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Hydrologic conditions in the Northwest Atlantic in 1970

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In 1970 PINRO's R/Vs Perseus III, Rossiya and Protsion conducted oceanographic research in Subareas 1, 2 and 3. More than 1,100 hydrographic stations were occupied over standard sections during six cruises. The main portion of the hydrographic work was completed by R/V Protsion.

At most of the stations temperature and salinity, as well as oxygen and phosphorus concentrations and other hydrochemical elements, were determined.

Mean estimates of temperature and salinity on the sections for different water masses and branches of currents were calculated in the boundaries determined by Elizarov (1962) and Burmakin (1971).

Subarea 1

In August 1970 hydrographic investigations were conducted by R/V Perseus III in the northern part of Davis Strait between 62°30'N and 65°30'N (Div.1C-1D). Treatment of the data obtained by means of the dynamic method showed that a secondary cyclonic vortex with low current velocities was located in the central part of the area investigated. This vortex developed on the northern periphery of the vortex of the Labrador Sea.

Comparison of the dynamic charts with charts of isotherms and isohalines obtained during the same survey shows good agreement between circulation, and temperature and salinity. The central part of the cyclonic vortex is characterized by the highest temperatures at all depths. The same result is obtained, if we compare the dynamic chart and distribution of salinity. At the surface in the area of the vortex it is above 33‰ (the maximum is 33.28‰). The water temperature fluctuated here from 3° to 4.4°. Especially great is the similarity between the surface currents and the temperature at 100 m, where the influence of summer warming is insignificant. The 1° isotherm at this depth is nearly the same in the pattern, as the isolines of dynamic heights in the area of the vortex, the space of the Tovqussaq Bank being occupied with below zero temperatures. It seems that the circulation field can be judged indirectly from observations of water temperature, and best from those at the 100 m level.

Estimates of discharge through Davis Strait on sections 11-A and 10-A were also obtained by means of the dynamic method (Table 1).

The results seem to contradict the present point of view on water transport through Davis Strait from the Baffin Sea into the Atlantic. It is quite possible that the results of calculations of water discharge were affected by the fact that no observations were made in coastal waters. Nevertheless, the predominance of discharge through the Strait in the northern direction in August 1970 allows us to make a supposition concerning the availability of great fluctuations of water exchange through Davis Strait.

It is possible to estimate the temperature conditions on Lille Hellefiske and Fyllas Banks in August from observations made on sections 10-A and 11-A. In Table 2, prepared by courtesy of I.I.Svetlov, these data are compared with data from observations made in previous years (though the data are not given for one and the same date).

Table 2 shows that the temperature of both components of the West Greenland Current was lower in Div.1C-1D (sections 10-A and 11-A) in August 1970, the 0-50 m layer being coldest in the years under consideration.

According to data obtained from section 8-A in September and October, temperatures 1-4° lower than in some previous years were also registered in Div.1F.

As far as one can judge from such fragmentary data, water temperature in August-October 1970 was lowest on the West Greenland Shelf, as compared with the temperature for the same months in the years under comparison. Cooling was especially marked in the surface layer and tended to increase from August to the end of the year.

Subareas 2 and 3

The comparative characteristics of temperature conditions for Subareas 2 and 3 in 1970 was shown by the mean temperature in the 0-200 m layer on standard hydrologic sections 8-A, 7-A, 6-A, 4-A, 3-A, 2-A, 1-A, and 44-A. In Table 3, the temperature is given for each month when the observations were made. The deviation of each mean temperature from its annual mean estimate on the date of observation is also given. Curves of seasonal variations of water temperature of the 0-200 m layer for each section (jet, water mass) were constructed from all available data obtained by the research vessels of the Polar Institute and the International Ice Patrol (see the paper by V.V.Burmakin, ICNAF, 1971). These curves allow us to estimate the anomaly of the mean temperature on each section on the date of observation.

Table 3 shows that in January 1970 temperature anomalies in the 0-200 m layer were positive on all sections made on the Grand Bank and Cabot Strait and fluctuated from 0.06 to 1.94°. The highest anomalies were recorded on section 1-A on the southwestern slope of the Grand Bank. A negative anomaly (-0.44°) on section 2-A recorded on the southern slope of the Grand Bank was the only exception to these positive anomalies.

Beginning in February, the anomalies were negative or near the norm in the whole of the Subarea 3. This was observed to the end of August.

In Subarea 2 observations were made in May and showed a positive anomaly of +0.20° (section 8-A, intercept B). In September positive anomalies were still found, but by the end of October negative anomalies (-0.04°) were observed in the main branch of the Labrador Current (B).

In autumn in Subarea 3 the anomalies were negative on the northeastern (section 7-A) and southeastern (sections 4-A and 3-A) slopes of the Grand Bank, whereas in the south (section 2-A) and in Flemish Cap Channel they were slightly positive (+0.06).

In September positive anomalies were observed in Cabot Strait and on the southwestern slope of the Grand Bank (sections 44-A and 1-A), but they were about 3 times smaller than those in January.

Thus, at the beginning of 1970, waters in Subareas 2 and 3 were warm, in spring and summer temperatures were below the norm and at the end of the year an insignificant warming was observed in the western part of Subarea 3, whereas, the waters in the east of the Grand Bank became considerably colder. Evidently, this can be explained by the simultaneous increase of intensity of the Labrador Current, which caused the cooling on the eastern slope of the Grand Bank, and of the Gulf Stream, that warmed the western part of the Bank.

The temperature of the 0-200 m layer, on sections 4-A and 3-A, adjusted for 15 May, and on section 8-A adjusted for 1 November, was compared with the norm (Table 4). On sections 4-A and 3-A the norms were calculated for the period 1936-41, 1949-54, 1956-59, 1961-63, 1968-69, and on section 8-A (B), for 1958, 1962, 1964-68. In our previous reports to ICNAF, the norms for sections 4-A and 3-A were those accepted by Elizarov (1962).

On sections 3-A and 8-A the mean temperature was calculated for the stations situated within the cold component of the Labrador Current, and on section 4-A, for the stations situated in the frontal zone of the waters of the Banks, of Labrador and North Atlantic waters.

Table 4 shows that, in spring and autumn 1970 on section 3-A and 8-A in cold Labrador waters, the temperature was below the norm, whereas, on section 4-A in the Frontal Zone it was above the norm. Signs of the anomalies, determined by two methods, coincide (Table 3 and 4).

Concerning the three year period, 1968-1970, in 1970 the temperature on the southeastern slope of the Grand Bank was lower by 0.20-1.41° and insignificantly higher in the area of South Labrador, than in 1968 and 1969 (Table 4).

A comparison of charts of water temperature distribution in the near-bottom layer on the Grand, Green and St. Pierre Banks for the last three years shows that the temperature at the bottom in 1970 was higher than in 1969 and inconsiderably lower than in 1968.

Salinity (Div.2J)

Observations carried out in the intercept B of the section 8-A give information on salinity of the main branch of the Labrador Current on the Hamilton Bank (Elizarov, 1962). Average values of salinity in the 0-200 m layer in the intercept B, calculated from data collected by the International Ice Patrol and USSR research vessels for the period 1936-57 (15 sections) are taken from Elizarov (1963), and for the period 1958-70 (45 sections) are calculated by us. The results of these calculations are inserted into the graph (Fig.1) in accordance with the date of each observation on the section. The figure shows that the many years' data used by us do not give complete information on the yearly variation of salinity, due to the fact that no observations were made in some months. However, the curve of the yearly variation of salinity can be drawn with a certain degree of approximation. If we accept the given curve for the "norm", it is possible to obtain the anomaly of salinity for every case observed on the section for the actual date of observations. Such a method of calculation of the value of salinity anomalies (as well as anomalies of other hydrological parameters) makes it possible to define the hydrological conditions of the year, even if the results from few observations made at different times are available in the given year. In Fig. 1 the upper and lower curves show the yearly variations of the extreme values of the mean salinity of the Labrador Current.

The method described was used to estimate the salinity of the Labrador Current in 1969 and 1970. Table 5 shows that in June 1969, the salinity of the Labrador Current was somewhat increased, and by the end of the year the negative anomaly reached 1/4‰. As noted by Templeman (1970) on 4 August 1969 the salinity on the Seal Islands-Hamilton Bank section at a depth of 30 m and more was almost always below the mean, being measured at different stations, but close to values obtained in the last four years, pertaining to the period 1951-1965.

Observations in 1970 show that in the spring to autumn period the salinity of the Labrador Current was somewhat above the norm or near it.

Conclusions

1. The secondary cyclonic vortex, which developed on the northern periphery of the circulation of the Labrador Sea, separated the West Greenland Current from the Baffin Land Current in August 1970. High temperatures and salinity are characteristic of the zone of the vortex.

2. From August to October water temperature on the West Greenland Shelf was the lowest for the last ten years. The cooling was most marked in the surface layer and evidently increased from August to the end of the year.

3. In the beginning of 1970 positive anomalies predominated in Subareas 2 and 3, in spring and summer of this year negative anomalies prevailed; by the end of the year some warming was observed in the western part of the Grand Bank and some cooling in the eastern part, and slight cooling at South Labrador.

4. As compared with the norm, the mean temperature of the 0-200 m layer on the eastern Grand Bank and adjusted for 15 May, and at South Labrador adjusted for 1 November had anomalies of the same signs, when compared with the curve of the yearly temperature variation. Though the values of the anomalies differed considerably.

5. In May-August 1970 in near-bottom layers of Subarea 3 the temperature was higher than in the same months of 1969 and insignificantly lower than in 1968.

6. From May to October 1970, salinity in the core of the Labrador Current was somewhat higher than the norm.

References

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Table 1. Water discharge through the Davis Strait in August 1970.

Section, date, position	Discharge to the north	Discharge to the south	Total discharge (to the north)
I0-A, I4-I6.VII			
$65^0 27'$, $-64^0 59'$, $-65^0 I0'$, $54^0 09'$, $-57^0 38'$, $-60^0 47'$,	3,59	2,36	I,23
II-A, 4-5.VII			
$63^0 57'$, $-63^0 03'$, $-63^0 4I'$, $53^0 00'$, $-58^0 56'$, $-62^0 30'$,	8,88	6,98	I,90

Table 2. Mean water temperature of the components of the West Greenland Current by layers in some years and months.

Date	Sections	Depths, m						
		0-50		0-200		50-200		200-500
		warm comp.	cold comp.	warm comp.	cold comp.	warm comp.	cold comp.	warm comp.
3.0c.I959	I0-A	2,40		I,52		I,II		3,40
I9.08.I963		3,82		2,62		2,20		3,32
8-9.0c.I964		3,3I		2,0I		I,46		3,5I
I0-I2.08.I967		3,08		I,3c		c,56		4,I4
I4-I6.0c.I970		2,57		I,62		I,30		4,03
3.0c.I964	II-A	4,09	3,96	4,24	3,55	4,25	3,36	4,90
I6-I0.0c.I969		2,20	I,3I	2,00	I,7I	I,90	I,70	4,3c
4-5.0c.I970		I,95	I,48	I,48	I,05	I,29	0,98	4,06
I3.09.I96I	8-A	7,52	4,44	6,85	5,36	6,66	5,66	5,92
23-24.09.I963		4,26	2,02	5,63	3,24	6,I4	3,76	5,59
I-2.09.I970		3,86	0,64	4,24	I,42	4,37	I,70	4,73
I9-2I.I0.I962	8-A	6,32	3,44	6,I2	4,I6	6,06	4,52	5,04
30-3I.I0.I963		4,96	-	5,45	-	5,62	-	5,26
27-29.I0.I964		6,6I	4,84	6,53	5,2I	6,52	5,38	5,39
I6-I9.I0.I966		6,59	2,60	6,27	3,25	6,I7	3,50	5,60
25-26.I0.I970		2,82	0,I3	4,07	I,I8	4,49	I,55	5,I3

Table 3. Mean temperature of the 0-200 m layer and its anomalies on standard sections in the areas of Labrador and Newfoundland in 1970.

Month		Sections							
		8-A(B)	7-A	6-A(G)	4-A	3-A	2-A	I-A	44-A
January	Date			3	7	9	25	I2	I7-I8
	t	-	-	4,0I	3,95	0,79	I,43	6,39	3,50
	Δt			+0,25	+0,83	+0,06	-0,44	+I,94	+0,72
February	Date					II			
	t	-	-	-	-	0,32	-	-	-
	Δt					-0,52			
May	Date	4-5	I7	I9	I5	I6			
	t	0,I8	0,90	I,39	2,05	0,48	-	-	-
	Δt	+0,20	-0,20	-0,2I	+0,04	-0,28			
June	Date								I9
	t	-	-	-	-	-	-	-	4,08
	Δt								-0,33
July	Date						I4	20	
	t	-	-	-	-	-	2,95	6,0C	-
	Δt						-0,09	-0,20	
August	Date		4	9					
	t	-	0,99	I,96	-	-	-	-	-
	Δt		-0,80	-I,29					
September	Date	4-5	22-23					24	27
	t	I,32	I,70	-	-	-	-	7,45	4,95
	Δt	+0,50	-0,67					+0,69	+0,53
October	Date	30		6	I0-II	I2	20		
	t	I,36	-	4,39	2,94	I,49	3,06	-	-
	Δt	-0,04		+0,06	-0,77	-0,48	+0,06		

Table 4. Mean temperature of the 0-200 m layer on sections 3-A, 4-A on 15 May and 8-A on 1 November for 1968-70 as compared with the norm.

Year	3-A, I5.05			4-A, I5.05			8-A, I.II		
	t° C	norm	Δt	t° C	norm	Δt	t° C	norm	Δt
I968	I,85	0,49	+I,36	2,25	I,7I	+0,54	0.50	I,00	-0,50
I969	0,80		+0,3I	3,46		+I,75	0,50		-0,50
I970	0,44		-0,05	2,05		+0,34	0,60		-0,40

Table 5. Mean salinity value and its anomaly of polar waters of the Labrador Current in the 0-200 m layer in accordance with the observations of the 1969 and 1970 on section 8-A.

Date	‰	‰
27-3I.07.I969	33,49	+0,I0
I7-I9.I2.I969	33,50	-0,25
4-5.05.I970	33,85	+0,07
4-5.09.I970	33,58	+0,I5
30.I0.I970	33,59	+0,04

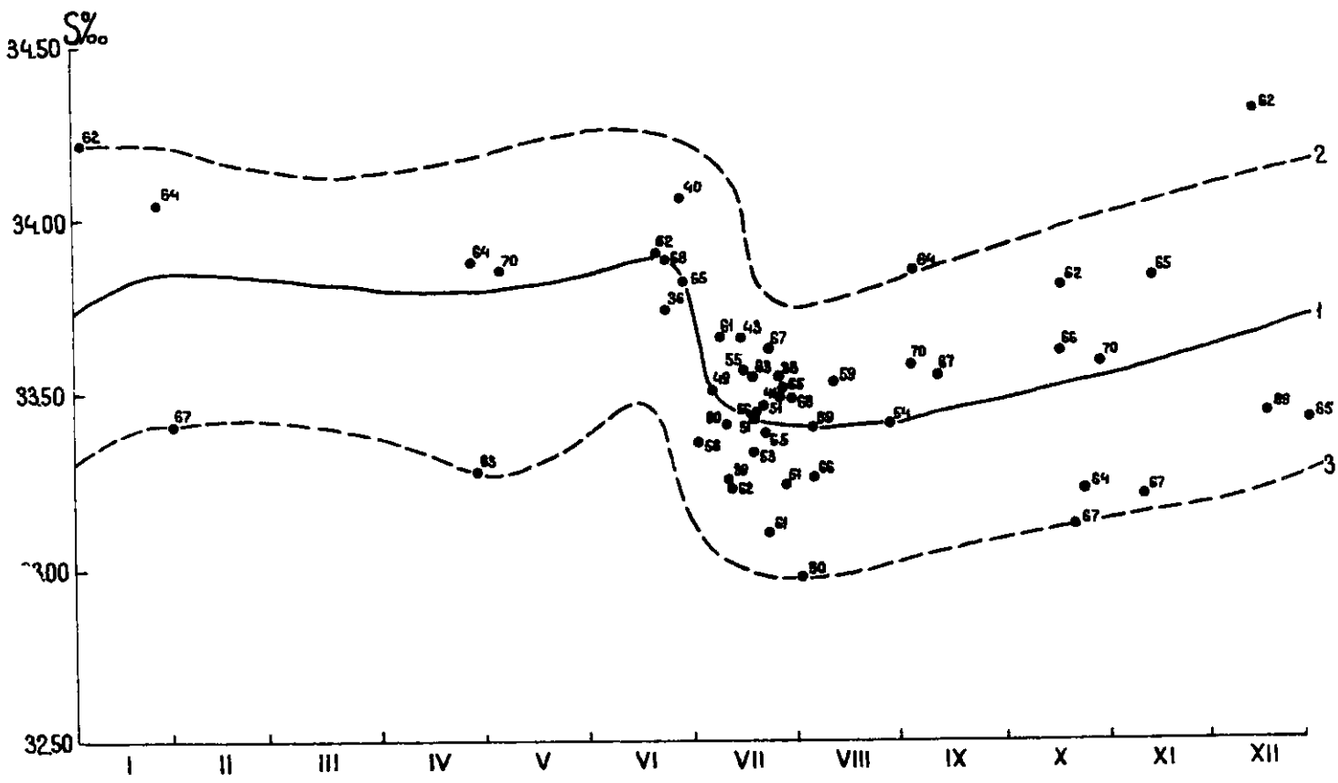

Fig. 1. Yearly variations of the mean (1) and extreme (2,3) values of salinity in the main branch of the Labrador Current on Hamilton Bank in the 0-200 m layer based on many years' data.