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OBSERVATIONS OF THERMAL STRUCTURE IN THE CENTRAL PACIFIC,(U)

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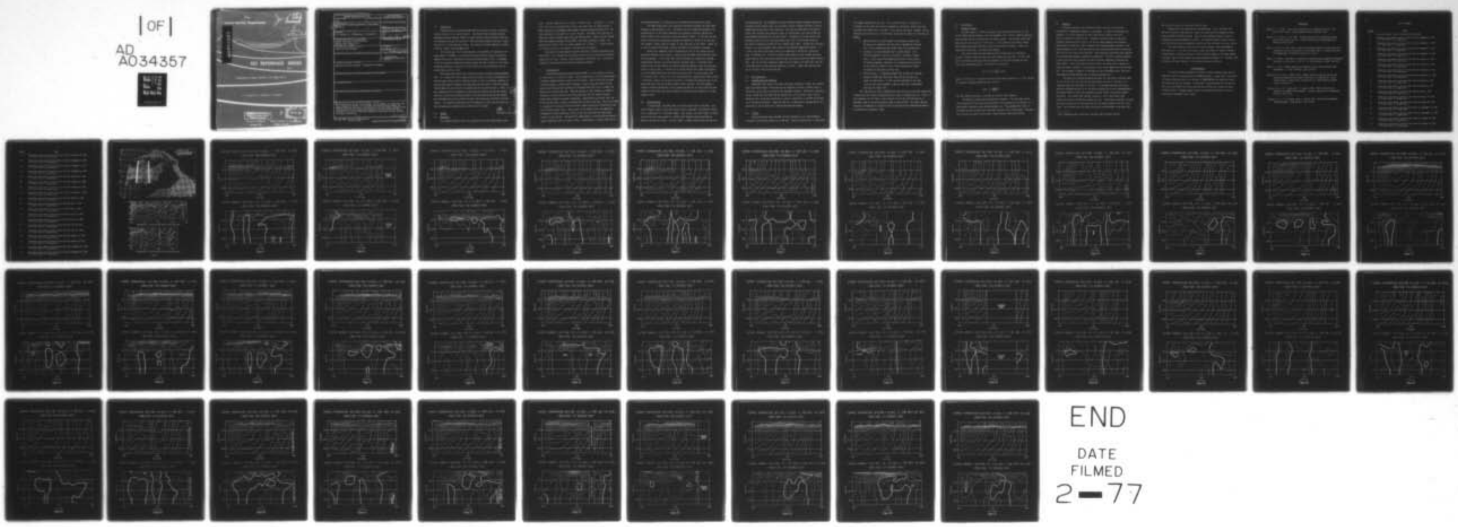

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76-19

OBSERVATIONS OF THERMAL STRUCTURE IN THE CENTRAL PACIFIC

T. P. Barnett, M. H. Sessions, P. M. Marshall

University of California Scripps Institution of Oceanography

November 1976 N00014-75-C-0152

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The ultimate goal of this field program, called AIRPAC, in conjunction with other programs in NORPAX, is to describe and quantitatively explain the observed temporal and spatial fluctuations of the near-surface thermal field. A knowledge of why the subsurface temperature patterns change and their relation to sea surface temperature anomalies, could have a direct bearing on climate forecasts.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

1.0 Introduction

Long-range Naval aircraft have been used for the past two years to observe thermal structure in the central Pacific. The aircraft have dispensed airborne expendable bathythermographs (AXBTs) at fixed locations along longitudes 158°W and 170°W between latitudes 30°N and 50°N. AXBTs have been dropped along each of these sections at a station spacing of 80 km. The sections have been repeated at roughly a monthly interval since November 1974.

The ultimate goal of this field program, called AIRPAC, in conjunction with other programs in NORPAX, is to describe and quantitatively explain the observed temporal and spatial fluctuations of the near-surface thermal field. A knowledge of why the subsurface temperature patterns change and their relation to sea surface temperature anomalies, could have a direct bearing on climate forecasts (see for example Namias 1972a,b, 1973).

The present preliminary report displays the data collected through September, 1976. It is hoped that visual inspection of this data by various investigators will interest them in the scientific problem at hand, as well as providing a feeling for how the ocean actually changes over large space and time scales. With this present limited objective, the text will do nothing more than present the data. Little, if any, explanation will be offered as to the mechanism causing the observed changes. With this in mind the following sections of the text describe briefly the methods and instrumentation used to collect the data, data processing, and finally the data display. The graphical presentation of each temperature section and the resulting derived temperature anomalies make up the body of the report.

2.0 Methods

2.1 Operations

The standard operation calls for occupying each section approximately every month. The data gathering exercise begins in Adak, Alaska. From Adak, a U.S. Naval Fleet P-3C flies to coordinate 50°N, 158°W, then south along the 158th meridian. AXBTs (see below) are dropped at 80 kilometer intervals between 50°N and 30°N. The plane continues on into Hawaii for a day's layover. From Hawaii the plane goes to Midway and, hence, proceeds north along the 170th meridian. AXBTs are again dropped every 80 kilometers between 30°N and 50°N. The flight terminates in Adak. The study area and flight tracks are shown schematically in Figure 1. A simple example of a typical section is also shown in the lower part of Figure 1.

An on-board Scripps technician insures that data is properly obtained during each flight. He is responsible for quality control as well as directing the general aspects of the flight. However, actual navigation, BT dropping, etc., are done by operational Navy personnel and they have proved most helpful.

2.2 Instrumentation

The airborne expendable bathythermograph (AXBT) is used to obtain a profile of temperature as a function of depth. The instrument works in the following manner. A computer command launches an AXBT from the aircraft. Upon hitting the airstream a rotochute deploys, slowing the BT's descent. Upon striking the surface of the water an end plate and the rotochute are jettisoned from the BT and it assumes the posture of a drifting spar buoy. With the ejection of the rotochute, an antenna is allowed to rise and, with the loss of the end plate, the salt water activates a battery that eventually provides system power. Approximately one minute after the BT has hit the water, a probe is released from the body of the buoy. The falling probe is connected to the buoy by a hard wire which returns temperature information to the still drifting surface float. Upon arrival in the surface float, the temperature information is used to modulate a radio carrier with the resulting signal being received in the aircraft. The probe falls approximately 1.53 m/sec and continuously returns temperature data to a depth of 335 m. Approximately 7 minutes after the BT has entered the water, a scuttle plug is activated and the entire unit sinks.

The AXBTs being used in this operation have been calibrated such that their accuracy is easily within ± .2°C. The details of this calibration procedure, the characteristics of the probes themselves are reported in Sessions, Barnett and Wilson (1976) as well as Sessions, Bryan and Barnett (1975). It will turn out that errors of the order of magnitude indicated are generally a factor of 10 less than the 'anomaly' signals that will appear in later sections of this report. Hence, for a study of large scale thermal variation the AXBT is an excellent instrument.

Another key component of the instrumentation used in this program are the navigation devices on the aircraft. Several types have been used during the course of the experiment. In one case, dual inertial systems are linked with a doppler ground speed indicator to provide positions accurate within ± 2 nautical miles. The drift rate on the inertial navigation systems has generally been less than one nautical mile per hour. A second type of system involves dual inertial navigation units with OMEGA update such that absolute position error is always better than ± 2 nautical miles. Suffice it to say, the navigational capabilities of the aircraft is excellent. Hence, we are able to go back to virtually the identical spot in the ocean time after time and re-drop an AXBT at that location. Thus the changes in thermal structure represented in the accompanying material are those resulting from changes in time rather than those induced by inaccurate spatial sampling in a high gradient field.

2.3 Data Recording

As stated above, the AXBT sends a VHF radio signal back to the plane. The audio frequency signal on the radio carrier can be converted to the desired information on temperature as a functional depth. Upon receipt, the radio signal is routed from the aircraft radio system to a digital data logging system constructed by Meredith Sessions of Scripps. The data logger is highly versatile and provides the following features: Two independent cassette recorders provide redundant capability and digitize the incoming signal at one second intervals thereby providing a vertical temperature profile with 1.53 m resolution. The data are digitized to the nearest 0.03°C, thus insuring that round-off errors are significantly less than calibration uncertainties associated with the AXBT itself. In addition to the two digital data recorders, there is also a hard copy printer that lists, at one second intervals, the value of frequency stripped off the incoming radio signal. Perhaps most important, however, is a visual display (strip chart) of the observed temperature profile. It is this strip chart record that allows us to determine if the BT was a successful drop. BT failure (i.e., failure to return a good signal at least through the mixed layer) requires that the aircraft return to the last drop position and replant another AXBT. This on-site data inspection capability has allowed us to return well over 95% of the data that it would have been possible to collect. Hence, the resulting data set is virtually free of holes and gaps.

3.0 Data Processing

3.1 Decoding and Error Checking

Immediately upon return to Scripps Institution following a flight, the cassette tapes are played through a Nova computer and converted to 9-track, 800 BPI tape in a format that can be read by virtually any reasonable computer. During this translation process, header data are added and any pecularities in the digital record, such as premature start of the data recording or a partial recording of a bad AXBT are deleted via an interactive terminal. Hence the tape that is generated is systematized in the sense that it can be read with a standard data editing program.

3.2 Editing

Once the data has been converted into BCD characters, it is read through an interactive data editing program on an IBM 1800. Numerical pecularities, if they occur, are flagged automatically for study. Also, each AXBT trace is displaved on a cathode ray tube (CRT) and visually inspected for continuity, spikes, and other "glitches" that might exist in the data. Very few are ever found. However, several difficulties that do occur are listed below, along with the manner in which they are handled.

a. Sharp spike due to signal dropout in an otherwise smooth trace: The data point responsible for the spike is deleted and replaced with a value interpolated from either side of the missing point.

b. A section of a trace unuseable due to signal dropout: This difficulty generally occurs as the probe is reaching its depth limit. In this region the temperature profile is quite smooth. The editing treatment, therefore, is to delete the noisy section of the record and replace it with linear interpolation between the regions of good data on either side.

c. Partical traces: It sometimes happens that the AXBT will operate properly through the mixed layer (about 100 m) and then lose signal for some reason. In this case the remainder of the trace is set to zero and no attempt is made at that time to interpolate from drops on either side.

The final data set that is developed for each section has thus been mechanically screened once and visually inspected twice for errors, incongruities, etc. Little, if any, tampering with the data is ever required so that the resulting data set is extremely close to the data originally taken on the aircraft. The clean, complete data set is forwarded to a large disc file on the Control Data 7600 machine where it is available for scientific study.

4.0 Data Display

4.1 Standard Sections

The upper panels of Figures 2 through 37 show the sections derived for each of the flights between November, 1974 and September, 1976. Several comments regarding these sections should be noted before the reader proceeds. The raw data fields that make up these plots consists of 1100 points. In all there are 25 stations between 30°N - 50°N and 54 depths selected in the vertical (every 6.1 meters). Hence, the contouring is done over a very dense data network.

The original data field has been low pass filtered prior to plotting to present a coherent picture of the large scale features in the field. In plots made prior to filtering, mesoscale eddies are apparent in the field although the same large scale properties persist. The filter is of the form

$$F(x) = 1/2\ (1-\left|\frac{x}{X}\right|),\quad |x|\leq X$$

where X = 160 km and x is distance from the station being studied (i.e., 0, 80, 160 km). The (spatial) response function of this filter is

$$Q(k) = X\ \left(\frac{\sin\pi kX}{\pi kX}\right)^2$$

Thus the response function is 3 db down at scales of 320 kilometers.

The following figures were constructed by computer. Thus the reader should not be surprised to find occasional pecularities in the drawing of the contours, i.e., sharp spikes, contoured lines running together, etc. These abnormalities occur infrequently and do not affect the significant features of the illustrations. Nevertheless, they are the type of things that a human contourer would have avoided.

4.2 Anomalies

A primary interest in our scientific study is to look at the vertical distribution of temperature anomalies in the ocean. In order to investigate this question, it is first necessary to form a mean field to subtract from each section to develop an anomaly field. Formation of the mean field is described elsewhere (Barnett and Ott, 1976) so for now we simply summarize the procedure. Approximately 100,000 XBTs, AXBTs, mechanical BTs and hydrographic sections in the region bounded by 30°N to 50°N and 140°W to 180°W were extracted from the historical data files for the time period 1949-1973. These numerous observations were subjected to two screening processes to delete bad information. The first screening compared a given trace with that expected from mean climatology developed by Robinson and Bauer (1973).* Values that were not within ±40% of the atlas value at depths of 0 and/or 120 meters resulted in the exclusion of that entire observation from the data set. This procedure allowed us to eliminate the most outrageous values that would have otherwise caused problems for our second screening test.

The second test involved computing the means at a variety of different depths (0, 30, 60, 90, 120, 150, 200, 250, and 300 meters) for each 2° latitude x 10° longitude square for each month of the year. The standard deviation about these means was computed and then all of the data associated with a given quadrangle/month was passed through a filter that accepted only data values within three standard deviations. This second step excluded 'outlayers,' but a surprisingly large portion of the data ($\sim$75,000 obs) passed this test. After double screening, the means were again formed from the remaining data for the space/time/depth intervals cited above. The resulting data set should constitute a good estimate of the mean field

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* This climatology used a fraction of the data used by Barnett and Ott.

over the last 25 years in the central Pacific Ocean.

Computation of the anomalies was straightforward. First, the mean field defined on the grid cited above was linearly projected onto the standard sections along the 158th and 170th meridian. Thus, for each standard station, we have a climatological average temperature profile. The anomalies simply result from subtracting from the observed temperature profile the long term mean at a given station.

The resulting anomaly section was low pass filtered in the same manner as described in 4.1. The results are shown in the lower panels of Figures 2 through 37 and provide a fascinating picture of month-to-month changes in the ocean thermal structure. Many of these changes have been documented elsewhere (T. P. Barnett, 1976). The bulk of the data, however, is now undergoing extensive analysis.

<u>Acknowledgments</u>

This work has been supported by the Office of Naval Research under contract N00014-75-C-0152 in association with the NORPAX program. A great deal of the credit for obtaining the data must go to the men of COMPATWINGSPAC who manned the planes from which the data was obtained. A great deal of gratitude goes also to those in ONR liaison and AIRPAC liaison who overcame many difficulties to make the actual flights possible. Commander Robert Lawson and Lieutenant John Kohli are to be particularly commended in this regard.

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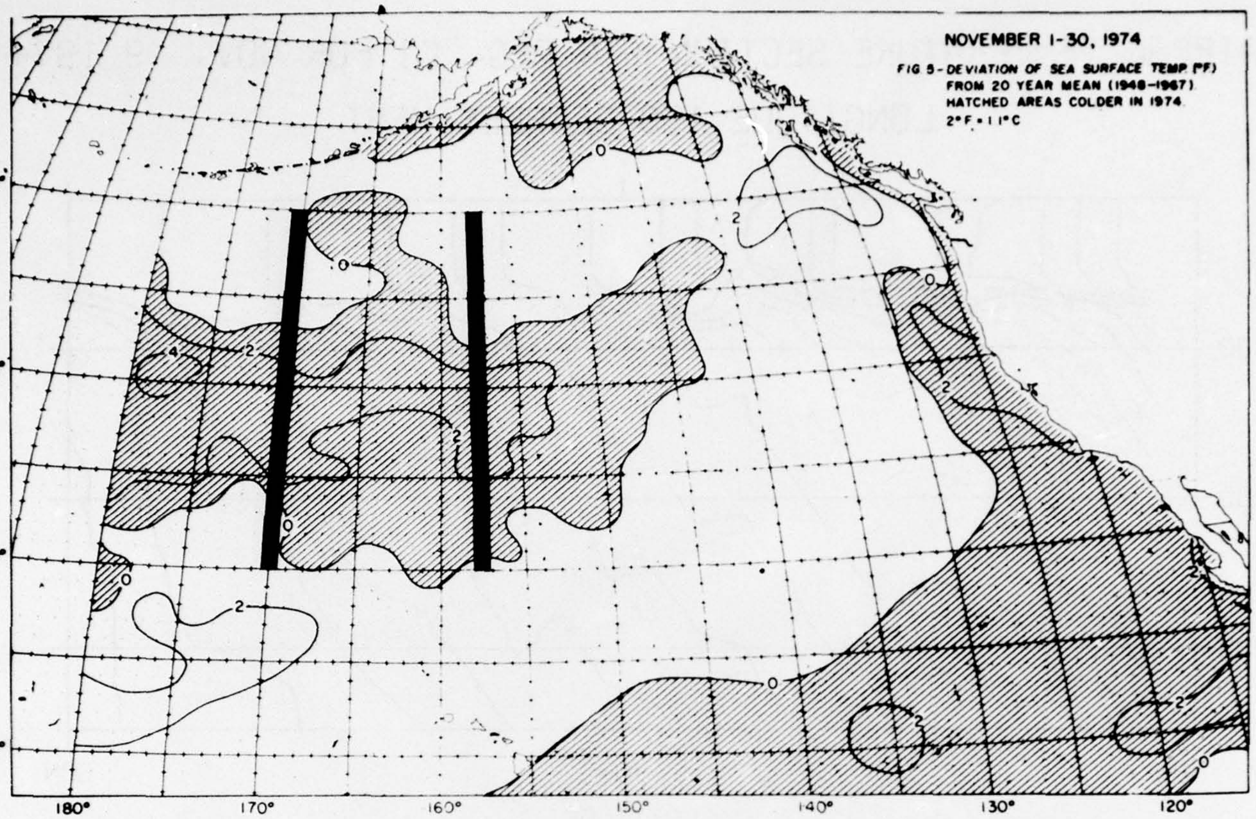
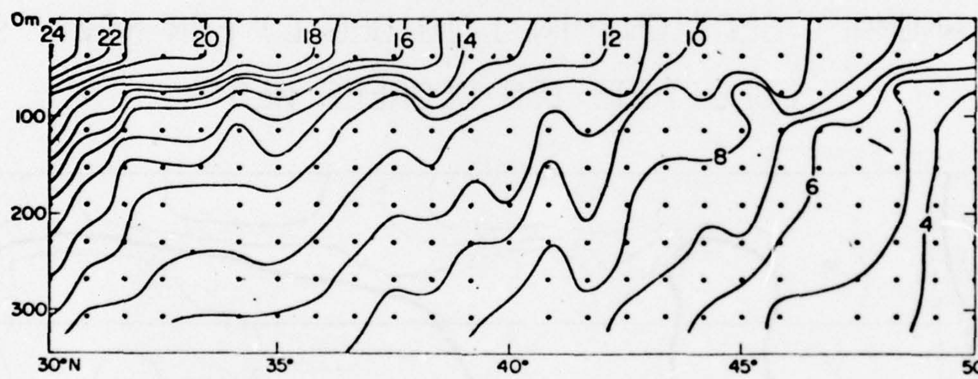
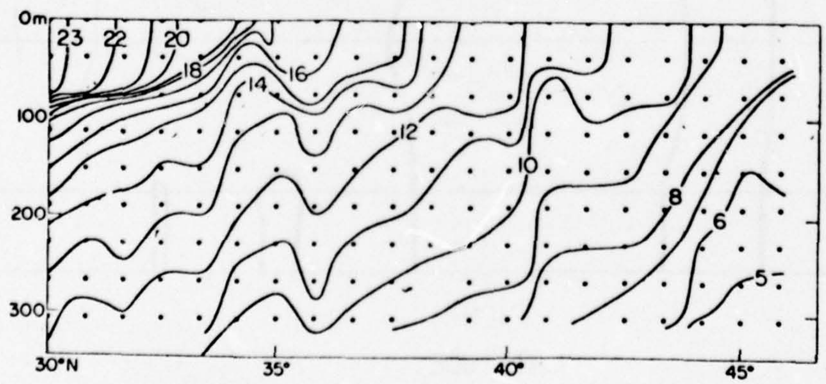




TEMPERATURE SECTION ALONG 158° W FOR 9 NOV. 1974

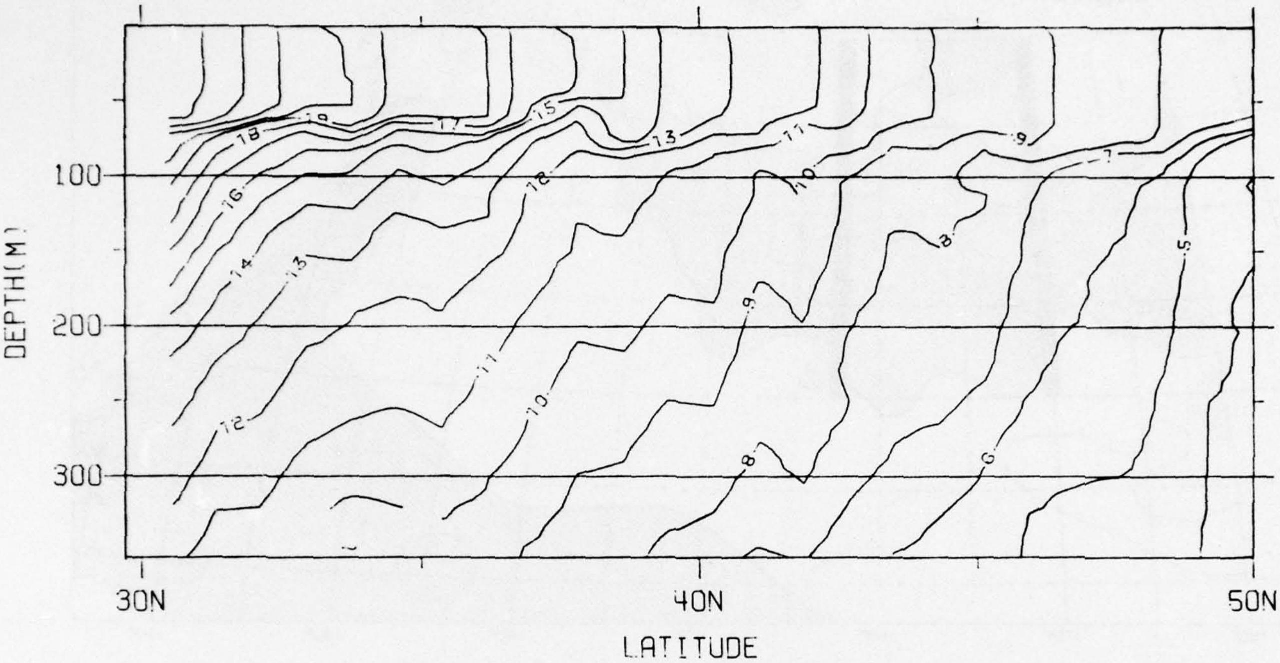


TEMPERATURE SECTION ALONG 170° W FOR 11 NOV. 1974

Figure 1

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR NOV. 9 1974

LONGITUDE 158 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR NOV. 9 1974

LONGITUDE 158 DEGREES WEST

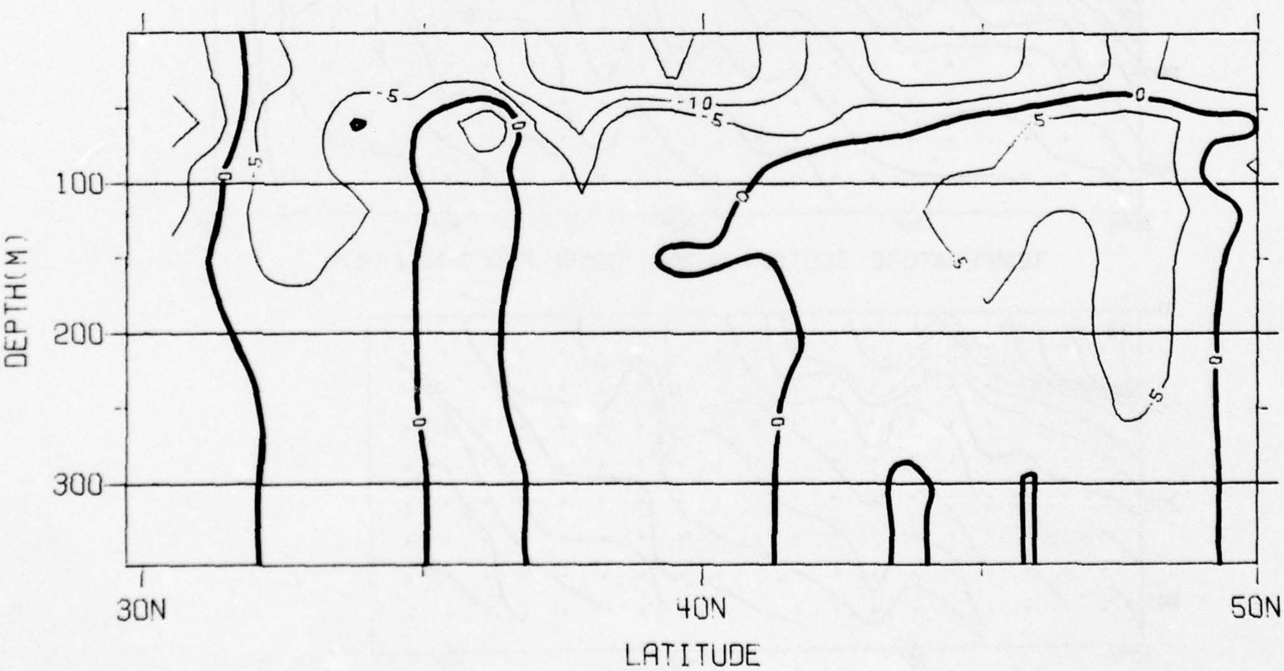
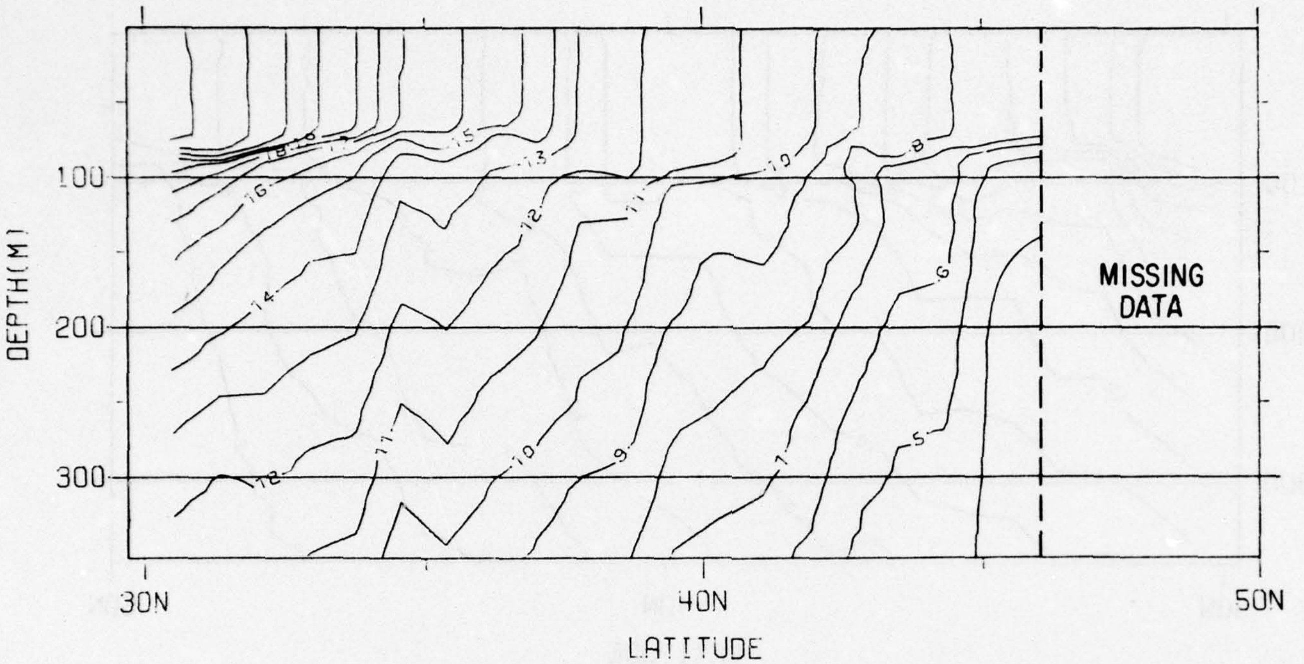


Figure 2

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR NOV. 11 1974

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR NOV. 11 1974

LONGITUDE 170 DEGREES WEST

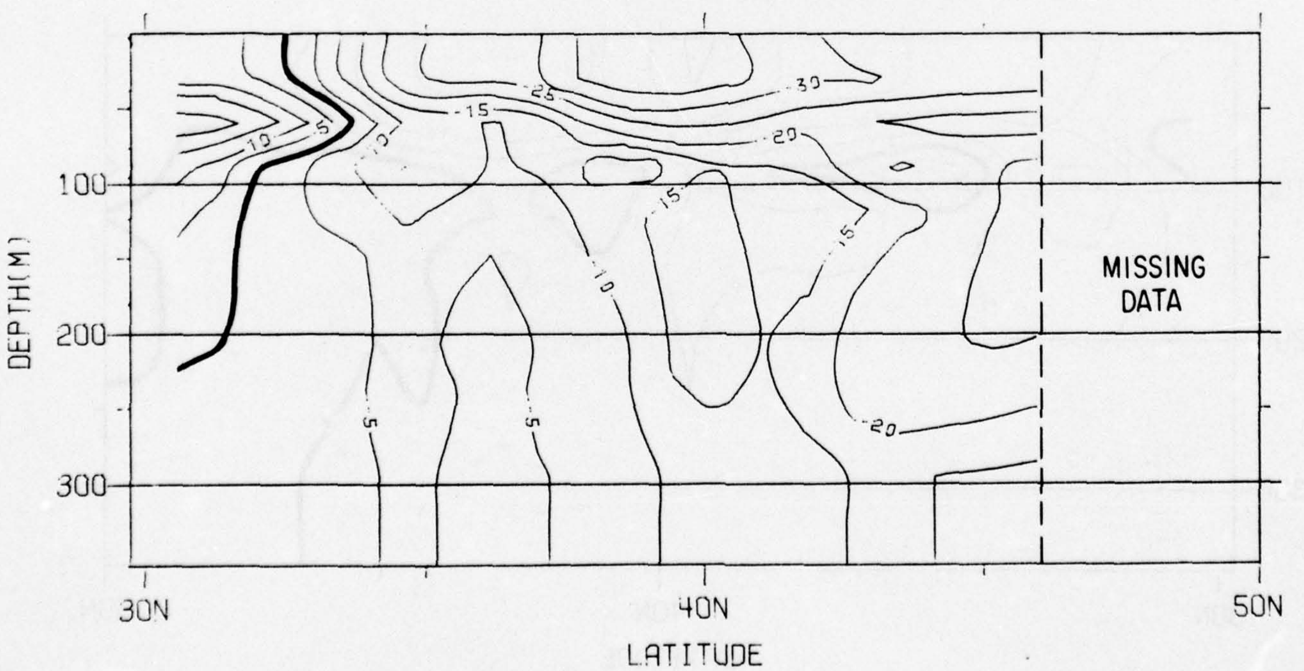
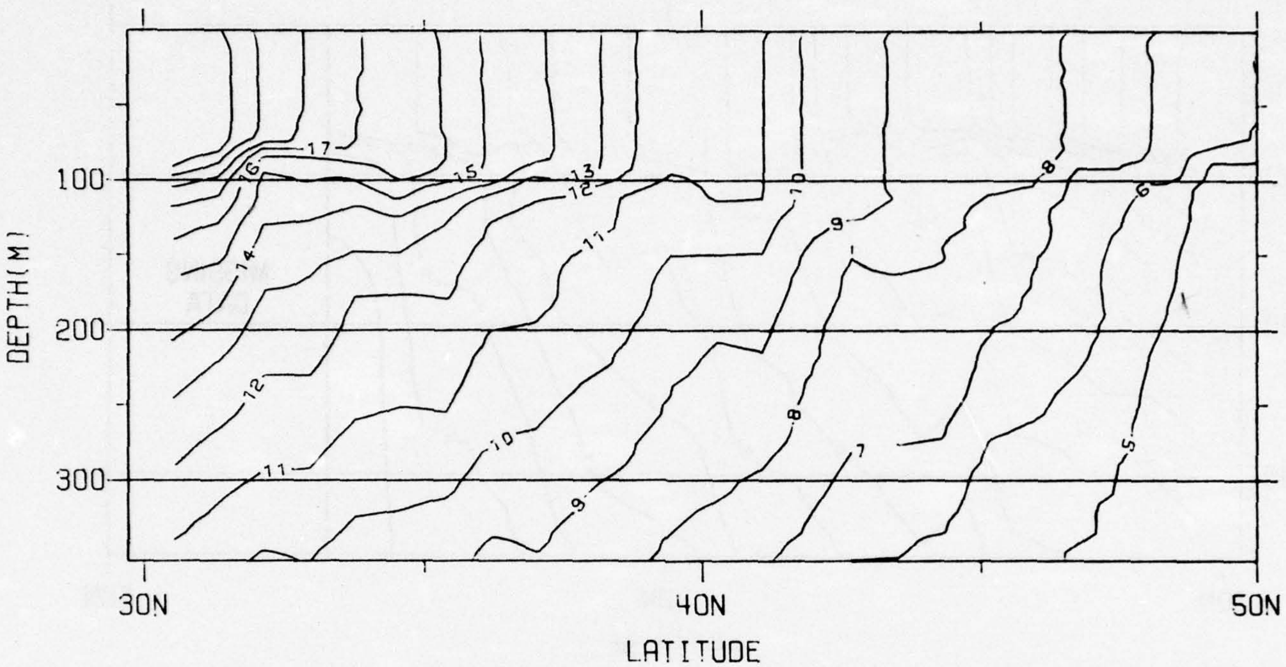


Figure 3

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR DEC. 7 1974

LONGITUDE 158 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR DEC. 7 1974

LONGITUDE 158 DEGREES WEST

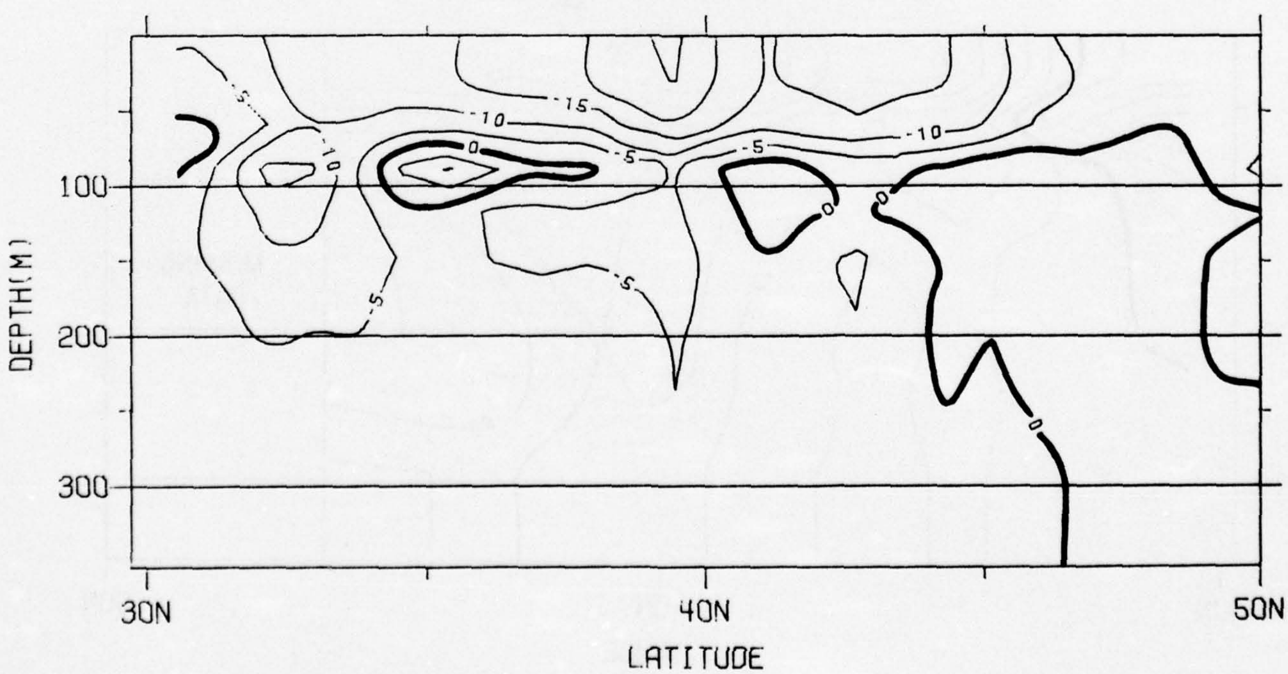


Figure 4

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR DEC. 11 1974

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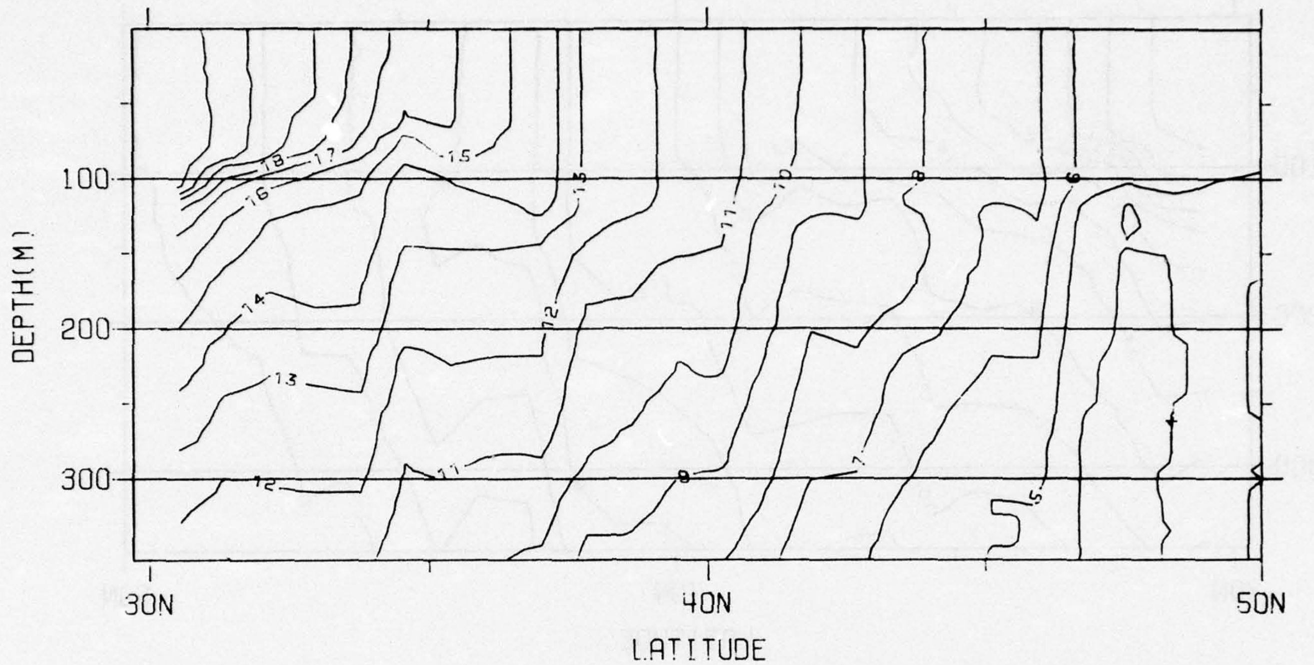

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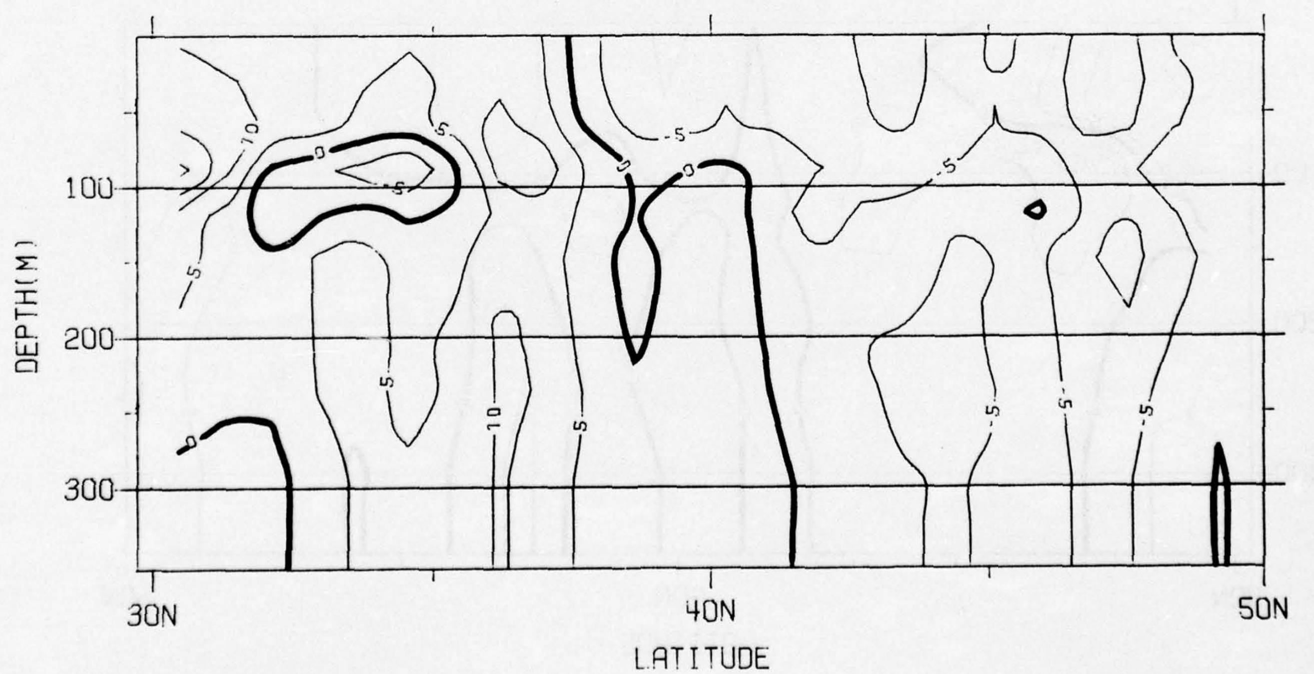

Figure 5

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR JAN. 11 1975

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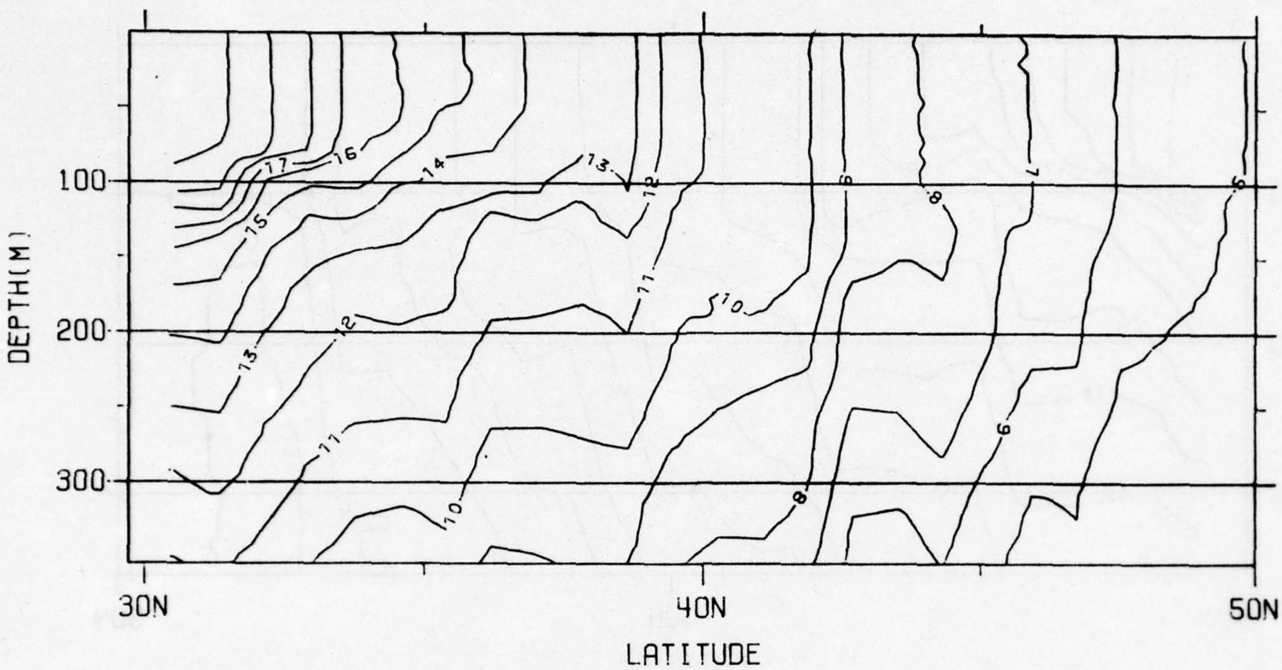

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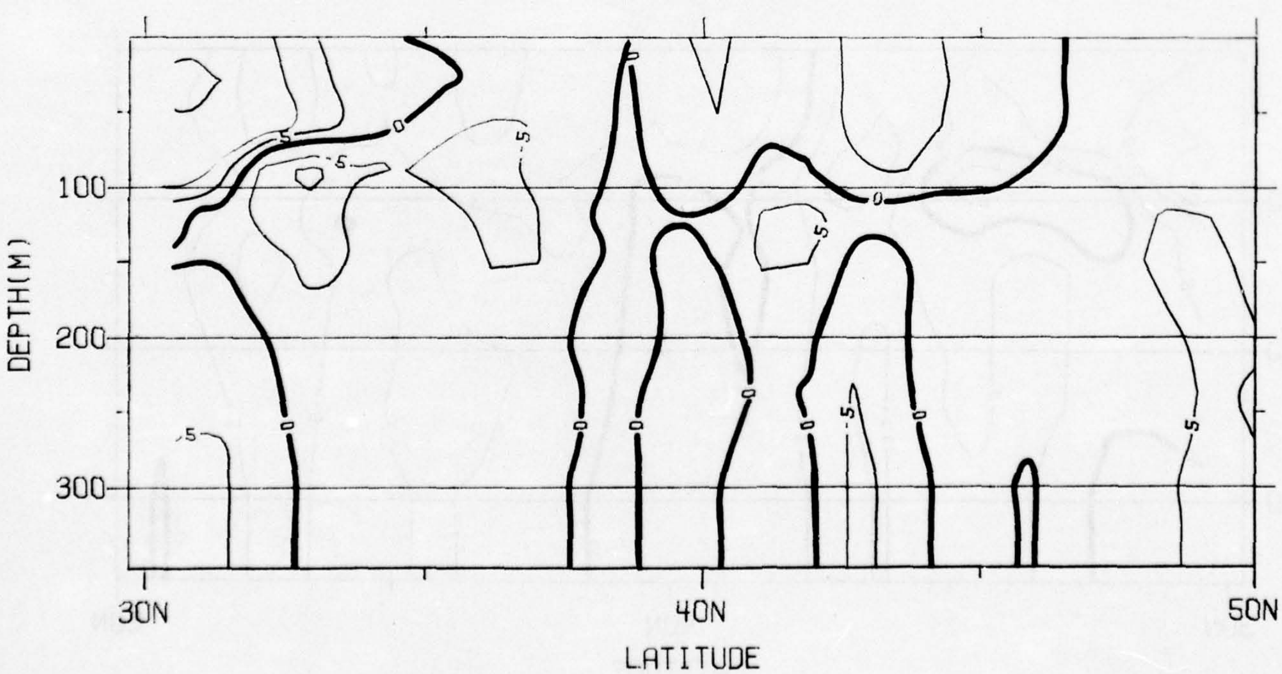

Figure 6

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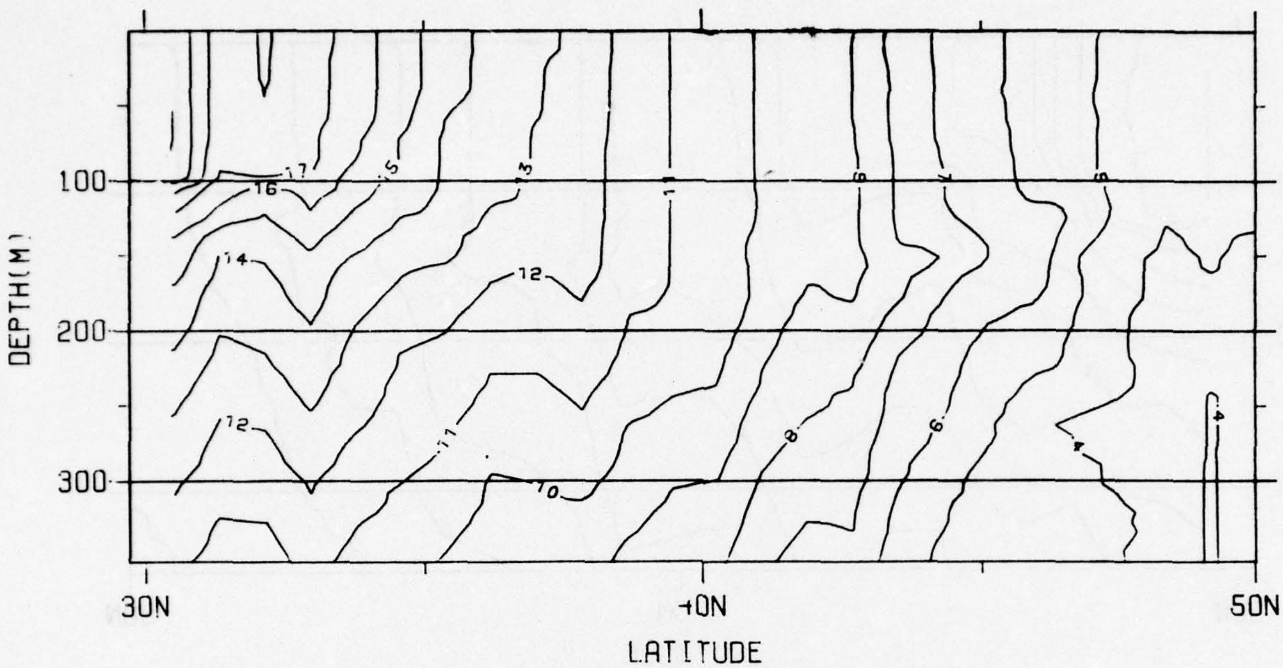
LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR JAN. 14 1975

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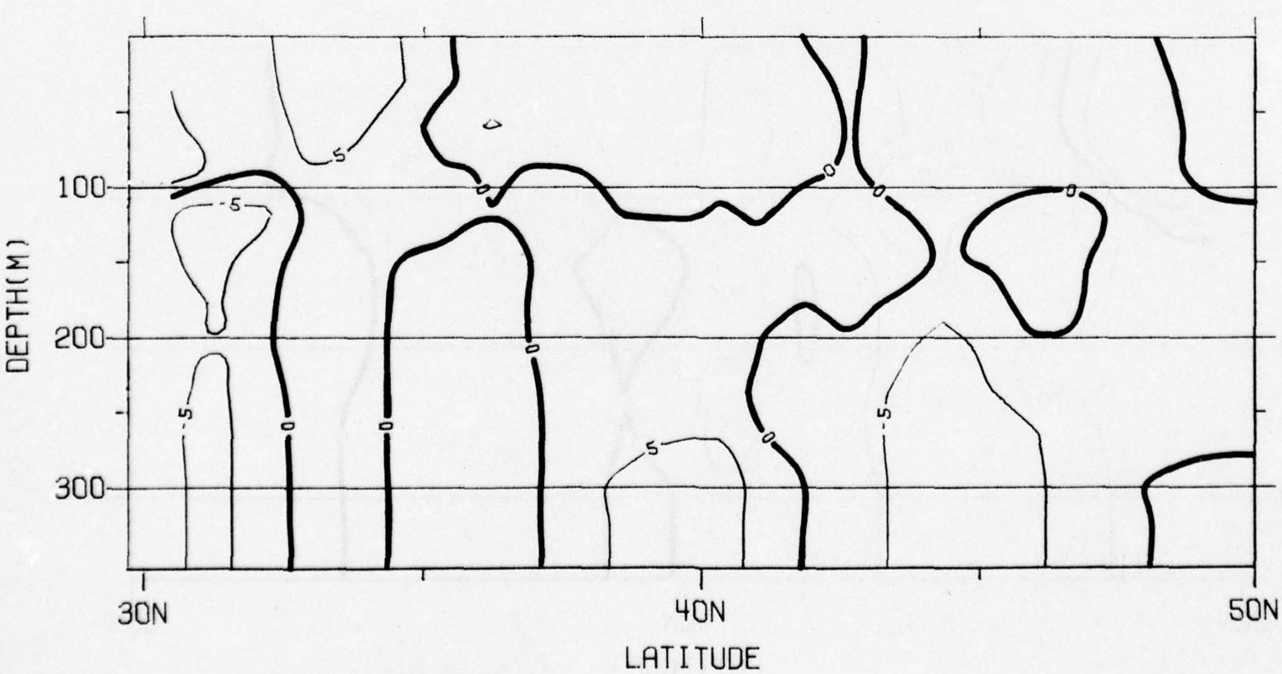
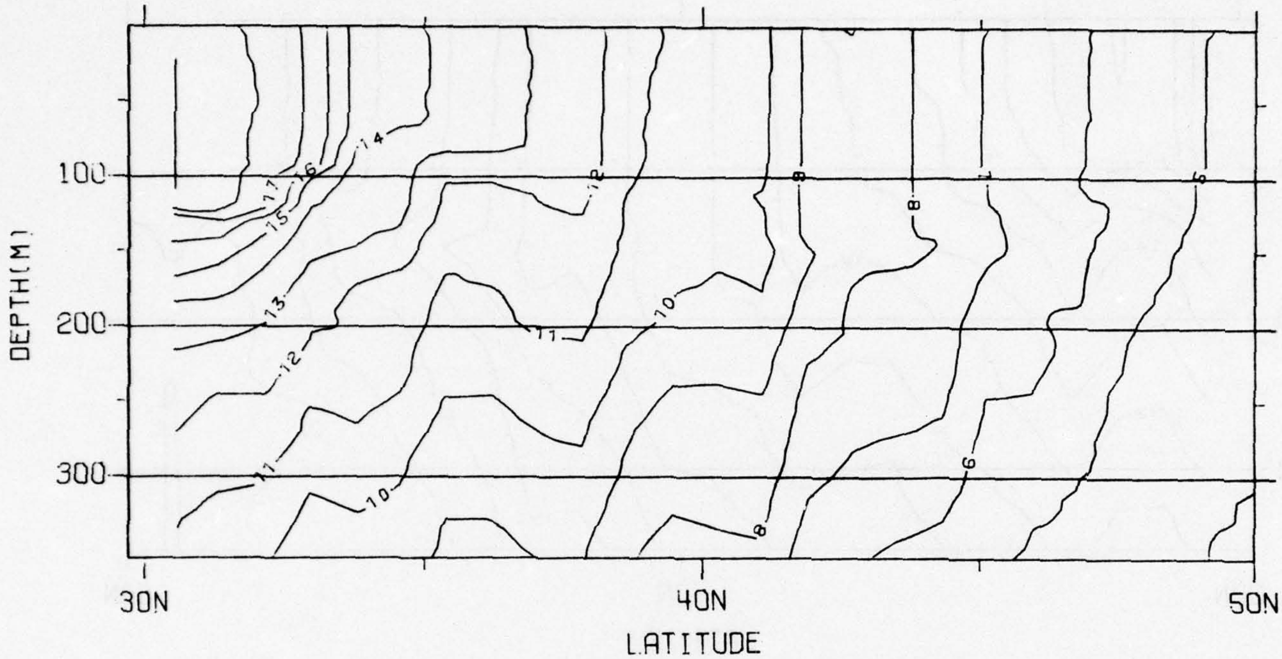


Figure 7

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR FEB. 9 1975

LONGITUDE 158 DEGREES WEST



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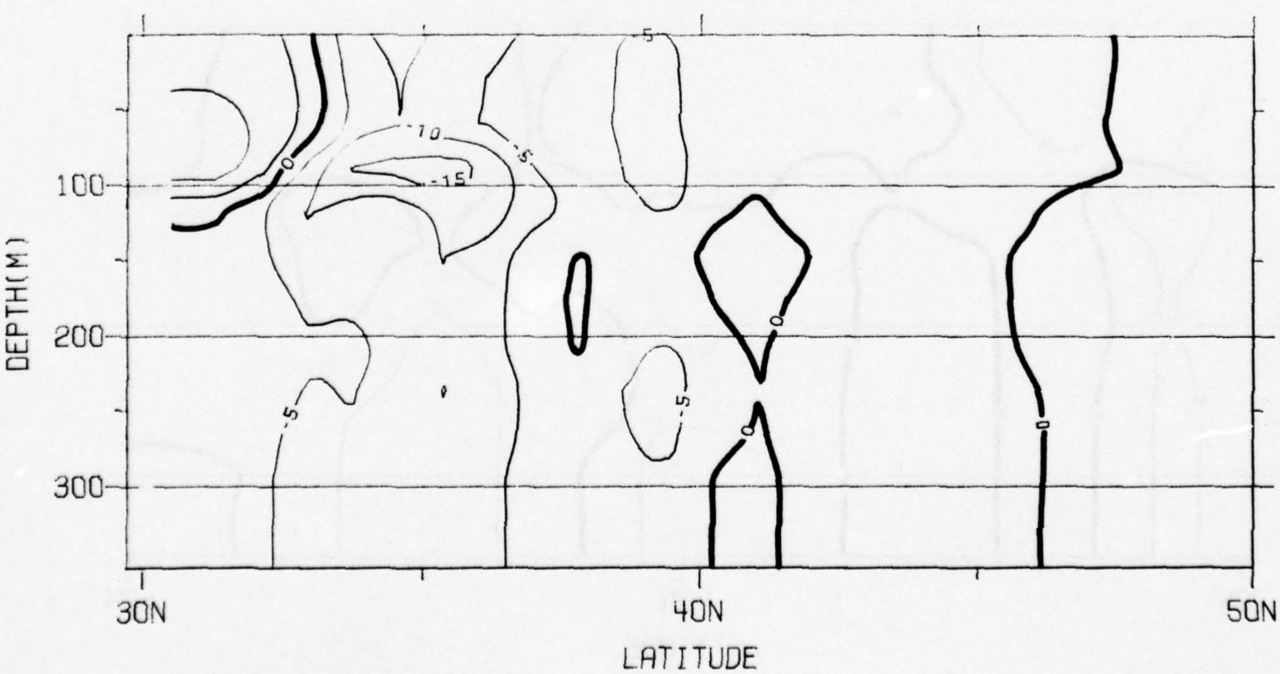

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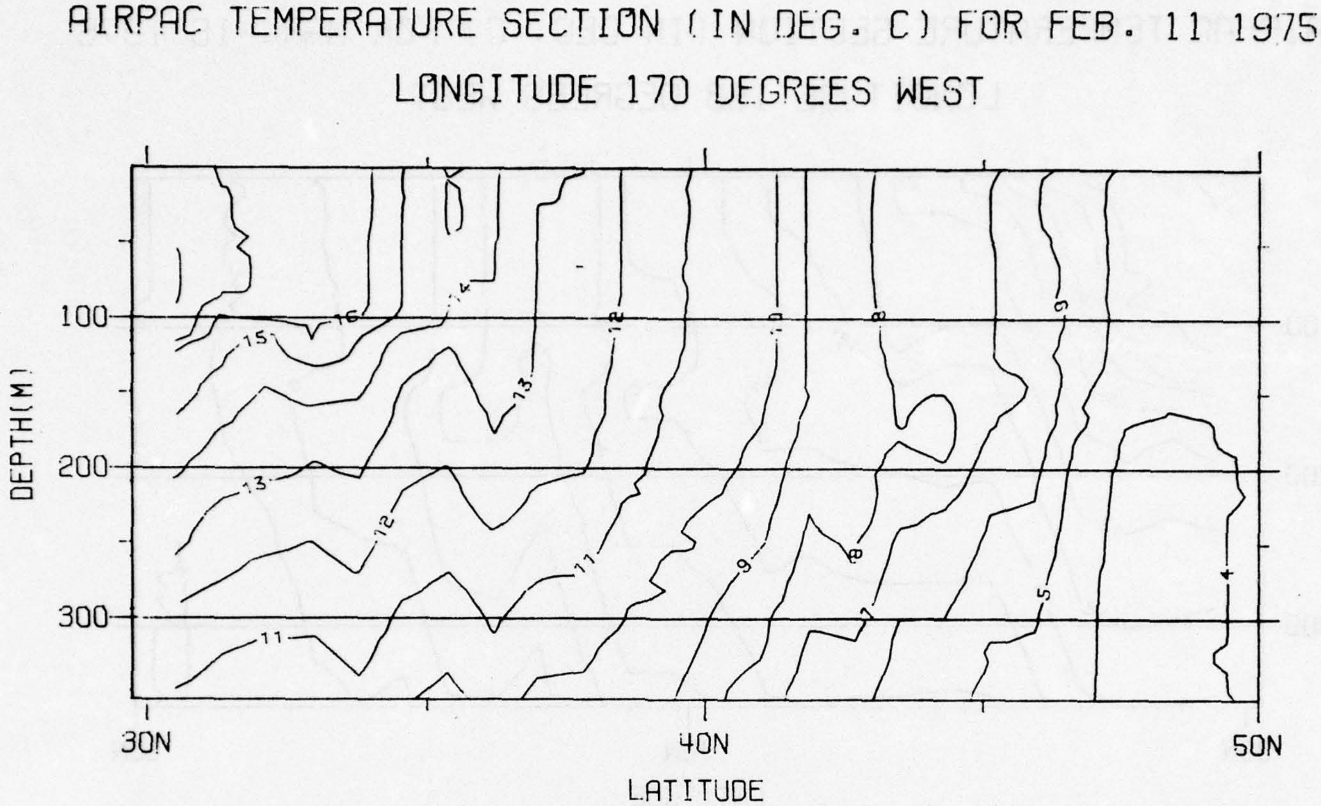
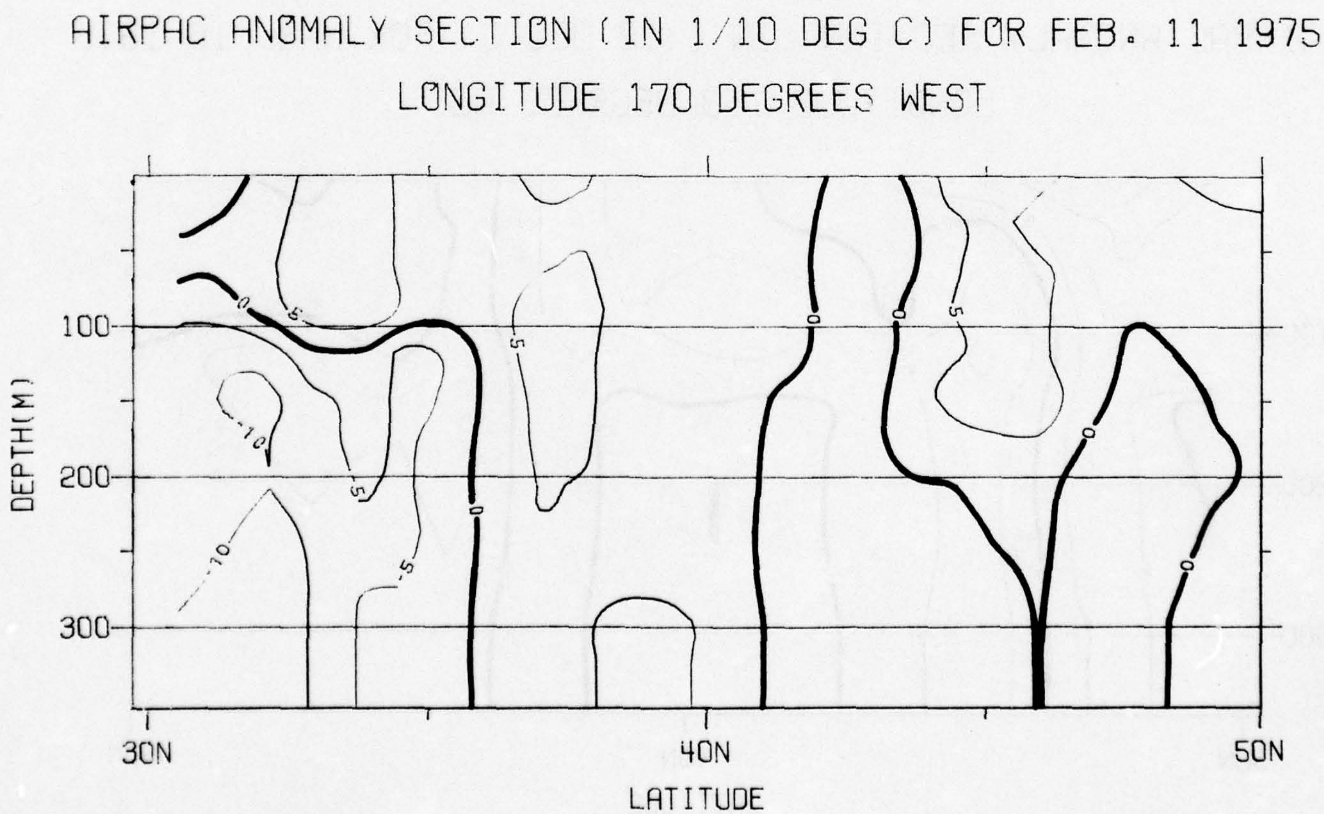


AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR FEB. 11 1975
LONGITUDE 170 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE

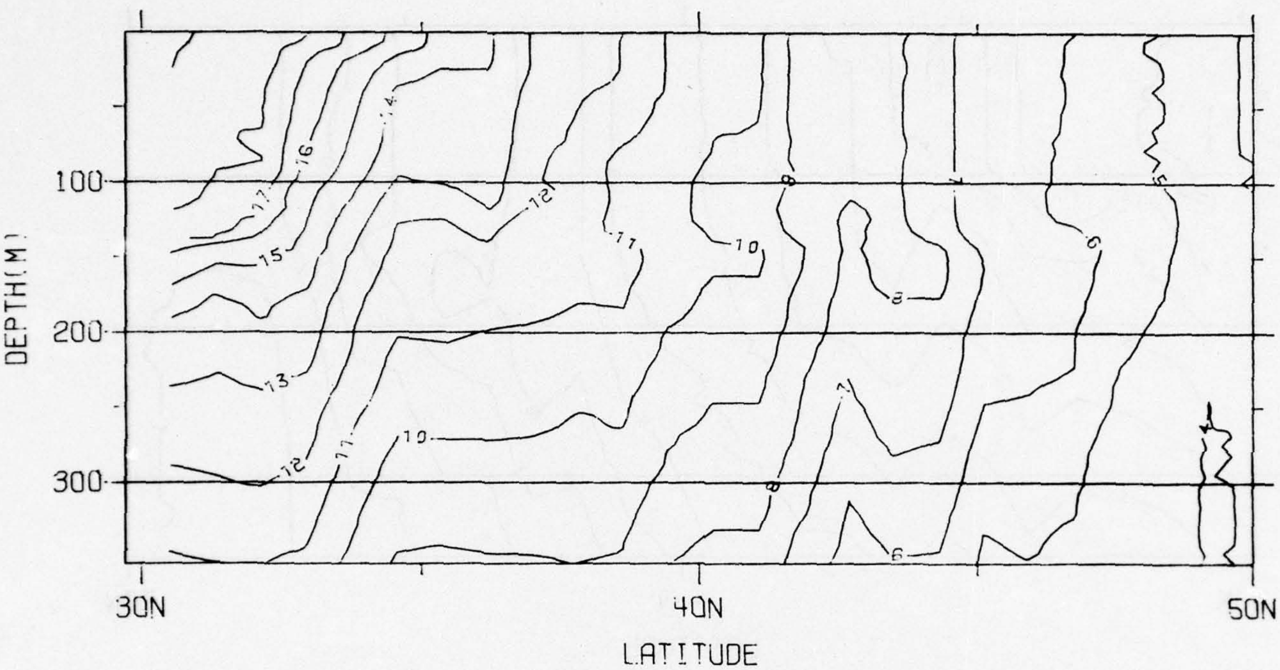


AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR FEB. 11 1975
LONGITUDE 170 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE

Figure 9

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR MAR. 16 1975

LONGITUDE 158 DEGREES WEST



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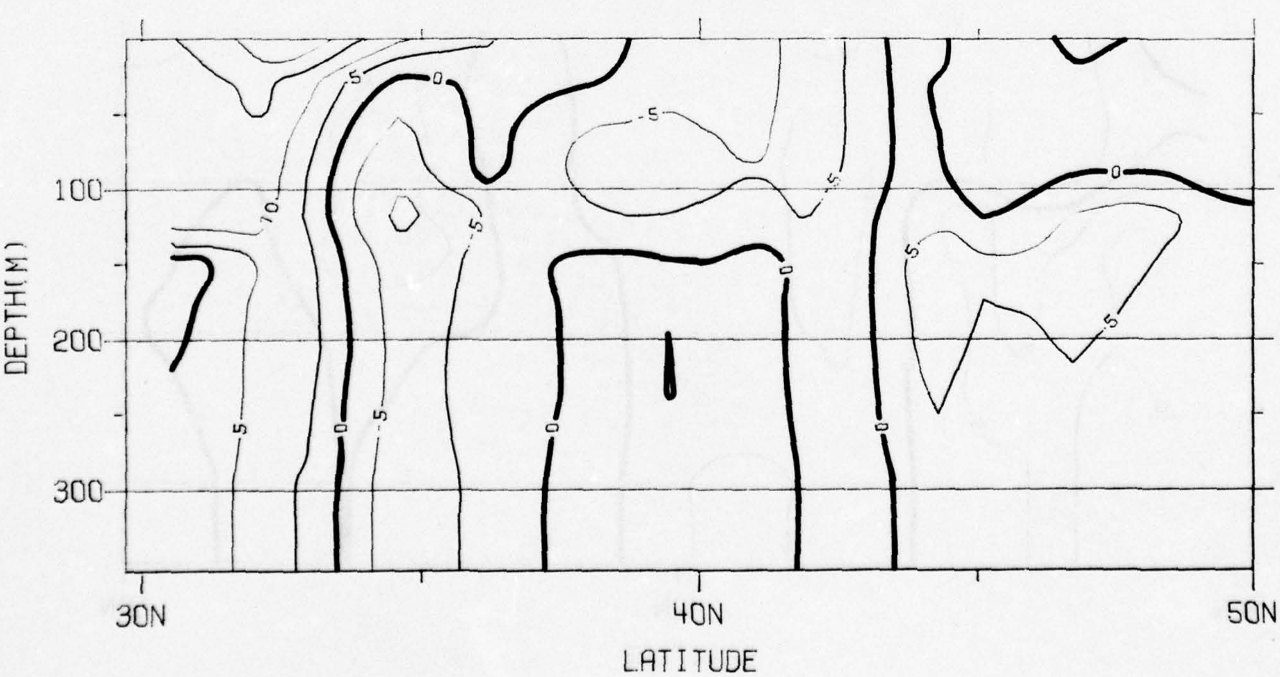

Figure 10

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR MAR. 18 1975

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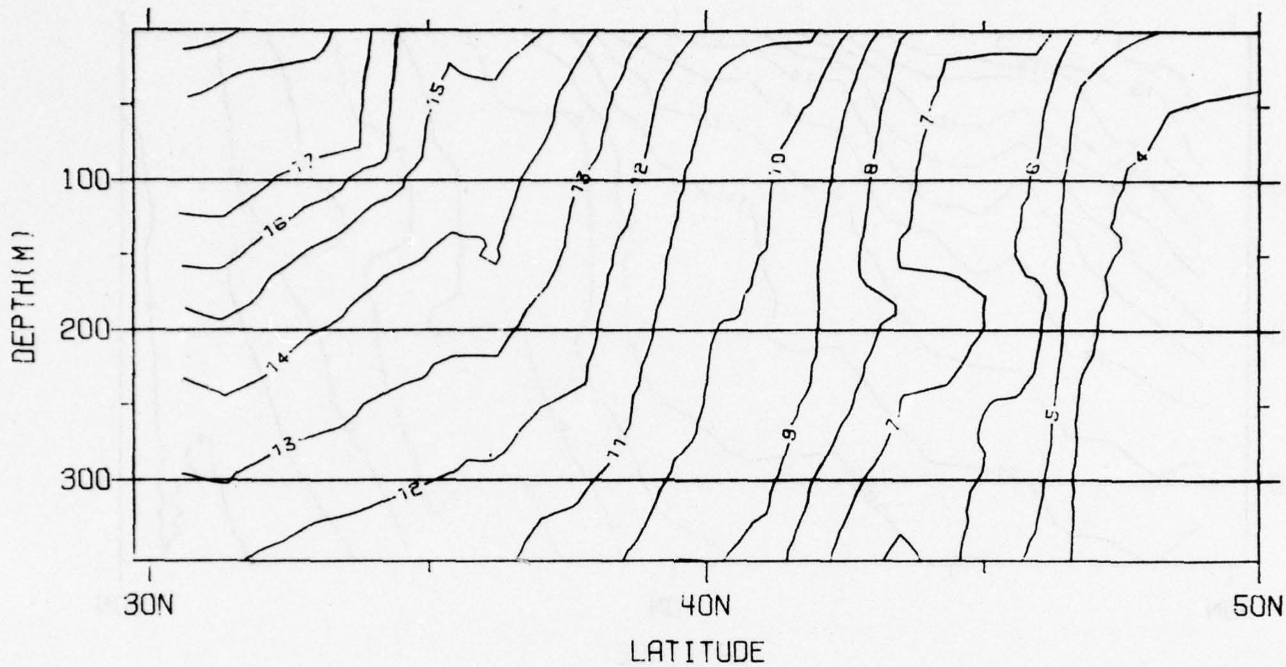

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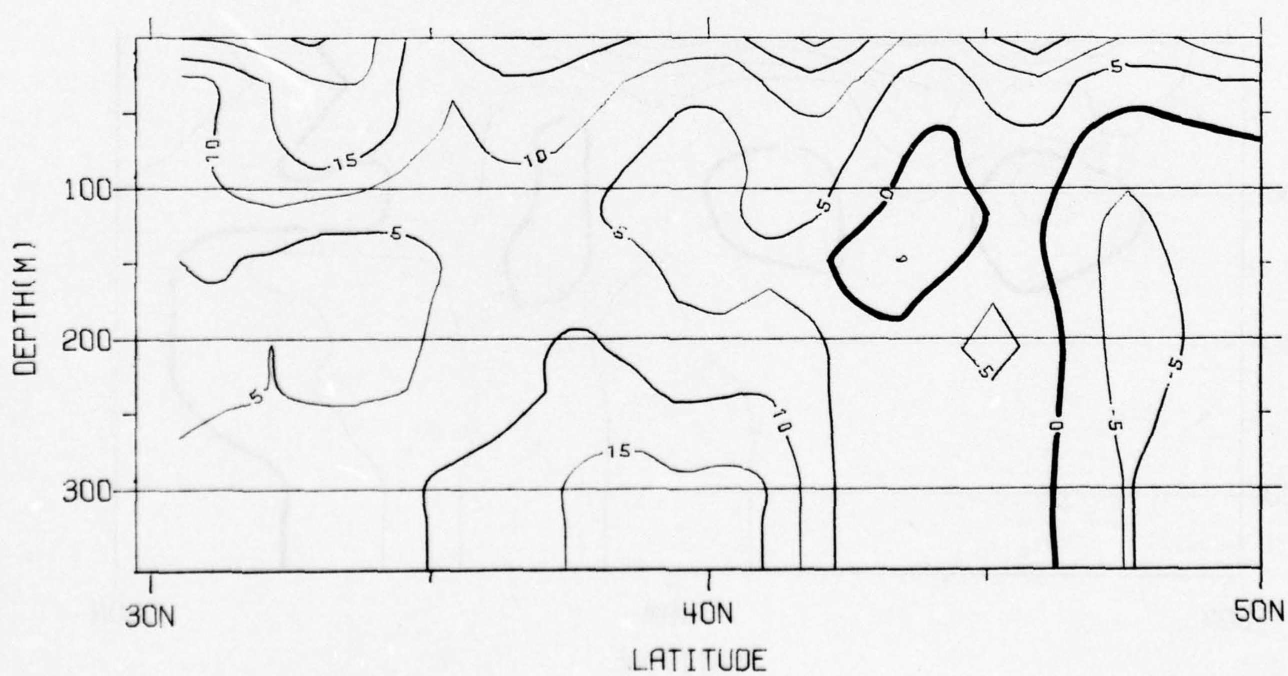

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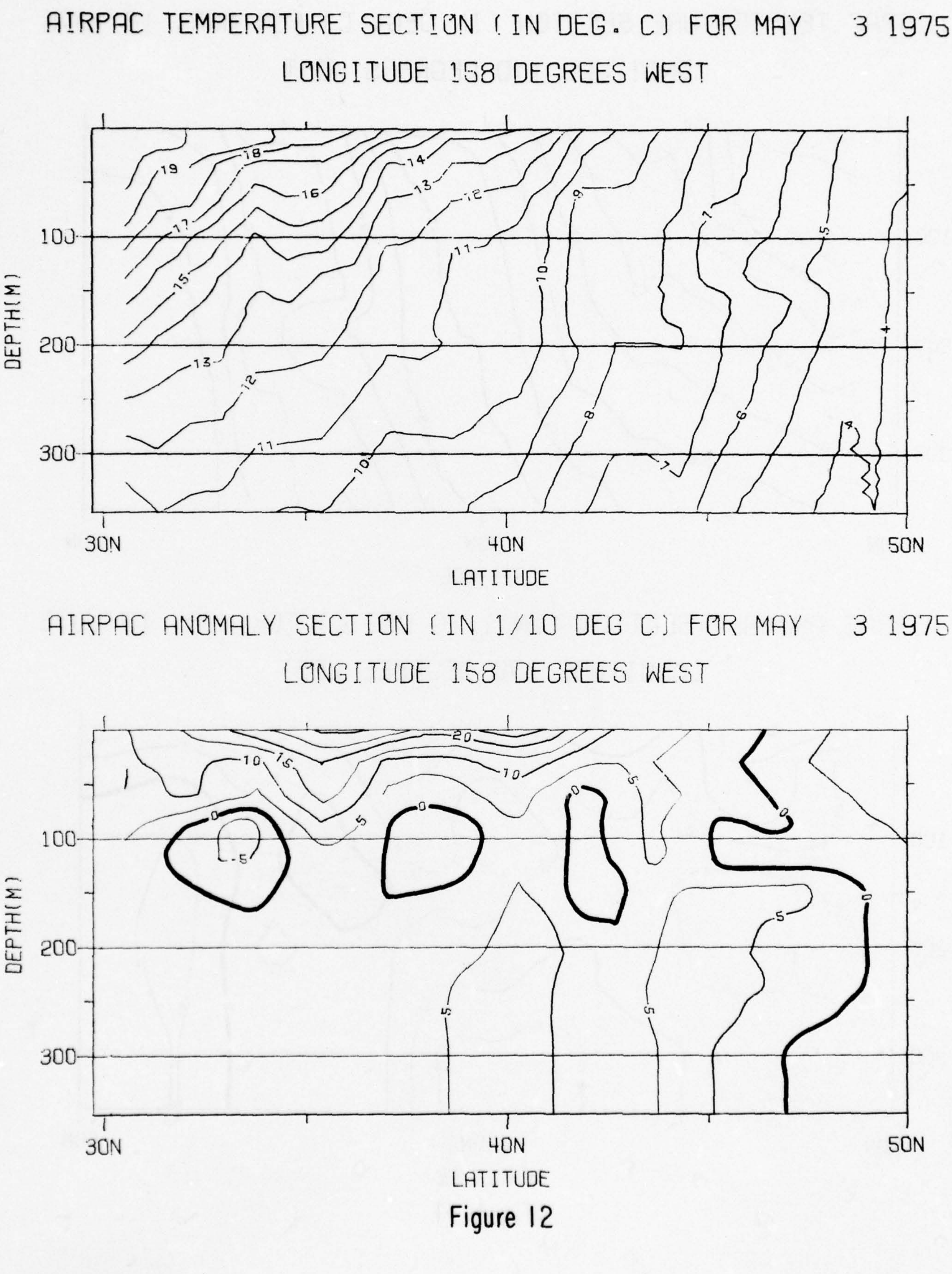
AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR MAY 3 1975
LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
19
18
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16
15
14
13
12
11
10
9
8
7
6
5
4
30N
40N
50N
LATITUDE
AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR MAY 3 1975
LONGITUDE 158 DEGREES WEST
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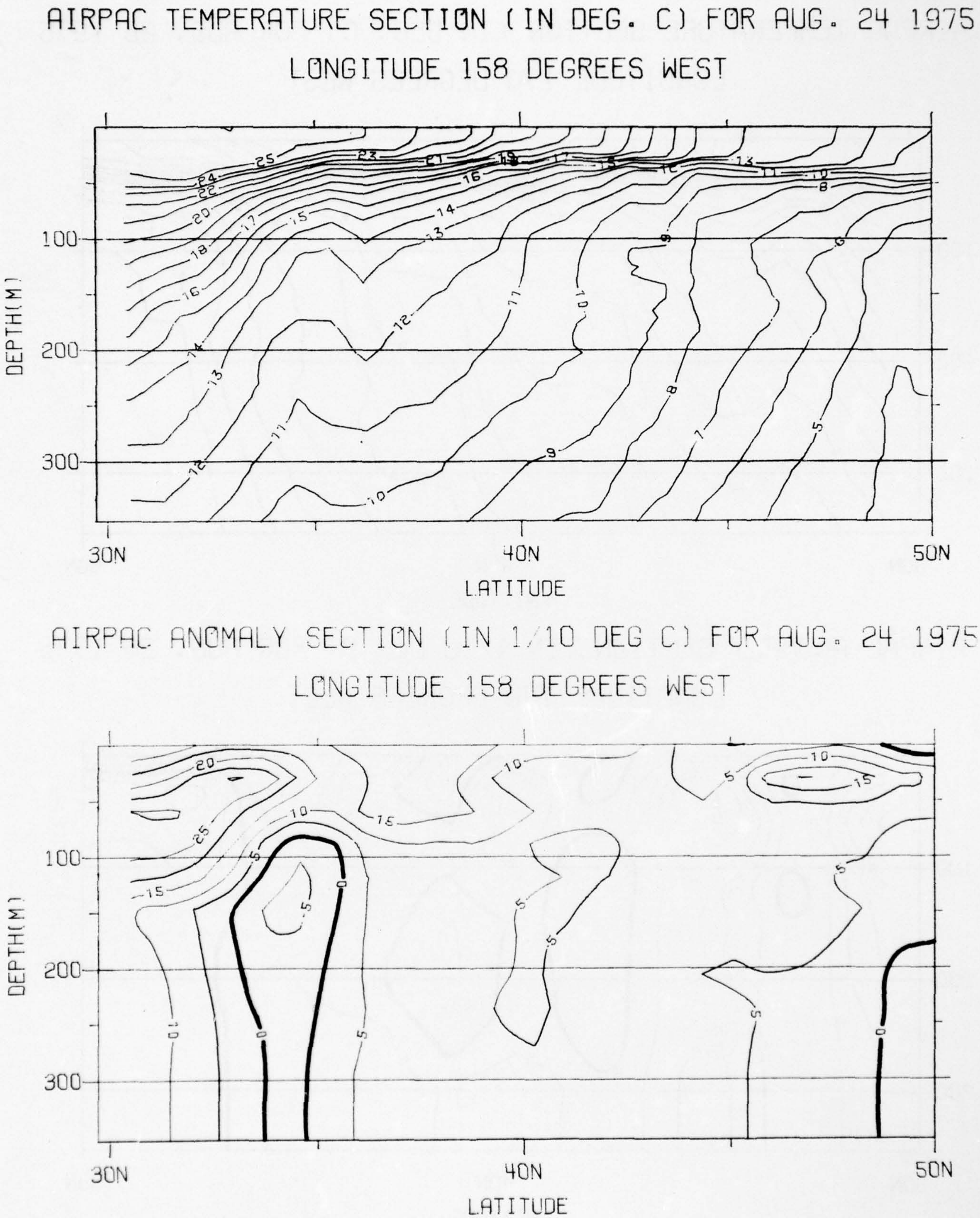
LATITUDE

Figure 12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LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
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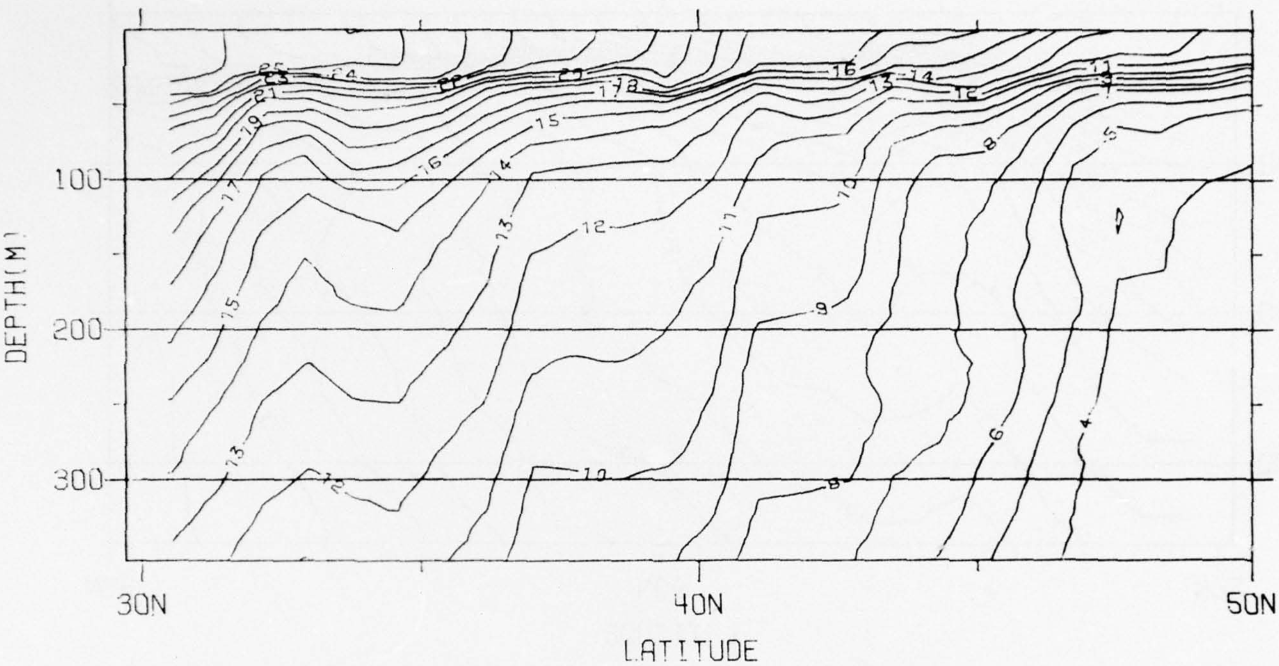
40N
50N
LATITUDE
AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR AUG. 24 1975
LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE

Figure 13

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR AUG. 26 1975

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR AUG. 26 1975

LONGITUDE 170 DEGREES WEST

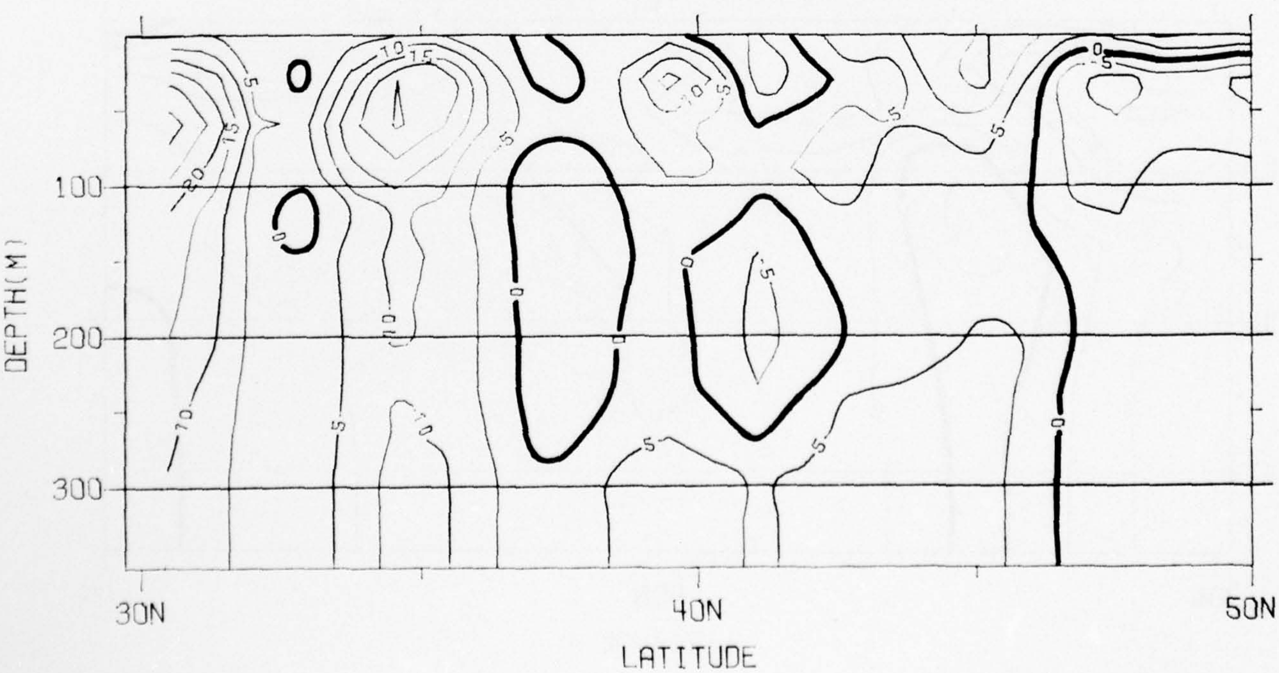
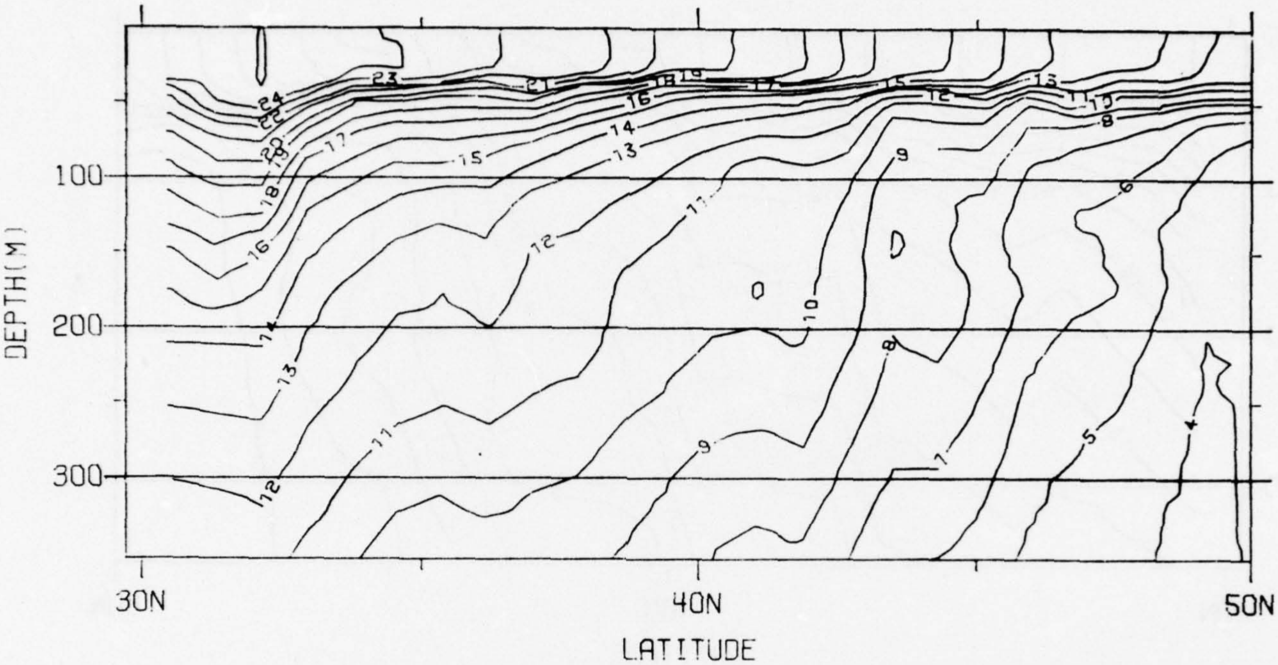


Figure 14

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR SEPT 11 1975

LONGITUDE 158 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR SEPT 11 1975

LONGITUDE 158 DEGREES WEST

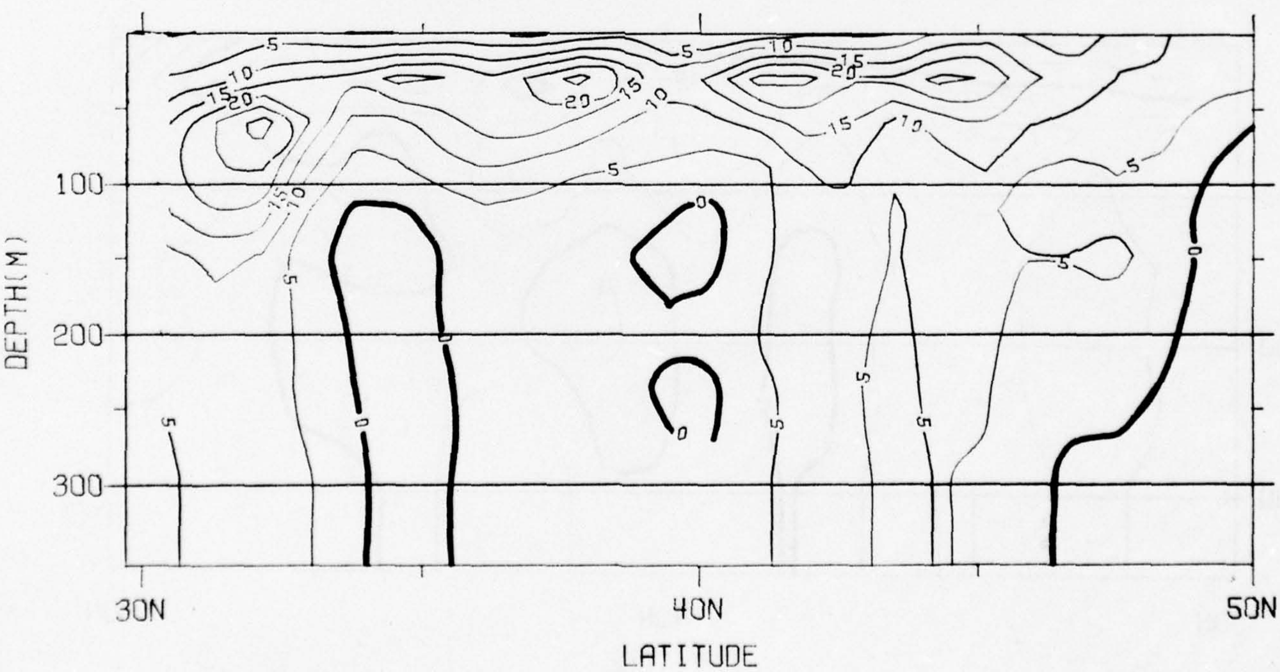
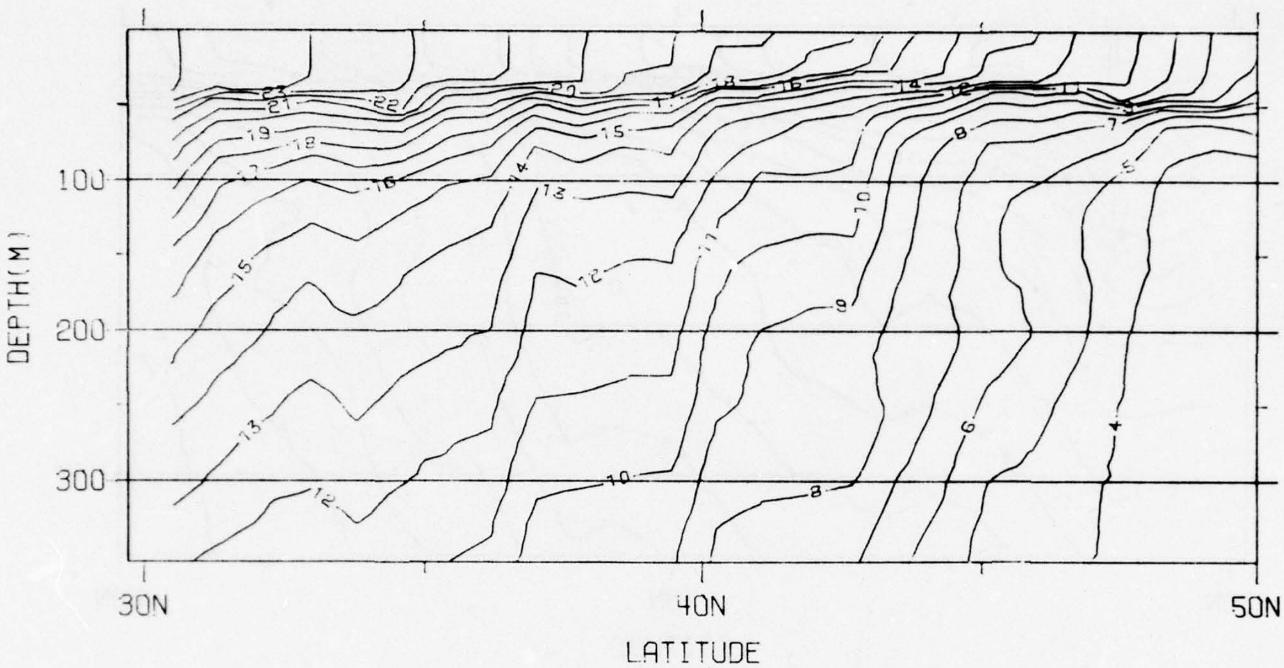


Figure 15

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR SEPT 14 1975

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR SEPT 14 1975

LONGITUDE 170 DEGREES WEST

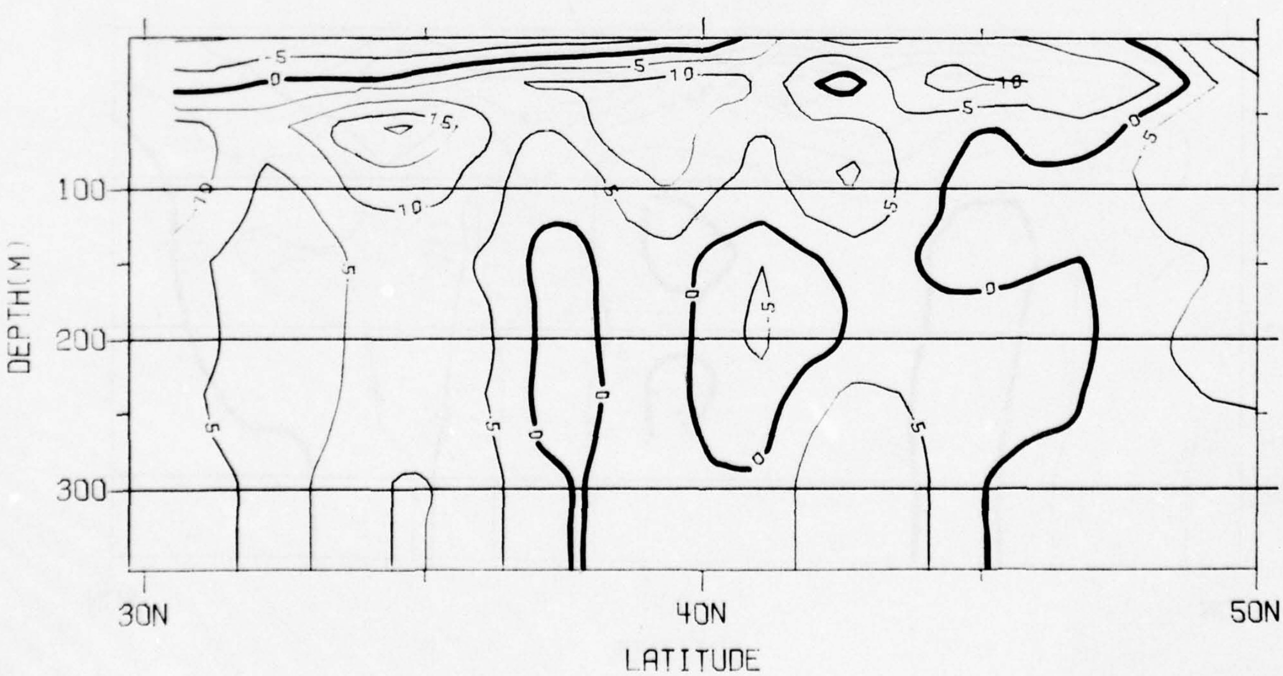


Figure 16

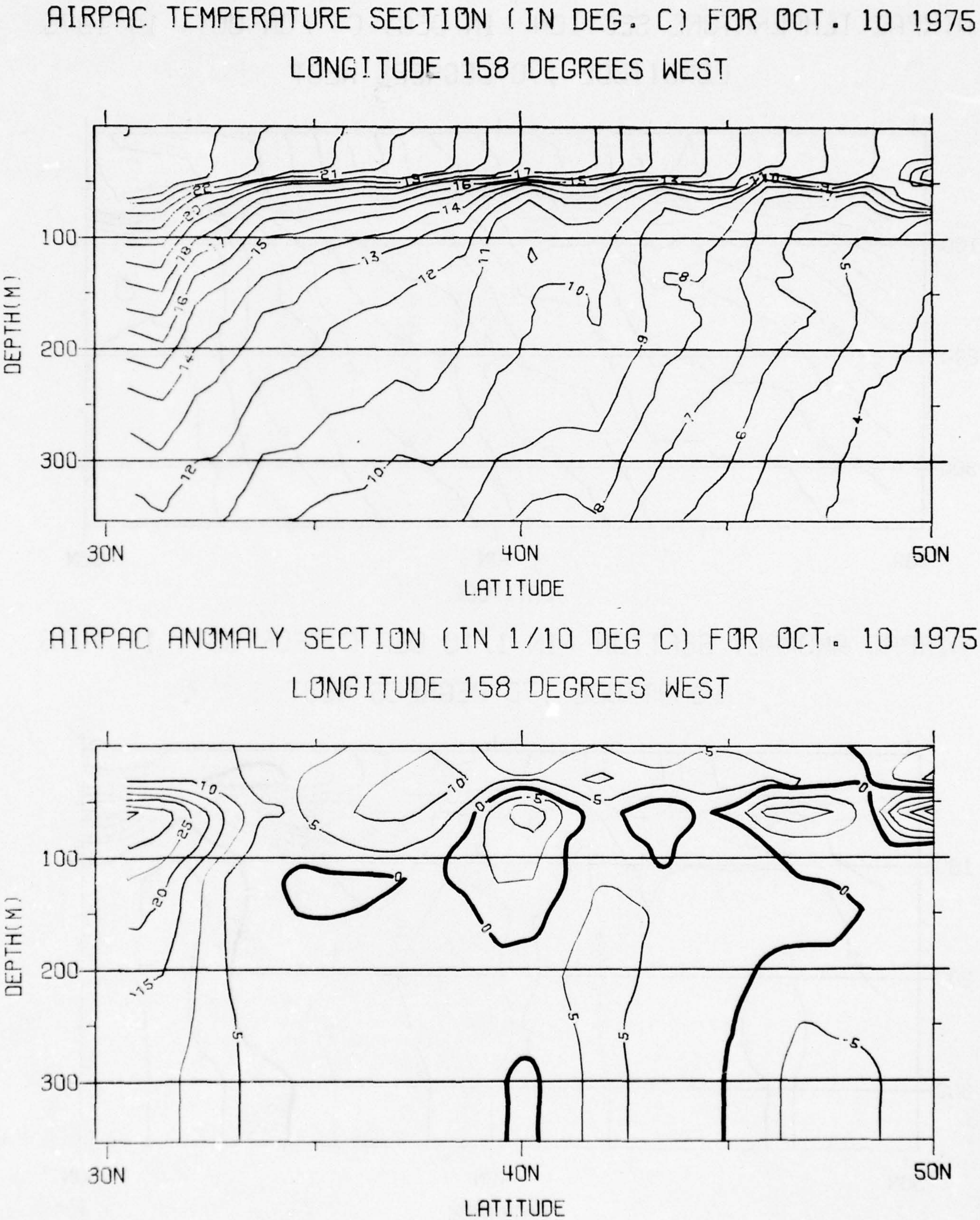
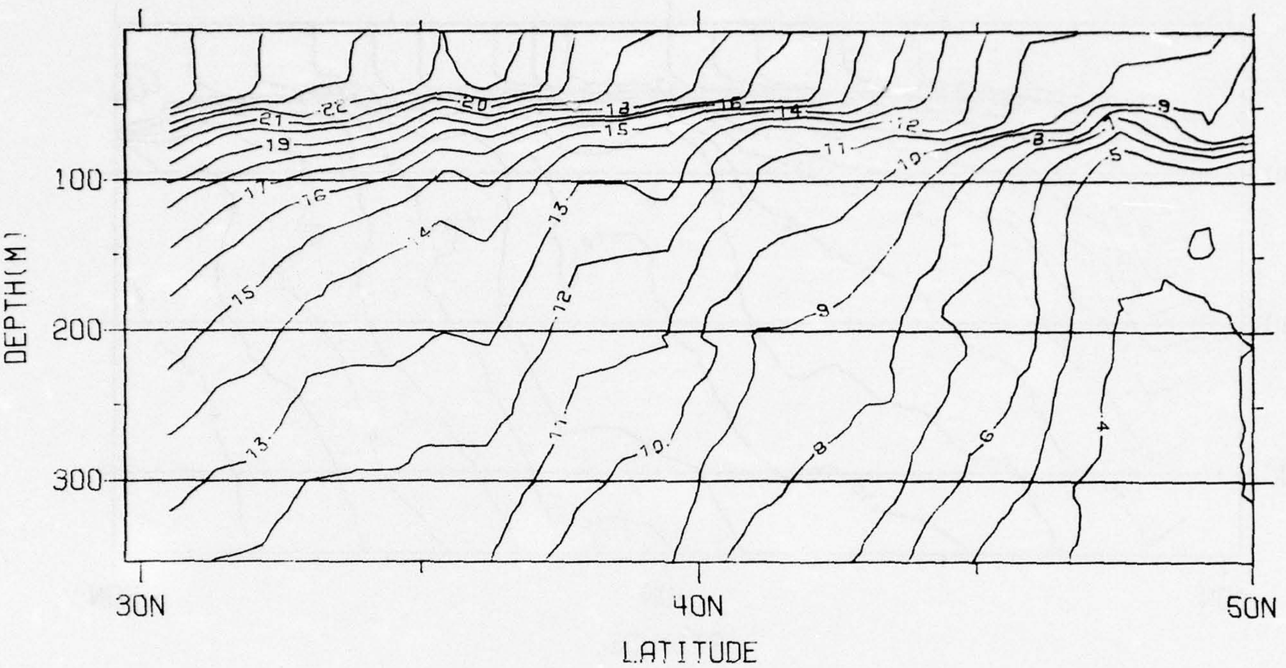

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR OCT. 10 1975
LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE
AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR OCT. 10 1975
LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE

Figure 17

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR OCT. 14 1975

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR OCT. 14 1975

LONGITUDE 170 DEGREES WEST

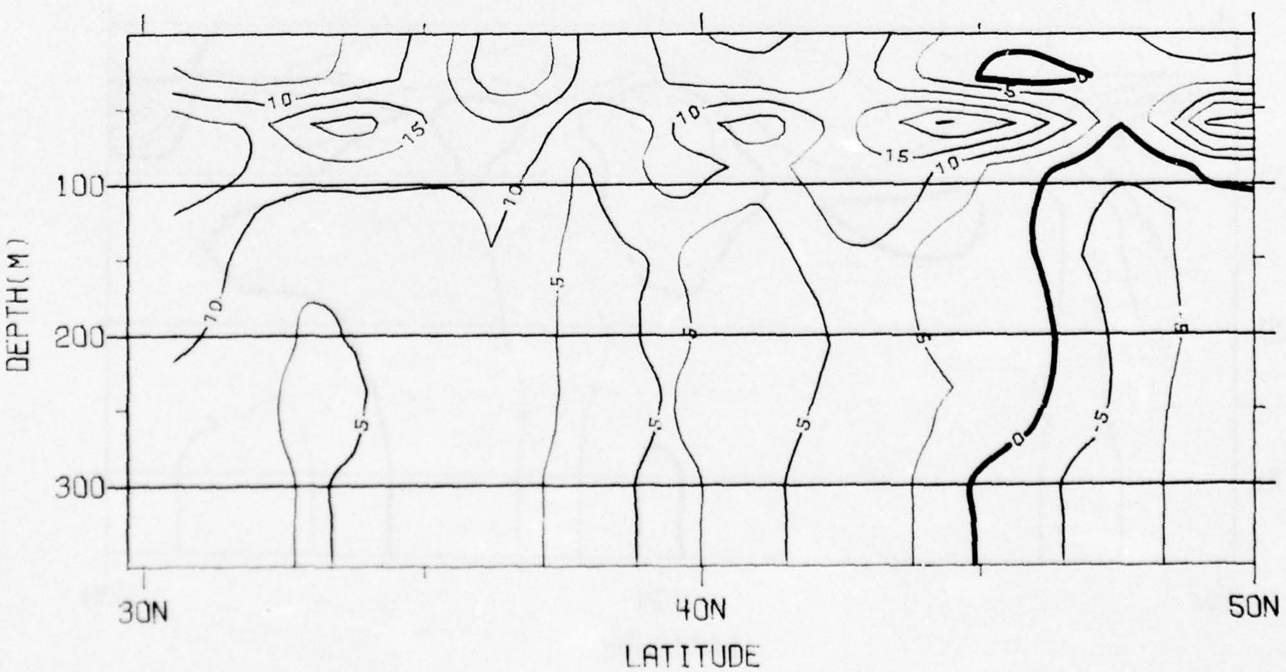


Figure 18

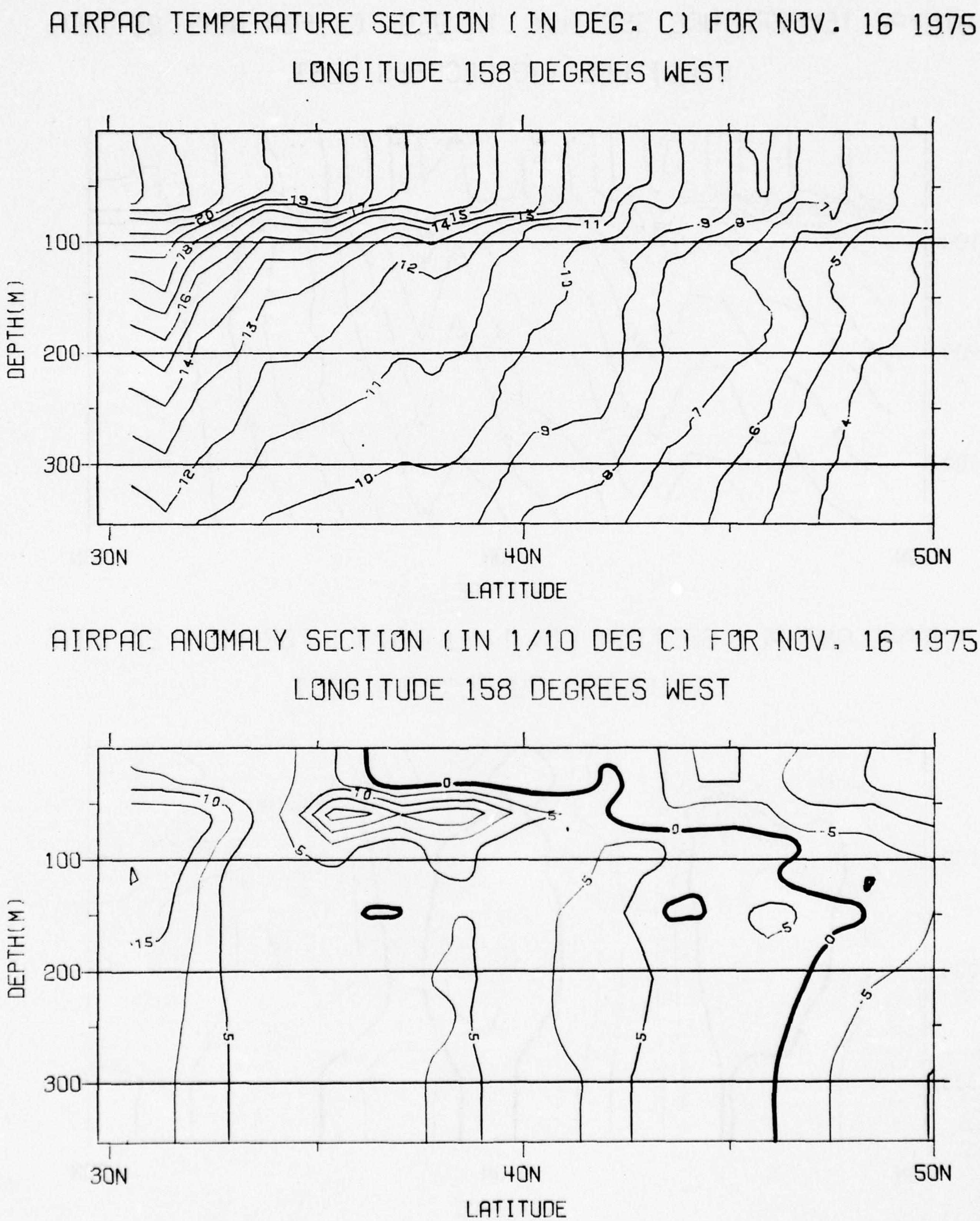

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR NOV. 16 1975
LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE
AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR NOV. 16 1975
LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE

Figure 19

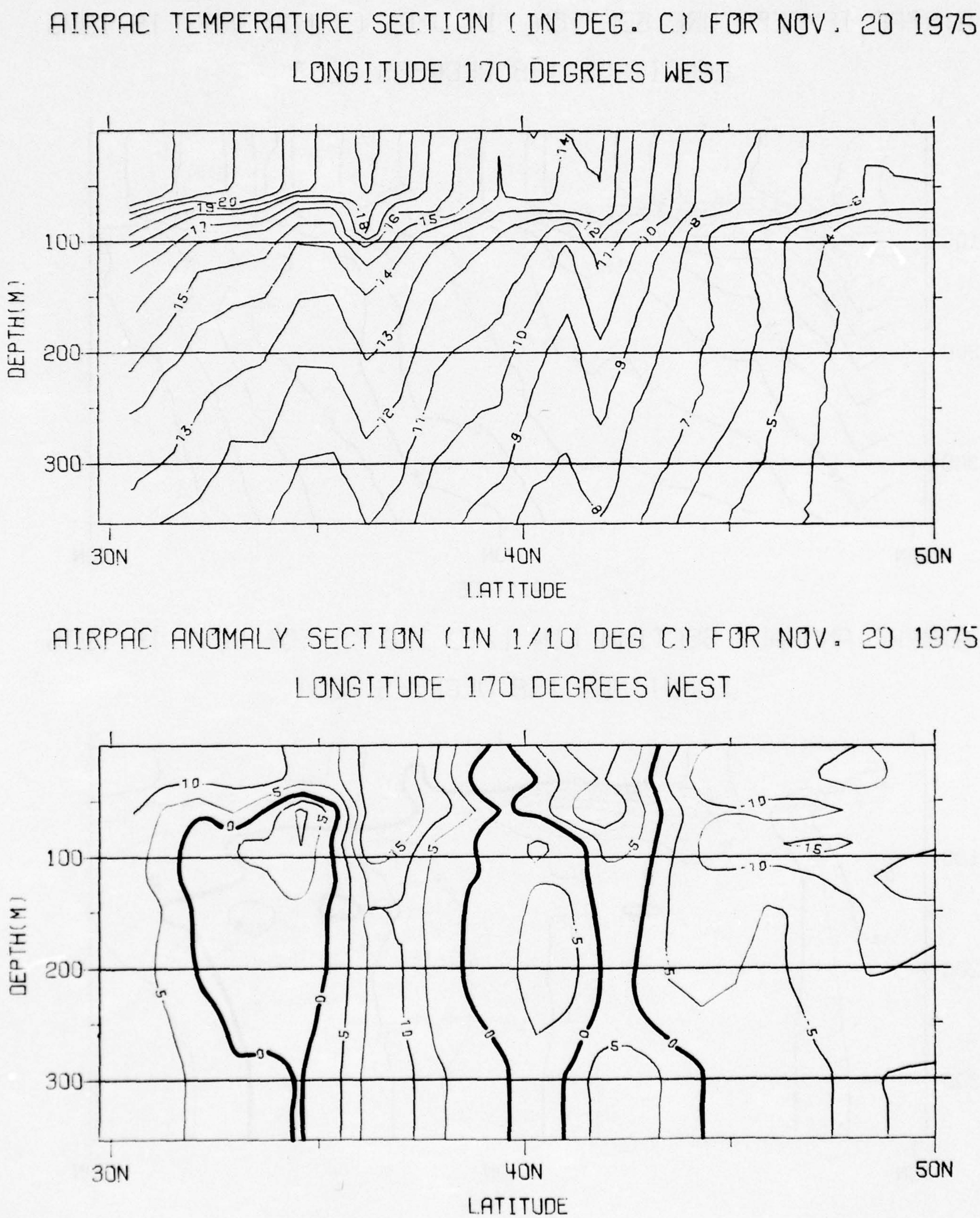
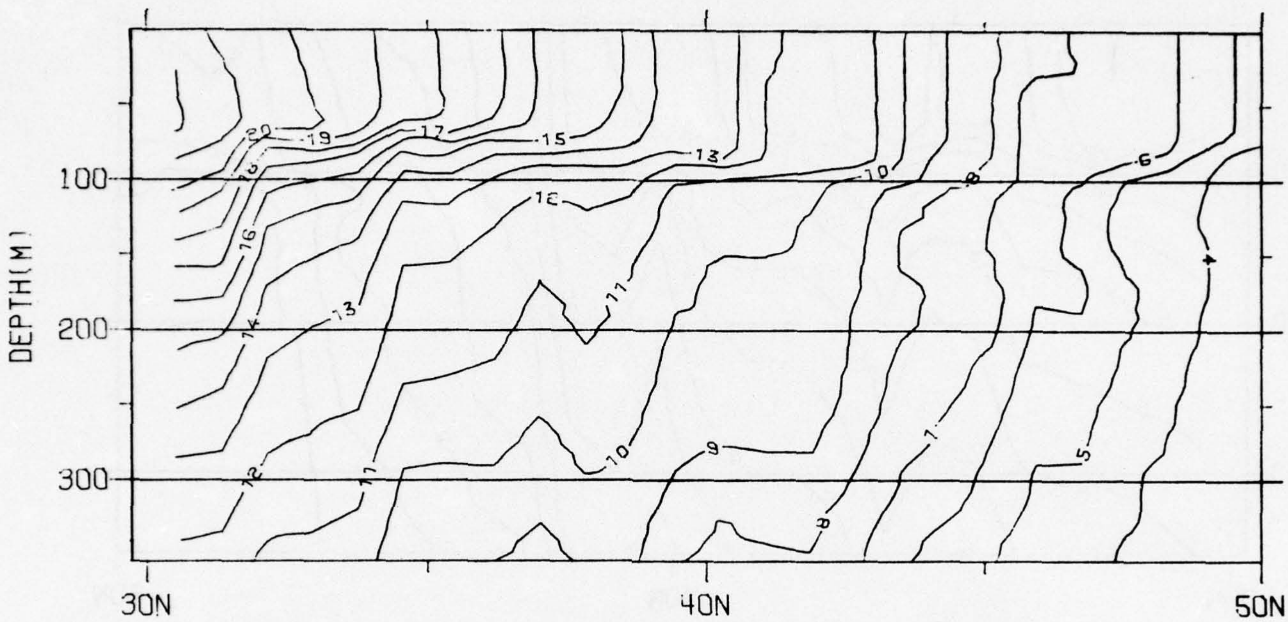

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR NOV. 20 1975
LONGITUDE 170 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE
AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR NOV. 20 1975
LONGITUDE 170 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE

Figure 20

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR DEC. 7 1975

LONGITUDE 158 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR DEC. 7 1975

LONGITUDE 158 DEGREES WEST

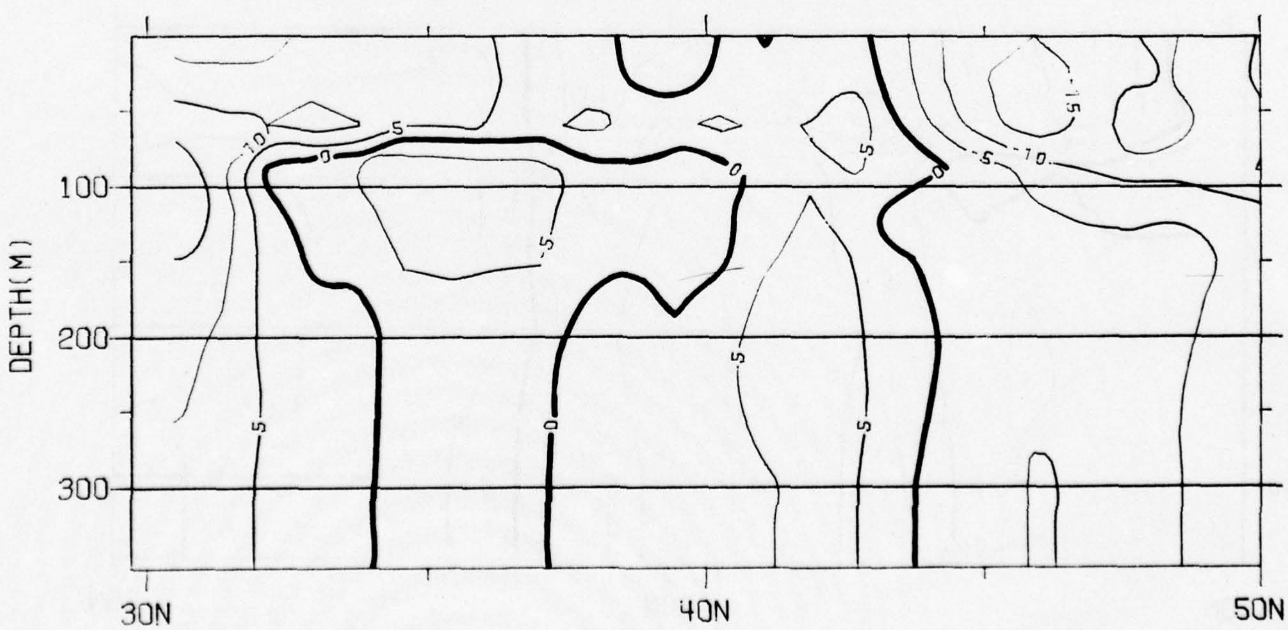


Figure 21

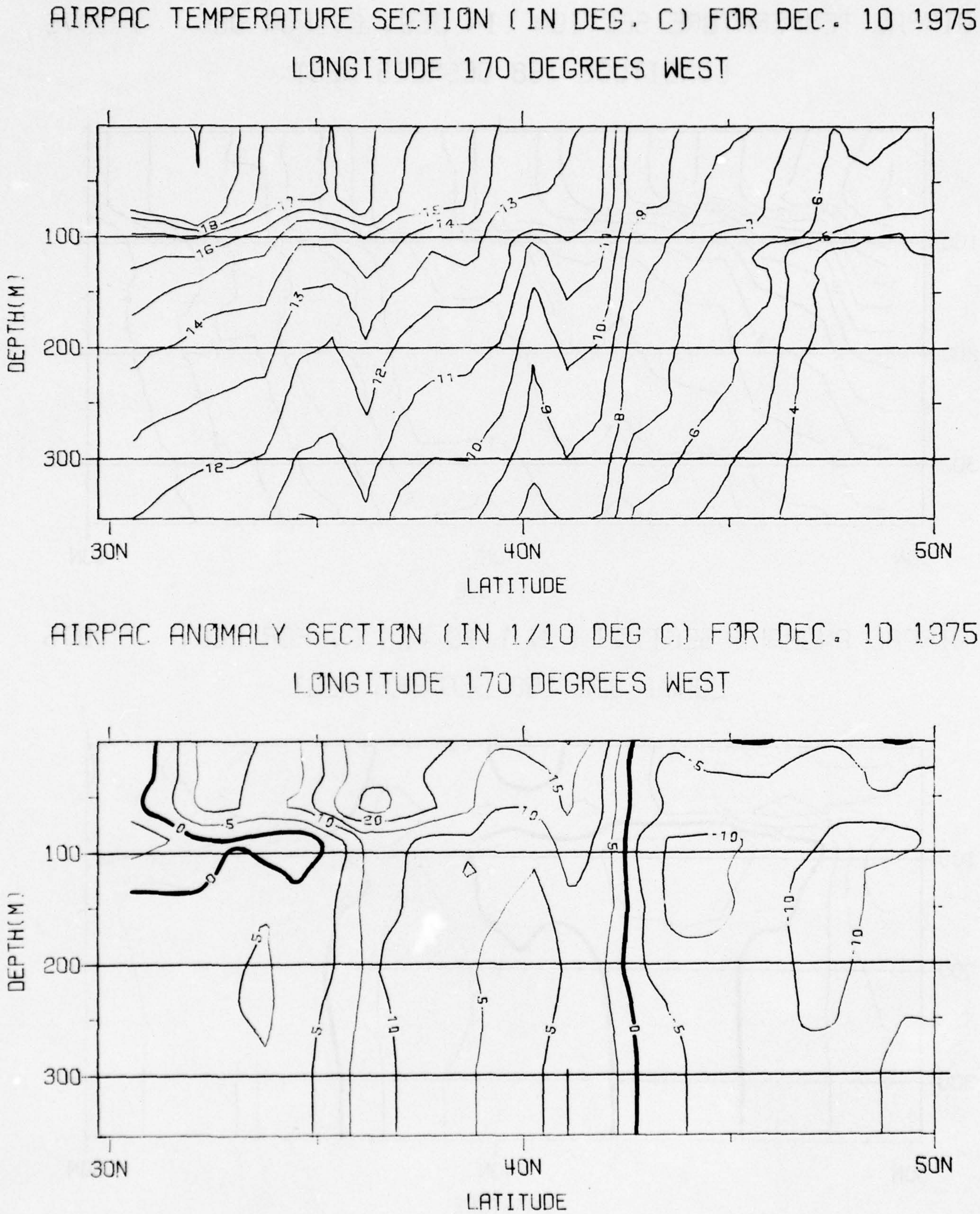
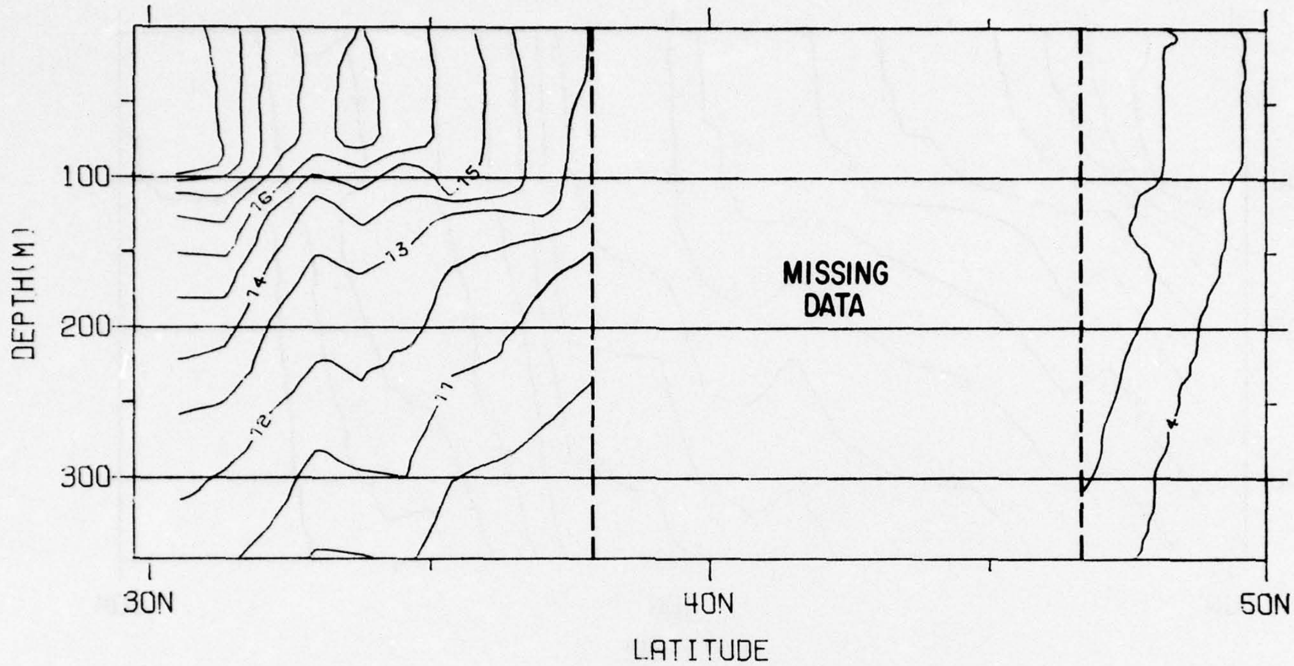

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR DEC. 10 1975
LONGITUDE 170 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE
AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR DEC. 10 1975
LONGITUDE 170 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE

Figure 22

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR JAN. 10 1976

LONGITUDE 158 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR JAN. 10 1976

LONGITUDE 158 DEGREES WEST

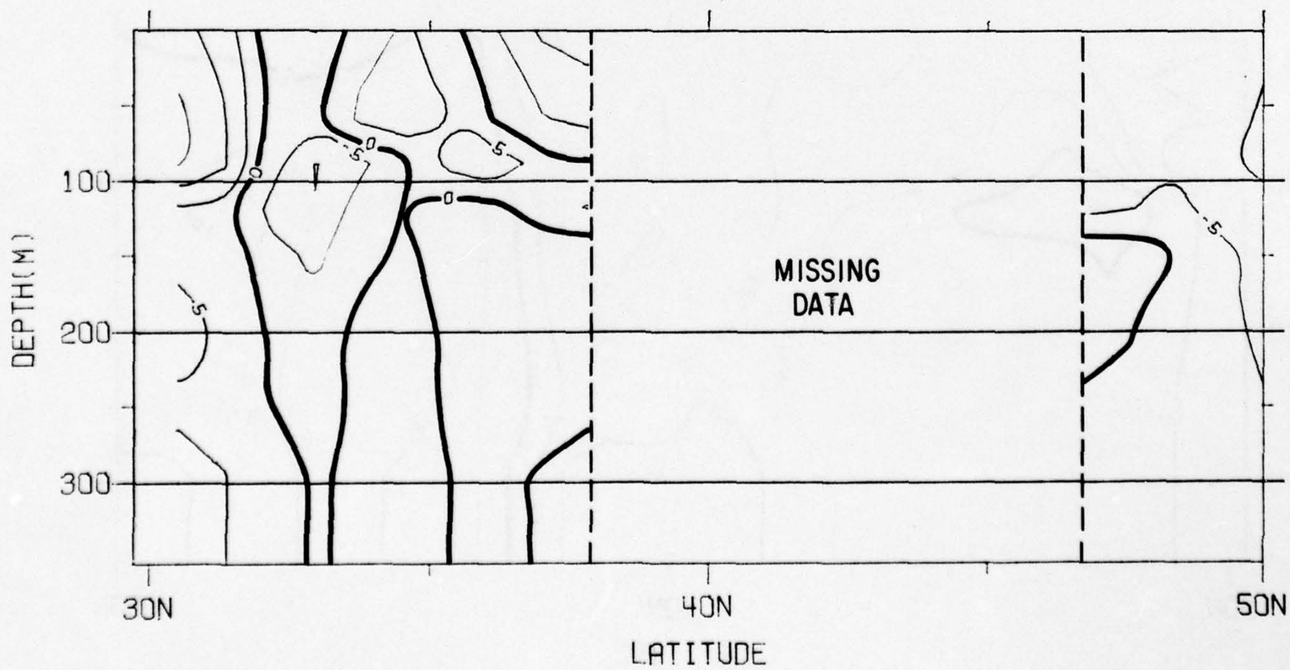
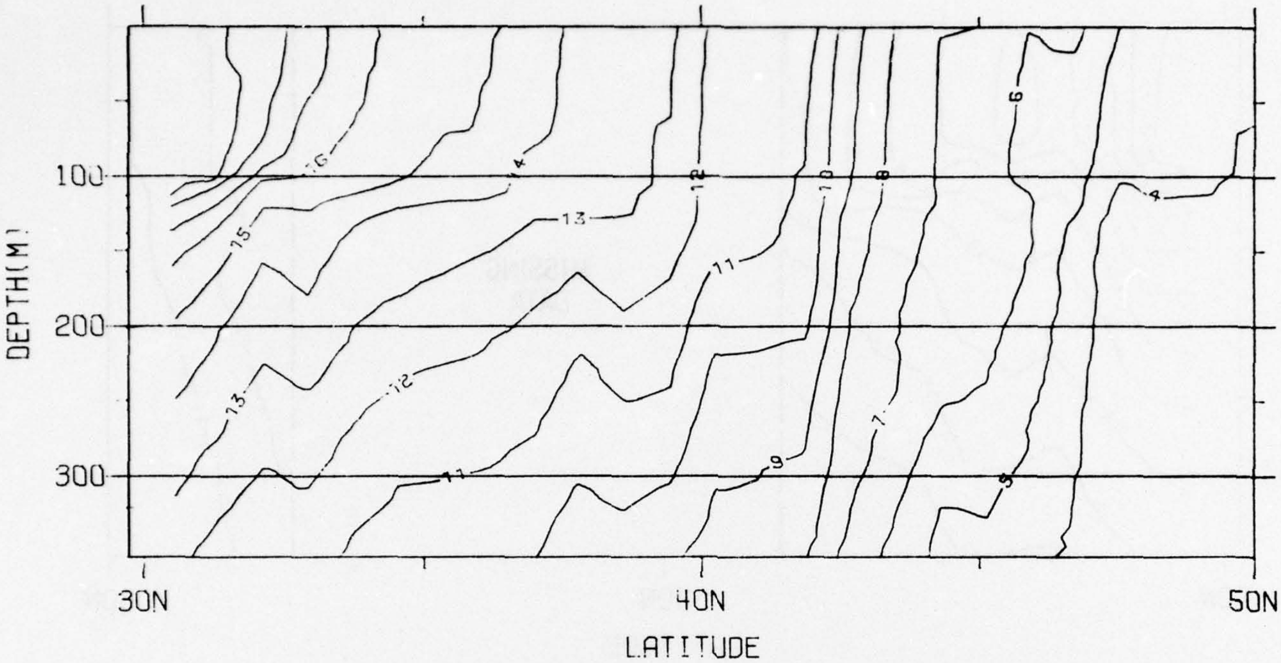


Figure 23

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR JAN. 14 1976

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR JAN. 14 1976

LONGITUDE 170 DEGREES WEST

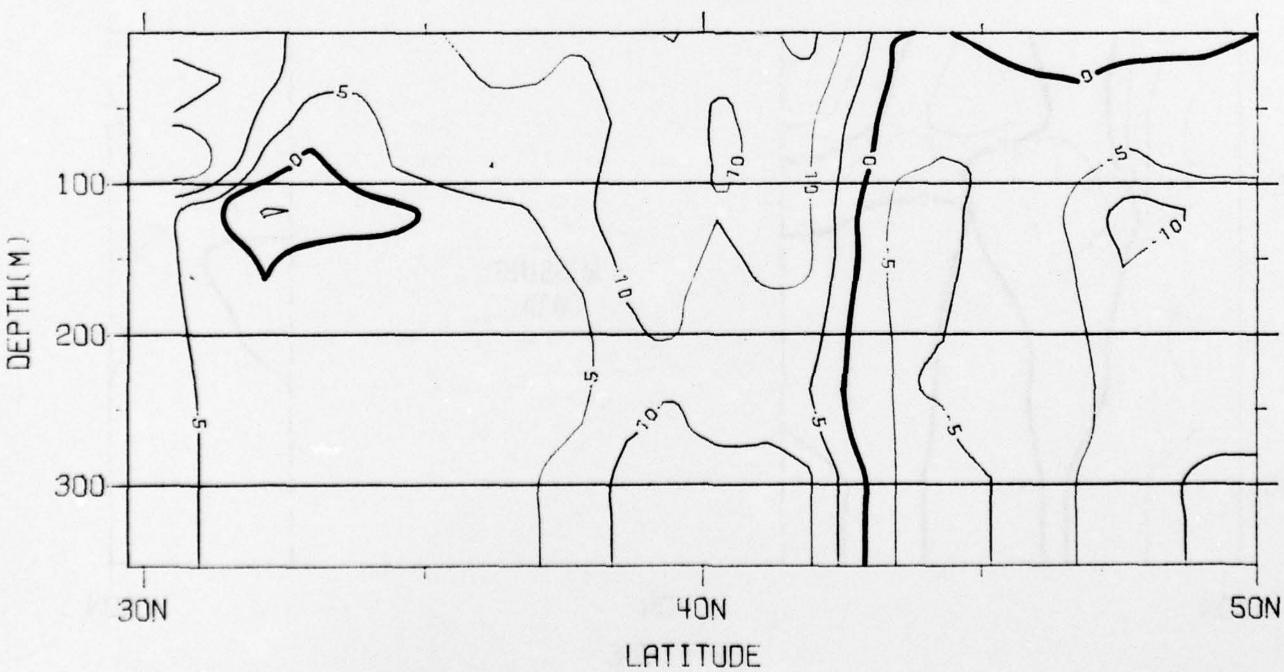
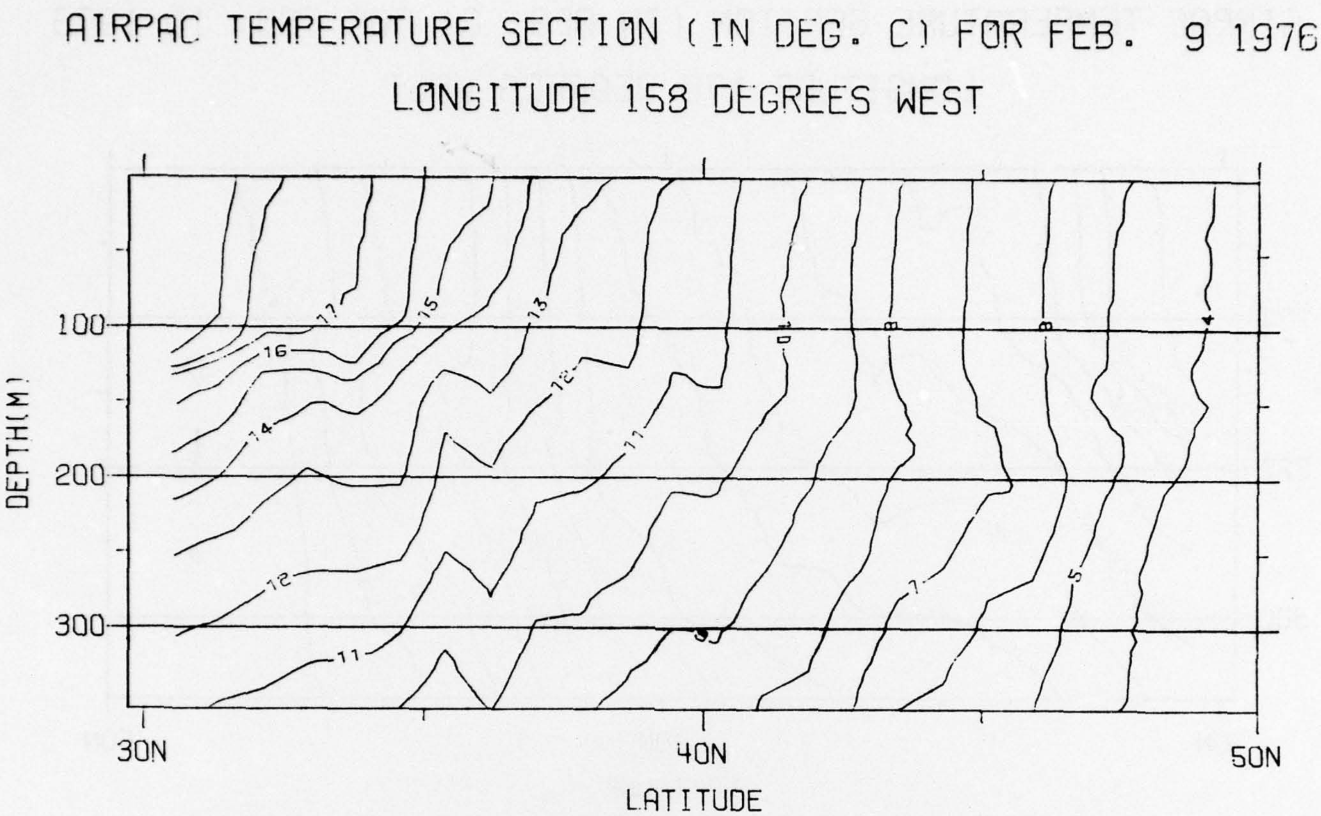


Figure 24


AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR FEB. 9 1976
LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE
17
16
15
14
13
12
11
10
9
8
7
5
4

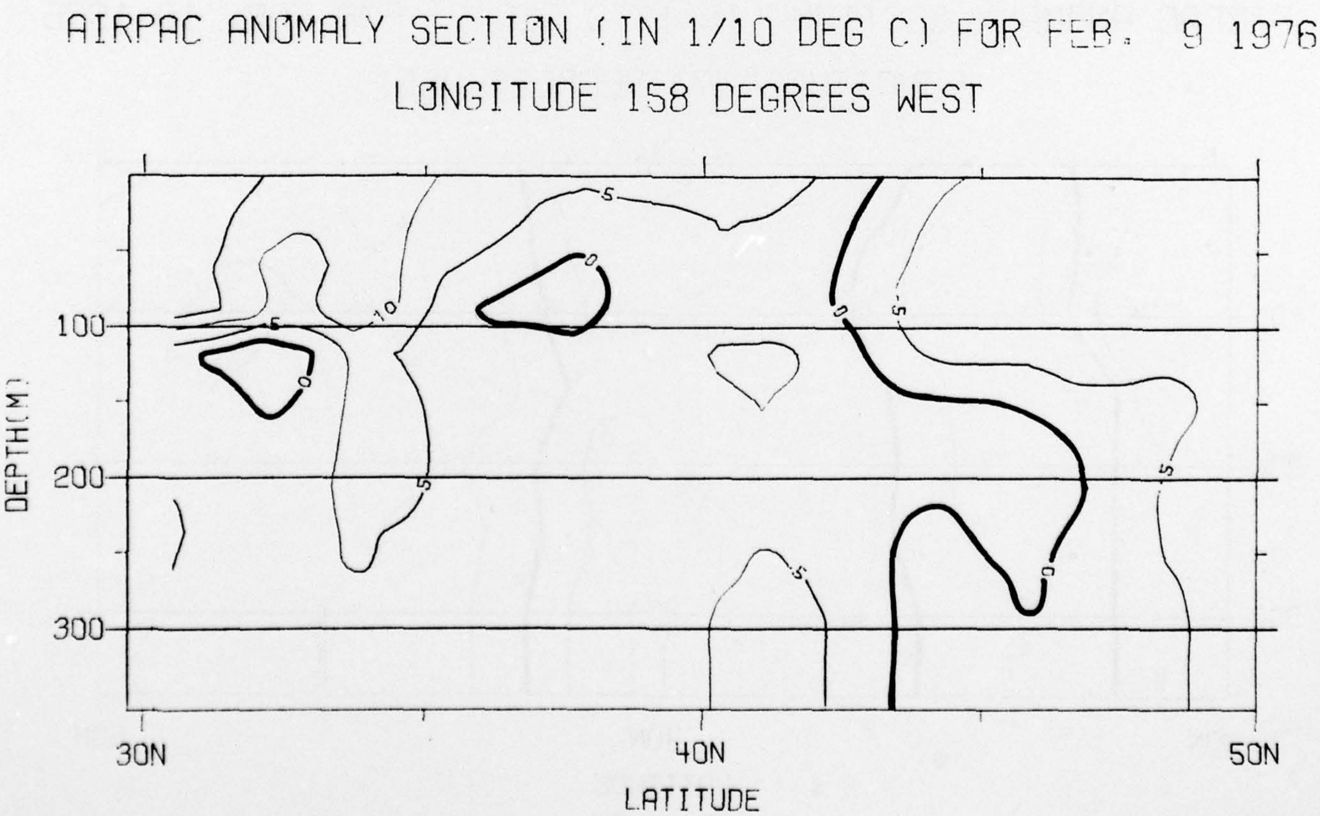
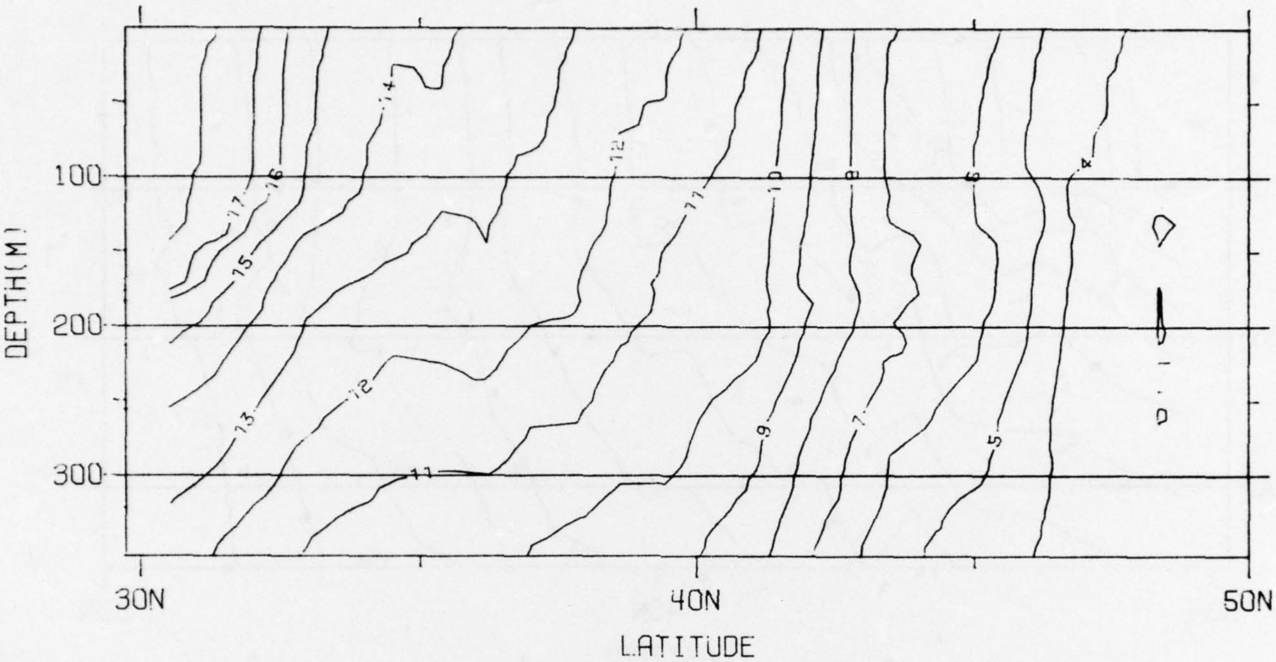

AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR FEB. 9 1976
LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE
5
0
-5
10

Figure 25

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR FEB. 10 1976

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR FEB. 10 1976

LONGITUDE 170 DEGREES WEST

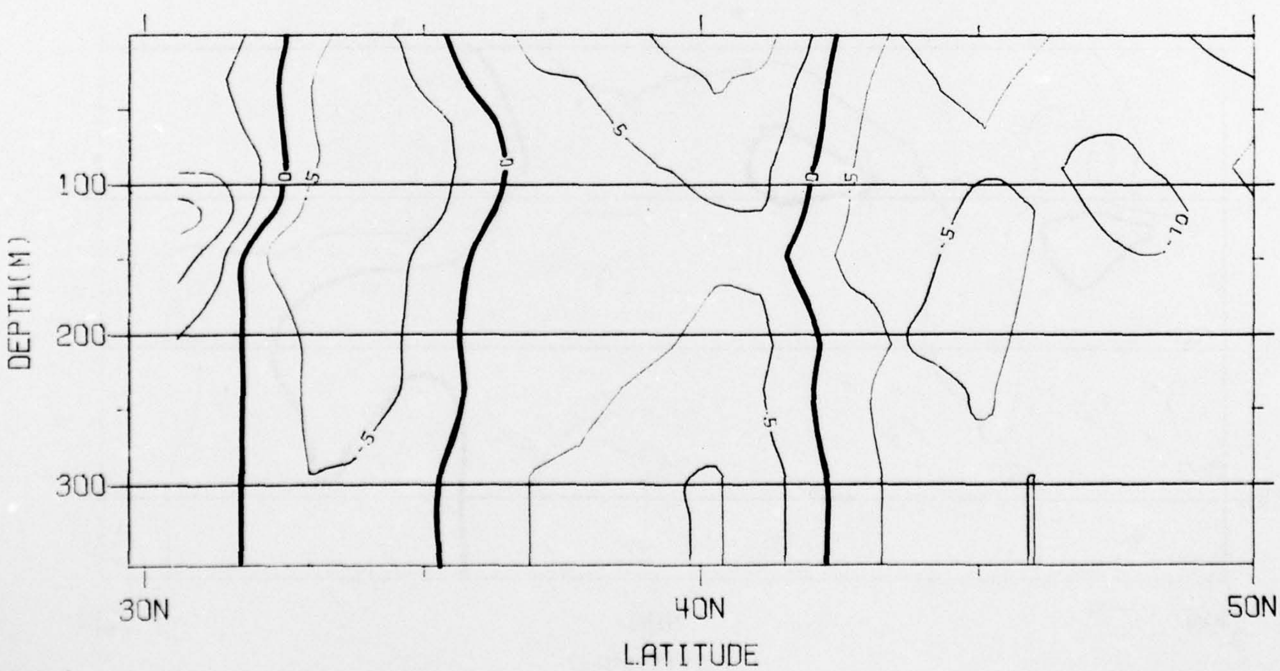
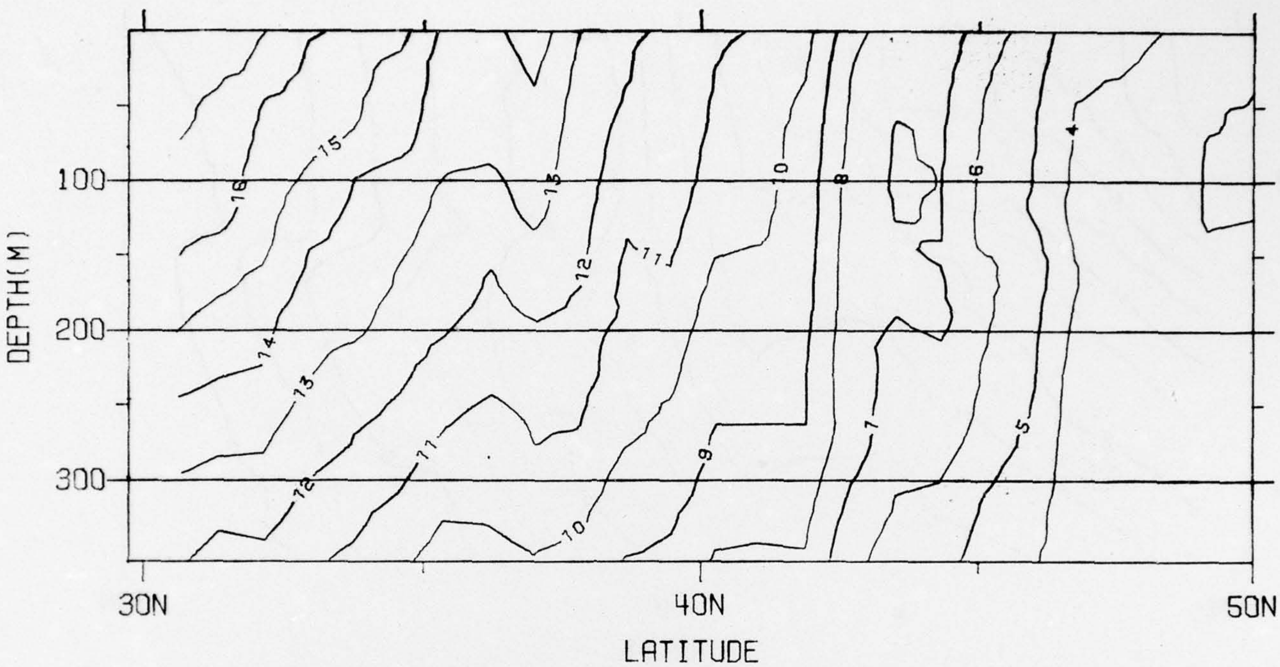


Figure 26

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR MAR. 22 1976

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR MAR. 22 1976

LONGITUDE 170 DEGREES WEST

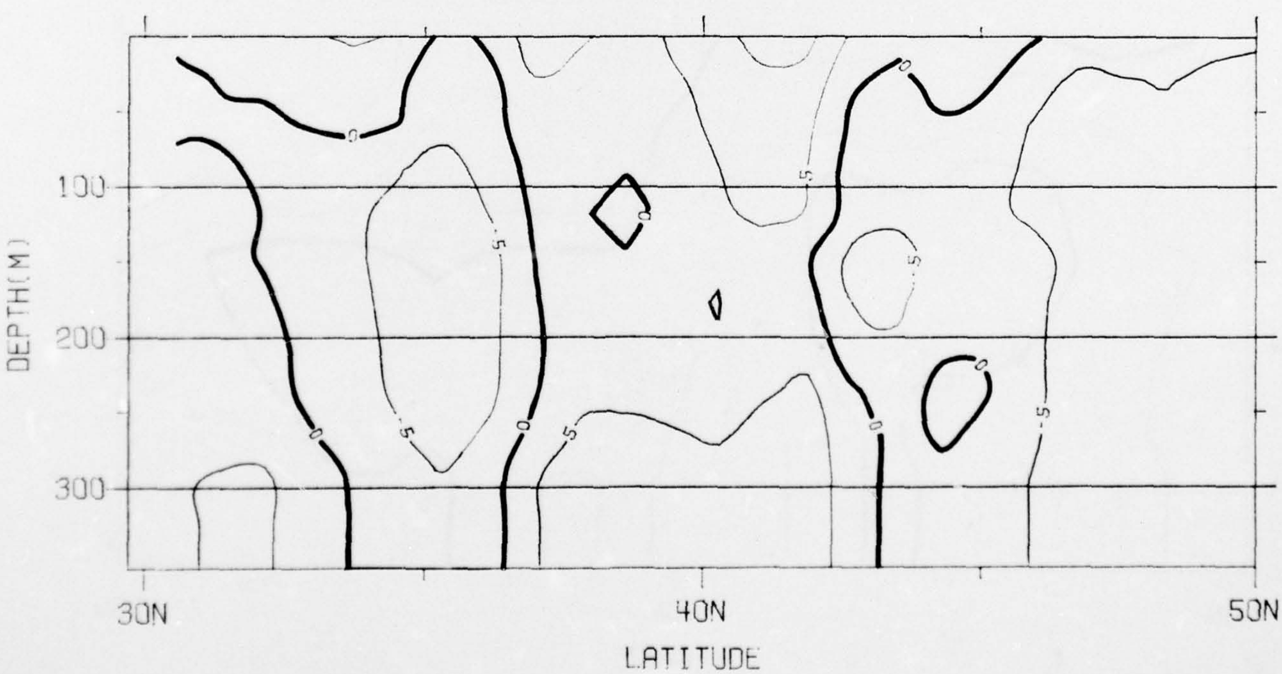


Figure 27

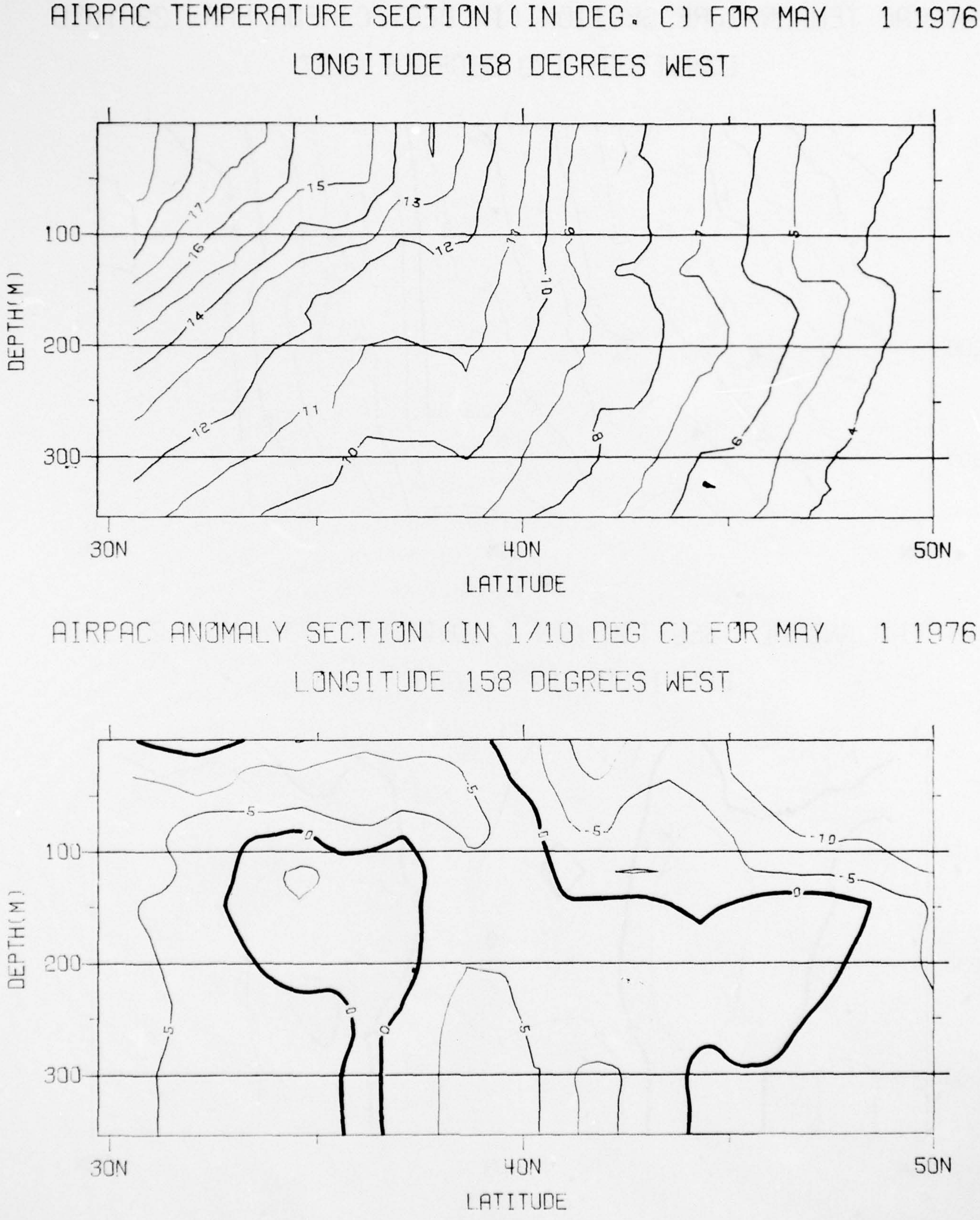

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR MAY 1 1976
LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE
AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR MAY 1 1976
LONGITUDE 158 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE

Figure 28

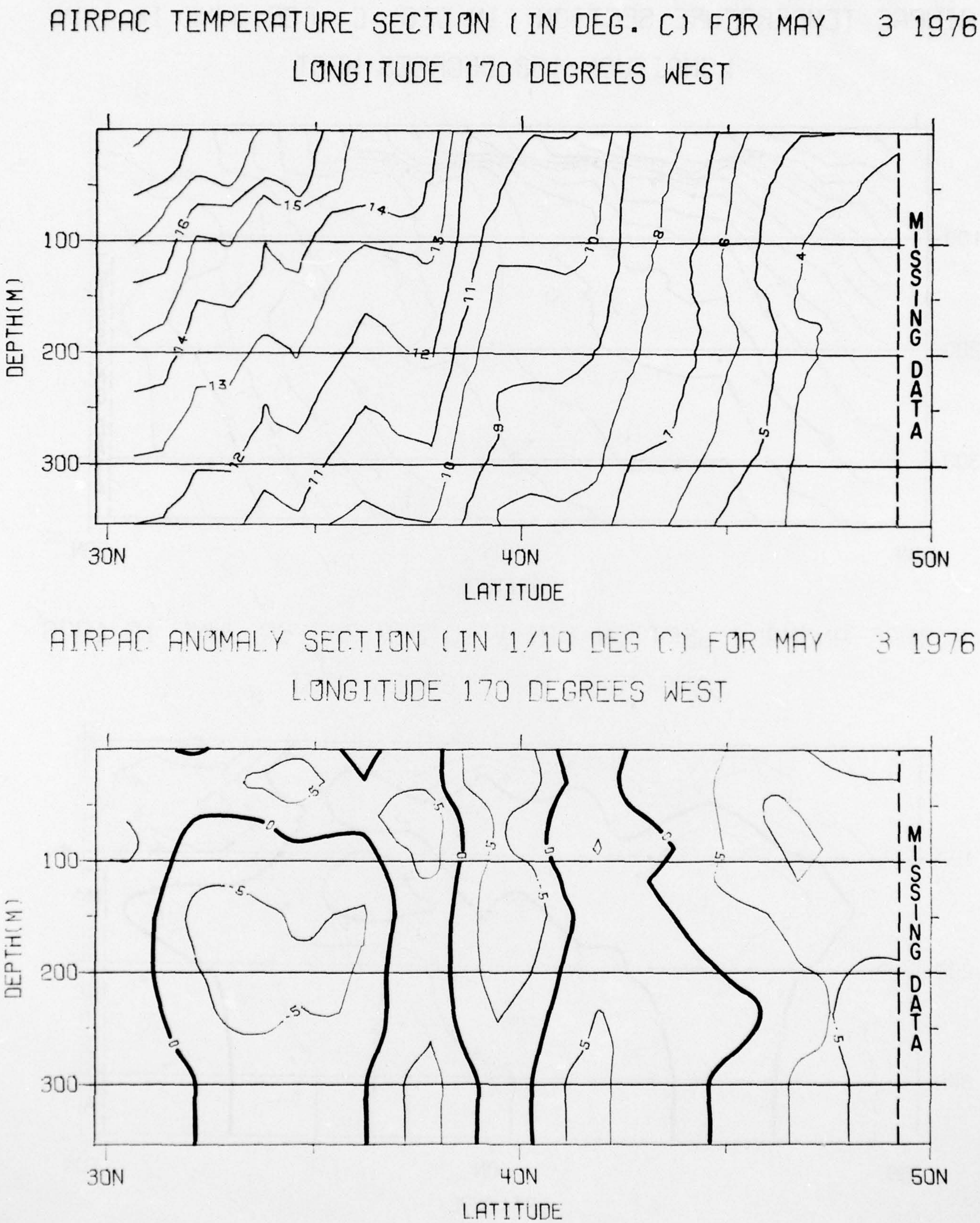
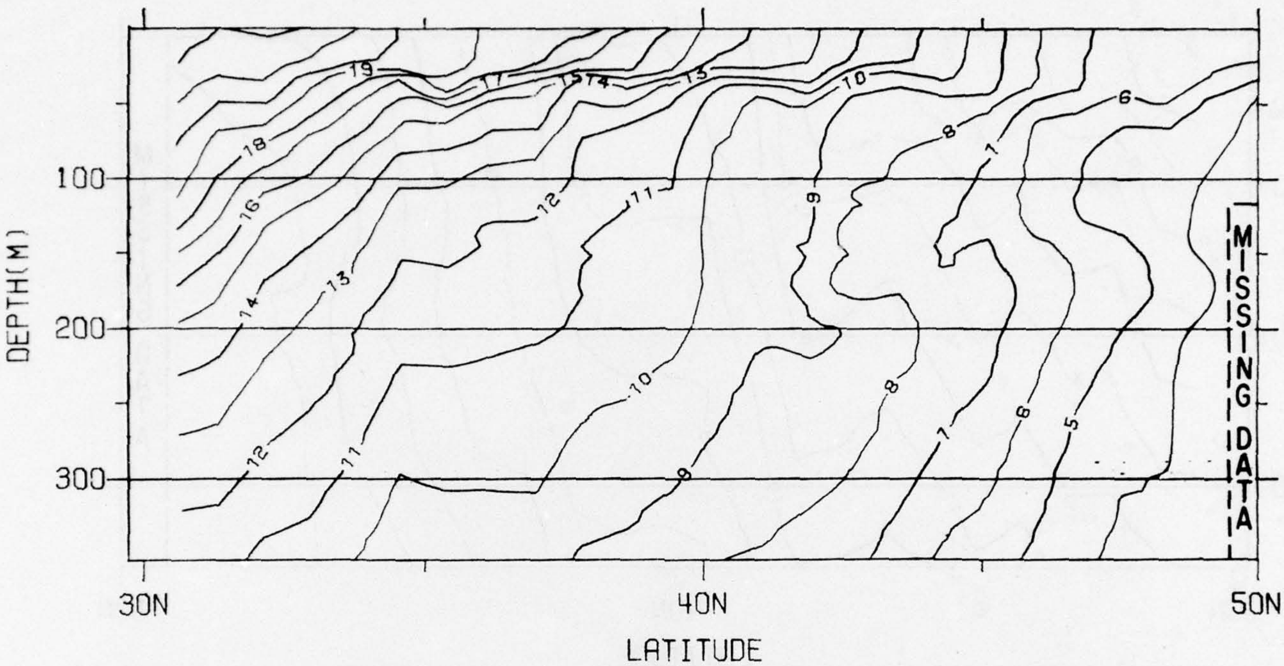

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR MAY 3 1976
LONGITUDE 170 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE
MISSING DATA
AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR MAY 3 1976
LONGITUDE 170 DEGREES WEST
DEPTH(M)
100
200
300
30N
40N
50N
LATITUDE
MISSING DATA

Figure 29

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR JUNE 16 1976

LONGITUDE 158 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR JUNE 16 1976

LONGITUDE 158 DEGREES WEST

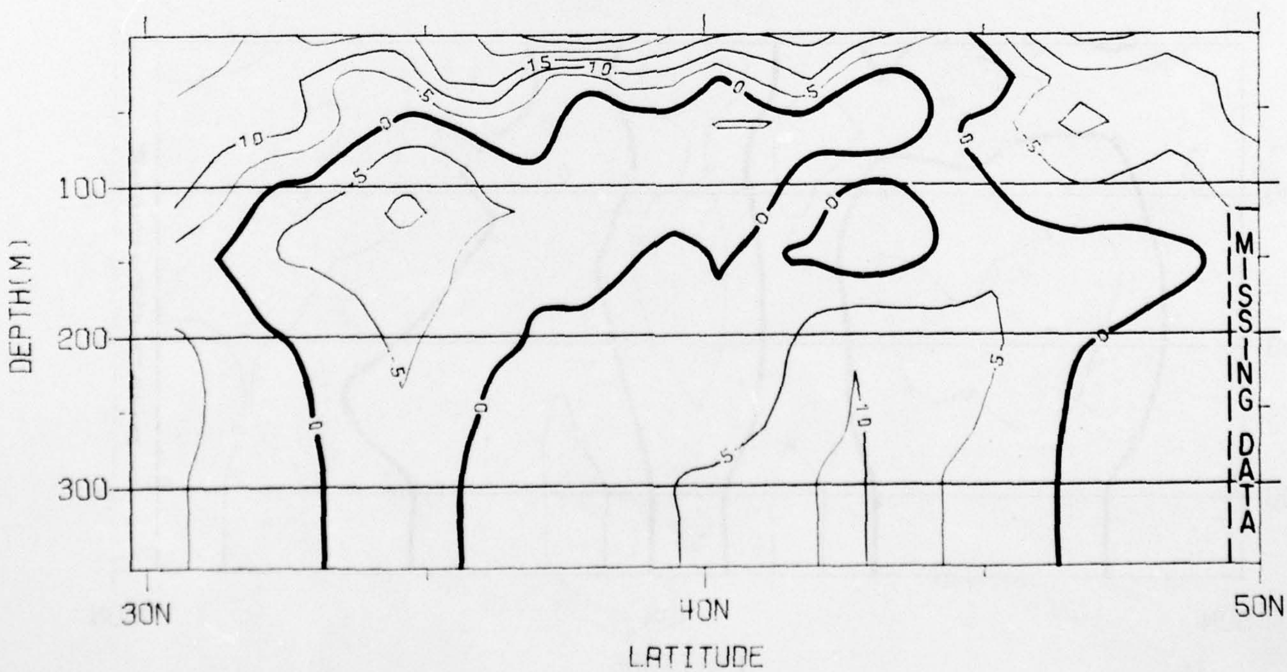
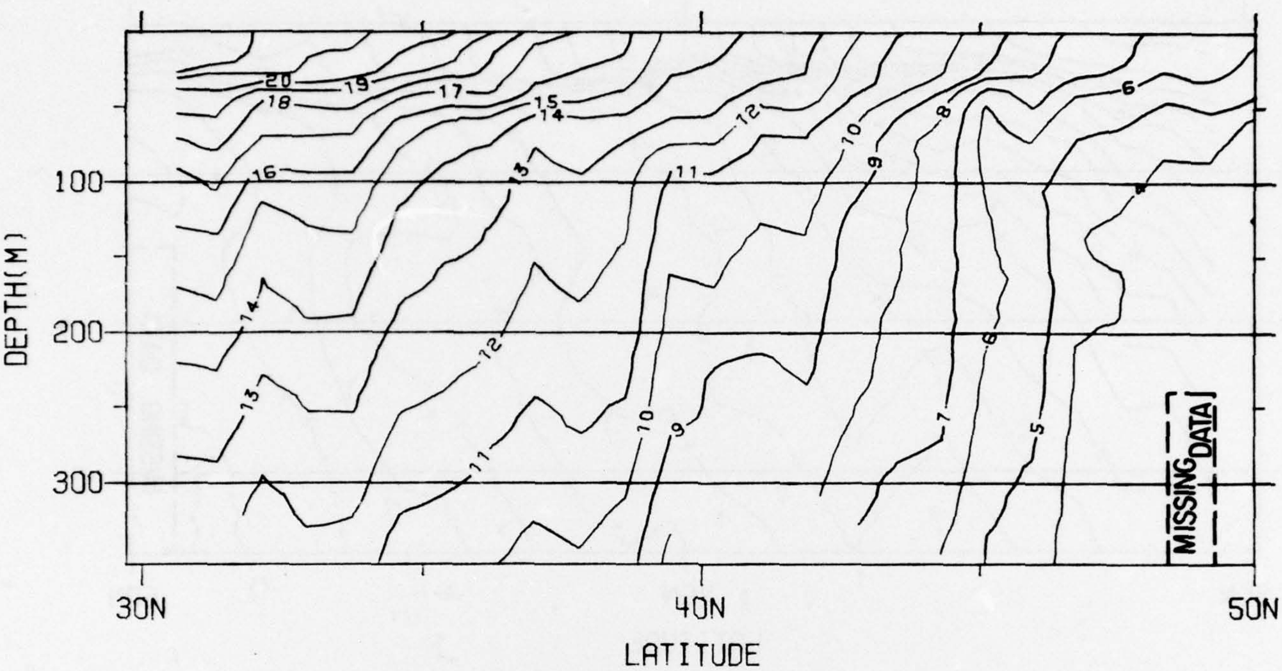


Figure 30

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR JUNE 18 1976

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR JUNE 18 1976

LONGITUDE 170 DEGREES WEST

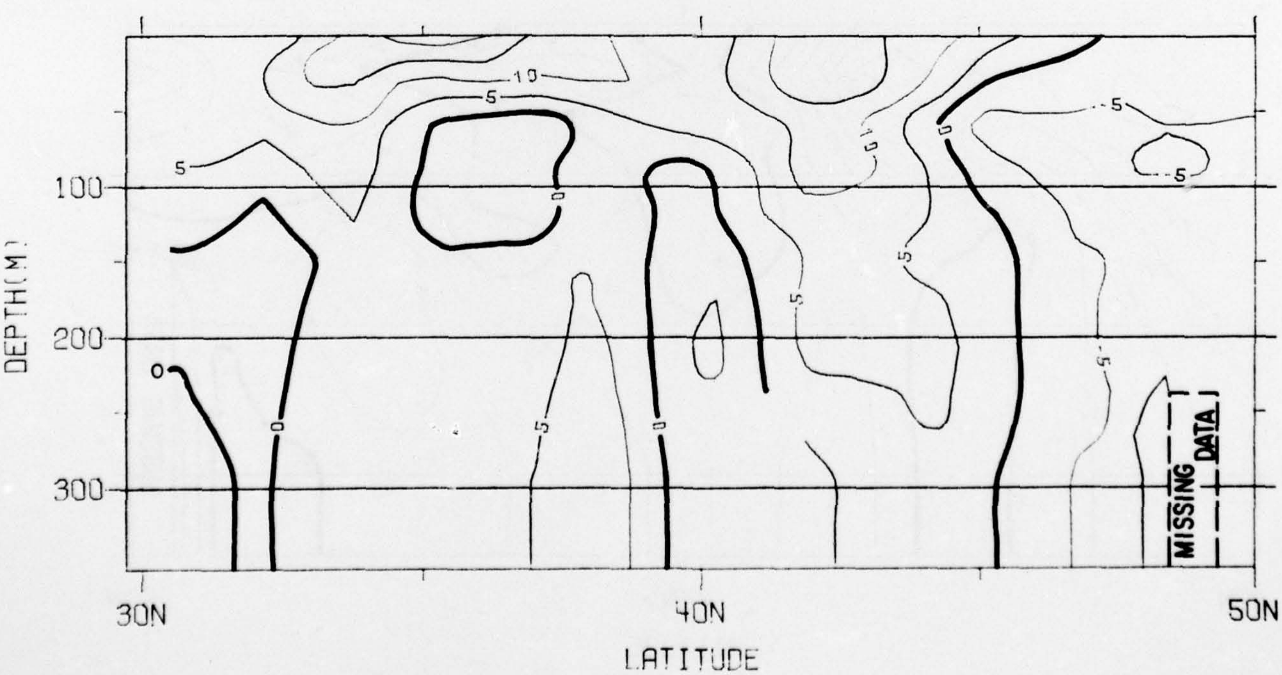
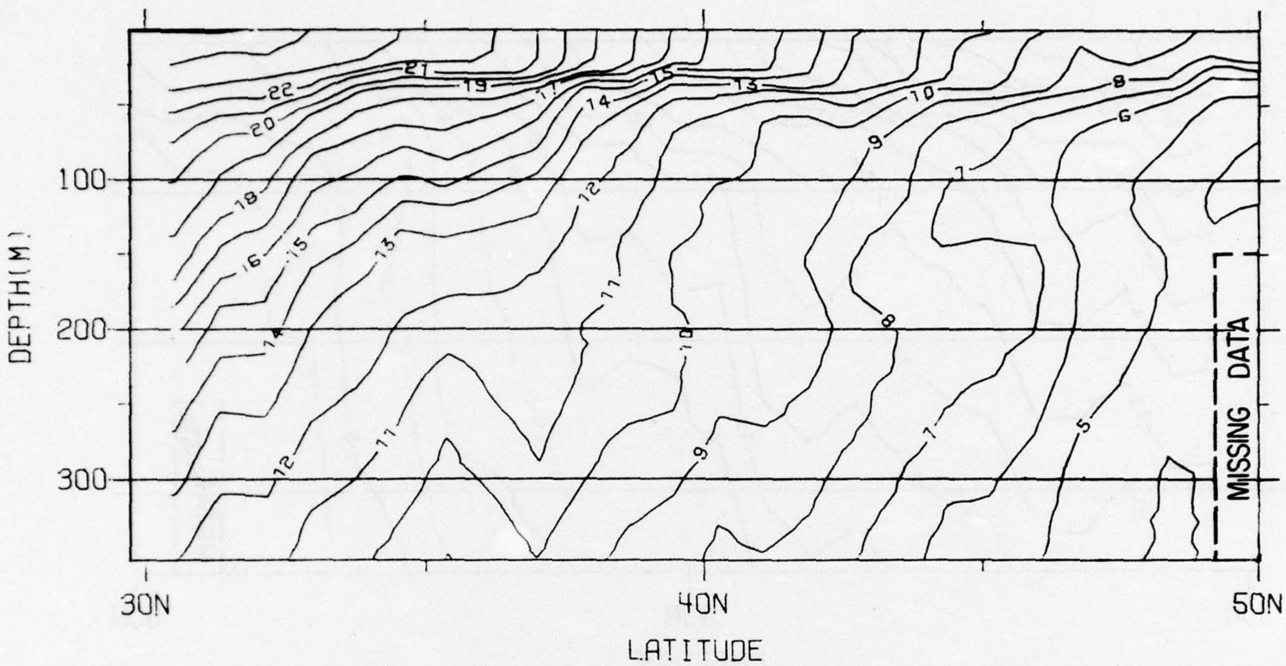


Figure 31

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR JULY 8 1976

LONGITUDE 158 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR JULY 8 1976

LONGITUDE 158 DEGREES WEST

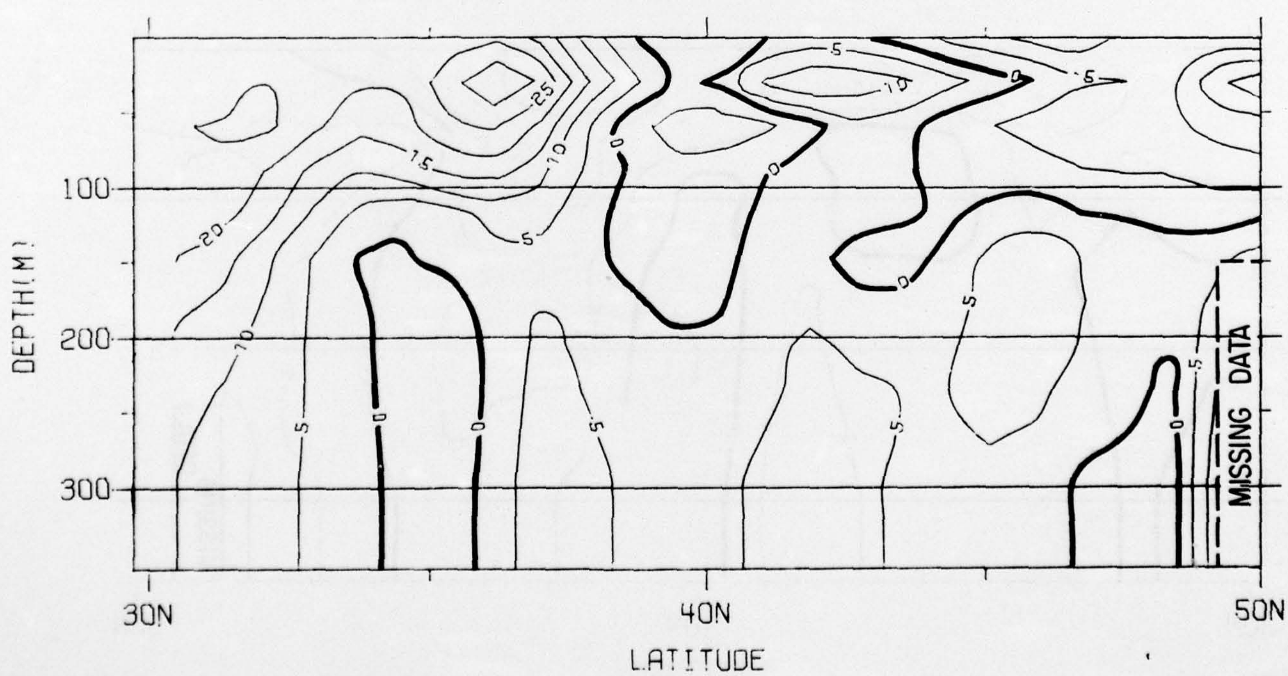
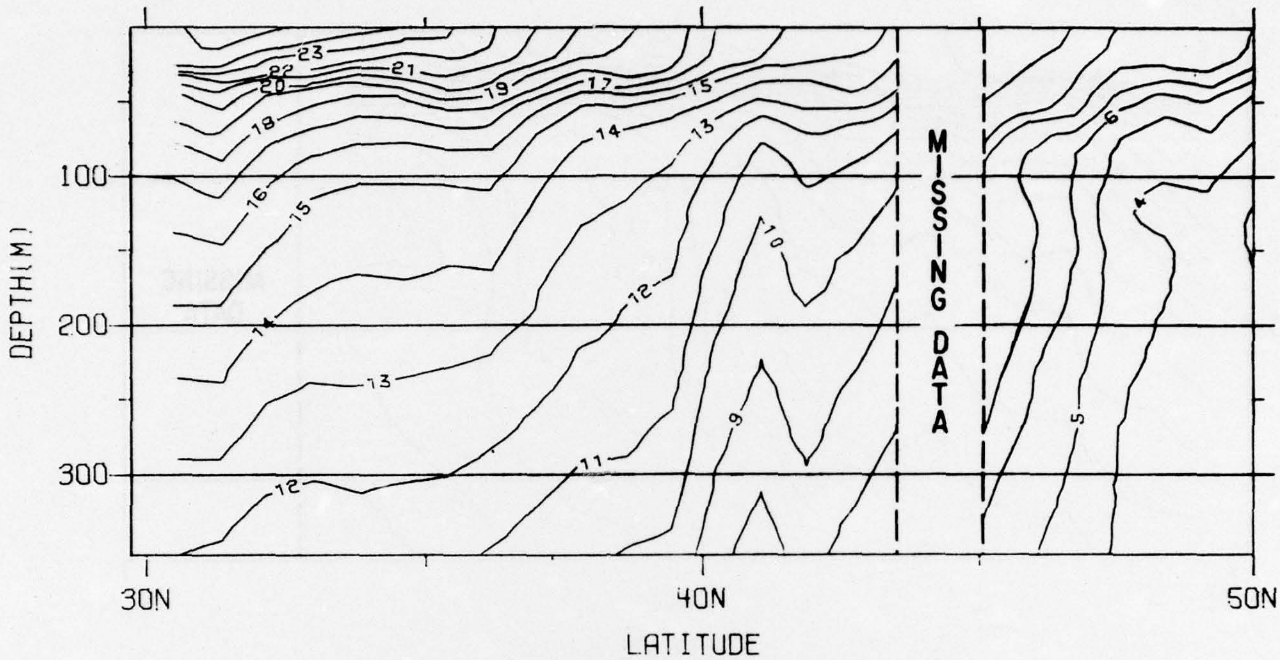


Figure 32

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR JULY 10 1976

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR JULY 10 1976

LONGITUDE 170 DEGREES WEST

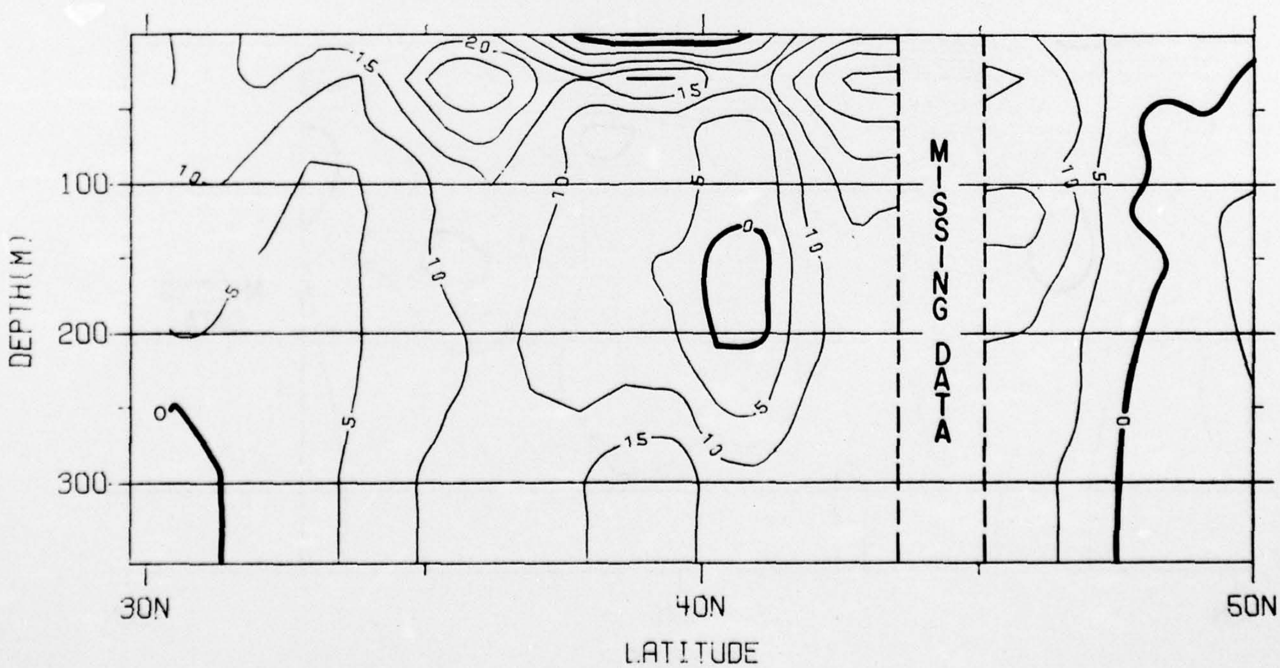
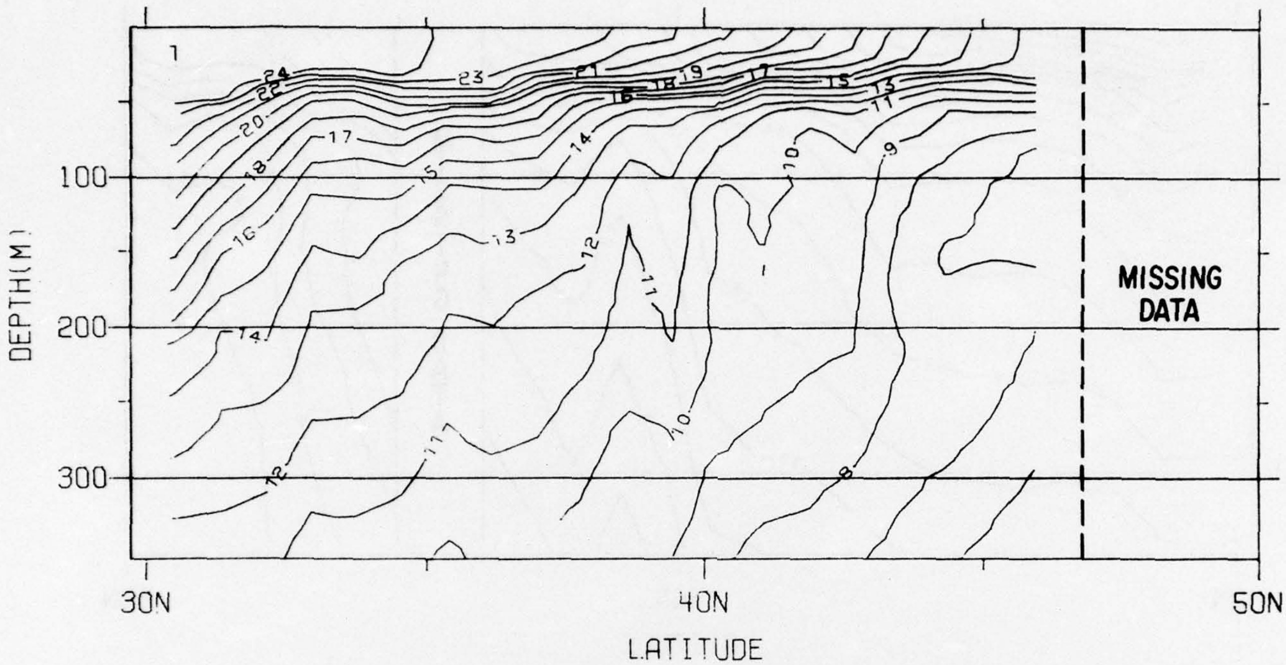


Figure 33

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR AUG. 21 1976

LONGITUDE 158 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR AUG. 21 1976

LONGITUDE 158 DEGREES WEST

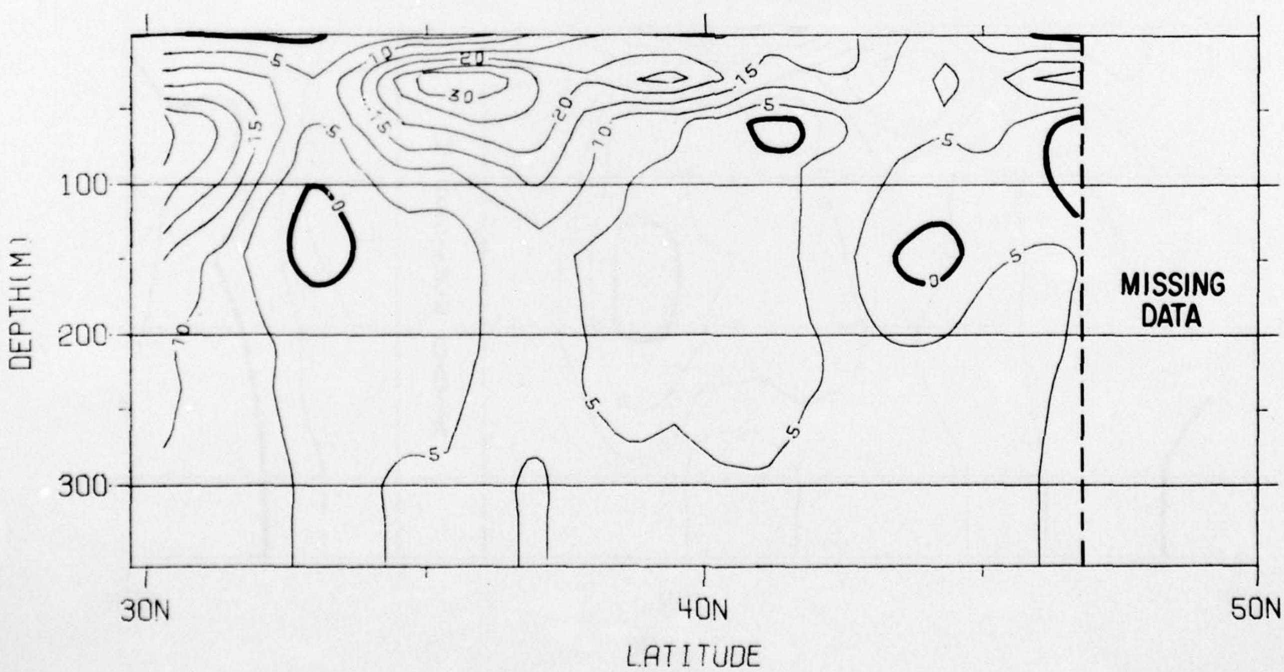
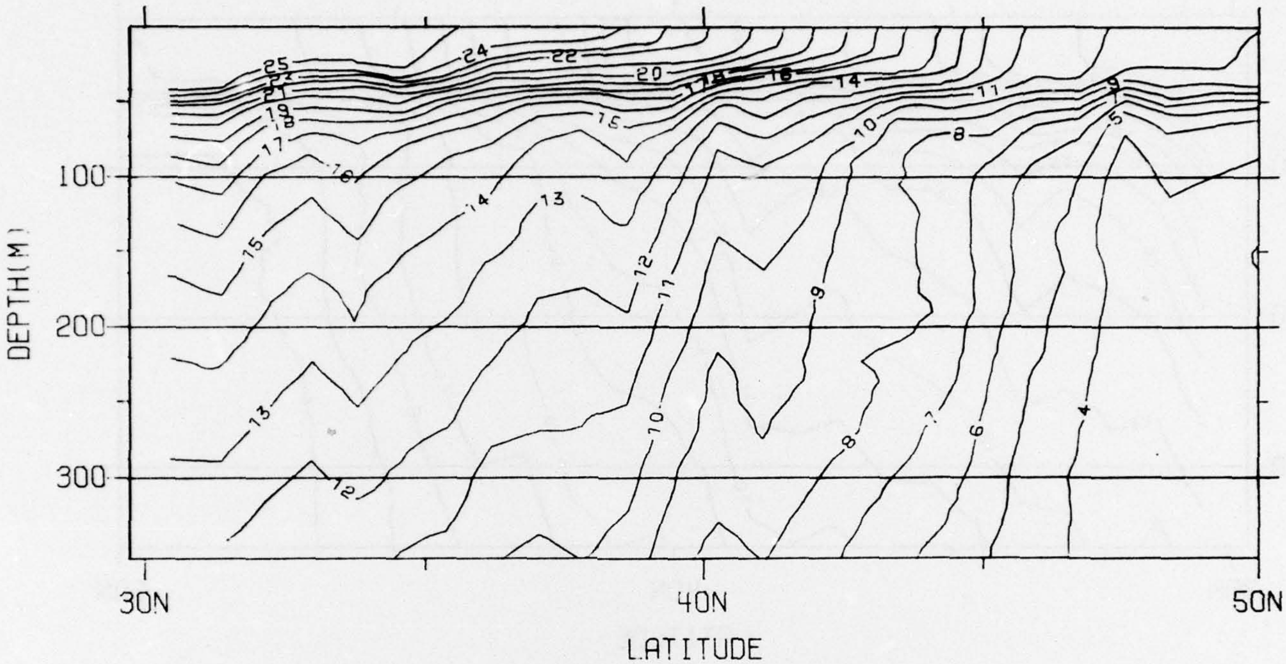


Figure 34

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR AUG. 24 1976

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR AUG. 24 1976

LONGITUDE 170 DEGREES WEST

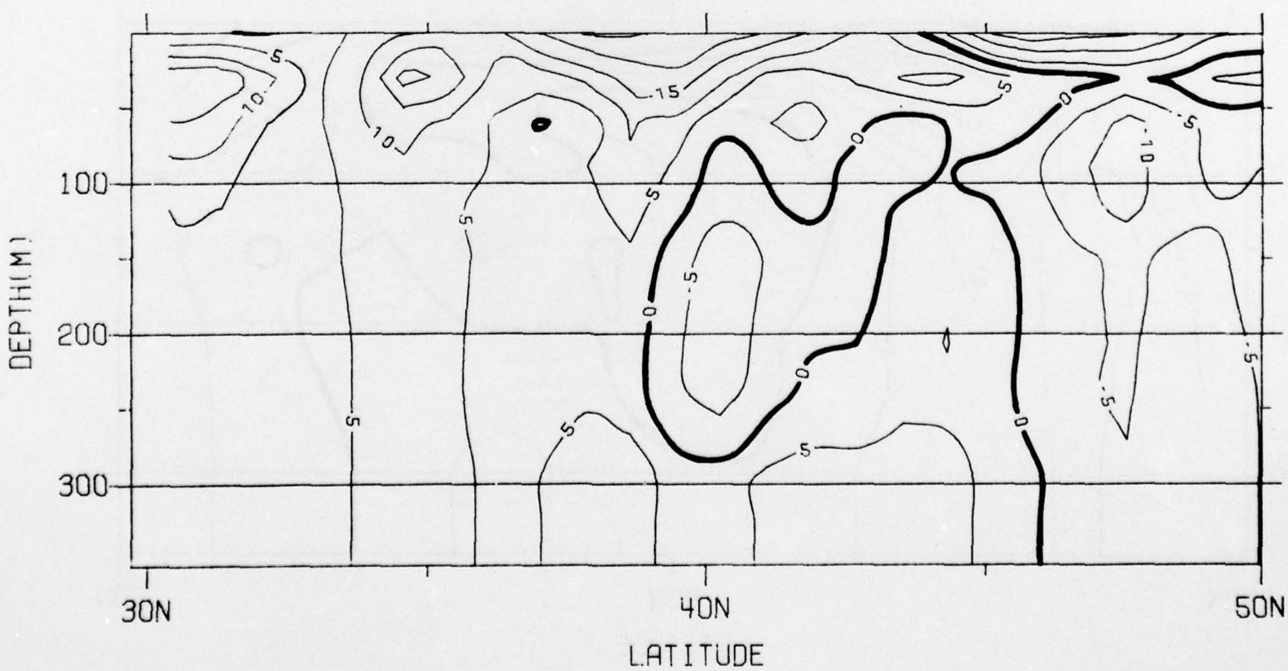
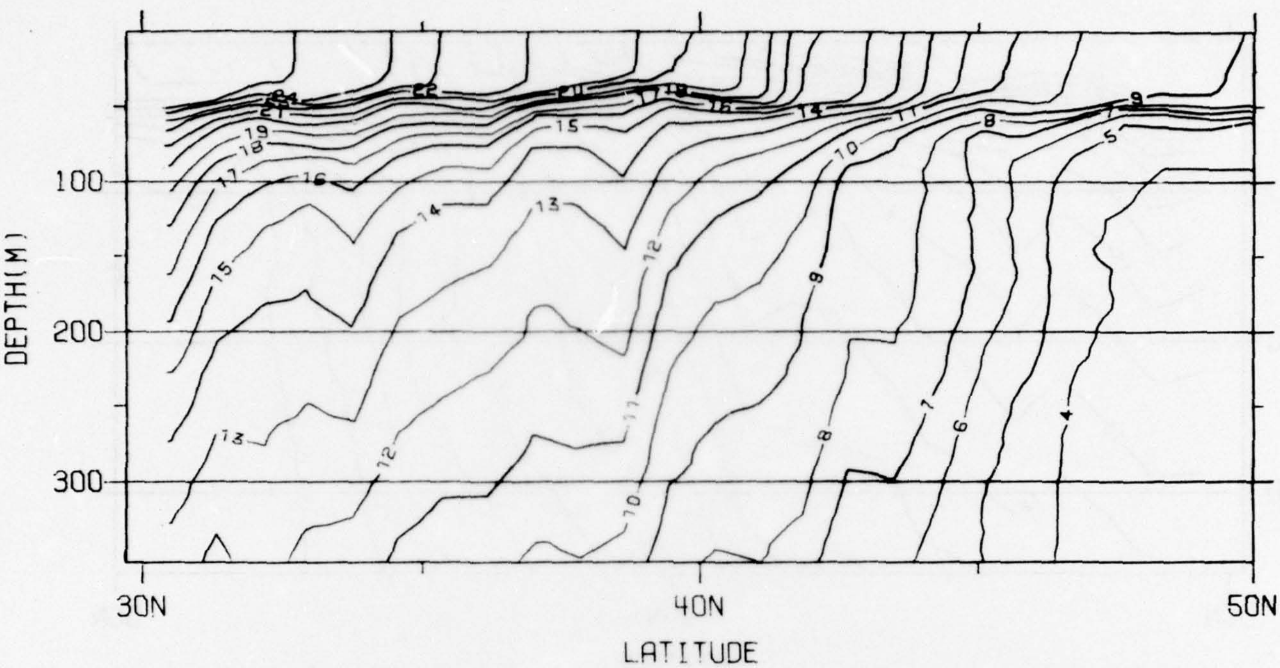


Figure 35

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR SEPT 20 1976

LONGITUDE 170 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR SEPT 18 1976

LONGITUDE 158 DEGREES WEST

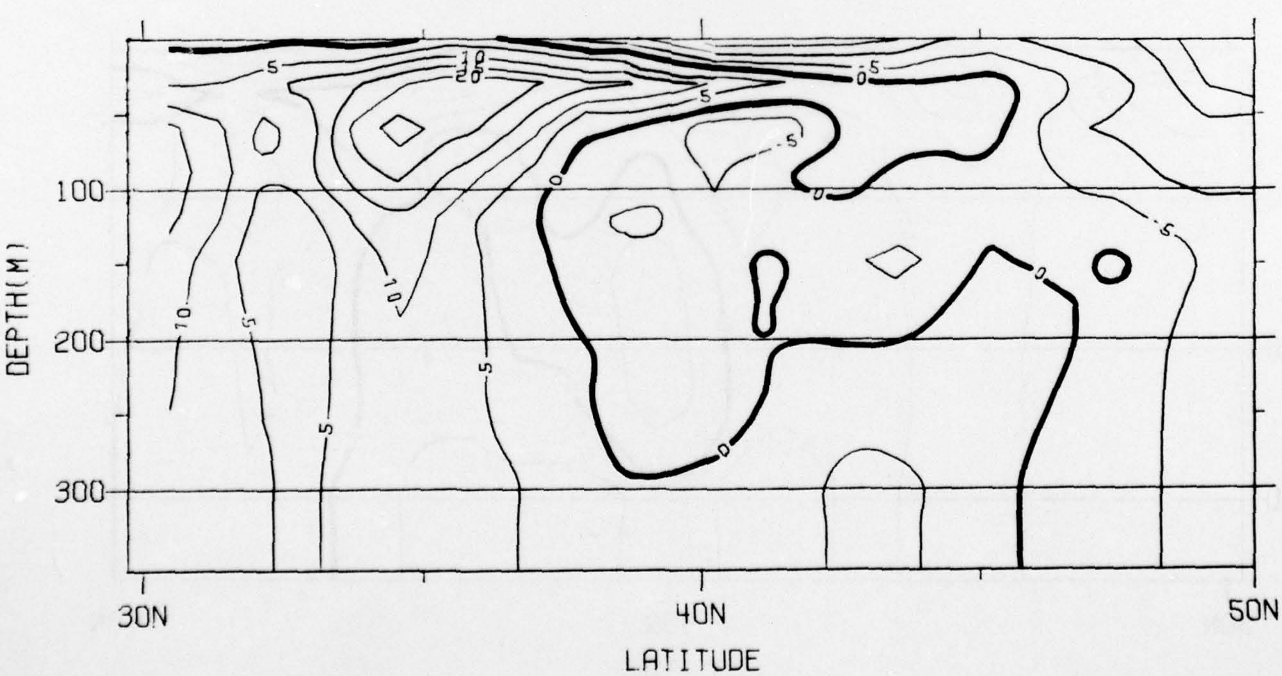
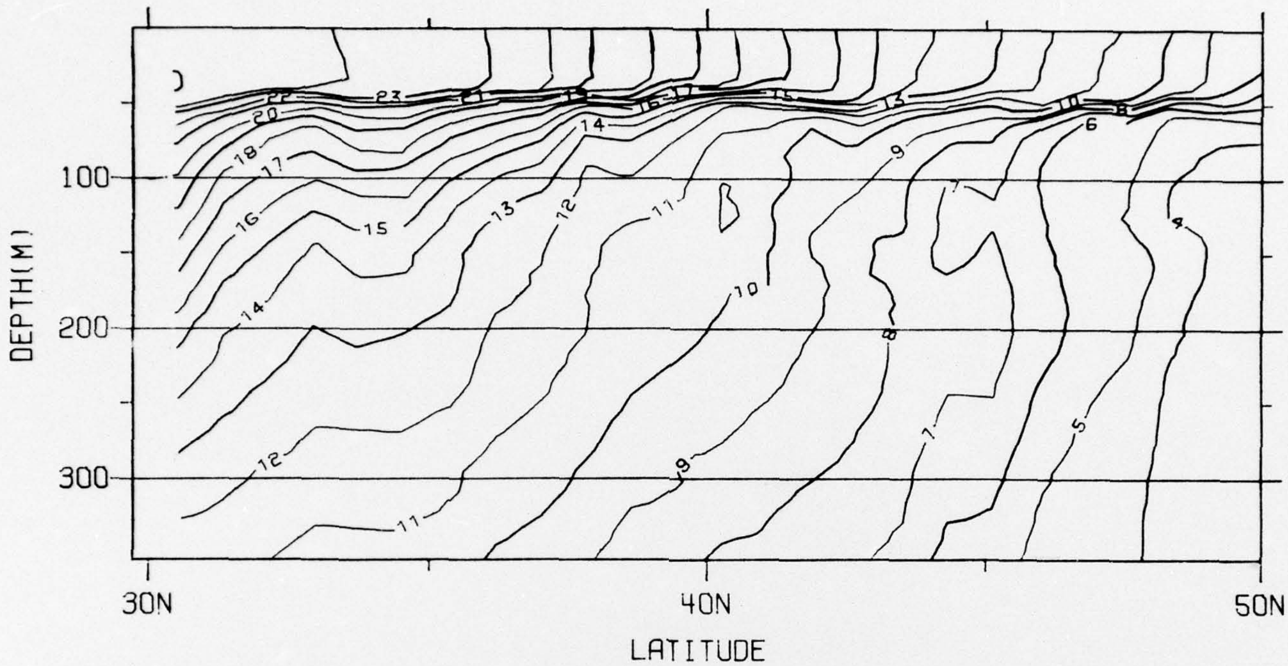


Figure 36

AIRPAC TEMPERATURE SECTION (IN DEG. C) FOR SEPT 18 1976

LONGITUDE 158 DEGREES WEST



AIRPAC ANOMALY SECTION (IN 1/10 DEG C) FOR SEPT 20 1976

LONGITUDE 170 DEGREES WEST

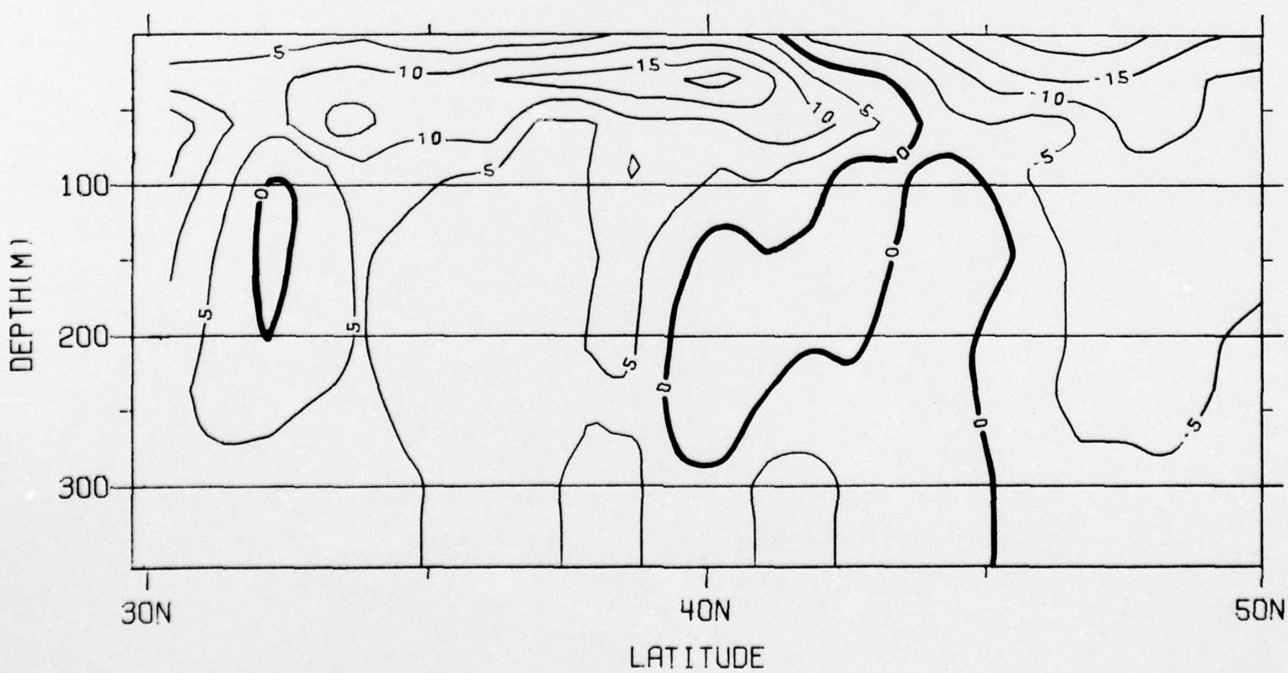


Figure 37