MODE HOT LINE NEWS

No. 84 November 28, 1975

XBT Issue:

Noble: XBT sections from R/V Chain 127
Seaver: Two XBT sections in the North Atlantic
Volkmann: Some XBT sections in the western North Atlantic
Wilson, Dugan: Thermal structure south of the Kuroshio Extension

SOME XBT SECTIONS IN THE WESTERN NORTH ATLANTIC

by Gordon Volkmann

A group of independent XBT sections taken in the western North Atlantic from 1970 to the present has been organized in this issue of the Hot Line News. Table I lists the North Atlantic sections included in this issue, as well as those sections which have appeared in previous issues. The letter designation in the list refers to the geographical location of each section as shown in Chart I. There has been no attempt made here to analyze the sections statistically.

The three sections down 70°W, from the Gulf Stream to the MODE-I area (M, N, O, Figures 7 and 8), show the Gulf Stream at the northern end with a continuous dip in the isotherms, and a slow rise of the isotherms toward the Sargasso Sea. All three sections show considerable activity on the scale of Fuglister-type rings and smaller. Activity at least comparable to what is shown in these sections at 70°W is evident in the four sections (U, V, W, X) between 62°30'W and 56°30'W discussed by McCartney in Hot Line News No. 74. (Note that the vertical exaggeration in the McCartney sections is not the same as that in this issue.) It appears that there are more larger-scale features in the eastern section and more smaller-scale features to the west; however, a numerical analysis is needed to confirm it.

Toward the west and south, section E (Figure 3) shows considerable lumpiness as far south as 26°N where it joins the series of Antilles sections (see below). Figure 1

(continued page 2, left column)

TWO XBT SECTIONS IN THE NORTH ATLANTIC

by George Seaver

Two XBT sections, made at constant latitude using 750 m probes with an approximate 20 km spacing, are shown in Figure 1.

The section along 34°30'N from 67°W to 10°W was taken on R/V Chain cruise 118 from 22 January to 2 February 1975. Five or six "Big Babies" were observed west of the Mid-Atlantic Ridge; proceeding eastward, their scales and amplitudes decreased. East of the ridge, the scales of the disturbances were smaller than those found in MODE-I.

One Big Baby, observed at 60°W, may be the same one observed by Val Worthington in November, 1974 (Hot Line News No. 74). If so, it had moved westward at a speed of about 3.7 km/day. Its horizontal scale was 350 km, and its amplitude was 340 m. (Does anyone see a phase tilt of the isotherms?) As the ship proceeded through this anomaly at a constant course and speed, the ship set indicated a cyclonic current pattern. As the wind direction and speed remained constant, the average surface velocities were calculated to be about 50 cm/sec. The shear between 350 m and 550 m was calculated at about 7 cm/sec. Strong sea surface temperature gradients were associated with this disturbance (a 1°C change over 25 km). In fact, the strongest horizontal gradients observed were those at the surface. (These surface gradients should be detectable with the VHRR sensors aboard operational satellites. Also, the sea-surface depression associated with the surface currents should be detectable with the radar altimeter now in use on NASA's GOES-III satellite. Unfortunately,

(continued page 2, right column)

SOME XBT SECTIONS IN THE NORTH ATLANTIC (continued)

in Hot Line News No. 79 (Cheney and Richardson) also shows ring-like features west of 72°W.

All of the sections which approach the Antilles (E-L, Figures 3, 4, 5 and 6) show a rise in the isotherms to the south at depths greater than about 400 m. At 57°W (Section S), Rossby and Evans (Hot Line News No. 70) show this as the North Equatorial Current and discuss small-scale (100 km) features. Small-scale, low-amplitude perturbations are also shown in the E-L sections, but it is not clear whether these are separated eddies or fluctuations in the speed and/or direction of the general flow (now referred to as the Antilles Current). Note that the large rise in the L section at 23°N to 24°N occurs within 35 km of San Salvador.

With eddy activity extending southward from the Gulf Stream region, northward from the Antilles arc, and eastward from the Florida current, there is an area of minimum activity in the middle. It is not, however, entirely quiescent. Section Q (Figure 9) shows a long (500 km), low-amplitude (125 m) rise in the deeper isotherms in the vicinity of 30°N, 55°W. Intimations of a similar rise may be seen on the Rossby and Evans section (T) between 32°N and 30°30'N (Hot Line News No. 70). That this may be a trough along 70°W is suggested by a similar rise at the southern end of two of the three sections down 70°W (N and O, Figures 7 and 8). The possibility of its westward extension through section E is masked by a larger and much shorter lump-trough combination. That it is not a permanent feature of this part of the ocean is shown by the fact that it is absent on both the 66°W and 50°W sections of the Fuglister Atlas (1960).

Reference

Fuglister, F. C. (1960) Atlantic Ocean Atlas of Temperature and Salinity Profiles and Data from the International Geophysical Year of 1957-1958. Woods Hole Oceanographic Institution Atlas Series, 1, Woods Hole, Mass.

TWO XBT SECTIONS IN THE NORTH ATLANTIC (continued)

some surface temperature gradients and surface currents were not associated with deeper phenomena; however, satellite observations, particularly as they become more sophisticated, can provide a high probability focus on deeper disturbances.)

The second XBT section was taken on R/V Chain from 24 May to 7 June, 1975 along 29°30'N from 20°W to 60°W. No anomalies were observed with the large scales seen in the section at 34°30'N. At 59°W and 54°W, displacements of the 15°C isotherm of 100 m were seen. To the east, the displacements were generally less than 50 m. Prior to sailing, the National Environment Satellite Service was informed of the track's location and of the transit time in an effort to compare ground observations with infrared satellite observations. A number of sea surface fronts were observed on the order of 1°C over 20 km. Unfortunately, due to meteorological conditions, these were in the "noise" of the satellite photographs.

A third section, taken during late October and early November, will appear in a future issue of the Hot Line News.

The MODE (Mid-Ocean Dynamics Experiment) Hot Line News is produced at the Woods Hole Oceanographic Institution. It is edited by Ferris Webster and Leigh Stoecker.

If you have material of interest for this newsletter, please get in touch with either of the above at the Woods Hole Oceanographic Institution, Woods Hole MA, 02543, Telephone (617) 548-1400.

THERMAL STRUCTURE SOUTH OF THE KUROSHIO EXTENSION

by Stan Wilson and John Dugan

From 3-5 November, 1975, a group of seven Navy ships (USS Anchorage, USS Badger, USS Barbour County, USS Duluth, USS Mauna Kea, USS Mobile, and USS Tuscaloosa), under the command of the Commander Amphibious Squadron Five, conducted an XBT survey south of the Kuroshio Extension in a swath centered on 31°N and extending approximately 2200 km between 160°E and 180°E (see Figures 10 and 11 a). The ships steamed in a line abreast with an initial lateral spacing between adjacent ships of 37 km, and a later spacing of 46 km. The corresponding swath widths were 222 km initially, and 278 km later. XBT drops, using T-4 and T-7 probes alternately, were made hourly; as the average ship speed was 17 knots, the spacing between XBT drops along a ship track was about 31.5 km.

It should be noted that Figures 11a, b, and c are based on XBT data which were quickly read off strip charts by various observers during the course of the survey; little checking for or correction of errors has been done. Figure 11a shows a plot of temperature at a depth of 400 m for all XBT's dropped. Figures 11b and c show vertical temperature sections based on XBT's dropped along the southernmost and next-to-northernmost tracks indicated in Figure 11a. These two sections were selected for presentation as they reveal dramatically different thermal structure, although separated only by 185 to 230 km. Figure 11b shows relatively small thermal features. On the other hand, Figure 11c shows four distinct cold eddy-like structures, the largest of which (located 300 to 400 km east of 160°E) is characterized by a 200 m vertical change in the depth of the 6°, 10°, and 14°C isotherms over a horizontal distance of 200 km. Three of the four cold eddy-like structures (except the one centered 1300 km east of 160°E) appear to have a surface expression which is on the order of 1°C cooler than surrounding surface waters. (Unfortunately, cloudiness in the area prevented acquisition of satellite-derived infrared sea-surface temperature maps.) This one cold eddy-like structure (centered 1300 km east of 160°E, or at 172°E) is the only one which appears to have closed isotherms to the north. The other three have open isotherms to the north, and their lateral extent cannot be determined.

Absolute navigation was based on satellite navigators installed on the next-to-northernmost and the next-to-southernmost ships; relative navigation was based on each ship's radar. Although we feel that ship positioning will be known to 1 or 2 miles, the positions of XBT drops indicated in Figure 11a are preliminary estimates and have a larger positioning error. Even so, significant ship drift was observed by the northern three ships which is consistent with cyclonic flow associated with the cold eddy-like feature between 162°E and 164°E of Figure 11a. Southerly drift on the order of two knots was experienced by these ships on the western side of this feature, and northerly drift on the order of one knot was on the eastern side.

Reference

Kawai, Hideo (1972) Hydrography of the Kuroshio Extension. Kuroshio, Physical Aspects of the Japan Current. H. Stommel, K. Yoshida, editors, U. of Washington Press, 235-352.

XBT SECTIONS FROM R/V CHAIN 127
by Marlene Noble

Two XBT sections taken in the northwestern Atlantic approximately one month apart are shown in Figure 2. The earlier section (Figure 2 [C]) was taken on R/V Chain 127, Leg I (Bob Spindel, Chief Scientist) from Woods Hole to Bermuda in mid-September. Strong eddy motions are indicated in the section. Note the sharp isothermal gradients near point B. 18° water, often found between 300-400 m, is observed below 600 m and above 200 m. One interpretation of this data (Phil Richardson) is that the section clipped the edges of Rings D and F shown in Figure 1 of Hot Line News No. 79 (100 and 400 km into the section, respectively), known to be in the area at this time.

The XBT section shown in Figure 2 (D) was taken on R/V Chain 127, Leg II (Eli Katz, Chief Scientist), which was returning to Woods Hole near the end of October on a track north and east of Leg I. A large-scale depression of the isothermal structure, similar to a section shown in the Fuglister Atlas (1960) at 66°W is observed. Results from Katz' tow fish between points E and F indicate no significant deviations from the indicated isotherms. An STD section taken near point F corresponds with the XBT section shown.

Reference

Fuglister, F. C. (1960) Atlantic Ocean Atlas of Temperature and Salinity Profiles and Data from the International Geophysical Year of 1957-1958. Woods Hole Oceanographic Institution Atlas Series, 1, Woods Hole, Mass.

ACKNOWLEDGEMENT

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Section	Chief Scientist	Contact	Vessel	Date	Description
A	G. Seaver	G. Seaver	R/V Chain 118	1/75	34°30'N
B	J. Teal	G. Seaver	R/V Chain 122	3/75	29°30'N
C	R. Spindel	M. Noble	R/V Chain 127I	9/75	Gulf Stream-Bermuda
D	E. Katz	M. Noble	R/V Chain 127II	10/75	Bermuda-Gulf Stream
E	W. G. Metcalf	G. Volkmann	R/V Atlantis II 56	3/70	Puerto Rico-70°W
F	National Marine Fisheries Service	G. Volkmann	Albatross 72-6	7/72	Norfolk-Antigua
G	National Marine Fisheries Service	G. Volkmann	Albatross 72-6	7/72	19°N-25°N along 67°W
H	National Marine Fisheries Service	G. Volkmann	Albatross 72-6	7/72	19°N-25°N along 68°W
I	National Marine Fisheries Service	G. Volkmann	Albatross 72-6	7/72	19°N-25°N along 69°W
J	National Marine Fisheries Service	G. Volkmann	Albatross 72-6	7/72	20°N-26°N along 71°W
K	National Marine Fisheries Service	G. Volkmann	Albatross 72-6	7/72	22°N-27°N along 72°W
L	National Marine Fisheries Service	G. Volkmann	Albatross 72-6	7/72	23°N-27°N along 74°W
M	D. Moller	G. Volkmann	R/V Knorr 36	12/73	Gulf Stream-MODE along 70°W
N	R. Heinmiller	G. Volkmann	R/V Chain 116	7/74	Gulf Stream-MODE along 70°W
O	N. Fofonoff	G. Volkmann	R/V Chain 107	10/72	Gulf Stream-MODE along 70°W
P	R. Heinmiller	G. Volkmann	R/V Chain 116	7/74	along 28°N, 70°W-54°W
Q	R. Heinmiller	G. Volkmann	R/V Chain 116	7/74	South along New England Seamounts, down 60°W
R	E. Katz	G. Volkmann	R/V Atlantis II 83		Equator-Barbados
S	P. Richardson	T. Rossby (see HLN No. 70)	R/V Trident 160	11/74	24°59', 49°37'- Barbados
T	P. Richardson	T. Rossby (see HLN No. 70)	R/V Trident 160	11/74	24°59', 49°37'W- Bermuda
U-X	V. Worthington	M. McCartney (see HLN No. 74)	R/V Knorr 43	10/74	56°30', 58°30' 60°30', 62°30'
U-X	V. Worthington	M. McCartney (see HLN No. 74)	R/V Knorr 48	3/75	56°30', 58°30' 60°30', 62°30'

TABLE I

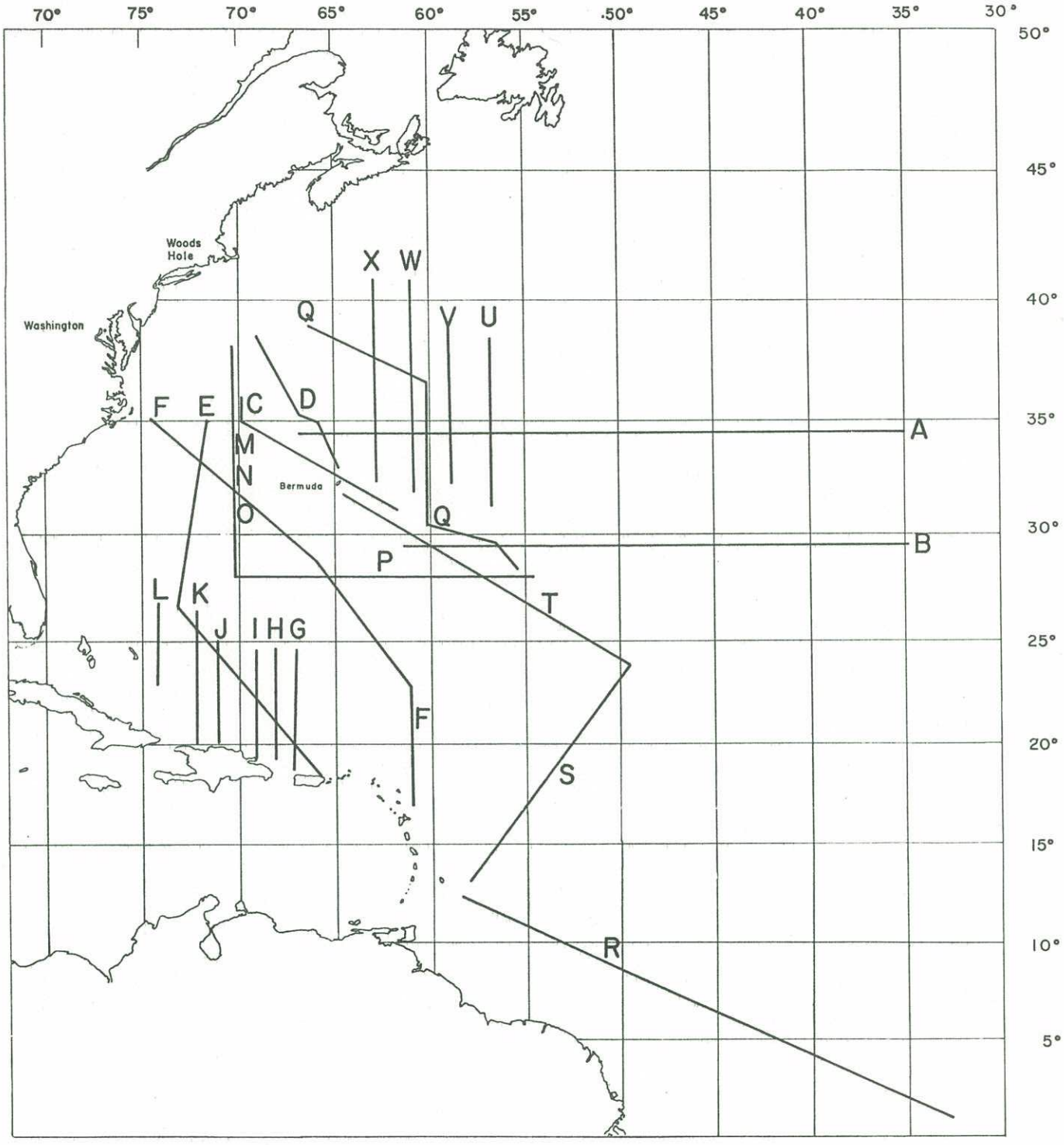
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CHART I

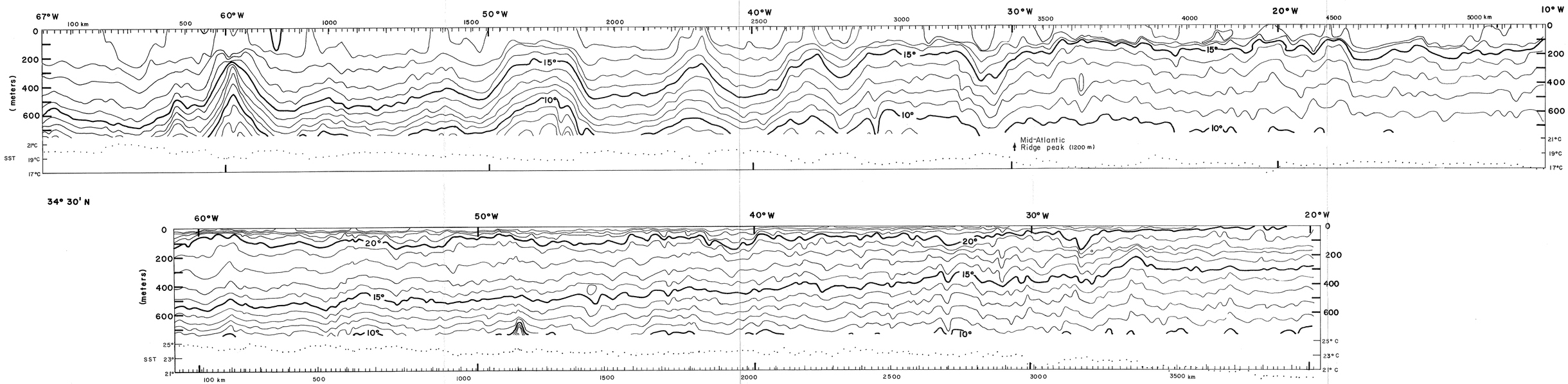
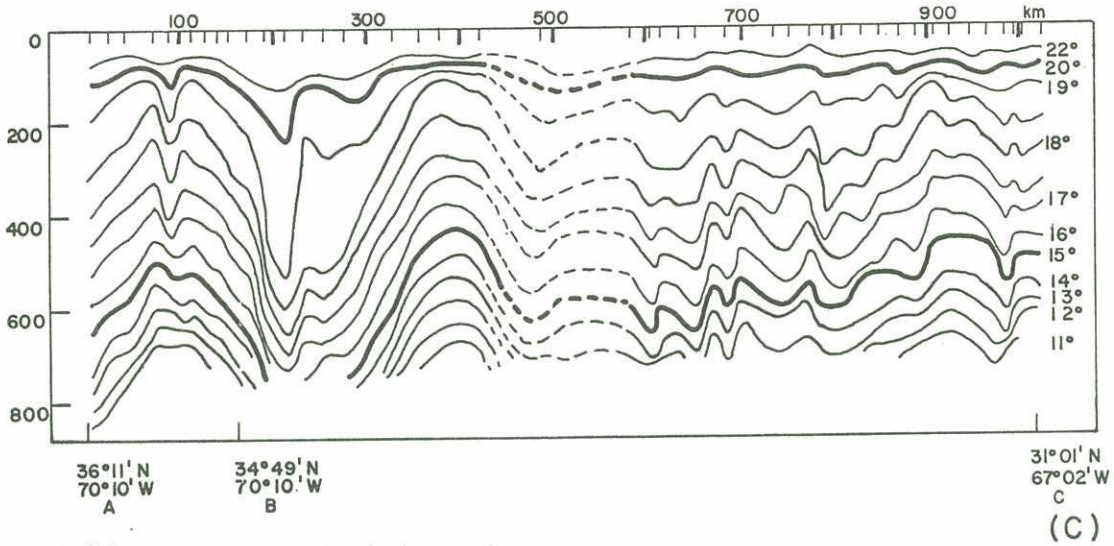
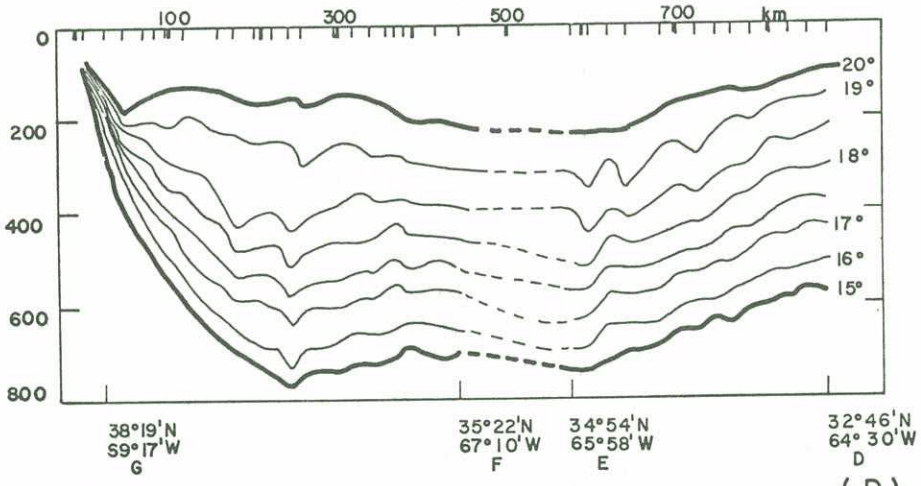


Figure 1 (Seaver)



Gulf Stream-Bermuda (R/V Chain 127I, September, 1975).



Bermuda-Gulf Stream (R/V Chain 127II, October, 75)

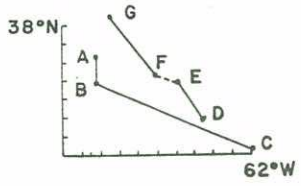
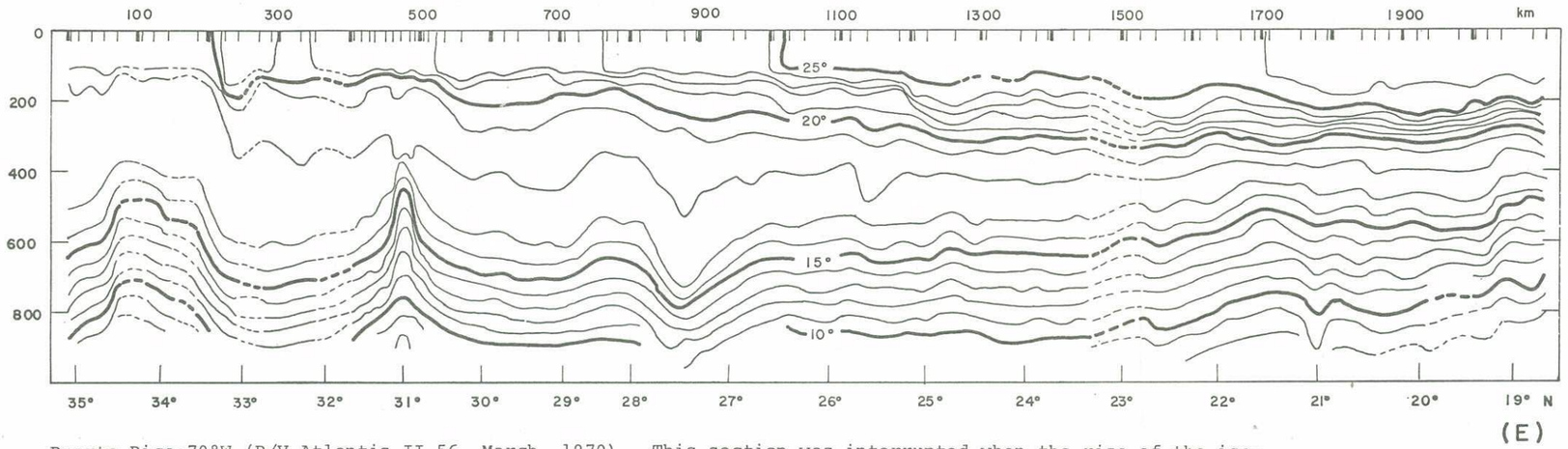
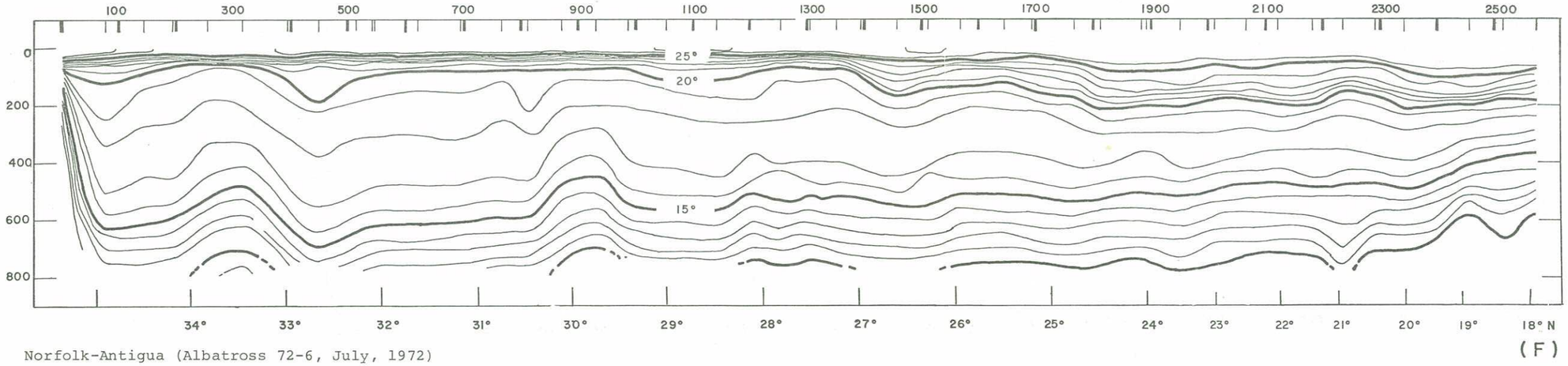


Figure 2 (Noble)

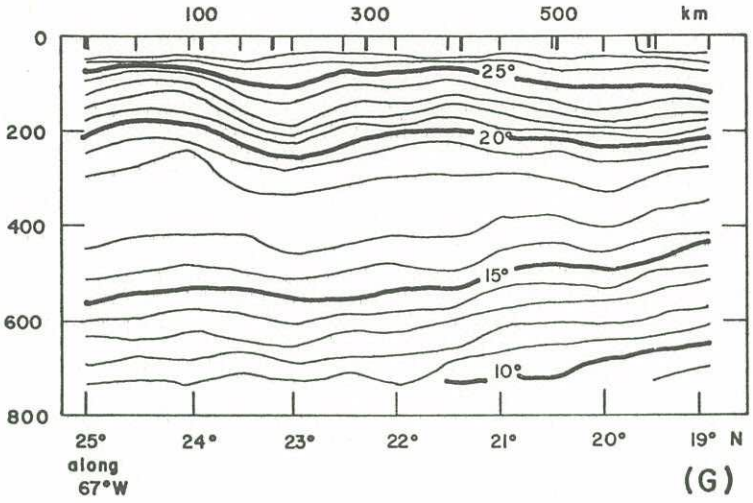


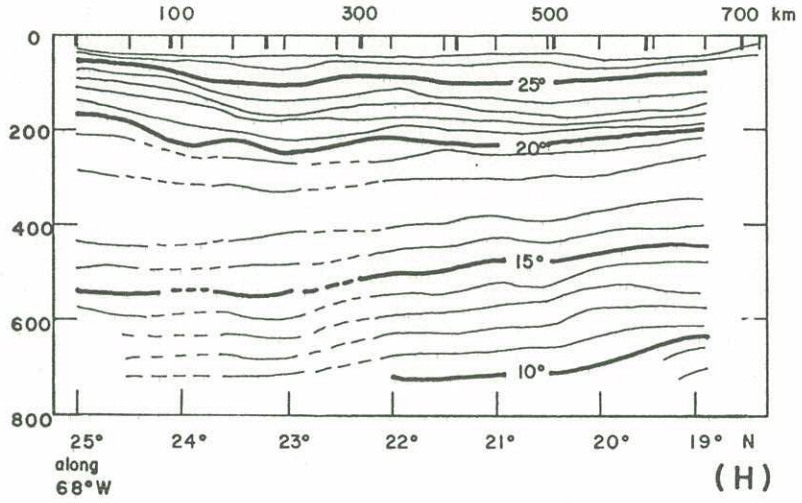
Puerto Rico-70°W (R/V Atlantis II 56, March, 1970). This section was interrupted when the rise of the isotherms at 32°N indicated that an eddy was near. The feature was surveyed with hydrographic stations and more XBT's. These show the center to be about 15 km east of the original ship track. The section shown here is a composite of these observations drawn to go through the center of the eddy.



Norfolk-Antigua (Albatross 72-6, July, 1972)

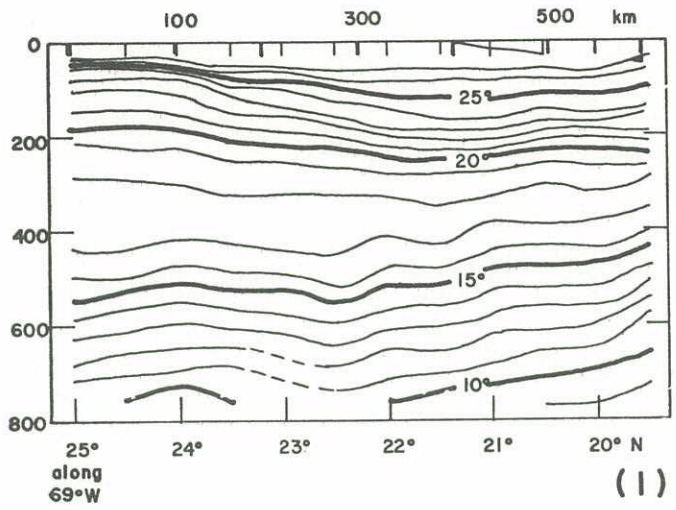
Figure 3 (Volkmann)

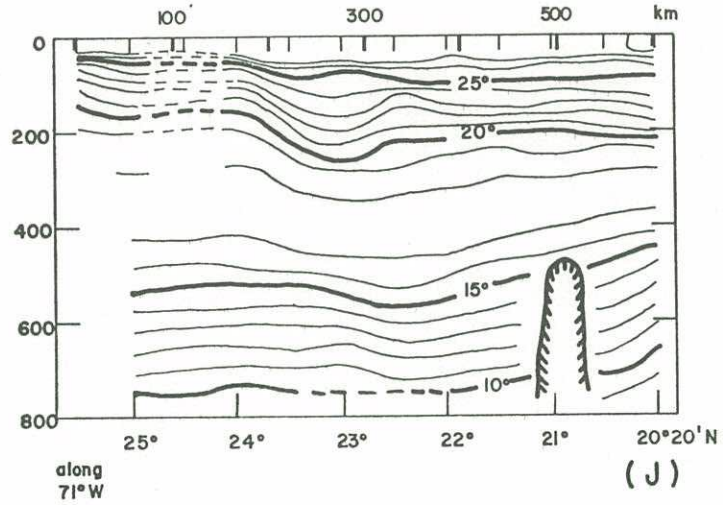




Albatross 72-6 (July, 1970)

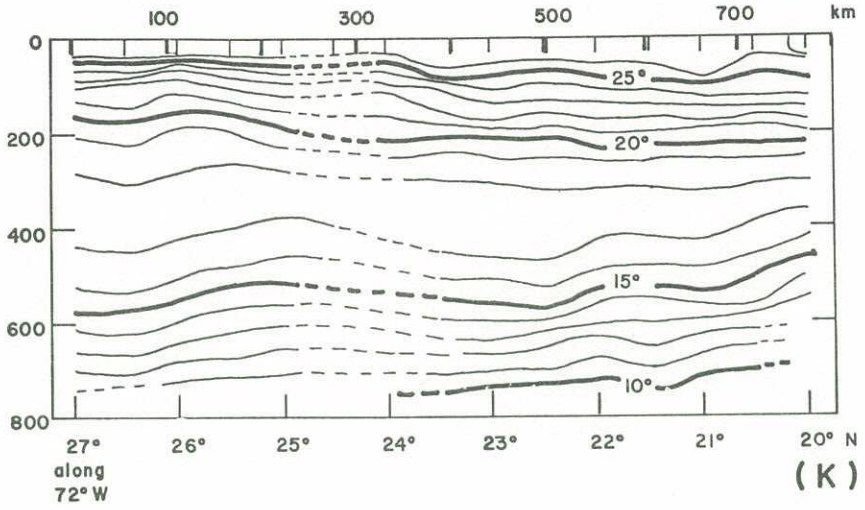
Figure 4 (Volkmann)

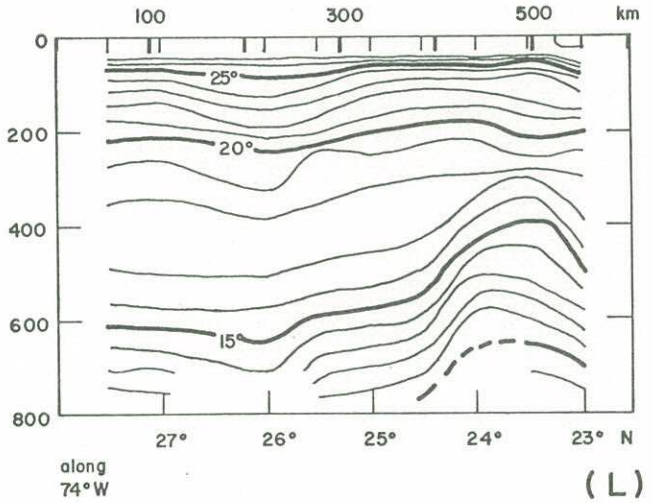




Albatross 72-6 (July, 1970)

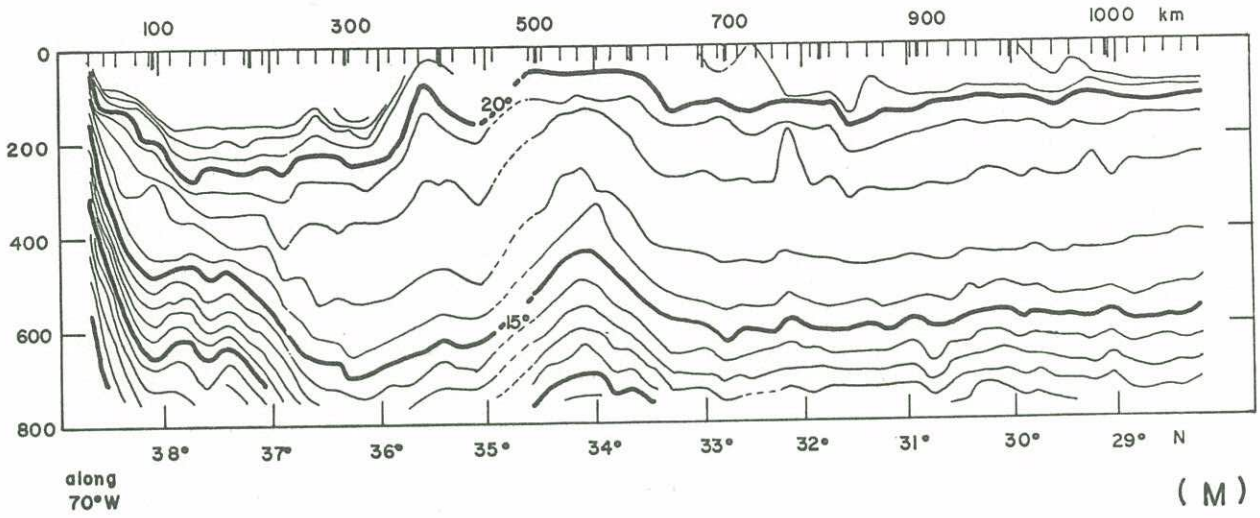
Figure 5 (Volkmann)



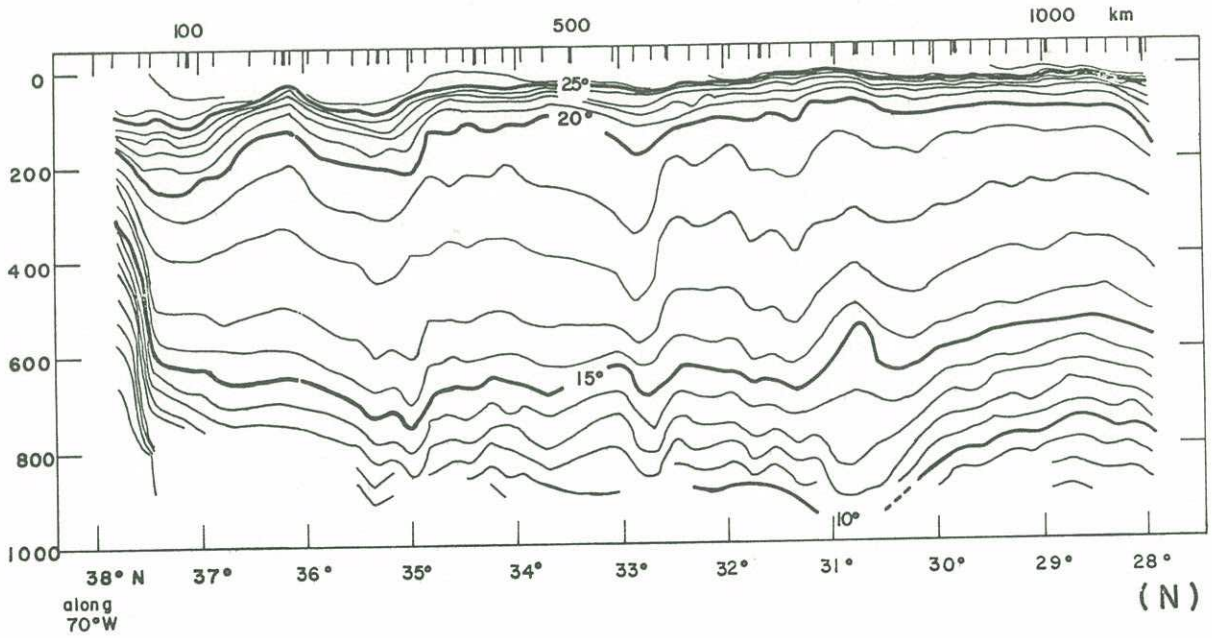


Albatross 72-6 (July, 1970)

Figure 6 (Volkmann)

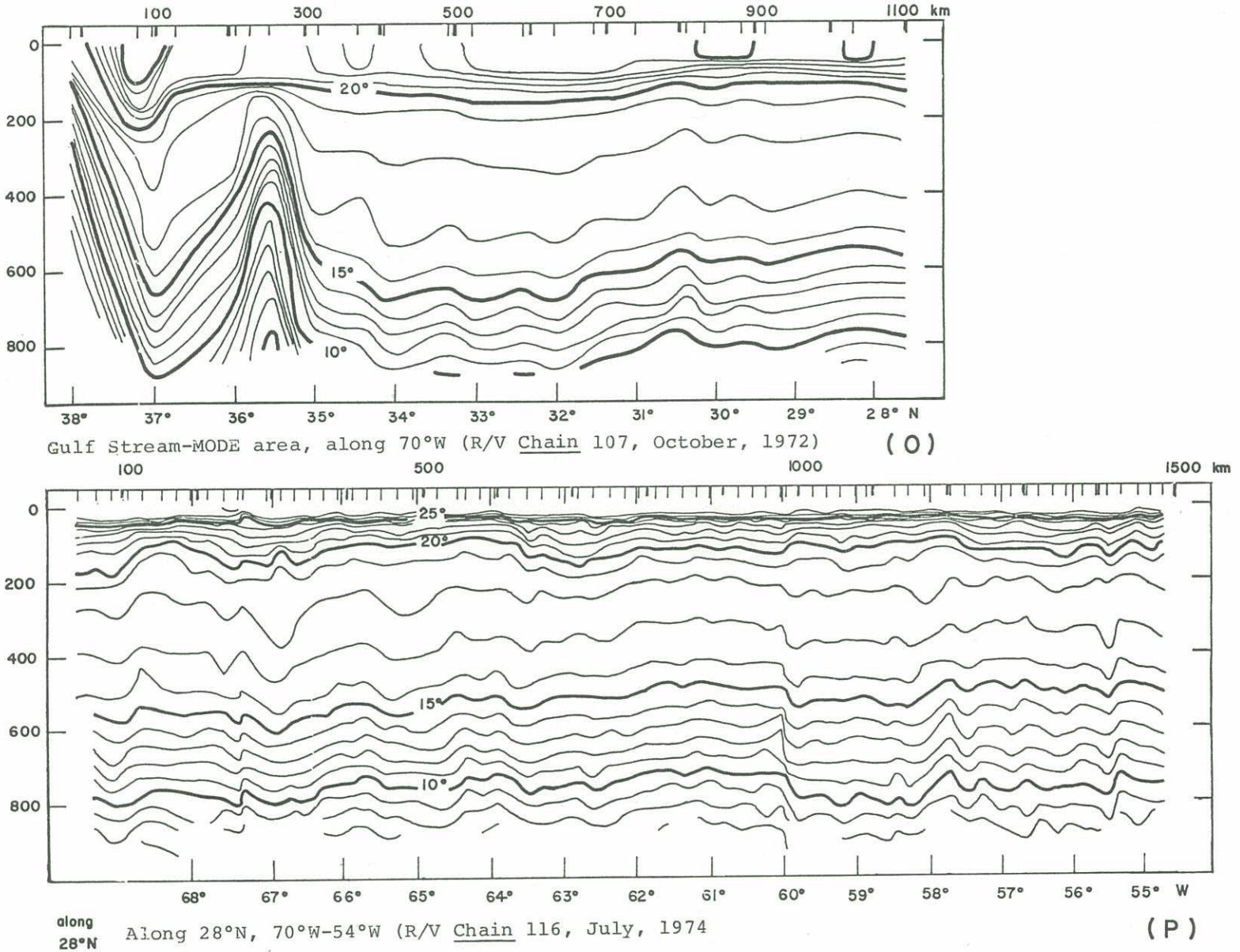


Gulf Stream-MODE-I area along 70°W (R/V Knorr 36, December, 1973)



Gulf Stream-MODE-I area along 70°W (R/V Chain 116)

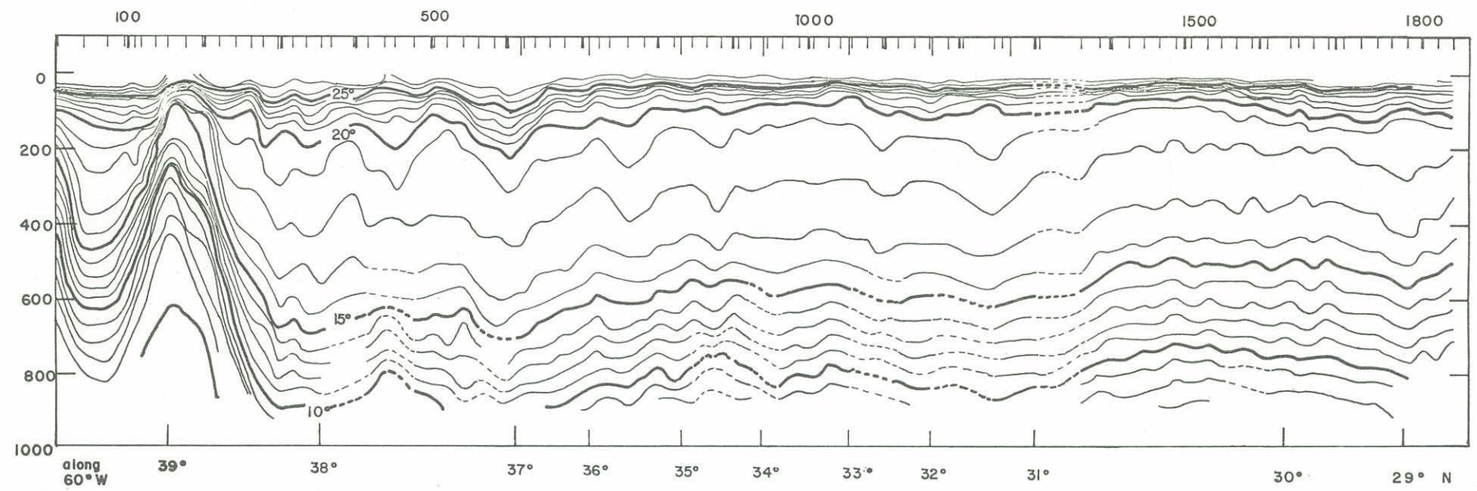
Figure 7 (Volkmann)



Gulf Stream-MODE area, along 70°W (R/V Chain 107, October, 1972) (O)

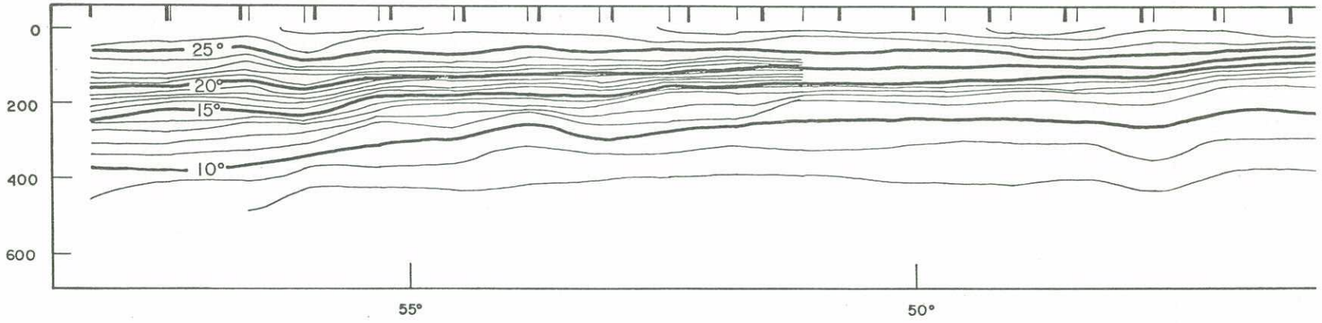
Along 28°N, 70°W-54°W (R/V Chain 116, July, 1974 (P)

Figure 8 (Volkmann)



South along New England Seamounts, down 60°W (R/V Chain 116, July, 1974).

(Q)



Equator-Barbados (R/V Atlantis 83).

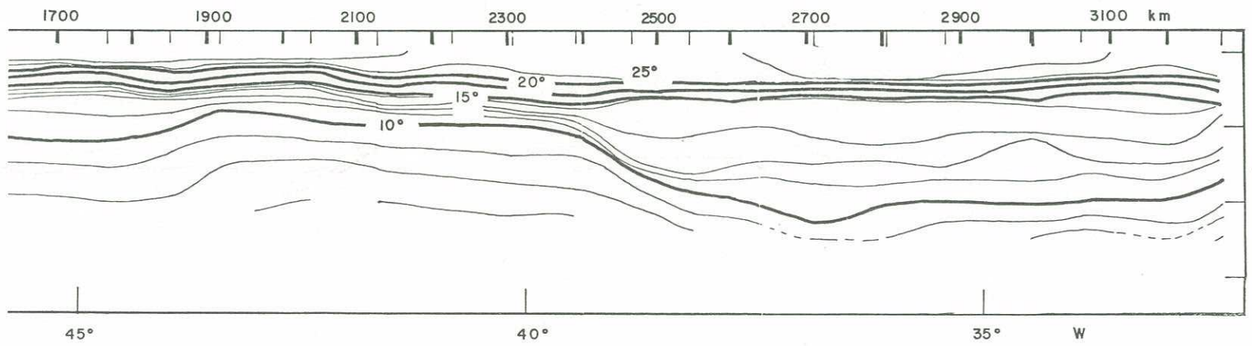
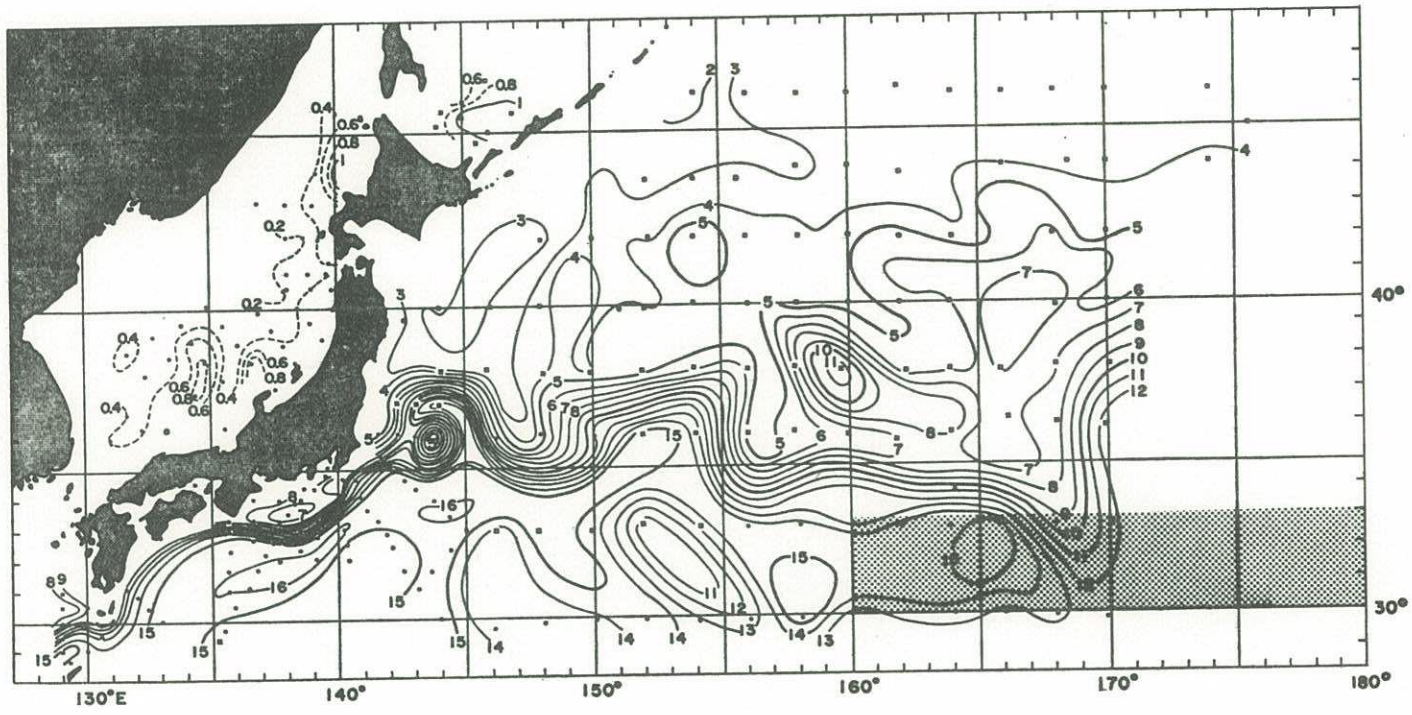


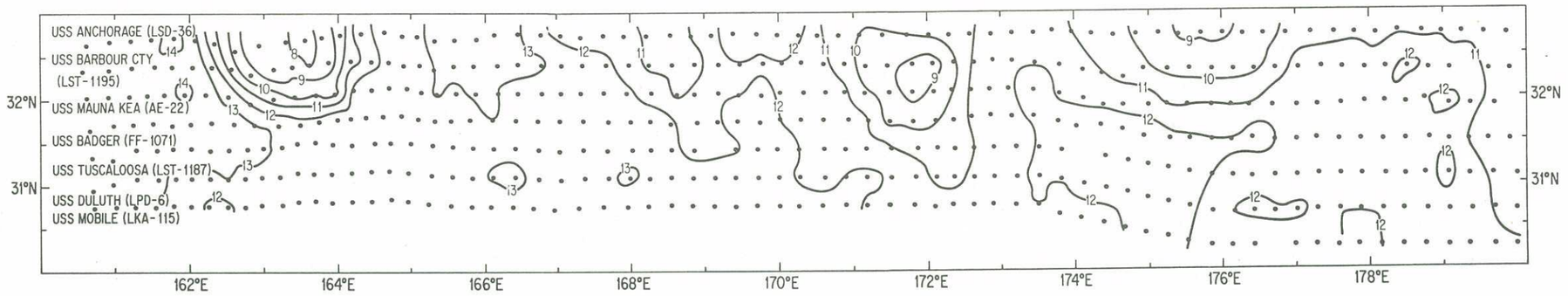
Figure 9 (Volkmann)

(R)



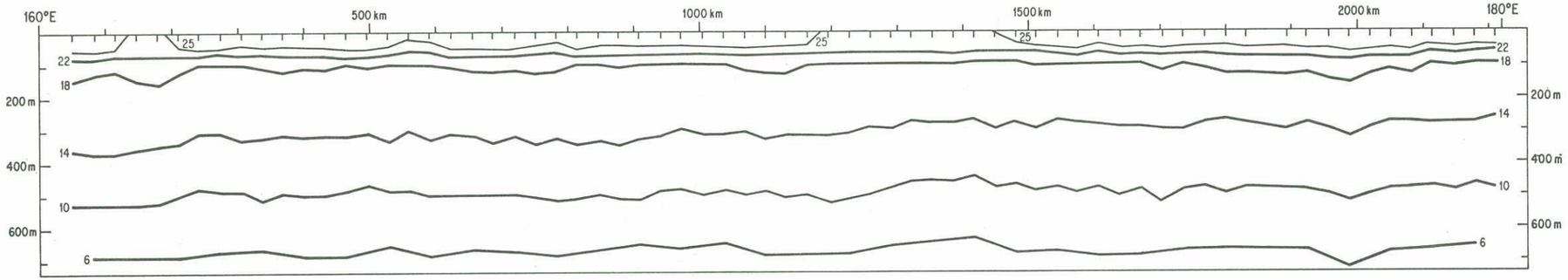
Temperature at 400 m depth in the summer and fall of 1957 around Japan (after Kawai, 1972). The shaded area represents that area surveyed by XBT's during 3-5 November 1975.

Figure 10 (Wilson and Dugan)



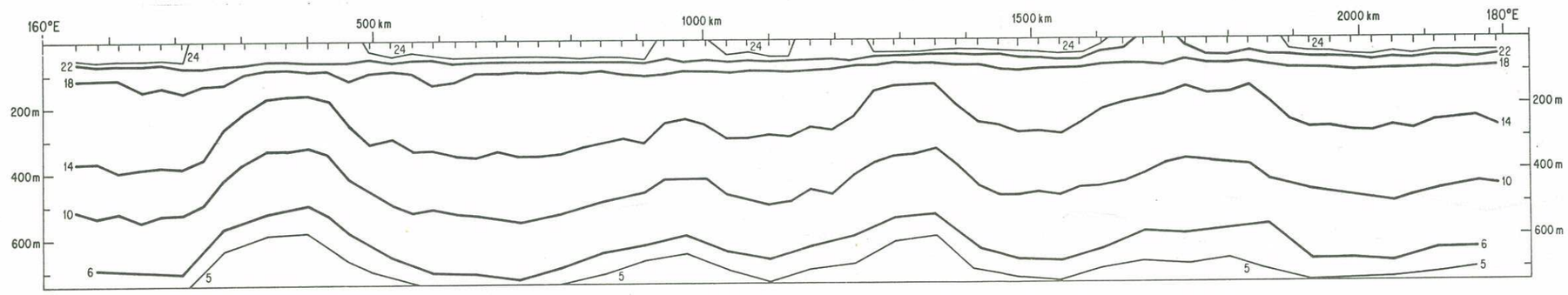
A

Temperature at 400 m depth based on XBT's dropped during 3-5 November. Dots represent approximate positions.



B

Vertical temperature section based on XBT's dropped by the USS Mobile along the southernmost track shown above.



C

Vertical temperature section based on XBT's dropped by the USS Barbour County along the next-to-northernmost track shown in the top figure

Figure 11 (Wilson and Dugan)