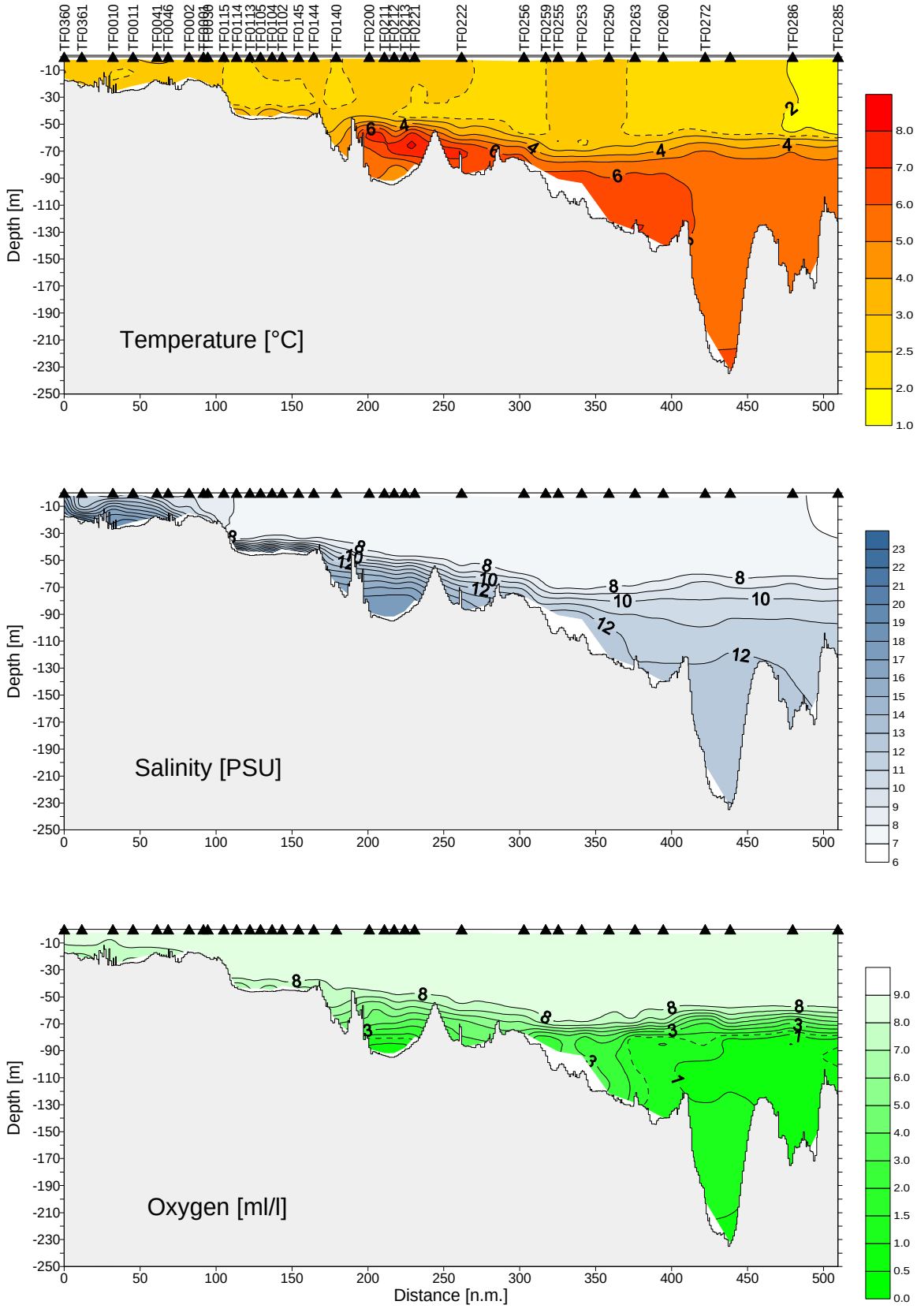
Table 2: Preliminary data from the near-bottom layer of selected regions

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 17.03.2004	TF0360 10	16	3.05	19.39	3.49	0.03	6.3	6.62
Mecklenburg Bight 16.03.2004	TF0012 5	22	2.56	17.64	1.0	0.03	3.5	8.40
Lübeck Bight 16.03.2004	TF0023 9	21	2.96	17.23	9.14	0.43	16.7	7.35
Arkona Basin 17.03.2004	TF0113 22	44	2.67	14.18	5.88	0.51	13.4	7.82
Oder Bight 18.03.2004	OB4 29	9	1.59	6.99	20.78	0.26	27.8	9.82
Bornholm Deep 19.03.2004	TF0213 52	88	4.65	17.95	10.02	0.9	48.8	0.34
SE Gotland Basin 20.03.2004	TF0259 56	86	6.08	11.34	7.97	2.26	39.7	1.34
Gotland Deep 22.03.2004	TF0271 57	233	6.84	13.07	11.14	2.02	42.7	0.79
Farö Deep 23.03.2004	TF0286 59	189	5.65	12.18	11.08	2.82	42.5	0.6
Landsort Deep 23.03.2004	TF0284 61	435	5.49	10.74	2.34	3.33	52.6	0.05
Karlsö Deep 24.03.2004	TF0245 63	106	4.98	9.56	0.03	4.00	53.9	-0.34


Monitoring
TF110403
16.03.2004 - 26.03.2004
Oxygen bottom concentration [ml/l]
IOW 2004, Sektion Physik - J.Donath
Longitude [°]
Latitude [°]
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0
21.0
22.0
59.0
58.0
57.0
56.0
55.0
54.0
0.05
-1(H2S)
0.60
-0.34(H2S)
0.79
1.09
1.34
3.04
0.34
0.52
7.82
10.16
10.51
9.82
8.40
6.62
O2.srf

Kiel Bight - Gotland Sea

TF110403
16.03.2004 - 26.03.2004



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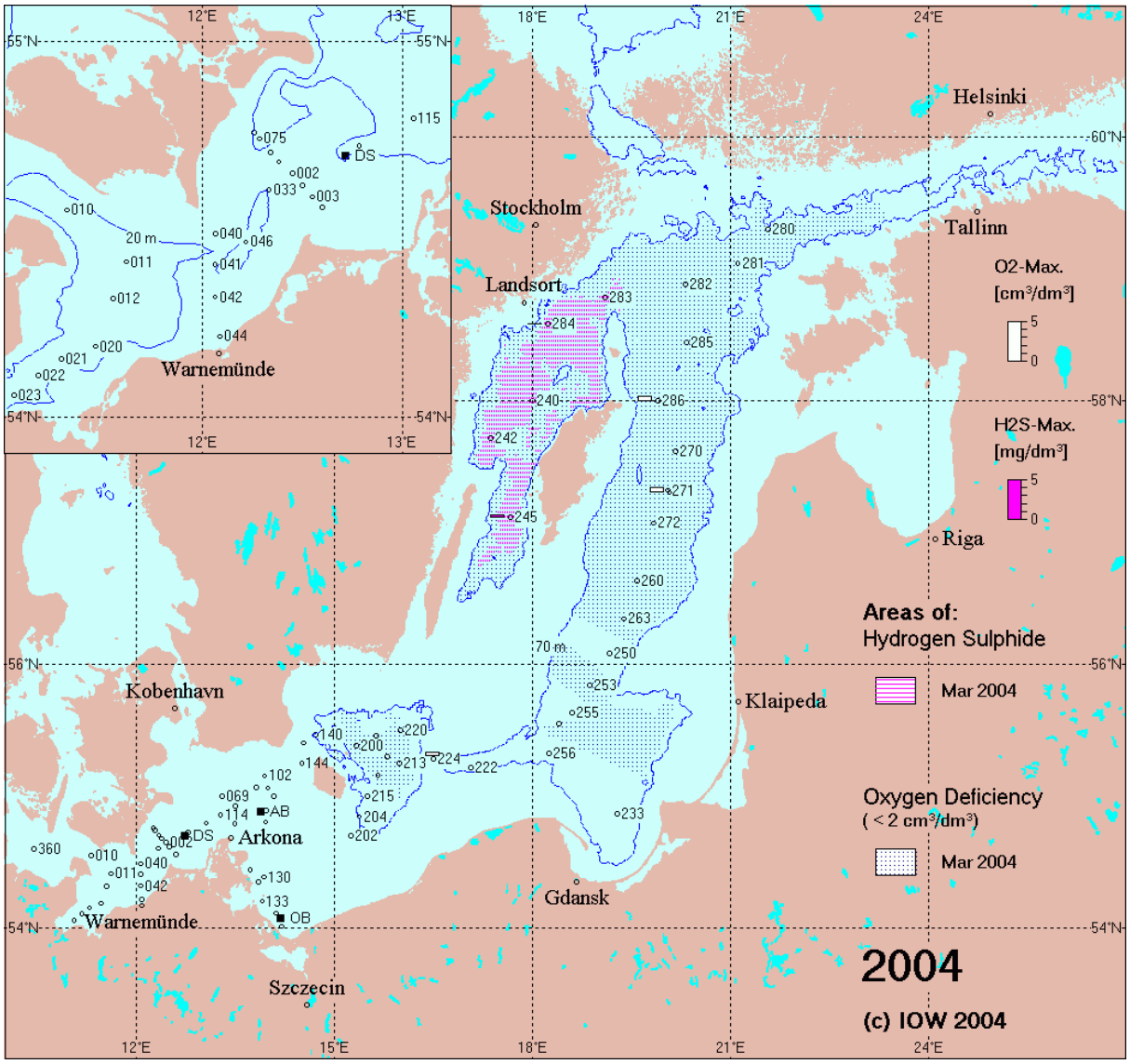
Helsinki
Stockholm
Tallinn
Landsort
Riga
Klaipeda
Kobenhavn
Arkona
Gdansk
Warnemünde
Szczecin
Warnemünde
O2-Max.
[cm³/dm³]
H2S-Max.
[mg/dm³]
Areas of:
Hydrogen Sulphide
Mar 2004
Oxygen Deficiency
(< 2 cm³/dm³)
Mar 2004
2004
(c) IOW 2004
20 m
70 m
12°E
13°E
15°E
18°E
21°E
24°E
54°N
55°N
56°N
58°N
60°N