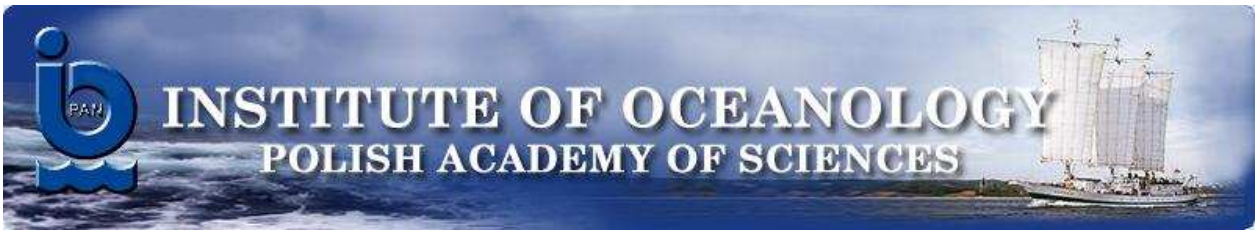

Powstańców Warszawy 55, 81-712 Sopot, Poland, P.O. Box 68

10 December, 2011

Cruise Report
RV Oceania, AREX2011

Institution	Institute of Oceanology Polish Academy of Sciences
Ship Name	RV Oceania
Cruise Name	AREX2011
Time Frame	20.06.2011 – 20.07.2011
Port Calls	Tromsø (Norway), Longyearbyen (Spitsbergen)
Research Area	the Norwegian, Greenland and Barents Seas
Chief Scientist	Waldemar Walczowski, Assoc. Prof.
Principal Project	AWAKE
Number of Scientist	12

Hydrological conditions of the Norwegian, Barents and Greenland Seas.

Walczowski W., Piechura J., Goszczko I, Promińska A., Wieczorek P.

1. Observations and deployments

The main part of the Arctic Experiment of the Institute of Oceanology, Polish Academy of Sciences (IO-PAN), the so-called AREX2011, was performed aboard RV Oceania between 20 June and 20 July, 2011. During this cruise part profiles along standard sections were done. As in previous years the sections were perpendicular to the general direction of the Atlantic Water (AW) inflow according to the West Spitsbergen Current (WSC) location, which is situated between the Barents Sea slope in the south-east area, the west Spitsbergen shelf-break/slope region in the north-east and a system of underwater ridges: Mohn Ridge and Knipovich Ridge on the west. Because of the convergence of the isobaths in the northern part, currents pattern and structure is complicated and forms a wedge, wide in the southern part and narrower on the north. Main effort concentrated in the northern part of the Atlantic Domain where processes controlling the AW inflow into the Arctic Ocean through the Fram Strait and the westward recirculation occur, moreover section located close to the Norwegian Gimsøy section was performed as it was before 2006.

All in all, 151 CTD profiles were taken along 11 sections (Fig.1, Tab.1). The Seabird CTD (SBE 911+) system with duplicate temperature and conductivity and some additional sensors (temperature sensors SBE3, conductivity sensors SBE4 and SBE 50 digital oceanographic pressure sensor, SBE 43 dissolved oxygen sensor, Alec Electronics Co., Ltd. Optical DO sensor Rinko III and Seapoint Sensors, Inc. Fluoroscein fluorometer) was used. SBE sensors were calibrated by the Sea-Bird Electronics service before the cruise.

Currents measurements were performed at all the CTD stations with downward looking lowered Acoustic Doppler Current Profiler (LADCP) as well. The self-recording 300 kHz RDI devices was used to profile entire water column during the standard CTD casts. Moreover, sustained currents measurements were performed during the whole cruise with the ship-mounted ADCP, RDI 150 kHz.

Three mooring systems were recovered and re-deployed in the Hornsund (one in the mouth, two inside the Hornsund fjord) in connection to the AWAKE Project. Moreover a new mooring was installed south of South Cape to investigate flow of the South Cape Current.

At some stations water samples collected with the rosette water sampler SBE32 were analyzed as concerned nutrients contents. Due to harsh weather some collections have to be canceled.

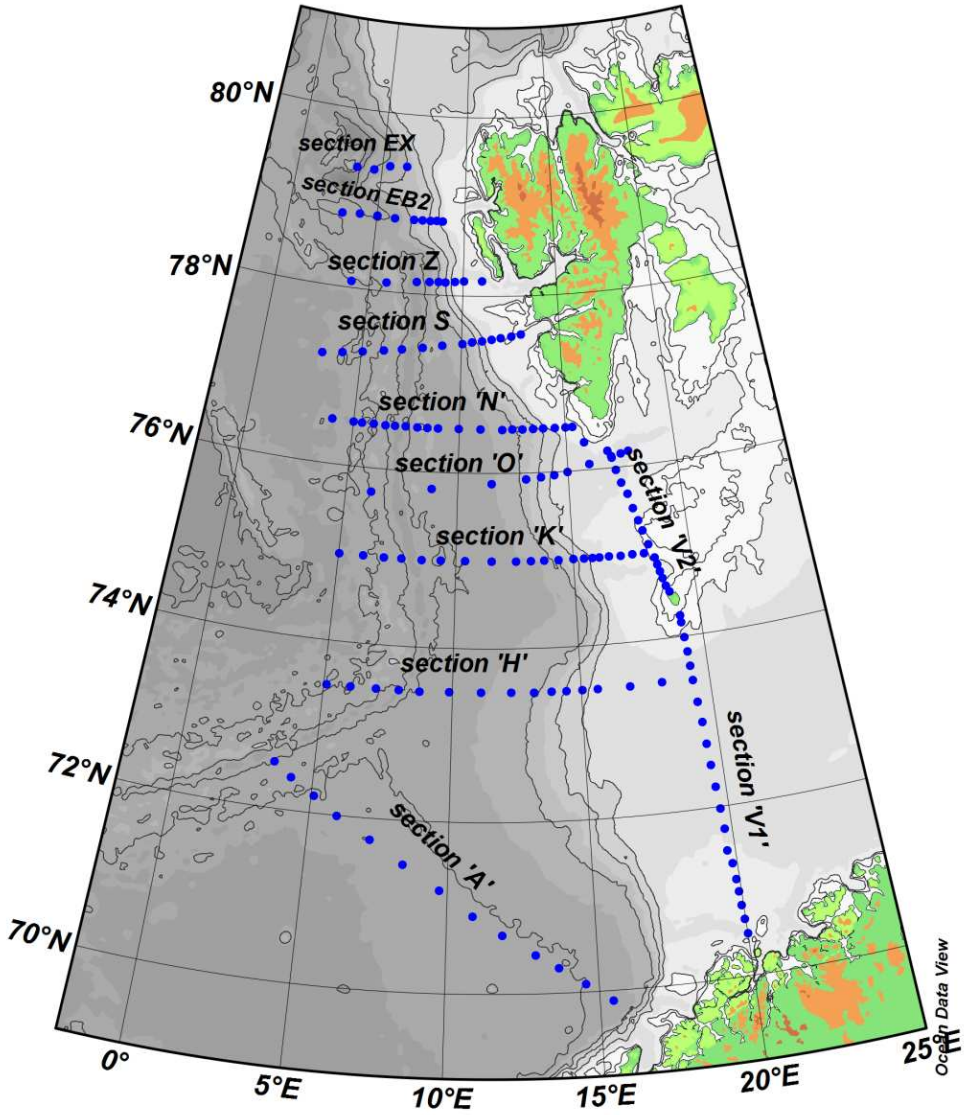

Figure 1: Geographical locations of CTD stations performed during IO-PAN Arctic Experiment AREX2011 aboard RV Oceania in summer 2011.

Tabel 1. CTD stations performed during the 2011 cruise and some of their main parameters.

No	Station	Depth	Latitude	Longitude	Date	Time	File/Cast
1	V1	135	70°30.03N	019°59.87E	20-Jun-2011	07:09	AR10_001
2	V2	150	70°39.99N	019°58.03E	20-Jun-2011	08:33	AR10_002
3	V3	175	70°50.02N	019°55.96E	20-Jun-2011	09:58	AR10_003
4	V4	185	70°59.86N	019°54.44E	20-Jun-2011	11:25	AR10_004
5	V5	215	71°08.51N	019°52.23E	20-Jun-2011	13:52	AR10_005
6	V6	215	71°20.06N	019°50.13E	20-Jun-2011	15:58	AR10_006
7	H2	415	73°30.62N	018°08.19E	24-Jun-2011	11:34	AR10_007
8	H5	450	73°29.87N	016°53.52E	24-Jun-2011	14:08	AR10_008
9	H7	485	73°29.89N	015°37.40E	24-Jun-2011	16:40	AR10_009
10	H4	695	73°29.93N	015°01.68E	24-Jun-2011	18:06	AR10_010
11	H8	1035	73°30.03N	014°24.40E	24-Jun-2011	19:47	AR10_011
12	H9	1315	73°29.96N	013°50.12E	24-Jun-2011	21:28	AR10_012
13	H10	1600	73°29.82N	013°09.83E	24-Jun-2011	23:54	AR10_013
14	H11	1835	73°29.93N	012°16.32E	25-Jun-2011	02:25	AR10_014
15	H12	2095	73°29.93N	011°05.35E	25-Jun-2011	05:21	AR10_015
16	H13	2325	73°30.02N	009°52.42E	25-Jun-2011	08:39	AR10_016
17	H14	2525	73°29.68N	008°42.39E	25-Jun-2011	11:54	AR10_017
18	H15	3060	73°29.74N	007°54.62E	25-Jun-2011	14:38	AR10_018
19	H16	2260	73°29.92N	007°01.18E	25-Jun-2011	18:02	AR10_019
20	H17	1930	73°29.97N	006°01.05E	25-Jun-2011	20:52	AR10_020
21	H18	2805	73°29.72N	005°05.94E	25-Jun-2011	23:16	AR10_021
22	A17	2565	72°32.52N	003°30.63E	26-Jun-2011	07:04	AR10_022
23	A16	2490	72°22.96N	004°11.33E	26-Jun-2011	09:57	AR10_023
24	A15	2830	72°12.05N	005°05.17E	26-Jun-2011	13:17	AR10_024
25	A14	2895	71°59.95N	005°59.04E	26-Jun-2011	16:56	AR10_025

26	A13	2865	71°45.36N	007°13.10E	26-Jun-2011	20:47	AR10_026
27	A12	2780	71°29.32N	008°24.95E	27-Jun-2011	01:03	AR10_027
28	A11	2675	71°12.35N	009°42.54E	27-Jun-2011	05:18	AR10_028
29	A10	2650	70°54.79N	010°52.40E	27-Jun-2011	09:21	AR10_029
30	A9	2675	70°41.28N	011°52.09E	27-Jun-2011	15:49	AR10_030
31	A8	2650	70°27.35N	012°57.05E	27-Jun-2011	19:48	AR10_031
32	A7	1880	70°17.73N	013°42.27E	27-Jun-2011	23:01	AR10_032
33	A5	1430	70°05.56N	014°34.37E	28-Jun-2011	03:02	AR10_033
34	A3	1520	69°53.00N	015°24.99E	28-Jun-2011	07:28	AR10_034
35	V7	245	71°29.03N	019°43.03E	29-Jun-2011	03:46	AR10_035
36	V8	265	71°44.50N	019°44.05E	29-Jun-2011	05:59	AR10_036
37	V9	315	71°58.80N	019°40.99E	29-Jun-2011	07:44	AR10_037
38	V10	330	72°14.35N	019°37.19E	29-Jun-2011	09:45	AR10_038
39	V11	400	72°29.44N	019°33.96E	29-Jun-2011	11:43	AR10_039
40	V12	400	72°44.50N	019°31.05E	29-Jun-2011	13:42	AR10_040
41	V12	415	72°59.93N	019°28.03E	29-Jun-2011	15:37	AR10_041
42	V14	455	73°14.23N	019°23.89E	29-Jun-2011	18:17	AR10_042
43	V15	480	73°29.29N	019°20.24E	29-Jun-2011	20:04	AR10_043
44	V15	350	73°39.36N	019°18.31E	29-Jun-2011	21:56	AR10_044
45	V17	235	73°49.36N	019°16.20E	29-Jun-2011	23:16	AR10_045
46	V18	130	73°59.49N	019°13.37E	30-Jun-2011	00:42	AR10_046
47	V19	75	74°09.77N	019°11.12E	30-Jun-2011	02:04	AR10_047
48	V20	60	74°14.74N	019°10.14E	30-Jun-2011	02:57	AR10_048
49	V21	25	74°31.99N	018°52.94E	30-Jun-2011	05:34	AR10_049
50	V22	70	74°36.23N	018°45.24E	30-Jun-2011	06:43	AR10_050
51	V23	100	74°41.40N	018°40.16E	30-Jun-2011	07:33	AR10_051
52	V24	230	74°46.38N	018°34.63E	30-Jun-2011	08:16	AR10_052

53	V25	205	74°51.37N	018°30.24E	30-Jun-2011	09:05	AR10_053
54	V26	70	74°56.37N	018°25.50E	30-Jun-2011	09:54	AR10_054
55	V27	70	75°05.57N	018°13.78E	30-Jun-2011	11:22	AR10_055
56	V28	65	75°15.43N	018°03.26E	30-Jun-2011	12:28	AR10_056
57	V29	105	75°22.60N	017°55.55E	30-Jun-2011	13:22	AR10_057
58	V30	135	75°31.56N	017°44.24E	30-Jun-2011	14:30	AR10_058
59	V31	215	75°41.43N	017°33.96E	30-Jun-2011	15:47	AR10_059
60	V32	290	75°49.38N	017°21.45E	30-Jun-2011	17:00	AR10_060
61	V33	320	75°58.46N	017°09.93E	30-Jun-2011	18:23	AR10_061
62	V34	285	76°06.93N	017°01.59E	30-Jun-2011	19:43	AR10_062
63	V35a	285	76°12.13N	016°51.09E	30-Jun-2011	21:08	AR10_063
64	K-3	155	74°59.90N	018°00.37E	01-Jul-2011	05:00	AR10_064
65	K-2	115	75°00.03N	017°30.18E	01-Jul-2011	06:09	AR10_065
66	K-1	130	74°59.87N	017°00.29E	01-Jul-2011	08:23	AR10_066
67	K0	230	75°00.08N	016°30.18E	01-Jul-2011	09:36	AR10_067
68	K1	215	75°00.01N	016°06.16E	01-Jul-2011	10:35	AR10_068
69	K2	320	75°00.03N	015°48.72E	01-Jul-2011	11:33	AR10_069
70	K3	805	75°00.03N	015°26.86E	01-Jul-2011	12:47	AR10_070
71	K4	1120	75°00.02N	014°59.99E	01-Jul-2011	14:24	AR10_071
72	K5	1555	74°59.92N	014°21.50E	01-Jul-2011	17:06	AR10_072
73	K6	1820	75°00.08N	013°44.84E	01-Jul-2011	19:25	AR10_073
74	K7	2010	75°00.04N	013°10.53E	01-Jul-2011	21:21	AR10_074
75	K8	2190	75°00.06N	012°32.80E	01-Jul-2011	23:32	AR10_075
76	K9	2410	75°00.07N	011°31.19E	02-Jul-2011	02:36	AR10_076
77	K10	2540	75°00.08N	010°22.42E	02-Jul-2011	05:53	AR10_077
78	K11	2595	75°00.15N	009°20.60E	02-Jul-2011	08:47	AR10_078
79	K12	2910	75°00.05N	008°31.74E	02-Jul-2011	11:32	AR10_079

80	K13	2260	75°00.05N	007°40.71E	02-Jul-2011	14:25	AR10_080
81	K14	2085	75°00.08N	006°55.92E	02-Jul-2011	16:51	AR10_081
82	K15	2875	75°00.16N	006°02.02E	02-Jul-2011	19:28	AR10_082
83	K16	3110	74°59.97N	005°00.36E	02-Jul-2011	23:20	AR10_083
84	O12	2500	75°43.97N	006°06.67E	03-Jul-2011	06:14	AR10_084
85	O-10	2385	75°48.75N	008°48.99E	03-Jul-2011	11:19	AR10_085
86	O-8	2095	75°52.99N	011°31.29E	03-Jul-2011	16:32	AR10_086
87	O-6	1385	75°55.84N	013°04.87E	03-Jul-2011	19:51	AR10_087
88	O-4	905	75°56.82N	013°45.79E	03-Jul-2011	21:45	AR10_088
89	O-2	340	75°58.07N	014°20.85E	03-Jul-2011	23:28	AR10_089
90	M4	340	75°59.76N	014°58.33E	04-Jul-2011	00:50	AR10_090
91	O2	390	76°04.05N	015°59.32E	04-Jul-2011	03:02	AR10_091
92	O4	285	76°07.98N	016°59.90E	04-Jul-2011	04:50	AR10_092
93	O5	310	76°09.33N	017°28.26E	04-Jul-2011	06:28	AR10_093
94	O6a	285	76°10.63N	017°48.92E	04-Jul-2011	07:33	AR10_094
95	Sørkapp	135	76°19.21N	015°49.71E	04-Jul-2011	13:10	AR10_095
96	S1	135	77°34.18N	013°00.72E	09-Jul-2011	06:26	AR10_096
97	S2	95	77°33.03N	012°31.23E	09-Jul-2011	07:40	AR10_097
98	S3	180	77°32.05N	011°59.10E	09-Jul-2011	09:21	AR10_098
99	S4	275	77°30.95N	011°30.38E	09-Jul-2011	10:44	AR10_099
100	S5	720	77°29.94N	011°01.55E	09-Jul-2011	12:18	AR10_100
101	S6	1245	77°28.95N	010°31.31E	09-Jul-2011	14:18	AR10_101
102	S7	1605	77°27.92N	010°01.44E	09-Jul-2011	16:50	AR10_102
103	S8	2090	77°26.06N	009°01.51E	09-Jul-2011	20:02	AR10_103
104	S9	2330	77°24.04N	008°01.55E	09-Jul-2011	23:54	AR10_104
105	S10	2600	77°21.98N	007°00.23E	10-Jul-2011	04:33	AR10_105
106	S12	2620	77°20.16N	006°04.78E	10-Jul-2011	15:39	AR10_106

107	S13	2390	77°18.08N	005°01.93E	10-Jul-2011	19:40	AR10_107
108	S15	2590	77°16.10N	004°02.42E	10-Jul-2011	22:54	AR10_108
109	S16	2920	77°14.05N	003°02.43E	11-Jul-2011	02:26	AR10_109
110	N-11	2635	76°30.42N	003°59.24E	11-Jul-2011	09:54	AR10_110
111	N-10	2400	76°30.03N	004°58.95E	11-Jul-2011	13:34	AR10_111
112	N-9	2590	76°30.10N	005°23.56E	11-Jul-2011	15:42	AR10_112
113	N-8	2570	76°30.03N	005°57.34E	11-Jul-2011	18:03	AR10_113
114	N-7	2520	76°29.98N	006°29.31E	11-Jul-2011	20:30	AR10_114
115	N-6	2965	76°30.06N	006°56.81E	11-Jul-2011	22:52	AR10_115
116	N-5	2545	76°30.17N	007°27.14E	12-Jul-2011	01:44	AR10_116
117	N-5	1790	76°29.92N	007°59.77E	12-Jul-2011	04:29	AR10_117
118	N-3	2295	76°29.89N	008°29.44E	12-Jul-2011	06:32	AR10_118
119	N-2	2290	76°29.90N	008°59.44E	12-Jul-2011	08:40	AR10_119
120	N-1	2235	76°30.05N	009°57.29E	12-Jul-2011	11:32	AR10_120
121	N0	2120	76°30.00N	010°59.54E	12-Jul-2011	14:31	AR10_121
122	N1	1920	76°29.58N	012°00.06E	12-Jul-2011	17:35	AR10_122
123	N1P	1760	76°29.83N	012°29.71E	12-Jul-2011	19:46	AR10_123
124	N2	1550	76°29.71N	012°57.48E	12-Jul-2011	21:53	AR10_124
125	N2P	1270	76°29.96N	013°27.90E	13-Jul-2011	00:01	AR10_125
126	N3	760	76°30.02N	013°56.94E	13-Jul-2011	01:41	AR10_126
127	N3P	210	76°29.96N	014°30.07E	13-Jul-2011	03:09	AR10_127
128	N4	160	76°29.94N	014°59.59E	13-Jul-2011	04:08	AR10_128
129	N4P	150	76°30.02N	015°18.95E	13-Jul-2011	05:50	AR10_129
130	Z1	255	78°10.44N	011°00.31E	13-Jul-2011	20:46	AR10_130
131	Z2	265	78°10.05N	010°02.23E	13-Jul-2011	22:17	AR10_131
132	Z3	270	78°09.49N	009°33.41E	13-Jul-2011	23:20	AR10_132
133	Z5	1120	78°09.08N	009°02.85E	14-Jul-2011	00:29	AR10_133

134	Z6	1570	78°08.97N	008°40.33E	14-Jul-2011	02:08	AR10_134
135	Z7	2215	78°08.73N	008°11.16E	14-Jul-2011	04:12	AR10_135
136	Z8	3425	78°08.09N	007°29.92E	14-Jul-2011	07:19	AR10_136
137	Z10	2515	78°06.19N	005°53.25E	18-Jul-2011	23:38	AR10_137
138	Z12	2940	78°04.65N	004°00.98E	19-Jul-2011	04:15	AR10_138
139	EB2-12	2455	78°49.28N	003°01.05E	19-Jul-2011	10:49	AR10_139
140	EX10a	2085	79°21.10N	003°28.81E	19-Jul-2011	15:40	AR10_140
141	EX9a	2050	79°21.02N	004°29.83E	19-Jul-2011	17:58	AR10_141
142	EX8	645	79°24.36N	005°25.38E	19-Jul-2011	20:13	AR10_142
143	EX7	1480	79°25.13N	006°27.53E	19-Jul-2011	22:12	AR10_143
144	EB-2	215	78°49.97N	008°44.24E	20-Jul-2011	07:30	AR10_144
145	EB2-3	710	78°50.18N	008°23.88E	20-Jul-2011	08:13	AR10_145
146	EB2-4	985	78°49.80N	008°03.47E	20-Jul-2011	09:37	AR10_146
147	EB2-5	1140	78°49.94N	007°35.21E	20-Jul-2011	11:11	AR10_147
148	EB2-6	1410	78°49.96N	007°07.00E	20-Jul-2011	12:37	AR10_148
149	EB2-8	2455	78°49.93N	006°01.48E	20-Jul-2011	14:57	AR10_149
150	EB2-10	2695	78°50.22N	005°00.94E	20-Jul-2011	18:10	AR10_150
151	EB2-11	2235	78°50.12N	003°59.76E	20-Jul-2011	21:13	AR10_151

2. Preliminary results

Section V1 closes the Barents Sea Opening area. Since it is performed every summer, it shows approximate rate of the exchange between the Norwegian and Barents Seas. As in 2010, weather conditions didn't allow us to examine the whole section, however, even from the scattered stations we could obtain general parameters of AW. Comparatively to the previous year, temperature seems to be similar, salinity increased a bit. Baroclinic transport calculated across the section was equal to 1.73 Sv (into the Barents Sea), heat transport equals 39 TW. Both attained maximal values ever noted at that section. The Norwegian Coastal Current reached wider range as well (Fig. 2).

Section V2 which crosses the mouth of the Storfjord Trough, closes the entrance between the Bear Island and the South Cape of Spitsbergen. In the southern part the AW inflow dominates in the intermediate and lower depths, in the northern part, the cold South Cape Current is visible in the surface layer in addition to the AW recirculation (outflow from the Storfjord Trough). Dense, cold water plume was present near the bottom following the topography. The area occupied by AW increased as compared to 2010. The salinity of AW increased considerably, temperature rise was not so significant (Fig. 3).

Section H is the most southern parallel one, performed along the 73°30'N. The properties of AW at this section (also at the section K) may anticipate AW properties observed in the Fram Strait even with one year time lag. Because of that they may be used as some kind of prediction for conditions occurring in the North. Unusual broadening of the AW inflow to the north was observed in 2011. All the observed and estimated parameters: the western location of the Arctic Front, thickness and area occupied by AW (the widest since 2000) clearly confirm this evidence. The AW temperature increased slightly (still comparable to the low values) since salinity increased significantly and reached the maximal value ever. There is an indication of the large AW inflow. Lack of positive correlation between temperature and salinity changes points out a strong local cooling in winter (Fig. 5).

Generally, temperature and salinity in the southern part increased (Fig. 2-7) in summer 2011. It may also suggest warm summer in the Fram Strait in 2012. In the northern part of the investigated area temperature decreased second time in a row, while salinity increased continuously (Fig. 8-11).

Section N is the longest „time series" of the IO-PAN and probably the most representative for the averaged parameters of AW in the whole examined area (between the North Norway and the Fram Strait). Decrease of temperature and increase of salinity was observed, similar to 2010. It may probably confirm the argument for local cooling (Fig. 8).

In addition to that, another evidence was observed – the northern advection of the warm water along the eastern branch of the WSC. The 5°C isotherm at 100 m depth was shifted significantly to the north, in comparison to 2010. Temperature above 5°C was noted even at EB2 section (not visible because of the griding procedure). It may confirm presumable warming in 2012 as well (Fig. 12).

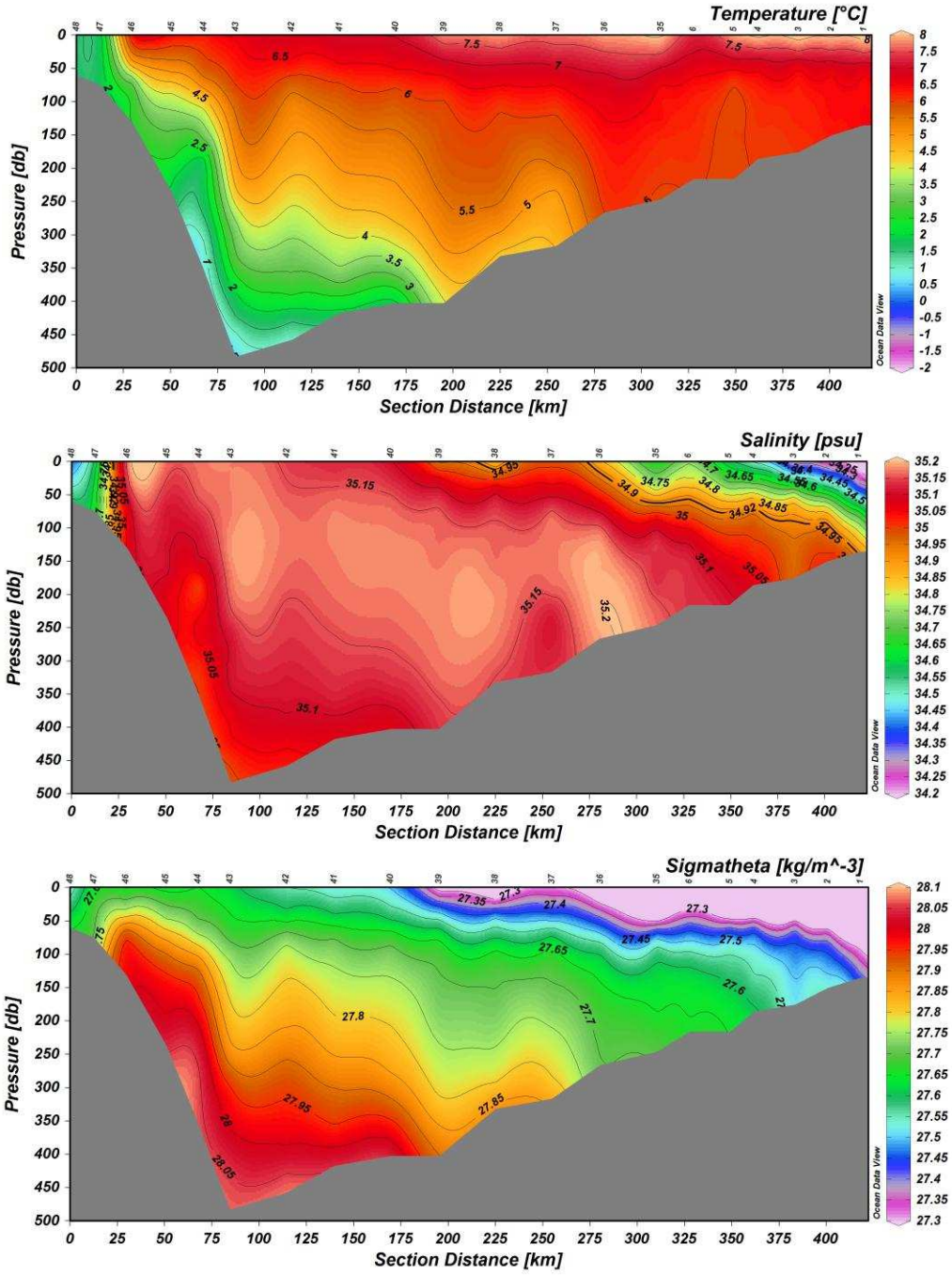

Figure 2: Temperature (θ), salinity and density (σ_θ) distribution along section V1.

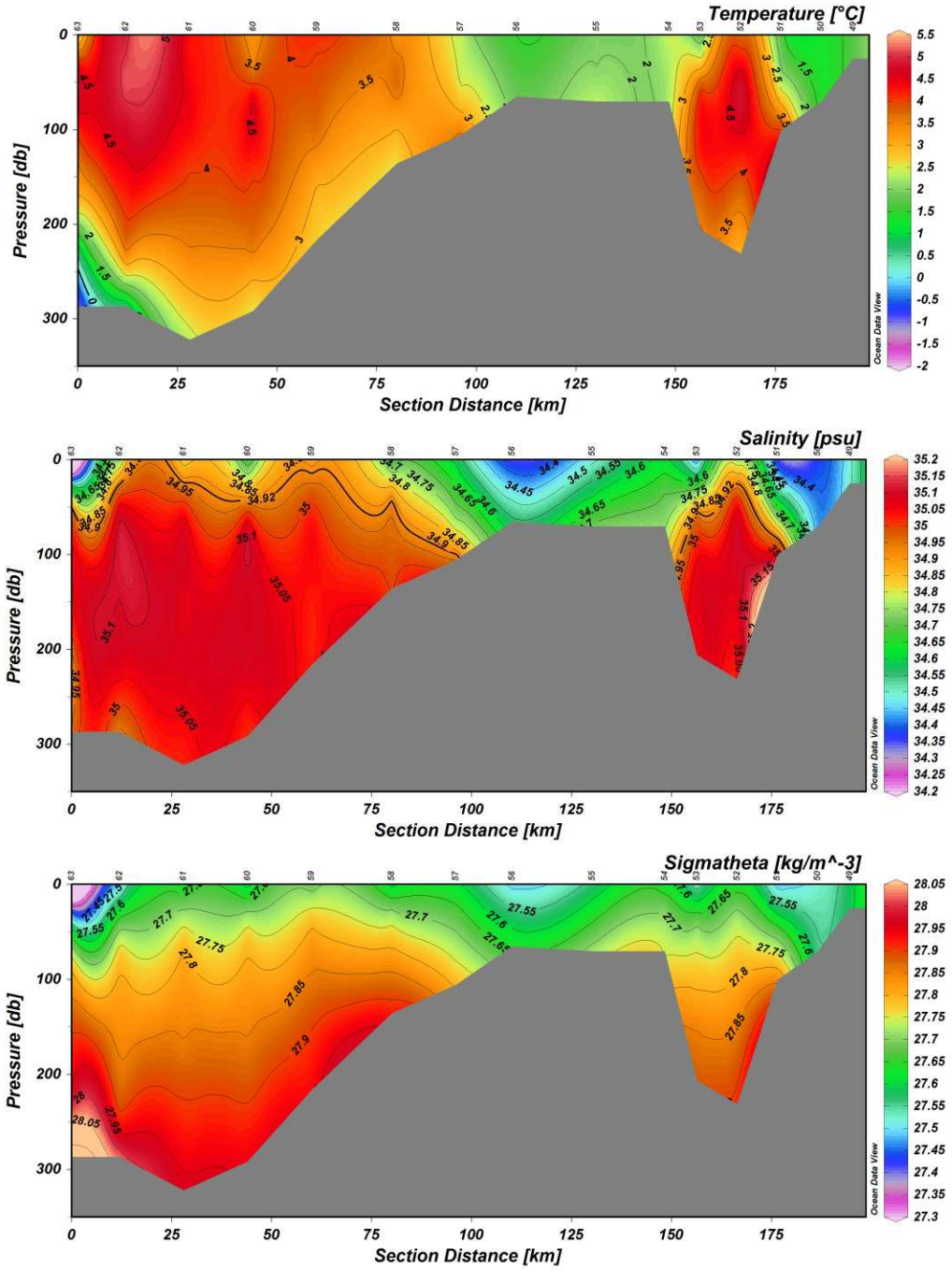

Figure 3: Temperature (θ), salinity and density (σ_θ) distribution along section V2.

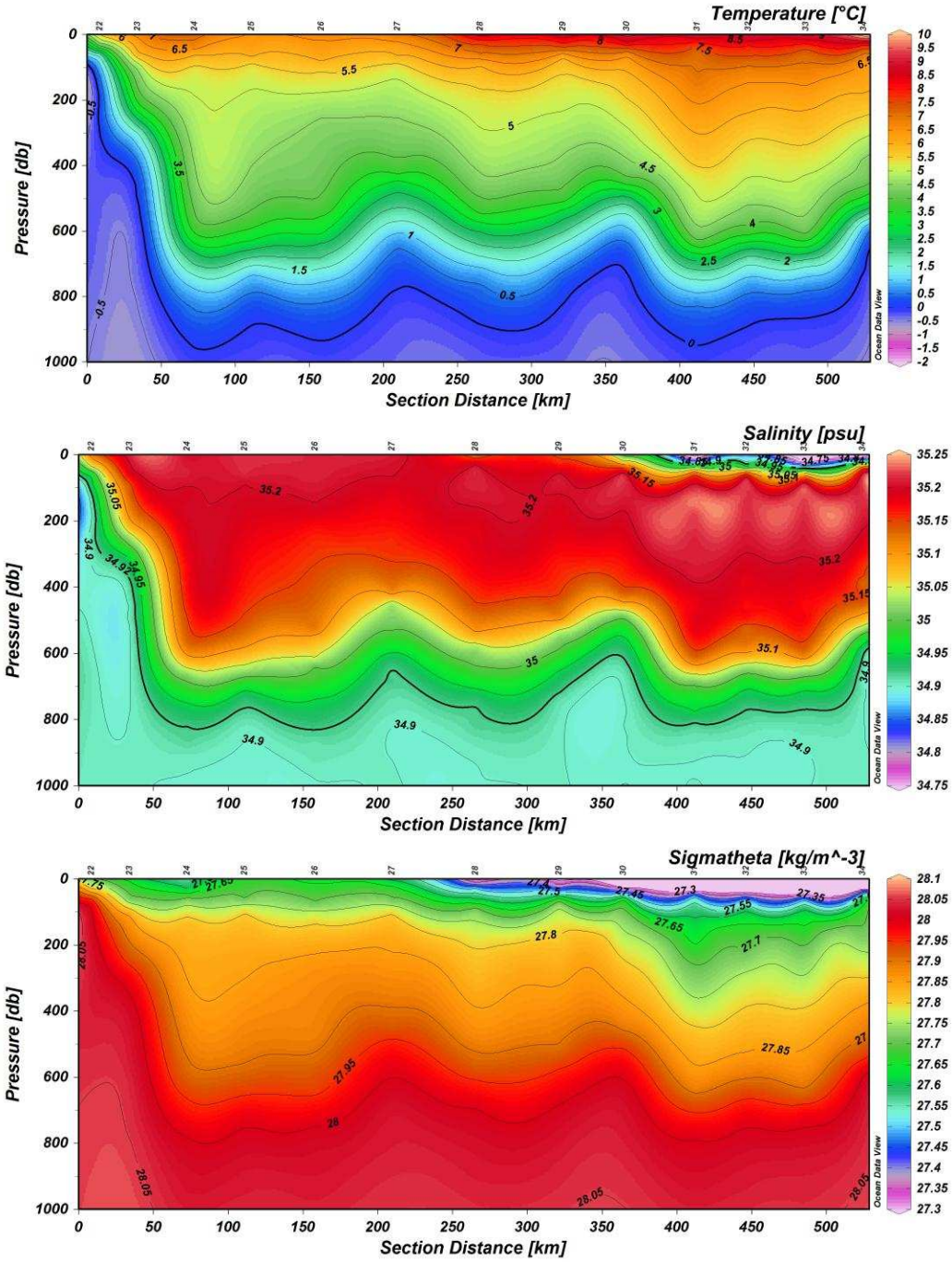

Figure 4: Temperature (θ), salinity and density (σ_θ) distribution along section A.

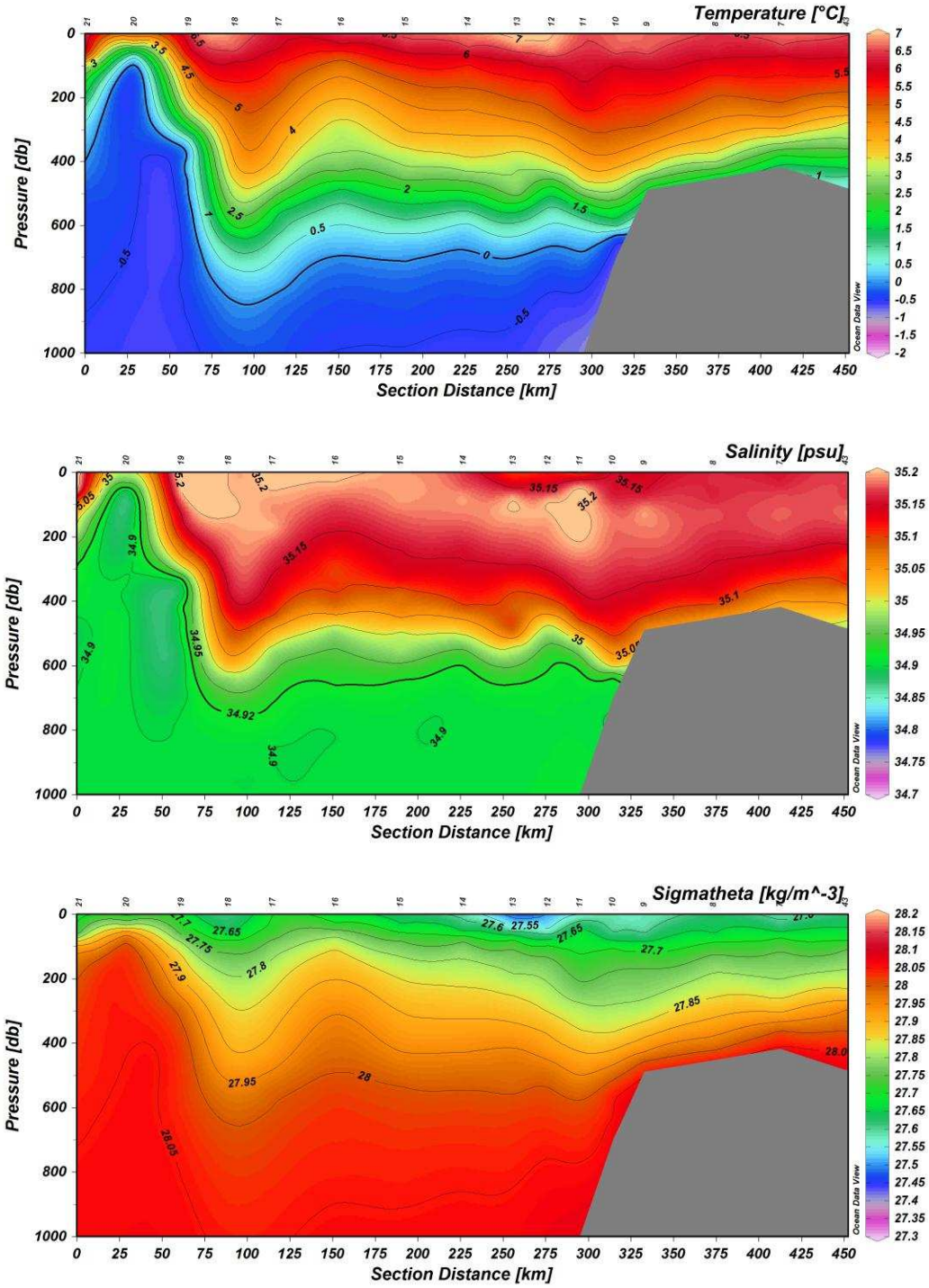

Figure 5: Temperature (θ), salinity and density (σ_θ) distribution along section H.

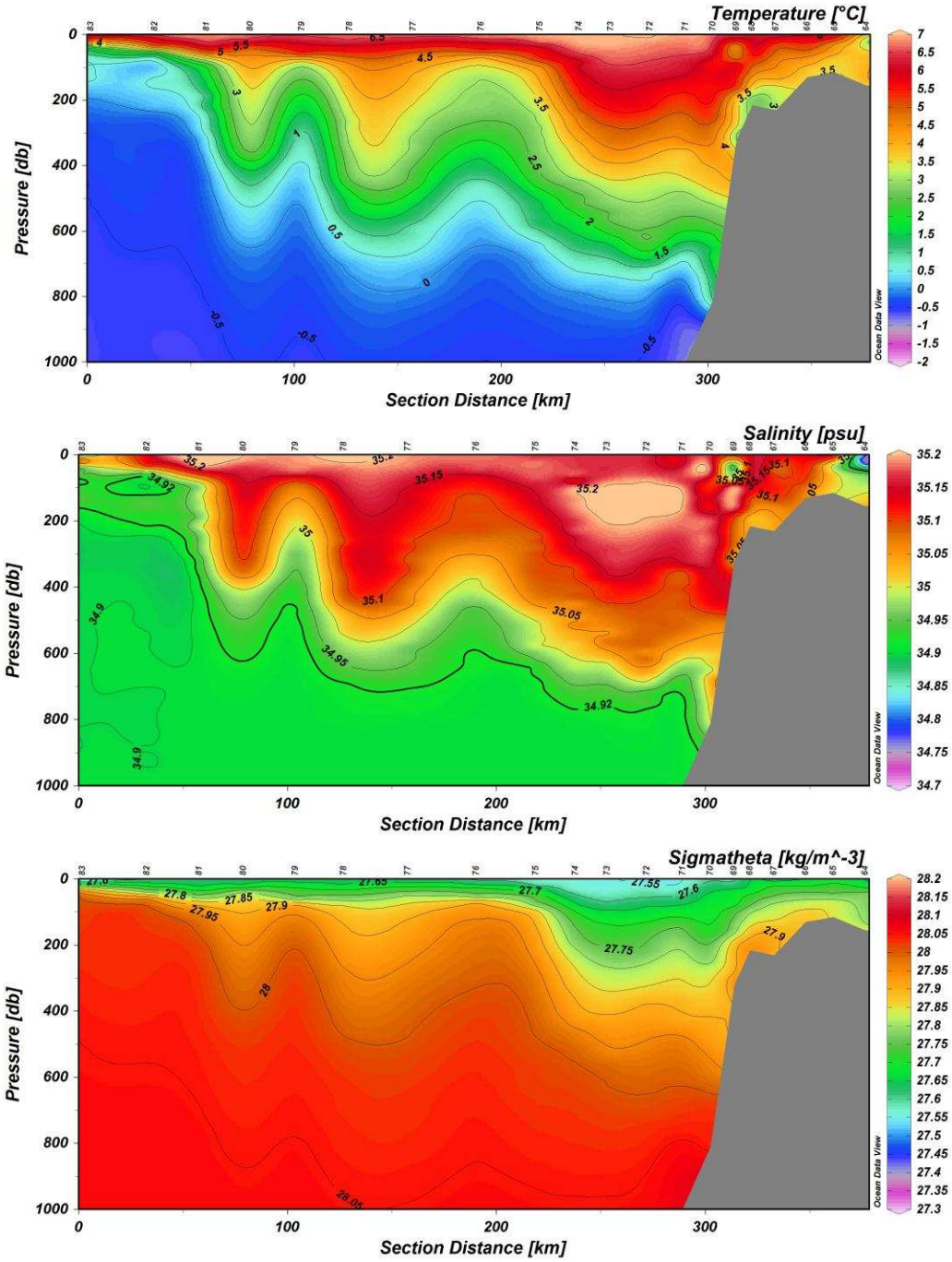

Figure 6: Temperature (θ), salinity and density (σ_θ) distribution along section K.

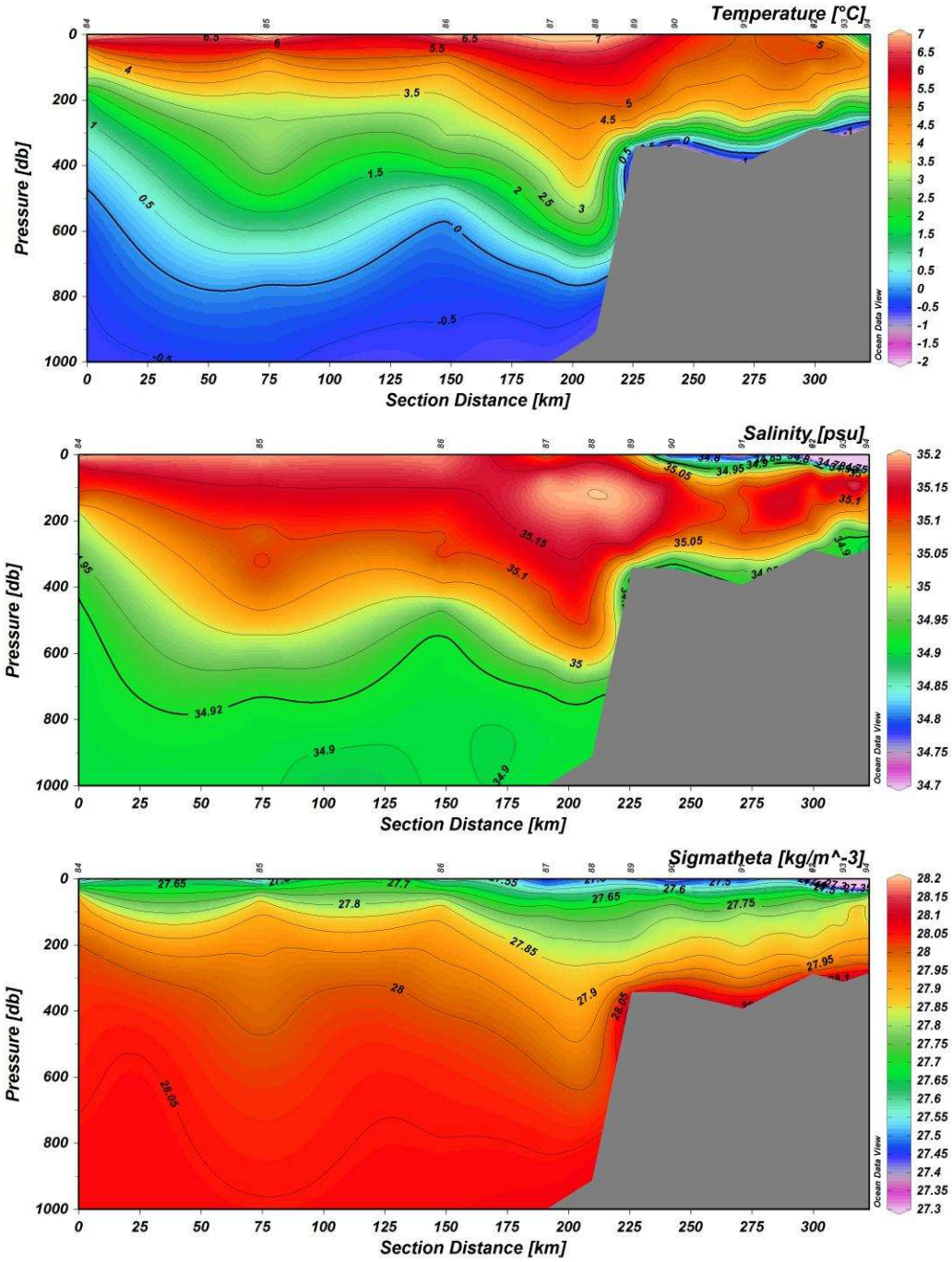

Figure 7: Temperature (θ), salinity and density (σ_θ) distribution along section O.

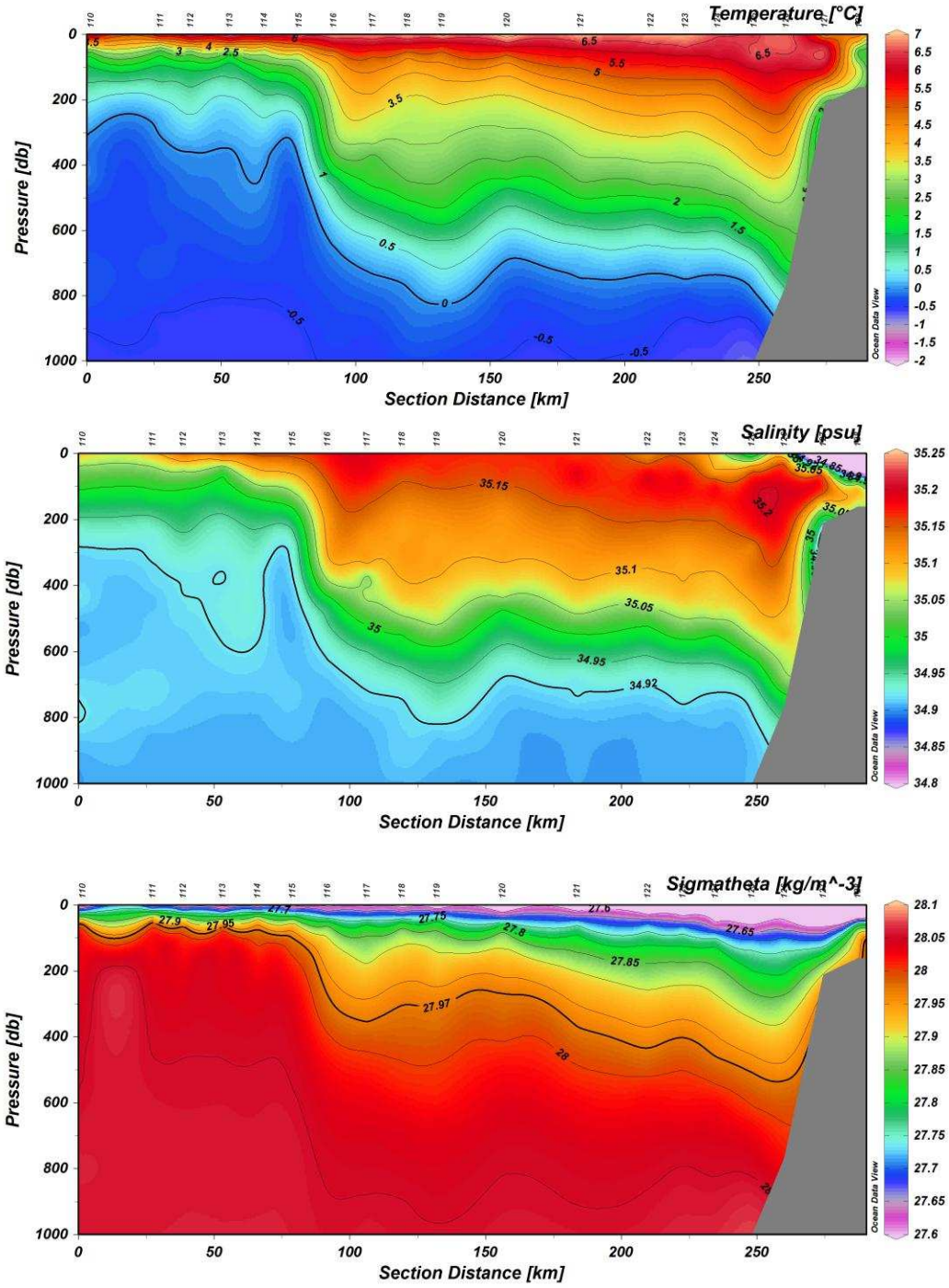

Figure 8: Temperature (θ), salinity and density (σ_θ) distribution along section N.

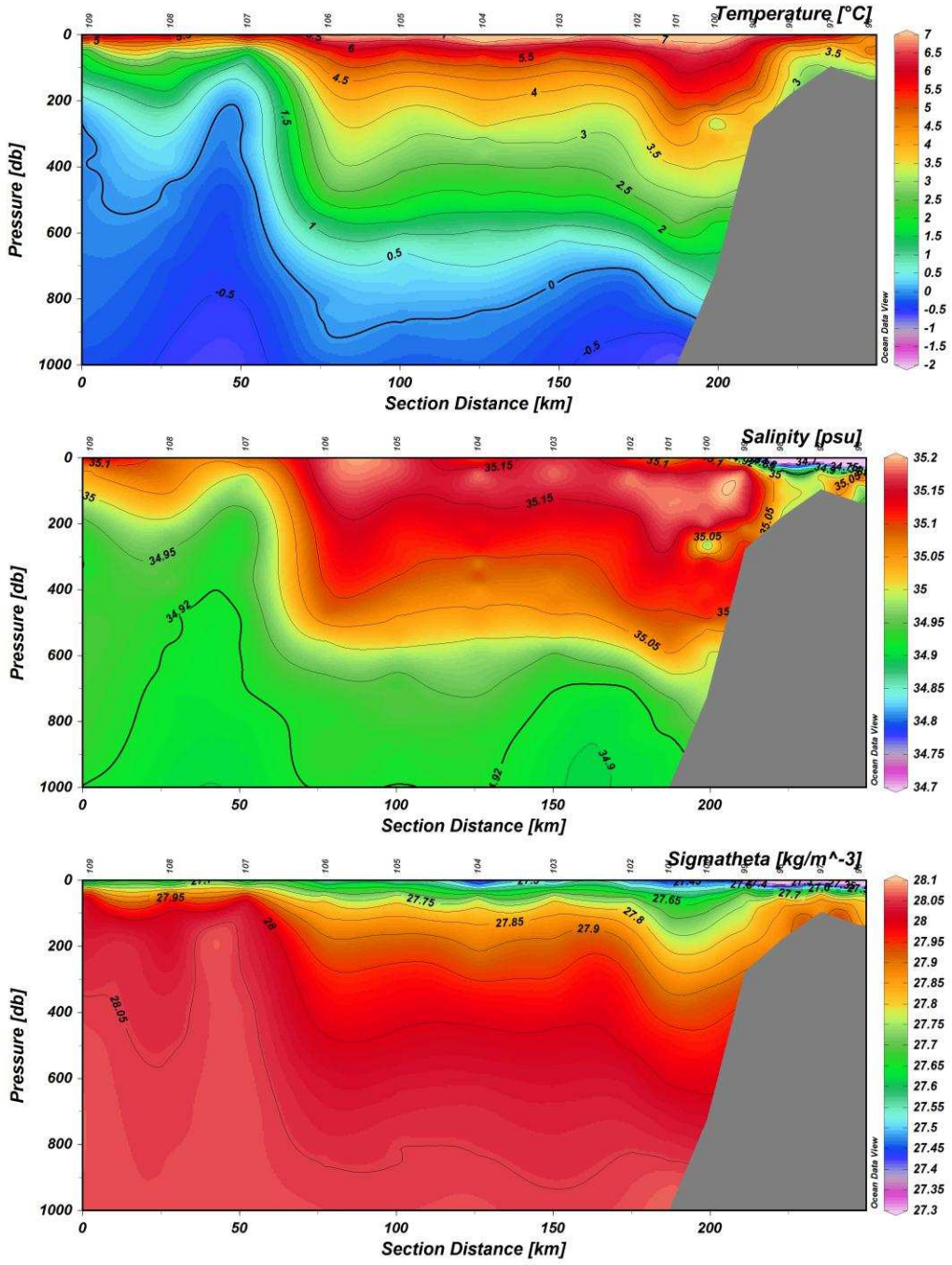

Figure 9: Temperature (θ), salinity and density (σ_θ) distribution along section S.

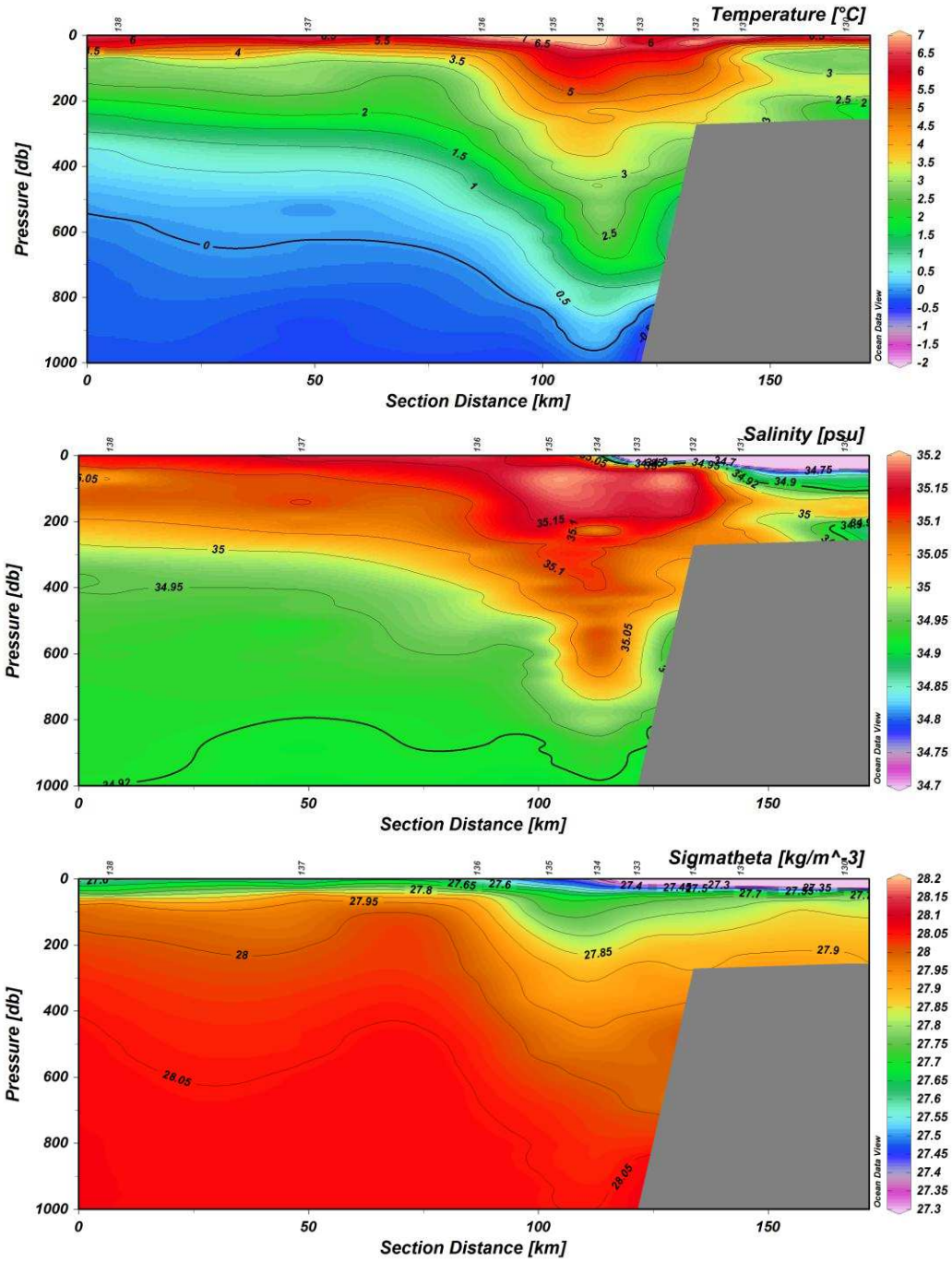

Figure 10: Temperature (θ), salinity and density (σ_θ) distribution along section Z.

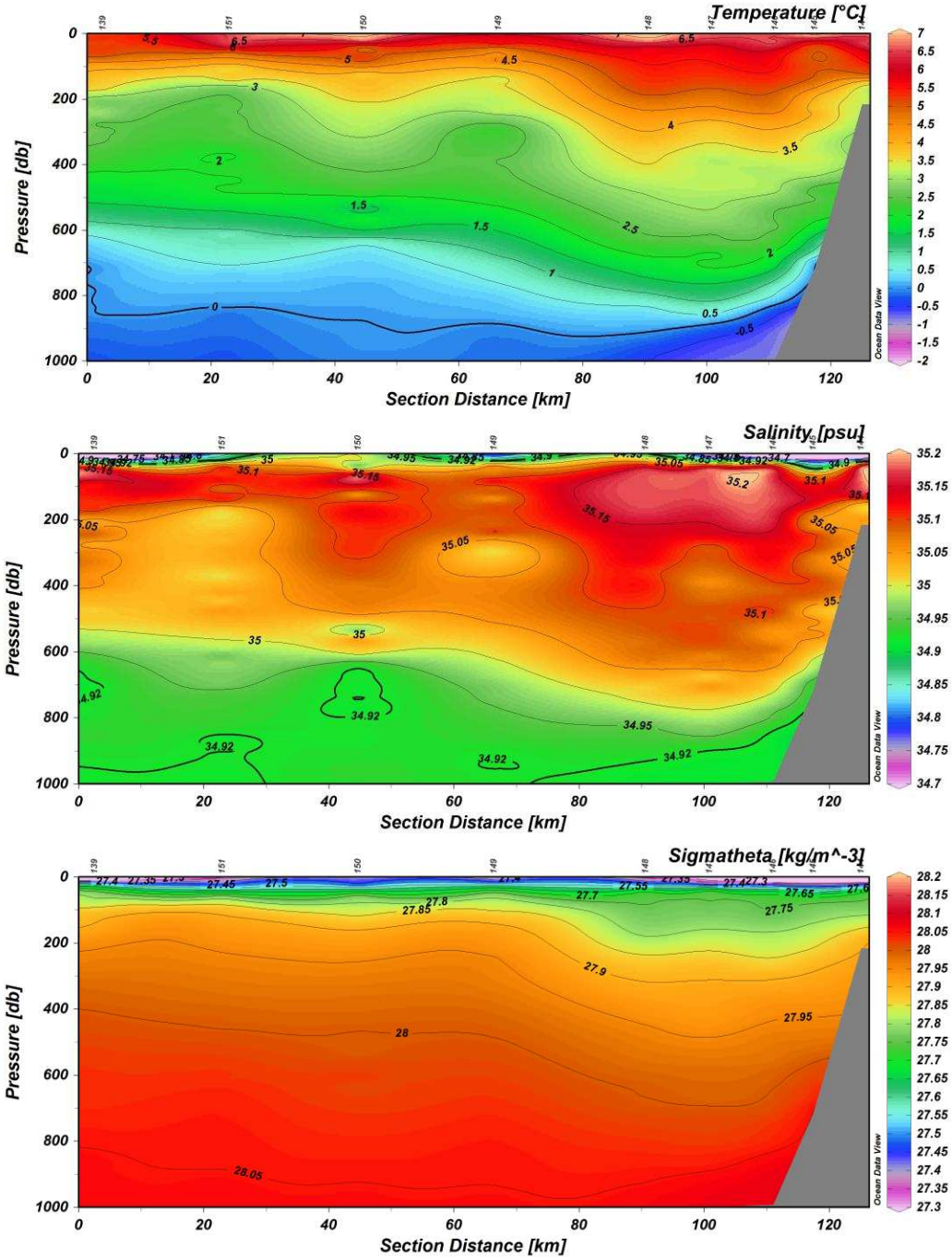

Figure 11: Temperature (θ), salinity and density (σ_θ) distribution along section EB2.

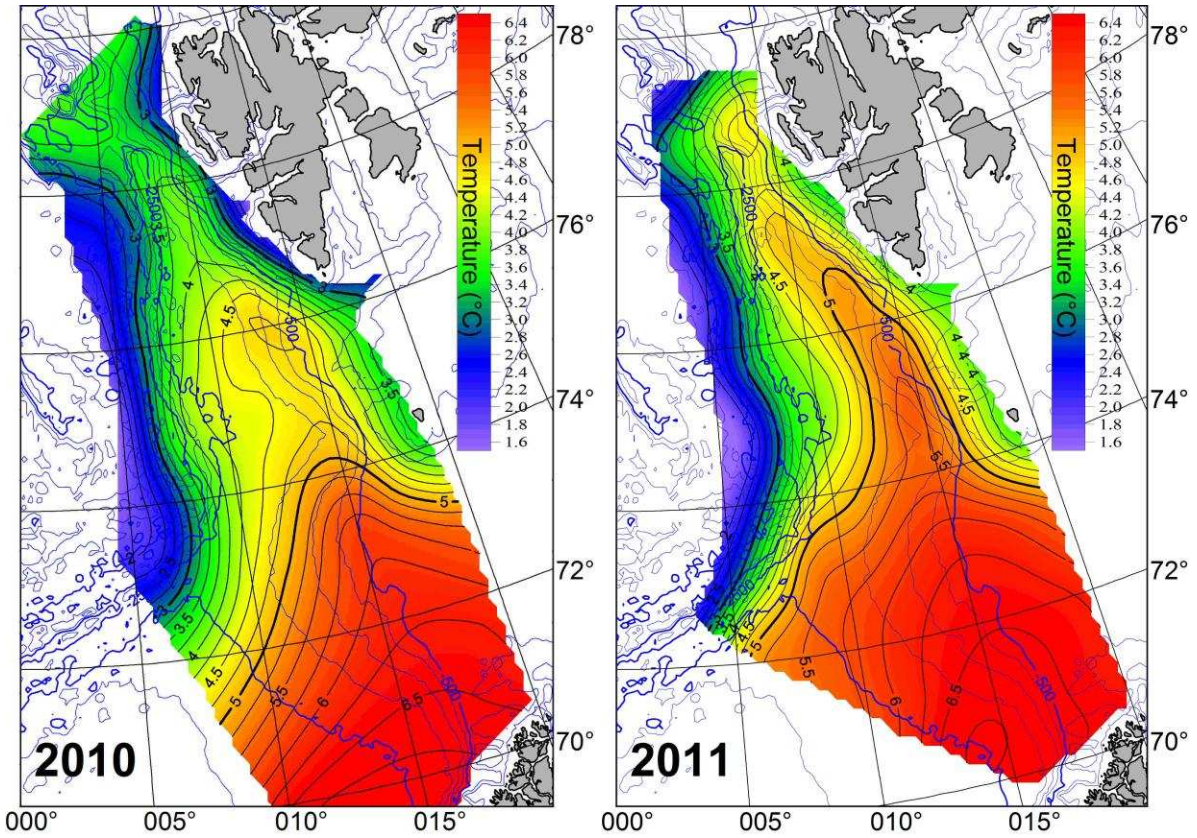

Figure 12: Temperature at 100 dbar in 2010 and 2011. Data from Gimsøy section provided by the Institute of Marine Research, Bergen were used in 2010.