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# Bottom Temperatures on the Continental Shelf and Slope South of New England During 1979

by

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Contoured vertical temperature sections were constructed from 22 expendable bathythermograph transects made across the shelf and upper continental slope south of New England along or near 71°00'W longitude during 1979 (Table 1, Fig. 1). Five representative sections are presented (Figs. 3-6). From these sections, a contoured diagram of bottom temperatures has been derived by plotting the bottom intersects of isotherms against depth and time (Fig. 2). Estimated times of passage of warm core Gulf Stream eddies, which pass through the slope water south of New England in a generally southwestward direction, are indicated by duration lines at the bottom of this figure, on the basis of eddy analysis by Fitzgerald and Chamberlin (this volume). Each line starts when an eddy first intersects a section line, and ends when the eddy has passed south of 39°31'N latitude.

The seasonal and transient variability of shelf and slope water bottom temperatures during 1979 are described in this report. Comparisons are made with data collected from along the same transect since 1974.

The shelf water south of New England extends from shore to a transition zone, the shelf/slope water front, which is visible at the surface during most of the year in satellite thermal infrared imagery. At the bottom, the front is identified by the 10°C isotherm, except during fall when shelf water at the bottom warms to its annual maximum (>10°C) and becomes thermetrically indistinct from slope water. Shelf water, however, can always be identified by salinities less than 35.0 $^{0}/_{00}$. From long-term historical data, Wright (1976) determined that the front usually intersects bottom at depths between 80 and 120 m, and slants seaward to the surface.

A band of warm slope water rests on the bottom beneath the shelf/slope water front and above the colder deep slope water. Mid depth of the warm band averages about 150 m. The presence of warm core eddies in the slope water region is usually evidenced by positive anomalies on the bottom in the depth range of the warm slope water, and sometimes penetrating shoreward to the shallower bottom ordinarily occupied by shelf water.

Shelf Water Events

The pattern of shelf water cooling was apparent in January as progressively cooler temperatures extended from shore to beyond 100 m bottom depth (Fig. 2). Water warmer than 13°C, between 80 and 160 m, in early January, is residual from the 1978 fall overturn. Cooling was most rapid during mid-January and continued to late February when the minimum bottom temperatures for the year were observed, and water less than 2°C extended to 80 m and less than 11°C to 150 m (Fig. 3).

The observed shelf water temperature minimums closely followed a period of remarkably cold atmospheric weather conditions. Average air temperatures at Providence, Rhode Island were 10.6°C below the 40 year mean during the middle two weeks of February.

At bottom depths less than 80 m, the low minimum temperatures observed in February 1979 were similar to those observed during the same month in 1977 and 1978, when below normal cold weather was also recorded. However, the minimums in 1979 were about 2°C cooler than observed at similar depths in the years 1974-1976 when the winters were moderate.

At bottom depths of 80-150 m, annual minimum temperatures as low as in 1979 (in February) were previously observed only in 1977, when the minimum was also in February. In the other years since 1974, the annual minimum bottom temperatures in this depth range occurred in April, rather than in February, but these minimums were from 2°-4°C warmer than the 1979 minimum.

The shelf/slope water front shifted abruptly shoreward during late February and early March, and became established in the vicinity of the 100 m isobath until mid-summer. In the earlier years, bottom temperatures have tended to decrease between 100-150 m as the shelf/slope front migrated toward a maximum offshore extension in April. Because the front shifted shoreward after February 1979, bottom temperatures between 100-140 m during March and

April ranged from 1°-4°C above the average of the previous five years for those months.

Shoreward of the shelf/slope water front, bottom temperatures warmed gradually during March and April. Water colder than 4°C was not observed after early May. In late April, bottom temperatures at less than 50 m began to rise as seasonal warming at the surface mixed downward. Establishment of the seasonal thermocline by early May (Fig. 4), however, markedly insulated the bottom water from subsequent rapid seasonal warming at the surface. In consequence, the nearly isothermal cold core at the bottom continued to warm slowly through the summer and early fall, at an average rate of <1°C per month, whereas the surface warmed about 4°C per month through August.

Annual maximum bottom temperatures occurred from late October to November as a result of downward mixing of the warm surface layer, as fall cooling progressed. Breakdown of the vertical temperature gradient (fall overturn) began inshore in October and extended offshore through November (Fig. 5). Warming to greater than 14°C on the bottom at depths of 30-80 m, however, probably resulted partly from penetration of slope water onto the shelf, perhaps through the influence of eddy 79-E (Fig. 2). Influence of this eddy on the shelf was evident also at and near the surface, where temperatures rose to as high as 17°C by mid-November (Fig. 6), after having fallen below 15°C in late October. As in the previous years, the shelf water became thermally indistinct from slope water when bottom temperatures on the shelf rose to 12°C.

The timing of maximum bottom temperatures in 1979 was similar to that observed in 1978, but later than in the years 1974-1977. Maximum bottom temperatures as high as 15°C were observed in all the previous years of observation, following the fall overturn, and were exceeded only in 1977 when a 17°C was recorded at mid-shelf while an eddy was present south of New England (Crist and Chamberlin 1979).

Slope Water Events

In 1979, bottom temperatures in the warm slope water band ranged from

greater than 13°C in early January to about 11.5°C in late February following a period of record cold weather. During most of the year, water warmer than 12°C was observed on the bottom at depths between 100-180 m, and the maximums recorded in this depth range did not go as low as 11°C.

During the past six years the maximum bottom temperature in the area of warm slope water was lowest in February 1977 (9.5°C) and highest (17°C) in February 1975 when a warm core eddy was passing south of the transect. Following the cold winters of 1977 and 1978 maximum bottom temperatures in the warm slope water band were observed below 11°C for most of the spring. Maximum bottom temperatures in the warm band were not observed below 12°C, throughout 1976.

Four warm core Gulf Stream eddies passed south of New England in 1979 (Fig. 2). The passage of each eddy coincided with greater than 12°C temperatures extending to depths greater than 170 m, as well as a shoreward deformation of the shelf/slope front at the bottom. The pattern of the eddy warming influence is similar to that observed in previous years.

At bottom depths between 200-400 m, temperatures during 1979 were generally similar in 1979 to those recorded in 1977, but about 1°C warmer than those recorded in 1978.

References

Crist, R. W. and Chamberlin, J. L. (1979). Bottom temperatures on the continental shelf and slope south of New England during 1977. Annal. Biol. Copenh. 34:21-27.

Fitzgerald, J. L. and Chamberlin, J. L. (this volume). Anticyclonic warm cove Gulf Stream eddies off the northeastern United States during 1979. Annal. Biol. this volume.

Wright, W. R. (1976). The limits of shelf water south of Cape Cod, 1941 to 1972. J. Mar. Res. 34:1-14.

Table 1. Temperature sections obtained south of New England in 1979.

| Section Number | Date | Vessel and Cruise Number | Inshore Coordinates | Offshore Coordinates |
|---|---|---|---|---|
| 1 | 14 Jan | CGC "Unimak" 7901 | 41°10'N, 71°00'W | 39°50'N, 71°00'W |
| 2 | 23 Jan | RV "Oceanus" OC-53 | 40°44'N, 71°00'W | 39°47'N, 71°01'W |
| 3 | 21 Feb | RV "Mt Mitchell" 7902 | 40°57'N, 71°00'W | 40°00'N, 70°59'W |
| 4 | 25 Feb* | RV "Oceanus" OC-55 | 41°13'N, 71°00'W | 39°43'N, 71°00'W |
| 5 | 8 Mar | RV "Delaware II" 7903 | 41°09'N, 71°15'W | 40°10'N, 70°49'W |
| 6 | 16 Apr | RV "Delaware II" 7904 | 41°16'N, 71°01'W | 39°50'N, 71°00'W |
| 7 | 1 May* | RV "Endeavor" EN-36 | 41°10'N, 71°00'W | 39°50'N, 71°17'W |
| 8 | 17 May | RV "Delaware II" 7905 | 41°20'N, 71°21'W | 39°59'N, 70°40'W |
| 9 | 23 May | RV "Endeavor" EN-37 | 41°10"N, 71°00'W | 40°00'N, 71°00'W |
| 10 | 5 Jun | RV "Endeavor" EN-38 | 41°10'N, 71°00'W | 39°49'N, 71°00'W |
| 11 | 1 Jul | RV "Endeavor" EN-38 | 41°10'N, 71°00'W | 39°50'N, 71°00'W |
| 12 | 8 Jul | RV "Endeavor" EN-39 | 41°10'N, 71°00'W | 39°50'N, 71°00'W |
| 13 | 26 Jul | RV "Endeavor" EN-40 | 41°10'N, 71°00'W | 39°50'N, 71°00'W |
| 14 | 7 Aug | RV "Albatross IV" 7908 | 41°22'N, 71°12'W | 40°56'N, 71°09'W |
| 15 | 19 Aug | RV "Endeavor" EN-41 | 41°10'N, 71°00'W | 39°49'N, 71°00'W |
| 16 | 21 Aug | RV "Belogorsk" 7901 | 41°20'N, 71°21'W | 40°11'N, 70°47'W |
| 17 | 20 Sep | RV "Oceanus" OC-70 | 41°11'N, 70°59'W | 39°50'N, 71°00'W |
| 18 | 10 Oct* | RV "Delaware II" 7910 | 41°11'N, 71°14'W | 40°04'N, 71°07'W |
| 19 | 17 Oct | RV "Albatross IV" 7911 | 41°20'N, 71°21'W | 39°59'N, 70°40'W |
| 20 | 23 Oct | RV "Endeavor" EN-43 | 41°10'N, 71°00'W | 39°50'N, 71°00'W |
| 21 | 13 Nov* | RV "Wieczno" 7903 | 41°09'N, 71°00'W | 39°57'N, 71°01'W |
| 22 | 10 Dec | RV "Albatross IV" 7913 | 41°09'W, 71°15'W | 39°59'N, 70°40'W |

* Figured in this report.

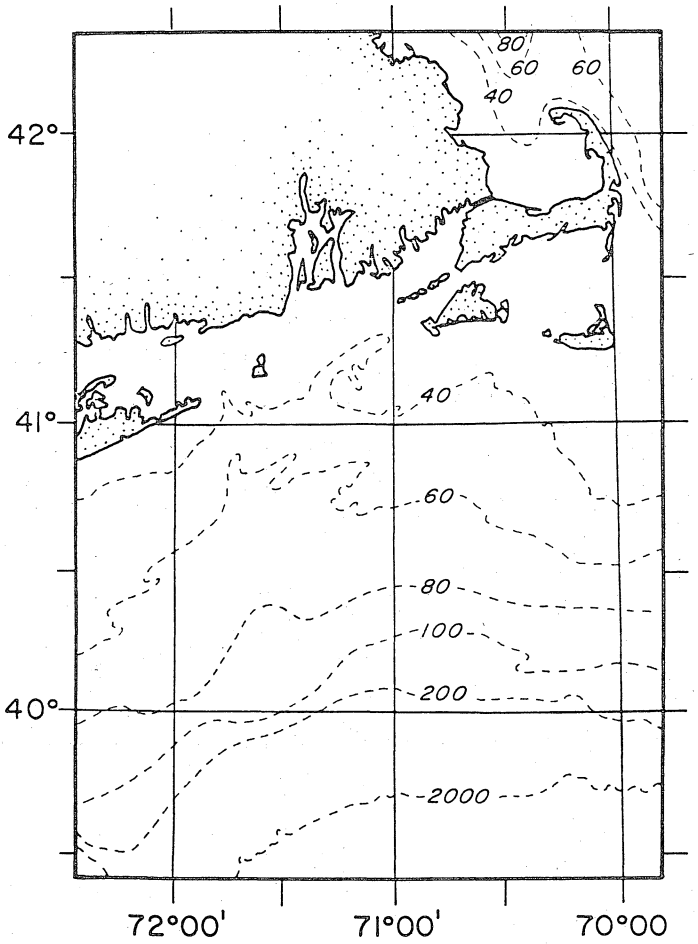


Figure 1. Area from which XBT transects are collected. Depth contours in meters. Cruise locations and dates are given in Table 1.

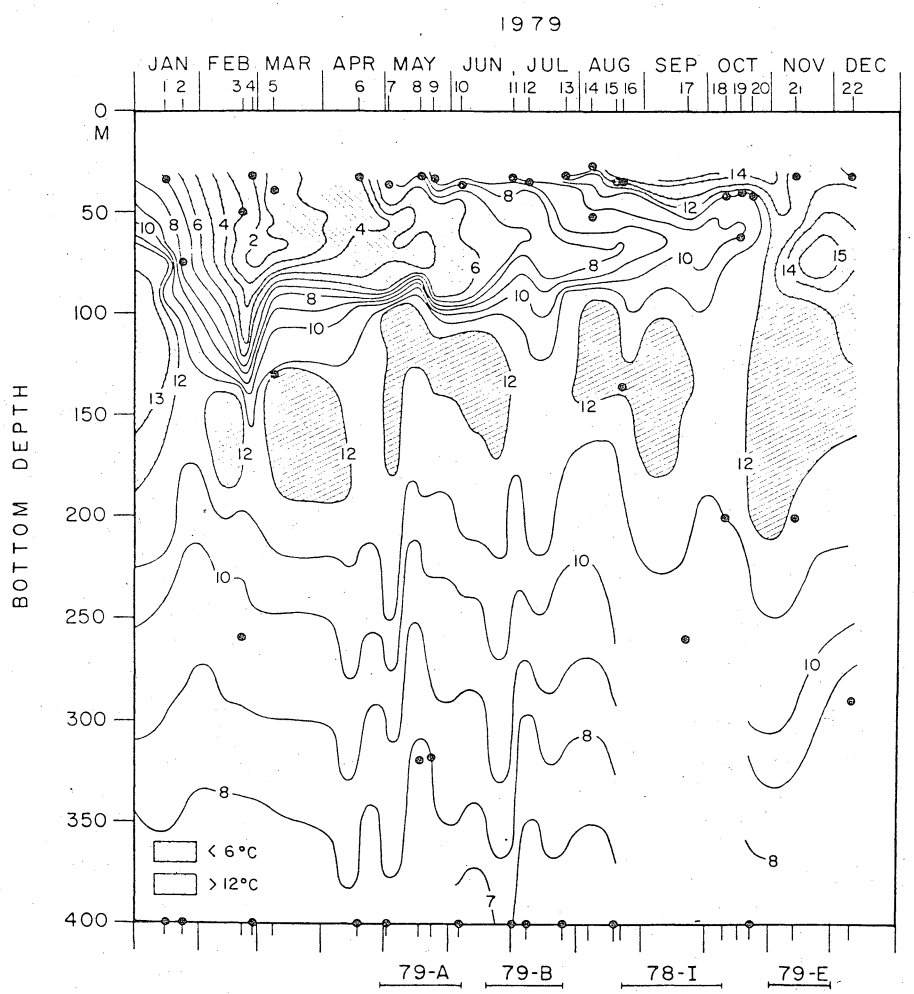


Figure 2. Bottom temperatures on the continental shelf and slope south of New England in 1979. Sections are numbered across the top (see Table 1). Dots indicate inshore and offshore bottom depth limits for each section. Horizontal lines at bottom of diagram show duration of warm core Gulf Stream eddy passages south of New England.

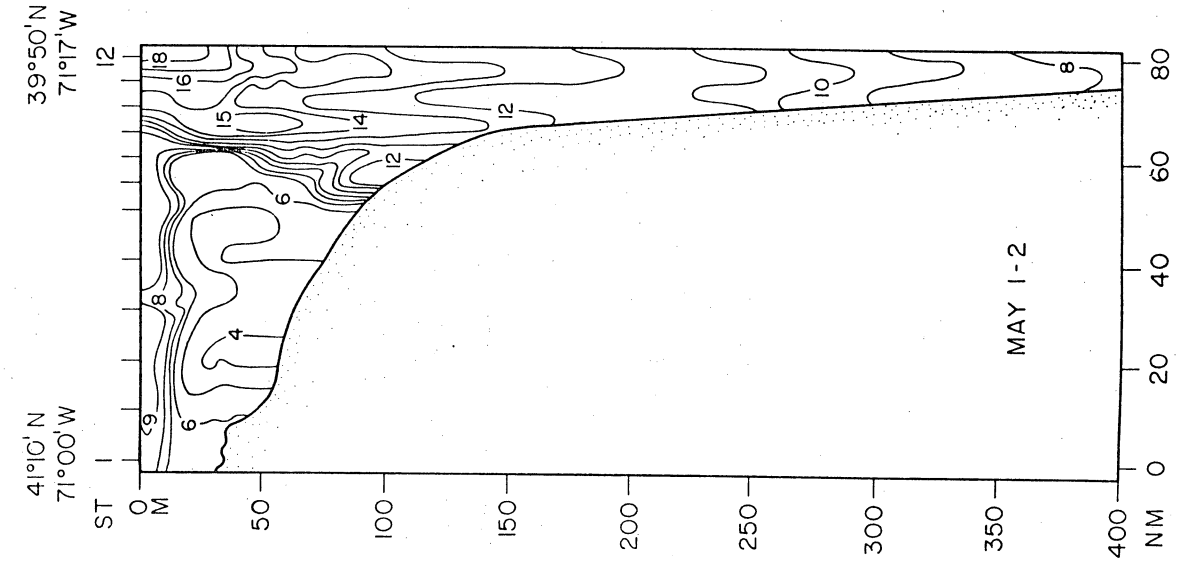


Figure 4. Vertical temperature section 7.

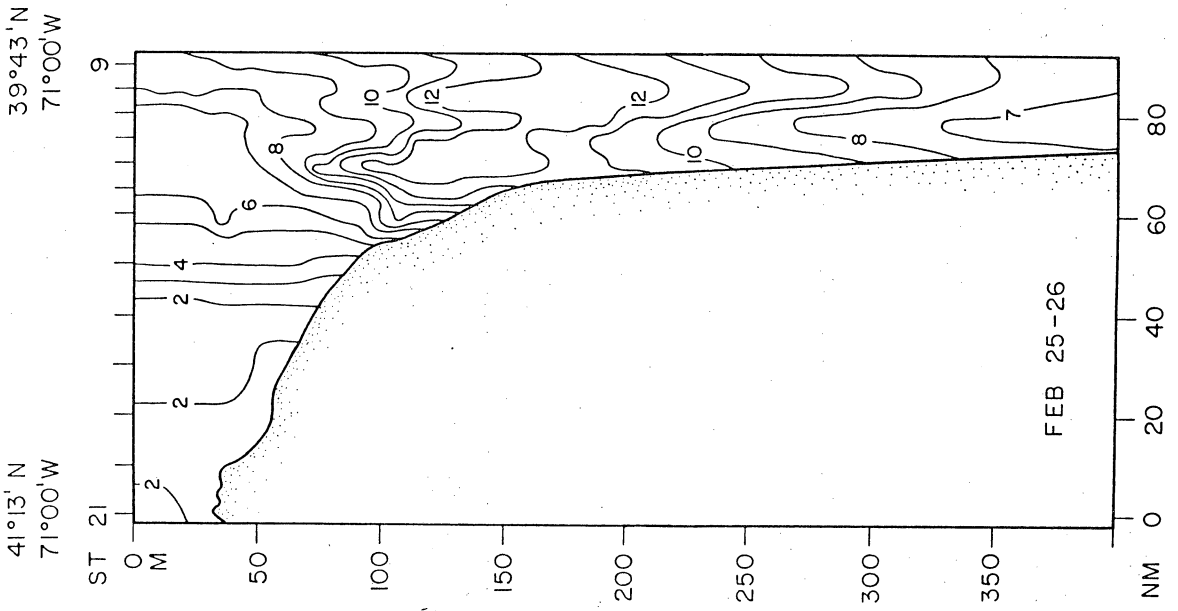


Figure 3. Vertical temperature section 4.

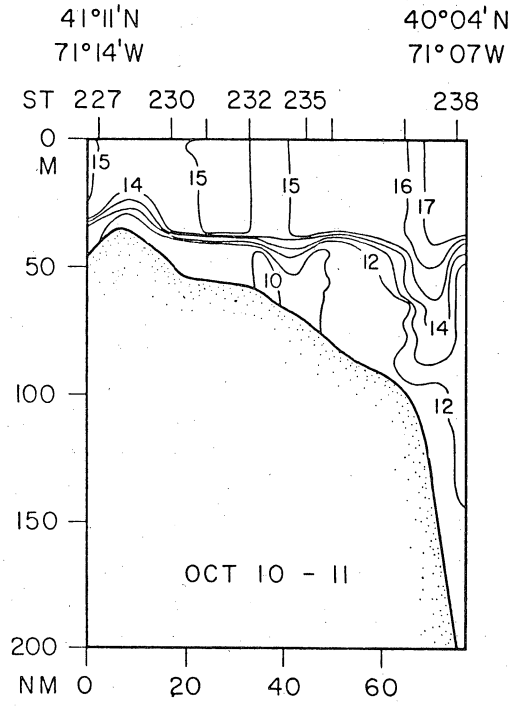


Figure 5. Vertical temperature section 18.

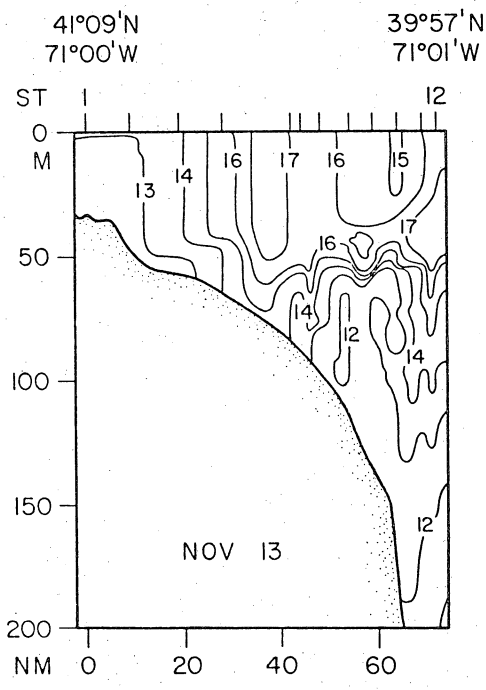


Figure 6. Vertical temperature section 21.