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ANNUAL MEETING - JUNE 1967Hydrological Conditions in the Labrador and Newfoundland Areas1965-1966By: V. V. Burmakin
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In 1965 and 1966, the scientists from the Polar Research Institute of Marine Fisheries and Oceanography (PINRO) conducted oceanographic investigations on board the R/V Sevastopol, Topseda and the scouting trawlers Pobeda, Novorossiisk, Kreml; Russia in the areas of Labrador and Newfoundland. Observations on the temperature, salinity, oxygen and biogenic salts (phosphates, nitrates and nitrites) were made at standard depths in standard sections 1A', 1A, 2A, 3A, 4A, 6A, 7A', 7A and 8A (Fig. 1 and Table 1). Observations were made on the same elements, except the biogenic ones, at the surface and in off-bottom layers at all trawling points.

Table 1. Hydrological observations in 1965 and 1966

Vessel	Date	Area	Sections	Object for Observation
<u>Sevastopol</u>	1964-65, December- February	Labrador, Grand Bank, Flemish Cap, St. Pierre	1A', 1A, 3A, 6A	t ^o , S‰, O ₂ , P, N.
<u>Pobeda</u>	1965, February- May	Labrador, Flemish Cap	6A	t ^o
<u>Topseda</u>	1965, June- September	Labrador, Grand Bank, Flemish Cap, West Greenland	3A, 4A, 6A, 7A, 7A', 8A, 10A-15A	t ^o , S‰, O ₂ , P, N
<u>Sevastopol</u>	1965, July- October	Grand Bank, Flemish Cap, Greenland, Cabot Strait	1A', 1A, 2A, 3A 4A, 6A, 7A, 18A	t ^o , S‰, O ₂ , P, N
<u>Novorossiisk</u>	1965-66, November- March	Labrador	8A	t ^o , S‰
<u>Sevastopol</u>	1965-66, December- February	Labrador, Grand Bank, Flemish Cap, Cabot Strait, Greenland	1A', 1A, 2A, 3A, 7A', 8A, 10A, 11A, 17A	t ^o , S‰, O ₂ , P, N
<u>Sevastopol</u>	1966 May-June	Southern part of Grand, Saint Pierre and Bankero Banks	2A, 1A', 1A	t ^o , S‰, O ₂ , P, N.
<u>Russia</u>	1966 May-July	Labrador Grand Newfoundland, St. Pierre, Bankero Banks	8A	t ^o
<u>Pobeda</u>	1966, May-August	West Greenland	-	t ^o
<u>Novorossiisk</u>	1966, May-July	Georges, Bankero, Grand Banks		t ^o

Table 1. (cont'd)

Vessel	Date	Area	Sections	Object for Observation
<u>Kreml</u>	1966, July-October	Labrador, Grand Bank	8A, 2A	t ^o , S‰, O ₂
<u>Pobeda</u>	September- October	West Greenland	10A, 15A	t ^o , S‰
<u>Kreml</u>	1966-67, December- February	Flemish Cap, Grand, St. Pierre Banks, Labrador	2A, 6A	t ^o , S‰, O ₂

In this paper temperature and salinity in the Labrador-Newfoundland area in 1965-1966 are compared with data of previous years.

The review of the weather conditions over the Northwest Atlantic for 1964-1966 made by Yakovlev B. A. is given in the beginning of this report.

Review of the Weather Conditions over the Northwest Atlantic
in 1965 and 1966

1965. In January, February and March, an active cyclonic activity prevailed over the Northwest Atlantic. Cyclones shifted to the northeastern part caused intense winds and outflow of warm air masses to the western coast of Greenland. The average temperature for the three months was from 3° to 6° higher than the normal one for Davis Strait and from 0° to 3° higher than the normal one for the Labrador Sea.

In April, May, June, July and August the cyclonic activity was somewhat weaker. Cyclones shifted mainly from Newfoundland to the east or north-east. The average temperature was about normal ^{a)}

In September, anti-cyclonic weather prevailed over the Davis Strait and an active cyclonic activity in the Southern Labrador Sea was mainly observed. The average temperature was about normal.

In October, November and December an active anti-cyclonic activity with sharp fluctuations in temperature was mostly recorded over the northwestern Atlantic. The average temperature was near the norm. In October and December, the weather in Davis Strait was somewhat cooler but in November warmer. The average temperature for the Labrador Sea ranged within the normal one. The annual average temperature was about normal or 0.7° higher.

1966. In January and February, an active anti-cyclonic activity was mostly observed there. Cyclones shifted mainly to the north-east, and the warm air masses were driven away further to the north, to the western coast of Greenland.

Thus, in Davis Strait, the average temperature was from 5° to 9° higher and over the Labrador Sea from 3° to 7° higher than the normal.

In March, April and May, cyclonic activity developed farther south and cold masses of Arctic air prevailed over the northwestern Atlantic. The average temperature in Davis Strait was from 3° to 6° and over the Labrador Sea from 1° to 3° below normal.

In June, July, August, September and October the cyclonic processes over the northwestern Atlantic were moderately developed but in June and September anti-cyclonic processes prevailed. In June and July, average temperature was somewhat below the norm (by 2° to 3° in Davis Strait and by 0° to 2° in the Labrador Sea). In August, September and October it was near normal or even 2° higher in all areas.

In November, an intensive cyclonic activity was mostly observed. Deep cyclones shifted from Newfoundland to the northeast causing sharp fluctuations in temperature and an intensification of the wind rate. Since the Arctic air frequently dropped in Davis Strait, the temperature there was from 1° to 3° below normal. It was near the average norm over the Labrador Sea.

^{a)} The average many-year temperature at the hydrometeorological points of the Labrador Sea and the Davis Strait (recommended by the USSR Hydrometeorological Center) is adopted for the norm.

In December, active cyclonic processes developed over eastern Canadian areas. The outflow of warm air masses prevailed over Davis Strait and the Labrador Sea. The average temperature over the Labrador Sea was from 2° to 4° and over Davis Strait from 6° to 8° above the norm. The average annual temperature was near the norm in Davis Strait and 1° to 2° below the norm in the Labrador Sea.

The temperature analysis of water masses in the
Labrador and Newfoundland areas
by season in 1965 and 1966

1965. Observations on off-bottom temperatures in water months showed that in 1965 the water in the Labrador and Newfoundland areas was colder than in 1963 (Fig. 2). In 1963, the off-bottom waters with negative temperature in the eastern part of the Grand Bank together with the coastal stream of the Labrador Current reached 45°30'N, in 1965 45°N, i.e. 30 miles farther south.

In 1963, these waters mixing with the main stream reached 49°W in the eastern part of the Grand Bank, and in 1965 they reached 48°W, being distributing 40 miles further to the east. In 1963, up to 5° to 6° waters were observed to the south of the Grand Bank, and in 1965 their temperature was 1° below.

In spring 1965, observations were made only in the Section 6A, along 47°N (Fig. 1), at Stations 1 to 3 situated in the area of so-called "cold nucleus" of the main stream of the Labrador Current, at Stations 4 to 6 in warm waters of the main stream and at Stations 7 to 9 in mixed waters of the North Atlantic Current. Table 2 shows the average temperature in the 0-200 m layer at these stations on March 19, 1965 compared to the norm (the average temperature calculated according to observations to the end of March, 1960, 1962-1965 and 1967).

Table 2. The average temperature in the 0-200m layer in the section 6A at the Stations (March 1965) compared to the norm

Temperature indices	Stations		
	1-3	4-6	7-9
Average t° (March 19, 1965)	0.05	2.08	3.72
norm	-0.22	1.86	3.94
anomaly	+0.27	+0.22	-0.22

Table 2 shows a lower intensity of the cold Labrador Current (positive anomalies +0.27 and +0.22 compared to the norm), which resulted in the higher than normal water temperature in the Section. The warm North Atlantic Current also fell off, its average temperature was below norm (-0.22).

Observations made during the summer of 1965 showed that the intensity of the Canadian Polar and Labrador Currents was lower than in previous years. In June and July 1965, the waters with negative temperature were registered within the 200m isobath (in the Section across the Greenland-Canadian Ridge) occupying one-quarter of Davis Strait, as compared with more than one-half in previous years.

In May-June 1965, an ice edge was observed farther to the north, as compared to its medium position for a number of years and that for 1962 (Fig. 3).

In the summer of 1965, off-bottom temperatures in the shallows of the Grand Bank were from 2° to 3° higher than those in 1964, whereas there was no difference in temperature on the slopes.

In September 1965, off-bottom temperatures over the peak of Flemish Cap Bank were from 2° to 3° higher and over the slopes about 1° lower than in September 1964.

On July 15, in Section 8A across Hamilton Bank (Fig. 1) the average temperature in the 0-200m layer was 0.67° higher in the coastal stream of the Labrador Current(A), 0.48° higher in the main stream (B), and was 1.00° lower in the slope waters (C) than the norm (Elizarov, 1962), i.e. the average temperature for 1936, 1948-1957 and 1961 (Table 3).

Table 3. The average temperature in the 0-200 m layer and the anomalies of the average temperature in Subarea 8A for July 15 (in centigrades).

Year	Part of the Section									
	A		B		C		AB		ABC	
	Average temperature	Anomaly								
1962	0.28	- 0.01	0.19	+ 0.04	3.73	+ 0.09	- 0.18	- 0.09	0.99	+ 0.08
1965	0.40	+ 0.67	0.63	+ 0.48	2.64	- 1.00	0.55	+ 0.64	0.91	0.00
1966	- 0.32	- 0.05	0.38	+ 0.23	-	-	- 0.07	+ 0.02	-	-
Norm (1936- 1961)	- 0.27		0.15		3.54		- 0.09		0.91	

As seen from the Table, in 1962 and 1966, the temperatures were about the norm indices. In the autumn of 1965, in Section 8A, the water temperature in the coastal stream (A) was 0.35° lower and in the main stream (B) 0.77° higher than in 1958, in general, a cold component (AB) was 0.13° higher (Table 4).

Table 4. The average temperature of the 0.-200 m layer in Section 8A, autumn 1958 and 1965

Date	Part of the Section		
	A	B	AB
24 November 58	1.15	1.34	1.25
12-13 November 65	0.80	2.11	1.38
Δ 65-58	- 0.35	+ 0.77	+ 0.13

The differences in the water temperature on the northeastern slope of the Grand Bank in autumn 1965 and 1964 may be seen from the temperature in Section 7A (Table 5). In 1965, the water temperature in the warm upper layer from the surface to 50 m was from 1° to 2° higher than in 1964, in the layer from 50 to 200 m (the main stream) - from 0.5° to 0.8° higher than in 1964. In autumn 1965, the water temperature in the off-bottom layers was somewhat lower than in summer 1964.

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Table 5. Temperature and salinity in Section 7A, September 1964 and 1965

Depth(m)	Year	47°00'N		49°30'W		47°20'N		48°55'W		47°36'N		48°30'W		47°50'N		48°12'W		48°00'N		47°55'W	
		1964	1965	1964	1965	1964	1965	1964	1965	1964	1965	1964	1965	1964	1965	1964	1965	1964	1965	1964	1965
0	t°	9.38	11.84	7.14	8.65	7.58	8.31	7.42	8.33	7.42	8.33	7.42	8.33	7.42	8.33	7.42	8.33	7.42	8.33	7.42	8.33
	S‰	32.38	32.12	32.40	31.81	32.55	32.26	32.90	32.48	32.90	32.48	32.90	32.48	32.90	32.48	32.90	32.48	32.90	32.48	32.90	32.48
	t°	9.21	-	7.02	-	7.03	-	7.52	-	7.52	-	7.52	-	7.52	-	7.52	-	7.52	-	7.52	-
10	S‰	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	t°	9.13	11.65	6.46	8.56	6.48	2.62	7.00	6.56	6.48	2.62	7.00	6.56	6.48	2.62	7.00	6.56	6.48	2.62	7.00	6.56
	S‰	32.55	32.14	32.41	31.81	32.68	32.66	32.99	32.50	32.68	32.66	32.99	32.50	32.68	32.66	32.99	32.50	32.68	32.66	32.99	32.50
20	t°	8.98	11.76	5.40	8.02	2.33	1.50	5.96	3.62	2.33	1.50	5.96	3.62	2.33	1.50	5.96	3.62	2.33	1.50	5.96	3.62
	S‰	-	32.48	-	31.86	-	32.70	-	32.78	-	32.70	-	32.78	-	32.70	-	32.78	-	32.70	-	32.78
30	t°	0.43	2.06	-1.28	5.45	-0.92	-0.30	1.44	-0.56	-0.92	-0.30	1.44	-0.56	-0.92	-0.30	1.44	-0.56	-0.92	-0.30	1.44	-0.56
	S‰	33.16	33.09	33.19	32.56	33.35	32.90	33.39	33.19	33.35	32.90	33.39	33.19	33.35	32.90	33.39	33.19	33.35	32.90	33.39	33.19
50	t°	-0.14	0.50	-1.01	0.73	-1.00	-0.84	1.01	-0.75	-1.00	-0.84	1.01	-0.75	-1.00	-0.84	1.01	-0.75	-1.00	-0.84	1.01	-0.75
	S‰	32.20	33.22	-	33.03	-	33.03	-	33.03	-	33.03	-	33.03	-	33.03	-	33.03	-	33.03	-	33.03
75	t°	-	-	-0.86	-0.18	-0.34	-0.89	-1.18	-0.48	-0.34	-0.89	-1.18	-0.48	-0.34	-0.89	-1.18	-0.48	-0.34	-0.89	-1.18	-0.48
	S‰	-	-	32.62	33.25	33.72	33.22	34.23	33.47	33.72	33.22	34.23	33.47	33.72	33.22	34.23	33.47	33.72	33.22	34.23	33.47
100	t°	-	-	0.02	-0.10	0.38	-0.10	-	0.36	0.38	-0.10	-	0.36	0.38	-0.10	-	0.36	0.38	-0.10	-	0.36
	S‰	-	-	33.84	33.51	-	33.60	-	33.79	-	33.60	-	33.79	-	33.60	-	33.79	-	33.60	-	33.79
150	t°	-	-	depth 135m	140	0.85	0.44	1.92	1.58	0.85	0.44	1.92	1.58	0.85	0.44	1.92	1.58	0.85	0.44	1.92	1.58
	S‰	-	-	-	-	34.10	33.78	34.41	34.16	34.10	33.78	34.41	34.16	34.10	33.78	34.41	34.16	34.10	33.78	34.41	34.16
200	t°	-	-	-	-	depth 195m	195m	2.31	2.06	2.31	195m	2.31	2.06	2.31	195m	2.31	2.06	2.31	195m	2.31	2.06
	S‰	-	-	-	-	-	-	34.51	34.29	34.51	-	34.51	34.29	34.51	-	34.51	34.29	34.51	-	34.51	34.29
300	t°	-	-	-	-	-	-	depth 250m	220m	-	-	depth 250m	220m	-	-	-	-	261m	-	-	261m
	S‰	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
400	t°	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S‰	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

The autumn 1965, in south-western slope of the Grand Bank (Section 1A), as well as in the north-eastern slope, the average temperatures in all the layers were higher than those in autumn 1964 (Table 6).

Table 6. Average temperatures in water layers along the Section 1A, autumn 1964 and 1965

Depths(m)	21 September 64	8 October 65	t°
0-50	9.01	10.55	+ 1.54
50-100	1.86	2.58	10.72
100-200	2.60	4.30	+ 1.70
200-500	3.72	4.92	+ 1.20

Thus, though early in 1965 waters with negative temperature distributed throughout an extensive area, some warming was observed in spring, summer and autumn, as a result of the decrease in the intensity of the cold Labrador Current.

1966. In the winter of 1965/1966, observations were made during the 24th cruise of the R/V. Sevastopol.

Comparison of the temperature conditions in the winter of 1965/1966 with those for the same season in 1962, 1963 and 1965 was made according to average temperatures for different water layers in Sections 1A', 1A, 2A, 3A, and 7A' (Fig. 1, Table 6-8, 10). The average temperatures along the sections were calculated for the limits shown with thick lines in Fig. 1.

Different layers were distinguished according to temperature distribution and salinity, taking into account the distribution of bottom animals (Nesis, 1965). In the Labrador and North Newfoundland area, the layer from the surface to 200m (Section 7A') is characteristic for the Labrador waters, the layer from 200 to 500 m is characteristic for the mixed Labrador and subarctic waters. On Grand Bank (Sections 1A', 1A, 2A, 3A) layers from the surface to 50 m are proper for the bank waters, layers from 50 to 100 m are characteristic for the mixed bank and Labrador waters, those from 100 to 200 m for Labrador waters, and those from 200 to 500 m for the mixed Labrador and deep subarctic waters.

On 12 January 1966, in Section 7A' the water temperature of the Labrador Current (layer 0-200 m) was 0.08°, and in the mixed Labrador and subarctic waters (layer 200-500 m) 0.78° higher than that in 12 January 1962.

That is also confirmed by the fact that even in December 1962, the temperature was lower than in January, 1966 (Table 7).

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Table 7. The average temperatures and the salinity in layers from the surface to 200 m and from 200 m to 500 m, Section 7A, 1962 and 1966.

Depth m	Date	50°40'	50°48'	50°56'	51°04'	51°14'	51°21'	51°31'	51°39'	51°42'	51°48'	51°51'	51°56'	52°00'	Av. t° and S% along the Section	Δt° and ΔS% 1966	Char- acter- istic
		55°00'	54°30'	54°00'	53°30'	53°00'	52°28'	52°00'	51°30'	51°15'	51°00'	50°46'	50°30'	50°15'			
0-200	12 January 1962	-0.37 32.88	-0.28 32.99	0.04 33.15	0.97 33.54	1.25 33.90	0.93 33.63	0.77 33.79	0.79 33.65	0.52 33.63	1.31 33.90	2.62 34.37	3.05 34.56	2.98 34.72	0.97 33.78	+0.08 -0.11	t° S%
	12 December 1962	0.17 33.03	0.07 33.14	0.41 33.40	1.05 33.59	1.25 33.72	1.04 33.56	0.88 33.58	1.22 33.90	1.60 34.12	1.70 33.92	- 34.15	2.50 34.37	3.37 34.68	1.10 33.69	-0.05 -0.02	t° S%
	12 January 1966	-0.33 32.94	-0.17 33.13	0.38 33.47	1.46 33.77	1.13 33.73	0.75 33.61	1.40 33.86	1.42 33.83	2.12 34.12	1.21 33.75	0.99 33.64	1.80 33.96	3.12 34.41	1.05 33.67	- -	t° S%
200-500	12 January 1962	- -	0.12 33.16	- -	2.66 34.28	2.59 34.64	2.04 34.34	2.40 34.44	2.45 34.40	2.57 34.37	2.52 34.44	3.62 34.72	3.19 34.69	3.09 34.85	2.32 34.32	+0.78 +0.16	t° S%
	21 December 1962	- -	0.98 33.69	1.27 34.05	1.92 34.35	2.46 34.47	2.61 34.56	2.40 34.49	2.71 34.63	2.62 34.64	3.10 34.58	- 34.62	3.58 34.70	3.90 34.92	2.41 34.45	+0.69 +0.03	t° S%
	12 January 1966	- -	1.70 33.73	2.20 33.98	3.65 34.59	3.10 34.57	3.20 34.62	3.15 34.60	3.09 34.57	3.44 34.63	2.84 34.42	3.00 34.39	4.04 34.77	4.36 34.82	3.10 34.48	- -	t° S%

Early in February 1966, the average temperature in all layers (Sections 3A and 2A) was from 0.8° to 2.0° higher than in February 1962 and in January 1963 and 1965 (Tables 8a, b).

Table 8. Average temperatures and water salinity in the 0-50 m layers and in those from 50 m to 100 m, from 100 m to 200 m, from 200 m to 500 m, 1962-1966

- a) The section 3A, south-eastern slope of the Grand Bank,
- b) Section 2A, southern slope of the Grand Bank

Depth (m)	Date		Layer m	Δt° $\Delta S\%$		Date		Δt° $\Delta S\%$ 66-62	
	28 Feb. 1962	13 Jan. 1965		8 Feb. 1966	24 Feb. 1962	15 Jan. 1963	5 Feb. 1966		
0-50	t°	0.65	1.06	2.26	+1.61	2.03	3.05	2.83	+0.80
	S‰	33.58	33.16	33.60	+0.02	33.01	33.15	32.85	-0.16
50-100	t°	0.63	1.08	2.59	+1.96	1.44	2.17	2.84	+1.40
	S‰	33.59	33.32	33.99	+0.40	33.23	33.42	33.25	+0.02
100-200	t°	1.53	1.84	3.55	+2.02	0.83	2.56	2.86	+2.03
	S‰	33.89	33.96	34.31	+0.42	33.62	34.26	34.17	+0.55
200-500	t°	2.51	2.80	3.86	+1.65	2.08	3.98	3.80	+1.72
	S‰	34.25	34.46	34.64	+0.39	34.20	34.77	34.62	+0.42

Thus, in 1966 warming continued in the main stream of the Labrador Current (Table 7), as well as in the mixed waters influenced by the North Atlantic Current (Table 8). Apparently, in 1965-1966, the decrease in intensity was proper for both, the Labrador Current and the Gulf Stream - the Atlantic Current System.

This is confirmed by the fact that in February 1966, in the section 2A, (42°20'N lat. and 50°15'W long.) in the 0-100 m layer the temperature was 14.5°, whereas in the same seasons of the other years the temperature in the same layer was only 6° to 7°. Consequently, in 1966, the salinity increased (Table 9).

Table 9. Temperature and water salinity at the station, the section 2A, 42°20'N Lat., 50°15'W Long. in different years

Date		Layer, m							
		0	20	50	100	200	300	400	500
9 Mar.	t°	3.18	3.20	1.98	5.75	5.25	6.28	5.72	5.17
1960 r.	S‰	-	-	-	-	-	-	-	-
15 Jan.	t°	5.50	5.35	3.77	3.38	3.95	4.71	4.16	3.70
1963	S‰	33.04	33.10	33.49	33.69	34.63	-	34.90	34.90
27 Mar.	t°	4.75	4.76	4.84	9.68	4.96	4.60	-	4.98
1964	S‰	33.84	33.84	33.91	35.05	34.61	34.82	-	35.03
6 Feb.	t°	14.56	14.62	14.61	14.57	12.76	10.87	9.41	5.05
1966	S‰	35.84	35.84	35.87	35.87	35.63	35.38	35.32	35.85

Thus, early in 1966, the left edge of the Gulf Stream waters came to within a short distance of the southern slope of the Grand Bank (Konstantinov K. Gr. and A. S. Noskov, 1966).

In February 1966, waters in the southwestern slope of the Grand Bank (Section 1A) were cooler than in February 1962, especially in their near-bottom layers (Table 10). This is explained by the fact that unlike the winter months of the six previous years the warm waters of the Gulf Stream did not enter this area.

On 30 January 1966, in Cabot Strait (Section 1A') the temperature in the 0-50, 50-100, 100-200 m layers was from 0.5° to 1.2° higher than that on 5 February 1962 due to the lower intensity of the coastal stream (Table 10 b). In the off-bottom (200-500 m) layers the temperature was 0.37° lower.

Table 10. Average temperatures and water salinity in the layers from the surface to 50 m, from 50 m to 100 m, from 100 m to 200 m, from 200 m to 500 m. 1962 and 1966.

- a) Section 1A - south-western slope of the Grand Bank
- b) Section 1A' - across the Cabot Strait

Depth m		Date		Δ t° Δ S‰ 66-62	Depth m	Date		Δ t° Δ S‰ 66-62
		1 Feb. 1962	2 Feb. 1966			5 Feb. 1962	30 Jan. 1966	
0-50	t°	3.10	2.21	-0.89	0-50	0.51	0.95	+0.44
	S‰	32.85	32.56	-0.29		32.32	32.44	+0.12
50-100	t°	3.06	1.95	-1.11	50-100	0.54	0.95	+0.41
	S‰	32.84	33.06	+0.22		32.33	32.68	+0.35
100-200	t°	4.54	2.58	-1.96	100-200	1.23	2.40	+1.17
	S‰	33.10	34.12	+1.02		32.80	33.52	+0.72
200-500	t°	9.93	3.15	-6.78	200-500	4.47	4.10	-0.37
	S‰	34.78	34.44	-0.34		34.19	34.59	+0.40

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Apparently, in the winter of 1966, warm waters did not enter Cabot Strait (Table 11). In 1966, in Cabot Strait, the water temperature at 200 m and 300 m depths was from 1° to 2° lower than in 1962 and 1964.

Table 11. Temperature and water salinity at the station, in the section 1A' in different years, 46°04'N Lat., 57°15'W Long.

Date		Depth, m						
		0	20	50	100	200	300	375
5 Feb. 1962	t°	0.50	0.51	0.46	0.50	5.44	6.31	-
	S‰	32.32	32.32	32.32	32.32	33.84	34.72	-
9 Dec. 1964	t°	4.02	4.05	4.08	0.63	3.70	5.10	3.92
	S‰	32.27	-	32.29	33.49	34.13	34.51	34.56
30 Jan. 1966	t°	0.82	0.80	0.82	0.97	3.12	4.04	3.98
	S‰	32.63	32.63	32.63	32.69	34.05	34.52	34.68

Thus, analysing temperature conditions from the end of 1965 to the beginning of 1966, one can conclude that:

- a) following the cold winter early in 1965, warm summer and autumn, positive temperature anomalies (compared to those in each year of the period 1962-1964) were observed to the end of the year in the waters of the whole Labrador-Newfoundland area, the temperature was especially high in the north Newfoundland Bank and the eastern and southern slopes of the Grand Bank;
- b) negative temperature anomalies were observed over the southwestern slopes of the Grand Bank, due to the lack of the inflow of the Gulf Stream waters there;
- c) in Cabot Strait, warm water nuclei were not observed in the off-bottom (200-500 m) layers, where negative anomalies were recorded. In the upper (0-50, 50-100, 100-200 m) layers, positive anomalies were observed.

Comparing temperature distribution in the surface and the off-bottom layers in May-June, 1966 with the same period in 1962, one can show a series of peculiarities (Fig. 4).

Thus, in May and June 1966, on the southwestern slope of the Grand Bank, the water temperature in the off-bottom layers was about 1° higher than the temperature in the surface layers, in May 1° higher and in June - 5° higher than that one in the same months, 1962.

In May 1966, both the southern slopes of Green and St. Pierre Banks and the northeastern slope of Cabot Strait had surface and near-bottom temperatures of approximately the same as in 1962.

In June 1966, the surface temperature was approximately 3° higher than in 1962, but off-bottom temperatures were somewhat cooler, as the front dividing the waters of different origin was about 50 m deeper.

In May 1966, in the Banquereau area the surface water temperature was 1° higher than in 1962, and off-bottom temperature was approximately the same in those years. In June of both 1966 and 1962, the Polar Front occupied the same position to the south of the Grand Bank, i.e. 50°15'W and 42°N, but in 1966 its temperature gradient between 7° and 18° was 0.2° per mile, and in 1962 0.3° per mile. In the winter of 1966, the Gulf Stream came very close to the southern slope of the Grand Bank "tail" (Table 9) whereas in spring 1966, it was observed at its normal position near 42°N.

As mentioned above, in the winter of 1966, the temperature on the southwestern slope of the Grand Bank was lower than in the previous six years. Apparently, the warm waters did not flow into the Bank area at that time of the year. By May and, especially, by June of 1966, the waters of the southwestern slope became warmer than in 1962, when the water temperature was near the norm (Fig. 4). This can be explained by the heating and the advection of water.

In the winter and the spring of 1966, in Cabot Strait the water temperature in the near-bottom layers was comparatively lower and in the surface layers higher than in the six previous years.

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In the summer of 1966, the average temperature in the cold component of the Labrador Current (Section 8A) differed slightly from the norm (Table 3).

In October 1966 following a comparatively norm summer, the water temperature was much higher than in 1962 and 1964, especially in the slope waters (C) (Table 12).

Table 12. Average temperature in the layer from the surface to 200 m (the section 8A) in October by years

Date	Part of section				
	A	B	C	AB	ABC
13 Oct. 1962	1.18	0.63	-	0.74	-
16-17 Oct. 1962	0.63	1.76	4.61	1.08	1.89
23-24 Oct. 1962	0.05	0.41	4.23	0.17	1.07
16-17 Oct. 1966	0.93	2.27	5.25	1.46	2.40

In January 1967, during the 26th cruise observations over the Section 8A were made from the R/V Sevastopol. The comparison between these observations and those for the same season of 1964 and 1966 is given in Table 13.

At compared stations (Section 8A between 54°44'N and 54°57'N) the temperature in the mixed waters of the Labrador Current (Arctic and Irminger components) is given in the last column of Table 13. The Table shows that in the winter of 1967 the waters became cooler as compared to those in winter 1966, but warmer than in winter 1964.

That is also confirmed by the data for stations 1-9, Section 6A, obtained on board the R/V Sevastopol on 19 March 1967. As in the Table 2, the temperatures are compared with the norm, i.e. the average temperature for 1960, 1962-1965 and 1967 (Table 14).

Table 13. Average temperature in the 0-200 m layer (Section 8A), January 1964, 1966 and 1967

Date	Part of the Section				Stations between 54° 44'N and 54° 57'N
	A	B	C	AB	
25 Jan. 1964	-	-	1.76	-	0.55
20 Jan. 1966	-0.84	1.33	-	0.23	2.19
30 Jan. 1967	-	-0.23	3.69	-	1.30

Table 14. Average temperature in the 0-200 m layer along the Section 6A by stations in March 1967 (compared with the norm)

Temperature indices		Stations		
		1-3	4-6	7-9
Over t°	19 March 1967	-0.45	1.93	4.00
	norm	-0.22	1.86	3.94
	anomaly	-0.23	+0.19	+0.06

It seems that the intensification of the Labrador (stations 1-3 and 4-6) and of the North Atlantic Currents takes place.

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Distribution of the salinity

The position of the near-bottom isohalines, -33.5‰ and 34.5‰, in the winters of 1963 and 1966 (Fig. 5) shows that by 1966, a higher salinity was observed in the area. If in similar (by their temperature conditions) winters, 1963 and 1965, the 33.5 and 34.5‰ isohalines almost coincided, by 1966, a movement of highly saline waters in the gulf was observed, and it was noticeable in the north Newfoundland Bank and poorer expressed on the slopes of the Grand Bank and the Cabot Strait.

In the autumn of 1965, salinity on the northeastern slope of Grand Bank (Section 7A, Table 5) was lower than in autumn 1967, though the temperature was higher. Apparently, this is caused by a higher discharge of the continental waters.

By the winter of 1966, the inflow of warm highly saline waters is more distinctly evident. In 1966, on the north Newfoundland Bank (Section 7A', Table 7) the surface salinity was 0.11‰ lower than in 1962, but in the off-bottom layers it was 0.16‰ higher. The same increase in salinity was also observed in Sections 2A, 3A (Table 8).

The lower intensity of the Gulf Stream and the position of its left edge near the south slope of the Grand Bank may be traced according to changes in salinity at the station (Section 2A) with positions 42°20'N and 50°15'W, where in winter 1966, the salinity in all the layers increased for 1-2‰ in comparison with 1963 and 1964 (Table 9).

The decrease in temperature in all the layers of the southwestern slope of the Grand Bank and in the near-bottom layer of Cabot Strait in the winter 1965-1966 was apparently caused by the smaller flow of the Gulf Stream. But, this fact influenced slightly the salinity, thus, in the 50-200 m layers, (Section 1A) and in all the layers of Section 1A' the salinity became higher with a decrease in the salinity only in the 0-50 m and 200-500 m layers of Section 1A (Table 10).

The same picture was observed in Cabot Strait, i.e. the lack of the warm nucleus in the off-bottom (200-500 m) layers and a stable high salinity (Table 11).

Apparently, the higher salinity in the 50-200 m layers in Sections 1A' and 1A was mainly caused by a lower flow of the fresh waters of the coastal stream of the Labrador Current.

Summary

1. Early in 1965, in the Labrador and Newfoundland areas, the distribution of cold waters with negative temperature in the surface and the near-bottom layers was greater in comparison with each year of the 1960-1964 period.
2. In the spring of 1965, water temperatures were higher than the long-term average for 1960-1967.
3. In the summer of 1965, water temperatures were from 0.5° to 1.0° higher than the long-term average for 1936-1961 due to intense solar heating and less intense cold and warm currents.
4. In late 1965 and early 1966, temperatures and the salinities for the Labrador and Newfoundland areas as a whole were the highest for the past 5 years. This was apparently due to the nearness of the left edge of the Gulf Stream to the southeastern and southern slopes of the Grand Bank. Probably, this position of the Gulf Stream can be explained by its lower intensity. In addition, the warm waters of the Gulf Stream did not flow to the southwestern slope of Grand Bank and into Cabot Strait. Because of this, the off-bottom layers were cooler in these areas late in 1965 and early in 1966 than in previous years.
5. In the summer of 1966, water temperatures in the Labrador area were near the normal for 1936-1961. On the southern slopes of Grand, St. Pierre and Banquereau Banks, the waters were warmer than in 1962. In summer, the water temperature for the whole area was, apparently, slightly higher than normal.
6. In the autumn of 1966, intensification of the warm and cold components of the Labrador Current, especially of the warm one took place. Therefore, the water was warmer than in 1965-1966.

7. In spring 1966-1967, the intensification of warm and cold currents continued on the eastern slope of Grand and Flemish Cap Banks (Section 6A) and the temperatures were about normal.

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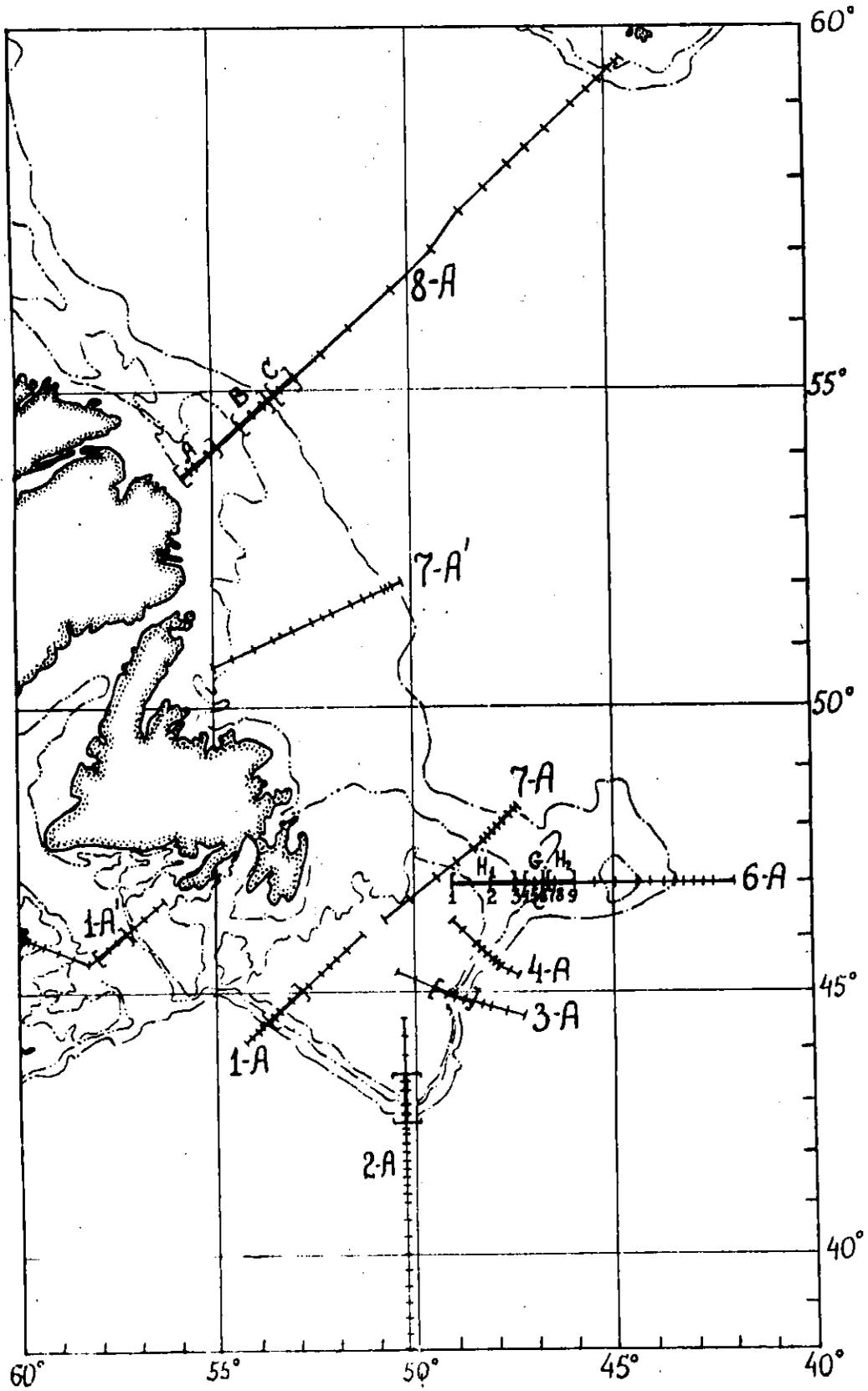


Fig. 1 Position of the Sections in the Labrador and Newfoundland areas (the limits where the average temperatures in the Sections were calculated are shown as thick lines).

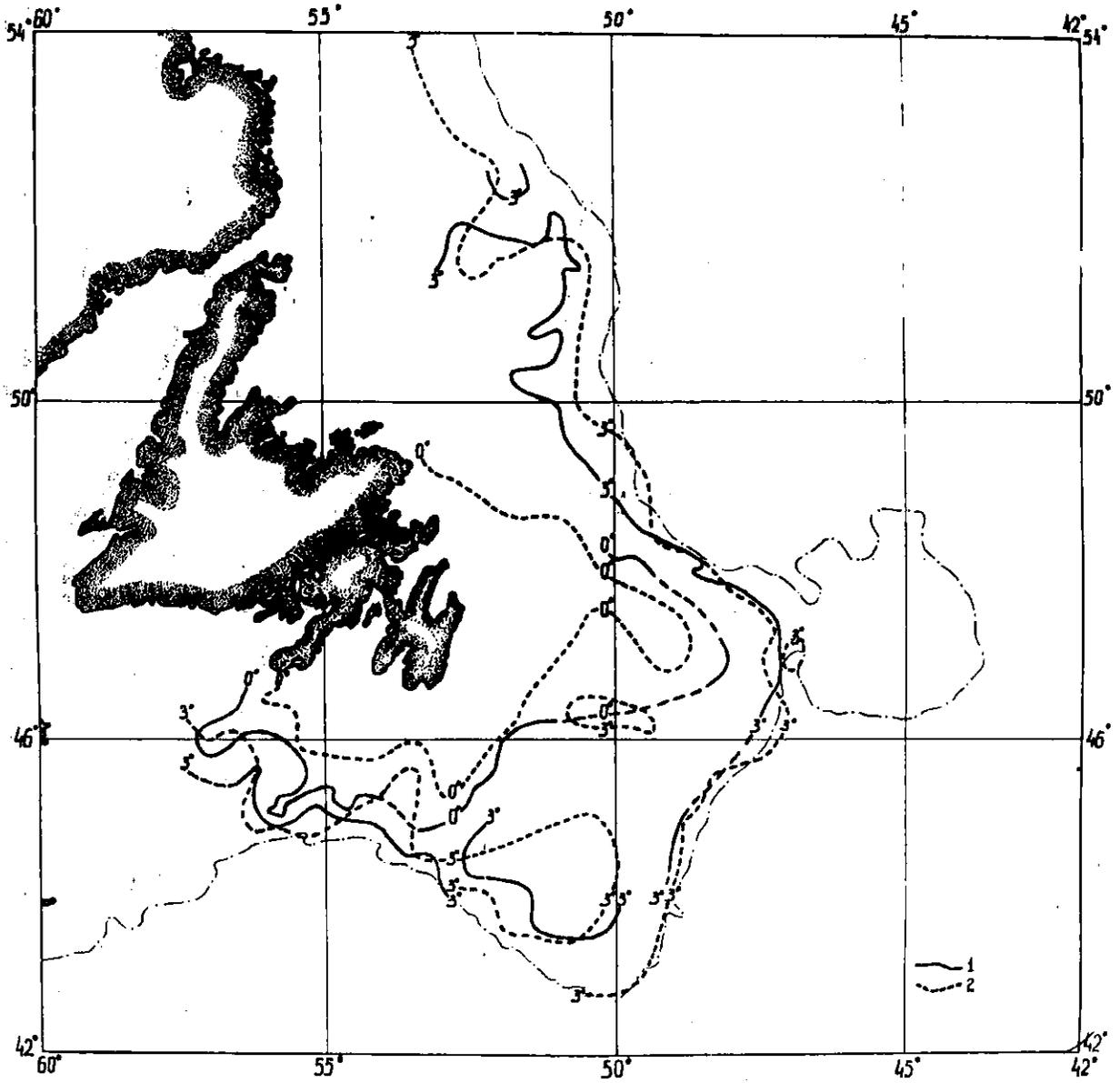


Fig. 2 Off-bottom (0° and 3°) isotherms near the Labrador and Newfoundland areas, winter 1965 (1) and 1963 (2).

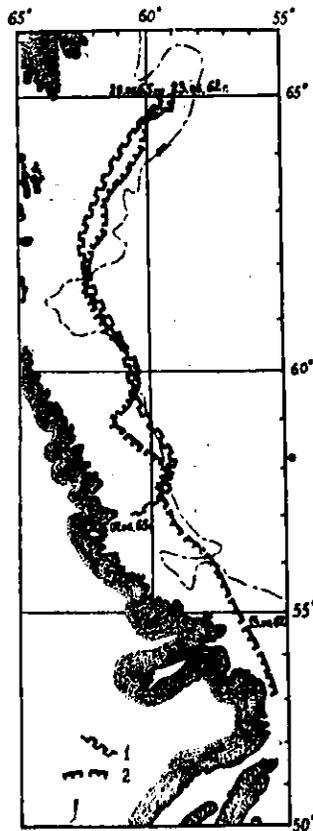


Fig. 3 The ice edge in the Labrador area,
May-June 1965 (1) and 1962 (2)

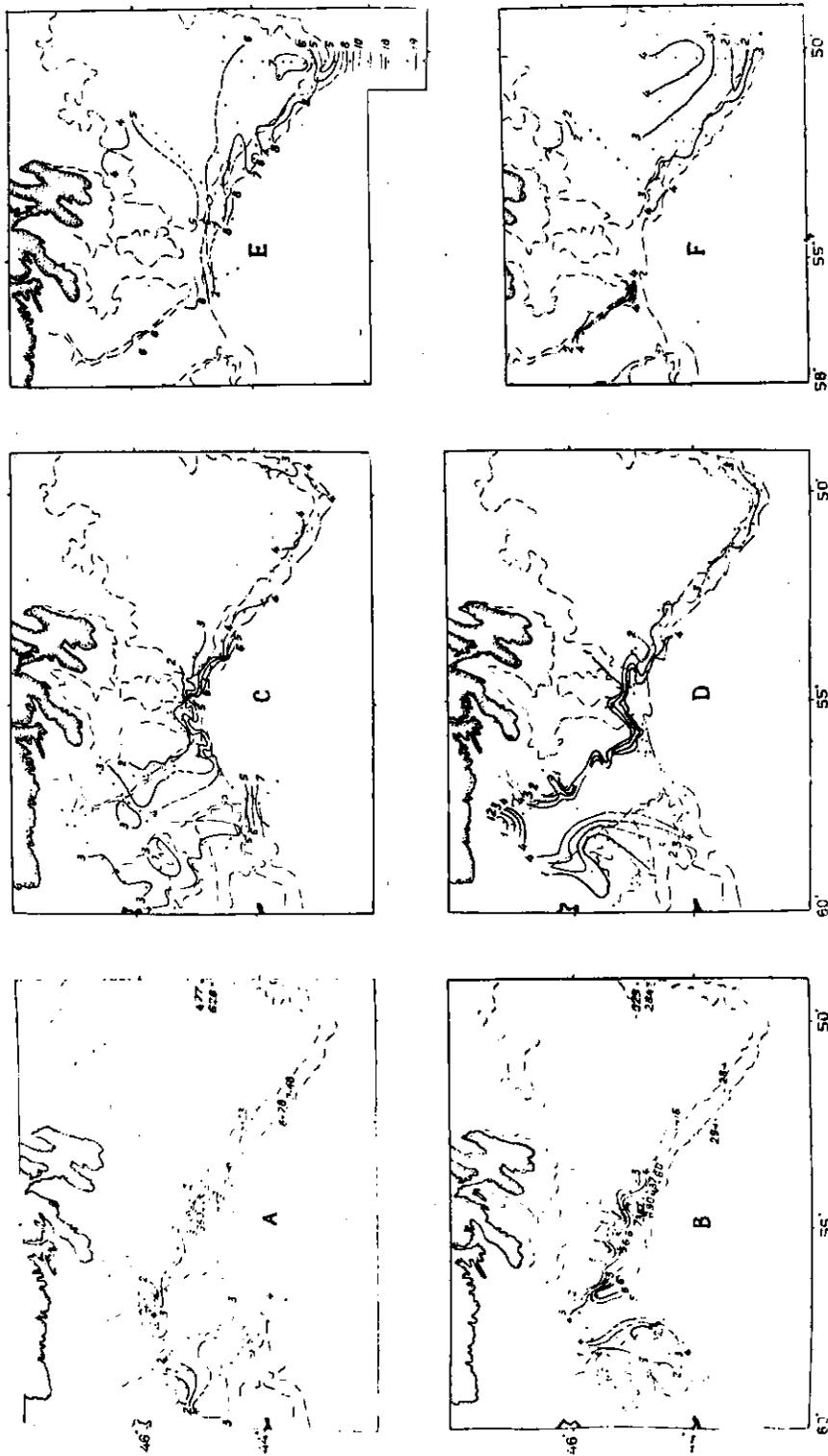


Fig. 4 Temperature distribution in the surface and the off-bottom layers: A and B - in May 1962 (temperatures in June 1962 are given as figures), C and D - in May 1966, E and F - in June 1966.

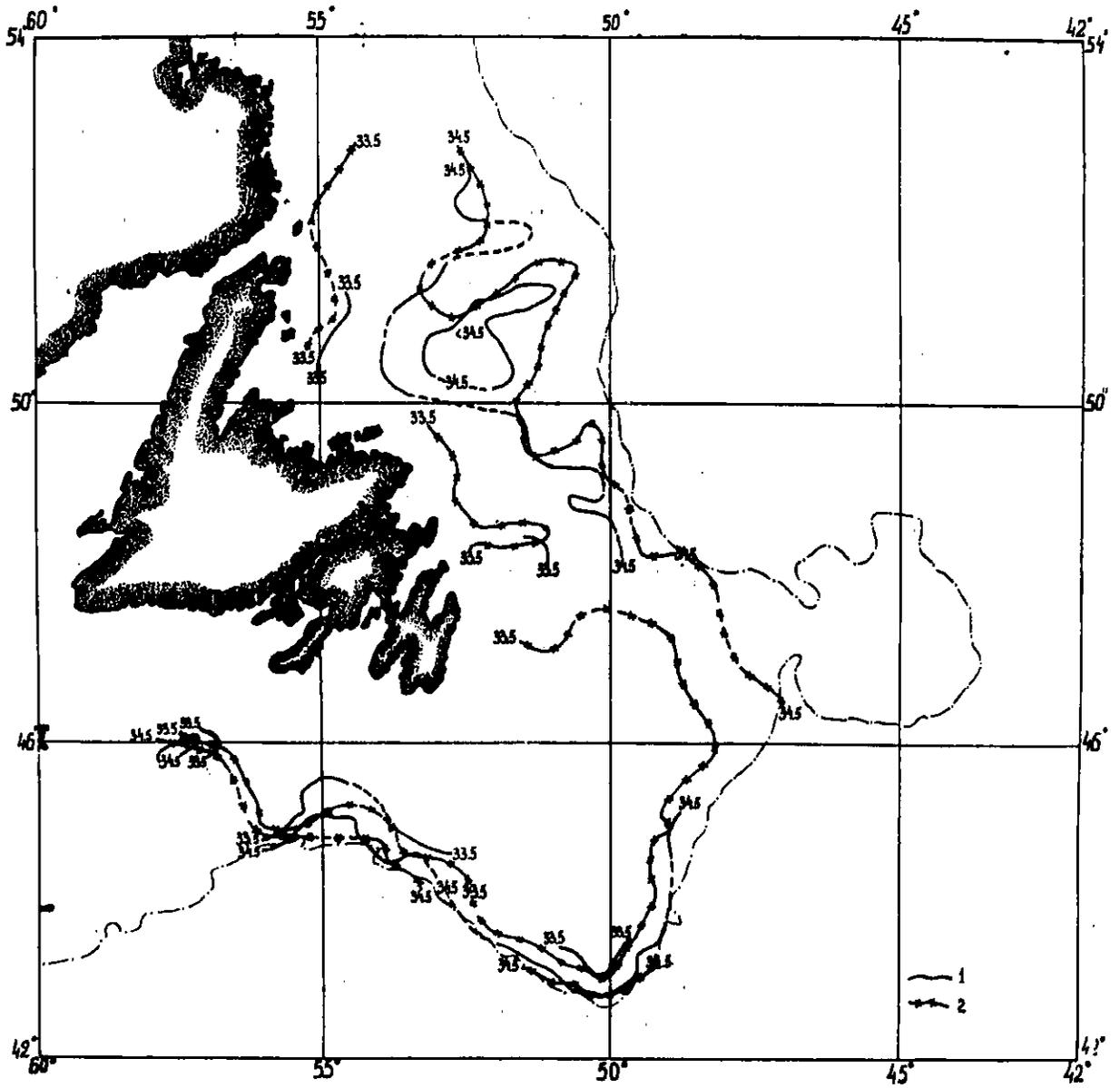


Fig. 5 The off-bottom (33.5‰ and 34.5‰) isohalines in the winter of 1966 (1) and 1963 (2).