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Overview of Environmental Conditions in the Northwest Atlantic in 1985

by

K. F. Drinkwater and R. W. Trites
Department of Fisheries and Oceans, Marine Ecology Laboratory
P. O. Box 1006, Dartmouth, Nova Scotia, Canada B2Y 4A2

INTRODUCTION

This report presents a brief overview of environmental conditions in the Northwest Atlantic during 1985. As in our previous annual reviews (Trites and Drinkwater 1984, 1985, 1986), it includes selected sets of oceanographic and meteorological data as well as information derived from NAFO research documents and national reports. Conditions in 1985 are compared to the previous year and the long-term mean. The latter, where possible, is based on the period 1951-1980 in compliance with the World Meteorological Organization Convention and the NAFO Scientific Council recommendations. Where such data are unavailable, 20-year (1961-1980) and 10-year (1971-1980) base periods are used, if possible.

OCEANOGRAPHIC OBSERVATIONS

Coastal Sea-Surface Temperatures

Daily coastal sea-surface temperature (SST) records were obtained off Halifax in Nova Scotia, St. Andrews in New Brunswick and Boothbay Harbor in Maine (see Fig. 1 for locations) as part of long-term monitoring programs. Monthly averages during 1985 were calculated and anomalies relative to the 1951-1980 long-term mean (Trites and Drinkwater 1984) are shown in Fig. 2 together with the 1984 anomalies. Wharf reconstruction at St. Andrews prevented data collection at that site during the last 3 months of 1985.

Off Halifax temperatures were generally above normal throughout the year with peak anomalies (1.8°C) in September and October. Only in those months did the anomalies exceed the monthly standard deviations recorded over the years 1951-1980. This is the third consecutive year that high SST anomalies have been recorded off Halifax during the latter half of the year. In contrast to Halifax, SST anomalies at St. Andrews were primarily negative with peak values of over 1°C below normal during May and June and again in September. Off Boothbay Harbor, temperature anomalies during the first half of the year fluctuated between positive and negative while in the latter half they reached a relatively constant positive value (0.5°C). Only during January did the monthly anomaly exceed its standard deviation.

The mean annual SST was 8.4°C at Halifax and 8.9°C at Boothbay Harbor (Fig. 3). These represent anomalies from their 1951-1980 averages of 0.6° and 0.1°C, respectively. While the annual anomaly at Boothbay Harbor continues a recent trend of near normal means, at Halifax recent data suggests above-normal temperatures. Owing to the lack of data during the last three months at St. Andrews, no annual average could be determined; however, for the combined months January to September, the anomaly at St. Andrews was -0.6°C.

Offshore Sea Surface Temperatures

The monthly pattern of sea-surface temperature anomalies along the continental shelf from Cape Hatteras to southern Labrador (Fig. 4) for 1971-84, described by Trites and Drinkwater (1986) was examined for 1985, and compared with earlier years (Fig. 5). The onset of lower temperatures in the latter part of 1984, for the area from the Gulf of Maine northward, noted by Trites and Drinkwater (1986) continued to develop through 1985. At the same time the area from the Gulf of Maine southward, which displayed a warming trend throughout much of 1984, continued to display above normal temperatures throughout virtually all of 1985. Sea surface temperatures from a larger region of the Northwest Atlantic (35° - 60°N, 40° - 76°W), which extends from the southern boundary of the NAFO area northward to southern Greenland (Fig. 6) and grouped into 24 smaller areas to coincide with major water masses (Labrador Current, Gulf Streams, etc.) or fishing banks (Georges Bank, Flemish Cap, etc.), were reported by Trites and Drinkwater (1986 MS) for the 1972-1984 period. Monthly mean temperatures were computed for 1985 for each of the 24 areas. Annual anomalies for 1984 and 1985, using the normal period 1972-80, and the mean annual temperature for the 1972-80 period, are shown in Table 1. A space-time plot of the annual anomalies, for the 24 areas for the 1972-85 period is shown in Fig. 7. This provides further confirmation that the "warm in the north" condition which prevailed for several years has ended, and that temperatures in the area from the Gulf of Maine, southward, including the Gulf Stream and Western Slope Water areas, were above normal. In many respects conditions closely matched those in 1975. Noting the tendency for a persistence of several years duration, would suggest that further cooling in the north may occur in 1986 and that the "cold in the north" condition, which prevailed in the early to mid-seventies, may continue for several years.

Temperature and Salinity Stations

Fyllas Bank

Hydrographic conditions on a standard section off West Greenland in the region of Fyllas Bank are monitored by the Institut fur Seefischerei, Hamburg, and the Greenland Fisheries and Environmental Research Institut, Copenhagen. This area is influenced by the cold, low salinity waters of the East Greenland Current and the warm, high salinity waters of the Irminger Current. Stein (MS, 1986) reports that over the bank (0-200 m) autumn temperatures in 1985 were 3.2°C or 0.6°C above the long term mean (1963-1985). This represents the second year that autumn temperatures have risen following the extreme temperature minimum recorded in 1983. "A mild winter 1984/85, a warm summer 1985, and a mild autumn 1985 contributed to a warming of the surface layer...." Stein noted. Off the bank, in the core of the extension of the Irminger Current at depths of 400 to 500 m, autumn temperatures were 0.8°C above those recorded in the previous two years. Buch (MS, 1986) found that low salinities accompanied the cold conditions of 1982 to 1984 and, with temperatures rising in 1985, so too have the salinities.

Station 27

Vertical profiles of temperature and salinity have been routinely obtained by the Northwest Atlantic Fisheries Centre since 1946 at Station 27, a site approximately 10 km off St. John's, Newfoundland. It is representative of the inshore Labrador Current. During 1985 Station 27 was visited 57 times with a monthly maximum of 8 in both January and February. No data were obtained during December. The data were linearly interpolated to standard depths (0, 10, 20, 30, 50, 75, 100, 125 and 150 m), where necessary, and monthly means were calculated at each of these depths. Anomalies, from the mid-month means produced by Keeley (1981), were computed and are shown in Fig. 8.

The year was dominated by below-normal temperatures throughout the water column. The only exception was positive anomalies observed during the late summer and early fall which were mainly confined to depths of 50 m or less. The temperature anomaly pattern is similar to the previous year and the negative anomalies in the waters below 50 m represent the fourth consecutive year of colder than normal water. Below 100 m temperatures were typically -1.5° to -1.6°C. Data from a transect along 47°N latitude (Flemish Cap Section) indicates the cold water extended across the entire width of the Grand Bank through to the core of the offshore Labrador Current (Akenhead, MS 1986). The volume of cold water during the last four years is also larger than was observed during the late seventies. Salinities in the upper layers were generally above normal through to July. Anomaly values were low, however, reaching a peak of 0.44 psu (practical salinity units) at the surface in July. From August to November strong negative anomalies were observed. In August the monthly mean salinity was calculated to be 30.33 and was more than 1 psu below normal. Similar negative anomalies were measured in 1984 during the summer and early autumn. During 1985 the salinity anomalies below 100 m were generally negative but low in magnitude (less than -0.1 psu).

Prince 5

Hydrographic measurements are also taken on a routine basis at Prince 5, a station at the mouth of the Bay of Fundy. Data have been collected by the St. Andrews Biological Station since the 1920's and mean conditions for the period 1951 to 1980 have been calculated by Drinkwater (MS 1986). The 1985 data for Prince 5 were kindly provided by I. Perry (St. Andrews Biological Station, personal communication). They consisted of one occupation per month and thus do not necessarily represent 'average' conditions for the month. The extent of the variability in temperature and salinity within each month is unknown but can arise from such effects as the tides, winds, solar heating, river discharge, offshore forcing, etc. Caution must therefore be exercised in interpreting the data when expressed as anomalies from the long-term mean. No significance should be given to individual anomalies, however, persistent anomalous features probably indicate real events.

The temperature anomalies at Prince 5 in 1986 were mostly low (less than 1°C) and exhibited many sign reversals in adjacent months (Fig. 9). Peak anomalies were in July and August with positive values of 3.3°C and 2.6°C at the surface. These compare to negative anomalies of less than 0.5°C for the coastal SST's at St. Andrews during these same months (Fig. 2). We conclude that there were no significant anomalous trends in temperature at Prince 5 during 1985. Salinities were observed to be above normal during the first half of the year but below normal in the last half. The positive anomalies in January, February and April varied between 0.3 to 0.8 and were above the standard deviations for the base period 1951-1980 (Drinkwater, MS 1986). From July to October the salinity anomalies exceeded their standard deviations throughout most of the water column and varied in magnitude from 0.3 to 0.5. The magnitude and persistence of the salinity anomalies suggest the trend from above to below normal values through the year is likely real.

Position of Shelf-Slope Front

As in previous years, variation in the Shelf-Slope water front from Georges Bank to Cape Romain, South Carolina, has been derived from the NOAA/NWS Oceanographic Analysis maps by Armstrong (MS, 1986). Based on the 10-year means (1974-83), the front, northeast of Cape Henry, is generally located furthermost from the coast in spring and closest to the coast in late summer and early autumn. South of Cape Henry, it is generally further offshore during summer and is more shoreward during winter. In 1985, this seasonal pattern was only evident south of Cape Henry, with the area to the northeast overshadowed by shorter period fluctuations. For the mid-Atlantic Bight the front was distinctly shoreward of the 10-year means, indicating that the surface area covered by shelf water was 14% less in 1985 than the 10-year mean.

Warm Core Rings

The life-history of anticyclonic warm-core Gulf Stream rings in the 45°-75°W area during 1985 has been derived from the NOAA/NESS Oceanographic Analysis maps issued on a tri-weekly basis and the "State of the Ocean: Gulf of Maine to the Grand Banks" documents issued monthly by the Bedford Institute of Oceanography.

A total of 24 warm-core rings were present in the area during some portion of 1985. Four rings, formed in 1984, survived well into 1985. During the year 20 new rings formed but only 4 persisted into 1986. Of the 20 new rings, 11 exceeded an age of 2 months. Their paths are shown in Fig. 10A. Rings whose death occurred in 1985 ranged in age from 9 to 362 days and had a mean life of 123 days. The statistics of ring formation and ring presence compiled by zones, each covering 2½° of longitude, are shown in Fig. 10B and 10C respectively. Although one or more rings were present at some time during the year in all zones within the 45°-75°W area, the maximum number occurred in the 57.5° - 60°W and 62.5° -65°W zones (Fig. 10C). However, despite the relatively high production and presence in the central zones, many of them were relatively short lived.

A breakdown of ring statistics based on dividing the total area into two regions separated by the 60°W meridian, indicates that 10 were generated in the western region in 1985 compared to 8 in 1984. During the 1974-1983 period, ring formation averaged 9 per year, ranging from 5 in 1974 to a maximum of 11 in 1979 and 1982 (Price, MS 1985). The average lifetime of rings generated in the western region and whose destruction occurred in 1985 was 119 days. This compares to 97 days for 1984 and a 1976-1981 mean of 120 days. For the eastern region, 10 rings were generated in 1985, identical to the number formed in 1984 (Trites and Drinkwater, 1986). Lifetime for the 8 rings whose death occurred in 1985 was 127 days and compares to a mean of about 3 months for those that occurred in 1984.

Examination of the statistics of ring formation in relation to month of the year for 1985 indicates that May, July, and August which produced 5, 4, and 6 rings respectively accounted for 75% of the yearly production. For the 8 month period from September to April, 4 rings formed, comprising only 20% of the yearly total.

A separate analysis of warm core Gulf Stream rings present in the area west of 60°W during 1985 was undertaken by Price and Barton (MS, 1986). They used, in addition to the NOAA/NWS Oceanographic Analysis maps, geometrically corrected and enhanced processing of satellite imagery to more clearly identify sea surface thermal features. Their analysis indicates that 11 rings (compared to 12 as reported above) were present in the area in 1985 (two formed late in 1984 and survived into 1985). From the estimated formation and destruction dates of each ring, lifespans for the nine rings whose destruction occurred in 1985 varied from 18 to 362 days, with a mean age of 126 days (compared to 119 days reported above).

Shelf-Slope Temperatures in the Mid Atlantic Bight

Monitoring thermal conditions along a transect extending seaward from New York Harbor across the Shelf and Slope continued in 1985 for the tenth year. Benway (MS, 1986) reports that cold pool temperatures in 1985 were approximately 1°-2°C above normal and less than 10°C water remained on the bottom only until mid-September, about two weeks briefer than usual. An abrupt temperature increase in the water column at mid-shelf occurred in November, coincident with the passage to the southwest of a Gulf Stream ring further offshore. For the first time since 1977, temperatures above 12°C persisted along the upper slope (100-200 M depth zone) for the entire year.

Waves

Wave and weather observations from many locations in the North Atlantic (weather ships, government and naval ships, merchant ships, and oil-drilling platforms) are transmitted every 6 h to the Canadian Meteorological and Oceanographic Center (METOC) at Halifax, Nova Sotia (see Neu, 1982). Trites and Drinkwater (1984, 1985, 1986) provided summary statistics of significant and extreme wave heights at three grid points in the Northwest Atlantic for each year of the 1970-1984 period. The mean monthly significant wave heights in 1984 and 1985, together with the averages for the 1970-80 period are given in Table 2. The monthly significant wave height anomalies (relative to the 1970-80 means) for the three areas are illustrated in Fig. 11. For the Labrador Sea, wave heights particularly in the winter, spring and autumn 1985 were higher than in 1984, and only in June and August were significant heights less than the decadal mean. For the Grand Banks area, conditions in 1985 were more variable than in 1984, and with a marked increase in heights in the October-December period compared to the mean. On the Scotian Shelf, wave heights during the first half of the year were generally higher than normal, while in the last 5 months of the year, heights were slightly below the decadal mean.

Compared to 1984, 1985 was a stormier year, as judged from the number of occurrences of significant wave-heights equal to or exceeding 6, 7, and 8 m (Fig. 12). In the Labrador Sea area, the number of occurrences of waves greater than 7 and 8 M were the highest recorded in the past 16 years. Even the number of occurrences of the greater than 6 M waves were exceeded only in 1978. For the Grand Banks and Scotian Shelf areas, wave conditions were much less severe than for the Labrador Sea area, and the number of occurrences of extreme waves (greater than 6, 7, 8 M) were close to the 10-year mean.

Sea Ice

The Ice Climatology Division of the Canadian Atmospheric Environment Service (AES) undertakes annually an analysis of ice conditions in the Gulf of St. Lawrence and off the east coast of Newfoundland and Labrador by determining the time of onset, duration, and latest presence of ice at 24 grid sites (Fig. 13). Results for 1982-83 and 1983-84 have previously been summarized by Trites and Drinkwater (1985, 1986). The analysis has been updated to include 1985 data. For each site the data extracted were ice duration in weeks for the 1984-85 season, average duration for all years of record, and maximum, minimum and average duration for years when ice was present (Table 3). The timing of first and last sea ice, the median dates and the dates for 1984 and 1985 are shown in Figure 14. For most sites, ice first appeared earlier than normal, persisted for a longer period and disappeared much later than usual. In terms of duration, ice was present, at most sites for longer periods in 1984-85 than for the previous year. For some sites (G10 in the Gulf of St. Lawrence, and N21 off southern Labrador) records were set both for earliest and latest dates of ice presence (Fig. 14).

Icebergs

The number of icebergs drifting south past 48°N latitude are monitored by the International Ice Patrol of the US Coast Guard. Data during the last three years have been collected using SLAR (Side-Looking Airborne Radar) which is believed to detect many more bergs than previous observational methods. For the

1984-85 ice season (October to September), a total of 1063 icebergs were reported. Icebergs were sited each month with monthly totals beginning in October of 3, 11, 7, 2, 57, 129, 208, 205, 247, 123, 39 and 32. The seasonal distribution is similar to previous years with 85% of the icebergs passing 48°N latitude between March and July. The total number of icebergs were less than half that reported in 1983-84 (2202) and lower than the 1982-83 total (1352). Comparison with data collected prior to 1982 is not felt to be meaningful because of the differences in observational techniques.

METEOROLOGICAL OBSERVATIONS

Air Temperatures

Monthly mean air temperature anomalies for Canada are published in the Monthly Supplement to Climatic Perspectives by the Atmospheric Environment Service of Canada. These anomalies are presented in Fig. 15.

Over Baffin Island, monthly mean air temperatures were above normal throughout 1985 except during March and April when negative anomalies of less than 2°C were observed. Peak positive anomalies occurred in December with values of 8° to 10°C which were 2 to 2.5 times the normal standard deviation. Along the Labrador Coast positive air temperature anomalies occurred during the winter (January and February) and throughout the summer and early autumn (June to October). Anomalies were generally within their standard deviations. In contrast to Baffin Island and Labrador, air temperatures around the Gulf of St. Lawrence and the Gulf of Maine as well as on Newfoundland were mostly below normal throughout most of the year. Exceptions included February and throughout most of the summer (July to September) when anomalies were positive but small (less than 2°C).

The annual anomalies of air temperature show positive anomalies throughout northern Quebec and Baffin Island and negative anomalies in more southern regions (Fig. 16). The anomalies are on the order of 1°C except on Baffin Island. Only there did the anomalies exceed their standard deviation. The pattern of annual air temperature anomalies for 1985 of positive in the north and negative in south is the reverse of conditions observed during 1983 and 1984 (Trites and Drinkwater 1985, 1986).

Sea-Surface Air Pressure

Monthly mean sea-surface pressures over the North Atlantic are published in Die Grosswetterlagen Europas by Deutscher Wetterdierst, Offenbach. Seasonal averages for 1985 (winter, December 1984 - February 1985; spring, March - May;

summer, June - August; autumn, September - November) and anomalies from their long term mean (1951-1980) were calculated. The long-term mean pressure patterns are dominated by a low pressure centered between Greenland and Iceland (the Icelandic Low) and a high pressure centered between Florida and northern Africa (the Bermuda-Azores High). The strength of the Low and High vary seasonally from winter maxima to summer minima. These means were provided by K.R. Thompson (pers. comm., Dalhousie University, Halifax).

During the winter season a westward shift in the position of the Icelandic Low produced below normal pressures (up to 5 mb) over the northern NAFO regions (Fig. 17). This anomalous low was centered slightly southwest of Greenland (58°N,50°W). Elsewhere, an anomalous high (almost 10 mb above normal) developed over the Norwegian Sea while near normal pressures were observed throughout the southern North Atlantic. In the spring the Icelandic Low remained further west and was deeper than normal. This, coupled with the anomalous high to the south, suggests stronger than normal westerly winds across the northern North Atlantic. In the summer above normal pressures were observed over much of northwest while slightly below normal values occurred in the south. This primarily resulted from a northward extension of the Bermuda-Azores High although the strength of the High was below normal. In the autumn a southward extension of the Icelandic Low produced an anomalous low pressure ridge in the middle of the North Atlantic Ocean. Anomalous highs developed in the west over most of the NAFO region and in the east over the Norwegian Sea.

SUMMARY

Nineteen-eighty-five was characterized by several anomalous features in the northern waters. Annual sea surface temperatures on the Grand Banks, off the Labrador Coast and in the Labrador Sea were below normal. For the fourth consecutive year colder than normal temperatures were observed in the subsurface waters throughout the year at Station 27 off St. John's, Newfoundland, with temperatures of -1.5°C to -1.6°C below 100 m. Wave data from the Labrador Sea showed higher significant wave heights than the long term mean and high storm activity was suggested from the highest number of occurrences of waves greater than 7 and 8 m over the past 16 years. The Arctic ice pack along Labrador and northern Newfoundland arrived earlier, stayed later, and extended further south than normal. Ice conditions in the Gulf of St. Lawrence were the heaviest in the last five years. The heavy ice is consistent with below normal air temperatures in December of 1984 and in the spring (March and April) of 1985. While the

northern waters off Canada appeared to be colder than normal water, off West Greenland they were slightly warmer than normal ending three years of extremely cold temperatures there.

On the Scotian Shelf near normal conditions appeared to prevail during 1985. A positive annual SST anomaly (0.6°C) occurred inshore at Halifax while over the Shelf (area SH in Fig. 6) ships of opportunity data indicated a negative SST anomaly (-0.2°C). Wave data for the Scotian Shelf showed normal conditions for both significant wave height and the number of occurrences of extreme waves. Off the Shelf the number of Gulf Stream eddies that formed, their location and their mean lifetime were also about average.

Finally, the negative annual SST anomalies that extended from the Gulf of Maine to the Labrador Sea ended a pattern of above normal temperatures that had persisted throughout the region since the mid-seventies.

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Table 1. Annual SST anomalies for the 1972-85 period, using the normal period 1972-80. Geographic locations of water masses are shown in Fig. 6.

Water Mass	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Mean
CF	-.14							.14			.10	-.12	-.01	1.03	3.62
LS	-.75	.11	-.24	.44	.16	-.13			.40		-.43	-.11	-.59		5.54
LCS	-.41	02		30		-.23	.16	.11	.04	-.10					2.19
OLC	-.28	-.07	-.38	-.12	-.16	.12	.19	.68	.01	.82	.24	.32	.06	-.90	5.17
ILC	-.06	-.25	-.57	-.30	.22	-.11	.27	.61	.20	.96	.40	.99	.52	-.38	4.83
FC	-.19	.02	-.27	.03	-.18	-.05	.07	.70	-.12	.83	-.39	.46	-.14	-.80	7.88
CGB	-.28	-.37	-.20	-.46	.51	.46	.09	.50	-.26	1.11	.34	1.37	.84	-.54	6.48
WGB	.05	-.11	-.33	-.63	.34	.16	.31	.30	-.08	1.19	.19	1.11	.62	-.69	6.13
SP	.03	-.24	-.52	-.35	-.04	.44	.30	.22	.18	1.14	.35	.87	.79	-.36	5.91
GSL	-.64	-.14	-.53	-.15	.11	.17	.30	.73	.15	.56	.46	.91	-.02	-.01	5.82
ESS	-.20	-.28	-.29	-.44	.20	-.05	.39	.53	.14	.46	.45	1.28	.56	-.29	7.10
SI	.11	-.38	-.40	-.62	.52	.33	.17	.39	-.11	.85	-.20	.96	.97	-.49	8.27
SH		-.24	-.61	-.34	.16	-.04	.35	.33	.39			1.43	.66	-.18	7.85
LHB	.31	-.47	-.25	-.35	.26	-.28	.13	.51	.14	.30	-.07	.86	.42	-.33	8.87
BR	.05	-.28		-.39	.86	-.12	.03	-.05	-.10	.25	-.28	1.07	.51	.17	8.84
Y	-.19	-.13	-.03	-.15	.42	-.43	-.13	.42	.22	.18	-.20	.05	.10	-.45	7.64
GOM	-.17	-.20	-.05	-.25	.35	.10	-.11	.39	-.05	.11	.07	.45	.45	.10	9.59
GB	-.27	-.36	.23	.00	.72	-.01	-.50	.00	.19	-.39	-.46	.48	.37	.21	10.17
SNE	-.26	-.11	.56	.17	-.01	-.31	-.31	.28	-.01	-.50	-.03	.38	1.08	.14	12.23
MAB	-.22	.15	.62	.57	-.52	-.08	-.36	-.20	.04	-.43	-.06	.61	.08	.80	14.87
ESW	.12	-.39	.30	.28	.12	.39	.22	-.65	-.39	-.03	-.37	.51	1.25	.02	15.54
WSW	-.15	.27	.37	-.17	.15	.02	-1.02	.53	-.01	-.92	-.48	-.27	-.17	.52	18.50
GS	.15	.10	.26	.20	-.15	.03	-.15	-.04	-.40	-.26	-.16	.08	.08	.11	22.94
SS	-.08	-.09	.15	.10	-.01	.02	-.08	.11	-.12	-.37	-.07	.04	-.05	-.14	22.26

TABLE 2. Monthly mean significant wave heights at three locations in the Northwest Atlantic derived from 12-hr wave charts for 1984 and 1985, and the mean heights for 1970-1980.

Labrador Sea (57.5°N, 52.5°W)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1984	2.95	2.48	2.61	1.77	1.90	1.78	1.74	2.34	2.93	3.08	4.27	4.16
1985	4.64	3.57	3.79	2.68	2.84	1.75	1.95	1.82	2.80	3.69	3.65	4.39
1970-80	3.50	3.36	3.20	2.56	2.02	1.84	1.75	2.01	2.61	3.14	3.33	3.64

Grand Banks (47.5°N, 47.5°W)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1984	3.44	3.02	2.40	2.78	2.23	2.12	2.00	2.05	2.78	3.11	3.30	3.81
1985	4.10	2.98	3.00	3.02	2.63	2.12	2.02	2.19	2.75	3.52	4.03	4.95
1970-80	3.76	3.48	2.88	2.78	2.22	2.07	1.94	2.22	2.75	3.19	3.41	3.96

Scotian Shelf (42.5°N, 62.5°W)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1984	2.68	2.90	3.47	2.65	1.98	1.73	1.68	1.35	1.92	2.15	2.12	2.68
1985	3.77	2.52	2.79	2.20	2.06	2.10	1.77	1.35	1.65	1.94	2.43	2.98
1970-80	2.91	2.77	2.80	2.35	1.82	1.70	1.57	1.62	1.76	2.16	2.69	3.00

TABLE 3

Historical data on presence and duration of sea ice at 24 sites off eastern Canada, and ice duration at these sites in the winter of 1984-85

SITE	PERIOD STUDIED	NO. OF YEARS	YEARS WITH ICE	ICE DURATION WEEKS when ice present min	max	mean	OVERALL MEAN	1984/85	1983/84
G-7	1966-85	18	18	6	14	9.9	9.9	11	13
G-10	1977-85	09	09	3	16	9.5	9.5	16	11
G-12	1968-85	18	18	2	15	11.1	11.1	12	13
G-22	1977-85	09	09	7	14	11.2	11.2	13	14
G-31	1969-85	17	16	8	17	11.9	11.2	11	11
G-33	1971-85	15	14	2	14	9.8	9.2	13	04
G-35	1962-85	24	12	1	11	3.5	1.7	01	00
G-86	1976-85	10	09	6	22	13.9	12.5	22	15
G-87	1971-85	15	14	1	12	6.9	6.5	11	12
N-19	1967-85	19	19	17	30	24.8	24.8	30	27
N-21	1968-85	18	18	5	28	18.3	18.3	28	25
N-23	1960-85	26	20	1	17	5.5	4.3	10	17
N-25	1960-85	26	02	1	01	1.0	0.0	00	01
N-27	1960-85	26	00	0	00	0.0	0.0	00	00
N-62	1968-85	18	18	8	27	18.0	18.0	27	23
N-64	1960-85	26	25	3	25	11.7	11.2	25	16
N-66	1960-85	26	20	1	16	7.5	5.7	16	12
N-68	1960-85	26	10	1	10	3.6	1.4	03	10
N-70	1961-85	25	00	0	00	0.0	0.0	00	00
N-108	1960-85	26	20	1	17	5.7	4.4	11	01
N-110	1960-85	26	19	1	12	4.6	3.4	12	04
N-112	1960-85	26	07	1	10	5.1	1.4	07	04
N-114	1960-85	26	03	1	02	1.3	0.2	01	00
N-228	1960-85	26	16	1	14	5.1	3.2	07	03

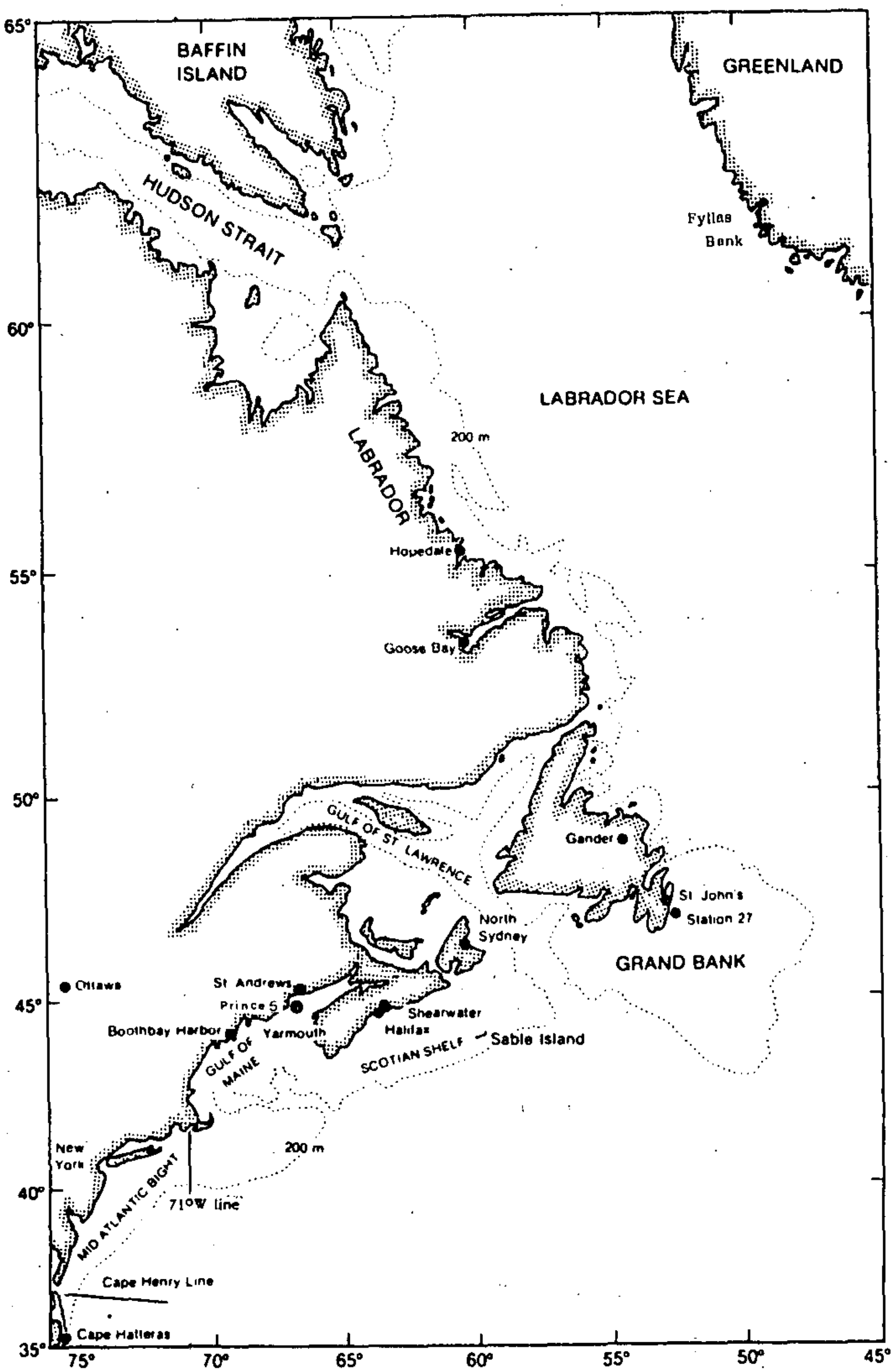

Fig. 1 Map of Northwest Atlantic showing oceanographic and meteorological stations and other place names mentioned in text.

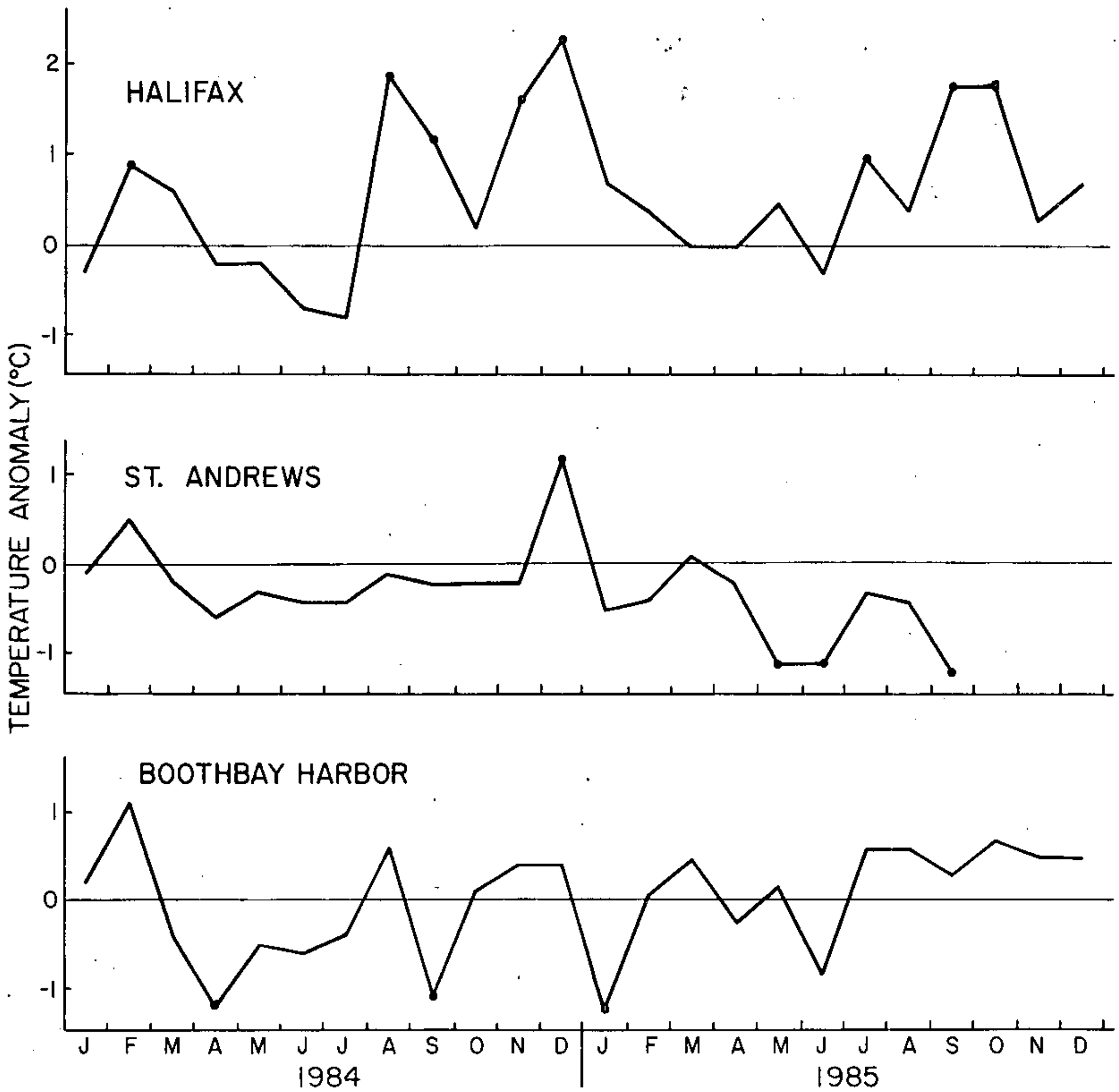

Fig. 2 Monthly sea-surface temperature anomalies at Halifax, St. Andrews and Boothbay Harbor during 1984 and 1985 relative to monthly means for the 1951-1980 base period. Dots indicate months when the anomaly equalled or exceeded one standard deviation. (No data were collected from October to December, 1985, at St. Andrews due to wharf reconstruction).

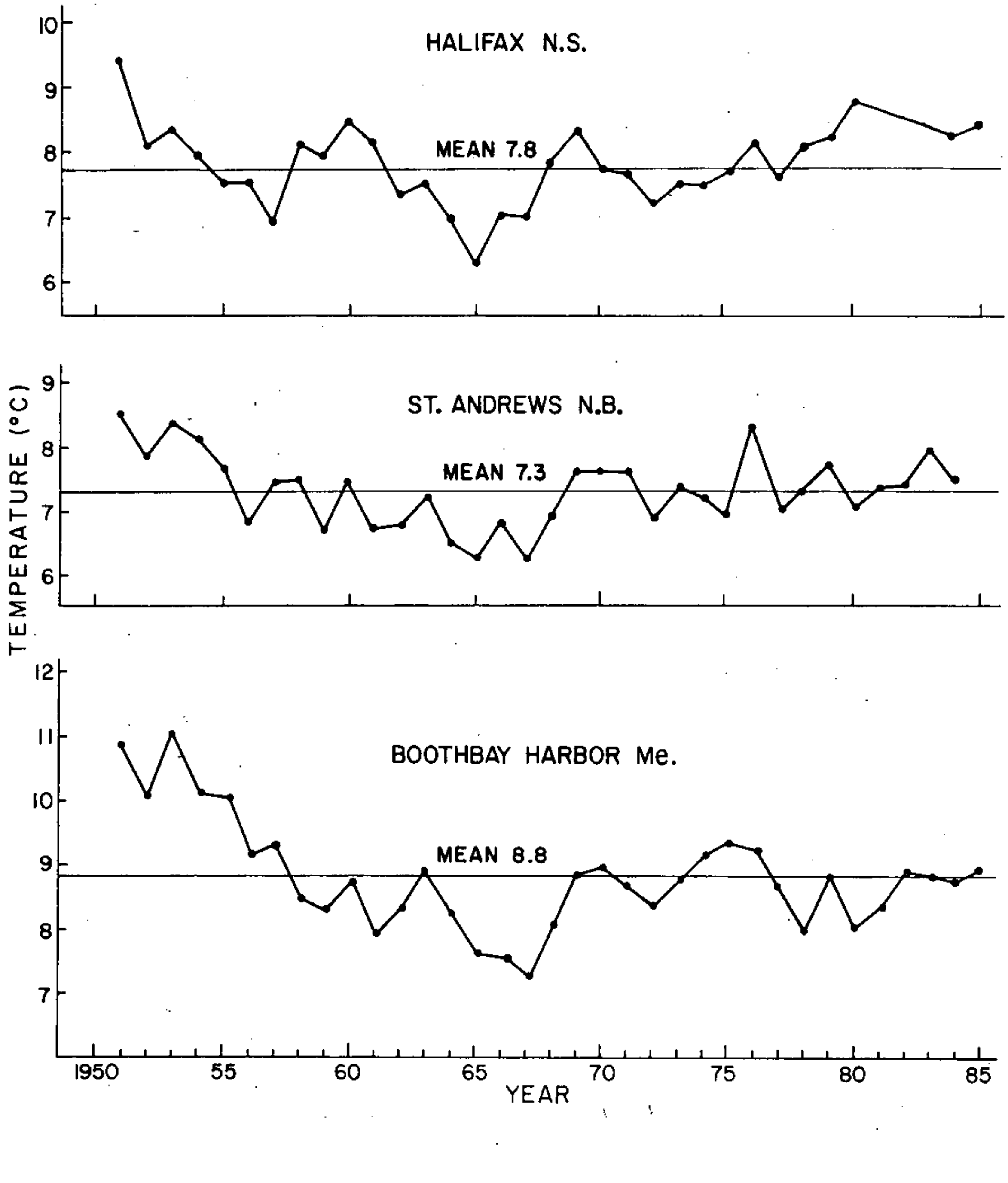

Fig. 3 Annual sea-surface temperature anomalies at Halifax, St. Andrews and Boothbay Harbor during 1951-1985. The mean was calculated over the base period, 1951-1980.

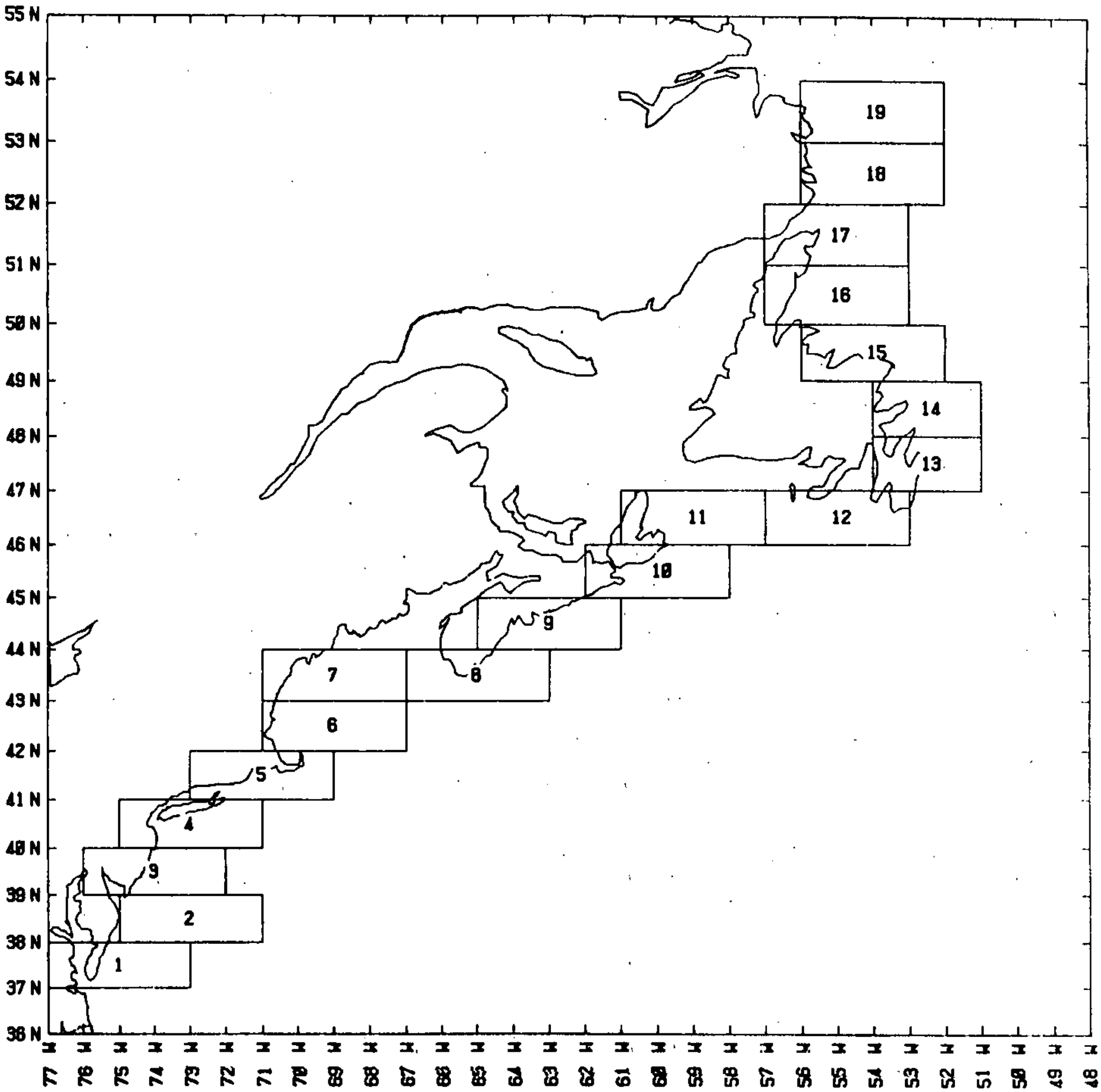

Fig. 4 Locations of 19 areas in the Northwest Atlantic (Chesapeake Bay to southern Labrador) for which sea-surface temperature data were grouped for analysis.

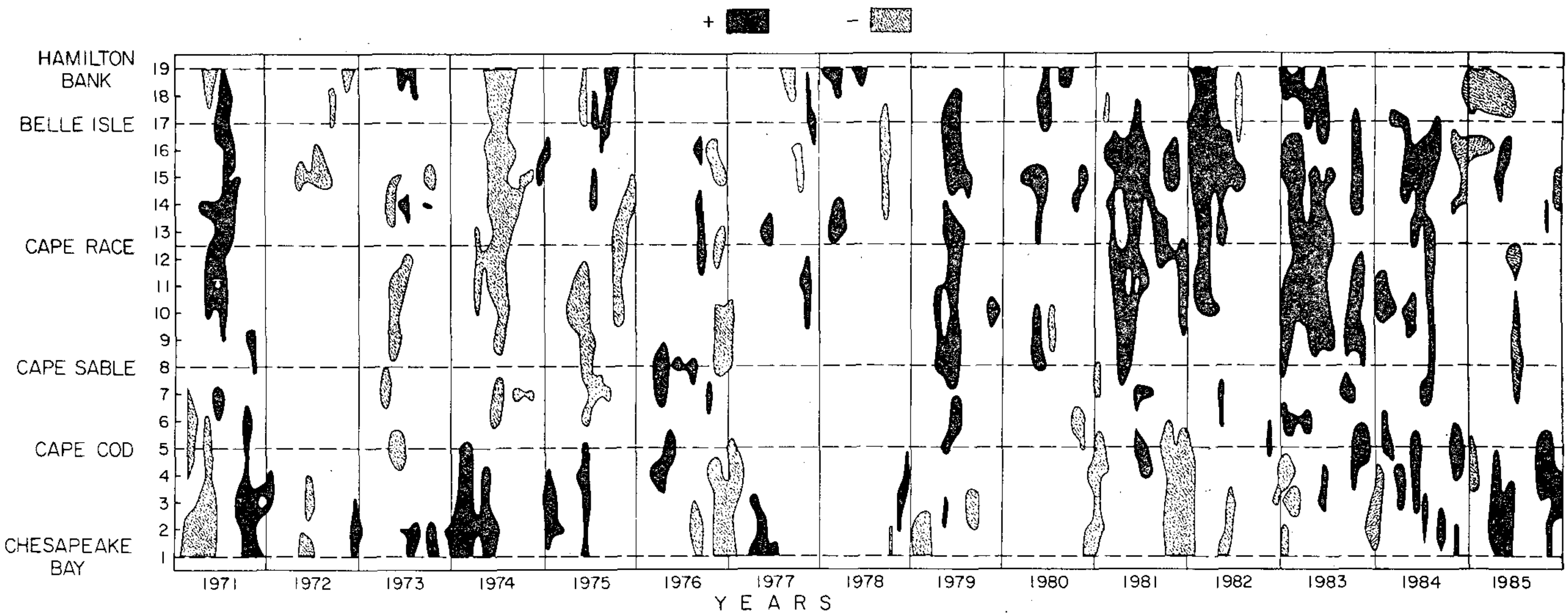

Fig. 5 Contoured plot of monthly sea-surface temperature anomalies (relative to the 1971-1980 base period) by area (Fig. 4) for the 1971-1985 period. (Only anomalies exceeding 1°C (dark) and less than -1°C (light) which extended in space through at least two neighbouring areas or in time for at least two consecutive months have been contoured).

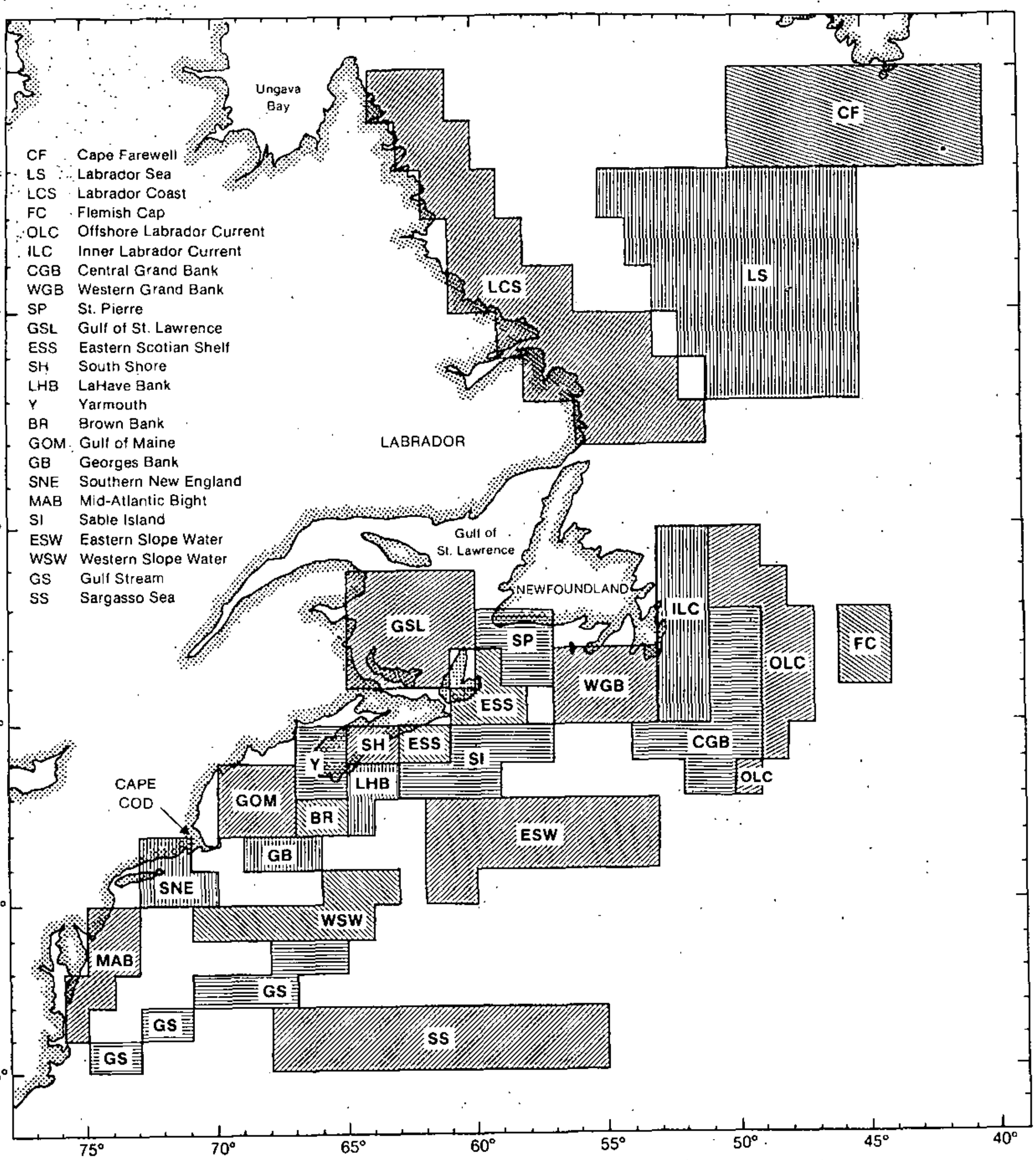

Fig. 6 Geographic boundaries of 24 subregions for which sea-surface temperatures were analyzed on a monthly basis for the period 1972-1985 period.

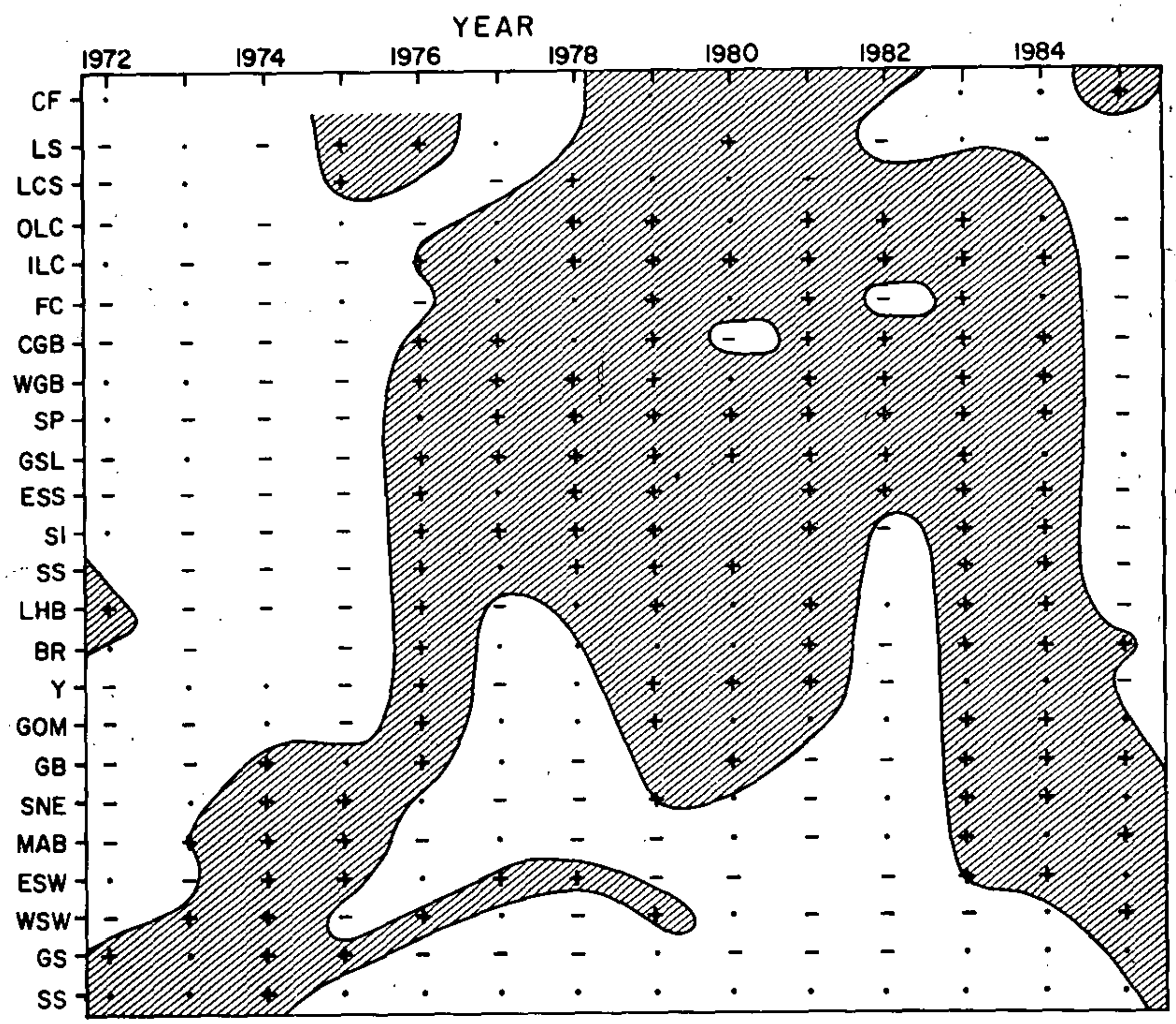

Fig. 7 Distribution of positive (+) and negative (-) annual sea-surface temperature anomalies in 1972-1984 by subregions (Fig. 6) relative to the means for the 1972-1980 base period. (Only anomalies less than -0.15°C and greater than 0.15°C were used in drawing the contours).

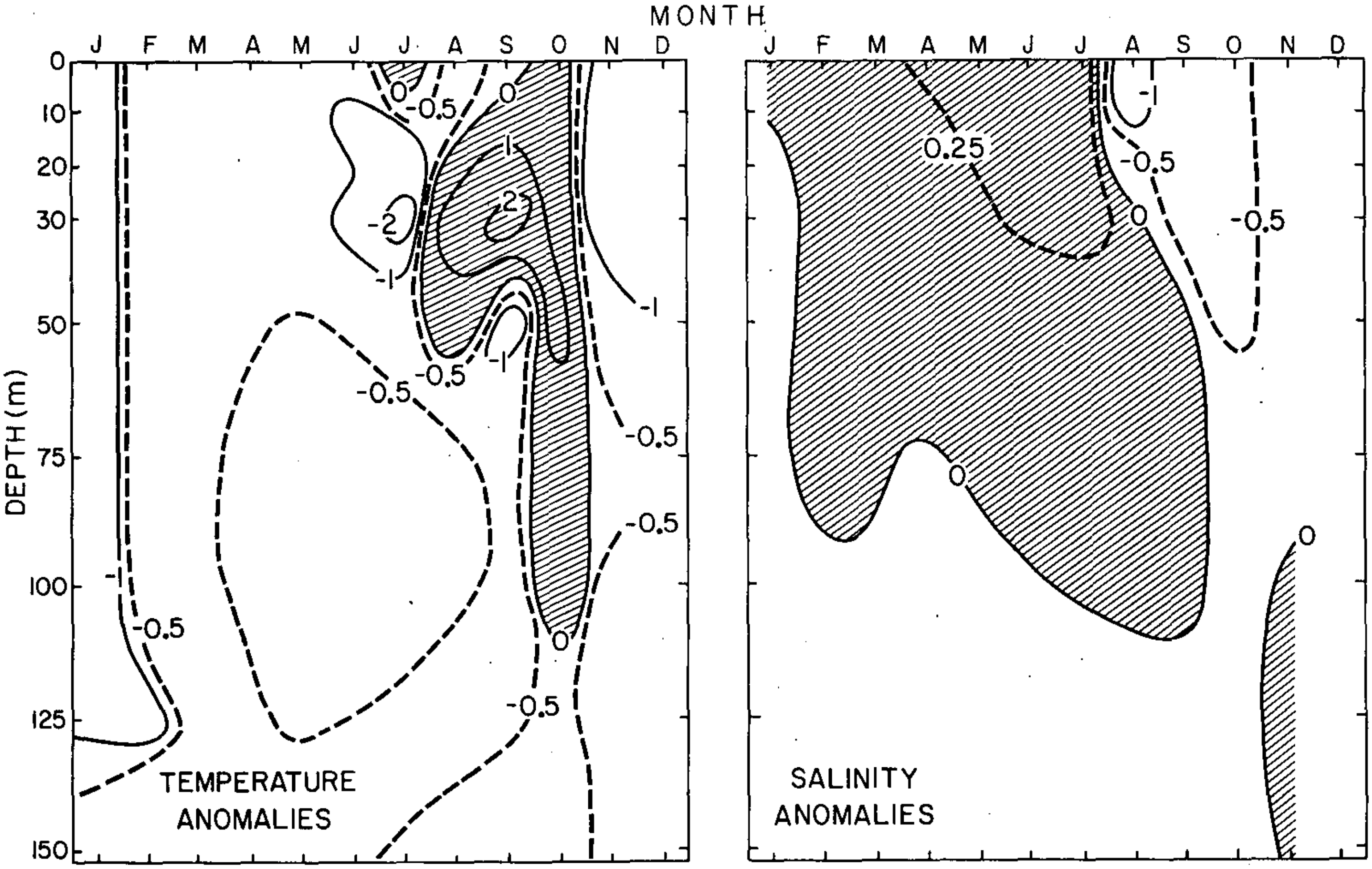

Fig. 8 Monthly temperature and salinity anomalies at Station 27 off St. John's, Newfoundland, during 1985 relative to 1946-1977 (Keeley, 1981). No data were collected in December. Shaded areas represent positive anomalies.

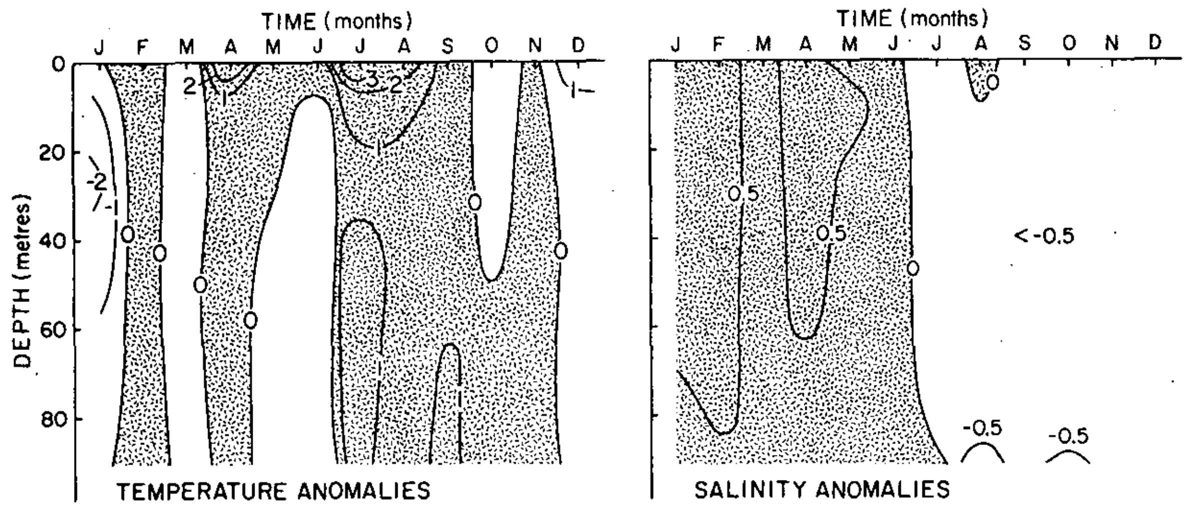

Fig. 9 Montlhy temperature and salinity anomalies at Prince 5 in mouth of the Bay of Fundy during 1985 relative to 1951-1980. Shaded areas represent positive anomalies.

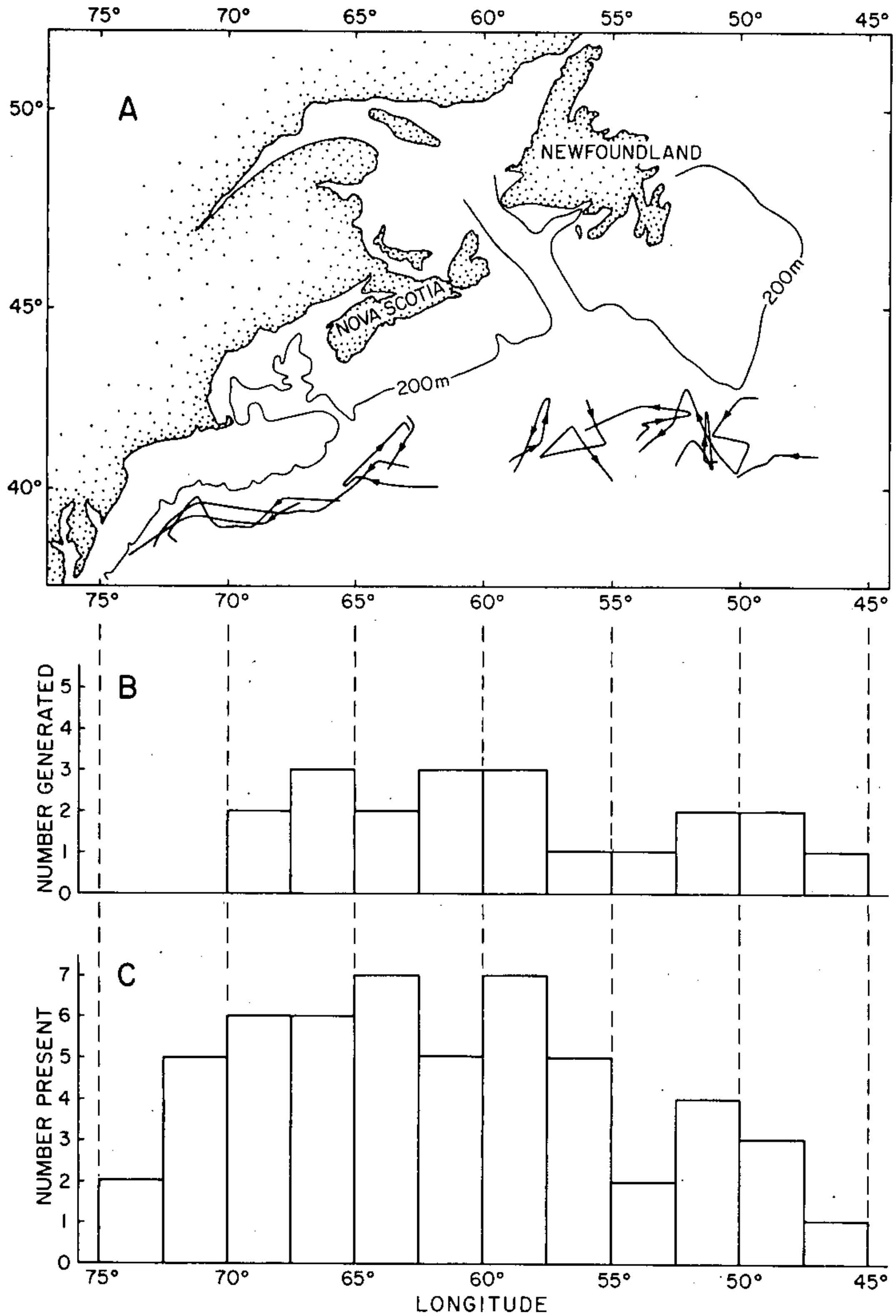

Fig. 10 Warm core Gulf Stream rings in the 45°-75°W area in 1985: (A) tracks of rings generated in 1985 having a lifespan longer than two months; (B) number generated in 1985 by each 2½° zone of longitude; and (C) number present in each zone during some part of year.

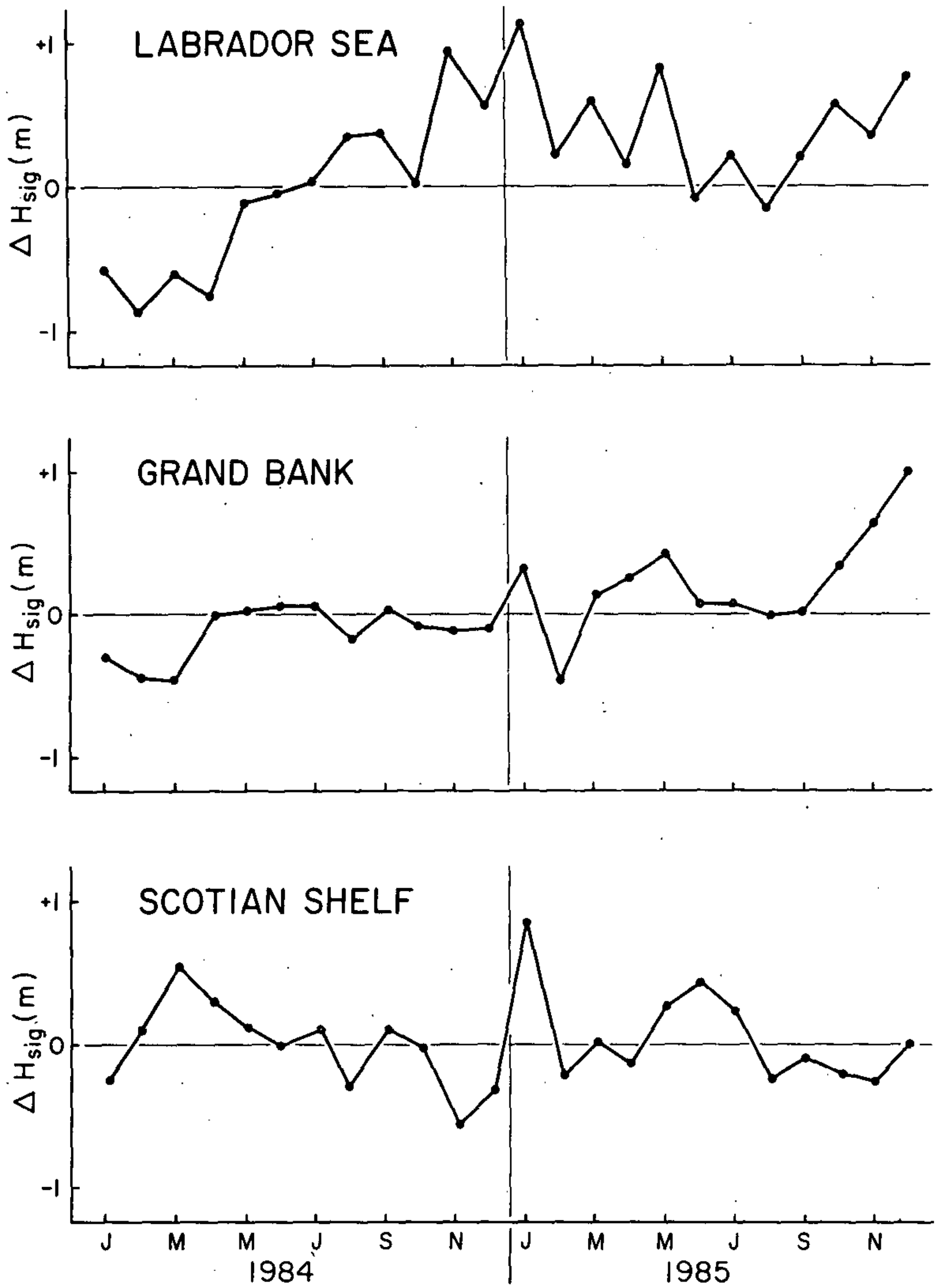

Fig. 11 Monthly significant wave-height anomalies (ΔH_{sig}) in three regions of the Northwest Atlantic for 1984-1985 relative to the means for the 1970-1980 base period.

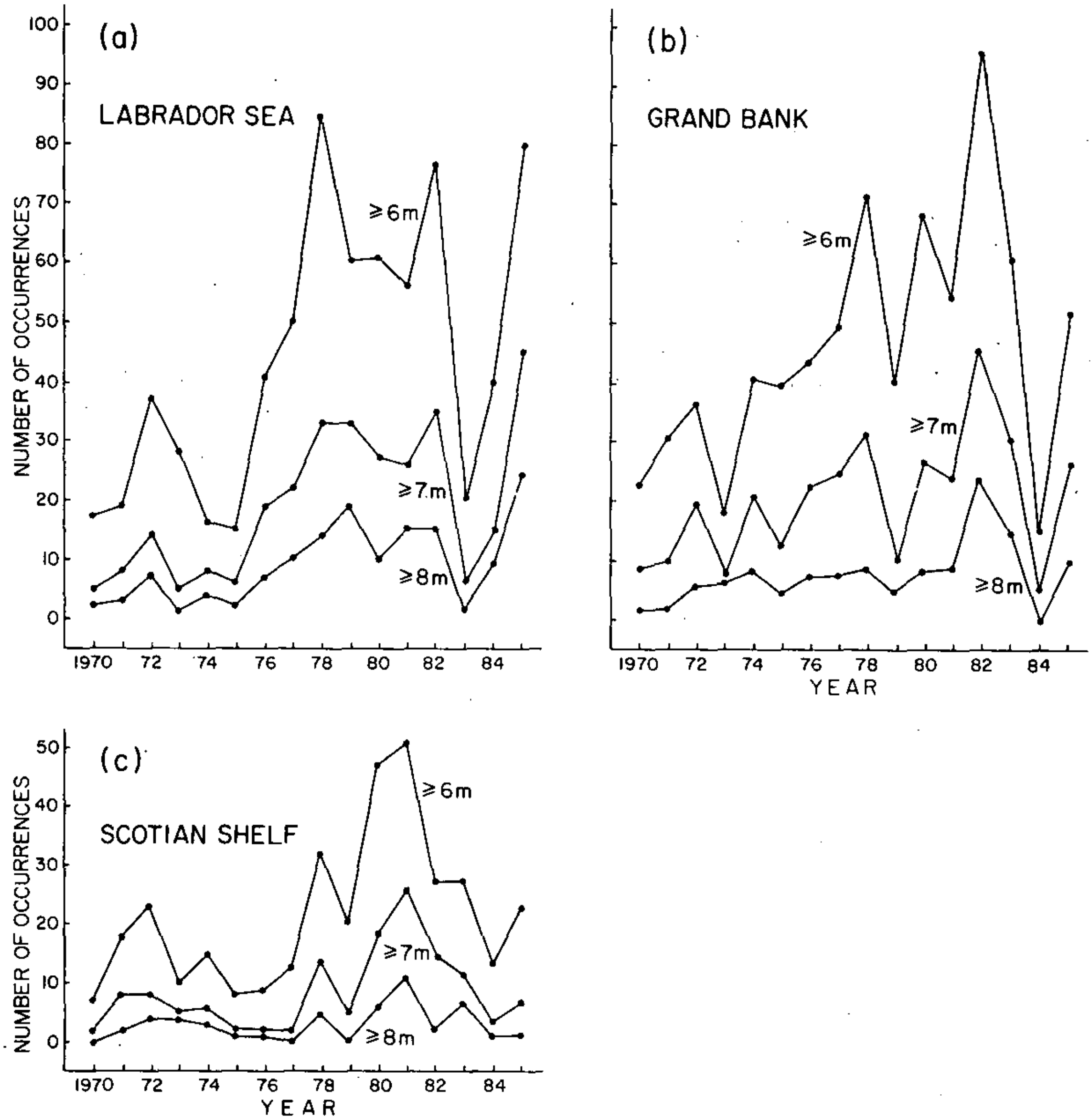

Fig. 12 Annual occurrences of storms during which wave heights exceeded 6, 7 and 8 m in three regions of the Northwest Atlantic during 1970-1985.

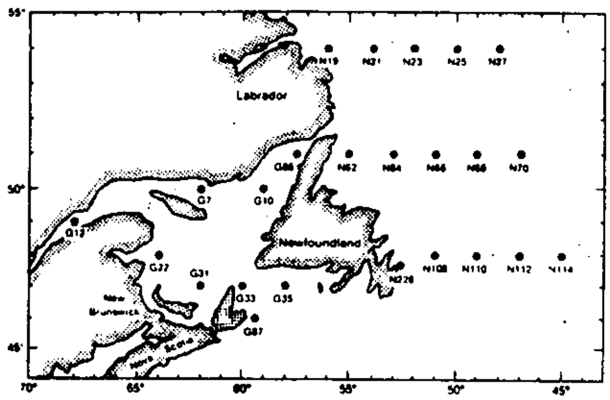

Fig. 13 Locations of 24 sites (grid points) where ice statistics have been extracted from ice charts by the Climatology Division of the Canadian Atmospheric Environment Service.

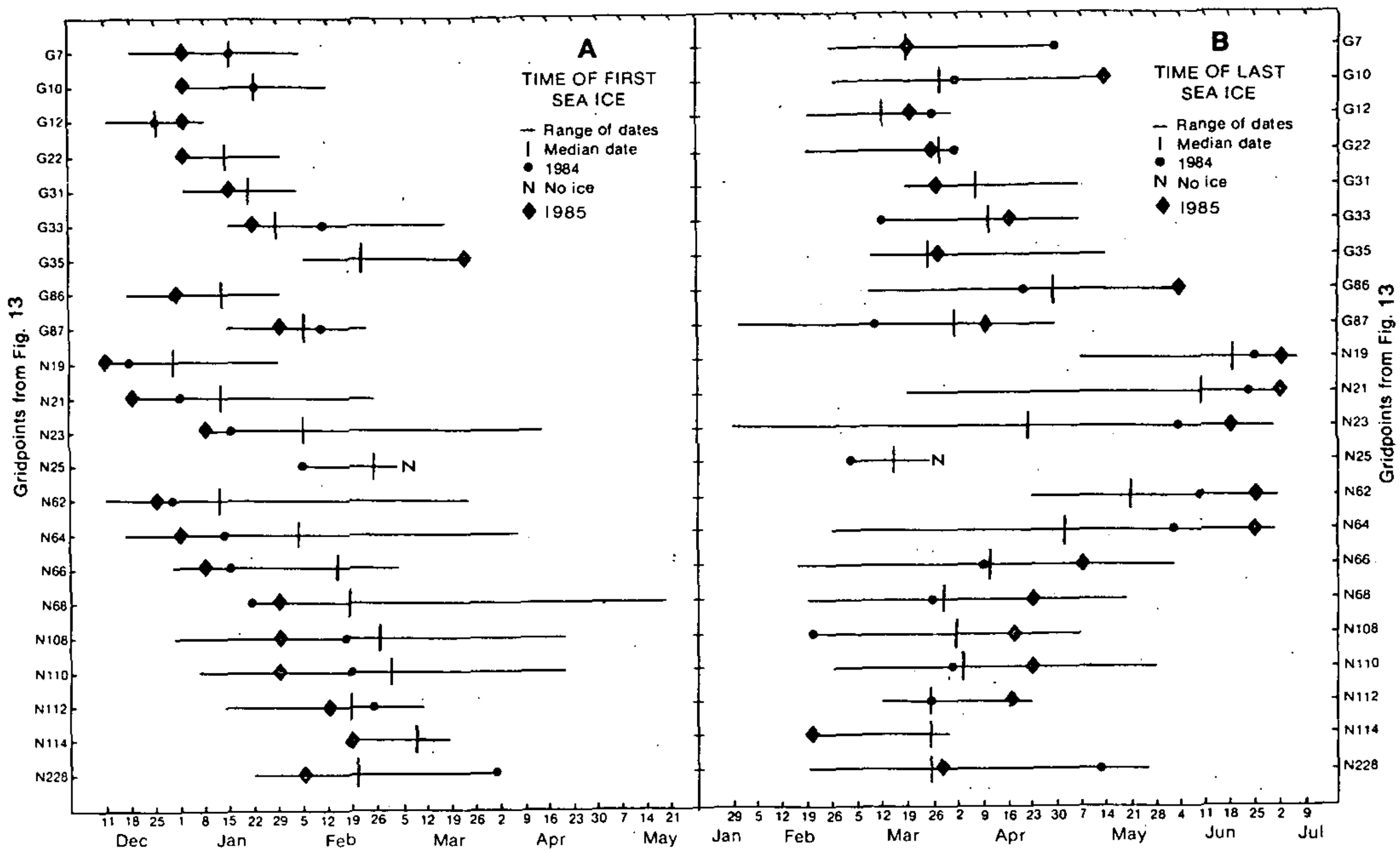

Fig. 14 Ranges of dates for the presence of first sea-ice (A) and last sea-ice (B) at 24 locations in the northwest Atlantic, with median dates and 1984-1985 dates.

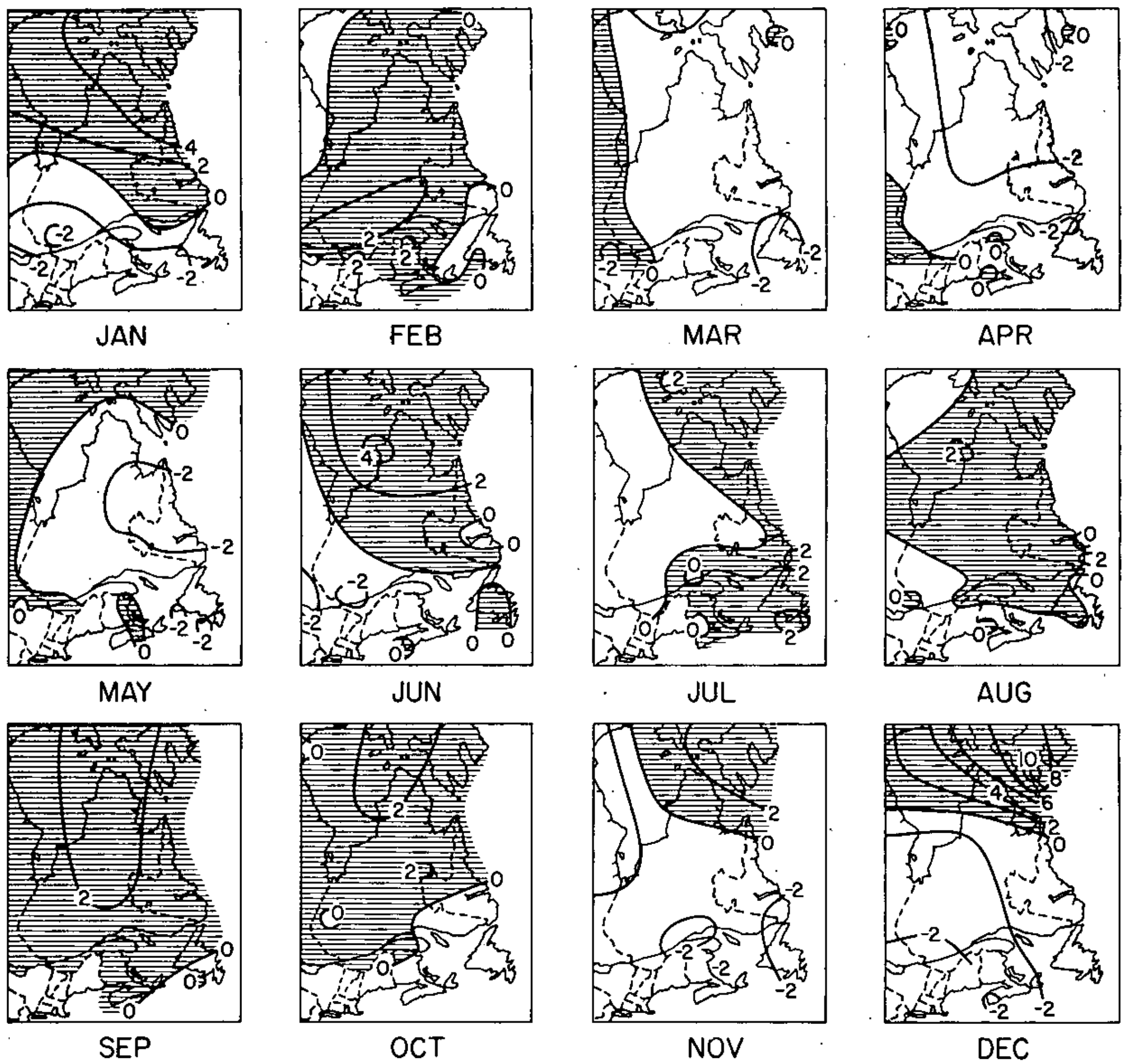

Fig. 15 The 1985 monthly air temperature anomalies (in °C) relative to 1951-1980 mean.

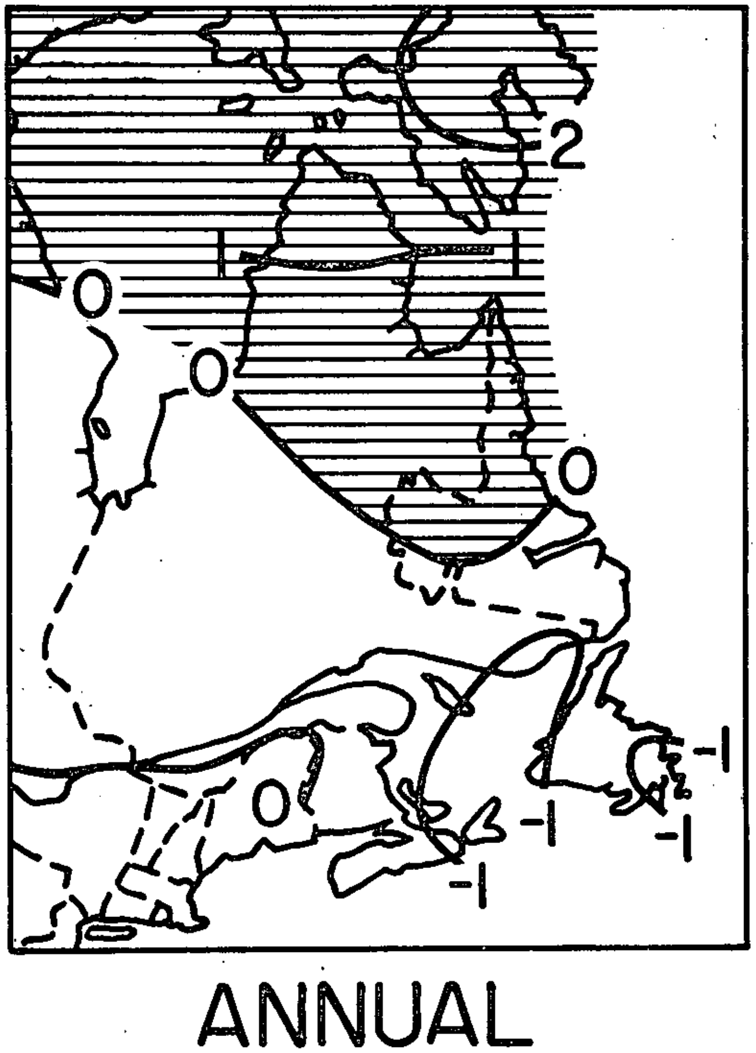

Fig. 16 The 1985 annual air temperature anomalies (in °C) relative to the 1951-1980 mean.

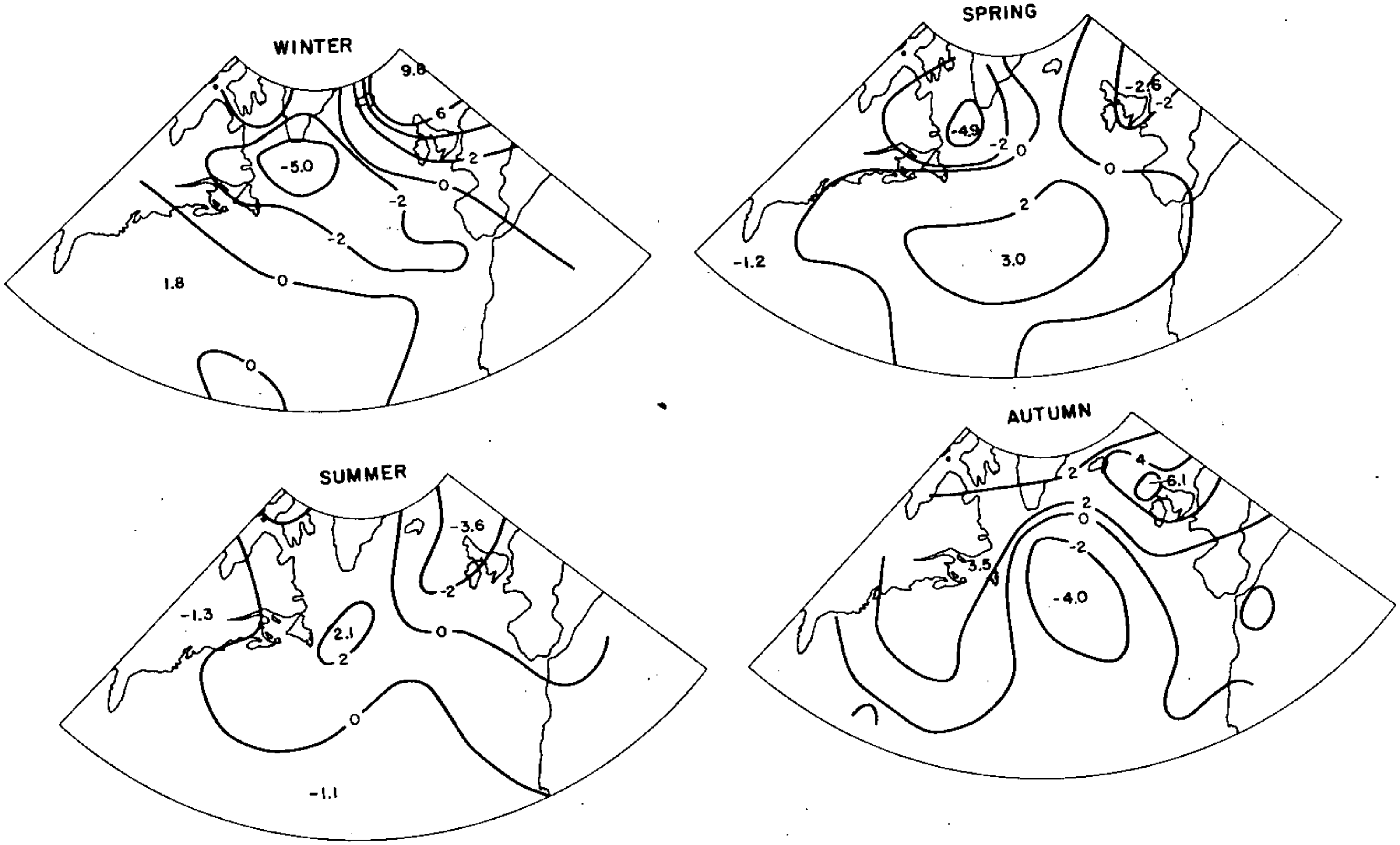

Fig. 17 Seasonal sea-surface air pressure anomalies (in mb) relative to the 1951-1980 base period.