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Circulation and salinity of waters in the south
Labrador and Newfoundland areas in 1975-1976

by

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Abstract

Peculiarities of geostrophic circulation and seasonal changes in the transport and salinity of the Labrador Current waters on standard hydrological sections in 1975-1976 and their difference from long-term mean values are considered on the basis of observations conducted by PINRO research vessels in Northwest Atlantic.

Materials and methods

Two hydrological surveys were carried out by R/V PERSEUS III (14th and 15th cruises) in the South Labrador and Newfoundland areas in the second half of 1975 and first half of 1976. During these cruises oceanological observations were made on standard sections and separate stations.

Materials of hydrological surveys served as the basis for the characteristics of peculiarities of geostrophic circulation, changes in transport and salinity of the Labrador Current waters in the areas investigated.

Geostrophic circulation

In 1975 a hydrological survey of the South Labrador and Newfoundland areas was conducted at the end of June - at the end of September, and in 1976 it was performed in March - beginning of July. In 1974 an analogous survey of the area was carried out in May-July (Kudlo, Borovkov, Boitsov, 1976). The terms

of observations in separate parts of the area do not coincide for the three surveys and difference in time from year to year may be from one to three months. Terms of observations coincided only for Divisions 30 and 3P in 1974 and 1975 (July).

In August 1975 (Fig.1) the field of geostrophic circulation in the South Labrador and Northern Newfoundland Bank areas was strongly washed away, jets of the Labrador Current were weakly pronounced. In the summer of 1976 (Fig.2) the Labrador Current in Divisions 2J and 3K was most distinctly pronounced within depths of 300-1000 m on the charts of dynamic topography. A small gradient circulation field, against the background of which there was formed a number of anticyclonic vortices of waters with low velocities of the current, was registered between the main and coastal streams.

In Division 3L a strong eddying of the stream line with considerable current velocities was registered in September 1975. In May 1976 the velocity of the Labrador Current in the area was less than in 1975. Three vortices were present over the northern part of the Great Newfoundland Bank.

At the end of June 1975 an anticyclonic circulation of waters occurred over the central part of the Flemish Cap Bank (Division 3M) which was also registered in the area earlier (Kudlo, Borovkov, Boitsov, 1976). In March 1976 geostrophic circulation of waters on the Flemish Cap Bank was of an unusual character. The Labrador Current waters as if "washed" the bank from the northwest to the southeast and east. If a similar situation remained in the subsequent months of the year, conditions for the development of eggs and larvae of commercial fishes in the area in 1976 should be considered to be extremely unfavourable due to their intensive carrying out beyond the boundaries of the bank.

Circulation of waters over the southern slope of the Great Newfoundland Bank (Division 3N and 3O) was peculiar in pattern in April 1976. Instead of a usual quazi-stationary vortex, which

also occurred in the area in September 1975, two oppositely directed vortices were formed as a result of the abrupt turn of the Labrador Current to the north at meridian 51°W. Return of those cold waters to the southwestern slope of the Great Newfoundland Bank took place along the western periphery of the cyclonic vortex of waters.

Changeability of the Labrador Current intensity

The values of transport of the Labrador Current on standard sections calculated by the dynamic method are shown in Table 1. The data presented in it make it possible to judge not only on the changeability of the current intensity from 1975 to 1976 but on the magnitude of departures of water transport for the date of observation from longterm mean values taken from the average curve of the annual run of water transport (Kudlo, 1973; Kudlo, Borovkov, 1975; Kudlo, Borovkov, Boitsov, 1976).

Division 2J. In August 1975 transport of the Labrador Current on section 8-A was two times higher than normal; in July 1976 a positive anomaly made up only $1.1 \times 10^6 \text{ m}^3/\text{s}$. It should be noted that ^{in 1975} the water transport in the 0-200 m layer made up $3.27 \times 10^6 \text{ m}^3/\text{s}$, while in 1976 it was equal to $2.67 \times 10^6 \text{ m}^3/\text{s}$, i.e. it decreased by $0.60 \times 10^6 \text{ m}^3/\text{s}$. An analogous decrease for the 0-2000 m layer made up $3.65 \times 10^6 \text{ m}^3/\text{s}$. This event is indicative of the fact that the main water transport in 1975 occurred in deep layers along the continental slope.

Division 3L. An increase in the intensity of the Labrador Current took place on section 6-A from June 1975 to the spring of 1976. Anomalies of water transport were equal to $1.8 \times 10^6 \text{ m}^3/\text{s}$ and $1.5 \times 10^6 \text{ m}^3/\text{s}$ for March and May 1976 respectively (Table 1).

On section 4-A (southeastern slope of the Great Newfoundland Bank, Division 3N) water transport was considerably lower than normal in May 1976.

Water transport was insignificant and considerably lower than longterm mean in the southern extremity of the Great Newfoundland Bank on section 2-A (Division 3N) in April 1976.

Changes in the salinity of the Labrador
Current on standard sections

The values of the average salinity of the Labrador Current waters in the 0-200 m layer, its norms and anomalies for the date of observations on standard sections in 1975-1976 are shown in Table 2. As will be seen from the table, salinity of the Labrador Current waters in the area investigated in the first half of 1976 was somewhat lower than normal. Negative anomalies of salinity therewith tend to increase from the north to the south of the area.

Conclusions

1. In the summer of 1976 the Labrador Current in the areas of South Labrador, Northern Newfoundland Bank and northeastern slope of the Great Newfoundland Bank in the field of geostrophic circulation was most distinctly pronounced over the continental slope, within depths of 300-1000 m. A small gradient circulation field, against the background of which there was formed a number of vortices with low velocities of the current, occurred between the main and coastal streams.

2. In March 1976 the Labrador Current waters as if "washed" the bank from the northwest to the southeast and east. If a similar situation remained in the subsequent months of the year, conditions for the development of eggs and larvae of commercial fishes in the area in 1976 should be considered to be extremely unfavourable due to their intensive carrying out beyond the boundaries of the bank.

3. In April-July 1976 the water transport of the Labrador Current was slightly increased on section 8-A across Hamilton Bank and section 6-A across Flemish Cap Channel and reduced relative to longterm mean on sections 4-A and 2-A (Division 3N).

4. In the summer of 1976 salinity of waters was somewhat lower than normal on all standard sections, negative anomalies therewith tended to increase from the north to the south of the investigated area.

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Table 1. Water transport of the Labrador Current, its norms and anomalies on standard sections in 1975-1976

Section, : Sector : layer :	Vessel, : cruise :	Date of obser- vations	Transport, $10^6 \text{ m}^3/\text{s}$		
			observ.:	norm	anomaly
8-A (ABC) 0-2000 m	PERSEUS III 14th cruise	17-18 August 1975	9.05	4,5	4,5
Division 2J	PERSEUS III 15th cruise	01-02 July 1976	5.40	4.3	I.I
6-A (H ₁ GH ₂)	PERSEUS III 14th cruise	25-26 June 1975	0.28	3.3	-3.0
0-bottom	PERSEUS III 15th cruise	23-24 March 1976	4.70	2.90	I.8
Division 3L	PERSEUS III 15th cruise	18-19 May 1976	4.82	3.2	I.5
4-A (1-12 st.) 0-1000 m Division 3N	PERSEUS III 15th cruise	11-12 May 1976	0,6I	4.2	-3.6
2-A 0-1000 m	GEMMA 10th cruise	01 January 1975	0.00	0.7	-0.7
Division 3N	PERSEUS III 14th cruise	18-19 September 1975	0.89	0,4	0.5
	PERSEUS III 14th cruise	19 September 1975	-0.02	0.4	-0.4
	PERSEUS III 15th cruise	02 April 1976	0.28	2.8	-2.5

Table 2. Average salinity of the Labrador Current in the 0-200m layer, its norms and anomalies on standard sections in 1975-1976

Section, sector	Vessel, : cruise	Date of observations	Salinity, ‰		
			observ.:	norm	anomaly
8-A (B)	PERSEUS III 14th cruise	17-18 August 1975	33.21	33.40	-0.19
	PERSEUS III 15th cruise	01-02 July 1976	33.62	33.69	-0.07
6-A	PERSEUS III 14th cruise	25-26 June 1975	33.85	33.96	-0.11
(G)	PERSEUS III 15th cruise	23-24 March 1976	33.76	33.99	-0.23
	PERSEUS III 15th cruise	18-19 May 1976	33.64	33.76	-0.12
4-A (6-12 St.)	PERSEUS III 15th cruise	11-12 May 1976	33.65	34.06	-0.41
2-A	GEMMA 10th cruise	01 January 1975	33.52	33.48	0.04
	PERSEUS III 14th cruise	18-19 September 1975	33.62	33.52	0.10
	PERSEUS III 14th cruise	19 September 1975	33.71	33.52	0.19
	PERSEUS III 15th cruise	02 April 1976	33.01	33.71	-0.70

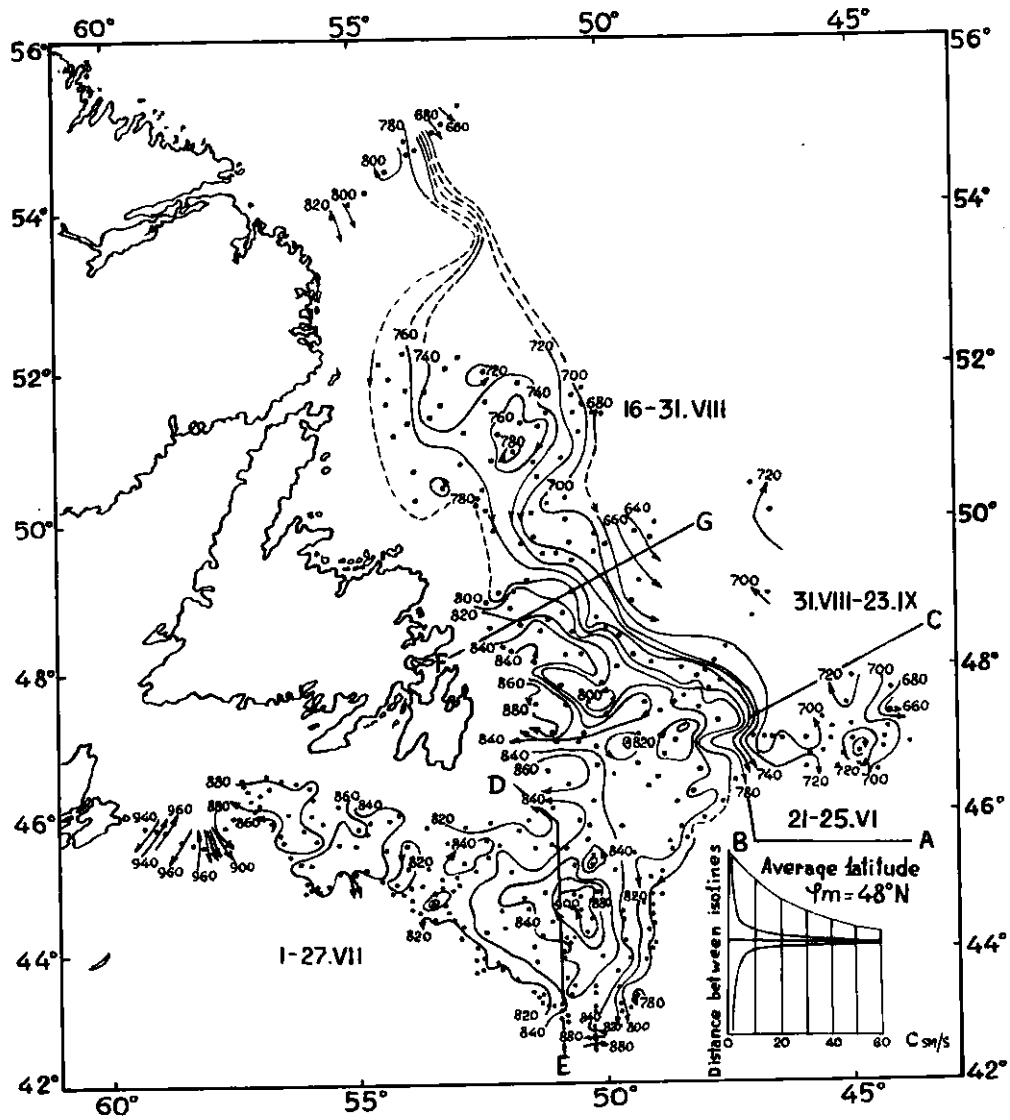


Fig. 1. Geostrophic circulation in the south Labrador and Newfoundland areas from 21 June to 23 September 1975, 0-200 dbars, 14th cruise of R/V *Perseus III*.

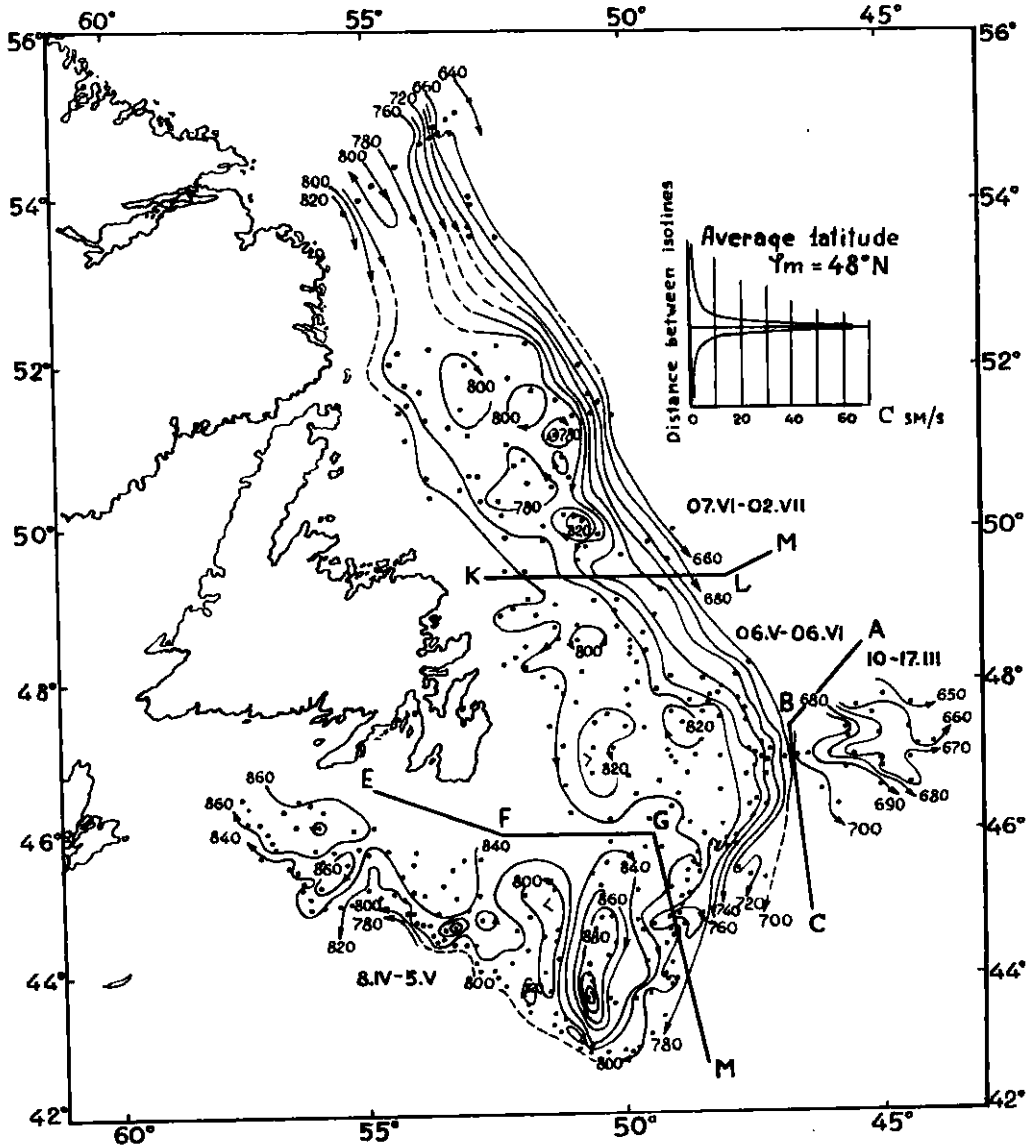


Fig. 2. Geostrophic circulation in the south Labrador and Newfoundland areas from 10 March to 2 July 1976, 0-200 dbar, 15th cruise of R/V *Perseus III*.