Northwest Atlantic Fisheries Organization

Serial No. N663

NAFO SCR Doc. 83/VI/15

SCIENTIFIC COUNCIL MEETING - JUNE 1983

# Bottom Temperatures on the Continental Shelf and Slope South of New England During 1982

by

R. Wylie Crist and Reed S. Armstrong

National Marine Fisheries Service, Atlantic Environmental Group
RR 7, South Ferry Road, Narragansett, Rhode Island 02882, USA

Annual summaries of bottom temperature have been prepared since 1974 from expendable bathythermograph (XBT) data collected along transects across the continental shelf and slope south of New England on or near 71°00'W Longitude (Fig. 1). This report summarizes the data collected during 1982, especially the seasonal and non-seasonal changes in bottom temperature, and compares it to data collected from the same area since 1974 and to bottom temperatures averaged for 1976-1981.

During 1982, 19 XBT transects were collected (Table 1). For each transect a contoured vertical temperature section was drawn. To construct the annual summary diagram of bottom temperatures (Fig. 2), the bottom temperatures recorded by the XBTs and intersects of isotherms with the bottom, determined from the contoured vertical sections, were plotted by depth and date, and contoured at 1°C intervals. To complete the bottom temperature diagram to shore, temperatures were determined for every tenth day through the year from the following two records: daily observations acquired from the NOAA National Ocean Survey of tide station temperature (0 m depth) at Newport, Rhode Island (41°30'N, 71°20'W); and, data collected from a recording thermograph placed on the bottom at Brenton Tower (20 m depth) in the mouth of Narragansett Bay (41°25'N, 71°25'W).

Passages of warm core Gulf Stream rings through slope water south of New England are noted as lines of duration along the bottom of Figure 2. Each duration line starts when the western edge of a ring crosses the transect line and ends when the ring's northern or northeastern edge passes south of 39°30'N. The ring durations are determined from AVHRR satellite imagery and from the ring analysis for 1982 by

Celone and Price (MS 1983).

Shelf water south of New England generally covers the bottom inshore of the 80-120 m isobath. At the surface near the 200-m isobath, a thermal gradient (front), separating the shelf water from the warmer offshore slope water, is usually visible in infrared satellite imagery except in the warmest part of the year. On the bottom, offshore and below shelf water and above cooler deep slope water, there is a slope water thermostad layer of relatively uniform, warm (10-12°C) water. The thermostad layer is present at depths ranging from about 100 to 200 m.

Shelf Water

During winter, vertically homogeneous shelf water progressively cools from nearshore to offshore along the bottom to beyond the 100 m isobath, accompanied by deepening of the shelf-slope front and intensification of the frontal gradient. Mid-winter shelf bottom temperatures typically range from near 0°C nearshore to 10°C at the shelf-slope front.

In 1982 the wintertime decline in shelf water temperatures and deepening of the shelf-slope front was interrupted by intrusions along the bottom of warmer waters of apparent offshore origin in late January and again in early April. The warm water intrusions coincided with the passage of warm core rings 81-F and 82-B. In late January, bottom temperatures between 60 and 85 m were from 1° to 5°C warmer than the average conditions recorded there since 1976. The onshore migration of warm water in April resulted in bottom temperatures about 2°C above the 1976-1981 average for the depth range of 40 to 80 m. Minimum temperatures across the shelf were similar to those reported in 1980 (Crist and Chamberlin, 1983), and in 1981 (Crist, MS 1982), cooling to 0°C at the coast in late January and to about 2.5°C at 40 to 80 m in late February and early March.

Thermal stratification was apparent in the water column by mid-April and bottom temperatures began rising over the inner shelf from vernal warming. Between the shelf-slope front and nearshore bottom water, the cold pool is found. From spring into autumn, the coolest water on the bottom across the shelf is found in the cold pool. From mid-April to mid-July 1982, nearshore waters along the bottom (0-20 m) increased 4° to 5°C per month as the thermocline deepened and intensified, whereas, in

the cold pool (60 m), bottom temperatures increased at a rate of 1° to 2°C per month.

During June and continuing into August, the shelf-slope front retreated shoreward along the bottom from a depth of about 120 m to near the 60-m isobath. As the retreating shelf water was replaced by slope water, bottom temperatures between 70 to 100 m increased from about 5°C to 13°C. During August, and associated with the shoreward retreat of the shelf-slope front, the cold pool diminished in size, and bottom temperatures were about 3°C above those observed there in the 1976-81 average. By late September, the cold pool had become re-established with temperatures near normal for that time of year (<10°C) returning.

As surface water began cooling and mixing downward during fall, bottom temperatures between 20 and 100 m increased to their annual maximum. At 20 m, the maximum bottom temperature for the year (18°C) occurred in mid-September and, at 100 m, the maximum of about 15°C occurred in late December. The warmest mid-shelf temperature recorded during the year was 15.6°C at about 70 m depth near the end of November, which is about typical, based on the 1974-1981 data. During the fall when shelf water along the bottom became warmer than 12°C, the thermal gradient separating shelf and slope water was indistinct.

Following the occurrence of the annual maximum bottom temperatures, typical pattern of cooling and mixing from mid-November through December produced vertically homogeneous shelf water which cooled rapidly from nearshore to offshore.

Slope Water

Maximum bottom temperatures in the upper slope water warm band between about 100 and 200 m were above 12°C for all of 1982, except during April when cooler conditions prevailed. Highest temperatures (>14°C) in the warm band developed from mid-January through February, during passage of warm core ring 81-F. Temperatures in excess 11°C were present in the upper slope water throughout the year, as is typical for the data since 1974.

Three warm core Gulf Stream rings passed through the slope water south of New England and close to the shelf in 1982 with a cumulative duration of about 3.5 months. A fourth ring, 82-D, moved past the area

during August but remained well offshore. Three or four rings have passed the transect every year since 1974, except in 1977, when seven rings were recorded with a cumulative duration of over six months.

Bottom temperatures in the deeper slope water (>200 m) were within the typical range during 1982, as compared to the 1974-1981 conditions, except during June. During June of 1982, the bottom temperature at 400 m was 8.5°C, which was about 2°C warmer than normal. Of the 1974-1981 data, only in 1976 have bottom temperatures in excess of 8°C been recorded at 400 m depth. Coincident with this June warming of bottom waters, a large surface lobe of shelf water extending offshore has been reported to have progressed past the area of this transect (Armstrong, MS 1983).

## References

ARMSTRONG, R. S. MS 1983. Variation in the shelf water front position in 1982 from Georges Bank to Cape Romain. NAFO SCR Doc. 83/VI/12, Ser. No. N660, 8 p.

CELONE, P. J., and C. A. PRICE. MS 1983. Anticyclonic warm-core Gulf Stream rings off the northeastern United States during 1982. NAFO SCR Doc. 83/VI/13, Ser. No. N661, 14 p.

CRIST, R. W. MS 1982. Bottom temperatures on the continental shelf and slope south of New England in 1981. NAFO SCR Doc. 82/VI/9, Ser. No. N497, 8 p.

CRIST, R. W., and J. F. CHAMBERLIN. 1983. Bottom temperatures on the continental shelf and slope south of New England in 1980. ICES Annales Biol., 37: 18-20.

Table 1. Temperature sections collected south of New England during 1982

| Section Number | Date | Vessel and Cruise Number | Coordinates Inshore | Coordinates Offshore |
|---|---|---|---|---|
| 1 | 6 Jan | RV "Oceanus" 82-01 | 41°10'N 71°00'W | 39°50'N 71°00'W |
| 2 | 27 Jan | RV "Endeavor" 82-01 | 41°10'N 71°25'W | 39°50'N 71°25'W |
| 3 | 8 Feb | RV "Oceanus" 82-02 | 41°10'N 70°58'W | 40°30'N 70°30'W |
| 4 | 10 Mar | RV "Albatross IV" 82-02 | 41°20'N 71°21'W | 39°59'N 70°40'W |
| 5 | 29 Mar | RV "Endeavor" 82-02 | 41°10'N 71°25'W | 39°50'N 71°26'W |
| 6 | 13 Apr | RV "Endeavor" 82-03 | 41°11'N 71°21'W | 39°50'N 71°21'W |
| 7 | 18 Apr | RV "Oceanus" 82-04 | 41°10'N 70°50'W | 40°50'N 70°32'W |
| 8 | 3 May | RV "Oceanus" 82-05 | 41°10'N 70°52'W | 39°56'N 70°49'W |
| 9 | 20 May | RV "Knorr" 82-01 | 41°05'N 71°01'W | 39°59'N 71°27'W |
| 10 | 15 Jun | RV "Oceanus" 82-06 | 41°09'N 71°00'W | 39°50'N 71°00'W |
| 11 | 1 Jul | RV "Oceanus" 82-07 | 41°10'N 70°58'W | 40°15'N 71°19'W |
| 12 | 25 Jul | RV "Endeavor" 82-04 | 41°00'N 71°00'W | 39°50'N 71°00'W |
| 13 | 7 Aug | RV "Oceanus" 82-08 | 41°10'N 71°00'W | 39°50'N 71°00'W |
| 14 | 23 Aug | RV "Oceanus" 82-09 | 41°10'N 71°00'W | 39°59'N 71°00'W |
| 15 | 12 Sep | RV "Delaware II" 82-11 | 40°59'N 71°18'W | 39°50'N 71°15'W |
| 16 | 5 Oct | RV "Albatross IV" 82-11 | 40°44'N 71°10'W | 40°05'W 70°58'W |
| 17 | 30 Oct | CGC "Vigilant" 82-02 | 41°11'N 70°59'W | 39°50'N 71°00'W |
| 18 | 29 Nov | RV "Endeavor" 82-05 | 41°10'N 71°00'W | 39°50'N 71°00'W |
| 19 | 9 Dec | CGC "Vigilant" 82-03 | 40°00'N 71°00'W | 39°50'N 71°01'W |

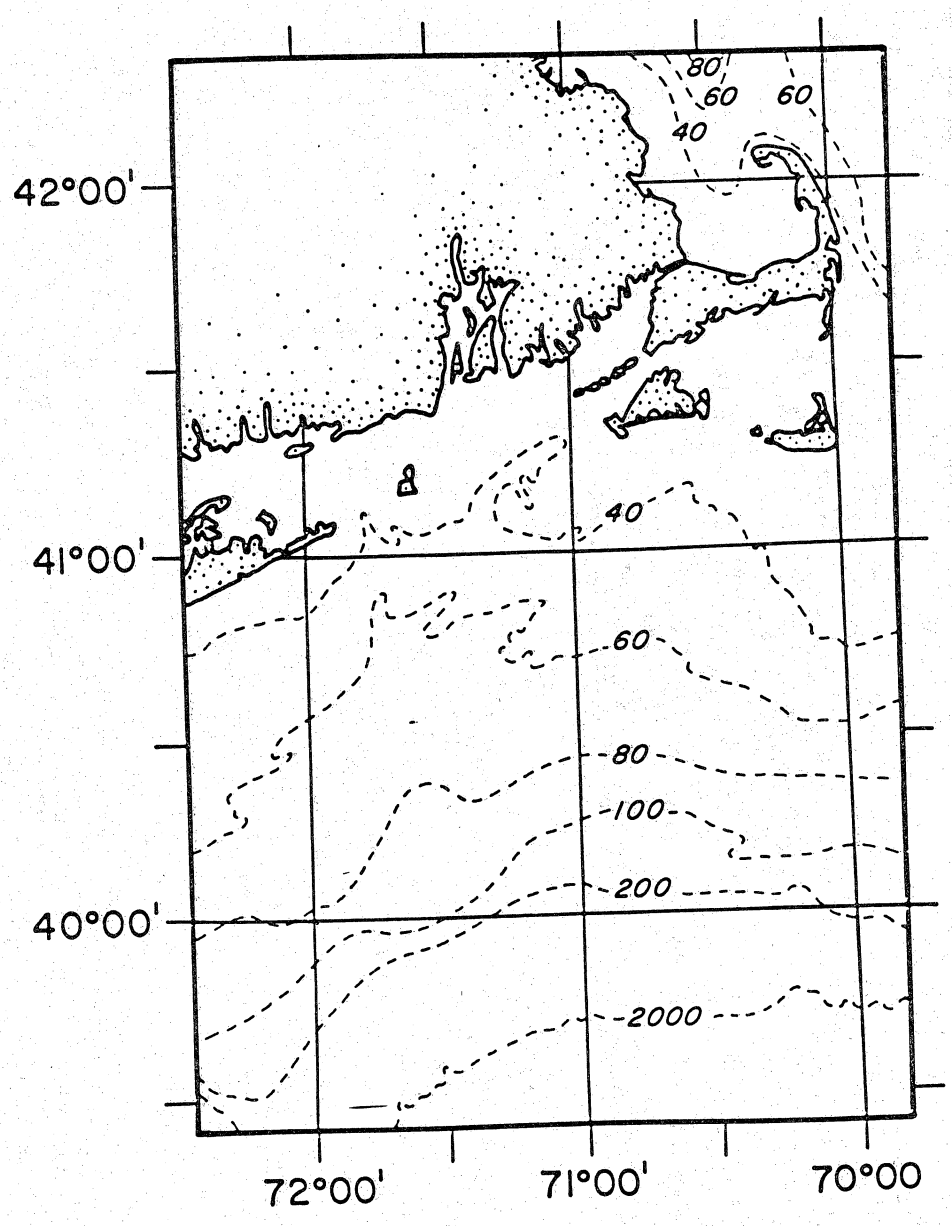


Figure 1. Location of 71°00'W transect south of New England. Depth contours in meters.

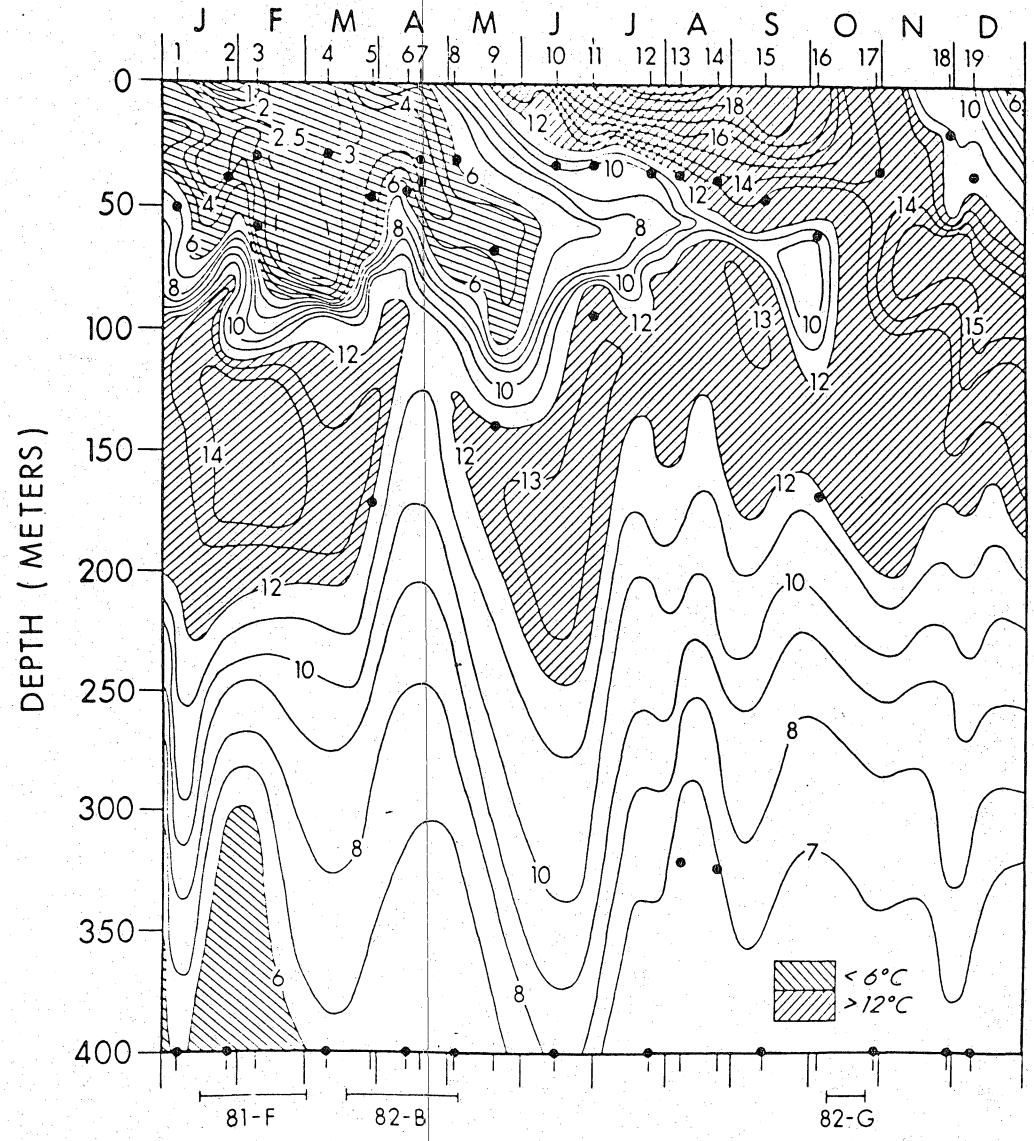


Figure 2. Bottom temperatures on the continental shelf and slope south of New England during 1982. Vertical sections are numbered along the top (see Table 1). Heavy dots mark inshore and offshore limits for each section. Horizontal lines at the bottom indicate duration of warm core ring passages south of New England.