Leibniz Institute for Baltic Sea Research Warnemünde

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

r/v "Elisabeth Mann Borgese"

Cruise- No. 06EZ1221

This report is based on preliminary data

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1. **Cruise No.:** 06EZ1221

2. **Dates of the cruise:** from 02.Nov.2012 to 15.Nov.2012

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

Name:	Elisabeth Mann Borgese
Nationality:	Germany
Operating Authority:	Leibniz-Institut or Baltic Sea Research Warnemünde

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, 05.11.18:00 – 06.11. 08:00

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

7. **Crew:**

Name of master:	U. Scholz
Number of crew:	11

8. **Research staff:**

Chief scientist:	Dr. Martin Schmidt
Participants:	Jan Donath
	Nadine Keiser
	Michael Pötzsch
	Ingo Schuffenhauer
	Uwe Hehl
	Ines Hand
	Jan Kreuzer
	Jenny Jeschek

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 in the area between the Kiel Bight and the Gotland Sea, (see the attached station maps). The work comprises meteorological,

hydrographical, chemical and biological investigations according to the COMBINE Programme of HELCOM and the long term data acquisition programme of the IOW.

Station work started with a CTD cast measuring pressure, temperature, conductivity (salinity), photosynthetic active radiation, oxygen concentration, fluorescence and turbidity, combined with water sampling for oxygen and nutrient determination and other biochemical measurements. In total 64 hydrographic stations were worked.

For data quality control of the hydrographic data, the CTD is equipped with a double set of sensors. The temperature sensor quality was checked by daily comparison with SIS reversing thermometers. In addition salinity samples were taken within mixed layers to be measured in the lab with a salinometer Autosal 9400. The oxygen sensors are calibrated with bottle data measured with a Titrino 716.

The cruise itself started with moderate winds but after a longer period with strong winds. In the Western Baltic wind speed was rising soon to 7Bf from south-west and made benthos sampling complicated. Surface cooling and convective mixing is favoured by air temperature mostly below the sea surface temperature in combination with a dew point temperature below the sea surface temperature. Because of strong wind, station work was not resumed after the scheduled overnight stop in Saßnitz from 5th.to 6th of November. After staying in Saßnitz and anchoring in the Tromper Wiek the ship was heading directly towards the Gotland Sea in the morning of the 8th of November. After a transit with rough weather conditions, station work could be continued at TF0271 during a short period of low sea state. Especially, the mooring equipped with a sediment trap, an ADCP and several thermistors could be recovered and layed out again. Working stations north and west of Gotland, wind varies from 4 to 7 Bf with prevailing southern direction. In the evening of 12th November station work was interrupted again by gale-force winds. In the morning of 13th November measurements were resumed and all scheduled stations could be worked.

West of the Darß Sill the usual temperature/salinity pattern formed during dissolution of a summer stratification is found: warmer and more saline water in the depth and less saline water at the surface already showing the signal from recent cooling. The water masses with higher salinity are displaced westward. Maximum bottom salinity amounts only to 20.4 and is found within the Fehmarn Belt at TF0010. This warm saline water is oxygen depleted and should be a remainder of the summer stratification. Towards Darß Sill the water body is vertically almost uniform with the exception of a thin warmer and more salty bottom layer. The remaining weak stratification permits a mixed layer depth of ~ 10 m over Darß Sill rising to about 15 m west of Darß Sill and 37 m in the central Arkona Basin. Surface nutrient concentration except silicate are low. There is some phosphate left over which allows possibly for phytoplankton activity keeping nitrate/nitrite exhausted.

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 (and, hence, older) than the saline water west of Darss Sill. There is only little water with sufficient density to propagate through Bornholms Gatt. Moreover there is some cold water with low salinity off Saßnitz (TF0150) with origin in the pool of Bornholm Sea winter water indicating a general outflow situation.

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 (not to be seen in Fig. 5) that indicate some inflow not dense enough to replace the Bornholm Sea bottom water. Below the winter water, 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 from anoxic conditions in the bottom water and related phosphate mobilisation and denitrification during the last 3 months.

The mixing surface layer in the **Gotland Basin** extends to a depth of 31 m at station TF0271. Here some warmer themocline water still exists, at other stations mixing reaches deeper down to the winter water, in part down to 60 m. Winter water extends from 45 m to 75 m depth. At station TF0271 the core of the winter water is at 65 m depth with a temperature of 3.5°C. Bottom water temperature in the central Gotland Basin is 6.4°C, bottom salinity is 12.19.

The redoxcline in the **Gotland Basin** is found in about 100 m depth. Downward from the core of the winter water layer, oxygen concentration tends nearly linearly to zero with increasing depth. Where water becomes anoxic there is a pronounced turbidity maximum. At some stations there are intrusions of oxic water below the uppermost redoxcline and several turbidity maxima are observed. Below the turbidity maximum usually hydrogen sulphide is found. At station TF0286 enhanced turbidity is observed also near the bottom. The video system attached to the CTD shows the difference between both the turbidity peaks. The turbidity in the redoxcline corresponds to opalescent water, whereas the turbidity at the bottom of TF0286 is related to extremly dense marine snow.

At all stations around Gotland hydrogen sulphide is found. The maximum concentration (oxygen equivalent) is -7.4 ml/l found at TF0271, less compared with values from August 2011. A large pool of nutrients is found below the redoxcline. At TF0271 phosphate concentration amounts up to 6.8 μmol/l, which is enhanced compared with August 2011. Nitrogen (as ammonium) concentration is about 40 μmol/l and silicate 111 μmol/l.

Nutrient surface concentration is generally low, phosphate about 0.6 μmol/l in the western Baltic Sea, and well below 0.2 μmol/l around Gotland. The nitrate/nitrate concentration is of the same order of magnitude or below the phosphate concentration. An exception is TF0113 in the Arkona Basin. The mixed layer depth is large and the ammonium found in the surface layer is most probably mixed up from the nutrient rich bottom water.

At several stations plankton was sampled with WP2 nets, sample depths 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 ...

At 8 stations (TF0360, TF0012, TF0010, TF0018, TF0030, TF0109, TF0152, TF0160) macrozoobenthos investigations were carried out. The stations were located in the Kiel Bight (1 station), Fehmarn Belt (1 stn) Mecklenburg Bight (2 stns), Darss-Rise (1 stn), Arkona Basin (1stn) and Pomeranian Bay (2 stns). At each station 3 van Veen grab samples were taken for later analysis of macrozoobenthic species (taxa, abundance and biomass). One additional sample will be used for sediment analysis. A dredge haul was used to record rare and mobile species at each station. Abiotic parameters like bottom water salinity and oxygen content were gathered from the physical and chemical oceanography at the same stations. The Kiel Bight station was taxonomically most diverse with high numbers and biomass of bivalve species. At the station in the centre of the Arkona Basin very low species numbers were observed. At no station a decline of species number and abundance due to oxygen depletion was detectable.

12. **Other measurements**

In the Baltic Sea the composition of sea water differs from that in the global ocean. In the course of a project to improve the knowledge on the equation of state of sea water for the Baltic Sea samples for direct density measurements are taken at several stations.

Attachments

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

Table 1: Surface layer (0 - 10m)

Area	Station	Tempera-ture	Salinity	PO_4	NO_{23} (DIN)	SiO_4
Date	Name/ No. **	°C	PSU	µmol/l	µmol/l	µmol/l
Kiel Bight	TF0360/08 03.11.2012	9.3	16.57	0.52	0.04 (0.30)	15.4
Meckl. Bight	TF0012/03 02.11.2012	9.3	11.2	0.62	0.15 (0.48)	17.2
Lübeck Bight	TF0022/06 02.11.2012	9.1	11.3	0.59	0.05	16.4
Arkona Basin	TF0113/21 03.11.2012	9.0	8.2	0.66	0.18 (3.16)	15.0
Pom. Bight	TF0160/31 04.11.2012	8.66	7.44	0.43	0.42	18.0
Bornholm Deep	TF0213/43 14.11.2012	9.31	7.70	0.54	0.28	11.1
Stolpe Channel	TF0222/50 13.11.2012	9.28	7.37	0.49	0.79	12.4
SE Gotland Basin	TF0259/48 12.11.2012	9.50	7.33	0.40	0.48	10.9
Gotland Deep	TF0271/32 09.11.2012	9.21	6.91	0.16	0.19 (0.91)	5.9
Fårö Deep	TF0286/34 09.11.2012	8.54	6.71	0.09	0.14 (0.48)	14.3
Landsort Deep	TF0284/38 10.11.2012	7.32	6.41	0.28	0.49 (0.99)	10.0
Karlsö Deep	TF0245/41 11.11.2012	7.34	6.76	0.3	0.23 (0.56)	13.7

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

DIN = $\Sigma\ NO_2^- + NO_3 + NH_4$

** 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 03.11.2012	17	10.5	18.6	5.69	0.81	0.32 (0.95)	20.8
Meckl. Bight	TF0012/03 02.11.2012	22	11.9	18.7	3.51	1.89	2.04 (5.78)	40.3
Lübeck Bight	TF0022/06 02.11.2012	22	12.3	19.4	2.65	2.65	2.27	51.6
Arkona Basin	TF0113/21 03.11.2012	44	12.9	16.4	2.97	1.28	7.35 (8.85)	32.0
Pom. Bight	TF0160/31 04.11.2012	13	8.64	7.44	7.43	0.44	0.43	18.3
Bornholm Deep	TF0213/52 13.11.2012	87	6.38	15.34	0.13	2.64	2.16 (3.46)	65,7
Stolpe Channel	TF0222/50 13.11.2012	90	5.92	12.31	2.27	1.58	7.09	44.2
SE Gotland Basin	TF0259/48 12.11.2012	86	5.05	9.96	0.33	2.6	2.4 (2.95)	51.1
Gotland Deep	TF0271/32 09.11.2012	228	6.42	12.17	-7.44	6.8	0.0 (39.83)	111.0
Fårö Deep	TF0286/34 09.11.2012	187	6.13	11.52	-3.2	4.8	0.0 (25.16)	78.9
Landsort Deep	TF0284/38 10.11.2012	430	5.63	10.48	-1.19	3.95	0.0 (8.77)	61
Karlsö Deep	TF0245/41 11.11.2012	105	5.20	9.65	-0.56	3.8	0.0 (6.71)	57.9

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

DIN = $\Sigma\ NO_2^- + NO_3 + NH_4$

** See maps

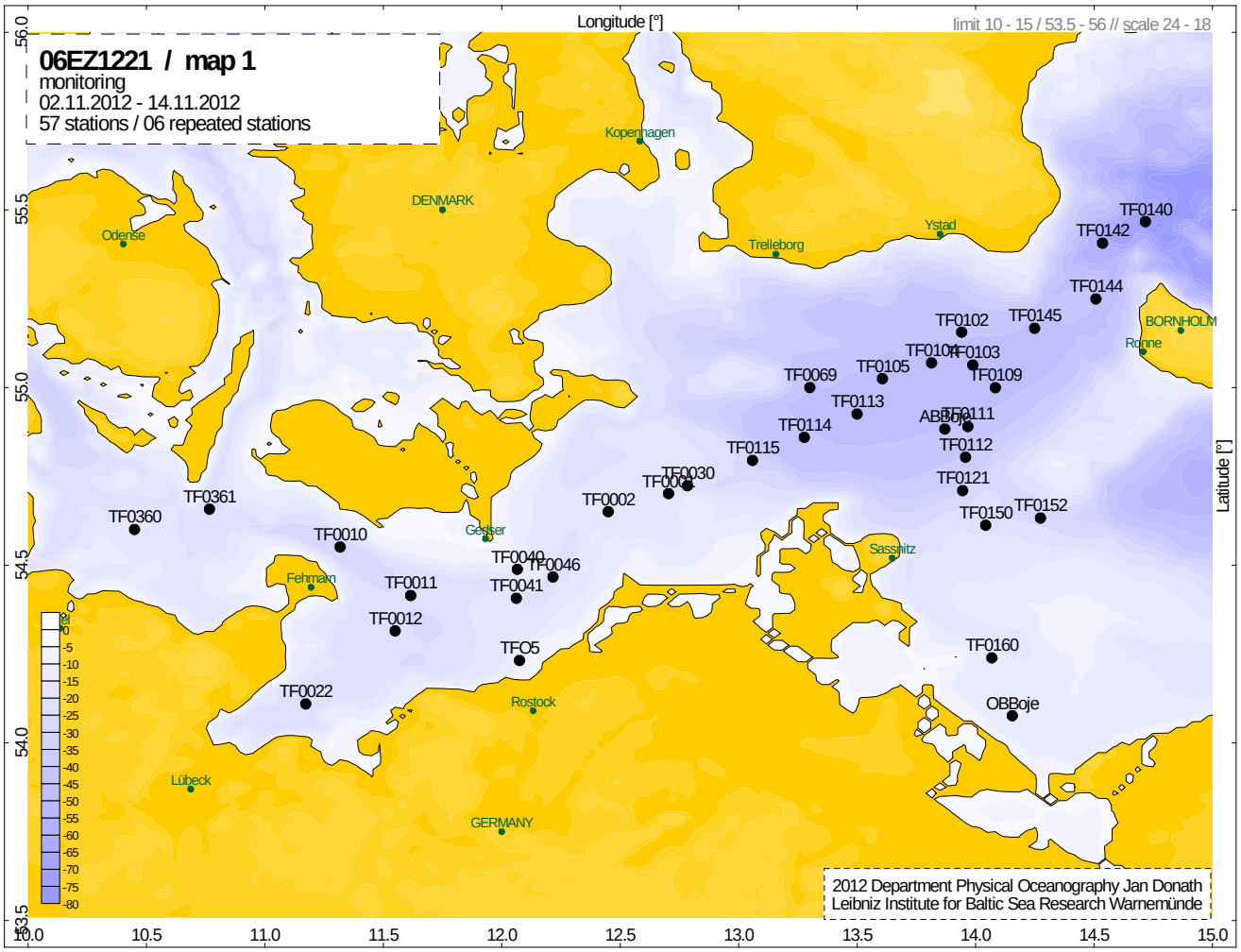
06EZ1221 / map 1
monitoring
02.11.2012 - 14.11.2012
57 stations / 06 repeated stations
Longitude [°]
limit 10 - 15 / 53.5 - 56 // scale 24 - 18
Latitude [°]
Kopenhagen
DENMARK
Odense
Trelleborg
Ystad
Rønne
BORNHOLM
Fehmarn
Gedser
Sassnitz
Rostock
Lübeck
GERMANY
TF0140
TF0142
TF0144
TF0145
TF0102
TF0104
TF0103
TF0105
TF0069
TF0109
TF0113
TF0111
TF0114
TF0115
TF0112
TF0121
TF0030
TF0004
TF0002
TF0150
TF0152
TF0361
TF0360
TF0010
TF0040
TF0046
TF0041
TF0011
TF0012
TFO5
TF0160
TF0022
OBBoje
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Figure 1

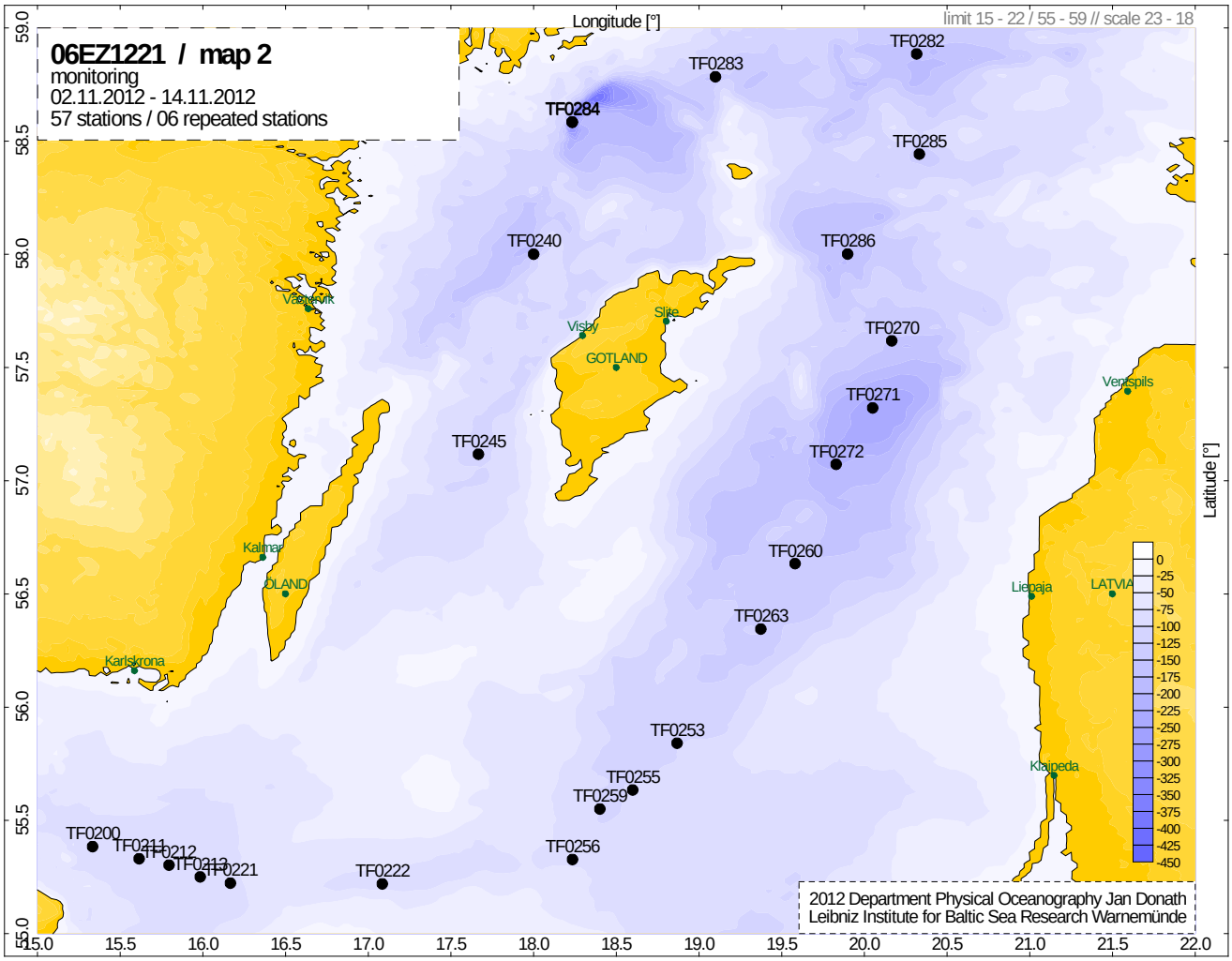
06EZ1221 / map 2
monitoring
02.11.2012 - 14.11.2012
57 stations / 06 repeated stations
limit 15 - 22 / 55 - 59 // scale 23 - 18
Longitude [°]
Latitude [°]
TF0282
TF0283
TF0284
TF0285
TF0240
TF0286
TF0270
TF0271
TF0245
TF0272
TF0260
TF0263
TF0253
TF0255
TF0259
TF0256
TF0200
TF0211
TF0212
TF0213
TF0221
TF0222
Visby
Slite
GOTLAND
Kalmar
ÖLAND
Karlskrona
Ventspils
Liepaja
LATVIA
Klaipeda
0
-25
-50
-75
-100
-125
-150
-175
-200
-225
-250
-275
-300
-325
-350
-375
-400
-425
-450
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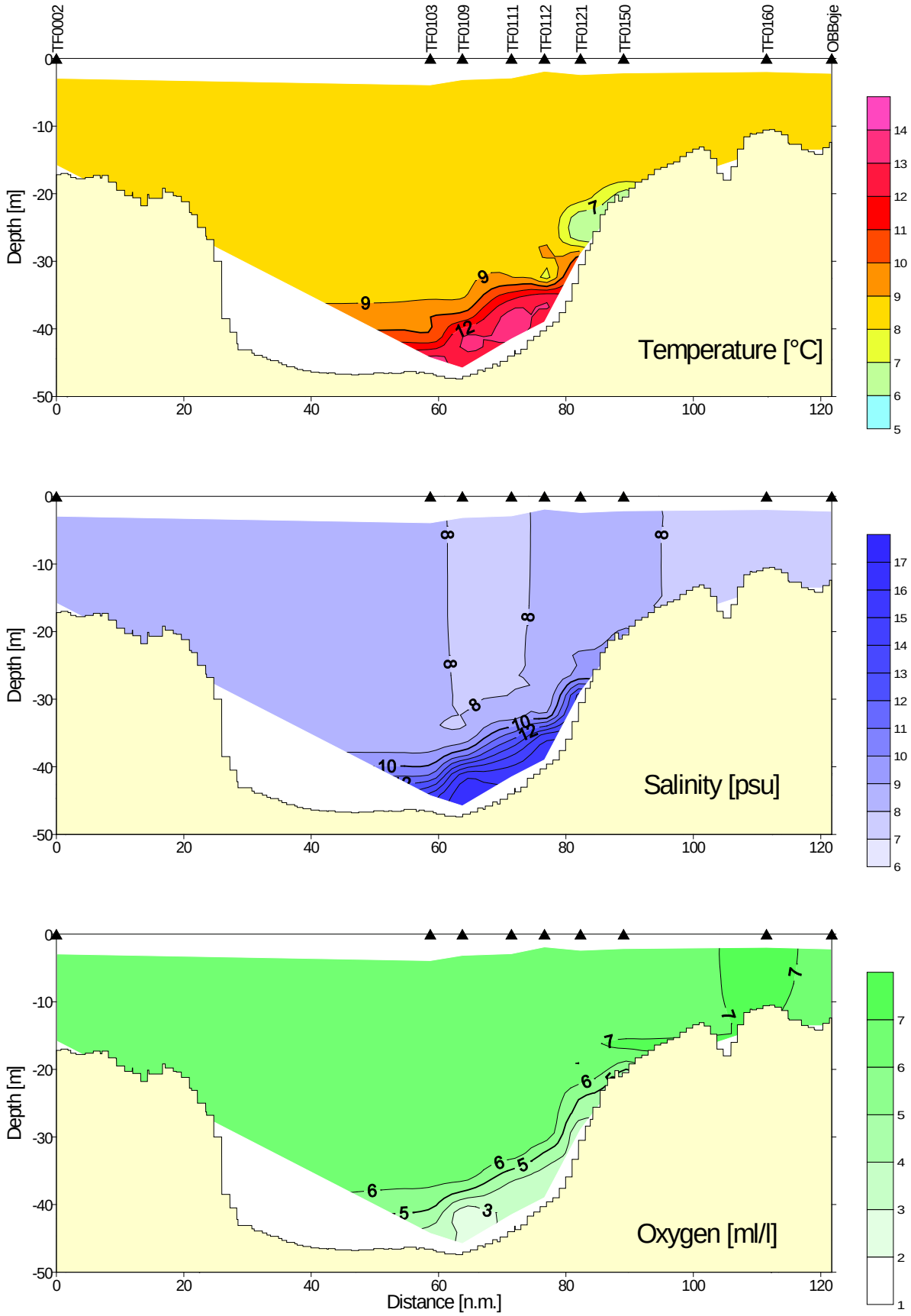
Figure 2

06EZ1221

Ystadschnitt
03.11.2012 16:48 - 05.11.2012 10:07 UTC

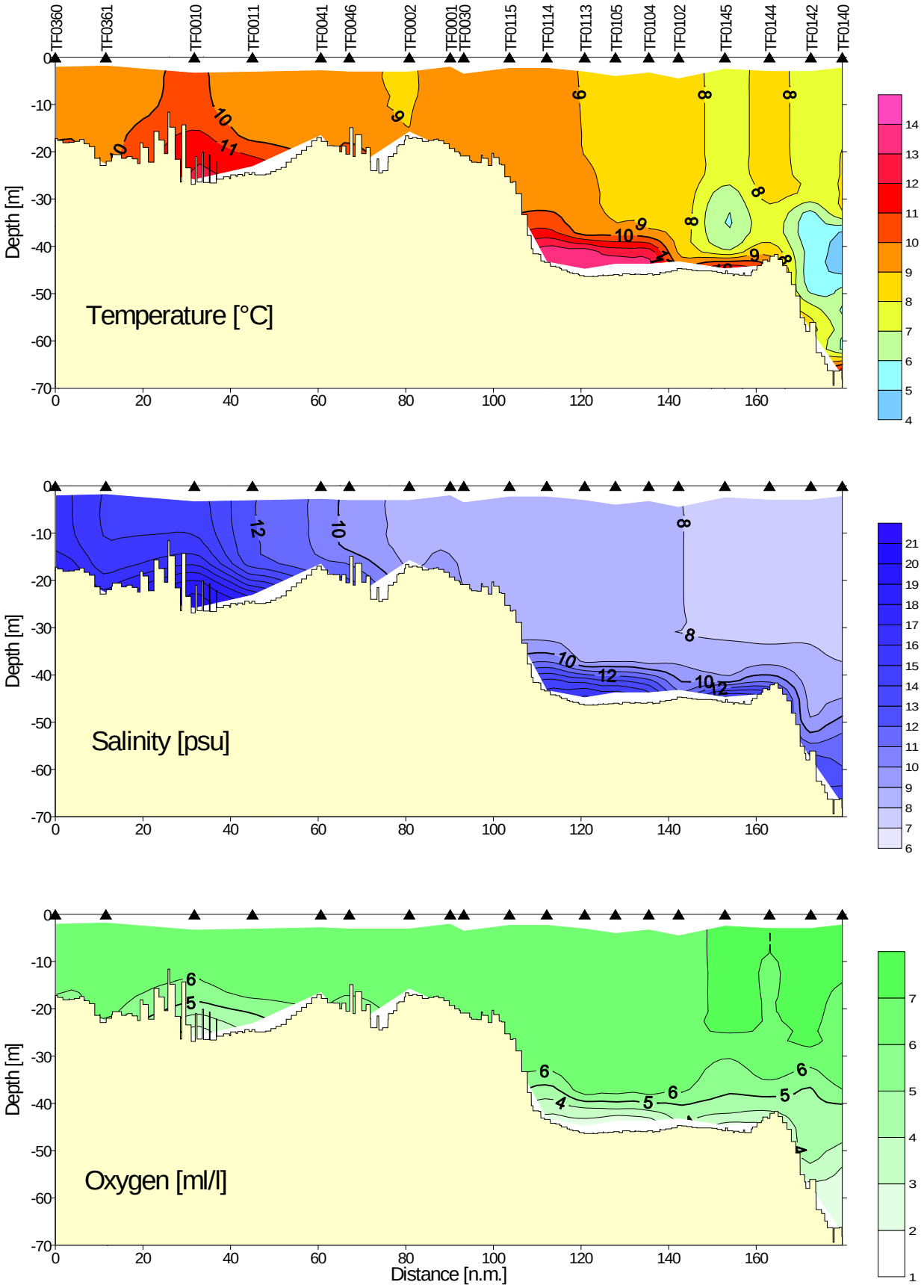


02.srf

Figure 3

06EZ1221

Fehmarnbelt-Bornholmbecken
02.11.2012 13:20 - 14.11.2012 01:57 UTC

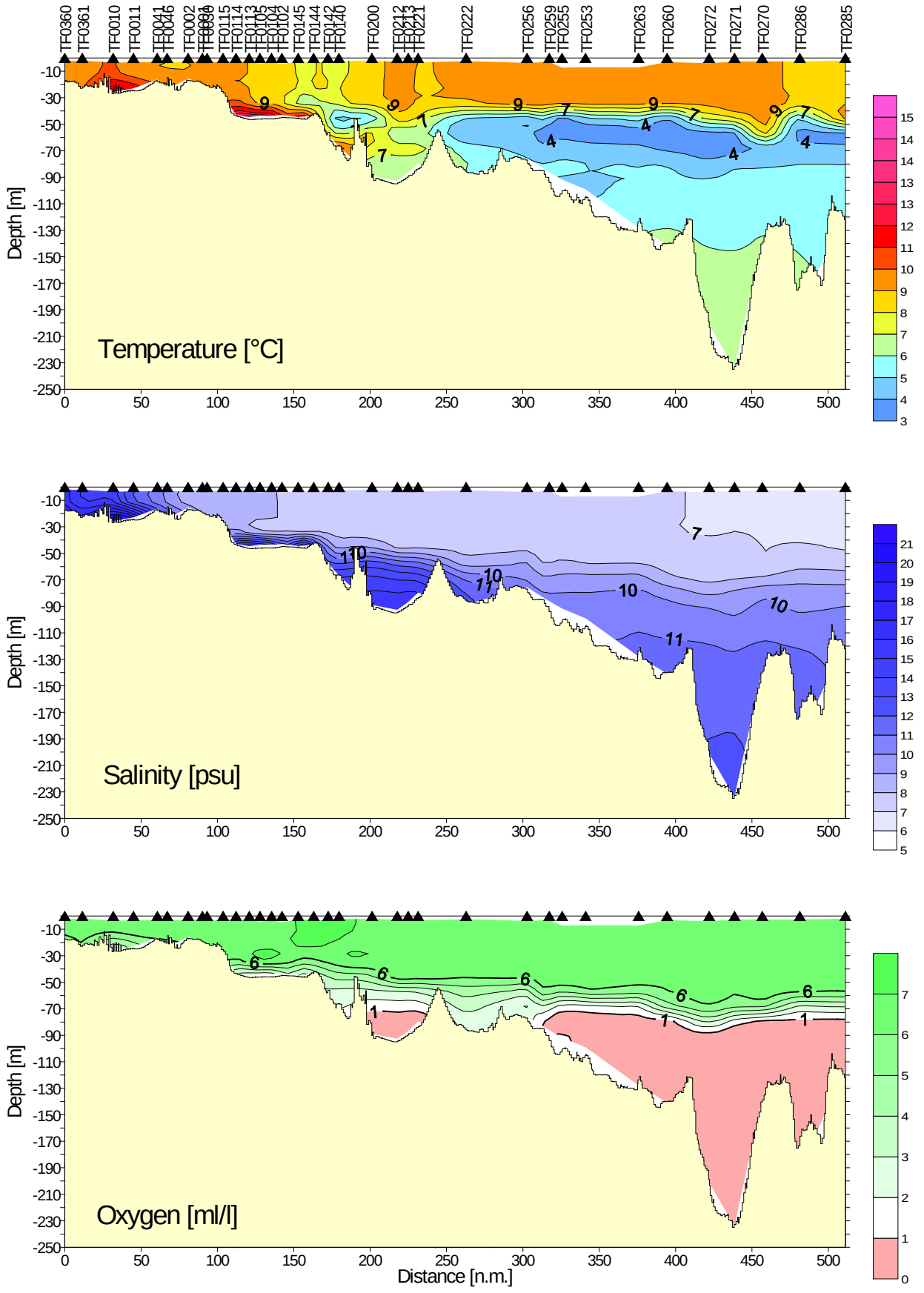


01.srf

Figure 4

06EZ1221

Kiel Bight - Gotland Sea
02.11.2012 13:20 - 14.11.2012 01:57 UTC



05.srf

Figure 5

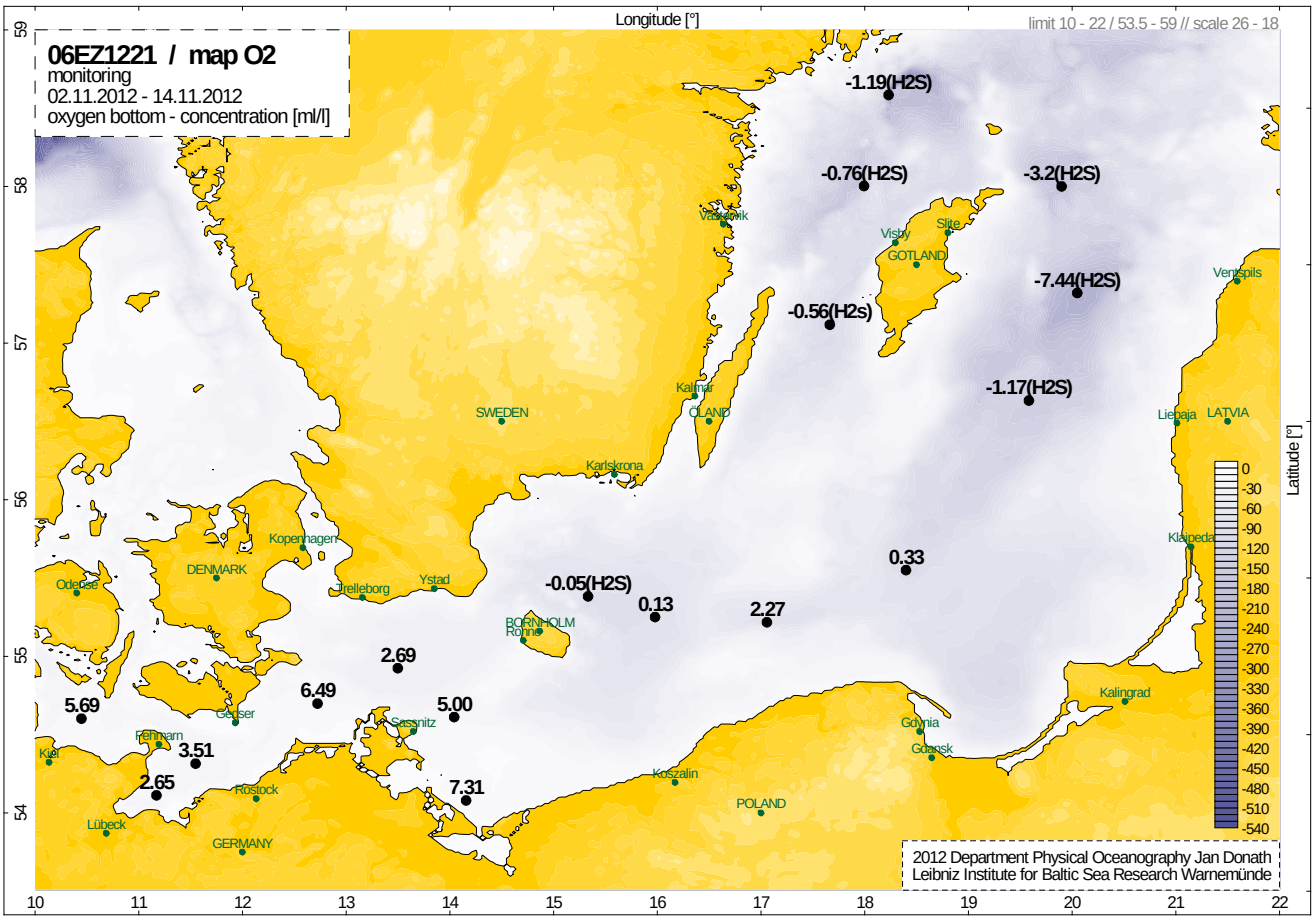

06EZ1221 / map O2
monitoring
02.11.2012 - 14.11.2012
oxygen bottom - concentration [ml/l]
Longitude [°]
limit 10 - 22 / 53.5 - 59 // scale 26 - 18
Latitude [°]
-1.19(H2S)
-0.76(H2S)
-3.2(H2S)
-7.44(H2S)
-0.56(H2s)
-1.17(H2S)
0.33
-0.05(H2S)
0.13
2.27
2.69
6.49
5.69
5.00
3.51
2.65
7.31
SWEDEN
DENMARK
GERMANY
POLAND
LATVIA
GOTLAND
ÖLAND
Kopenhagen
Karlskrona
Ystad
Trelleborg
Rönne
Sassnitz
Rostock
Lübeck
Kiel
Fehmarn
Gedser
Odense
Kalmar
Visby
Slite
Vaxholm
Ventspils
Liepaja
Klaipeda
Kaliningrad
Gdynia
Gdansk
Koszalin
0
-30
-60
-90
-120
-150
-180
-210
-240
-270
-300
-330
-360
-390
-420
-450
-480
-510
-540
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Figure 6