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Description of 1986 Oceanographic Conditions on the Northeast Continental Shelf

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Contents

Abstract

Oceanographic observations from four surveys in 1986 (winter, spring, early fall and late fall) on the Northeast Continental Shelf are reported. Surface and bottom distributions and cross-shelf vertical distributions of both temperature and salinity are presented in the form of contour maps. Average values for specific regions of the shelf and layers of the water column are presented in the form of time series plots. The observations are compared to similar data collected since 1977.

Introduction

Since the summer of 1977 (see Figure 1), in an attempt to monitor the seasonal and interannual variability of the physical environment on the Northeast Continental Shelf (see Figure 2), the National Marine Fisheries Service (NMFS) has occupied 184 standard oceanographic stations from Cape Hatteras to Cape Sable as part of the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program (Sherman 1980).

Temperature and salinity observations from four surveys conducted in 1986 are summarized in this report. All of the surveys were accomplished aboard NOAA research vessel *Delaware II* during the following time periods:

DEL8601	(7 January - 12 February)
DEL8603	(6 May - 7 June)
DEL8607	(25 August - 24 September)
DEL8610	(3 November - 12 December)

A series of figures that portray some of the more significant features of the oceanographic structure in 1986 are included in this report. These include computer-generated contour plots of temperature and salinity for surface and bottom horizontal distributions. Cross-shelf vertical distributions of temperature and salinity are plotted as well. These cross-shelf profiles display data from a series of transects labeled A to G in Figure 2. Finally, a set of time series plots (1977-1987) shows average temperature and salinity for different layers of the water column and regions of the shelf (Figure 3).

Methods

Niskin bottles (made of PVC) with reversing thermometers were used to sample temperature and salinity at standard water depths (1, 5, 10, 15, 20, 25, 30, 35, 50, 75, 100, 150, 200, 250, 300 meters) for each station occupied. Surface temperatures were checked with a concurrent bucket sample. Bottom observations were taken from the deepest bottle, generally within 10 m of the bottom to a maximum of 300 m. In water depths less than 75 m, a special bottom-tripped bottle was used to obtain a salinity sample from within 1 m of the bottom. Salinity samples were analyzed after each cruise with a Guildline Autosal salinometer. Details of the procedures at sea may be found in Kirschner (1980) and Patanjo *et al.* (1982).

Coverage of the 184 standard stations was nearly complete for all four cruises in 1986.

The following two methods were used to compare 1986 conditions with other years of MARMAP sampling:

1. Surface and bottom temperature anomalies were obtained by comparing the 1986 observations with mean temperatures calculated by Mountain and Holzwarth

(in preparation). They determined the mean annual cycle of surface and bottom temperature at each MARMAP station by combining all observations at the station from the period 1977 to 1987. Using a multiple linear regression model for temperature as a function of Julian day, they determined a best fitting sum of harmonic curves with frequencies of one, two, and three cycles per year. The standard deviation of the original data from the fitted annual curve was calculated as an indication of the interannual variability over the 11 year period.

2. To calculate average temperature and salinity over a wide range of the shelf, the study area was divided into five regions (see Figure 3). Each standard MARMAP station was assigned a surface area to represent its contribution to the total water mass within the region. Areal-weighted mean values of temperature and salinity were calculated in each region for all MARMAP cruises on which at least half of stations in the region were occupied. The mean values were determined for a near surface and a near bottom layer, and, in the Gulf of Maine, for an intermediate layer as well.

Data Portrayals

The horizontal distributions of sea surface and bottom temperature for the four cruises are shown in contour maps in Figures 4 to 7.

To compare the temperatures in 1986 with conditions in previous years, the surface and bottom temperature anomalies were determined by subtracting the value of the mean annual curve for the appropriate day at each station from the observed temperature. To provide an indication of the statistical significance or the degree of variation relative to conditions in other years, the differences were normalized by the standard deviations associated with the annual curve fit at each station. The normalized anomalies were then contoured. Three of the four cruises (DEL8601, DEL8603 and DEL8607) showed significant anomalous features, which can be seen in Figures 8, 9 ,and 10. Horizontal and vertical hatching indicate significantly (more than two standard deviations from the mean) colder and warmer water, respectively.

Distributions of both surface and bottom salinity were contoured for all four cruises (Figures 11 to 14).

Vertical distributions of temperature (Figures 15 to 21) and salinity (Figures 22 to 28) were contoured along the cross-shelf transects.

The areal-weighted average temperature and salinity values from all MARMAP cruises were plotted (Figures 29 to 30) for those regions of the study area and layers of the water column in which the 1986 observations appeared to deviate from conditions in other years.

Discussion

In general, the oceanographic conditions observed in 1986 were similar to the 11 year MARMAP mean. Typical (mean) conditions are described elsewhere. MARMAP observations are discussed in Mountain and Jessen (1987) for the Gulf of Maine and in Manning (in preparation) for the Middle Atlantic Bight (MAB). Conditions in 1987 are discussed in Manning and Lierheimer (1988).

Two anomalous events were detected in 1986. In May, the bottom waters in a large area southeast of Long Island were warmer and saltier than usual (Figures 9b and 12b). Warm core ring (WCR) 86-A, detected southeast of this region on NOAA satellite imagery, may have injected slope water up onto the shelf. This warm/salty local event was superimposed on an apparent larger scale encroachment of slope water onto the outer shelf (compared to other years) that had been observed throughout the entire Middle Atlantic Bight on the first three cruises of 1986 (Figures 29 and 30).

In the last few days of August, the water column seaward of Chesapeake Bay was anomalously well mixed. The surface temperatures were as much as 4° to 6°C colder than the mean and the bottom temperatures were 1° to 2°C warmer than the mean (Figure 10). The middle panel of Figure 31 depicts this condition at nearshore MARMAP stations 12, 13, and 14 and may be compared to typical stratified conditions observed in 1985 and 1987.

Winds recorded at Norfolk, Virginia (NOAA/NWS) on 29 August were 14.3 knots (average of 8 readings), not much greater than the typical August values (10.8 knots). Coupled with the anomalously low air temperatures (approximately 10°C less than normal 48 hours prior to the MARMAP observations) however, they were apparently strong enough to extract heat from the surface layer and induce a local turnover.

Other anomalous temperatures and salinities were recorded in 1986, but because they occurred over such small areas (1-2) stations, they are not discussed here. Events may well have occurred in the time periods between MARMAP surveys and, therefore, gone undetected.

References

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Mountain, D.G. and P.F. Jessen. 1987. Bottom waters of the Gulf of Maine, 1978-1983. *Jour. Mar. Res.* 45:319-345.

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Patanjo, D., S.R. Nickerson, and F. Steimle. 1982. Report on temperature, salinity, and dissolved oxygen measurements made on MARMAP surveys between October 1977 - December 1978. WoodsHole, MA: NMFS Northeast Fisheries Center. Laboratory Reference Document 82-03. MARMAP contribution MED/NEFC 82-11.

Sherman, K. 1980. MARMAP, a fisheries ecosystem study in the Northwest Atlantic: fluctuations in ichthyoplankton-zooplankton components and their potential for impact on thesystem. In Advanced Concepts on Ocean Measurements for Marine Biology, eds. F.P. Diermer, F.J. Vernberg, and D.Z. Mirkes, pp. 9-37. Columbia, SC: University of South Carolina Press.

Acknowledgements

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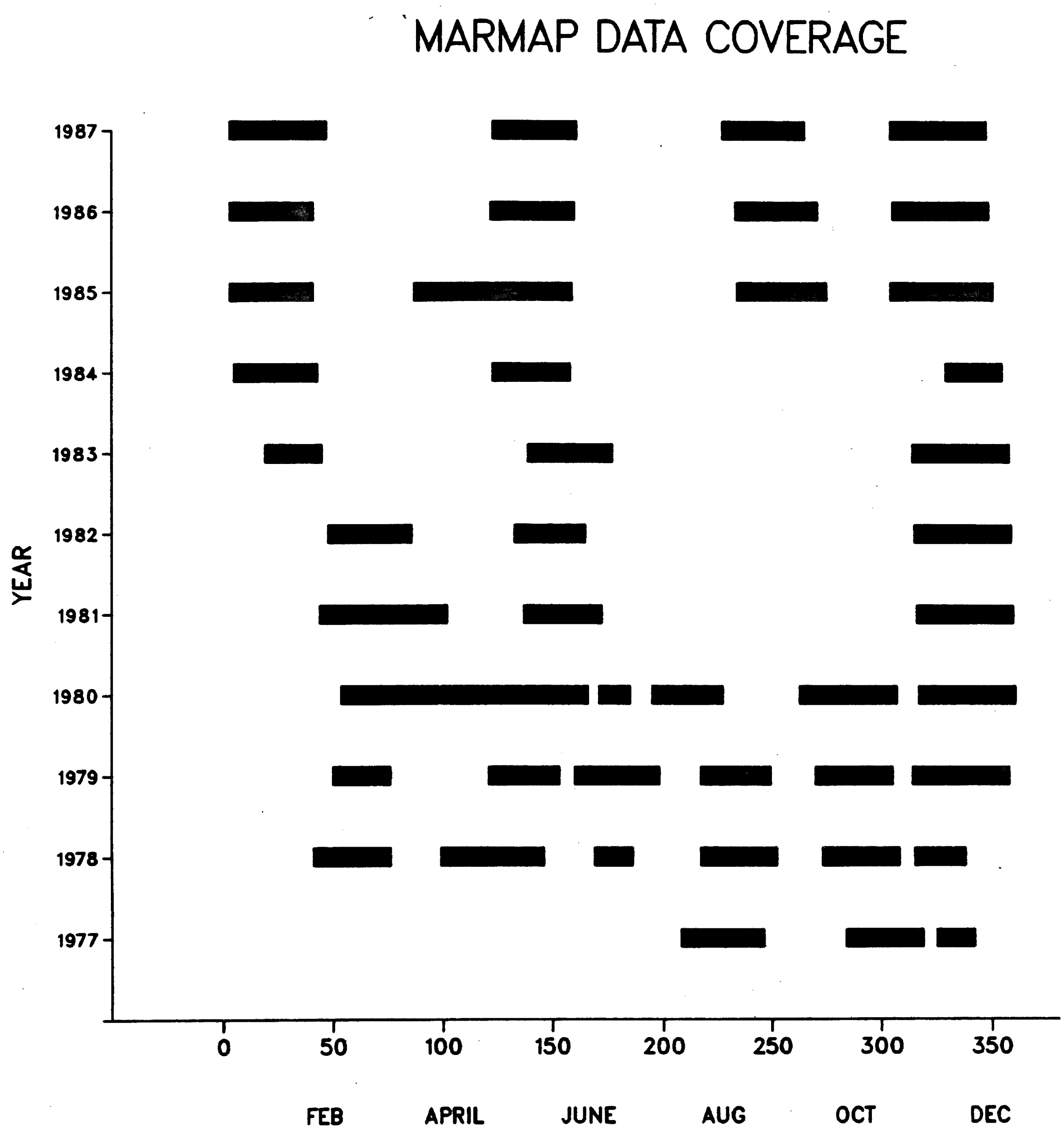


Figure 1. Timing of MARMAP sampling, 1977 to 1987.

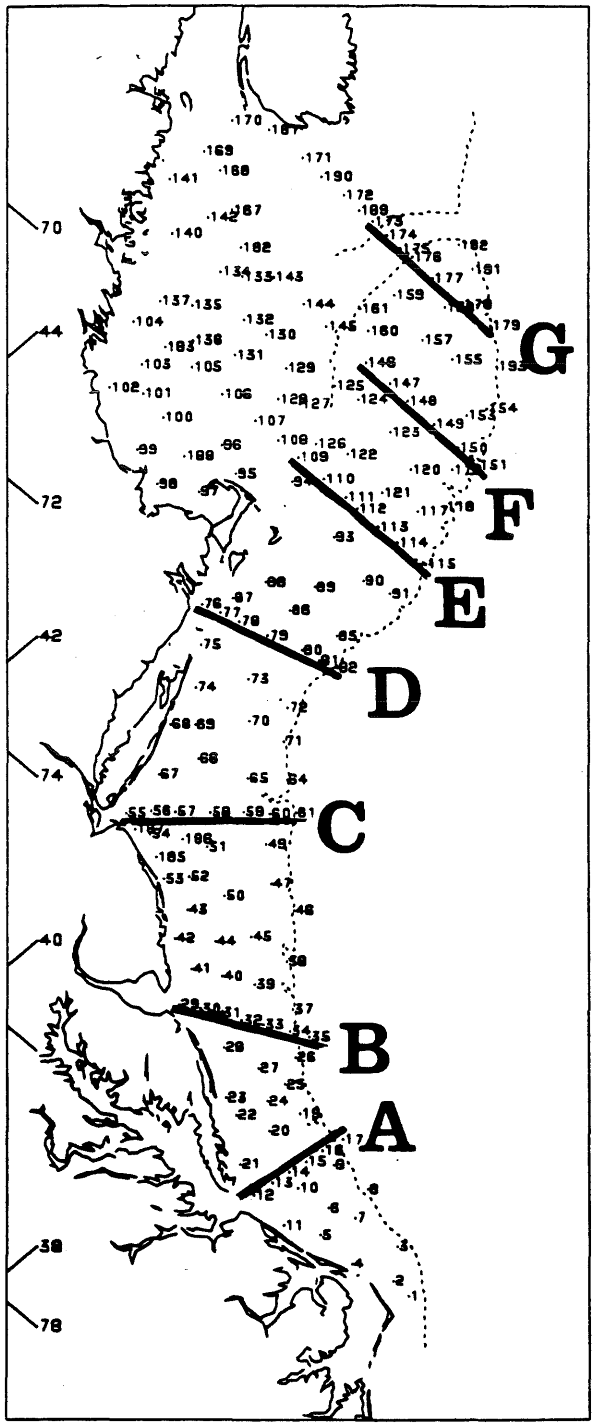


Figure 2. Standard oceanographic stations on the Northeast continental shelf. The dashed line represents the 200 m isobath. Bold lines represent standard cross-shelf transects.

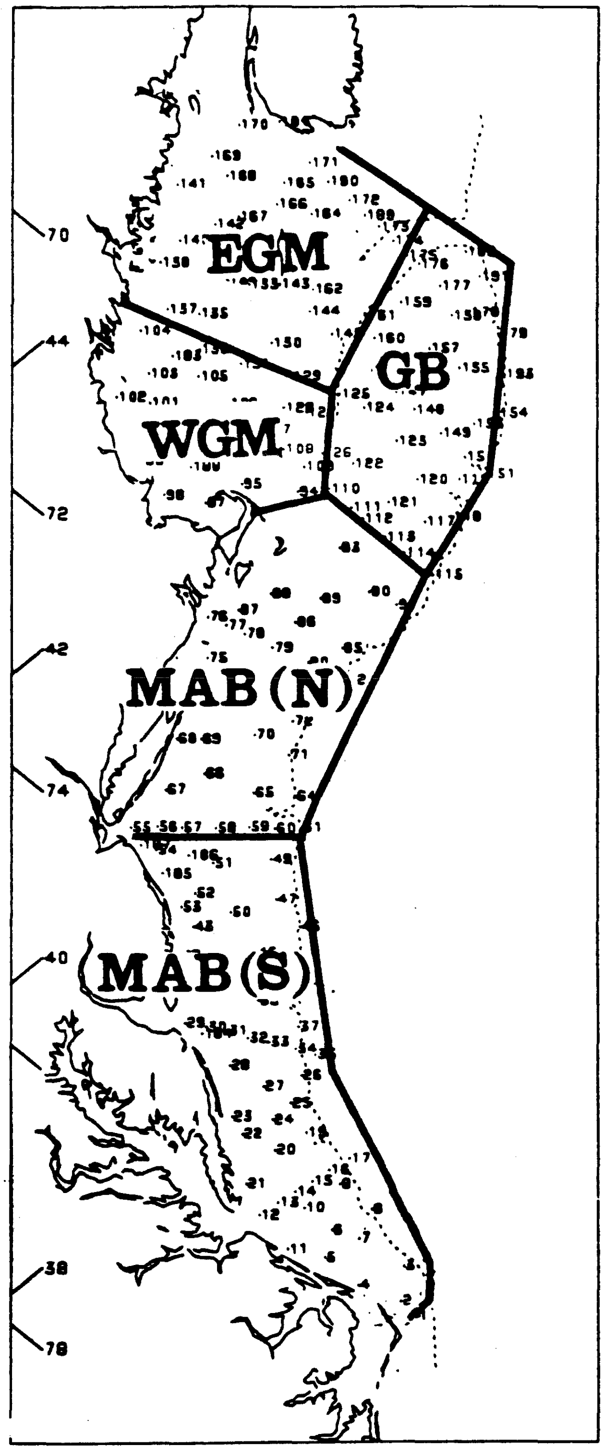
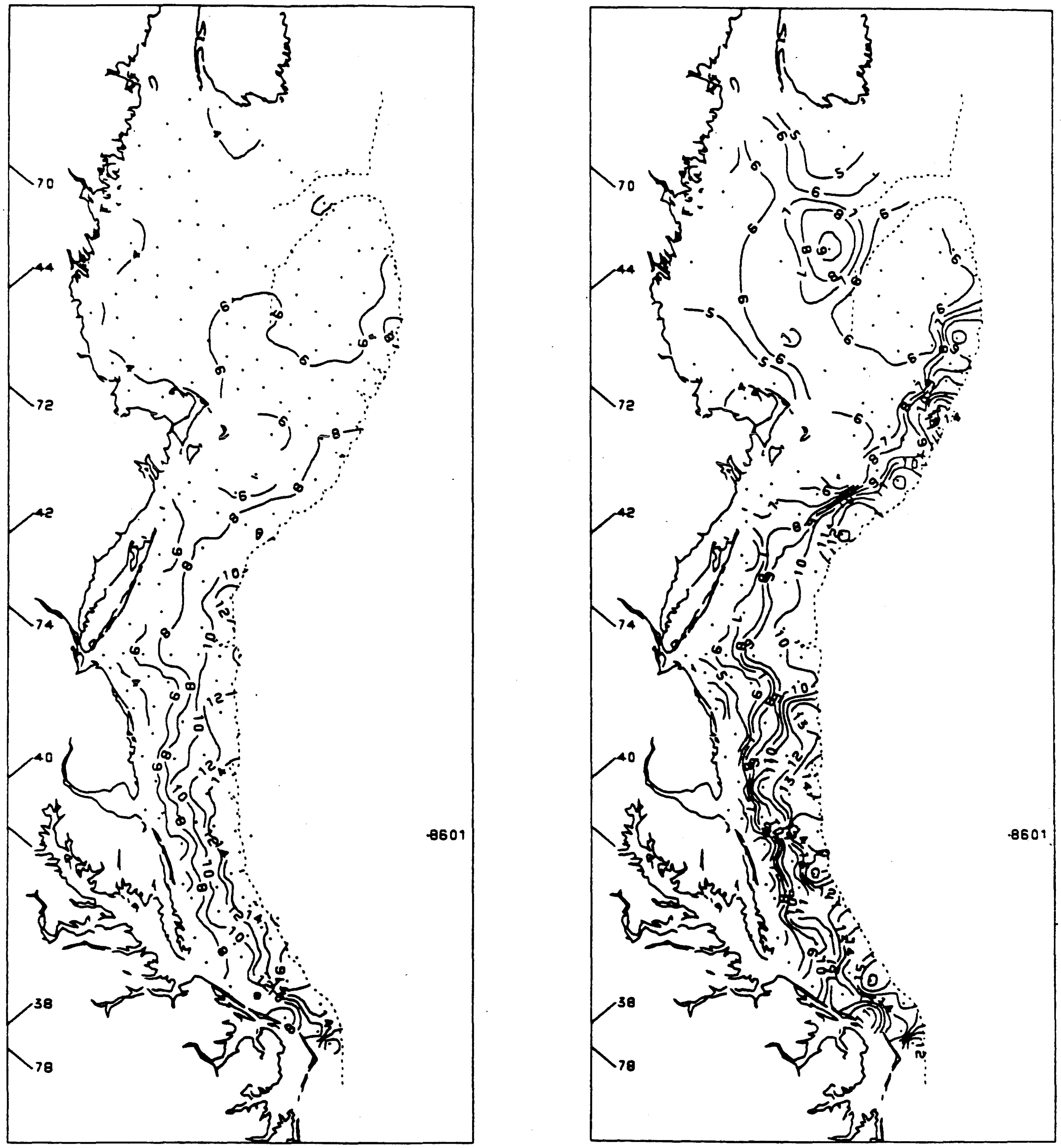


Figure 3. Five regions on the Northeast continental shelf.



a b

Figure 4. 1986 a) surface and b) bottom temperature (°C) distribution: Winter.

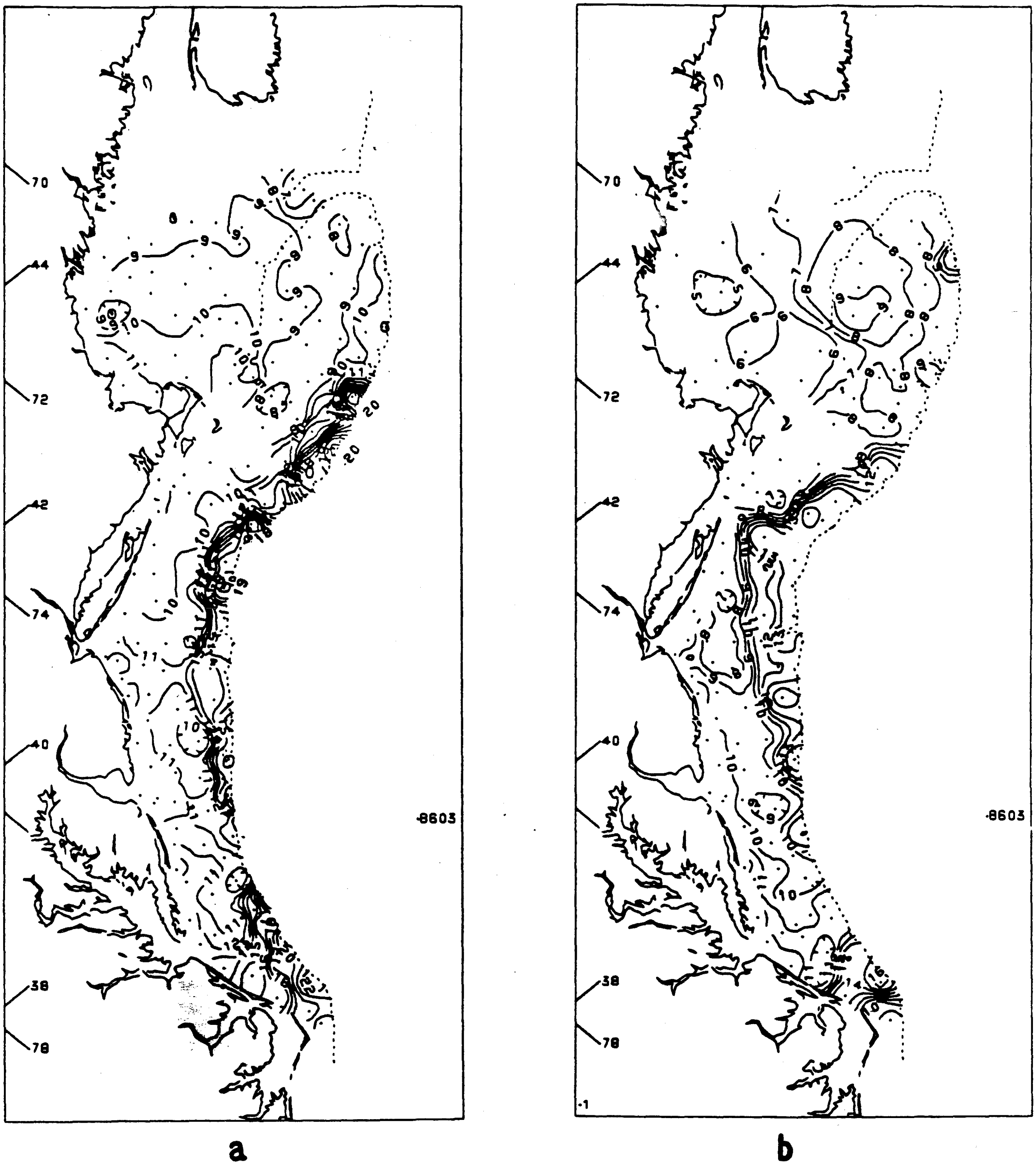
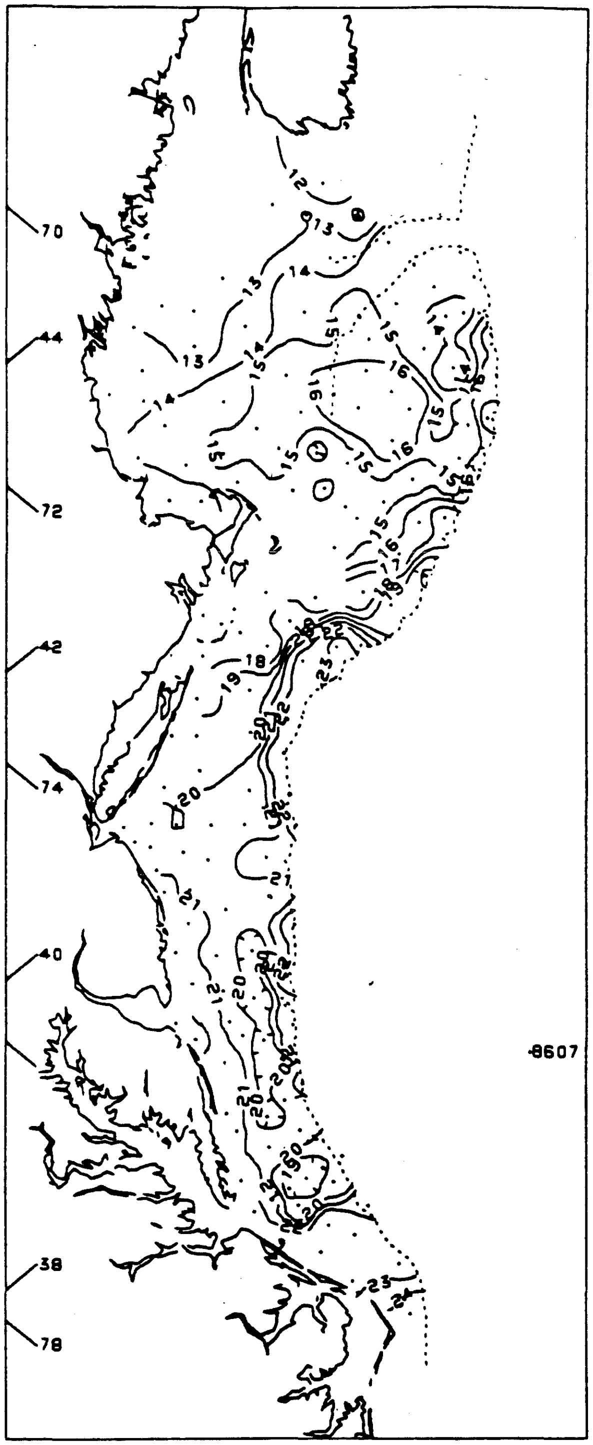


Figure 5. 1986 a) surface and b) bottom temperature (°C) distribution: Spring (DEL8603).



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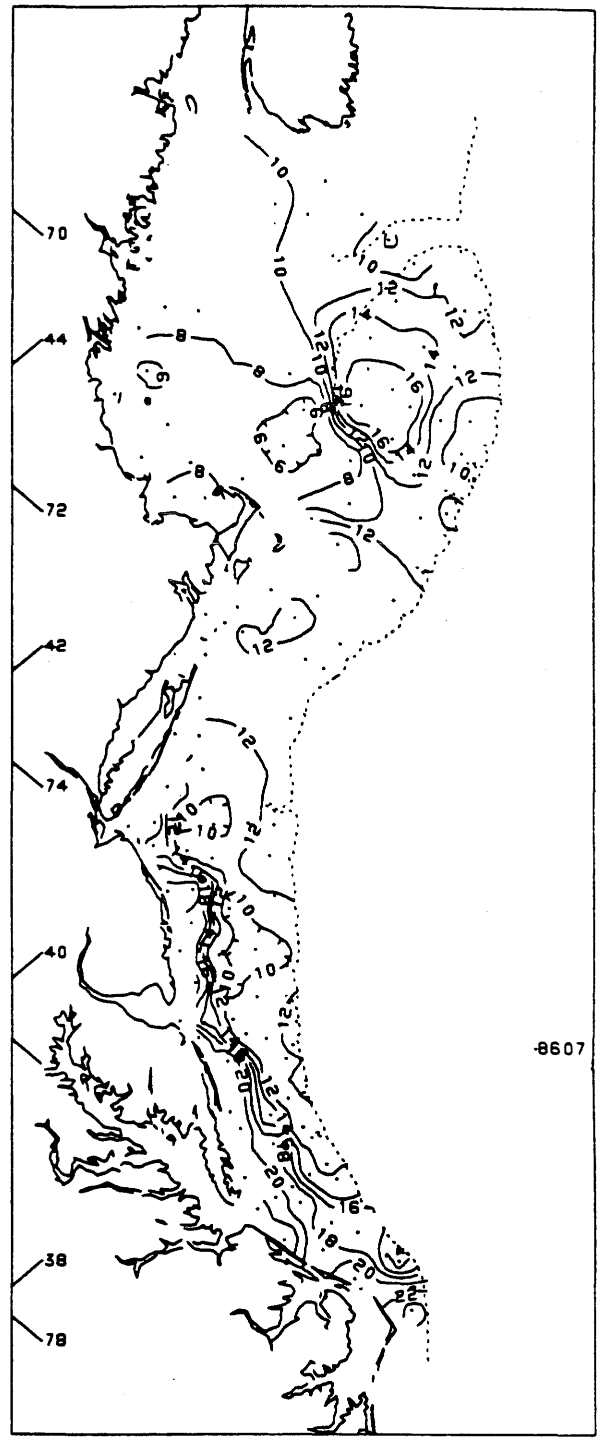
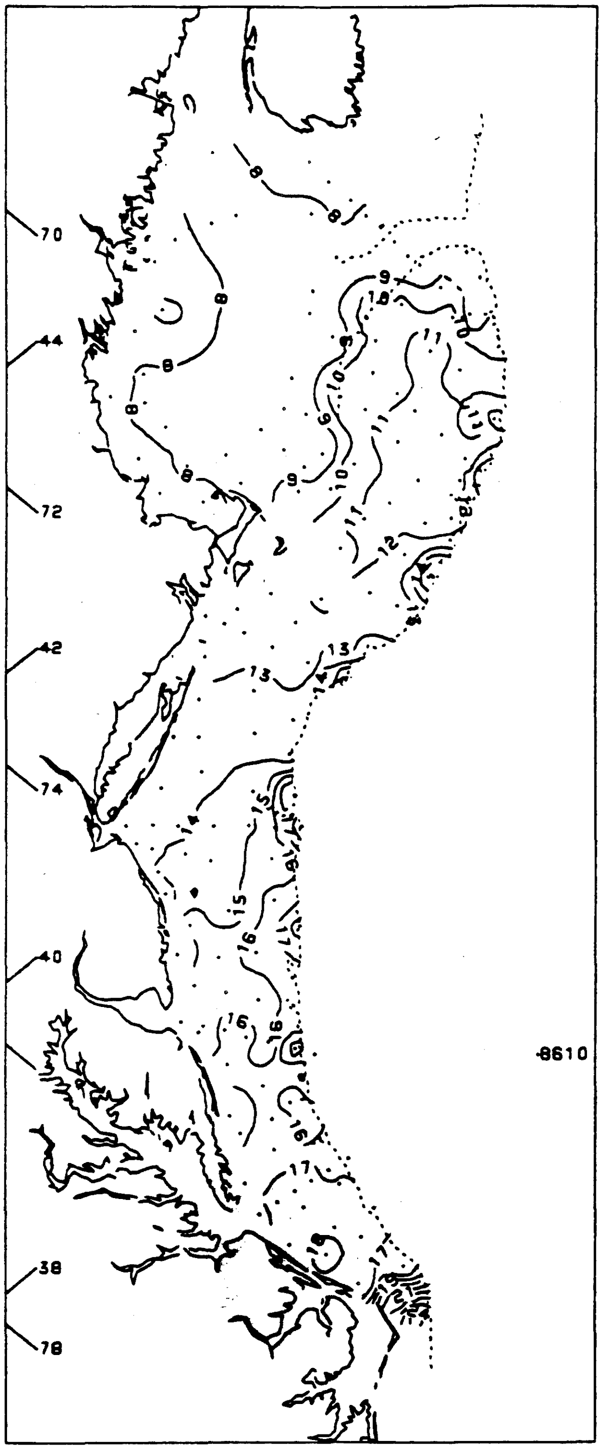


b

Figure 6. 1986 a) surface and b) bottom temperature (°C) distribution: Early fall (DEL8607).



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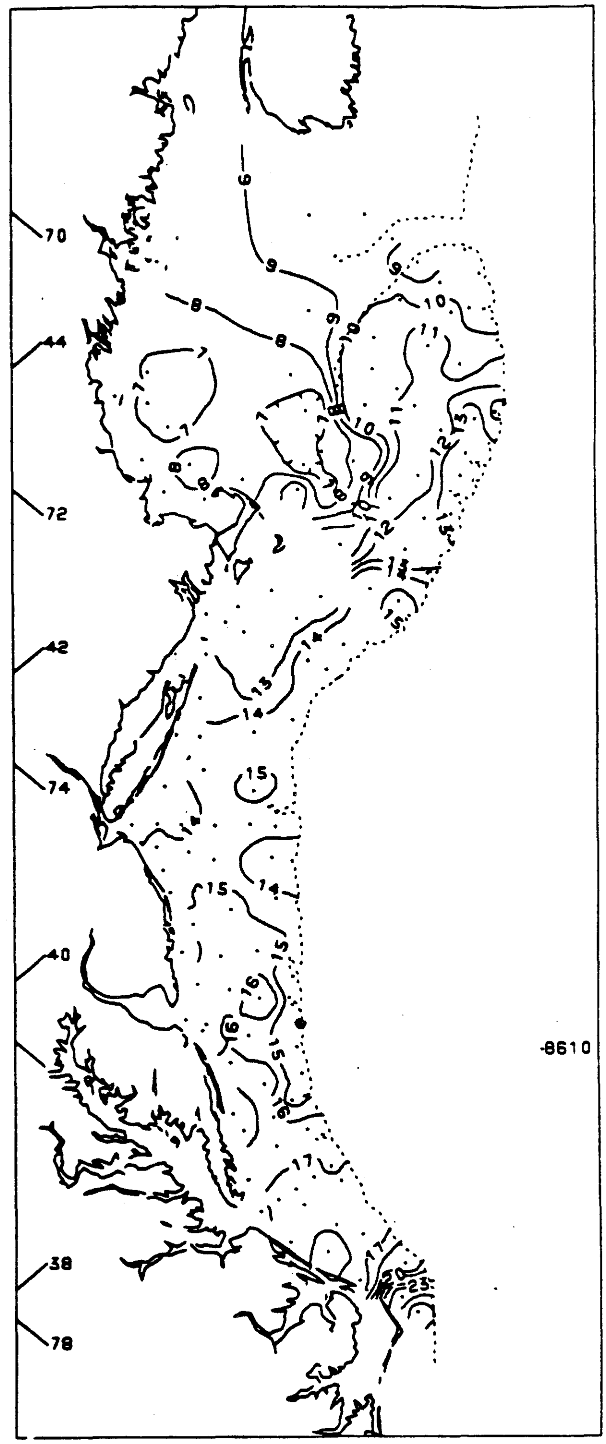
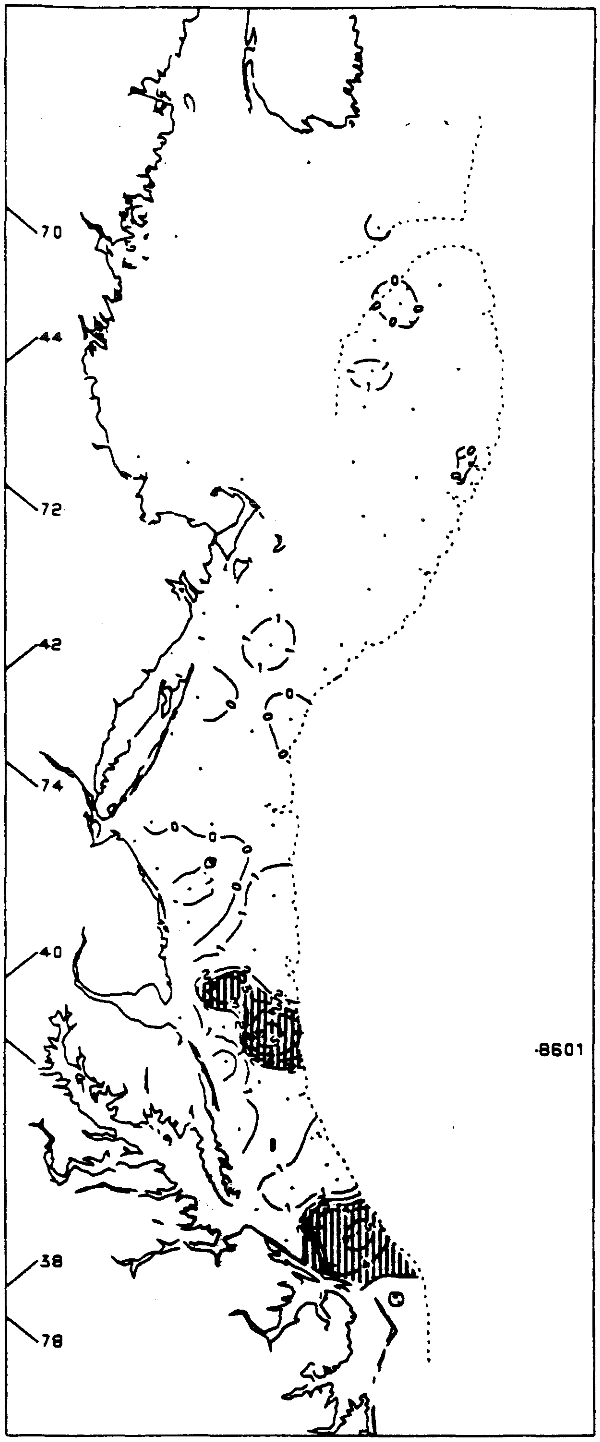


b

Figure 7. 1986 a) surface and b) bottom temperature (°C) distribution: Late fall (DEL8610).



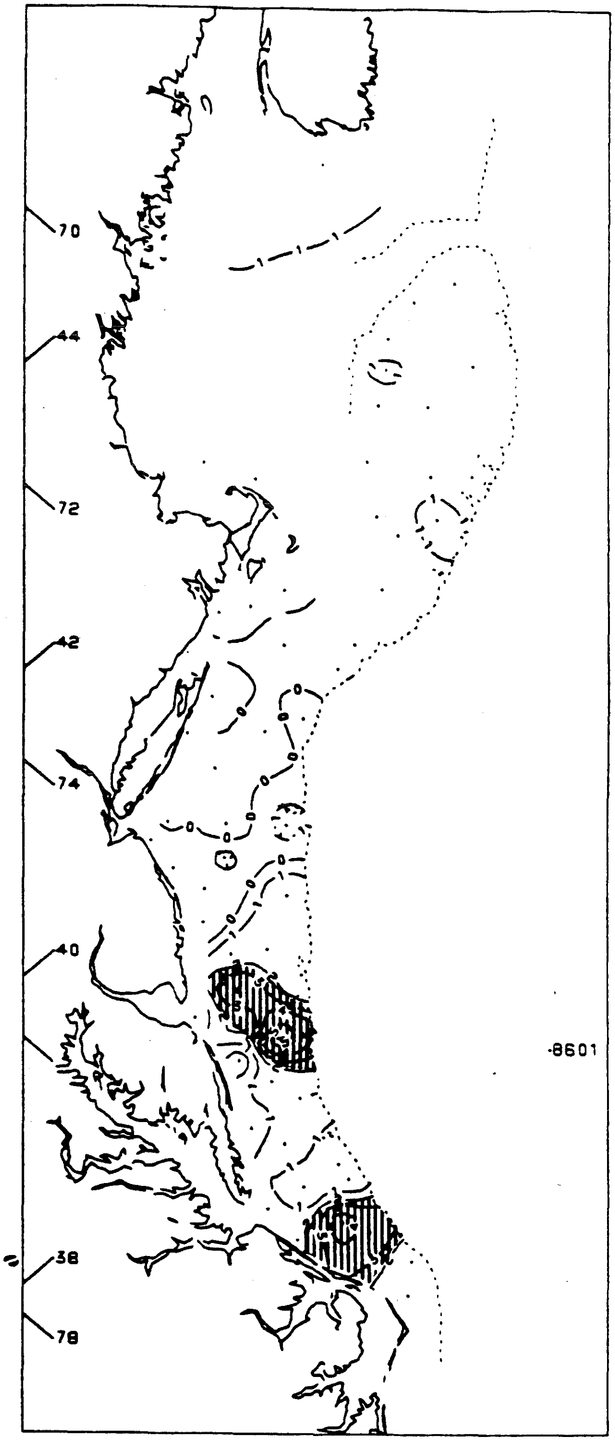


Figure 8. Normalized a) surface and b) bottom temperature anomaly for DEL8601. Contours are multiples of the standard deviation for the mean annual temperature curves. See text for explanation. Hatched areas are more then two standard deviations above (vertical) the 11 year mean.

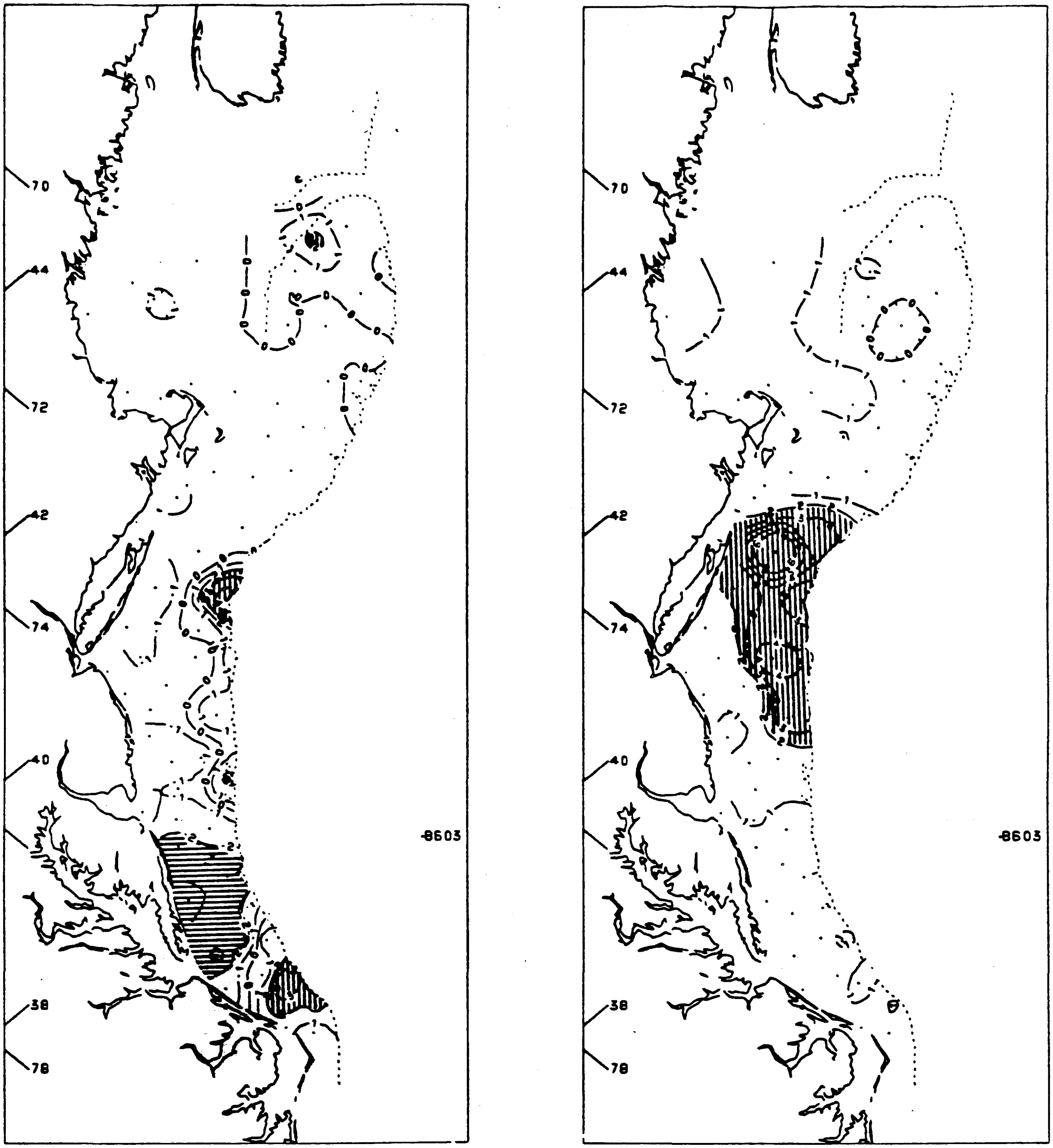


Figure 9. Normalized a) surface and b) bottom temperature anomaly for DEL8603. Contours are multiples of the standard deviation for the mean annual temperature curves. See text for explanation. Hatched areas are more than two standard deviations above (vertical) or below (horizontal) the 11 year mean.

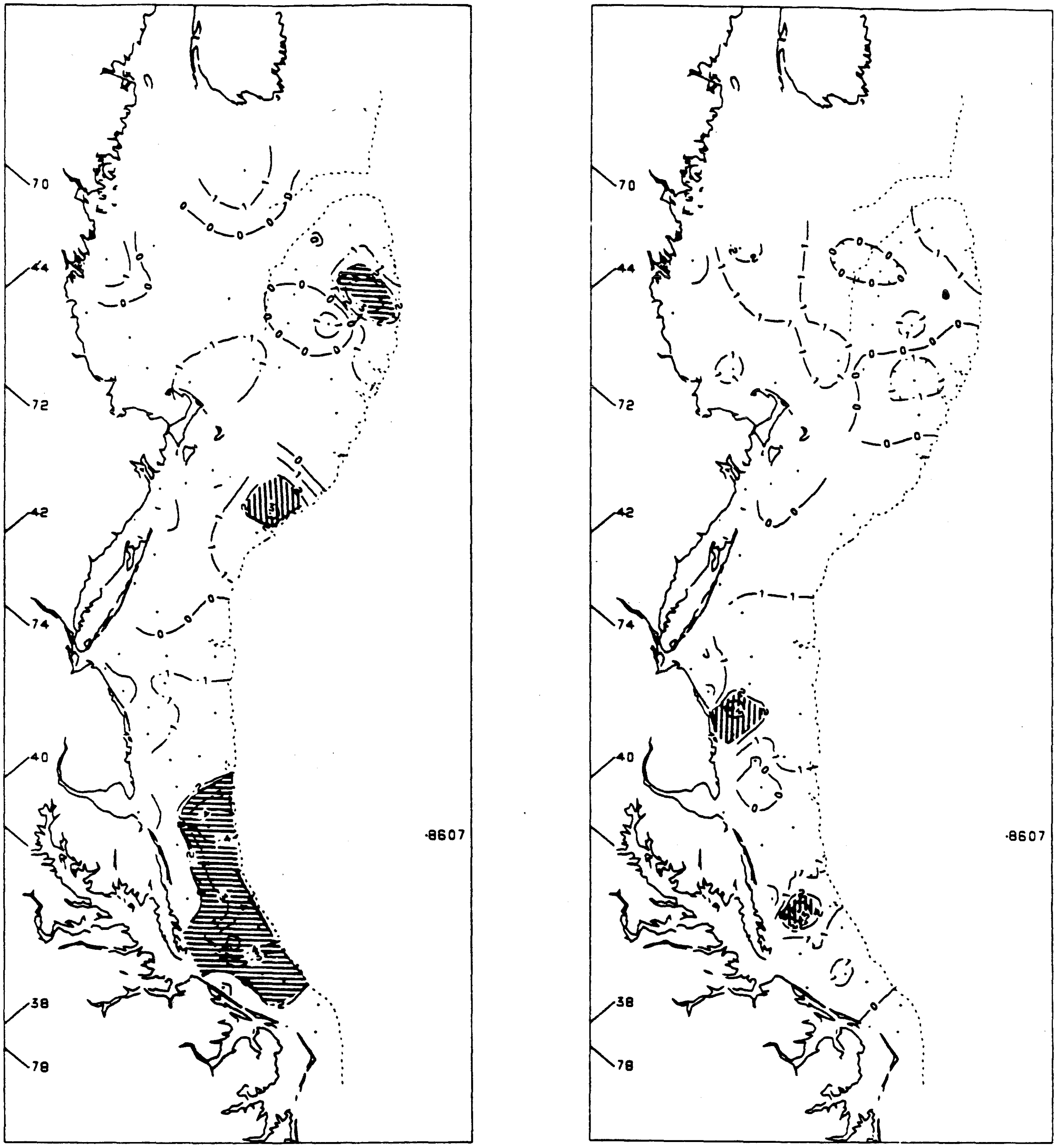
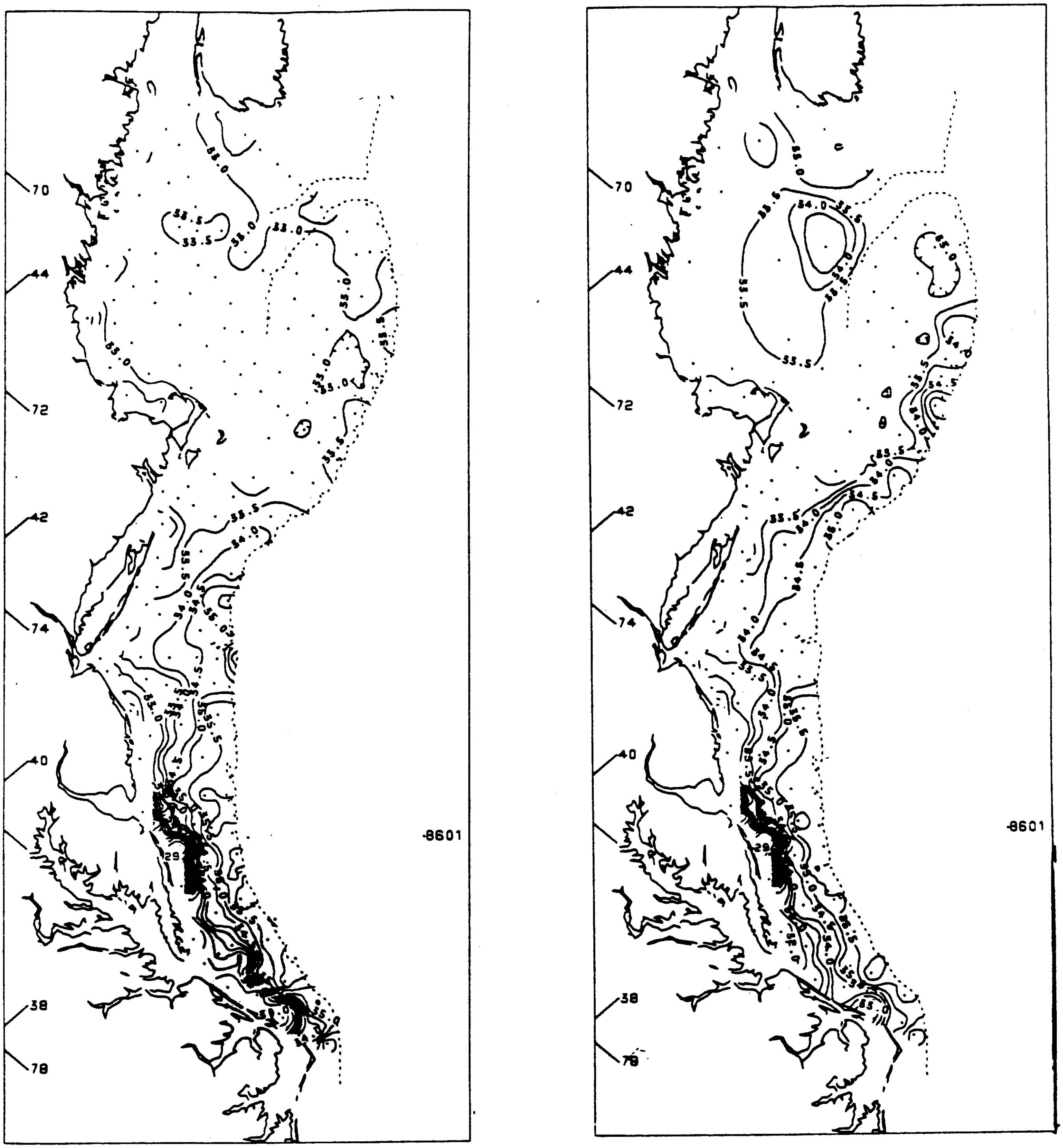


Figure 10. Normalized a) surface and b) bottom temperature anomaly for DEL8607. Contours are multiples of the standard deviation for the mean annual temperature curves. more than two standard deviations above (vertical) or below (horizontal) the 11 year mean.



a b

Figure 11. 1986 a) surface and b) bottom salinity (PSU) distribution: Winter (DEL8601).

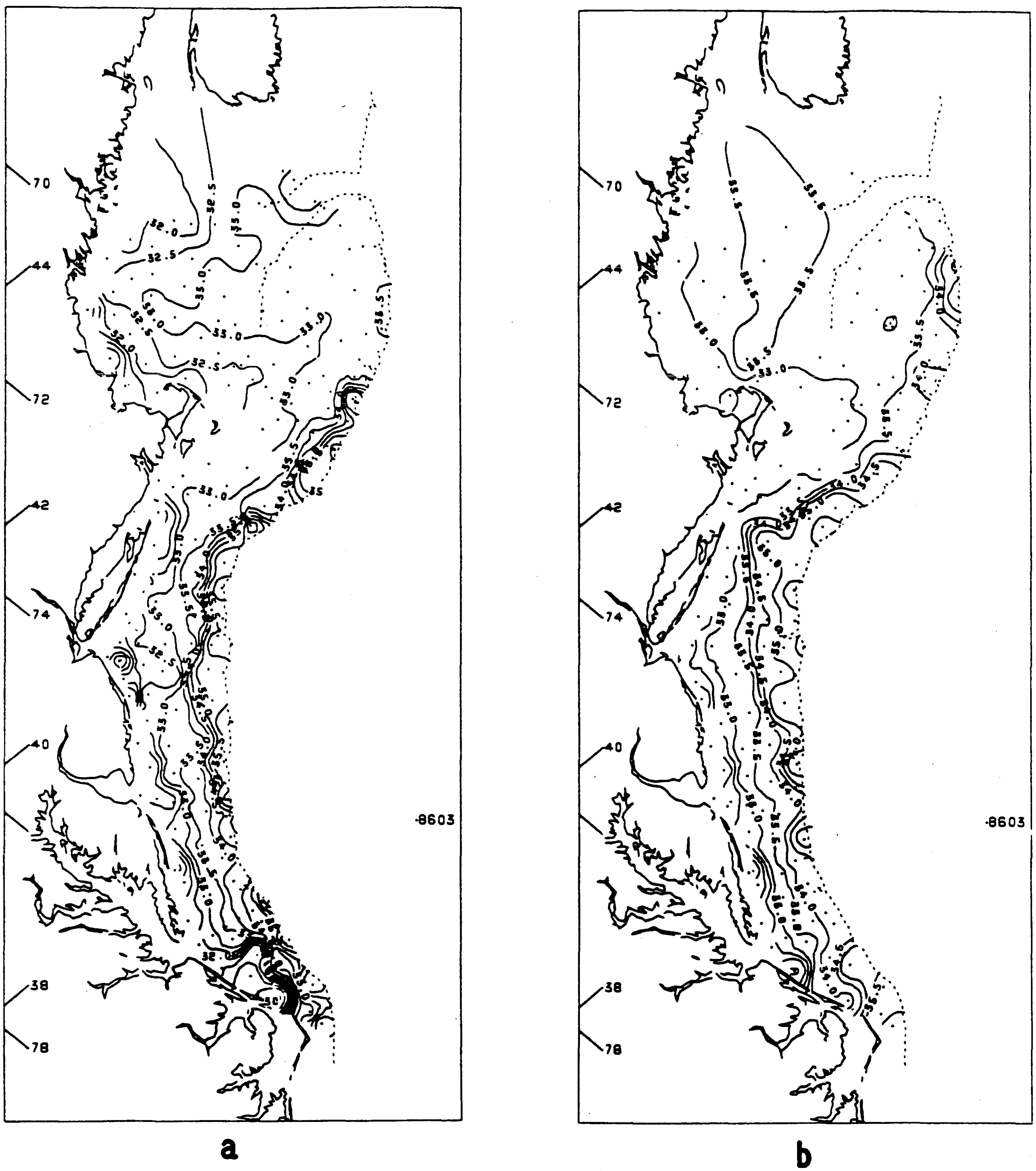


Figure 12. 1986 a) surface and b) bottom salinity (PSU) distribution: Spring (DEL8603).

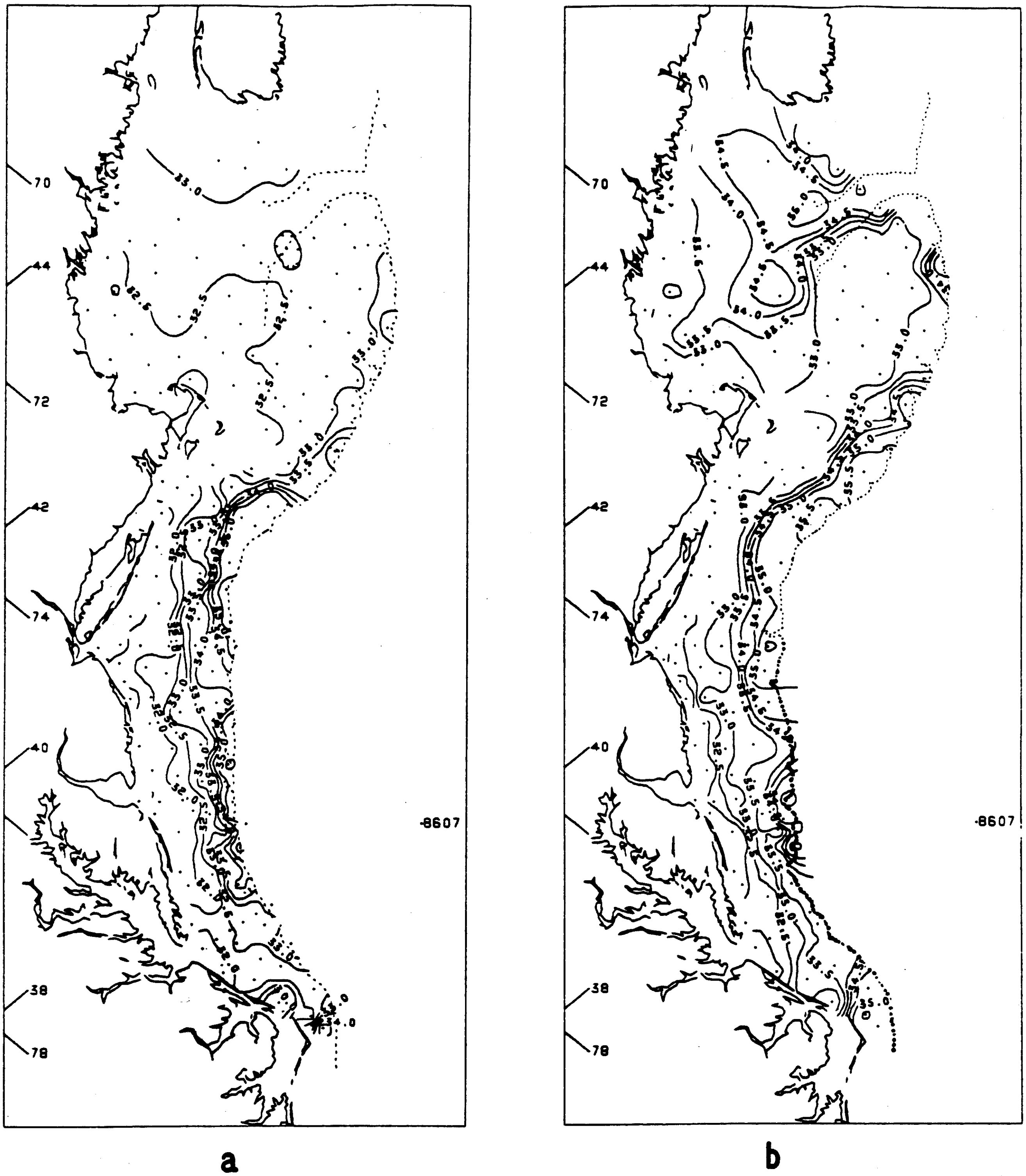


Figure 13. 1986 a) surface and b) bottom salinity (PSU) distribution: Early fall (DEL8607).

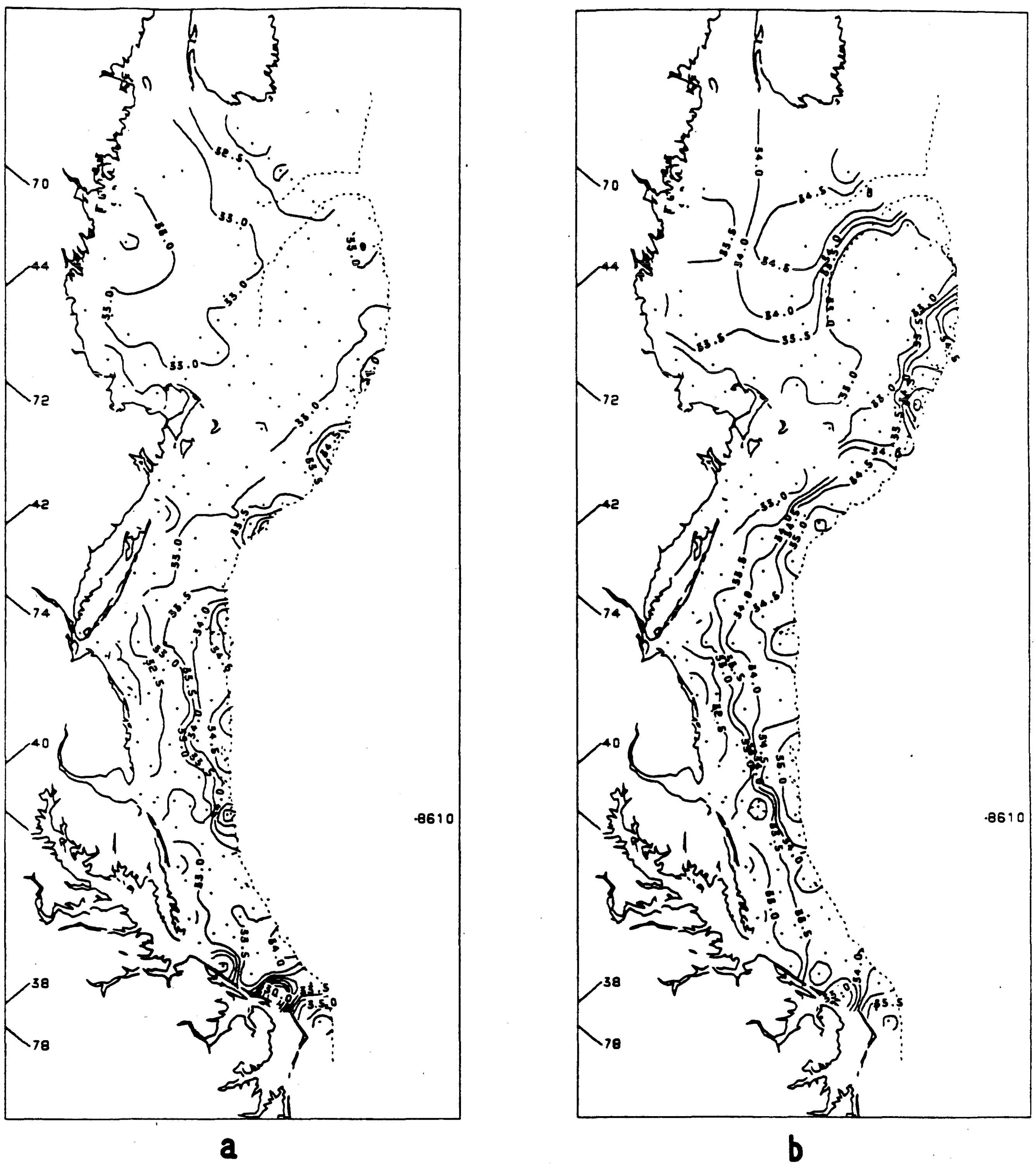


Figure 14. 1986 a) surface and b) bottom salinity (PSU) distribution: Late fall (DEL8610).

SECTION A TEMPERATURE

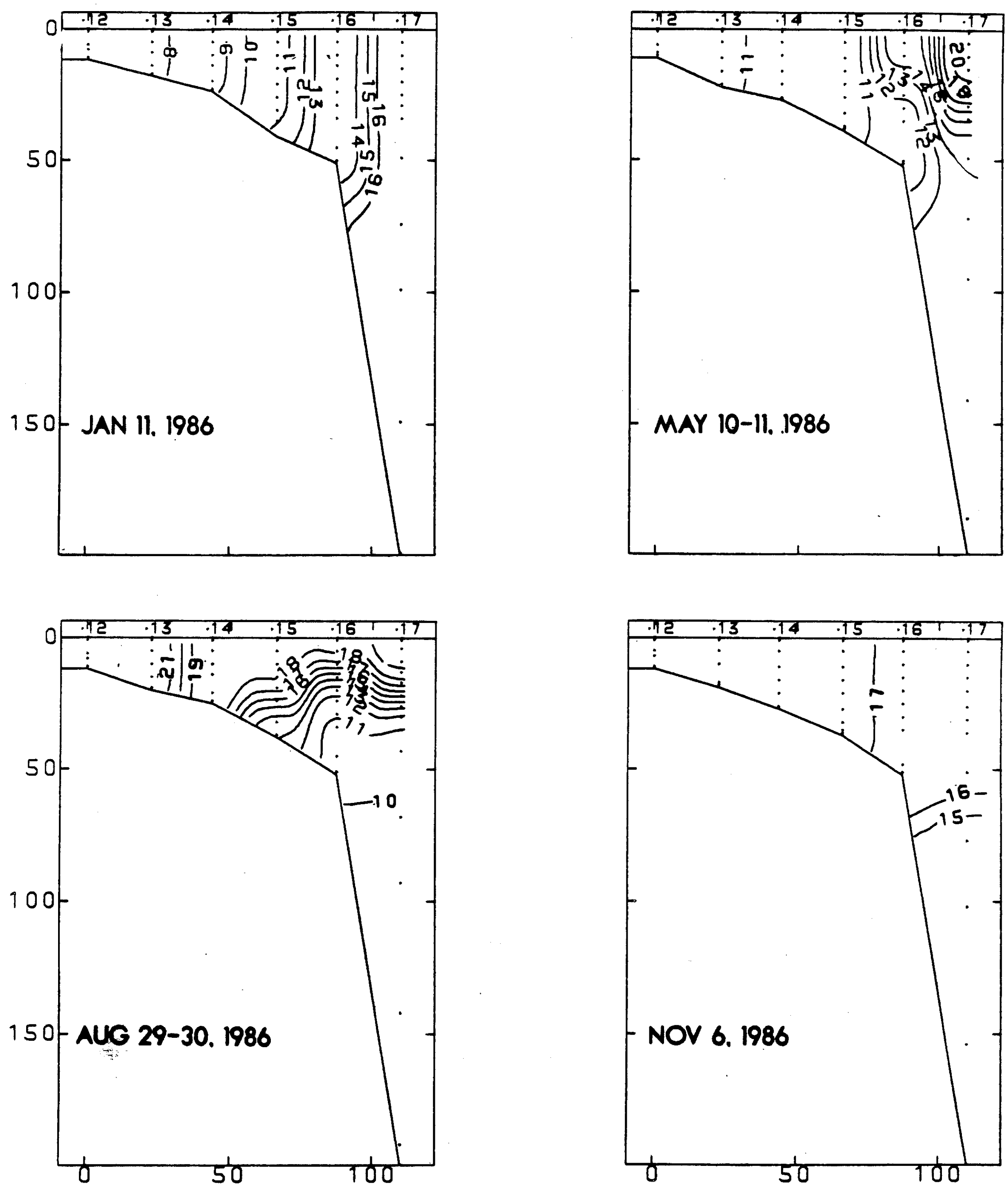


Figure 15. Temperature (°C) transect east of Chesapeake Bay including stations 12 to 17. Contour intervals are 1°C for January, May, August, and November, respectively.

SECTION B TEMPERATURE

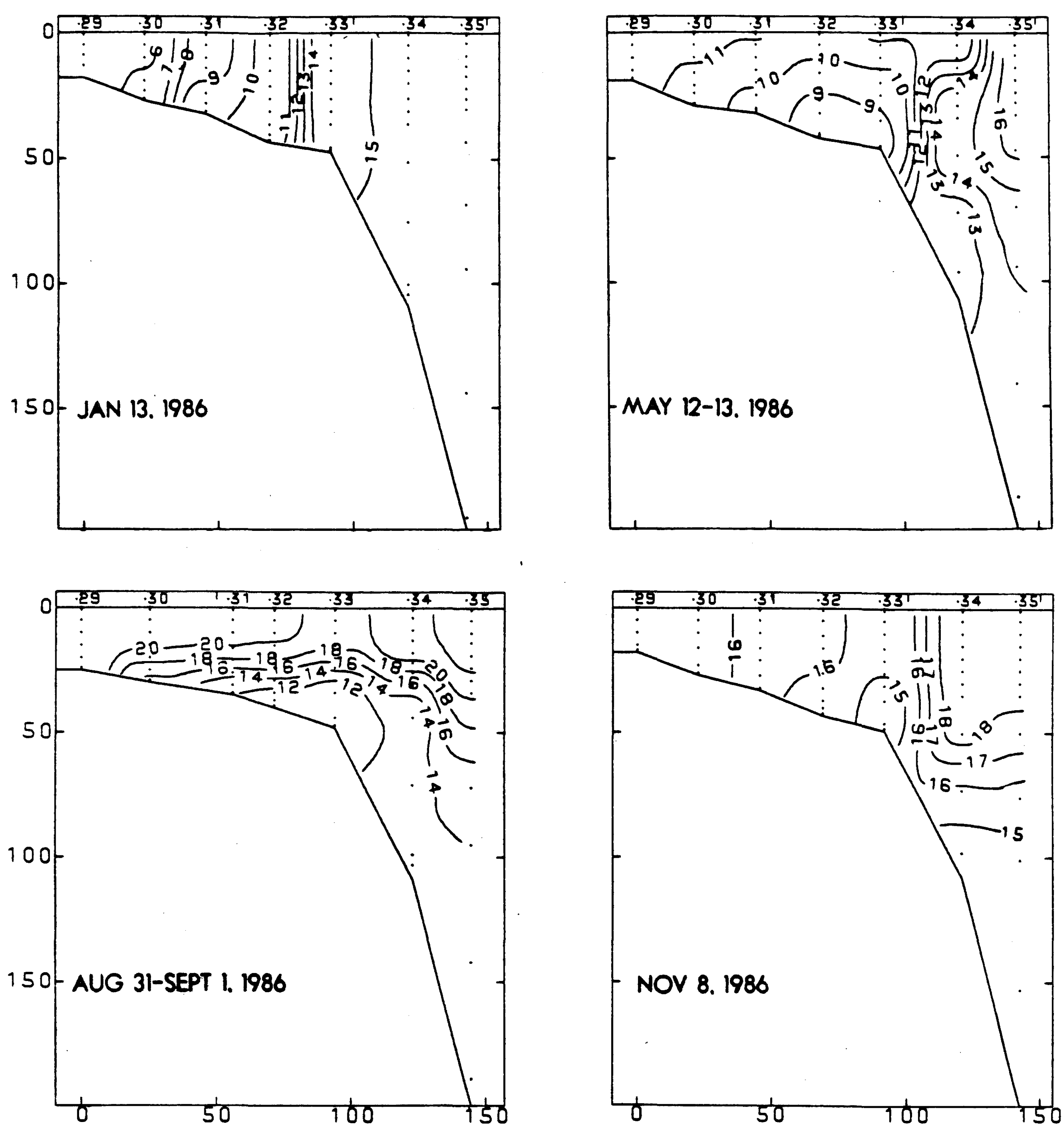


Figure 16. Temperature (°C) transect southeast of Delaware Bay including stations 29 to 35. Contour intervals are 1°, 1°, 2°, and 1°C for January, May, August, and November respectively.

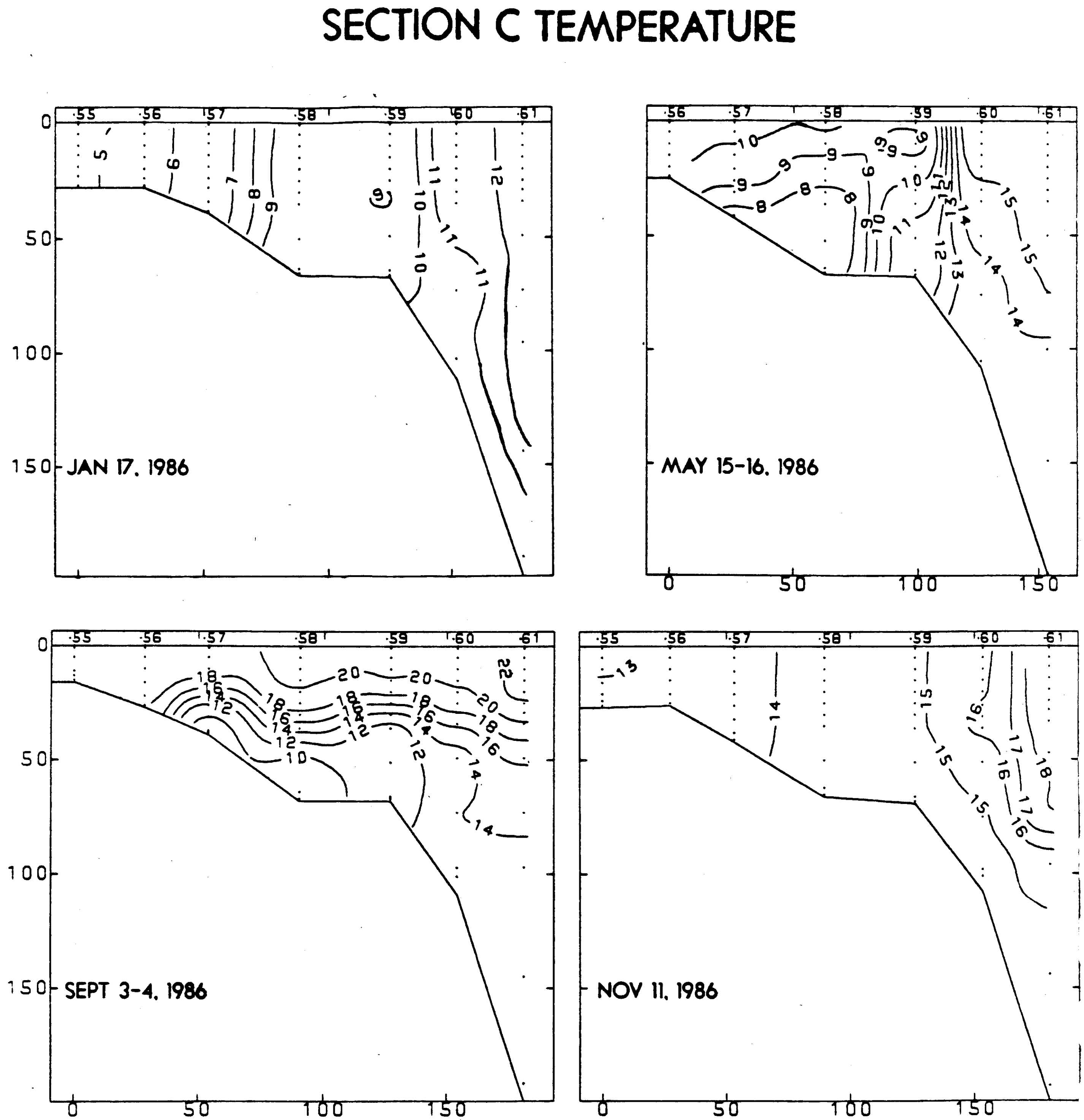


Figure 17. Temperature (°C) transect southeast of Hudson-Raritan Estuary including stations 55 to 61. Contour intervals are 1°, 1°, 2° and, 1°C for January, May, September, and November, respectively.

SECTION D TEMPERATURE

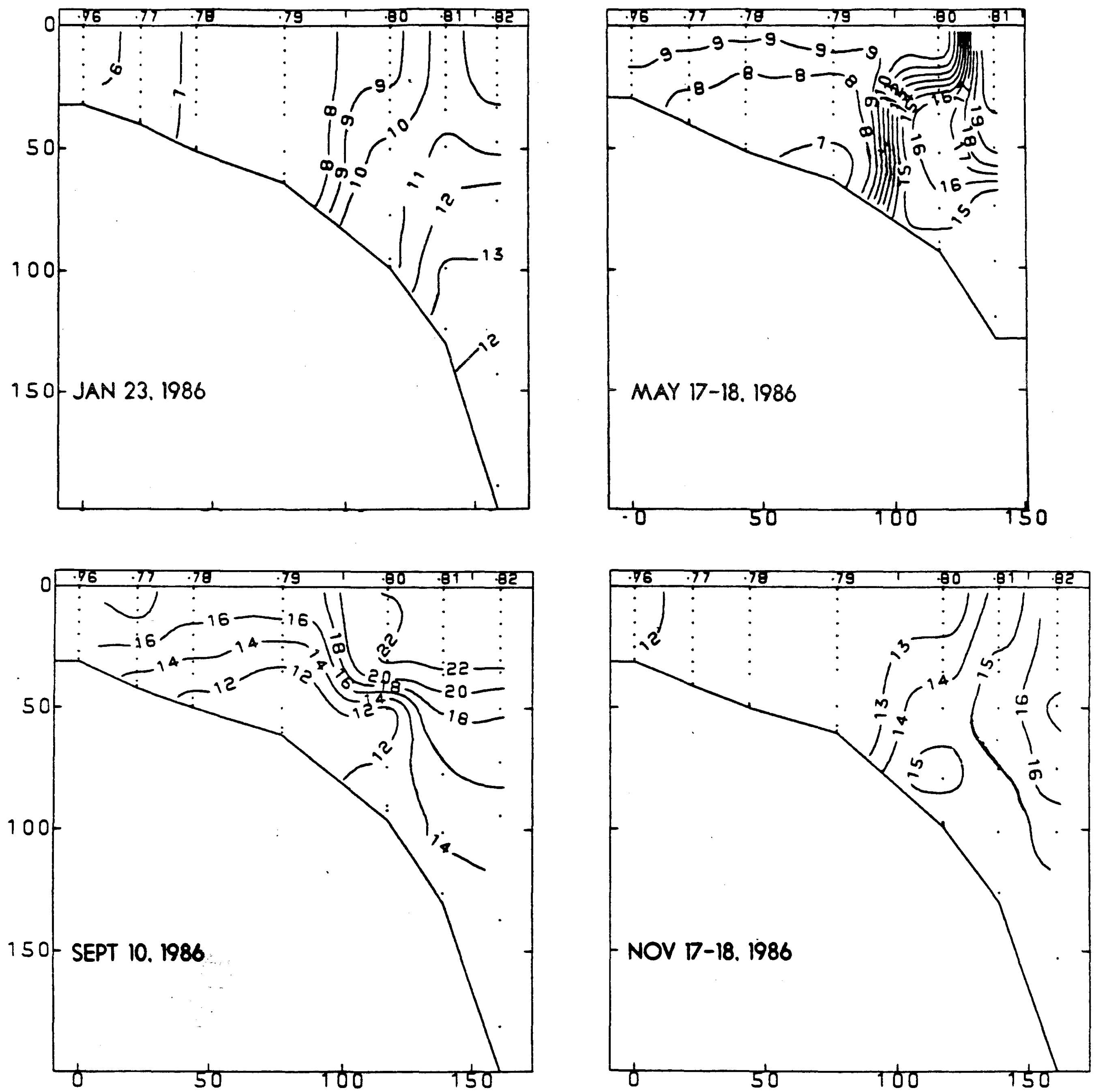


Figure 18. Temperature (°C) transect southeast of Block Island including stations 76 to 82. Contour intervals are 1°, 1°, 2°, and 1°C for January, May, September, and November, respectively.

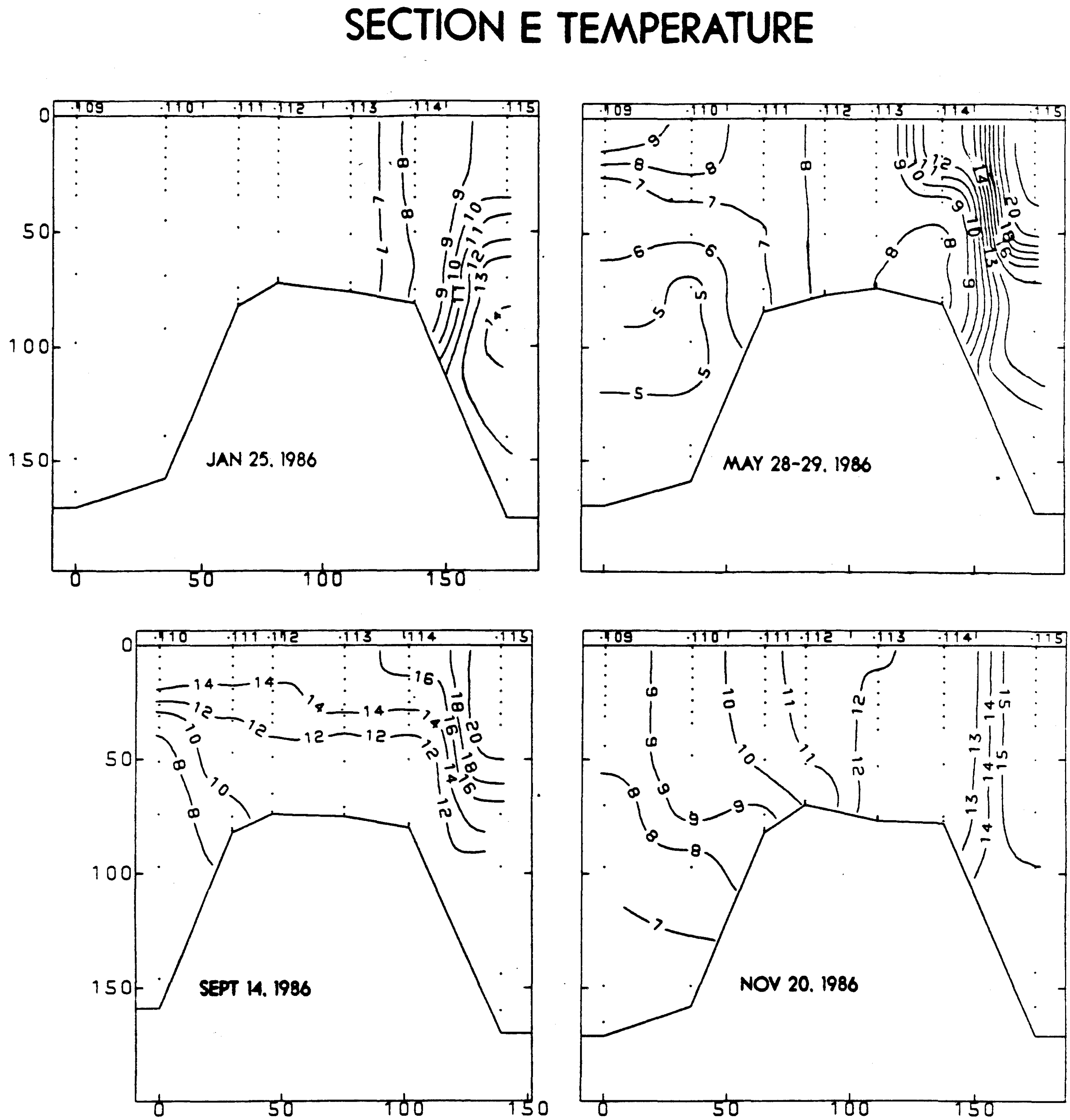


Figure 19. Temperature (°C) transect north-south along the axis of the Great South Channel including stations 109 to 115. Contour intervals are 1°, 1°, 2°, and 1°C for January, May, September, and November, respectively.

SECTION F TEMPERATURE

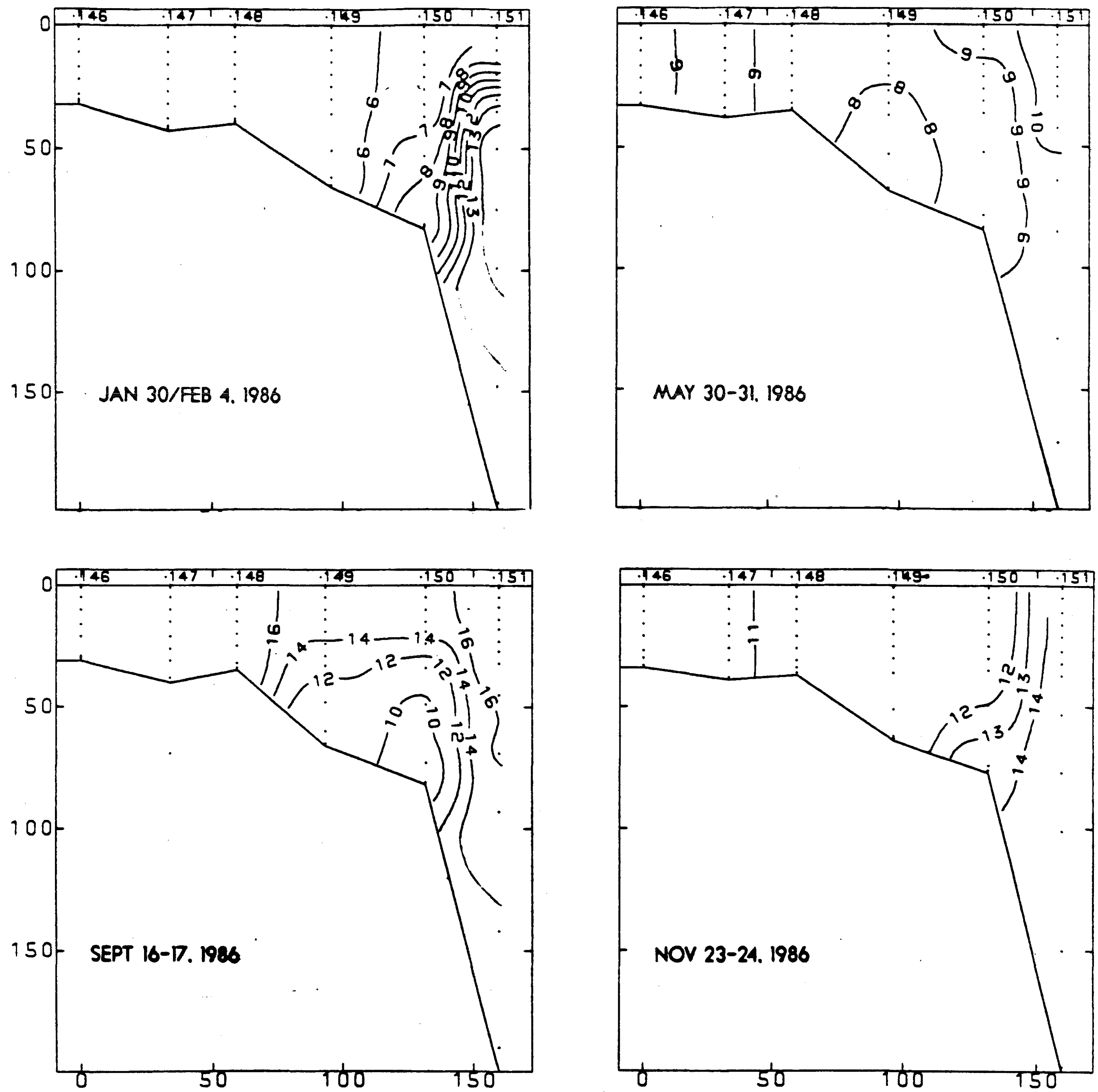


Figure 20. Temperature (°C) transect across the central portion of Georges Bank including stations 146 to 151. Contour intervals are 1°, 1°, 2°, and 1°C for January/February, May, September, and November, respectively.

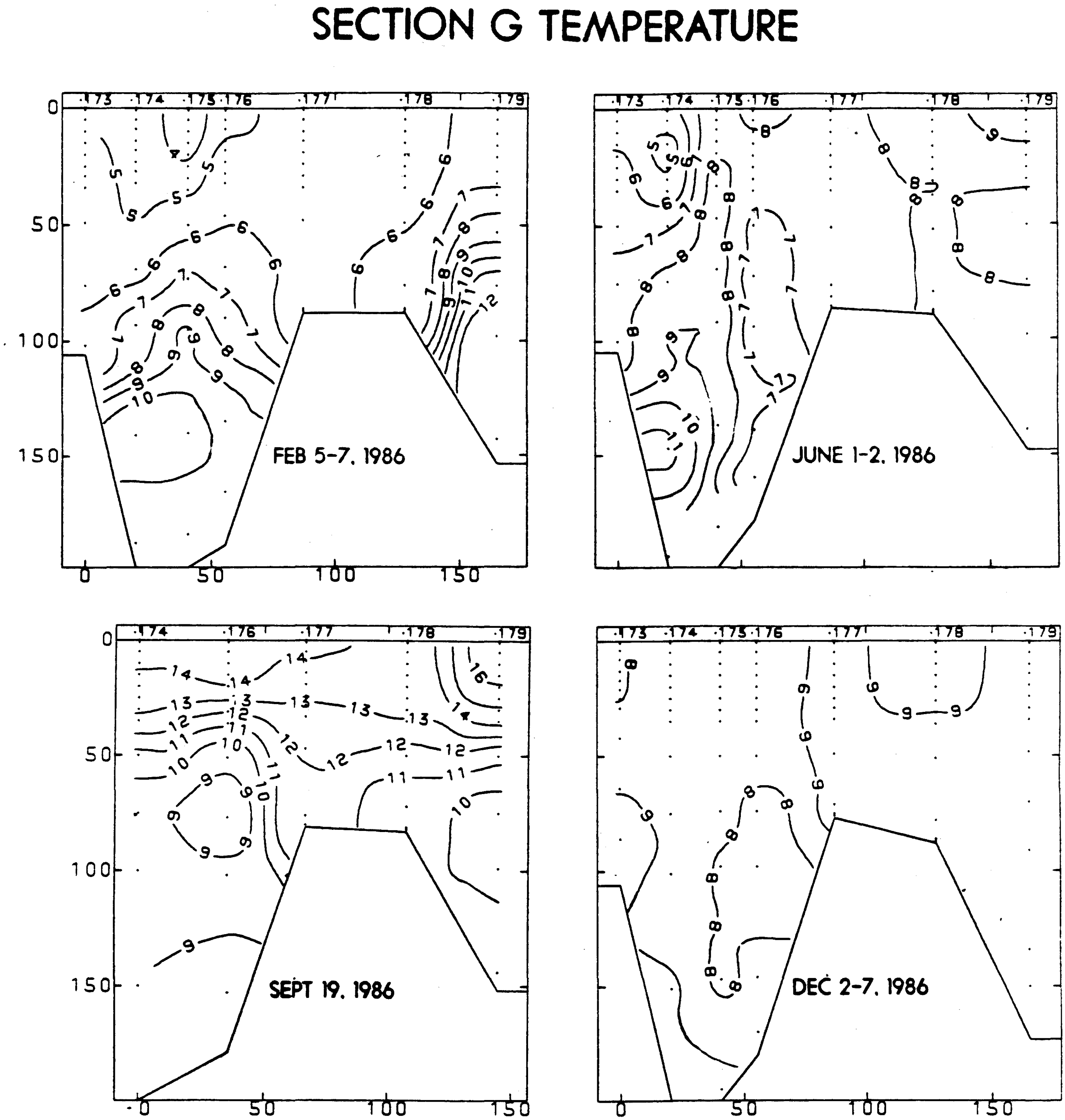


Figure 21. Temperature (°C) transect north-south across the eastern portion of Georges Bank including stations 173 to 179. Contour intervals are 1°C.

SECTION A SALINITY

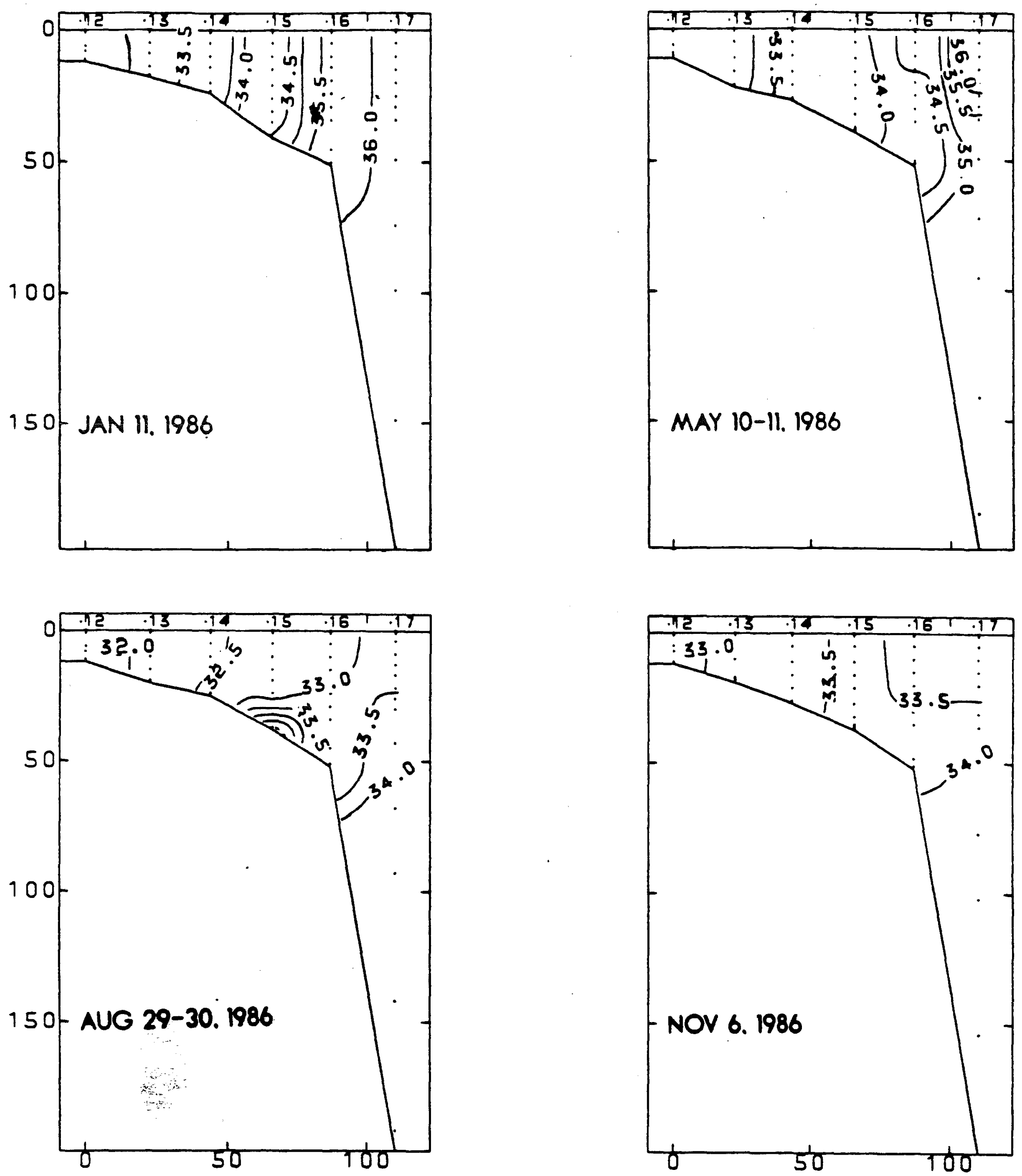


Figure 22. Salinity (PSU) transect east of Chesapeake Bay including stations 12 to 17. Contour intervals are 0.5 PSU.

SECTION B SALINITY

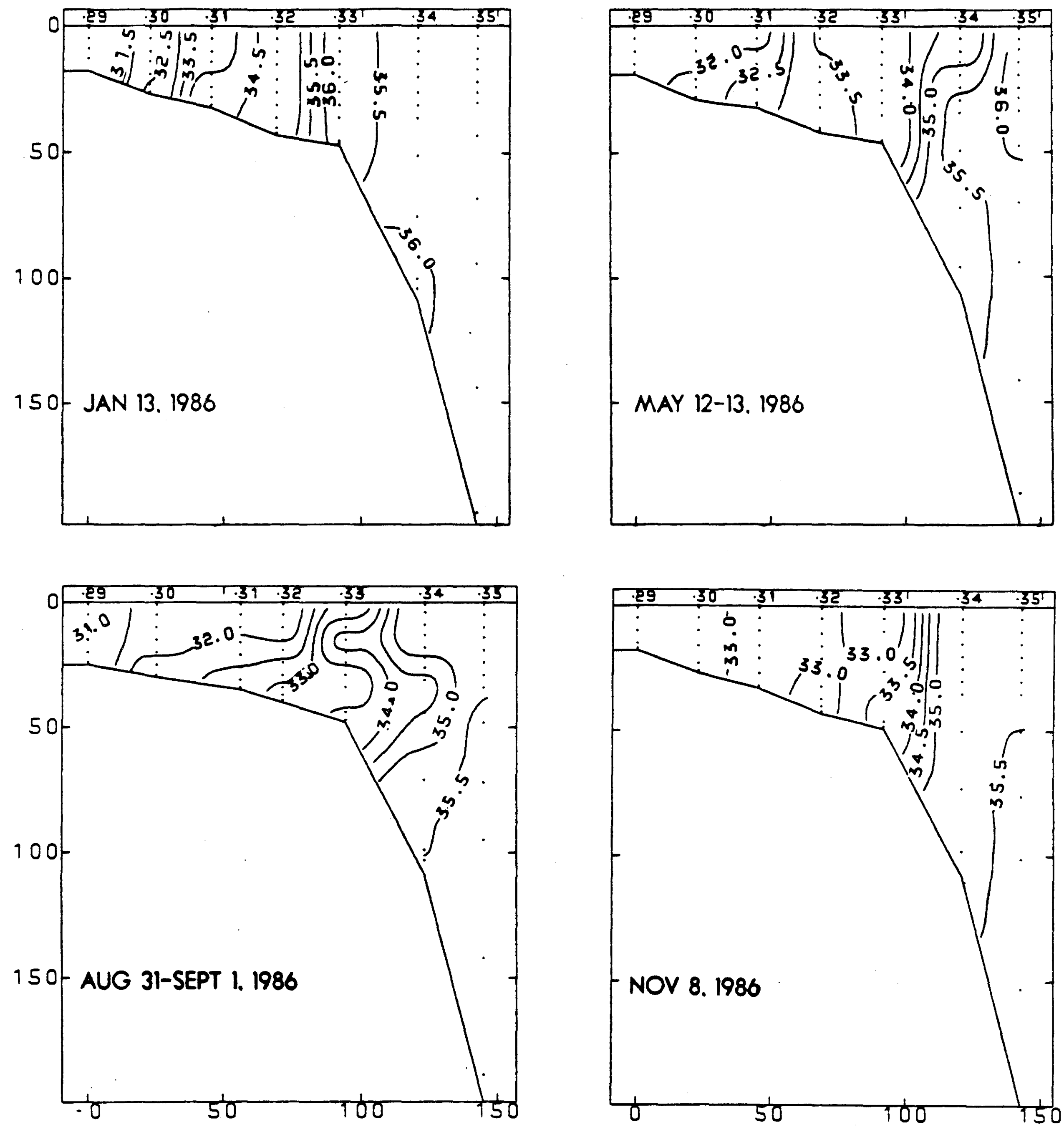


Figure 23. Salinity (PSU) transect southeast of Delaware Bay including stations 29 to 35. Contour intervals are 0.5 PSU.

SECTION C SALINITY

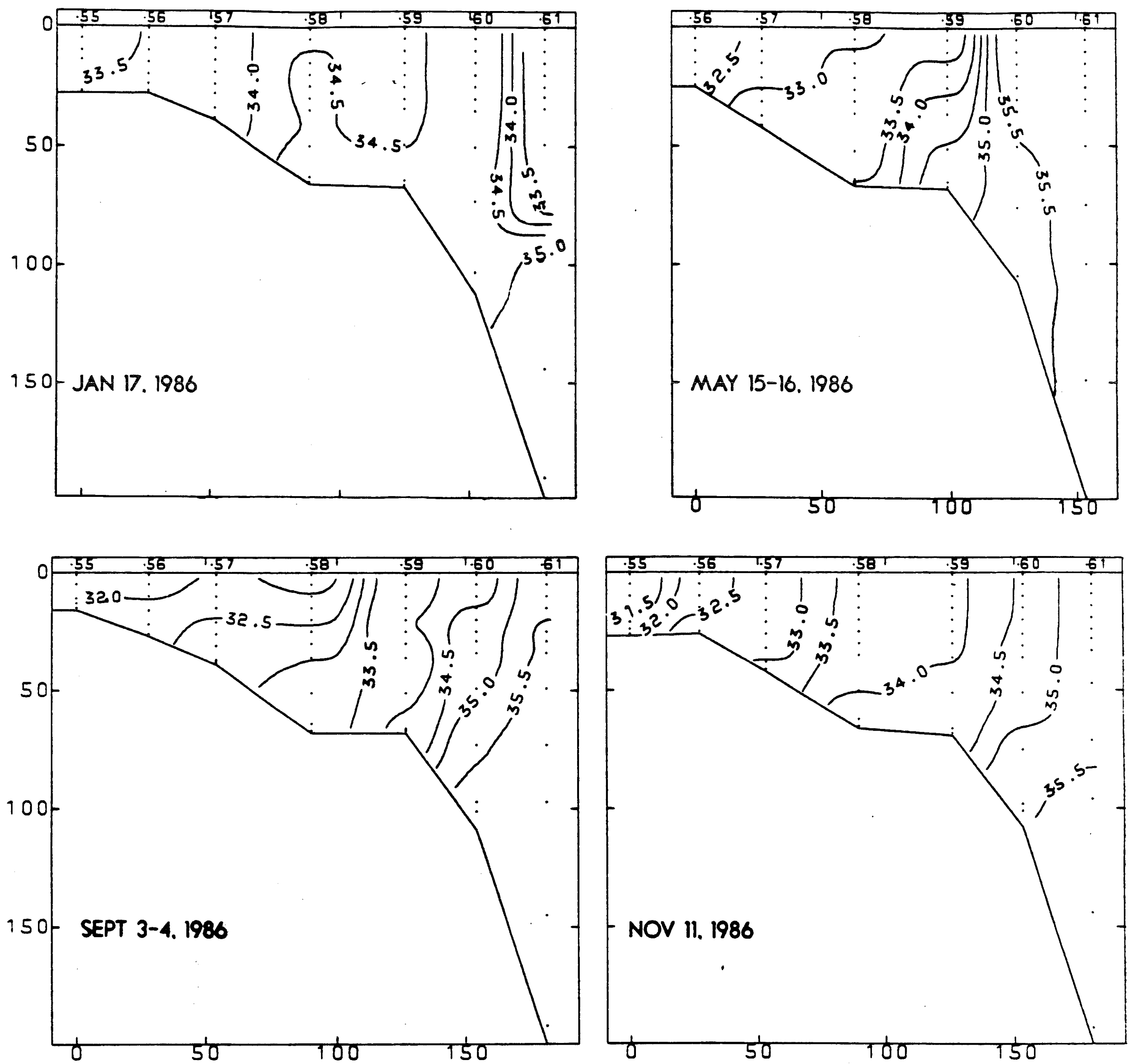


Figure 24. Salinity (PSU) transect southeast of Hudson-Raritan Estuary including stations 55 to 61. Contour intervals are 0.5 PSU.

SECTION D SALINITY

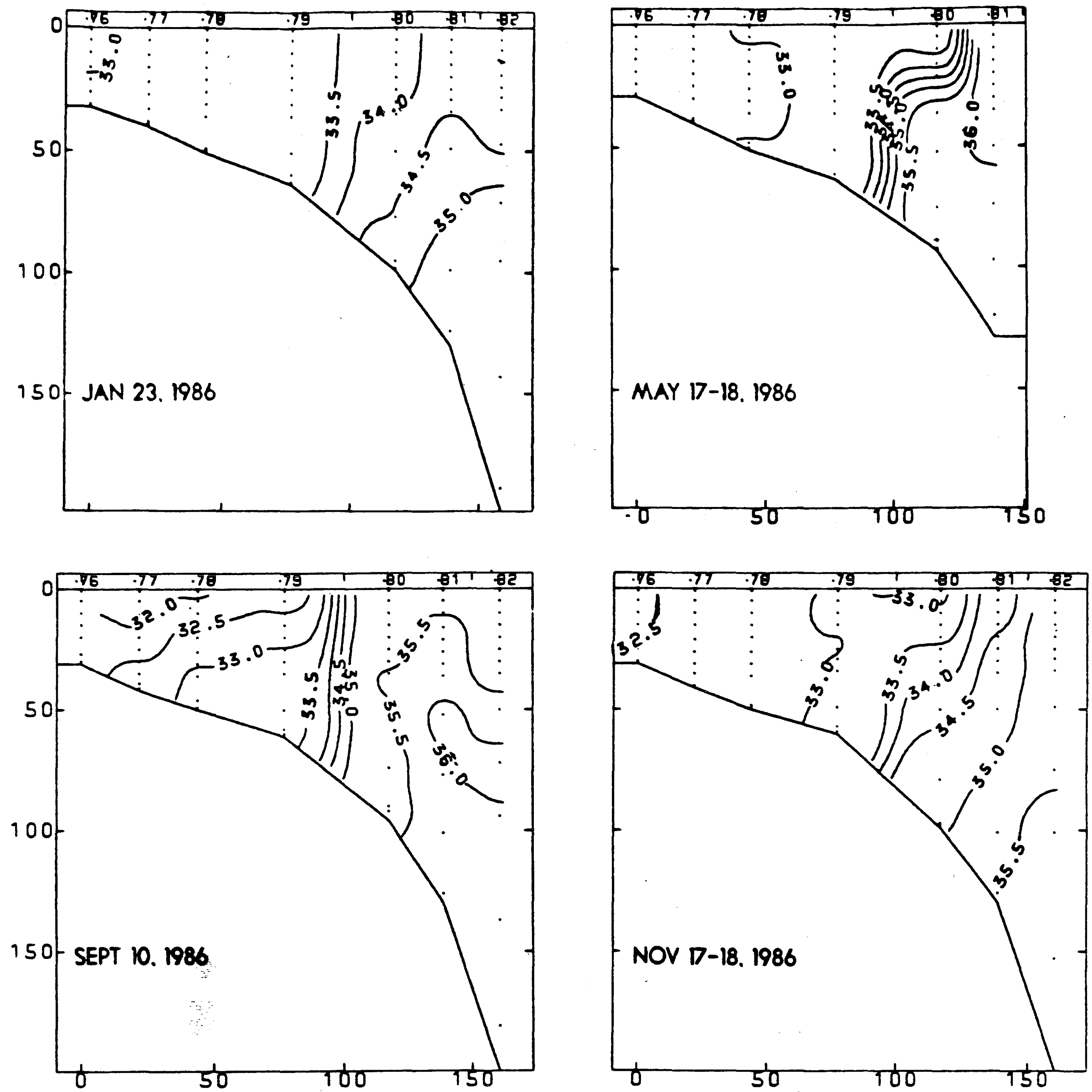


Figure 25. Salinity (PSU) transect southeast of Block Island including stations 76 to 82. Contour intervals are 0.5 PSU.

SECTION E SALINITY

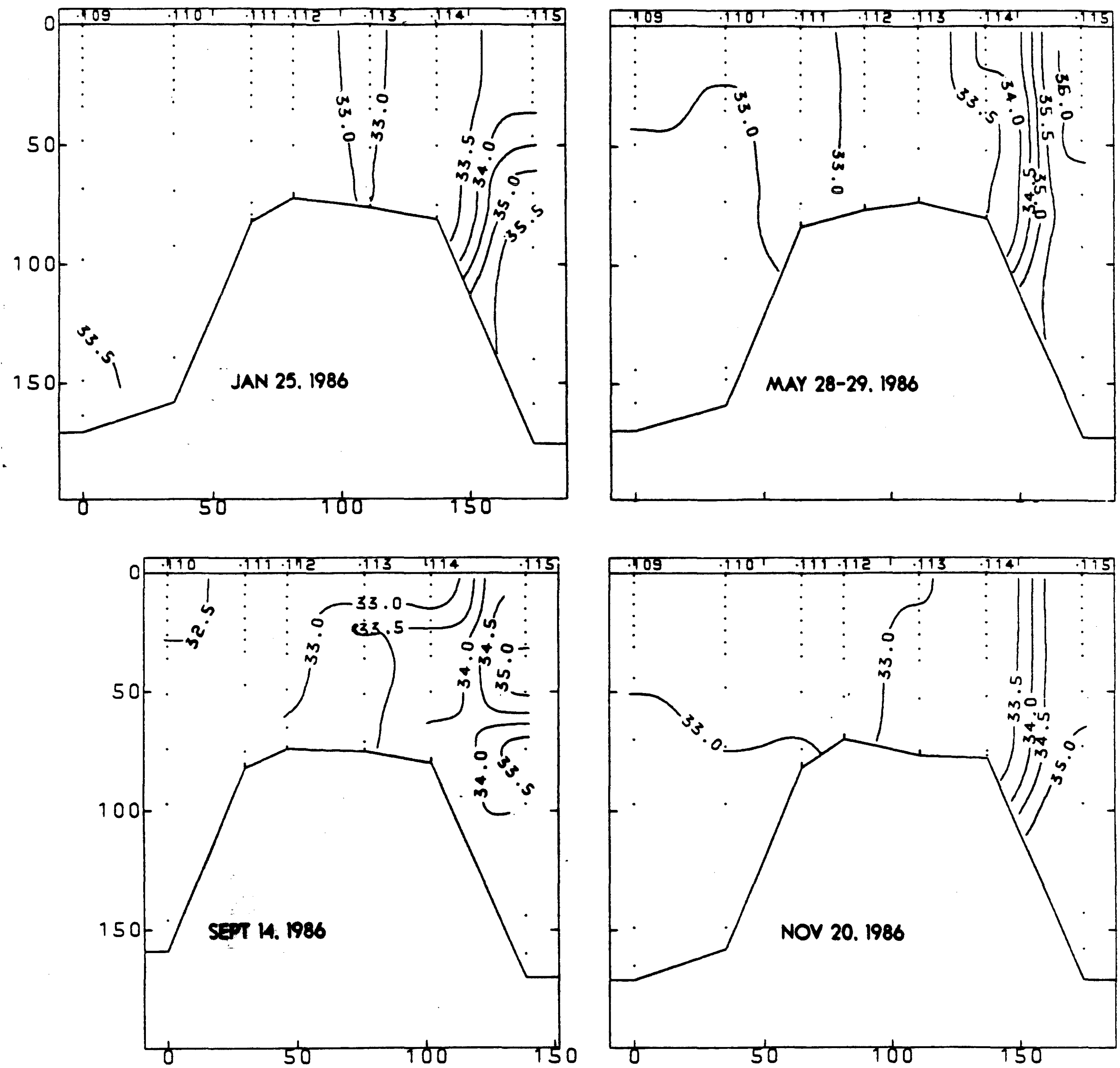


Figure 26. Salinity (PSU) transect north-south along the axis of the Great South Channel including stations 109 to 115. Contour intervals are 0.5 PSU.

SECTION F SALINITY

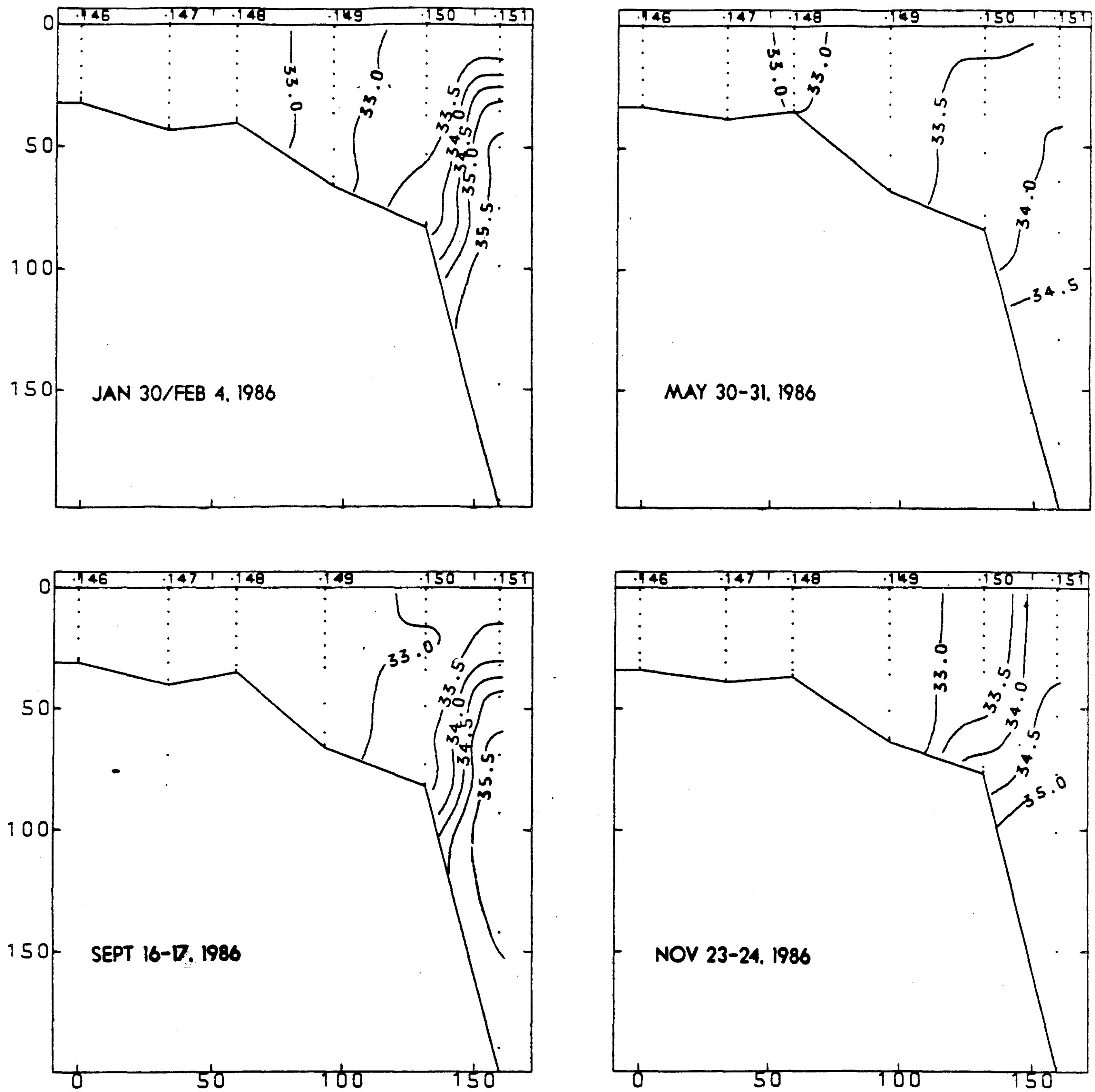


Figure 27. Salinity (PSU) transect north-south over the central portion of Georges Bank including stations 146 to 151. Contour intervals are 0.5 PSU.

SECTION G SALINITY

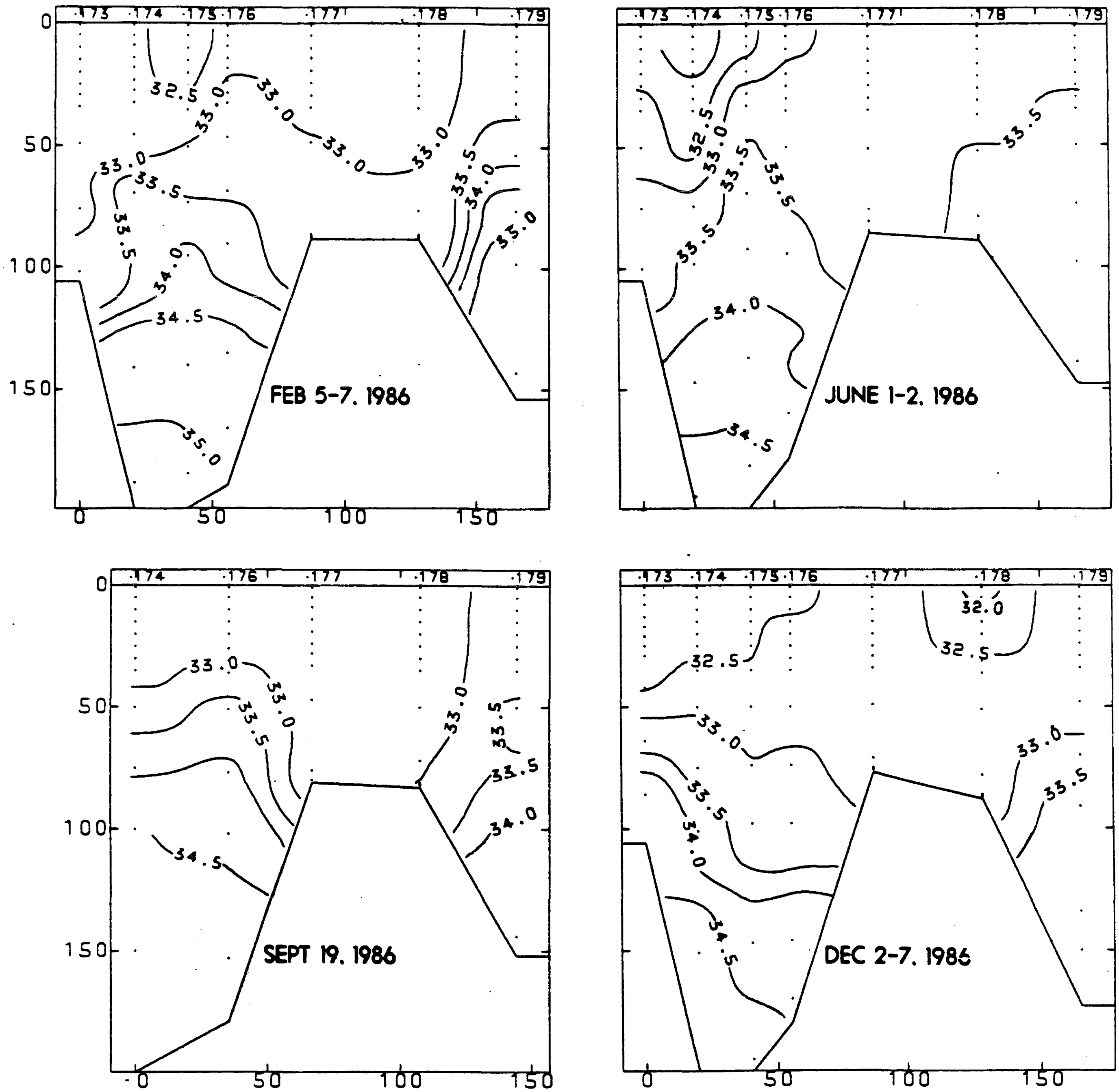


Figure 28. Salinity (PSU) transect north-south over the eastern edge of Georges Bank including stations 173 to 179. Contour intervals are 0.5 PSU.

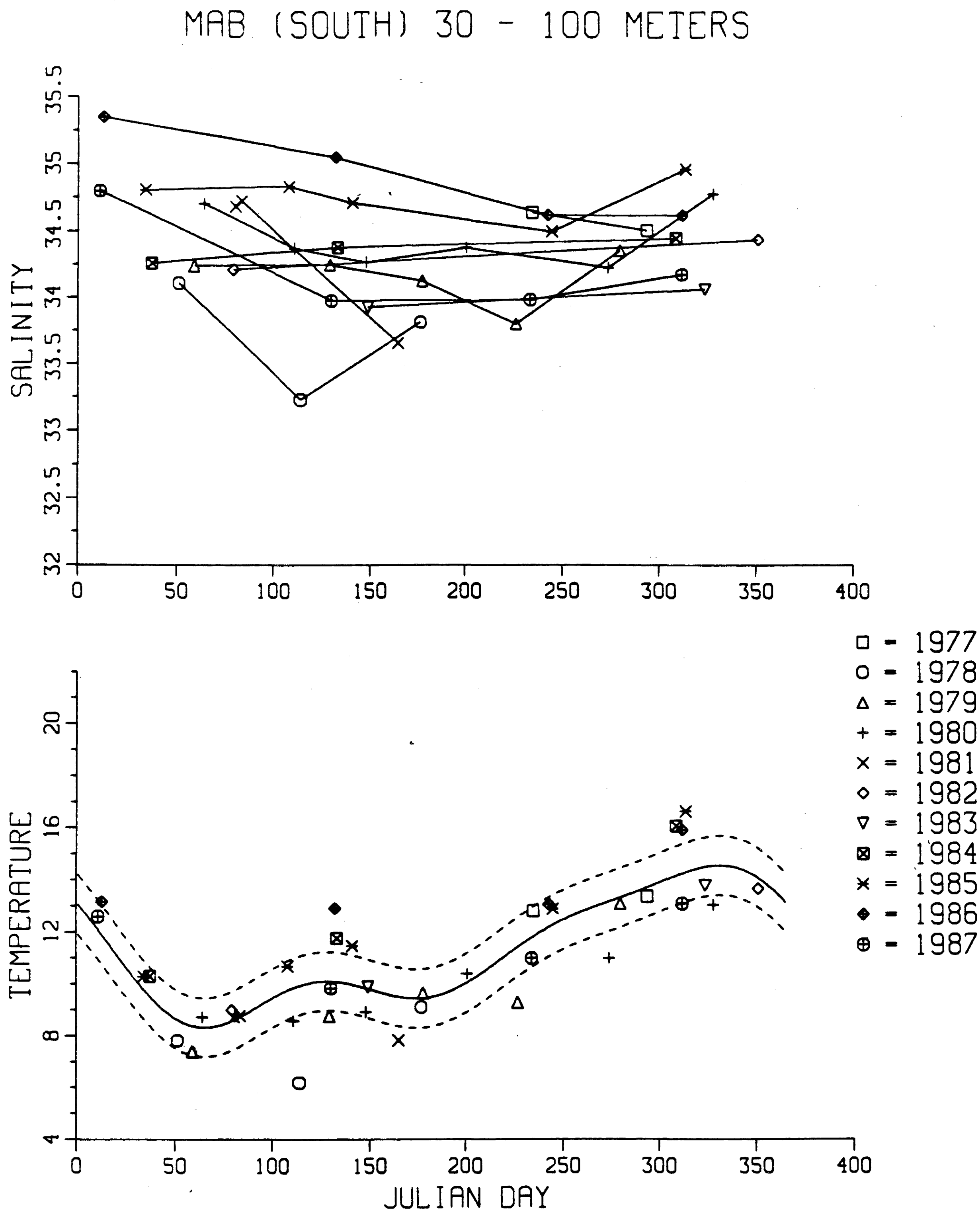


Figure 29. Mean values of temperature and salinity for the subsurface layer (30 to 100 m) in the southern sector of the Middle Atlantic Bight (1977 to 1987). The bold and dashed lines in the lower panel represent the mean and standard deviation of temperature as obtained by Mountain and Holzwarth (1988).

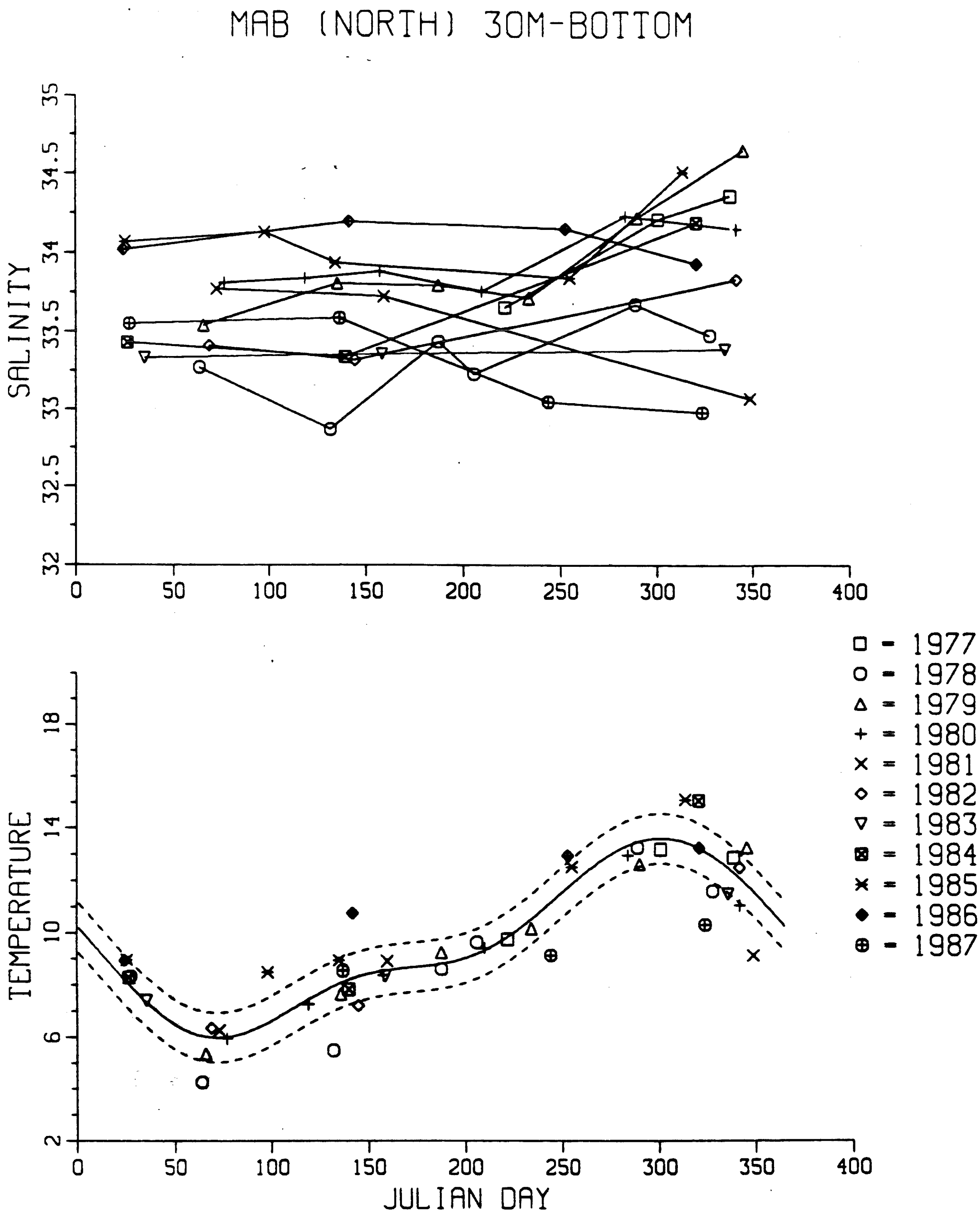


Figure 30. Mean values of temperature and salinity for the subsurface layer (30 to 100 m) in the northern sector of the Middle Atlantic Bight.

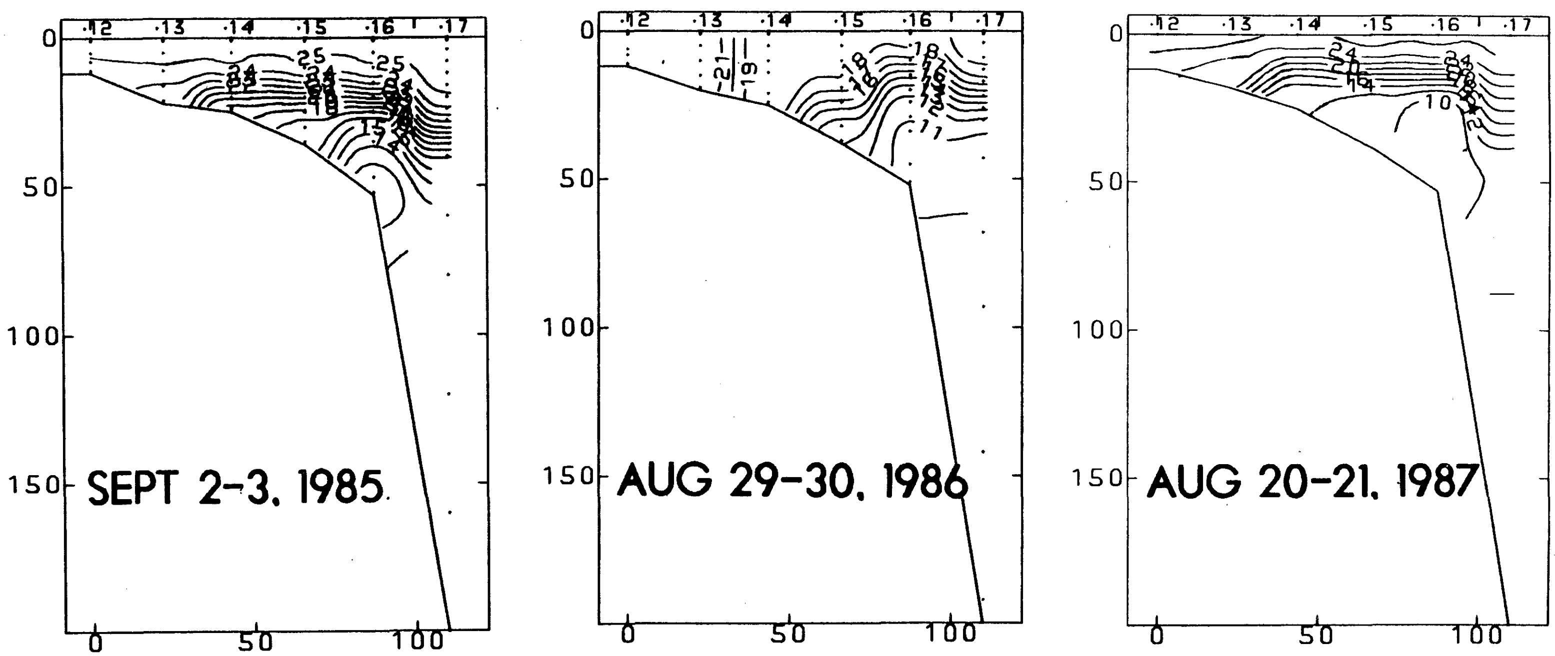


Figure 31. Early fall temperature (oC) profiles east of Chesapeake Bay. Contour intervals are 1°, 1°, and 2°C for 1985, 1986, and 1987 respectively.