

Northwest Atlantic



Fisheries Organization

Serial No. N496

NAFO SCR Doc. 82/VI/8

SCIENTIFIC COUNCIL MEETING - JUNE 1982

Variation in the Shelf Water Front Position
in 1981 from Georges Bank to Cape Romain

by

R. S. Armstrong

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

The shelf water front along eastern North America is delineated by the zone between cooler, less saline shelf water and the warmer, more saline slope waters that lie offshore. The surface position of the shelf water front can usually be determined from thermal infrared imagery such as is available from Very High Resolution Radiometers (VHRR) on NOAA satellites. The NOAA National Environmental Satellite Service (NESS) interprets the VHRR 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 Gulf Stream position and warm core anticyclonic eddies.

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 are 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. 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 1981 frontal positions could be ascertained along the bearing lines in 81% 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 1981 (Fig.2). Long-term mean positions from June 1973 to December 1977 serve as a base for comparison of 1981 values.

Casco Bay (120°): The long-term mean positions (1973-1977) remain consistently offshore of the 200 m isobath, but show pronounced seasonal change and large variability in most months. Offshore progression during the winter to a maximum in March is followed by a transition to a more constant, shoreward position during the summer months. Offshore movement with large variability occurs again in the fall, followed by a shift to the most shoreward position and least variable position in December. The December position may not be representative, however, because it is based on only two weekly positions, both from 1975.

During 1981, any seasonal pattern to the front's location was overshadowed by the influence of six warm-core eddies that transited the region. In the wake of each generally westward moving eddy the front was drawn well offshore of the long-term mean positions. At the beginning of the year the front was about 150 km offshore of normal, under the last effects of an eddy that was moving away to the west. In mid-February another eddy caused the front to shift almost 250 km offshore of normal, but this lasted only briefly as the eddy was quickly resorbed by the Gulf Stream. From early April until mid-June, two eddies formed and apparently combined into one large eddy, causing the shelf water front to be drawn about 200 km offshore of the long-term mean position. By mid-July, another eddy began influencing the frontal position so that by late in July the front was about 300 km seaward of normal as measured along the bearing line. This eddy remained in the area until late October, moving only slowly toward the west and generally kept the front more than 100 km offshore of normal for about 15 weeks. In December the sixth eddy began influencing the front so that by the end of the year, the front was more than 200 km offshore of the long-term mean location. Only during the brief periods between eddies did the front tend to return to the long-term mean positions (in early February, during March, in late June through early July and in late November).

Nantucket Island (180°): The long-term monthly mean positions show

a regular annual cycle fluctuating offshore and onshore of the 200 m isobath. The maximum distance offshore is in February and the extreme onshore position occurs in September. Variability was less than half the magnitude on Casco Bay (120°), and more uniform, with maxima in the winter and summer.

Through most of 1981, the shelf water front remained offshore of the location of the 200 m isobath and did not follow the normal seasonal translation. From mid-January to early April the front was near the long-term mean position, but by mid-April the front shifted to more than 150 km offshore of normal in the wake of a warm-core eddy. The front remained well offshore of normal for about 2 months, until the eddy had moved southwestward enough so as to no longer influence the front. During June the front was near the long-term mean position. During the summer, the front typically moves shoreward of the 200 m isobath, but in 1981, the front was located about 50 to 100 km offshore of this seasonal position as another eddy passed the area. In November, the front shifted to more than 150 km offshore of normal as a large meander developed in the Gulf Stream to the west of the area.

Sandy Hook (130°): The long-term mean positions are close to the 200 m isobath from January to June, except for a 25 km offshore excursion in April. In July the front shifts 50 km shoreward and remains shoreward to a lesser degree for the rest of the year. Variability is generally greater than on the Nantucket (180°) line, although less than on the Casco Bay (120°) line. Maximum variability in winter and summer is a common characteristic of the Sandy Hook (130°) and Nantucket (180°) lines.

The front was close to the long-term mean position from the beginning of the year until May in 1981, except for an offshore excursion in early April in the wake of an eddy. The front shifted offshore by about 150 km in mid-May as another eddy crossed the bearing line, followed by a slow retreat shoreward that lasted through most of June. Because of insufficient thermal contrast, the shelf water front could not be discerned during July and most of August. Through September until mid-October the front was close to the long-term mean position. For about a month, beginning in mid-October, the front was located about 50 km offshore of normal as an eddy had moved southwest of the bearing line. In early December, the front shifted to more than 150 km offshore of normal as a large shore-

ward meander developed in the Gulf Stream off this area. Clouds obscured the area during mid- and late-December, except during the last week of the year when it appeared that the front was moving back toward the shelf-break.

Albemarle Sound (90°): On this bearing line, near Cape Hatteras, the long-term monthly means show an annual cycle that is almost opposite what has been found for the bearing lines to the north, and with the least amplitude. The means are shoreward of the 200 m isobath from January through May, offshore from June to September, and inshore again from October through December. Variability is low during January to June, abruptly increases in July, and steadily declines during the rest of the year. Because the Gulf Stream is normally close to the continental shelf in the vicinity of this bearing line, large fluctuations in the position of the shelf front do not normally occur.

The shelf water front remained close to the 1973-1977 mean positions from January through May of 1981, except during April when the front moved offshore by about 50 km, followed by an incursion to 80 km shoreward of the 200 m isobath. These abrupt shifts in the frontal position in April seemed to result from frictional influences of undulations in the Gulf Stream. From June through September, the front could not be detected because of insufficient thermal contrast in the surface water. The boundary between nearshore water and the Gulf Stream north wall was discernible and its position is shown by the heavy line (Fig. 2). In mid-July, the Gulf Stream north wall was located shoreward of the 200 m isobath. At that time, the Gulf Stream along this bearing line approximately doubled in width as an eddy was resorbed to the north, off the mouth of Chesapeake Bay. During October, the shelf water front was again discernible and was located near the long-term mean position. In November and December, slope water was absent along the bearing line and shelf water extended out to the north wall of the Gulf Stream. The position of this shelf water-Gulf Stream front is labelled as the Gulf Stream north wall in Figure 2.

Yearly mean: The mean positions of the shelf water front followed the general, geographic trend of the 1973-1977 means, but were displaced seaward of the long-term mean positions on all bearing lines, and much farther offshore for the lines off Albemarle Sound and northward (Fig. 3). The 1981 mean frontal positions ranged from 10 to 135 km seaward of the 1973-1977 means and were typically about 40 km further offshore.

Variability in the shelf water front positions was comparable to, or slightly greater than, the long-term means on all bearing lines, as indicated by the standard deviation (Fig. 3). Taken with the yearly means of the frontal position, the standard deviations indicate that the distinctly offshore position of the front was a persistent condition throughout the year.

Discussion

North of Cape Henry the shelf water front is typically positioned in a more offshore location during the first half of the year and in a more shoreward location during most of the latter half of the year. From Cape Romain to Albemarle Sound, the normal annual pattern is about the opposite. In 1981, the front generally followed the seasonal pattern south of Albemarle Sound, but north of Albemarle Sound any seasonal pattern was overshadowed by the persistent seaward location of the front. North of Albemarle Sound, the front was only rarely shoreward of the long-term, monthly mean positions. Most of the seaward excursions of shelf water north of Albemarle Sound corresponded to the passage of warm-core eddies in the slope water.

References

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

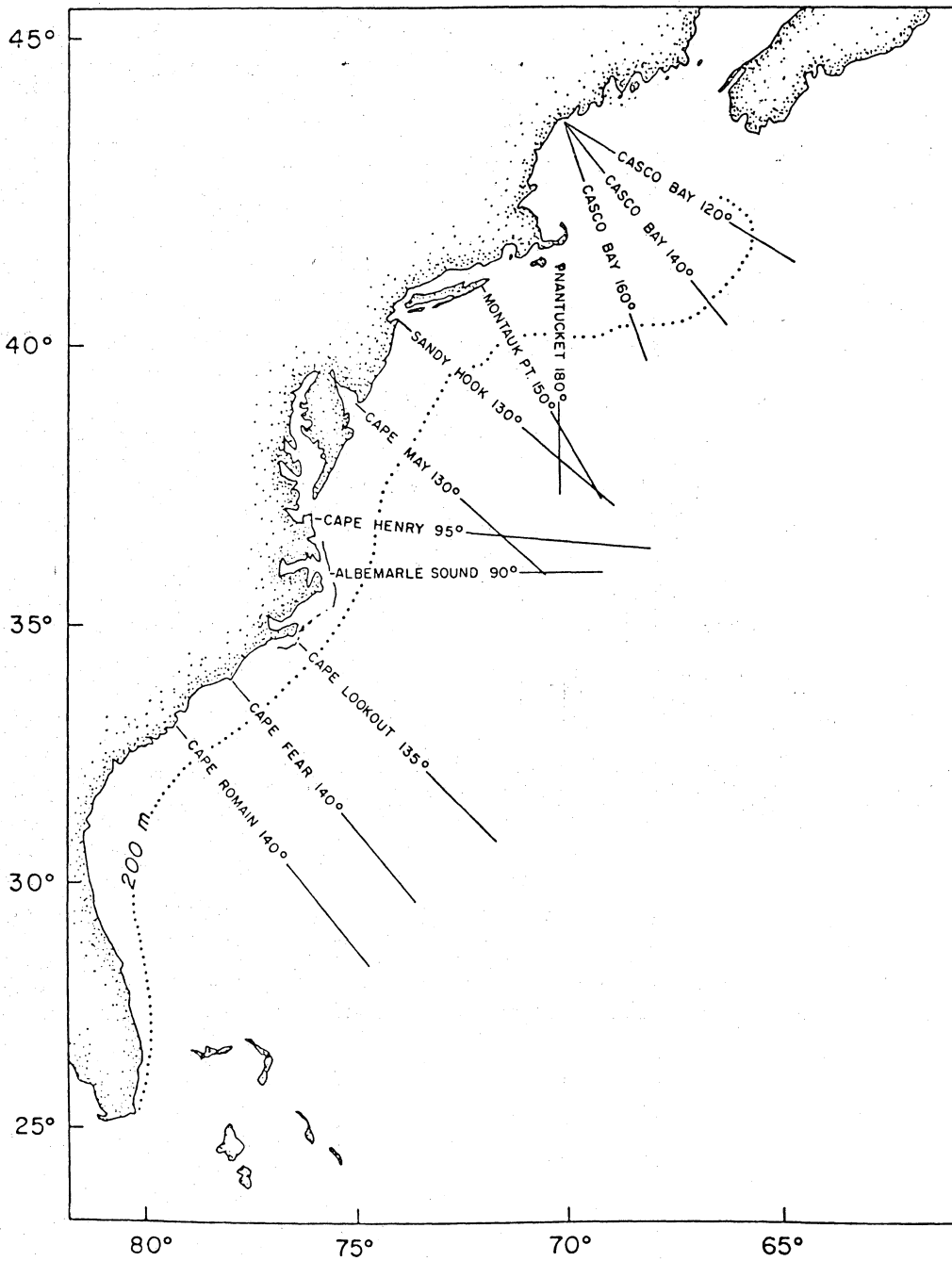


Figure 1. Reference points and bearing lines used to portray variation in position of the shelf water front relative to the 200 m isobath (dotted line). The degrees are azimuths of the lines.

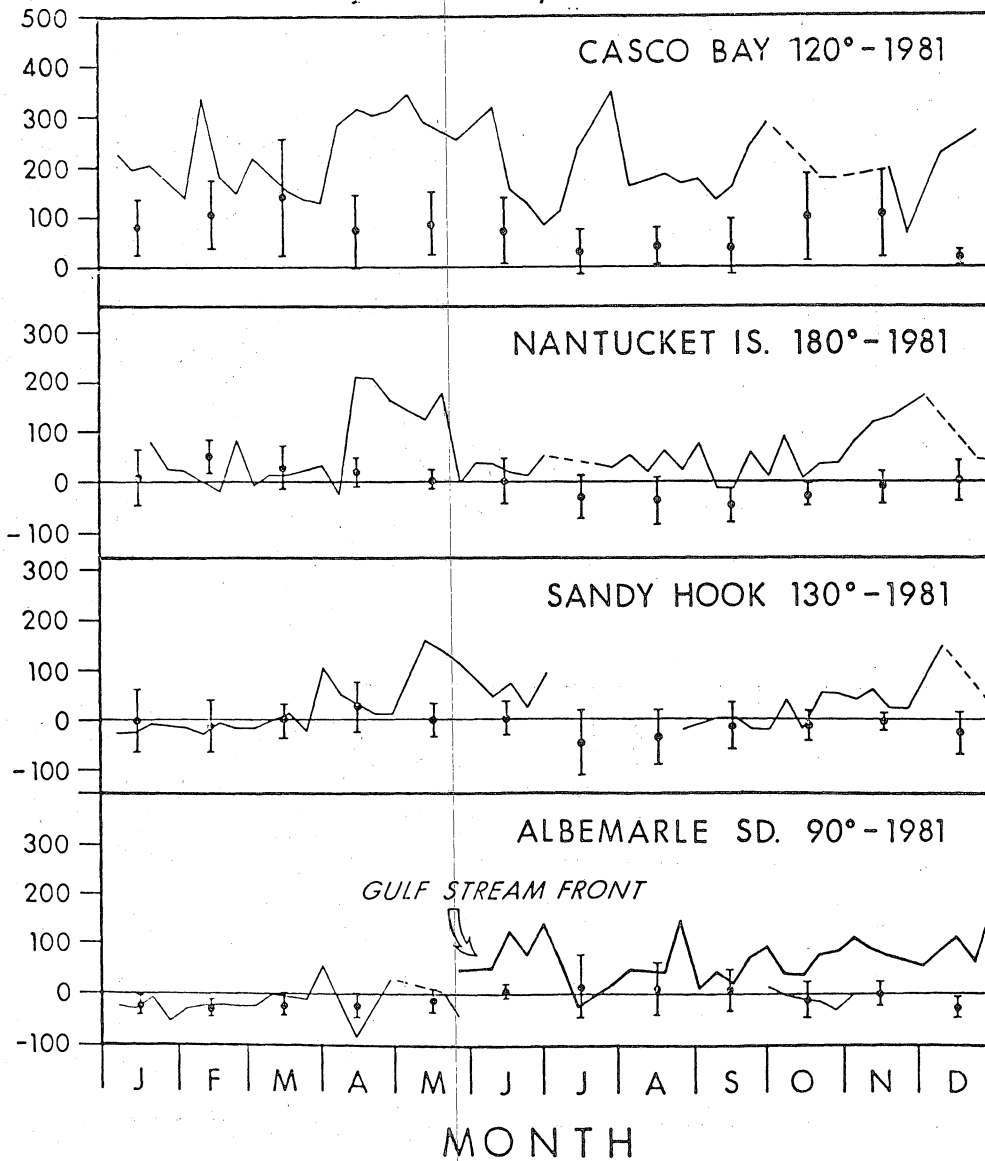


Figure 2. Shelf water frontal positions in 1981 relative to the 200 m isobath (positive is seaward) on selected bearing lines. Dotted lines indicate gaps in the data of two to four weeks and breaks in lines indicate gaps greater than a month. Mean monthly positions of the front are shown as dots with the vertical lines representing ± 1 standard deviation around the means for the base period June 1973 to December 1977.

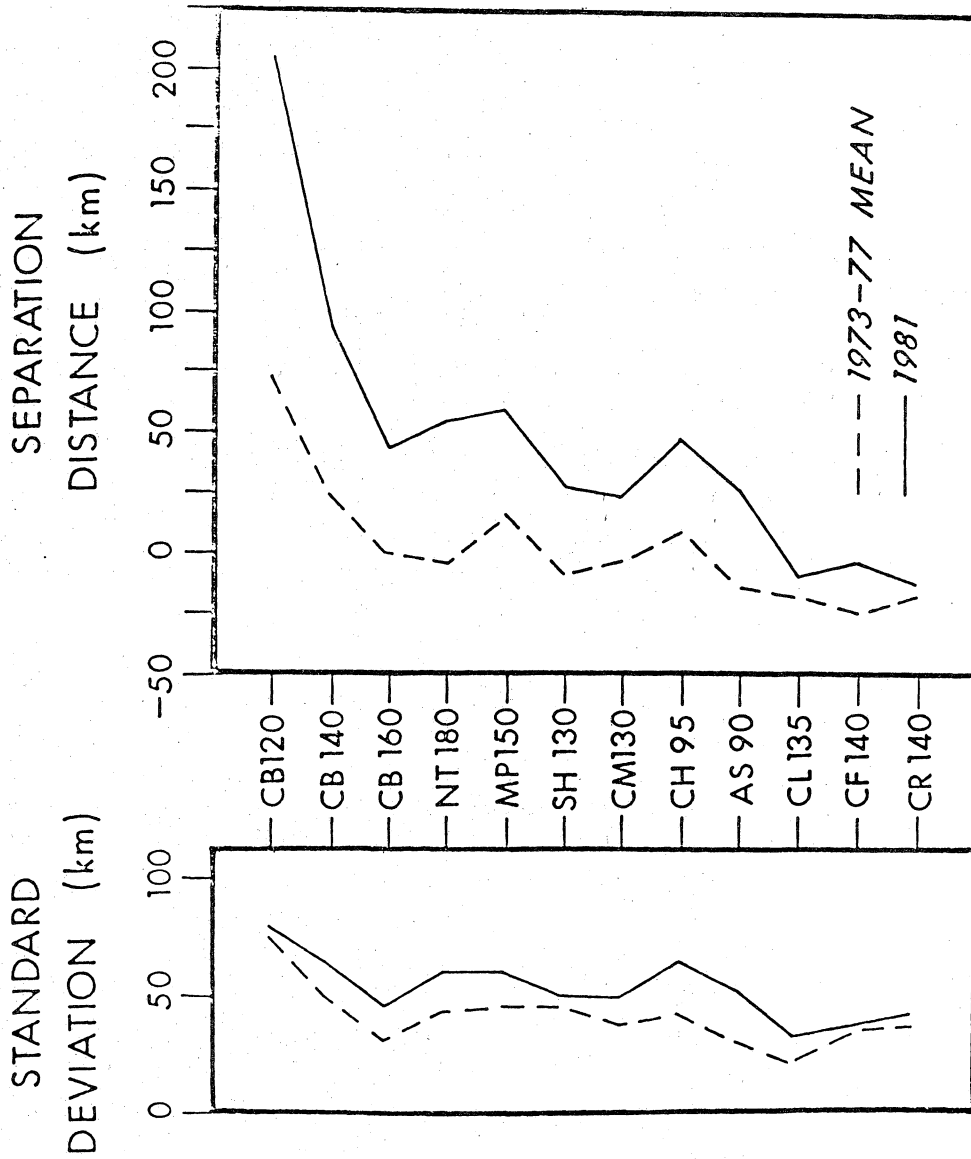


Figure 3. Mean positions of shelf water front, during 1981, relative to the 200 m isobath (positive is seaward) and standard deviations of weekly positions at each bearing line. Long-term means and standard deviations for the June 1973 to December 1977 base period are shown for comparison.