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Variation in the Shelf Water Front Position in 1985 from Georges Bank to Cape Romain

by

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The shelf water front along eastern North America is delineated by the narrow gradient zone between cooler, less saline shelf water and the warmer, more saline slope water that lies offshore. The surface position of the shelf water front can usually be determined from thermal infrared imagery such as is available from Advanced Very High Resolution Radiometers (AVHRR) on NOAA satellites. The NOAA National Weather Service and National Environmental Satellite, Data and Information Service (NESDIS) interprets the AVHRR satellite imagery and produces charts (Oceanographic Analysis) which are issued three times a week for the region north of Cape Hatteras and twice a week for the region southward. The charts are constructed from a composite of imagery collected during the day prior to issuance and depict the shelf water front and other oceanic features such as the Gulf Stream and its warm core anticyclonic rings.

The position of the shelf water front off eastern North America was determined from the Oceanographic Analysis charts, following the method described by Gunn (1979). Distances from the coast to the front were measured along twelve bearing lines from Cape Romain, South Carolina to the Gulf of Maine (Fig. 1). In general, the front is bound to the shelf break, consequently the distances along each bearing line were reduced to give departures of the front from the 200-m isobath (the shelf break). To preserve the weekly spacing of frontal observations a single Oceanographic Analysis chart was selected each week as representative of the shelf front location for the week.

During 1985 frontal positions could be ascertained along the

bearing lines in about 92% of the weekly observations. Gaps occurred because of cloud cover or because of the lack of thermal contrast in the satellite imagery.

Four representative bearing lines: Casco Bay (120°), Nantucket Island (180°), Sandy Hook (130°), and Albemarle Sound (90°) have been selected to show the fluctuations of the frontal position during 1985 (Fig. 2). Long-term mean positions for the ten years, 1974-1983, serve as a base for comparison of 1985 values. Major displacements in the front often correspond to the passage of anticyclonic warm core rings. Names and paths of rings used in this report are from the analyses of Price and Barton (MS 1986).

Casco Bay (120°): The ten-year mean positions (1974-1983) remain consistently offshore of the 200-m isobath, and show large variability in most months. A seasonal pattern in the frontal position is not apparent, although the front tends to be more offshore during the winter and spring months and shoreward in the fall. The most offshore location occurs in January and most shoreward position in October. The January and October mean positions also exhibit the least variability.

During most of 1985 along the Casco Bay (120°) bearing line, the shelf water front was located about 50 to 100 km shoreward of the ten-year mean positions, but remained seaward of the shelf break (200-m isobath) throughout the year. In early January, in the wake of ring 84-G, the front was at its most seaward position for 1985 (almost 300 km offshore of the 200-m isobath). By mid-February the front retreated to near the 200-m isobath, followed by an offshore excursion to near the ten-year mean positions for the latter half of February and until mid-March. With the approach of ring 85-B in late March, the front retreated shoreward and remained well shoreward of the long-term monthly mean positions through June. In the wake of ring 85-A in July, the front shifted to more than 200 km seaward of the 200-m isobath and then receded to near the shelf break until mid-August. From late August through mid-October, ring 85-G traced an erratic path near this bearing line and led to offshore excursions of the front in late August, late September and in mid-October. During the mid-October event, shelf water extended to more than 200 km seaward of the shelf break. In the latter half of December, the front shifted offshore to more than 250 km seaward

of the 200-m isobath, while a Gulf Stream meander developed well northward of normal near the bearing line.

Nantucket Island (180°): The long-term mean positions exhibit a distinct annual cycle, with the front located near the 200-m isobath from June through November, and offshore of the shelf break for the other half of the year. The front is at the most offshore position in April and the extreme onshore position occurs in October. Variability is about half the magnitude on Casco Bay (120°), with the largest variability in April.

For the first half of January in 1985, the front was located more than 70 km seaward of the 200-m isobath, which was its most seaward position for the year. By the end of January, the front had shifted to its most shoreward position (about 60 km shoreward of the 200-m isobath) for the year. From mid-February until mid-March, the shelf water front was near the ten-year, monthly mean positions. From mid-March until July, the front was located near the shelf-break (200-m isobath), under the persisting presence of ring 84-G. From mid-July until mid-September, first ring 85-B and then ring 85-F drifted westward across the bearing line. With the passage of each ring, the front shifted shoreward as the rings approached, followed by offshore excursions in the wake of the rings. From mid-September until the end of the year, the front was located near the ten-year monthly mean positions. In early November the front shifted to about 60 km seaward of the 200-m isobath in the wake of ring 85-C. The frontal positions in 1985 tended to follow the long-term mean annual cycle, except the front was about 40 to 50 km shoreward of normal during April and May.

Sandy Hook (130°): The 1974-1983 monthly mean positions indicate that the shelf water front remains near the 200-m isobath from July through March and is more offshore during April through June. The most shoreward positions are in October and February and the most offshore location of the front is in May. Variability is of similar magnitude to that of the Nantucket Island (180°) line, with maximum variability in May and July and minimum values in October and November.

From mid-January through June of 1985, the shelfwater front was generally positioned shoreward of the 200-m isobath and was about 40 to

50 km shoreward of the ten-year mean positions. From July through October, the front was located near the long-term monthly mean positions. With the approach of ring 85-C during November, the front retreated to about 50 km shoreward of the 200-m isobath. For the year, the front was at its most shoreward position in late February-early March, when it was about 80 km shoreward of the 200-m isobath. In the wake of ring 84-G in late July, the front was about 80 km seaward of the 200-m isobath for its most offshore location in 1985.

Albemarle Sound (90°): On this bearing line, near Cape Hatteras, the long-term monthly mean positions of the shelf water front show a regular annual cycle fluctuating offshore and onshore of the 200-m isobath. From January to March the front is located about 20km shoreward of the shelf break, during April the front shifts offshore until it is about 15-20km seaward of the shelf break for May through September. In October through December, the front shifts shoreward and it is located near the shelf break. Maximum variability for the ten-year record occurs in August and the minimum is in February.

In 1985, the shelf water front positions followed the trend of the long-term annual cycle, but were generally 20-40 km shoreward of the ten-year monthly mean positions. For most of the year the front was located shoreward of the 200-m isobath. The most shoreward positions of the front (about 50 km shoreward of the 200-m isobath), occurred during periods in late January to mid-March and in mid-June. In late October the front was at its most seaward location (about 40 km offshore of the 200-m isobath), when slope water was absent along the bearing line and shelf water extended to the shoreward edge of the Gulf Stream.

Yearly mean: The ten-year, annual mean positions of the shelf water front along the twelve bearing lines (Fig. 3) indicate that the front is typically about 115km seaward of the 200-km isobath on the eastern-most line (Casco Bay 120°). The separation of the front from the shelf break steadily decreases until the Nantucket 180° line. From there southward to the Cape Henry 95° line, the front is generally about 15-20km offshore of the shelf break. Along the Albemarle Sound 90° line, the front is located over the 200-m isobath and, for the three bearing lines south of Cape Hatteras, the front is typically about 10-15km shoreward of the shelf break. Variability in the frontal position from the ten-

year record, as indicated by the standard deviation (Fig. 3) shows maximum variation at the Casco Bay 120° line and minimum variability along the Cape Lookout 135° line.

The annual mean positions for 1985 were shoreward of the long-term means, except along the Casco Bay 140° line, which was 15 km seaward of the ten-year mean. Along the Casco Bay 120° and Sandy Hook 130° bearing lines, the annual mean positions were about 30 km shoreward of the long-term means, and frontal positions were about 10-20 km shoreward of the ten-year means for the other nine bearing lines. Standard deviation values for 1985 were only about 50-75% of the long-term values, except along the Casco Bay 160° line, where the standard deviation of weekly values in 1985 was about equal to the ten-year value.

Discussion: Based on the ten-year means (1974-1983), north and east of Cape Henry, the shelf water front is typically positioned in a more offshore location during the spring and in a more shoreward location during late summer and early fall. From Cape Romain to Cape Henry, the front is located more offshore during summer and is more shoreward during winter. In 1985, frontal positions generally followed the long-term mean seasonal pattern for bearing lines from Cape Romain to Cape Henry, but along most of the other lines, any seasonal cycle was overshadowed by shorter period flucuations. Along all bearing lines in 1985, except Casco Bay 160° line, the shelf water frontal positions were distinctly shoreward of the ten-year means. For the bearing lines within the Mid-Atlantic Bight (Albemarle Sound 90° to Nantucket island 180°), the annual mean frontal positions in 1985 ranged from about 10 to 30 km shoreward of the long-term means. Based on the distance from the coast to the front, these frontal positions imply that at the surface in the Mid-Atlantic Bight, the area covered by shelf water was 14% less in 1985 than normal (1974-1983 means).

References

Gunn, J. T. 1979. Variation in the shelf water front from Georges Bank to Cape Romain in 1977. ICES Annales Biol., 34 : 36-39.

Price, C. A., and K. W. Barton. MS 1986. Anticyclonic warm core Gulf Stream rings off the northeastern United States during 1985. NAFO SCR Doc. 86/77, Serial No. N1197, 17 p.

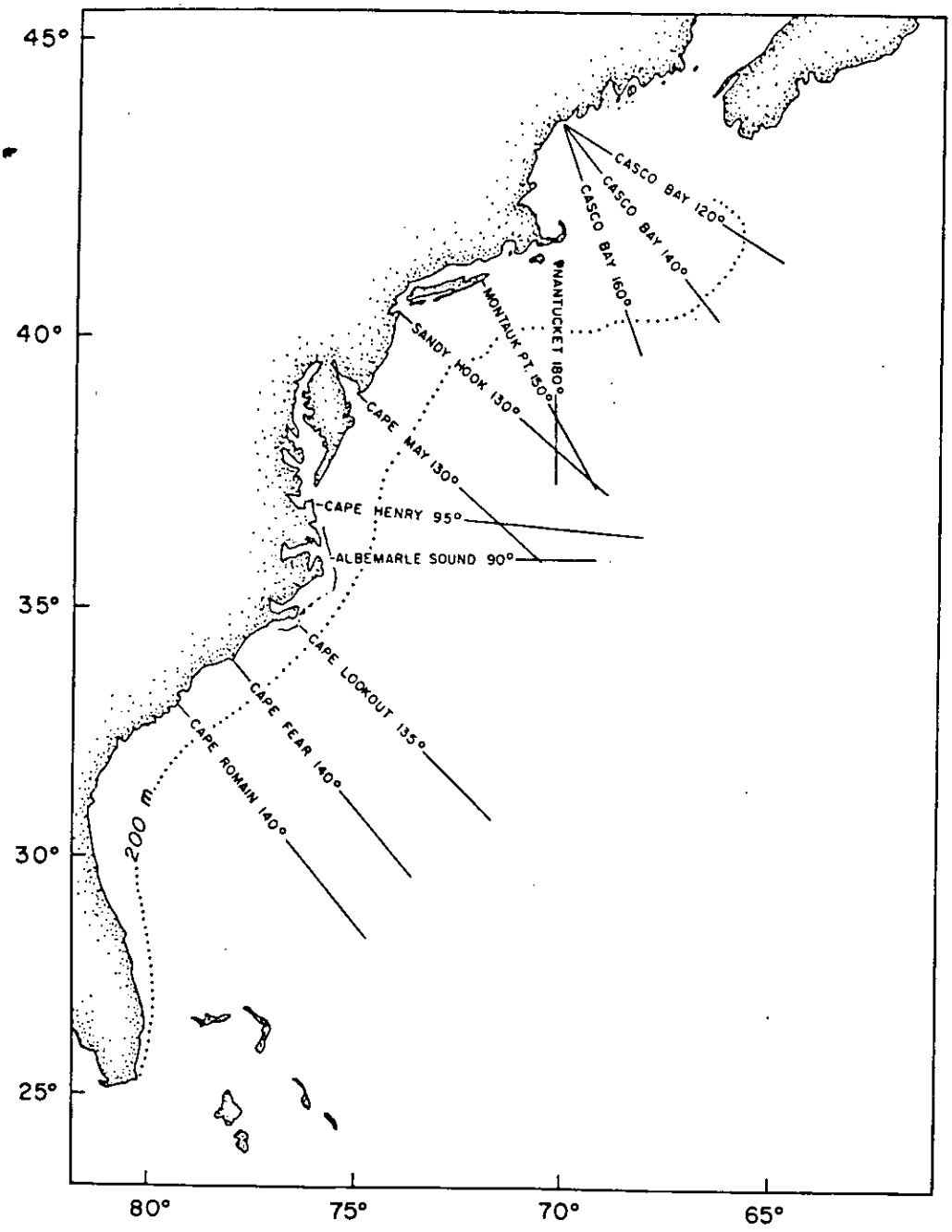

Figure 1. Reference points and bearing lines used to portray variation in position of the shelf water front relative to the 200-m isobath (dotted line). The degrees are azimuths of the lines

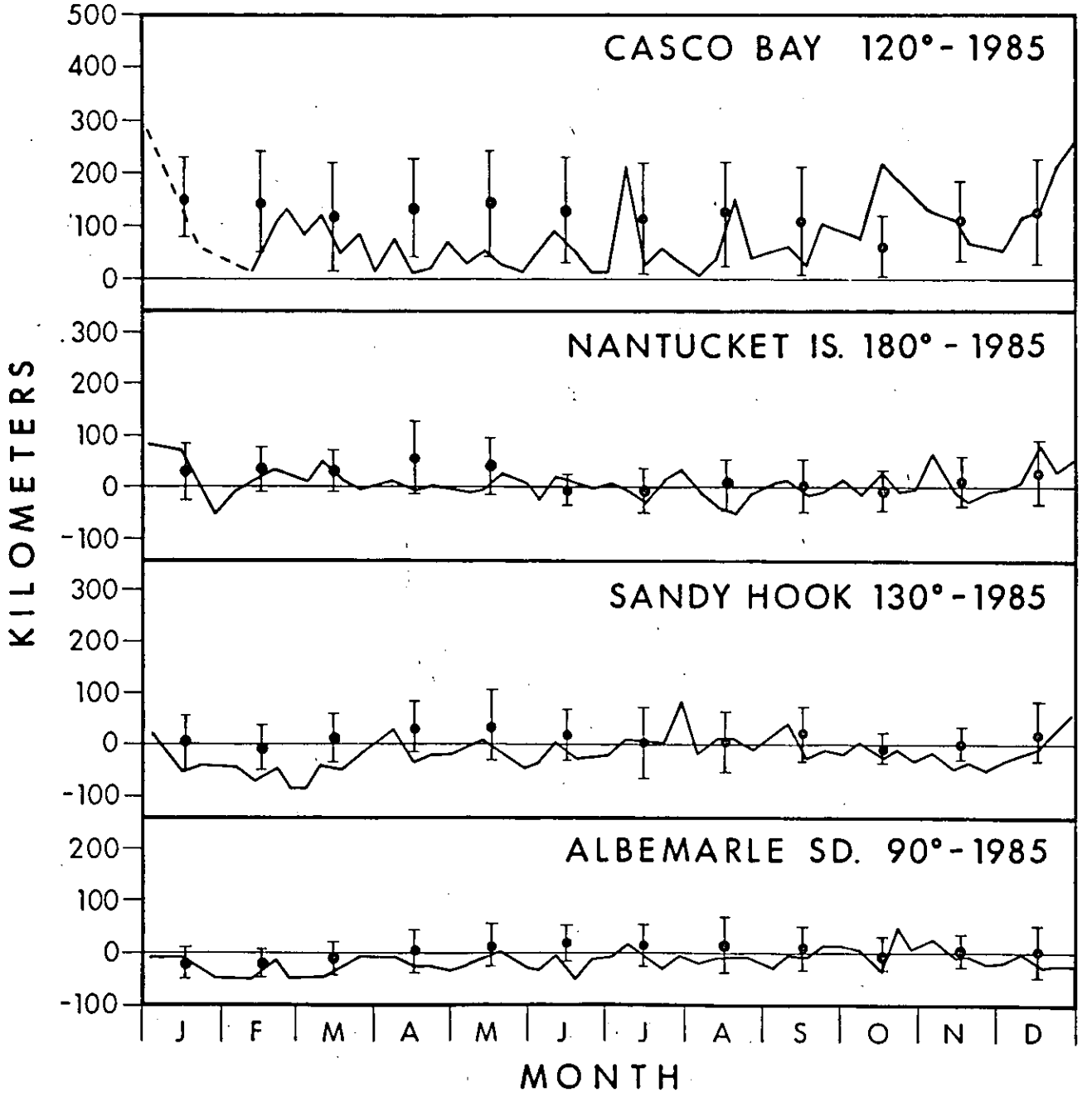

Figure 2. Shelf water frontal positions in 1985 relative to the 200-m isobath (positive is seaward) on selected bearing lines. Dashed lines indicate gaps in the data of two to four weeks. Ten-year (1974-1983) mean monthly positions of the front are shown as dots with the vertical lines representing ±1 standard deviation around the means.

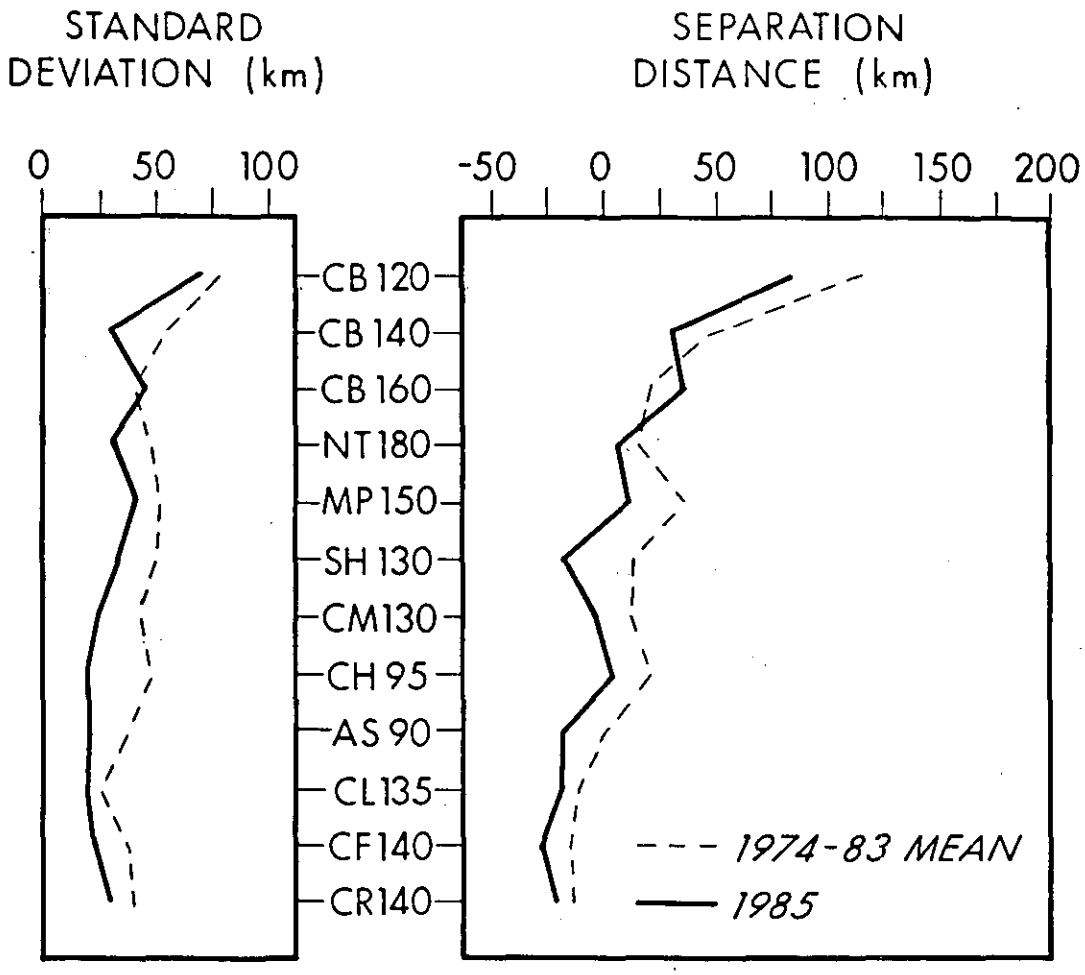

Figure 3. Mean positions of shelf water front, during 1985, relative to the 200-m isobath (positive is seaward) and standard deviations of weekly positions at each bearing line. Long-term means and standard deviations for the 1974-1983 base period are shown for comparison.