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Water Column Thermal Structure Across the Shelf and Slope Southeast of Sandy Hook, New Jersey in 1987

by

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Abstract

Monitoring of shelf and upper slope water events in the New York Bight continued in 1987 for the twelfth year as part of the NEFC Ships of Opportunity Program (SOOP). Temperature-depth profiles were constructed from 17 expendable bathythermograph (XBT) transects extending from the entrance of New York Harbor through the 106-Mile Dump Site. From the XBT profiles, depictions of the water column temperature structure and of bottom temperatures through the year have been derived. During 1987, water temperatures on the shelf and upper slope followed the normal annual cycle, but bottom temperatures at mid-shelf were about 2°C cooler than normal during summer and about 4°C cooler than normal during fall overturn. As in 1985 and 1986, bottom temperatures on the upper slope continued to be warmer than normal. Abrupt changes in bottom temperature on the outer shelf and upper slope were associated with the passage of one warm core ring in February through May.

Introduction

Monitoring of water temperatures across the continental shelf and upper slope in the New York Bight continued in 1987 for the twelfth year. Temperature-depth profiles were constructed from 17 expendable bathythermograph (XBT) transects extending from the entrance of New York Harbor through the 106-mile Dumpsite (Fig. 1). Information about the XBT cruises conducted and the oceanic features monitored in the New York Bight is presented in Table 1.

Methods

A "station-through-time" diagram (Fig. 2) and a bottom temperature diagram (Fig. 3) depict the major oceanographic/climatological events occurring in this portion of the New York Bight in 1987. The "station-through-time" diagram was constructed by plotting the temperatures in the water column above the 65-m isobath from each cruise at the date of the cruise and contouring the temperatures, at 1°C intervals, through time for the year. The 65-m isobath was selected for its mid-shelf location, a position in the cold pool not influenced by the Hudson Canyon. The bottom temperature diagram was constructed following the method of Chamberlin (1977), by deriving bottom water temperatures from each contoured section, plotting the temperatures against depth and date, and contouring at 1°C intervals. To complete the bottom temperature diagram to shore, the record of daily observations of water temperature was acquired from the NOAA Data Bouy Center of sea surface temperature at Ambrose Tower, New York Harbor.

Two distinct water masses, shelf water and slope water, reside in the New York Bight. A thermal transition zone, the shelf/slope front (SSF) separates the inshore shelf water from the offshore slope water and is visible at the surface on satellite imagery for most of the year. The surface position of the SSF usually is over the 200-m isobath; while the bottom indicator, the intersection of the 10°C isotherm with the bottom, occurs between 80-120 m depths (Wright, 1976). Based on the analyses of Gulf Stream warm core rings in 1987 by Barton and Sano (MS 1988), two rings were present along this transect during the year. In comparison, for the years 1977-1983 and in 1985-1986 an average of four rings were present each year with a maximum of five in 1982 and minimum of three in 1978, 1981 and 1986. The year 1984 was unusual in that no warm core rings migrated far enough to the south and west to enter the transect envelope (Fig. 1).

Shelf Water Events

In 1987, sea surface temperatures nearshore (top of Fig. 3) ranged from a minimum of about 2.9°C in late February to a maximum of over 23°C in mid-August. Sea surface temperatures at mid-shelf ranged from less than 5°C in mid-March to greater than 24°C in mid-August (Fig. 2), reflecting the normal timing lag and temperature increase from nearshore to offshore.

Thermocline development began in early April, as usual, and reached maximum intensity of about 1°C per meter of depth through the thermocline in mid-August. Deepening of the thermocline took place through the summer until

fall overturn was completed in early November.

Bottom Temperature Events

In 1987 cold pool water (water < 10°C) lasted on the bottom until early November, which is more than a month later than usual (Fig. 3). The extent of water on the bottom cooler than 5°C (a subjective way of estimating winter intensity) was much greater than normal as compared to previous years. In 1987 5°C water lasted on the bottom until mid-April, which is typical, but its extent to about 70m bottom depth was greater than normal.

With fall overturn, temperatures on the bottom were generally less than 11°C in November over most of mid- to outer shelf depths (50 - 100 m). The November bottom temperatures were about 4°C colder than normal, compared with the compilations by Cook (1985) and temperatures encountered in 1984-1986. On the upper slope, at depths of 100 m to 200 m, water temperatures exceeding 12°C persisted throughout the year, except from mid-March through April. Since 1977, water warmer than 12°C has remained on the upper slope for the entire year only twice, in 1985 and 1986.

With the passage of two warm core rings through the slope water along the transect line in 1987, only ring 86-I seemed to come close enough to the shelf and upper slope to have any distinct effects on bottom temperatures (Fig. 3). With ring 86-I, bottom temperatures on the upper slope at depths of about 200m and greater first increased about 2°C during February and early March, and then decreased by about 3°C in April. In May, bottom temperatures increased to about 13°C at depths of 80-100m on the outer shelf with the ring's passage.

Summary

In 1987, cold pool temperatures on the bottom at mid-shelf during summer were cooler than observed in 1986 and were about 2°C cooler than normal. At mid- to outer- shelf depths, bottom temperatures during fall overturn were about 4°C colder than normal. For the third consecutive year, bottom temperatures along the upper slope remained above 12°C for all, or most, of the entire year, which seems to continue a pattern of warming of bottom temperatures on the upper slope for the period since 1977. Distinct changes in bottom temperatures on the outer shelf and upper slope accompanied the passage of one warm core ring (86-I) during February through May.

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Table 1. Water Column Thermal Structure in 1987

Vessel	Cruise No.	Date	Depth range of the cold pool Minimum/Maximum depth (m)	Bottom depth (m) of 10°C isotherm SSF indicator	Rings present along transect
Oleander	87-01	Jan 09	Isothermal	62	
Oleander	87-02	Feb 06-07	Isothermal	107	
Oleander	87-03	Mar 06-07	Isothermal	116	86-I
Oleander	87-04	Apr 10-11	Transitional	85	86-I
Oleander	87-05	May 08-09	Transitional	69	86-I
Oleander	87-06	May 13-14	Transitional	85	86-I
Oleander	87-07	Jun 05-07	28-70	70	
Oleander	87-08-09	Jul 09-15	32-76	76	87-E
Oleander	87-11	Aug 19	31-85	85	87-E
Oleander	87-12	Sep 04	34-72	72	87-E
Oleander	87-13	Oct 02-03	42-80	80	
Oleander	87-14	Oct 23	55-85	85	
Oleander	87-15	Oct 28-29	65-105	105	
Oleander	87-16	Nov 13-14	Isothermal	-	
Oleander	87-17	Dec 05	Isothermal	-	
Oleander	87-18	Dec 09	Isothermal	66	

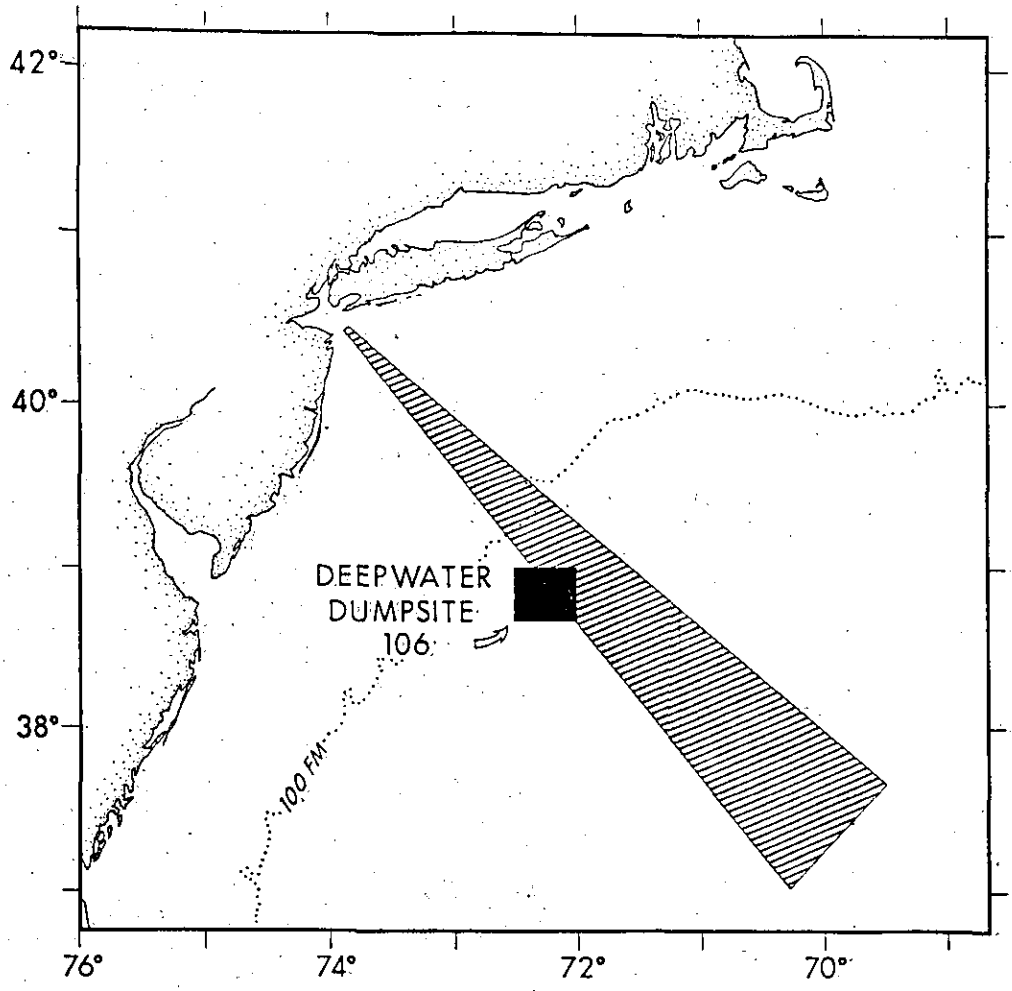

Figure 1. Envelope of 1987 transects in the New York Bight from the entance of New York Harbor to beyond the 106 Dumpsite.

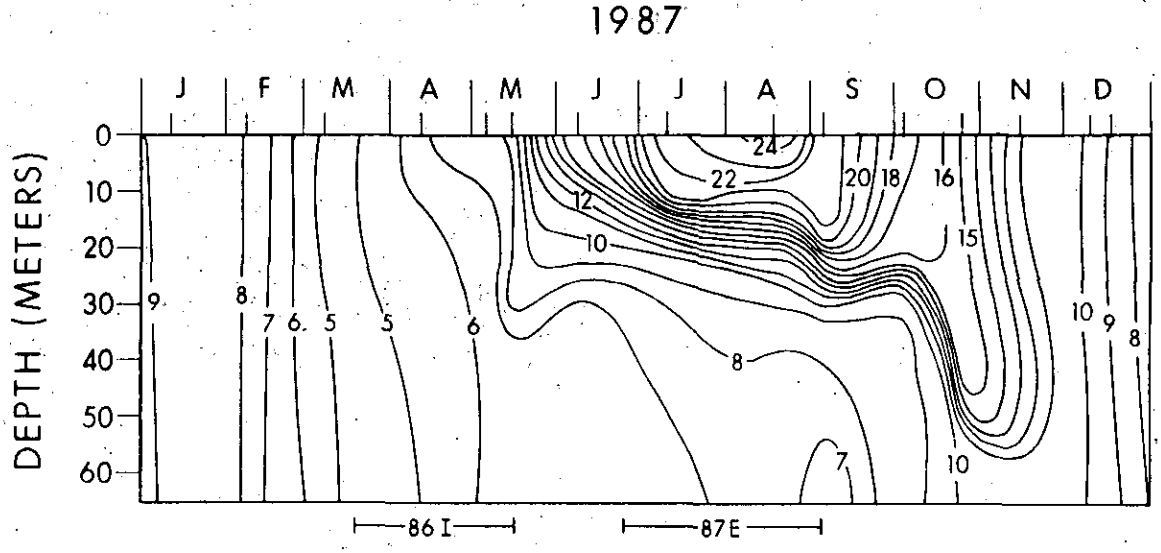

Figure 2. Station through time depicting seasonal water column temperatures at 65 m. Lines at the bottom of the diagram indicate the duration of Gulf Stream warm core rings in the New York Bight area.

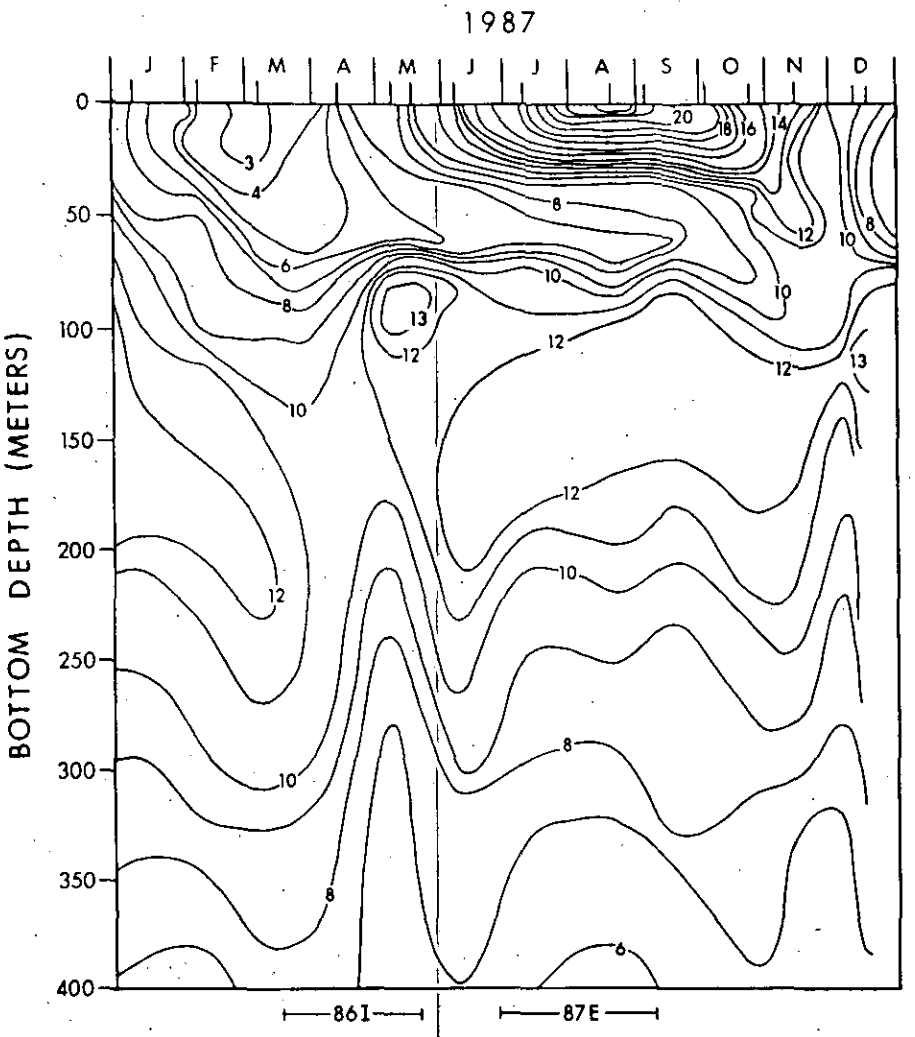

Figure 3. Bottom temperature diagram of the continental shelf and slope waters from New York harbor to the 106 Dumpsite. Lines at the bottom of the diagram indicate the duration of Gulf Stream warm core rings in the New York Bight area.