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

Leibniz Institute for Baltic Sea Research Warnemünde

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

r/v "Heincke"

Cruise- No. 06HK1004

This report is based on preliminary data

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1. **Cruise No.:** 06HK1004 / HE341

2. **Dates of the cruise:** from 09.Nov.2010 to 22.Nov.2010

3. **Particulars of the research vessel:**

Name:	Heincke
Nationality:	Germany
Operating Authority:	Alfred-Wegener-Institut für Polar- und Meeresforschung Sektion Biologische Anstalt Helgoland,

4. **Geographical area in which ship has operated:**
Western and Southern Baltic Sea between Kiel Bight and Bornholm Sea

5. **Dates and names of ports of call**
Sassnitz, 12.11.18:00 – 13.11. 09:00

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

7. **Crew:**

Name of master:	R. Voss
Number of crew:	12

8. **Research staff:**

Chief scientist:	Dr. Martin Schmidt
Participants:	Jan Donath
	Nadine Keiser
	Svenja Zimmermann
	Ingo Schuffenhauer
	Uwe Hehl
	Ines Hand
	Jan Kreuzer
	Nancy Schindler
	Günther Plüschke
	Dr. Ralf Prien
	Arkadius Lis
	Heiko Witt
	David Meyer

9. **Co-operating institutions:**

All institutions dealing with HELCOM monitoring programmes.

10. **Scientific equipment**

CTD SBE 911+ with doubled sensors, SBE oxygen sensor and WETLABS Fluorometer
Electronic Reversing Thermometer
Rosette with water samplers
Plankton nets, WP2 net, filtration set
Van Veen grab, dredge
Autoanalyser, Photometer, Titrino 716
Ships weather station (WERUM)

11. **General remarks and preliminary result** (ca. 2 pages)

The cruise was carried out in the Baltic Sea from Kiel Bight to Gotland Sea, (see the attached station maps). The meteorological, hydrographical, chemical and biological investigations were performed according to the COMBINE Programme of HELCOM and the ongoing long term data acquisition programme of the IOW.

Each hydrographic station started with a CTD cast measuring pressure, temperature, conductivity (salinity), photosynthetic active radiation, oxygen concentration, fluorescence and turbidity, at most stations combined with water sampling for oxygen and nutrient determination and other biochemical measurements. In total 33 hydrographic stations were worked. For quality control of the hydrographic data the CTD is equipped with a double set of sensors. The oxygen and conductivity sensors are calibrated with bottle data measured with a Titrino 716.

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. Secchi depths of 7-8 m in the southern and western Mecklenburg Bight indicated that no bloom occurred here during the cruise. However, at station TF0046 (Kadet Channel), Secchi depth was only 4.5 m. At all investigated biological stations, *Ctenophore Mnemiopsis* could be found with high abundance. It was especially large (about 3 cm) at station O5 in front of Warnemünde.

Between Kiel Bight and Arkona Basin (TF0360, TF0012, TF0010, TF0018, TF0030, TF0109, TF0152, TF0160) benthos is sampled with a van Veen grap and by dredging with drifting ship. At each station three parallel grab samples are taken supplemented by an additional sample for sediment type determination in the laboratory.

The cruise started with calm weather followed by strong south-westerly winds in the evening of 11. Nov. increasing during the night to a severe storm with wind speed up to 20 m/s. Station work was interrupted and some Arkona Sea station must be skipped but could be worked next day. Air temperature was mostly below the sea surface temperature which implies surface water cooling and vertical mixing. Station work in the Bornholm and Gotland Sea were allowed by moderate easterly winds. Two moorings could be recovered in the Gotland Deep, a hydrographic mooring, a sediment trap and a profiling mooring could be laid out. Persistent easterly winds, partially stormy, were balanced until the end of the cruise by a stable high pressure area over Scandinavia. Nevertheless all stations could be sampled.

In the Gotland Basin near station TF0271 two moorings could be recovered and laid out again. The moorings are part of the long term observational programme of the IOW. One mooring is equipped with a sediment trap below the redoxcline, the other one measures near bottom currents with a 300 kHz ADCP and temperature and salinity in several levels. A third mooring laid out near TF0271 is described below in point 12.

A strong horizontal salinity gradient is found across **Darß Sill**. **West of the Darß Sill** bottom salinity varies between 23 and 18 surface salinity is high between 15 and 17.2. Surface temperature is below the bottom temperature, but the existence of vertical salinity stratification indicates, that the surface cooling is still not sufficient for deep vertical mixing. Phosphate concentration in the surface layer is already enhanced but nitrate+nitrite concentration is still low. Like in previous years the N/P – ratio is remarkably low, especially in the Lübeck and Kiel Bight. In the bottom layer nitrogen and phosphate are enhanced, but are smaller than in the previous year. Here also the N/P-ration is reduced. The bottom water is oxic with low apparent oxygen utilisation.

East of Darß Sill a warm saline bottom layer is found with a salinity of about 15 in the central Arkona Basin. This water mass is warmer than the saline water west of Darss Sill but apparent oxygen utilisation in the bottom water is low, which indicates only a short history of this water mass since the last contact with the sea surface. The upper 20 - 30 m surface layer reveals as completely mixed.

In the **Bornholm Basin** the surface layer thickness amounts more than 40 m but the cold winter water layer is still present and stretches from 40 m to 70 m depth. There are several warm intrusions that indicate inflow not dense enough to replace the Bornholm Sea bottom water. Below a 30 m thick layer of stagnant, 8°C warm bottom water with salinity of 16.1 is found, that has almost no oxygen but is also without hydrogen sulphide. The nitrate/nitrite concentration in the deep water (1.8 μmol/l) is reduced compared with the summer values of 8 μmol/l (cruise report 06AK1003). Phosphate is enhanced (4.5 μmol/l), which can be understood by anoxic conditions in the bottom water and related phosphate mobilisation and denitrification during the last 3 months.

The surface layer in the **Gotland Basin** extends to a depth of 45 m where a sharp thermocline to the Gotland Sea winter water is met. At station TF0271 the core of the winter water is at 56 m depth and has a temperature of 2.8°C. Below this depth temperature and salinity are monotonically increasing. At about 100 m depth temperature reaches 6.3°C and is slightly undulating around this value below. Salinity is increasing from 8 in the winter water core to 12.38 at the bottom maintaining a stable stratification throughout the water column. In the deep water there is a meridional temperature gradient with lower temperature in the south near Stolpe Channel. The temperature and salinity values of the water mass found there suggest an origin by mixing inflowing water from the Bornholm Basin with winter water. The water in the Gotland Deep is warmer and must have flown in previously. Accordingly, the deep water in the southern part of the Gotland Basin is suboxic or anoxic but no hydrogen sulphide is found, whereas a big pool of hydrogen sulphide has formed in the Gotland Deep.

The redoxcline in the **Gotland Basin** is found in about 125 m depth and is related to a remarkable turbidity maximum. Below 90 m depth the oxygen concentration is less than 2 ml/l, below the water is anoxic and the deep water contains ample of hydrogen sulphide. The oxygen equivalent amounts -7 ml/l in the Gotland Deep. The accumulated nutrient concentration compares with Atlantic values, phosphate is 6.05 μmol/l, ammonium is 32.6 μmol/l.

The findings in the **Landsort Deep** are similar. The winter water core is found at 50 m depth with a temperature of 3.1°C. Below a depth of 75 m the water is suboxic, and only spurious oxygen is found below 100 m depth. In the 125 m sample hydrogen sulphide is detected. Temperature and salinity are monotonically increasing. Bottom temperature is 6.2°C, bottom salinity 10.79. Phosphate concentration, 3.25 μmol/l is lower than in the Gotland Deep, dissolved inorganic nitrogen (ammonium) concentration is 6.8 μmol/l. The negative oxygen equivalent of hydrogen sulphide near the bottom is -1.39 ml/l in the Landsort Deep and -1.56 ml/l in the Karlsö Deep.

In the Gotland Deep a remarkable signal in the echo sounder was observed more or less permanently between 70 m and 50 m depth indicating a large population of organisms, but not of fish, below the winter water layer. This may be related to catches of moon jellies Aurelia aurita in the plankton net. However, the CTD was covered occasionally with red tentacles of jellies, which should not stem from Aurelia aurita.

Recovering a lost mooring a lot of diverse plastic waste was brought from the sea floor to the surface just from catching a line with a hook over 50 m distance. This indicates pollution of the sea floor in the Gotland Basin with plastic waste of different origin.

12. **Other measurements**

In situ determination of iron(II) in the anoxic zone of the Central Baltic Sea

To determine the concentration of iron(II), an important redox-element in anoxic water, an in situ wet chemical analyzer is used developed in the National Oceanography Centre of Southampton by Dr. Douglas Connelly and Dr. Ralf Prien. This sensor employs the method of unsegmented continuous flow analysis. The sample stream is inoculated with ferene as spectrophotometric reagent, and extinction proportional to the concentration of the analyte is determined. The figure below shows the fluid handling system including two solenoid pumps, two valves, one mixer and the absorption cell as well as the electronics, which can be mounted to a CTD-device. The successful application of the sensor is a step towards the ability to measure highly resolved redox profiles.

The in situ wet chemical analyzer

The IOW profiling mooring

The IOW profiling mooring for the Gotland Deep GODESS (Gotland Deep Environmental Sampling Station) was deployed for its third trial near station TF0271 at a water depth of 244 m.

The deployed system is a first version with a Sea & Sun multi-parameter CTD (parameters: conductivity, temperature, pressure, Chlorophyll-a fluorescence, pH, oxidation / reduction potential, and turbidity) and the Rinko oxygen optode connected to the CTD. The depth of the profiling body is controlled by the underwater winch. Winch and CTD were programmed to take a profile every 8 hours, starting on the 16. November at 14:00 UTC and ending on the 16. February 06:00 UTC. The mooring layout is shown in Fig. 10.

Attachments

Tables 1 - 2: Preliminary results for selected parameters in the surface layer and the near bottom layer (unvalidated results)
Fig. 1: The station grid in the Western and Southern Baltic
Fig. 2: The station grid in the Central Baltic
Fig. 3: Oxygen concentrations in the near bottom layer for selected stations
Fig. 4: Transect from the Kiel Bight to the Gotland Basin for temperature, salinity and oxygen (unvalidated data)
Fig. 5: Transect from the Fehmarn Belt to the Bornholm Basin for temperature, salinity and oxygen (unvalidated data)
Fig. 6: Meridional transect through the Arkona Basin for temperature, salinity and oxygen (unvalidated data)
Fig. 8: Zonal transect through the Bornholm Basin for temperature, salinity and oxygen (unvalidated data)
Fig. 8: Transect through the Gotland Basin for temperature, salinity and oxygen (unvalidated data)
Fig. 9: Transect around northern Gotland for temperature, salinity and oxygen (unvalidated data)
Fig. 10: The mooring layout

Table 1: Surface layer (0 - 10m)

Area	Station	Temperature	Salinity	PO_4	NO_{23}	SiO_4
Date	Name/ No.**	°C	PSU	µmol/l	µmol/l	µmol/l
Kiel Bight	TF0360/08 10.11.2010	9.1 (9.6)	17.27 (15.24)	0.43 (0.35)	0.12 (0.08)	6.7
Meckl. Bight	TF0012/03 09.11.2010	9.4 (10.4)	16.31 (9.76)	0.39 (0.37)	0.21 (0.50)	5.4
Lübeck Bight	TF0022/06 10.11.2010	9.1 (9.9)	15.60 (15.93)	0.48 (0.40)	0.46 (0.16)	7.5
Arkona Basin	TF0113/21 11.11.2010	8.6 (9.67)	7.24 (8.01)	0.29 (0.32)	0.59 (0.30)	7.7
Pom. Bight	TF0160/28 12.11.2010	8.1 (8.30)	6.86 (6.86)	0.29 (0.32)	3.14 (2.02)	14
Bornholm Deep	TF0213/43 14.11.2010	8.82	7.18	0.25	0.45	5.7
Stolpe Channel	TF0222/45 14.11.2010	8.4	7.1	0.19	0.39	5.6
SE Gotland Basin	TF0259/47 14.11.2010	7.8	6.95	0.26	0.5	7.2
Gotland Deep	TF0271/54 15.11.2010	7.7	7.06	0.18	0.54	6.3
Fårö Deep	TF0286/56 17.11.2010	7.1	7.05	0.17	0.6	7.7
Landsort Deep	TF0284/58 18.11.2010	6.46	6.71	0.32	1.26	7.73
Karlsö Deep	TF0245/60 19.11.2010	6.96	6.71	0.24	1.15	9.3

Values in brackets are from 2009

* Σ NO_2^- + NO_3; NO_2 was present only in traces in most areas under investigation
** See maps

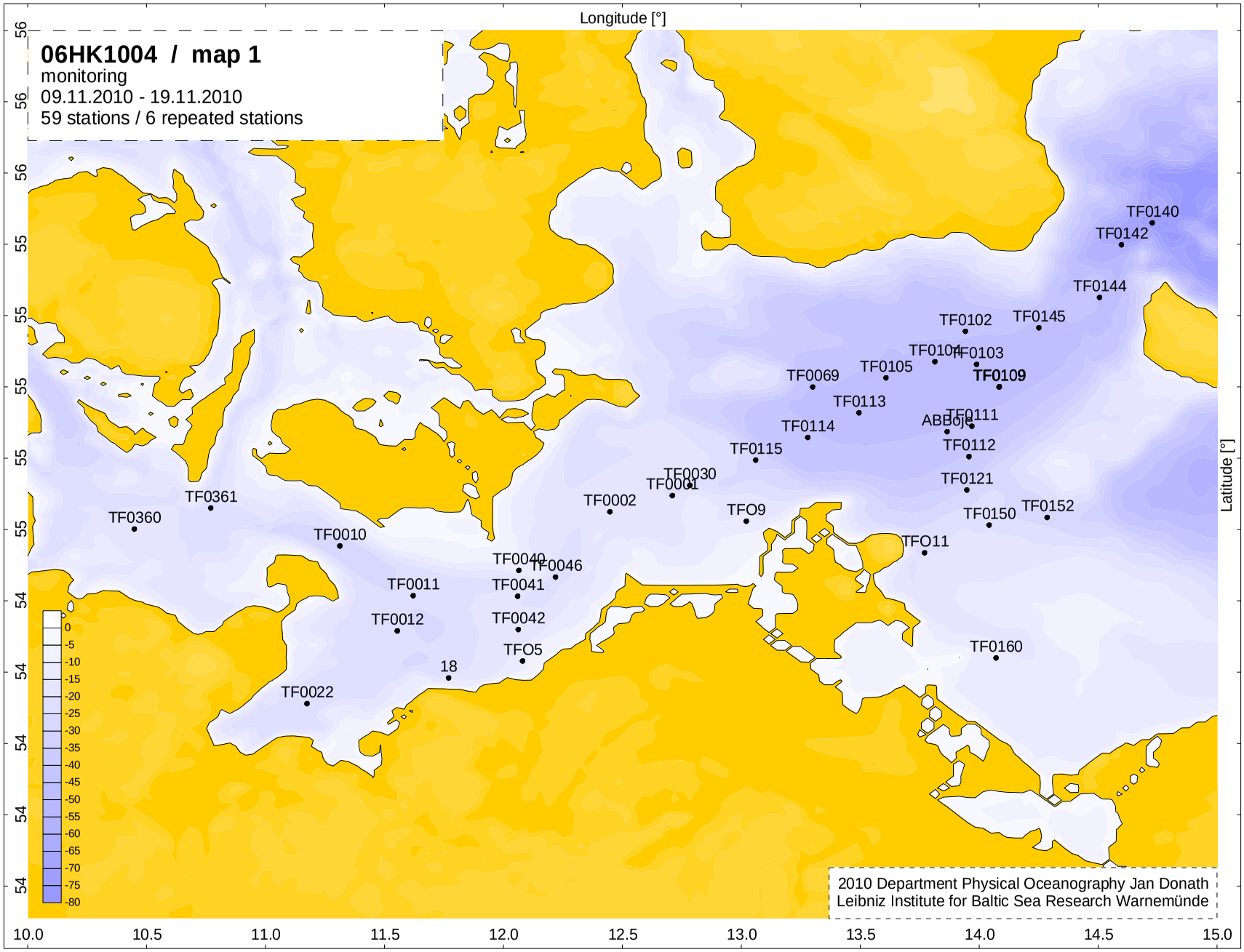
Table 2: Bottom-near water layer

Area	Station	Depth	Temp.	Salinity	O_2	PO_4^{3-}	NO_{23}^{-} *	SiO_4
Date	Name/ No. **	m	°C	PSU	ml/l	µmol/l	µmol/l	µmol/l
Kiel Bight	TF0360/08 10.11.2010	18	10.11 (11.95)	22.94 (22.33)	4.93 (4.34)	0.86 (1.05)	3.01 (5.08)	20.9
Meckl. Bight	TF0012/03 09.11.2010	23	10.07 (12.90)	20.1 (17.77)	5.65 (4.16)	0.86 (1.01)	2.53 (4.26)	15.2
Lübeck Bight	TF0022/06 09.11.2010	23	10.41 (10.74)	19.07 (14.96)	4.58 (4.86)	1.21 (1.11)	2.66 (3.70)	21.4
Arkona Basin	TF0113/21 11.11.2010	46	9.97 (13.81)	15.22 (16.03)	6.58 (2.71)	0.8 (1.40)	2.12 (8.50)	14.6
Pom. Bight	TF0160/28 12.11.2010	12	8.06 (8.31)	6.86 (6.86)	7.79 (7.87)	0.26 (0.30)	3.18 (2.0)	15.4
Bornholm Deep	TF0213/43 14.11.2010	87	8.03	16.14	0.07	4.65	1.78/3.89	63
Stolpe Channel	TF0222/45 14.11.2010	90	6.78	13.27	2.96	1.54	7.48	36.3
SE Gotland Basin	TF0259/47 14.11.2010	86	6.14	10.66	0.2	2.89	5.83	47.6
Gotland Deep	TF0271/54 15.11.2010	228	6.42	12.39	-7.01	6.05	0.42/32.6	94.2
Fårö Deep	TF0286/56 17.11.2010	187	6.72	11.89	-2.97	4.8	0.28	71.8
Landsort Deep	TF0248/58 18.11.2010	431	6.2	10.79	-1.39	3.75	0.13/7.79	60.1
Karlsö Deep	TF0245/60 19.11.2010	101	5.58	10.2	-1.56	4.05	0.17	63.0

Values in brackets are from 2009

* Σ NO_2^- + NO_3; NO_2 was present only in traces in most areas under investigation

** See maps


06HK1004 / map 1
monitoring
09.11.2010 - 19.11.2010
59 stations / 6 repeated stations
Longitude [°]
Latitude [°]
TF0140
TF0142
TF0144
TF0145
TF0102
TF0104
TF0103
TF0105
TF0069
TF0109
TF0113
TF0111
ABBOJE
TF0114
TF0112
TF0115
TF0030
TF0001
TF0121
TF0361
TF0002
TF0152
TF0360
TFO9
TF0150
TF0010
TFO11
TF0040
TF0046
TF0011
TF0041
TF0012
TF0042
TFO5
TF0160
18
TF0022
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
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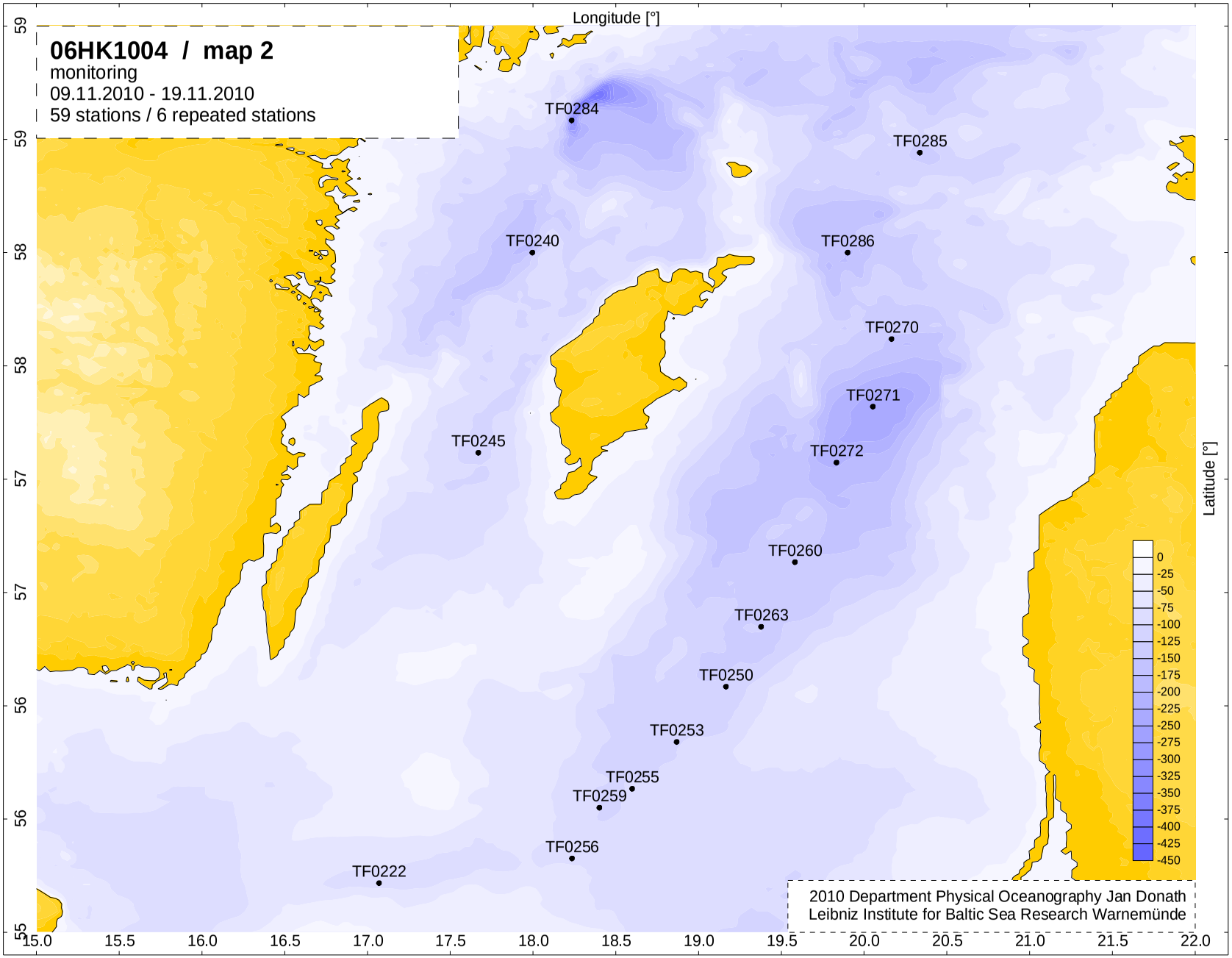
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
56
55
54


06HK1004 / map 2
monitoring
09.11.2010 - 19.11.2010
59 stations / 6 repeated stations
Longitude [°]
Latitude [°]
TF0284
TF0285
TF0240
TF0286
TF0270
TF0271
TF0245
TF0272
TF0260
TF0263
TF0250
TF0253
TF0255
TF0259
TF0256
TF0222
0
-25
-50
-75
-100
-125
-150
-175
-200
-225
-250
-275
-300
-325
-350
-375
-400
-425
-450
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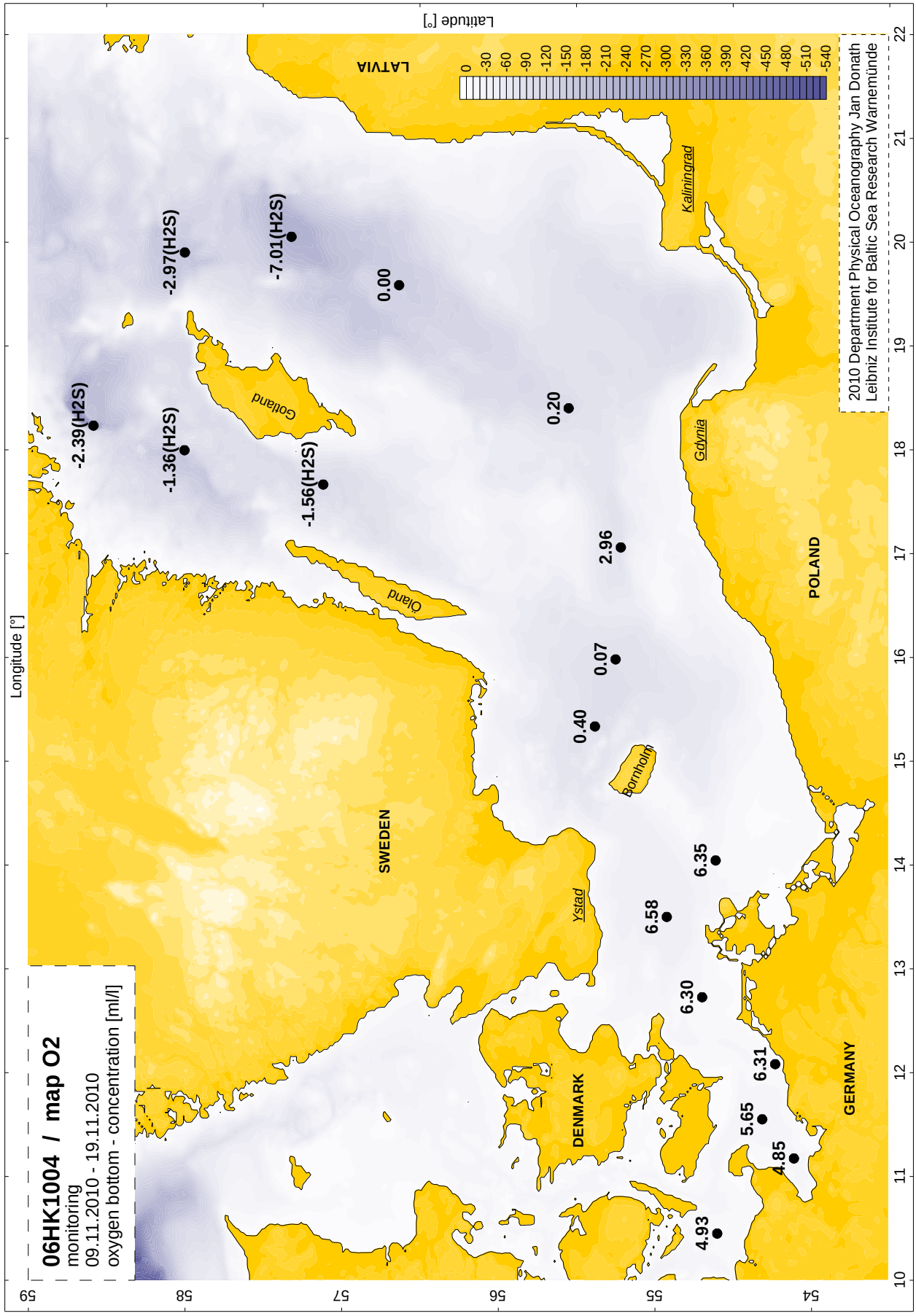
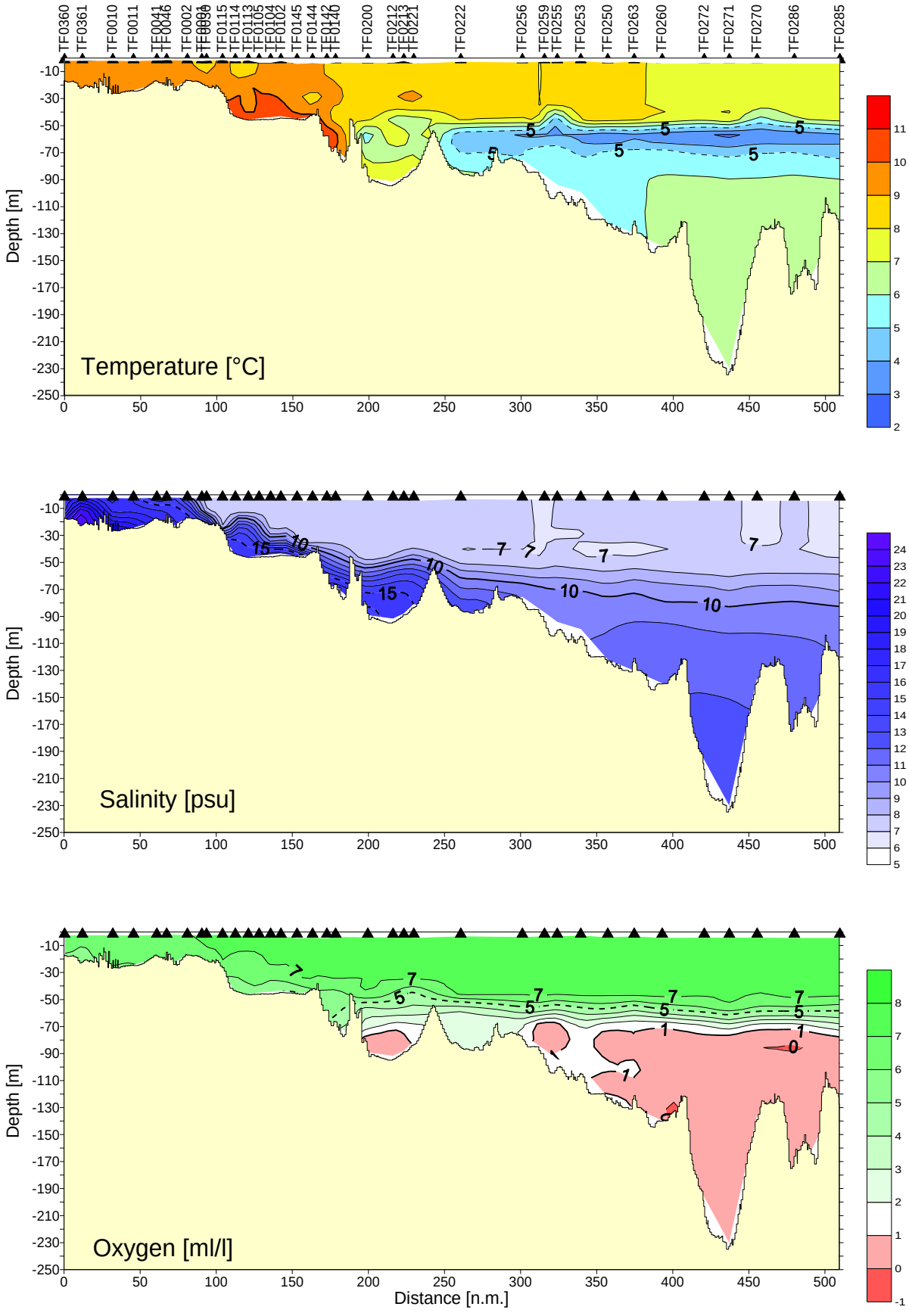

06HK1004 / map O2
monitoring
09.11.2010 - 19.11.2010
oxygen bottom - concentration [ml/l]
2010 Department Physical Oceanography Jan Donath
Leibniz Institute for Baltic Sea Research Warnemünde
Longitude [°]
Latitude [°]
SWEDEN
DENMARK
GERMANY
POLAND
LATVIA
Gotland
Öland
Bornholm
Ystad
Gdynia
Kaliningrad
-2.39(H2S)
-1.36(H2S)
-2.97(H2S)
-1.56(H2S)
-7.01(H2S)
0.00
0.20
2.96
0.07
0.40
6.58
6.30
6.35
6.31
5.65
4.85
4.93

Figure 3

06AK1004

Kiel Bight - Gotland Sea
09.11.2010 13:43 - 17.11.2010 21:00 UTC



05.srf

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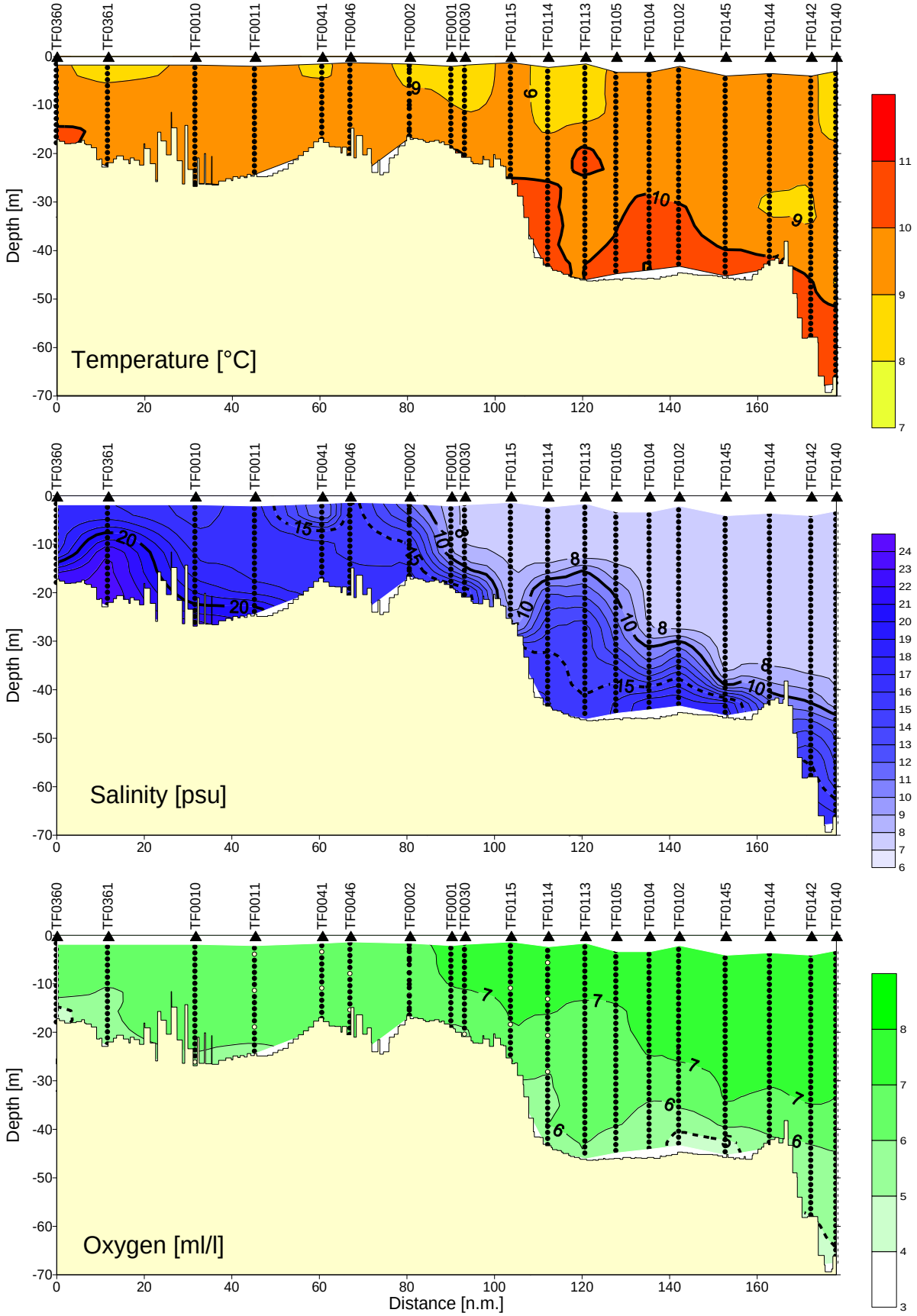
Figure 4

06AK1004

Fehmarnbelt-Bornholmbecken
09.11.2010 13:43 - 13.11.2010 22:58 UTC



01.srf

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Figure 5

06AK1004

Ystadschnitt
12.11.2010 07:32 - 13.11.2010 17:52 UTC

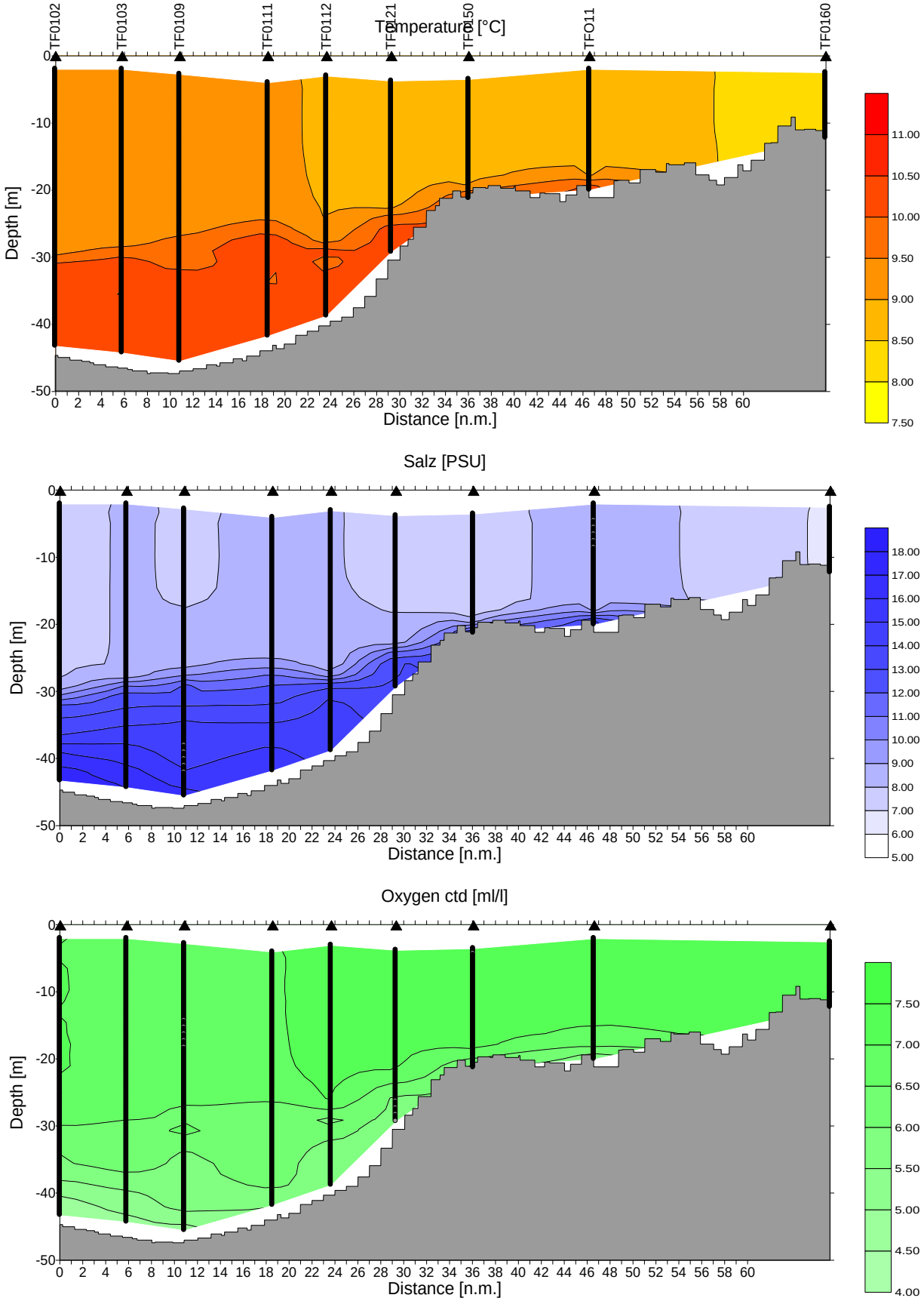

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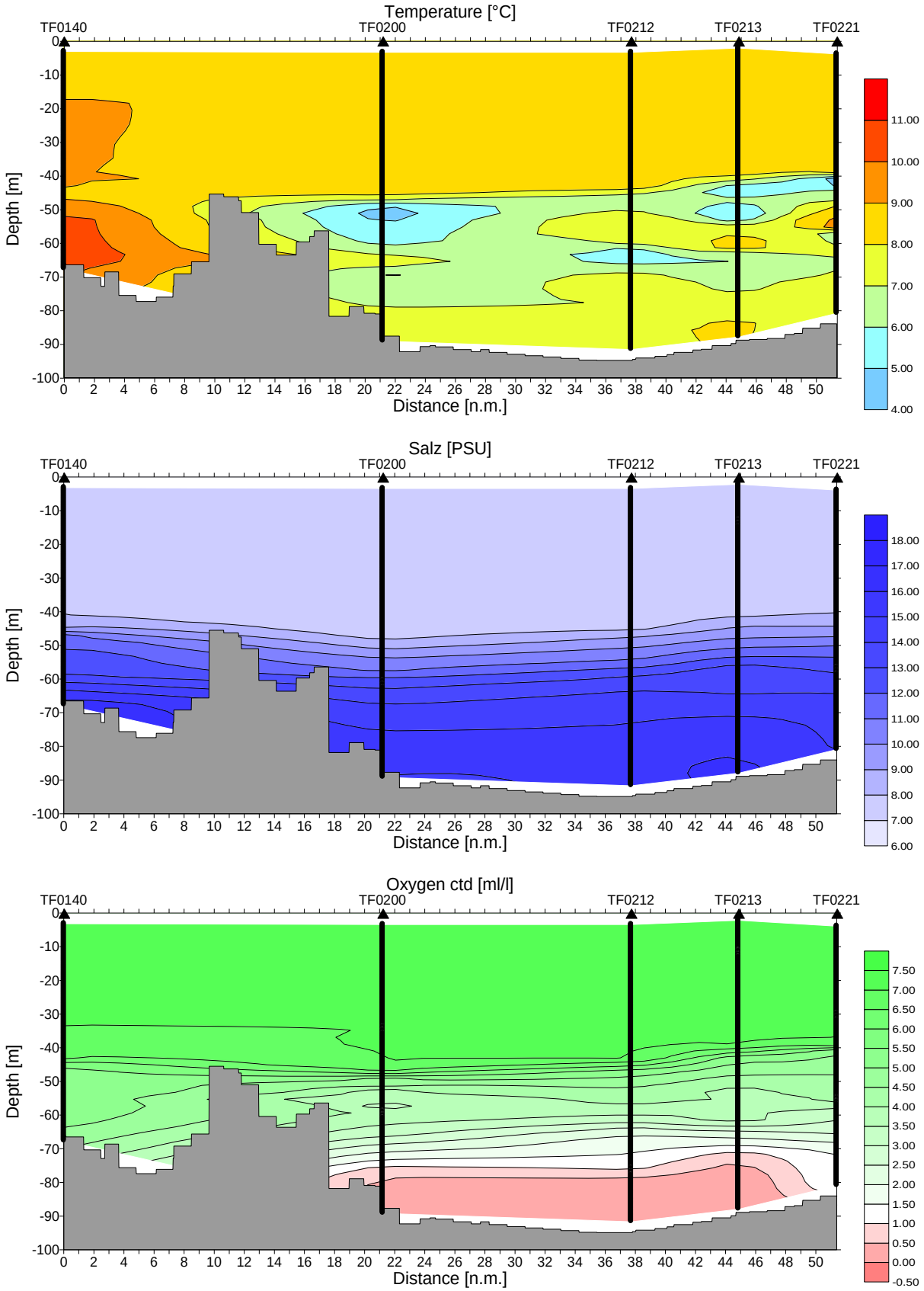
Figure 6

06AK1004

Bornholmbecken
13.11.2010 22:58 - 14.11.2010 07:38 UTC



03.srf

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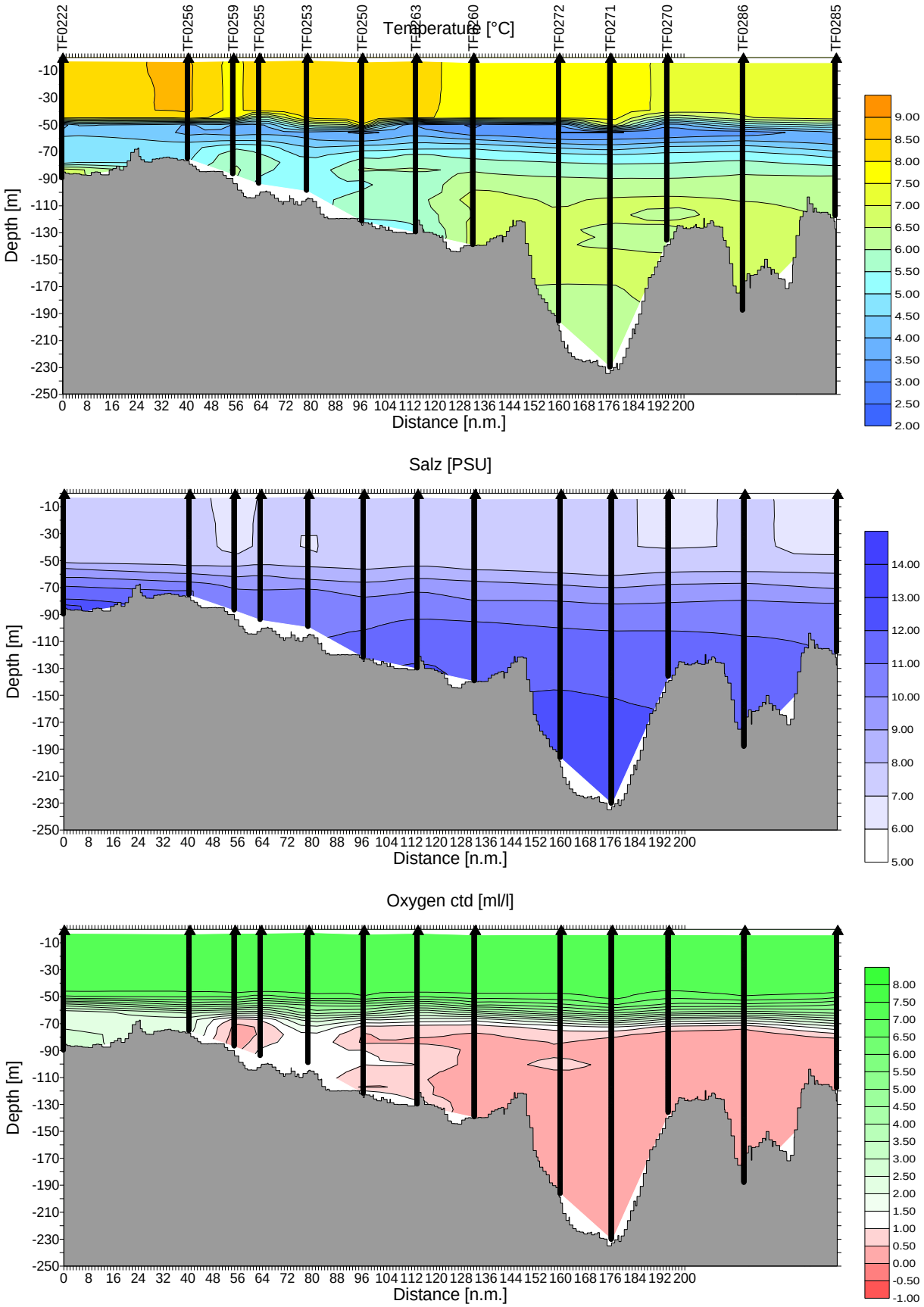
Figure 7

06AK1004

Gotlandbecken
14.11.2010 10:42 - 17.11.2010 21:00 UTC



04.srf

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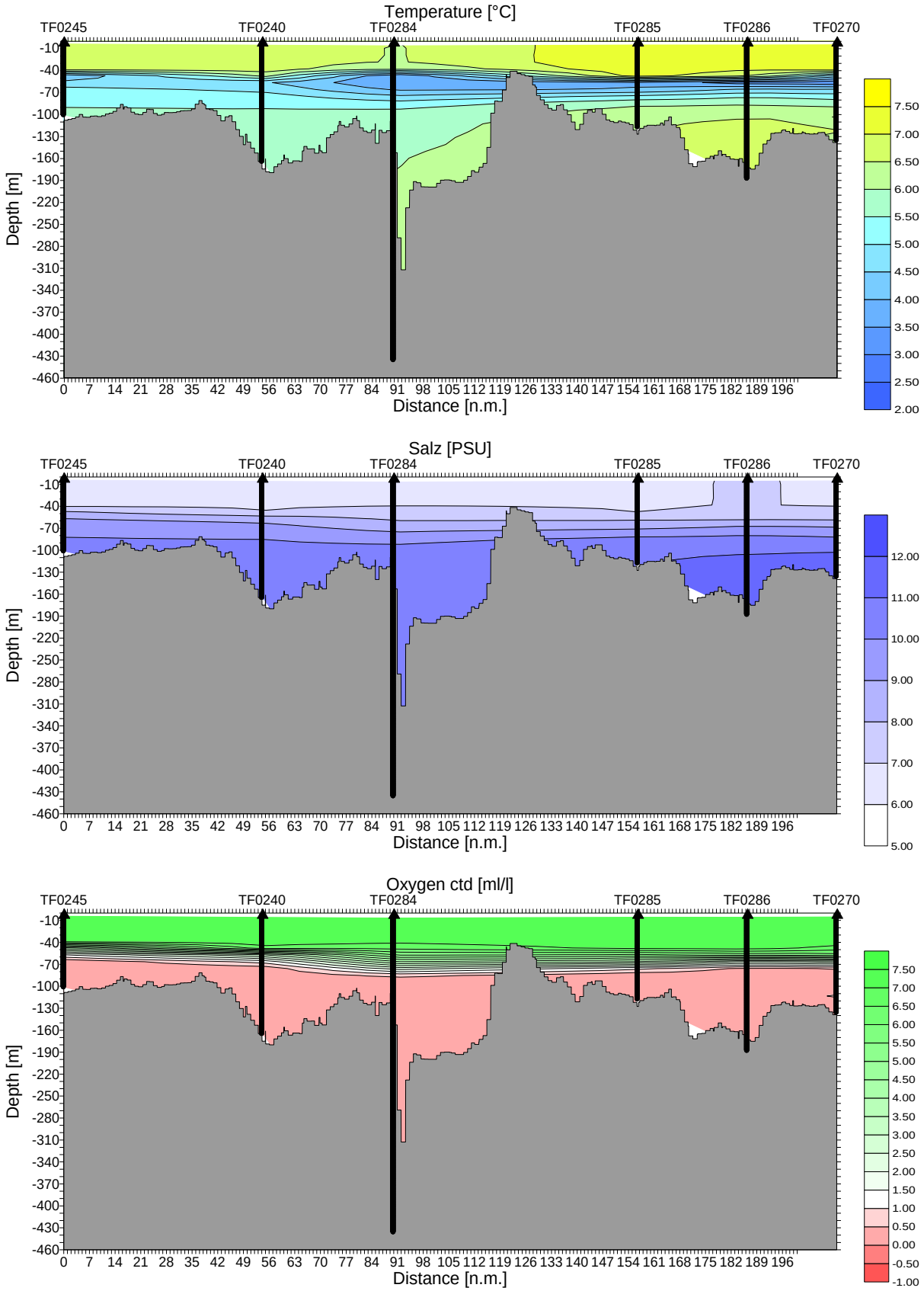
Figure 8

06AK1004

Um Gotland
17.11.2010 12:38 - 19.11.2010 01:13 UTC



04a.srf

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Figure 9

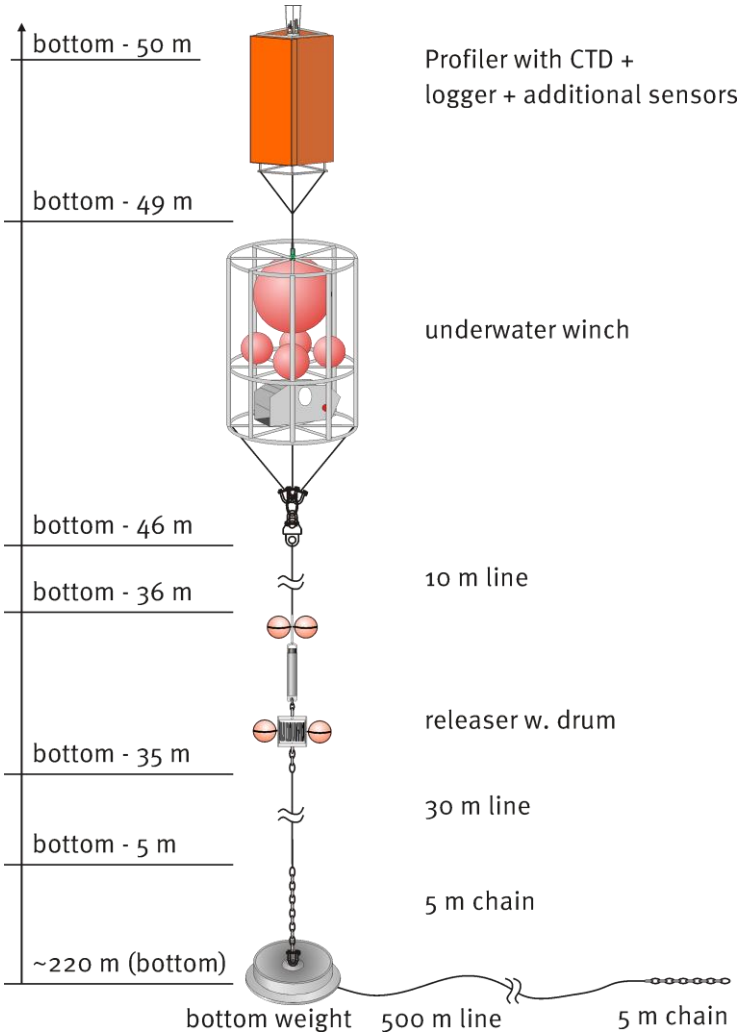
bottom - 50 m
bottom - 49 m
bottom - 46 m
bottom - 36 m
bottom - 35 m
bottom - 5 m
~220 m (bottom)
Profiler with CTD +
logger + additional sensors
underwater winch
10 m line
releaser w. drum
30 m line
5 m chain
bottom weight
500 m line
5 m chain

Figure 10