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Overview of Environmental Conditions in the Northwest Atlantic in 1985

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Abstract

Environmental conditions in the Northwest Atlantic during 1985 are summarized, using principally time series of oceanographic and meteorological data, such as those from fixed stations and the daily to weekly repetitive coverage of surface conditions by satellites and ships of opportunity. Temperatures, as well as wave and sea-ice conditions, displayed anomalous features, particularly in the more northerly waters. While mean annual sea-surface temperatures in the offshore areas from the Scotian Shelf to the Labrador Sea declined from 1984 to 1985, they were slightly higher than normal off West Greenland, ending 3 years of extremely low temperatures there. Subsurface temperatures on the northern Grand Bank, as evidenced by data from Station 27 off St. John's, were lower than normal for the fourth consecutive year.

Introduction

This paper contains a brief overviw of environmental conditions in the Northwest Atlantic during 1985. As in the previous three annual reviews (Trites and Drinkwater, 1984, 1985, 1986), it includes selected sets of oceanographic and meteorological data as well as information from national research reports and other research documents which were presented at NAFO Scientific Council meetings. Conditions in 1985 are compared with those of the preceding year and the long-term means, the latter, where possible, being based on the 1951-80 period, in compliance with the convention of the World Meteorological Organization and recommendations of the Scientific Council. Where such data were unavailable, 20-year (1961-80) and 10-year (1971-80) base periods are used.

Oceanographic Observations

Coastal sea-surface temperatures

Daily coastal sea-surface temperatures (SST) records were obtained at 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 1951-80 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.

Temperatures at Halifax 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 1951-80 period. This is the third consecutive year that high SST anomalies have been recorded at Halifax during the latter half of the year. In contrast to Halifax, SST anomalies at St. Andrews were primarily negative with the lowest (<−1.0° C) values

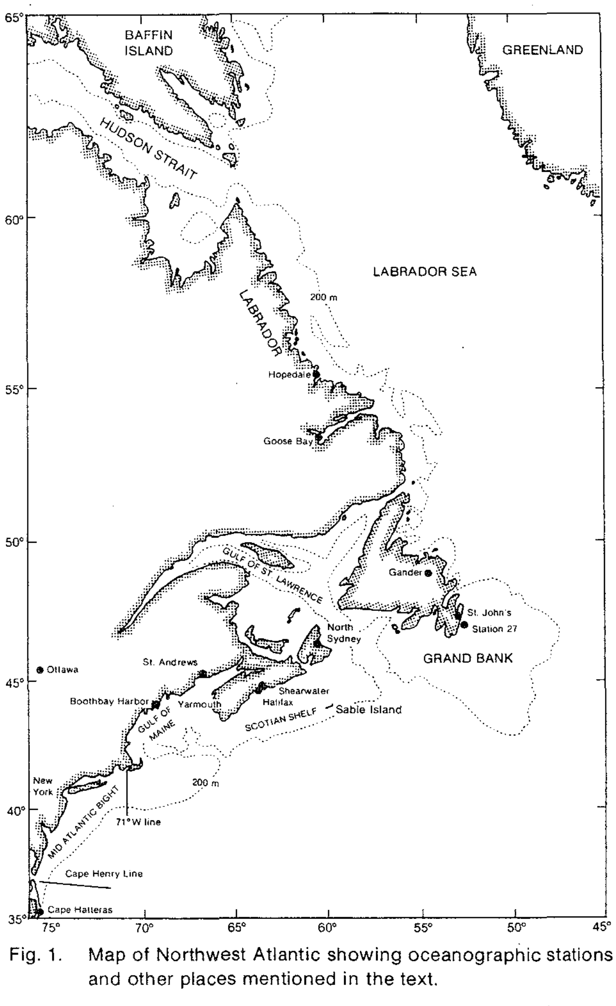

Fig. 1. Map of Northwest Atlantic showing oceanographic stations and other places mentioned in the text.

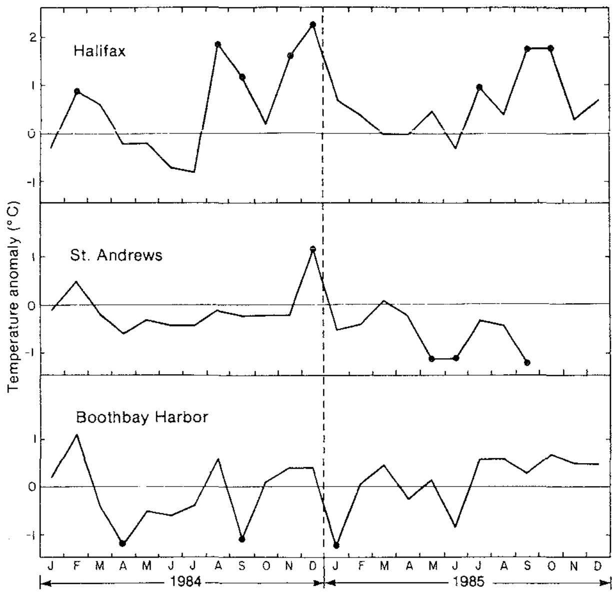

Fig. 2. Monthly sea-surface temperature anomalies at Halifax, St. Andrews and Boothbay Harbor in 1984 and 1985 relative to monthly means for the 1951-80 base period. (Dots indicate months when the anomalies equalled or exceeded one standard deviation. Lack of data for October-December 1985 at St. Andrews was due to wharf reconstruction.)

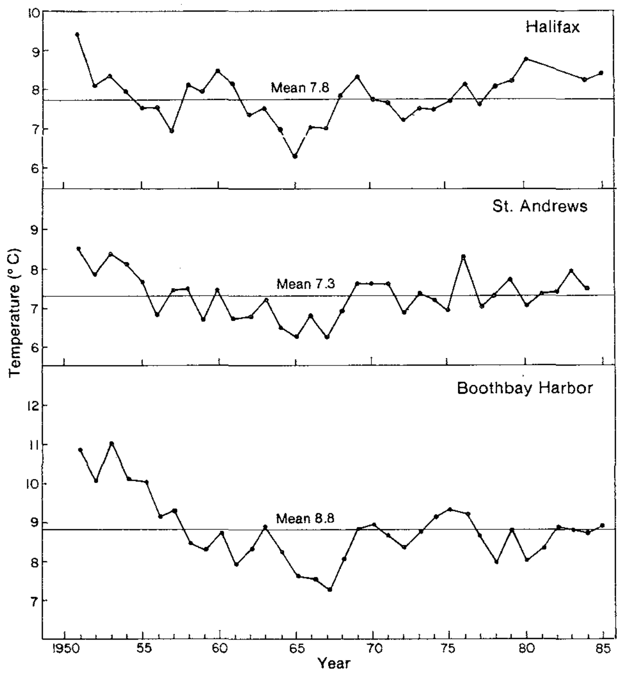

Fig. 3. Annual sea-surface temperature anomalies at Halifax, St. Andrews and Boothbay Harbor during 1951-85, relative to means for 1951-80 base period.

during May and June and again in September. At Boothbay Harbor, temperature anomalies fluctuated between positive and negative values during the first half of the year and reached a relatively constant positive value (0.5° C) during the latter half of the year. 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), representing anomalies of 0.6° and 0.1° C respectively from their 1951-80 averages. While the annual anomaly at Boothbay Harbor continues a recent trend of near-normal means, recent data at Halifax indicate above-normal temperatures. The lack of data during the last 3 months at St. Andrews prevented determination of an annual average, but, for the combined months of 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 during 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 temperature anomalies for a large 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 is divided into 24 smaller areas to coincide with major water masses (Labrador Current, Gulf Stream, etc.) or fishing banks (Georges Bank, Flemish Cap, etc.), were reported by Trites and Drinkwater (1985) for the 1972-80 base period and extended by Trites and Drinkwater (1986) for 1981 to 1984. The monthly mean temperature for each of the 24 areas was computed for 1985. The annual anomalies for 1981 to 1985 relative to the 1972-80 base period 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 during 1972-85 is shown in Fig. 7. This provides further confirmation that the "warm in the north" condition which prevailed for several years has ended and the temperatures in the region 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. If the tendency for conditions to persist for several years continues, further cooling in the north may be expected in 1986.

Temperature and salinity stations

Fyllas Bank. Hydrographic conditions on a standard section across Fyllas Bank off West Greenland are monitored by the Greenland Fisheries and Environmental Research Institute, Copenhagen, Denmark, and the Sea Fisheries Institute, Hamburg, Federal

Republic of Germany. This area is influenced by the cold low-salinity water of the East Greenland Current and the warm high-salinity water of the Irminger Current. Stein (MS 1986) reported that the autumn temperature of the 0-200 m layer in 1985 was 3.2° C, which is 0.6° C above the long-term mean (1963-85). This represents the second year that autumn temperatures have risen, following the extreme temperature minimum recorded in 1983. Stein noted that "a mild winter 1984/85, a warm summer 1985, and a mild autumn 1985 contributed to a warming of the surface layer ...". Off the bank, in the core of the extension of the Irminger Current at depths of 400-500 m, autumn temperatures were 0.8° C above those recorded in the previous 2 years. Buch (MS 1986) found that low salinities accompanied the cold conditions of 1982 to 1984, and that, with rising temperatures in 1985, the salinities have also increased.

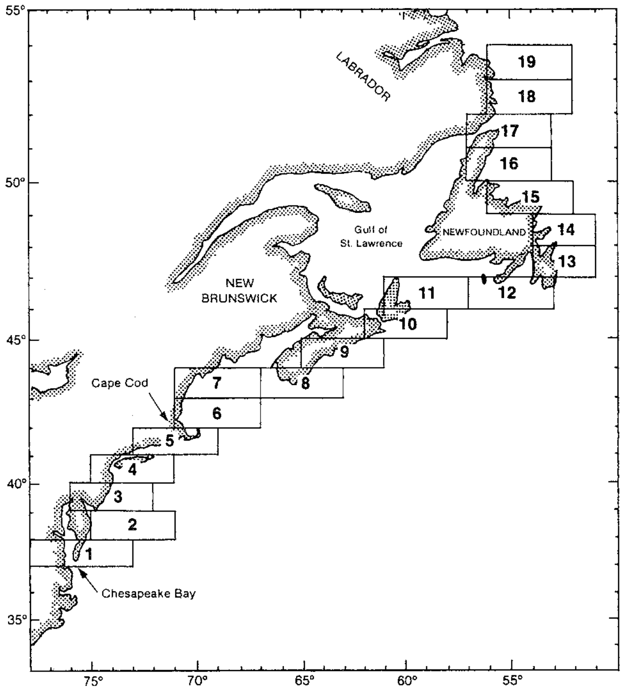

Fig. 4. Locations of 19 areas in the Northwest Atlantic (Chesapeake Bay to southern Labrador) for which sea-surface temperature data were grouped for analysis.

Station 27. Vertical profiles of temperature and salinity have been routinely obtained by the Northwest Atlantic Fisheries Centre, St. John's, Newfoundland, since 1946 at Station 27, which is located approximately 10 km off St. John's. Conditions at this station are considered to be representative of the inshore Labrador Current. The station was visited 57 times during 1985, with a monthly maximum of eight in both January and February. No data were obtained in 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. Temperature and salinity anomalies for 1985 relative to the mid-month means for the 1947-77 period (Keeley, 1981) are shown in Fig. 8.

The year was dominated by below-normal temperatures throughout the water column, the only exception being postive anomalies during late summer and early autumn, which were mainly confined to depths of 50 m or less. The 1985 temperature-anomaly pattern was similar to that of the previous year, and the negative anomalies at depths below 50 m represent the fourth consecutive year of colder-than-normal water. Temperatures were typically -1.5° to -1.6° C in depths greater than 100 m. Data from a transect along 47° N latitude (Flemish Cap Section) indicated that cold water extended across the entire width of the Grand Bank to the core of the offshore Labrador Current over

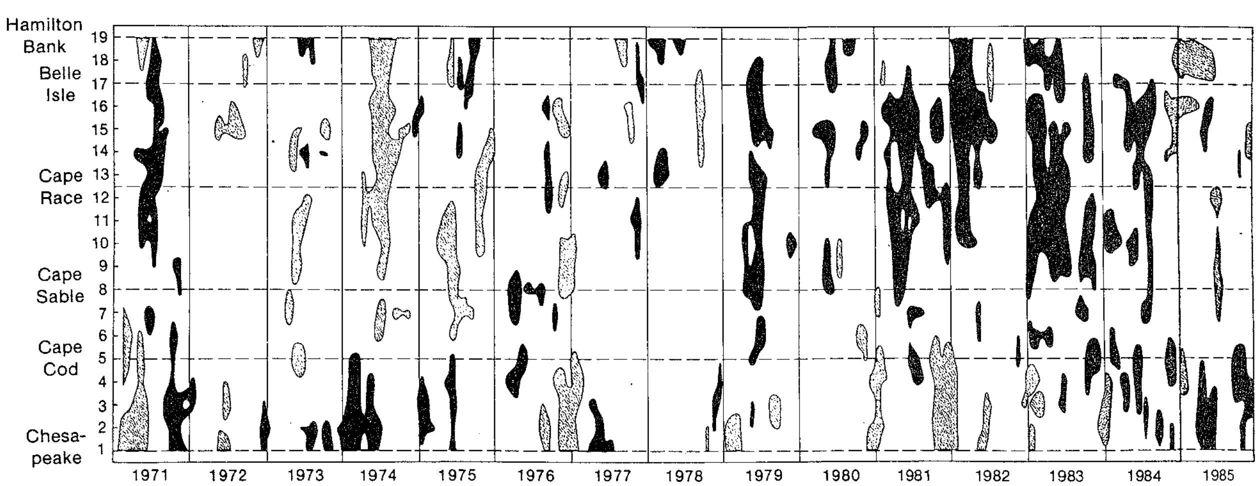

Fig. 5. Contoured monthly sea-surface temperature anomalies (relative to the 1971-80 base period) for the 1971-85 period by area (Fig. 4). (Only anomalies exceeding 1° C (black) and less than -1° C (dotted) which extended in space through at least two neighbouring areas and in time for at least two consecutive months have been contoured.)

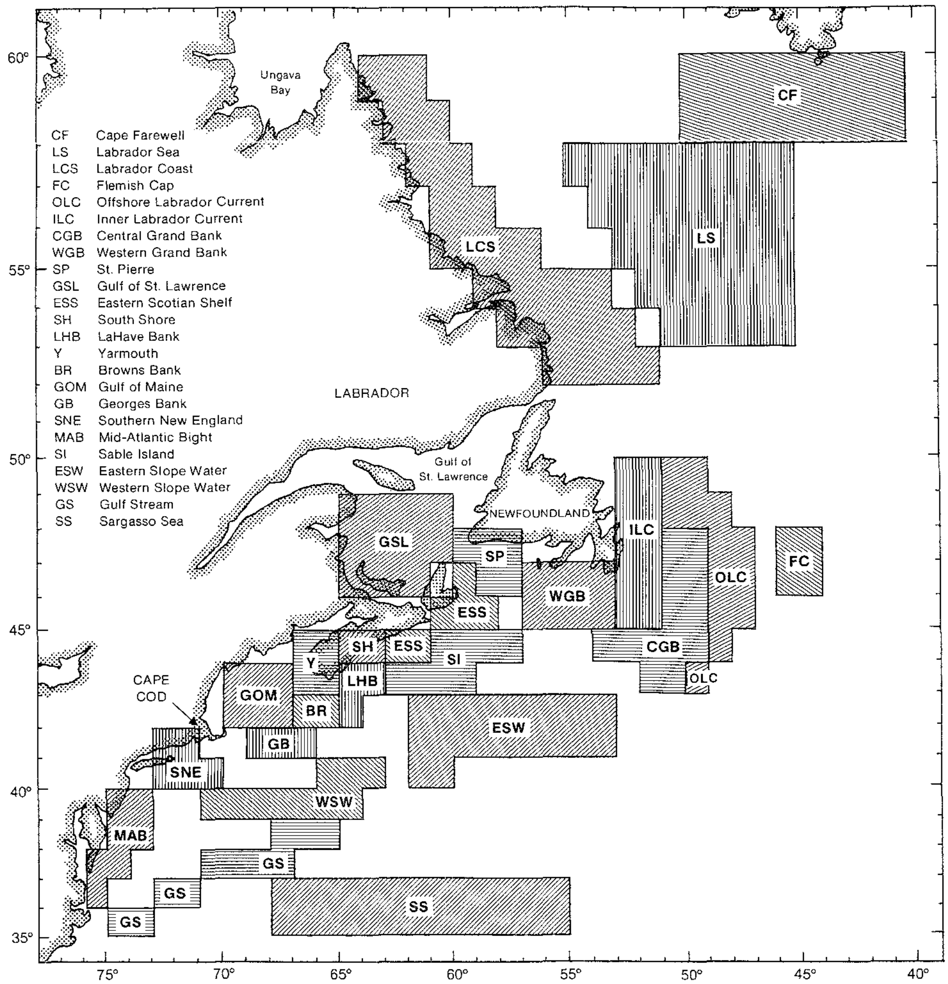

Fig. 6. Geographic boundaries of 24 subregions (Cape Hatteras to Cape Farewell) for which sea-surface temperatures were analyzed on a monthly basis in the 1972-85 period.

Fig. 7. Distribution of positive (+) and negative (-) annual sea-surface temperature anomalies in 1972-85 by subregion (Fig. 6) relative to the means for the 1972-80 base period. (Only anomalies less than -0.15°C and greater than +0.15°C were used in drawing the contours.)

the eastern slope of the bank (Akenhead, MS 1986). The volume of cold water during the last 4 years was larger than that observed during the late 1970's. Salinities in the upper layers were generally above normal from January to July, but anomalies were small, the largest being 0.44 psu (practical salinity units) at the surface in July. Strong negative anomalies were observed from August to November, with the mean salinity for August (30.33) being more than 1 psu below normal. Similar negative anomalies were noted in 1984 during the summer and early autumn. During 1985, the salinity anomalies for depths greater than 100 m were generally negative but small in magnitude (less than 0.1 psu).

Prince 5. Hydrographic measurements are taken on a routine basis at Prince 5, a station off St. Andrews near the entrance to the Bay of Fundy. Data have been collected by the St. Andrews Biological Station since the 1920's and mean conditions for the 1951-80 period have been calculated (Drinkwater, 1987). The station was visited once per month and, thus, the data do not

TABLE 1. Mean sea-surface temperatures for selected areas of the Northwest Atlantic in 1972-80, and anomalies for 1981 to 1985 relative to the base period. (Geographic locations of water masses are shown in Fig. 6. Blank space indicates that annual averages not computed when data missing for one or more months.)

Water mass	Mean Temp. 1972-80[a]	Annual anomalies (°C) 1981	1982	1983	1984	1985
CF	3.62		0.10	-0.12	-0.01	1.03
LS	5.54		-0.43	-0.11	-0.59	
LCS	2.19	-0.10				
OLC	5.17	0.82	0.24	0.32	0.06	-0.90
ILC	4.83	0.96	0.40	0.99	0.52	-0.38
FC	7.88	0.83	-0.39	0.46	-0.14	-0.80
CGB	6.48	1.11	0.34	1.37	0.84	-0.54
WGB	6.13	1.19	0.19	1.11	0.62	-0.69
SP	5.91	1.14	0.35	0.87	0.79	-0.36
GSL	5.82	0.56	0.46	0.91	-0.02	-0.01
ESS	7.10	0.46	0.45	1.28	0.56	-0.29
SI	8.27	0.85	-0.20	0.96	0.97	-0.49
SH	7.85			1.43	0.66	-0.18
LHB	8.87	0.30	-0.07	0.86	0.42	-0.33
BR	8.84	0.25	-0.28	1.07	0.51	0.17
Y	7.64	0.18	-0.20	0.05	0.10	-0.45
GOM	9.59	0.11	0.07	0.45	0.45	0.10
GB	10.17	-0.39	-0.46	0.48	0.37	0.21
SNE	12.23	-0.50	-0.03	0.38	1.08	0.14
MAB	14.87	-0.43	-0.06	0.61	0.08	0.80
ESW	15.54	-0.03	-0.37	0.51	1.25	0.02
WSW	18.50	-0.92	-0.48	-0.27	-0.17	0.52
GS	22.94	-0.26	-0.16	0.08	0.08	0.11
SS	22.26	-0.37	-0.07	0.04	-0.05	-0.14

[a] See Trites and Drinkwater (1985) for annual anomalies pertinent to the 1972–80 base period.

necessarily represent 'average' conditions for the month. The extent of variability in temperature and salinity within each month is unknown, but variation can arise for such effects as 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, but persistent anomalous features probably indicate real events.

The temperature anomalies at Prince 5 in 1986 were mostly small (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° and 2.6° C at the surface. However, since negative anomalies of less than 0.5° C were observed at the surface at St. Andrews during these same months (Fig. 2), it is concluded 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 and below normal in the last half. The positive anomalies in January, February and April varied from 0.3 to 0.8 psu and were larger than the standard deviations for the 1951–80 base period (Drinkwater, 1987). 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 psu. The magnitude and persistence of the salinity anomalies indicate that the trend from above-normal to below-normal values throughout the year is likely to have been real.

Position of shelf-slope front

As in previous years, variation in the shelf water-slope water front from Georges Bank to Cape Romain, South Carolina, has been derived from the NOAA/NWS Oceanographic Analysis Maps (Armstrong, MS 1986). From the 10-year means (1974–83), the front, northeast of Cape Henry, is generally located

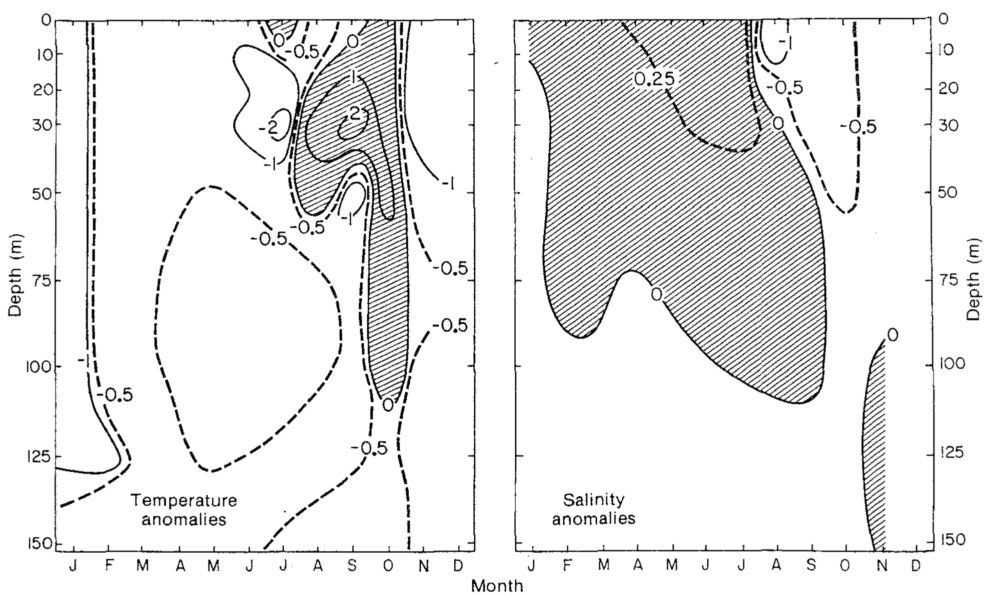

Fig. 8. Monthly temperature and salinity anomalies at Station 27 off St. John's, Newfoundland, during 1985 relative to the 1946–77 period (Keeley, 1981). (Shaded areas represent positive anomalies. No data were available for December.)

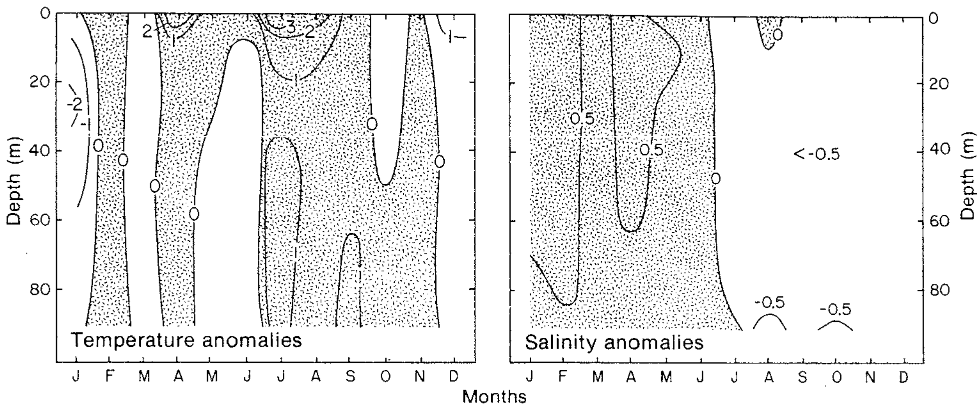

Fig. 9. Monthly temperature and salinity anomalies at Prince 5 near the entrance to the Bay of Fundy during 1985 relative to the 1951-80 base period. (Shaded areas represent positive anomalies.)

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 region from 45° W to 75° W during 1985 was derived from the NOAA/NESS Oceanographic Analysis Maps and from the "State of the Oceans: Gulf of Maine to the Grand Banks" reports which are 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 of which survived into 1985 from 1984, and only four of the 20 new rings formed in 1985 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 2.5° 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°-60.0° W and 62.5°-65.0° W zones Fig. 10C). However, despite the relatively high production and presence of rings 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, indicated that 10 rings were generated in the

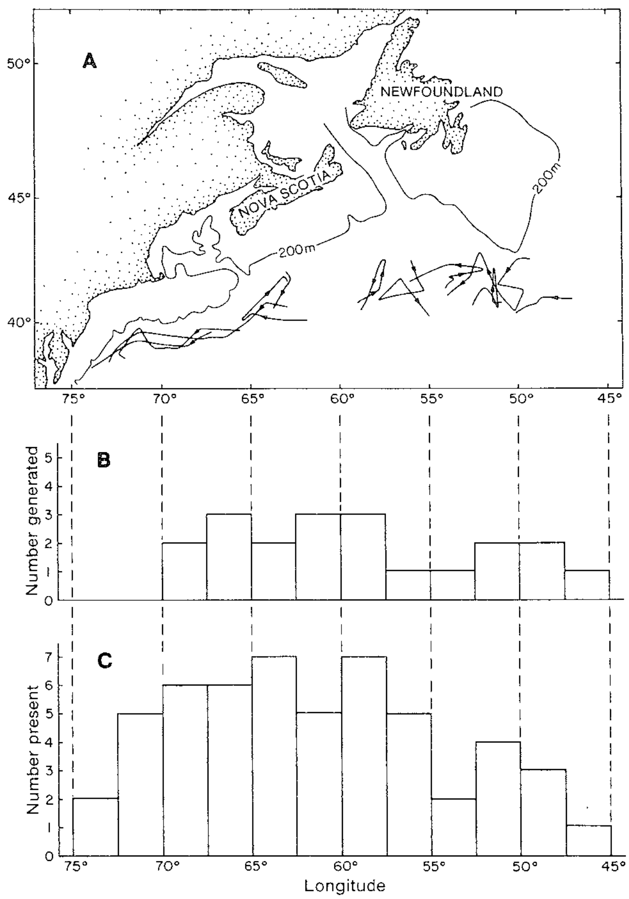

Fig. 10. Warm-core Gulf Stream rings in the region between 45°W and 75°W during 1985: (A) tracks of rings with a lifespan longer than 2 months; (B) number of rings generated in each 2.5° zone of longitude; and (C) number of rings present in each 2.5° zone during some part of the year.

western region in 1985 compared to 8 in 1984. During the 1974-83 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 1976-81 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). Average lifetime for the 8 rings whose death occurred in 1985 was 127 days, in comparison with a mean of about 90 days for those that occurred in 1984.

Examination of the statistics of ring formation in relation to month for 1985 indicated that May, July and August, which produced 5, 4 and 6 rings respectively, accounted for 75% of the yearly production. For the remaining 9 months (January-April, June, September-December), 5 rings were formed, comprising only 25% of the yearly total.

A separate analysis of warm-core Gulf Stream rings 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 indicated that 11 rings (compared to 12, 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 10th year. Benway (MS 1986) reported that cold-pool temperatures in 1985 were approximately 1° to 2° C above normal and less than 10° C water remained on the bottom only until mid-September, about 2 weeks shorter 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) 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 hr to the Canadian Meteorological and Oceanographic Center (METOC) at Halifax, Nova Scotia (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 1970-84 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 Bank area, conditions in 1985 were more variable than in 1984, but there was a marked increase in wave heights in the October–December period relative to the mean. On the Scotian Shelf, wave heights during the first half of 1985 were generally higher than normal, while heights in the last 5 months of the year were slightly below the decadal mean.

From the number of occurrences of significant wave-heights equal to or exceeding 6, 7 and 8 m (Fig. 12), 1985 was a stormier year than 1984. In the Labrador Sea, the number of occurrences of waves greater than 7 and 8 m were higher than any recorded in the past 16 years. Even the number of occurrences of waves greater than 6 m were exceeded only in 1978. On the Grand Bank and Scotian Shelf, wave conditions were much less severe than in the Labrador Sea, and

TABLE 2. Monthly mean significant wave heights (m) at three locations in the Northwest Atlantic (derived from 12-hr wave charts) for 1984 and 1985 relative to means for the 1970-80 base period.

	Labrador Sea (57.5°N 52.5°W)			Grand Bank (47.5°N 47.5°W)			Scotian Shelf (42.5°N 62.5°W)		
Month	1970-80	1984	1985	1970-80	1984	1985	1970-80	1984	1985
Jan	3.50	2.95	4.64	3.76	3.44	4.10	2.91	2.68	3.77
Feb	3.36	2.48	3.57	3.48	3.02	2.98	2.77	2.90	2.52
Mar	3.20	2.61	3.79	2.88	2.40	3.00	3.80	3.47	2.79
Apr	2.56	1.77	2.68	2.78	2.78	3.02	2.35	2.65	2.20
May	2.02	1.90	2.84	2.22	2.23	2.63	1.82	1.98	2.06
Jun	1.84	1.78	1.75	2.07	2.12	2.12	1.70	1.73	2.10
Jul	1.75	1.74	1.95	1.94	2.00	2.02	1.57	1.68	1.77
Aug	2.01	2.34	1.82	2.22	2.05	2.19	1.62	1.35	1.35
Sep	2.61	2.93	2.80	2.75	2.78	2.75	1.76	1.92	1.65
Oct	3.14	3.08	3.69	3.19	3.11	3.52	2.16	2.15	1.94
Nov	3.33	4.27	3.65	3.41	3.30	4.03	2.69	2.12	2.43
Dec	3.64	4.16	4.39	3.96	3.81	4.95	3.00	2.68	2.98

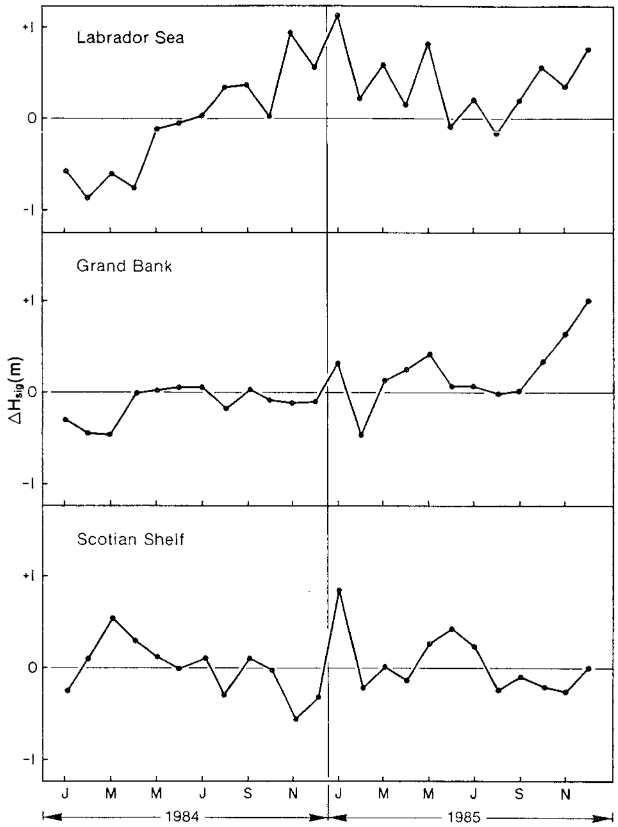

Fig. 11. Monthly significant wave-height (ΔH_{sig}) in three regions of the Northwest Atlantic during 1984 and 1985 relative to means for the 1970-80 base period.

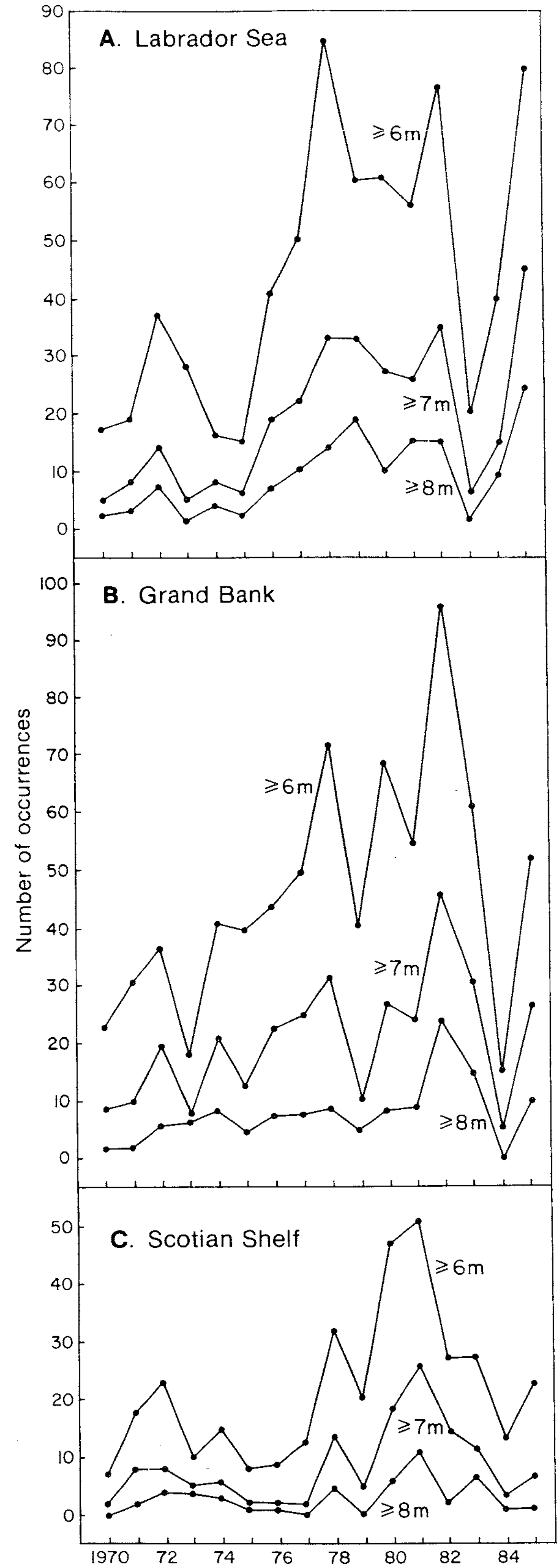

Fig. 12. Annual occurrences of storms during which wave heights exceeded 6, 7 and 8 m in three regions of the Northwest Atlantic duirng 1970-85.

the numbers of occurrences of extreme waves (greater than 6, 7 and 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 ice seasons (December-July) were previously summarized by Trites and Drinkwater (1985, 1986). The present analysis has been updated to include data for the 1984/85 season. For each site, the extracted data were ice duration in weeks for the 1984/85 season, average duration for all years of record, as well as 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 the 1983/84 and 1984/85 seasons are shown in Fig. 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 in 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 of 48° N latitude in each year is monitored by the International Ice Patrol Division of the United States Coast Guard. Data during the last 3 years have been collected with the use of SLAR (Side-Looking Airborne Radar) which is believed to detect many more icebergs than previous observational methods. For the 1984-85 ice season (October to September), a total of 1,063 icebergs were reported, the monthly distribution from October 1984 to September 1985 being 3, 11, 7, 2, 57, 129, 208, 205, 247, 123, 39 and 32. The seasonal distribution was similar to those of previous years, with 85% of the icebergs passing south of 48° N latitude during March-July. The total number of icebergs in 1984/85 was less than half the total in 1983/84 (2,202) and lower than the 1982/83 total (1,352). Comparison of recent data with observations prior to 1982 is not considered to be meaningful because of the differences in observational techniques.

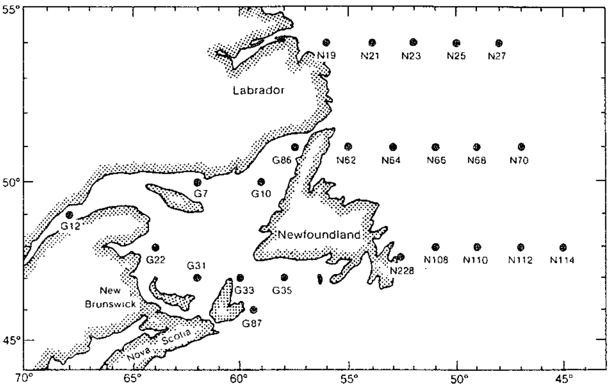

Fig. 13. Locations of 24 grid points where ice statistics have been extracted from ice charts by the Climatology Division of the Canadian Atmospheric Environment Service.

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, 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

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 1984/85 (October-September) ice year, with 1983/84 data in parentheses.

Site (Fig. 1)	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	9	9	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	9	9	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 (4)
G-35	1962-85	24	12	1	11	3.5	1.7	1 (0)
G-86	1976-85	10	9	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	2	1	1	1.0	0.0	0 (1)
N-27	1960-85	26	0	0	0	0.0	0.0	0 (0)
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	3 (10)
N-70	1961-85	25	0	0	0	0.0	0.0	0 (0)
N-108	1960-85	26	20	1	17	5.7	4.4	11 (1)
N-110	1960-85	26	19	1	12	4.6	3.4	12 (4)
N-112	1960-85	26	7	1	10	5.1	1.4	7 (4)
N-114	1960-85	26	3	1	2	1.3	0.2	1 (0)
N-228	1960-85	26	16	1	14	5.1	3.2	7 (3)

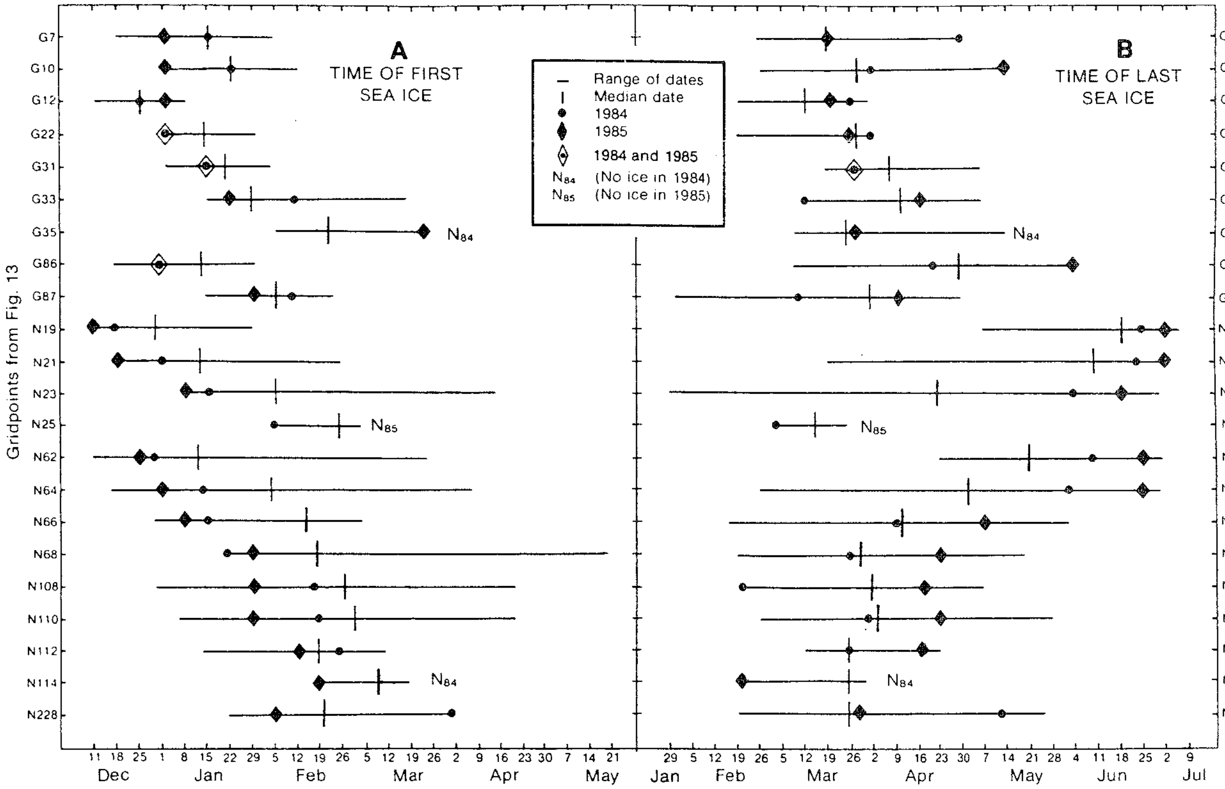

Fig. 14. Ranges of dates for the presence of first sea-ice (A) and last sea-ice (B) at 22 sites (Fig. 13) in the Northwest Atlantic, with median dates and the 1984 and 1985 dates. (Ice has never been observed at N27 and N70.)

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 in Newfoundland were mostly below normal throughout most of the year, the exceptions being February and July-September when anomalies were positive but small (less than 2° C).

Annual air temperature anomalies were positive throughout northern Quebec and Baffin Island and negative in more southerly regions (Fig. 16). The anomalies were usually less than 1° C, and only in Baffin Island did they exceed their standard deviations. The pattern of annual air temperature anomalies for 1985, positive in the north and negative in south, is the reverse of conditions that were observed during 1983 and 1984 (Trites and Drinkwater, 1985, 1986).

Sea-surface air pressure

The long-term mean pressure patterns are dominated by a low pressure centered between Greenland and Iceland (Icelandic Low) and a high pressure centered between Florida and northern Africa (the Bermuda-Azores High). The strengths of the Low and High vary seasonally from winter maxima to summer minima. Monthly mean sea-surface pressures over the North Atlantic are published in *Die Grosswetterlagen Europas* by Deutscher Wetterdierst, Offenbach, Federal Republic of Germany. Seasonal averages for 1985 and anomalies from their long-term means (1951–80) were calculated for winter (December 1984–February 1985), spring (March–May), summer (June–August) and autumn (September-November). These means were provided by K. R. Thompson (Dalhousie University, Halifax, pers. comm.).

During the winter season of 1985, 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 and 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, indicated stronger-than-normal westerly winds across the northern North Atlantic. In the summer, above-normal pressures were observed over much of northwestern part of the region 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

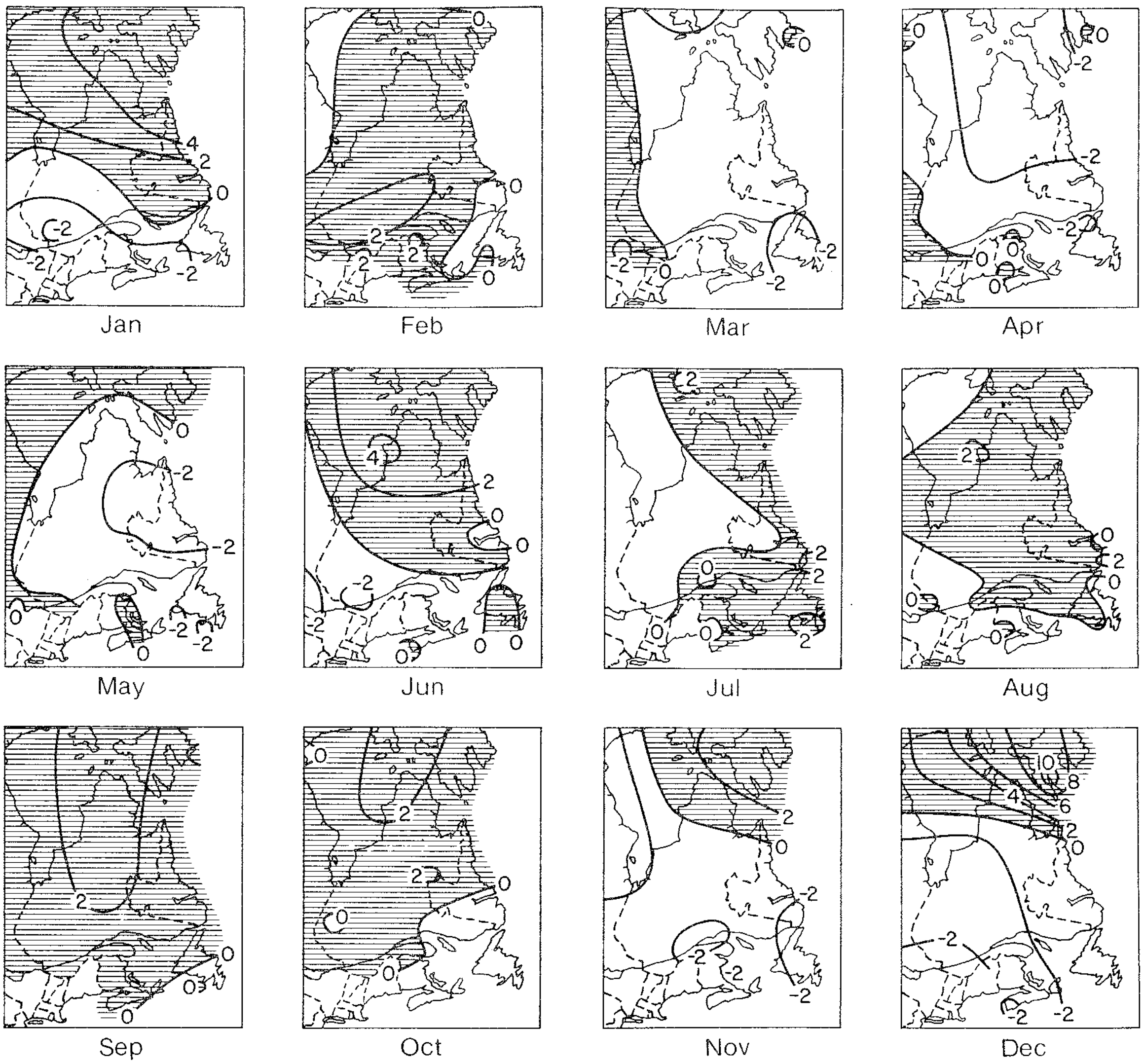

Fig. 15. Monthly air temperature anomalies (°C) over eastern Canada in 1985 relative to means for the 1951–80 base period.

the Icelandic Low produced an anomalous low pressure ridge in the middle of the North Atlantic. Anomalous highs developed in the west over most of the NAFO region and in the east over the Norwegian Sea.

Summary

In the northern waters, 1985 was characterized by several anomalous features. Annual sea-surface temperatures on the Grand Bank, off the Labrador Coast and in the Labrador Sea were below normal. For the fourth consecutive year, lower-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° to -1.6°C in depths greater than 100 m. Wave data from the Labrador Sea showed higher significant wave heights than the long-term mean, and high storm activity was implied 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 northeastern Newfoundland coasts arrived earlier, stayed later and extended further south than normal. Ice conditions in the Gulf of St. Lawrence were the heaviest in the last 5 years. The occurrence of heavy ice was 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, waters off West Greenland were slightly warmer than normal, ending 3 years of extremely low 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, but data from ships of opportunity indicated a negative SST anomaly (-0.2°C) over the Shelf (area SH in Fig. 6). Wave data for the Scotian Shelf showed normal condi-

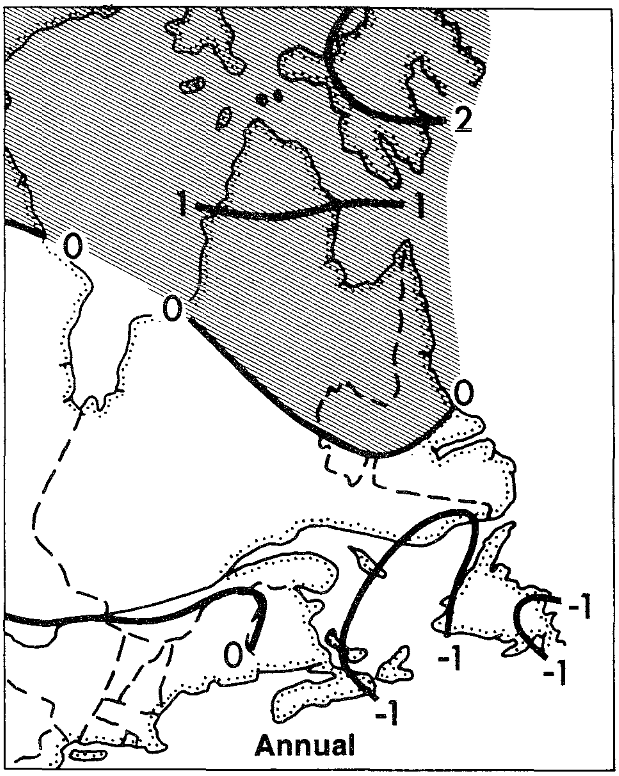

Fig. 16. Annual air temperature anomalies (° C) over eastern Canada in 1985 relative to 1951-80 base period.

tions for both significant wave height and the number of occurrences of extreme waves. Off the Scotian Shelf, the number of Gulf Stream eddies that formed and their mean lifetime were also above 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-1970's.

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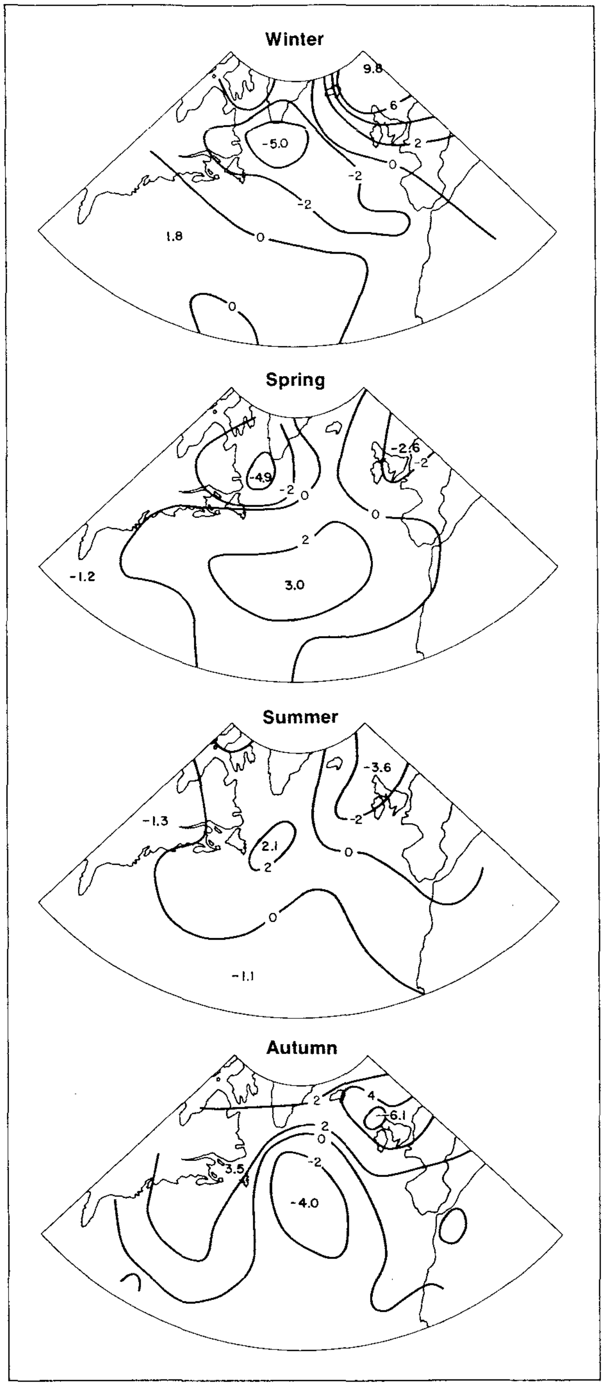

Fig. 17. Seasonal sea-surface air-pressure anomalies (mb) over the North Atlantic in 1985 relative to the 1951-80 base period.

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