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Water Column Thermal Structure Across the Shelf and Slope Southeast of Sandy Hook, New Jersey in 1981

by

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Monitoring of the shelf water and upper continental slope water events in the New York Bight continued in 1981 for the sixth year. Temperature-depth profiles were constructed from 22 expendable bathythermograph (XBT) transects, extending from the entrance of New York Harbor through the 106-Mile Dumpsite (Fig. 1). The transects collected and the oceanic features monitored in the New York Bight are presented in Table 1.

A "station through time" diagram (Fig. 2) and a bottom temperature diagram (Fig. 3) depict the major oceanographic/climatological events occurring in the New York Bight in 1981. The "station through time" diagram was constructed by plotting through time the temperatures in the water column above the 65 m isobath, using 1°C contour intervals. The 65 m isobath was selected for its mid-shelf location, a position in the cold cell and not influenced by the Hudson Canyon. The bottom temperature diagram was constructed following Chamberlin's (1977) method, by deriving bottom water temperatures from each contoured section, plotting these temperatures against depth and date and contouring at 1°C intervals.

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. The surface trace of the SSF usually occurs near the 200 m isobath, while the bottom indicator, the intersection of the 10°C isotherm with the bottom, occurs between 80 and 120 m depths (Wright, 1976).

Shelf Water Events

Lack of transects from January through mid-March 1981 precluded comparison of water mass conditions at this time with 1977-1980. However, monthly sea surface temperature data obtained from National Ocean Survey (NOS) tide stations averaged 3.1°C in January, fell to a minimum of 2.8°C by early February and rose to 4.2°C by mid-March. The minimum sea surface temperature of 2.8°C in February was warmer than the minimums of 0.0-2.2°C recorded in 1977-1980 during the same period.

Vertically isothermal conditions (5-8°C) remained in the shelf water through mid-April, with the upper limit 1-3°C colder than 1979, but comparable to 1977, 1978 and 1980 (Fig. 2). By early May, vernal warming had stratified the shelf water and isolated colder winter water from the surface, forming the "cold pool."

A weighted mean cold pool temperature was determined from each transect (Table 1). The value was calculated by 1) determining the area defined by each isotherm forming the cold pool; 2) multiplying each area by the respective temperature to determine a weighted temperature, and 3) dividing the sum of the weighted temperatures by the sum of the areas (Annls biol., Copenh., 36:15-25).

The weighted mean cold pool temperature warmed from 6.8-7.1°C in early June to 8.0°C by mid-August (Table 1). A rapid increase to 10.7°C occurred by mid-September, followed by a leveling off to 10.8°C by late October. The minimum weighted mean cold pool temperature in June 1981 was 6.8°C, while minimum temperatures in June 1978-1980 were 5.1-5.4°C (1.4-1.7°C colder).

The thermocline developed in early May concomitantly with the cold pool (Fig. 2). The thermocline temperatures ranged from 9-15°C in early June, intensified to a macimum of 10°-23°C in mid-July and reduced to 12 - 20°C by mid-September. The temperature gradient in the thermocline changed to <0.6/meter in mid-June, 1.1°C/meter in mid-July and 0.7°C/meter by late September.

The maximum gradient of the thermocline occurred in July, when the mixed layer reached to 5-7 m depth (Fig. 2). At this time the thermocline ranged in depth from 10-20 m and subsequently commenced deepening as wind speed and storm frequency increased. The thermocline had deepened to 25-40 m by late August, but retained a temperature range of 12-23°C.

Through October the thermocline continued to weaken, but remained at 35-40 m depth, over remnants of the cold pool.

Fall overturn occurred in mid-November, as is normal for the New York Bight, and isothermal conditions (at about 11 - 12°C) were reestablished. The 1981 maximum shelf water bottom temperature of 11.6°C occurred subsequent to fall overturn and was slightly cooler than 12.3°C, the average maximum for 1977-1980.

By the end of December the water column had cooled to <9°C. A slope water intrusion in mid-December (>11°C) extended into depths of about 50 m (Fig. 2).

Bottom Temperature Events

Vertically isothermal conditions disappeared by the end of April (Fig. 3). Minimum cold pool temperatures of <5°C were recorded in June 1981, and were equal to those of June 1980, but were warmer than those reached in June 1977-1979 (<4°C).

Shelf water bottom temperatures warmed to >8.0°C by late August 1981 (Fig. 3). In 1978-1980 this warming did not occur until late September, while it occurred by late July 1977.

The 10°C isotherm remained close to or deeper than its historical offshore limit (120 m) from March through June 1981 (Table 1). According to surface salinity data, the shelf/slope front (SSF) remained 26-80 km (14-43 nm) offshore of the 100 m isobath 75% of this same period.

As summer progressed, the 10°C isotherm moved near to or shallower than its historical nearshore mean. The only observations of the SSF moving significantly shoreward (28-30 km, 15-16 nm) of the 200 m isobath occurred in mid-September when Eddy 81-C impacted on the New York Bight (Table 1, Fig. 3). The SSF moved to a maximum of 130-167 km (70-90 nm) offshore in mid-October as shelf water was entrained along the northeast edge of Eddy 81-C. As the eddy withdrew, the SSF moved shoreward.

Slope water (>12°C) appeared intermittently on the bottom from May through October (Fig. 3). The appearance of 13°-15°C slope water at the shelf break (130-230 m depth) several times before fall overturn was an unusual occurrence. One occurrence of 13°-14°C slope water at 80-140 m depths had been recorded in 1979. Subsequent to fall overturn slope water intrusions (12°C-16°C) have occurred yearly to depths of 45-70 m.

Summary

The weighted mean cold pool temperatures were warmer in June 1981 than June 1977-1980. The slope water bottom temperatures were >8.0°C by late August 1981, an event that did not occur until late September 1978-1980, but occurred by late July 1977. Several intrusions of slope water 13°C-15°C occurred on the bottom at the shelf/slope break (130-230 m) in 1981, while water this warm had been observed only once before in 1979.

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TABLE 1. WATER COLUMN THERMAL STRUCTURE IN 1981

Vessel	Cruise Number	Date	Cold Cell weighted avg. temp. (°C)	Depth range of cold cell minimum/maximum depth (m)	Bottom depth (m) of 10°C isotherm	Position (km) of shelf/slope front shoreward (-) or seaward (+) of 200 m isobath *	Rings present along transect
"Oleander"	81-01	27-28 Mar	Isothermal (3°-6°C)	-	112	+2	-
"Kelez"	81-03	1 Apr	Isothermal (4°-6°C)	-	125	>+76	80-F
"Oleander"	81-02	10-11 Apr	Isothermal (5°-7°C)	-	90	+80	80-F
"Oleander"	81-03	15-16 Apr	Isothermal (6°-7°C)	-	118	+50	80-F
"Oleander"	81-04	9 May	7.0	31-110	134	+26	80-F
"Rigel"	81-03	3 Jun	6.9	34-108	116	>+46	-
"Oleander"	81-05	5 Jun	7.1	30-100	130	+74	-
"Oleander"	81-06	10 Jun	6.8	37-100	104	-7	-
"Delaware II"	81-07	29 Jun-1 Jul	-	-	-	-	-
"Albatross IV"	81-07	9-14 Jul	6.9	33-74	80	>+18	-
"Oleander"	81-07	10-11 Jul	7.3	28-82	92	+118	-
"Oleander"	81-08	15-16 Jul	7.6	26-78	82	+37	-
"Oleander"	81-09	13-14 Aug	8.0	36-77	79	+61	-
"Oleander"	81-10	19-20 Aug	8.0	34-60	68	+52	-
"Oleander"	81-11	18-19 Sep	10.7	32-94	78	-28	81-C
"Oleander"	81-12	23-24 Sep	10.7	50-140	102	-30	81-C
"Oleander"	81-13	16-17 Oct	-	-	78	+167	-
"Oleander"	81-14	21-22 Oct	10.8	44-98	76	+130	-
"Oleander"	81-16	13-14 Nov	Isothermal (12°-13°C)	-	-	+32	-
"Oleander"	81-17	19-20 Nov	Isothermal (11°-12°C)	-	-	+4	-
"Oleander"	81-18	12-13 Dec	Isothermal (7°-11°C)	-	66	+148	-
"Oleander"	81-19	17-18 Dec	Isothermal (6°-10°C)	-	58	+28	-

* In Annls biol., Copenh, 36:15-25 and Annls biol., Copenh. 37, the table heading should have read "nautical miles" instead of "km".

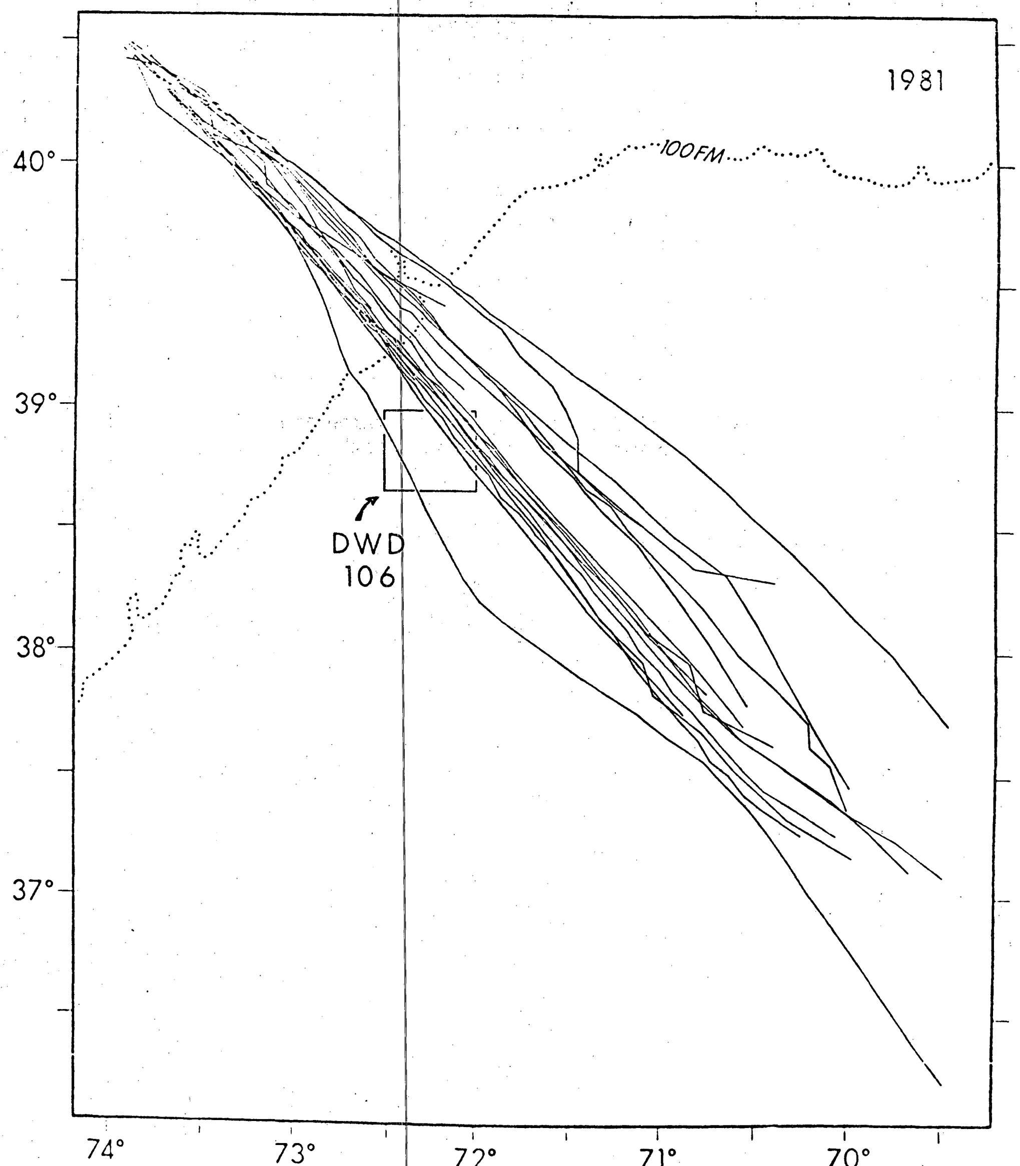

Figure 1. Envelope of 1981 transects in the New York Bight from the entrance of New York Harbor to the 106 Mile Dumpsite.

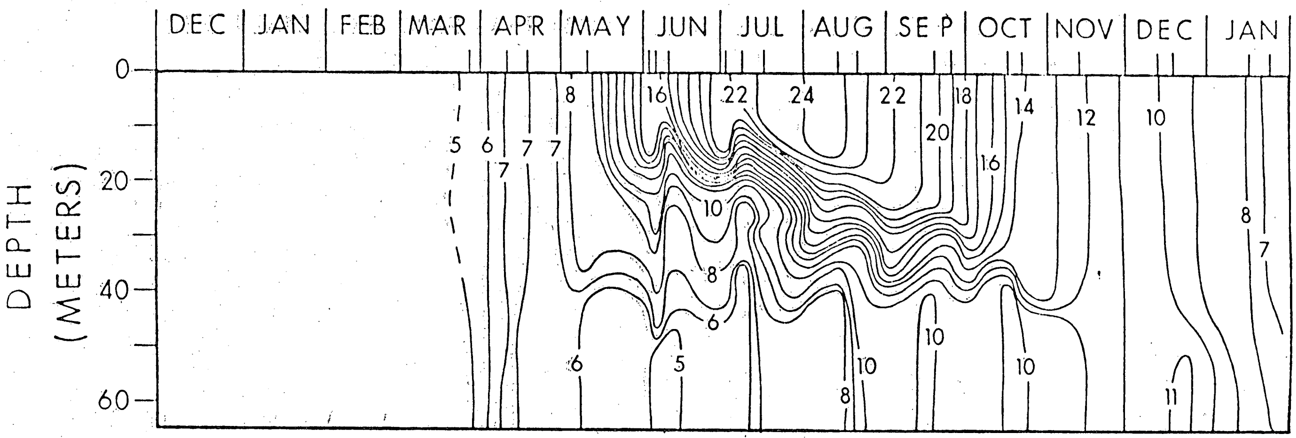

Figure 2. Station through time depicting temperature trends in the water column above the 65-m isobath.

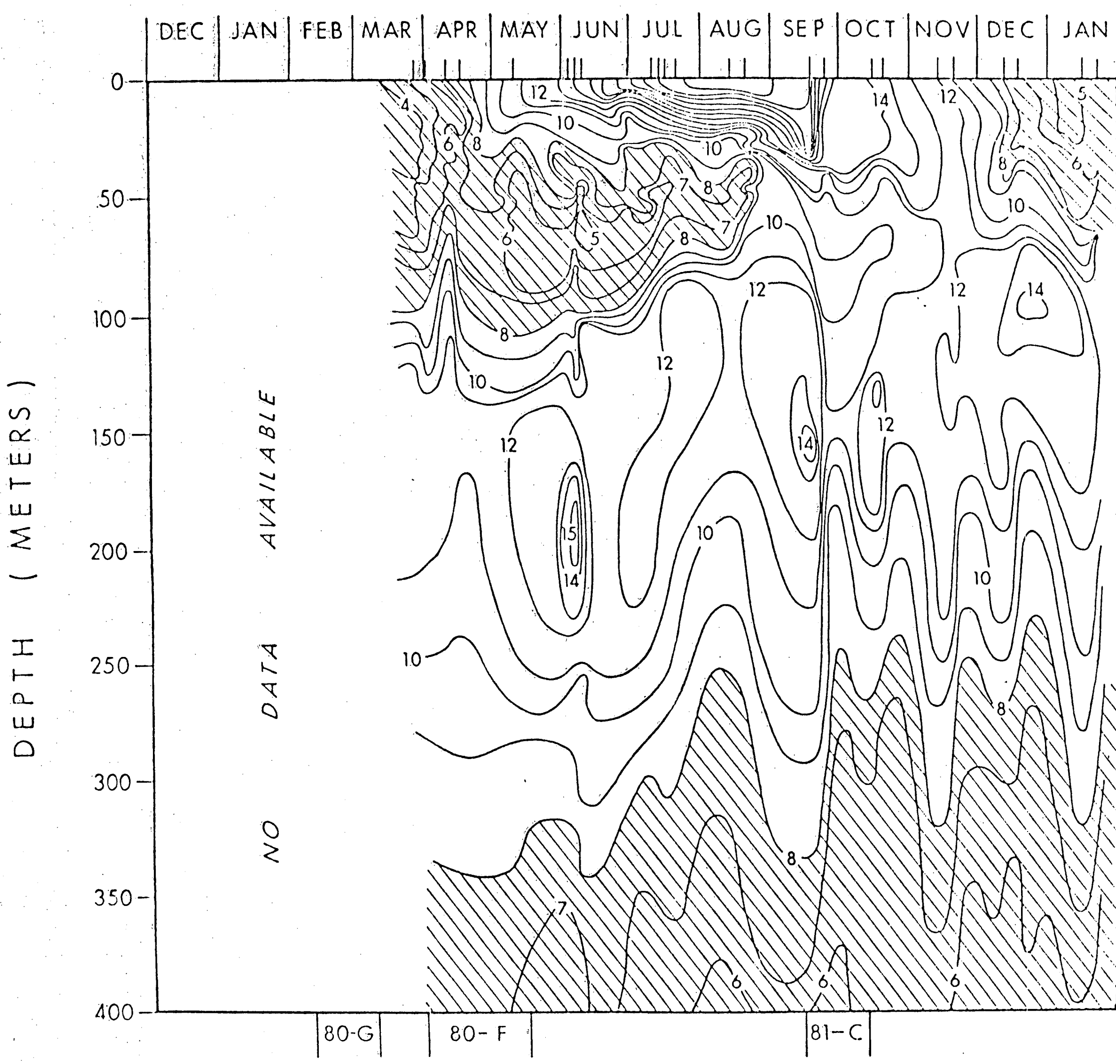

Figure 3. Bottom temperature diagram of the continental shelf and slope waters from New York Harbor to the 106 Mile Dumpsite. Lines at the bottom of the diagram indicate the duration of warm core Gulf Stream rings in the New York Bight area.