NOAA Technical Memorandum ERL AOML-27

SYNOPTIC AND MEAN MONTHLY 20°C TOPOGRAPHIES IN THE EASTERN GULF OF MEXICO

Robert L. Molinari

Atlantic Oceanographic and Meteorological Laboratories
Miami, Florida
June 1977

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / Environmental Research Laboratories

NOAA Technical Memorandum ERL AOML-27

SYNOPTIC AND MEAN MONTHLY 20°C TOPOGRAPHIES IN THE EASTERN GULF OF MEXICO

Robert L. Molinari
Physical Oceanography Laboratory

Atlantic Oceanographic and Meteorological Laboratories
Miami, Florida
June 1977

UNITED STATES DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator

Environmental Research Laboratories
Wilmot N. Hess, Director

Page

CONTENTS

SYNOPTIC AND MEAN MONTHLY 20°C TOPOGRAPHIES IN THE EASTERN GULF OF MEXICO

Robert L. Molinari
National Oceanic and Atmospheric Administration
Environmental Research Laboratories
Atlantic Oceanographic and Meteorological Laboratories
Miami, Florida

ABSTRACT. Synoptic and mean-monthly 20°C isothermal surface topographies are presented to make these data available to other investigators. Historical literature in which many of the synoptic topographies are considered are also listed. Finally, other data representations are given in which the large variability about the climatological averages is indicated.

1. INTRODUCTION

Atlantic Oceanographic and Meteorological Laboratories personnel were involved with scientists from other institutions in a "Compilation and Summation of the Historical and Existing Physical Oceanographic Data from the Eastern Gulf of Mexico" (SUSIO, 1975) for the Bureau of Land Management (BLM). One portion of this study was designed to summarize the characteristics of the deep basin circulation in the eastern Gulf of Mexico.

Temperature topographies are useful approximations to the density field and, therefore, to the geostropic circulation in the eastern Gulf of Mexico (see Leipper (1970), for instance). Thus, one of the parameters selected to describe the deep basin circulation in the BLM report was the 20°C isothermal surface topography obtained from synoptic cruise data. These topographies are presented in this report so as to provide other investigators the benefit of these data.

In addition, monthly mean 20°C topographies were computed and are presented. When available, dynamic height distributions of the sea-surface relative to 500 db were prepared and are given. Finally, some representative salinity cross-sections through the major circulation features were constructed and are included in this report.

2. 20°C TOPOGRAPHIES

2.1 Synoptic data

The National Oceanographic Data Center (NODC) of the National Oceanic and Atmospheric Administration prepared the base charts from which the contoured 20°C topographies were produced. The charts gave the station position, the data type, i.e., whether Nansen station, STD station, expendable bathy-

thermograph or mechanical bathythermograph observation, and the depth of the 20°C isotherm. If the station data did not include the depth of the 20°C surface, NODC computed the isotherm depth by linear interpolation. The charts were then subjectively contoured, and the resulting data-set is given in Appendix 1.

Appendix 1 also includes dynamic topographies of the sea-surface relative to 500 db and representative salinity cross-sections. The similarities between the dynamic and isotherm topographies, particularly in regions of strong current, demonstrate the reliability of the isotherm topography as an indicator for geostropic motions.

As discussed in the introduction, these data are presented primarily to inform other investigators of their availability. Most of the data have been discussed in other publications which considered the circulation in the eastern Gulf of Mexico, and, in particular the major flow feature in this region, the Loop Current. For instance, Nowlin and McLellan (1967) and Nowlin (1972) discussed the wintertime circulation pattern using the February to March 1962 data. Leipper (1970) based his suggestion for an annual cycle of the intrusion of the Loop Current on the 1965-1966 data-set. Nowlin and Hubertz (1972) demonstrated the summertime variability in the current regime using the June 1966 and 1967 data. Cochrane (1972) documented an eddy separation event using the 1969 observations. Finally, Maul (1975) observed a Loop intrusion cycle similar to that of Leipper in 1972-1973. Therefore, no detailed analysis of these data will be presented in this report.

2.2 Climatological data

As part of the BLM study, NODC computed average temperature values by 1° square and month from their XBT and MBT data-files. The depth of the climatological monthly 20°C surface was computed by linear interpolation from data at 5 m intervals. The mean 20°C topographies were subjectively contoured and are presented in Appendix 2.

The 150 m isopleth of the 20°C surface is located near the core of the Loop Current as indicated by the maximum gradients in the dynamic topographies. Appendix 2 also includes bi-monthly compilations of synoptic 150 m isopleths compared to climatological isopleths. These figures illustrate the large variability observed about the mean conditions.

3. ACKNOWLEDGMENTS

The compilation of these data would not have been possible without the efforts of Mr. M. Rinkel, State University System of Florida Institute of Oceanography (SUSIO); Mr. J. Cochrane, Texas A&M University; and Dr. G. Maul, NOAA, Atlantic Oceanographic and Meteorological Laboratories. This work was funded by the Bureau of Land Management, Department of Interior, through contract Number 08550-CT4-16, administered by SUSIO.

4. REFERENCES

Cochrane, J. D. (1972). Separation of an anticyclonic and subsequent developments in the Loop Current (1969). IN: Contributions on the Physical Oceanography of the Gulf of Mexico, Capurro and Reid, Editors, Gulf Publ. Co., Houston, pp. 91-106.

Leipper, D. F. (1970). A sequence of current patterns in the Gulf of Mexico. J. Geophys. Res., 75, pp. 637-657.

Maul, G. (1975). An evaluation of the use of the Earth Resources Technology Satellite for observing ocean current boundaries in the Gulf Stream system. NOAA Tech. Report ERL 355 AOML 18, 125 pp.

Nowlin, W. D. (1972). Winter circulation patterns and property distribution. IN: Contributions on the Physical Oceanography of the Gulf of Mexico, Capurro and Reid, Editors, Gulf Publ. Co., Houston, pp. 3-51.

Nowlin, W. D., and J. M. Hubertz (1972). Contrasting summer circulation patterns for the eastern Gulf: Loop Current versus anticyclonic ring. IN: Contributions on the Physical Oceanography of the Gulf of Mexico, Capurro and Reid, Editors, Gulf Publ. Co., Houston, pp. 139-148.

Nowlin, W. D., and H. J. McLellan (1967). A characterization of the Gulf of Mexico waters. J. Mar. Res., 25, pp. 29-59.

SUSIO (1975). Compilation and summation of historical and existing physical oceanographic data from the eastern Gulf of Mexico. State University System of Florida Institute of Oceanography Final Report to the Bureau of Land Management, Contract Number 08550-CT4-64.

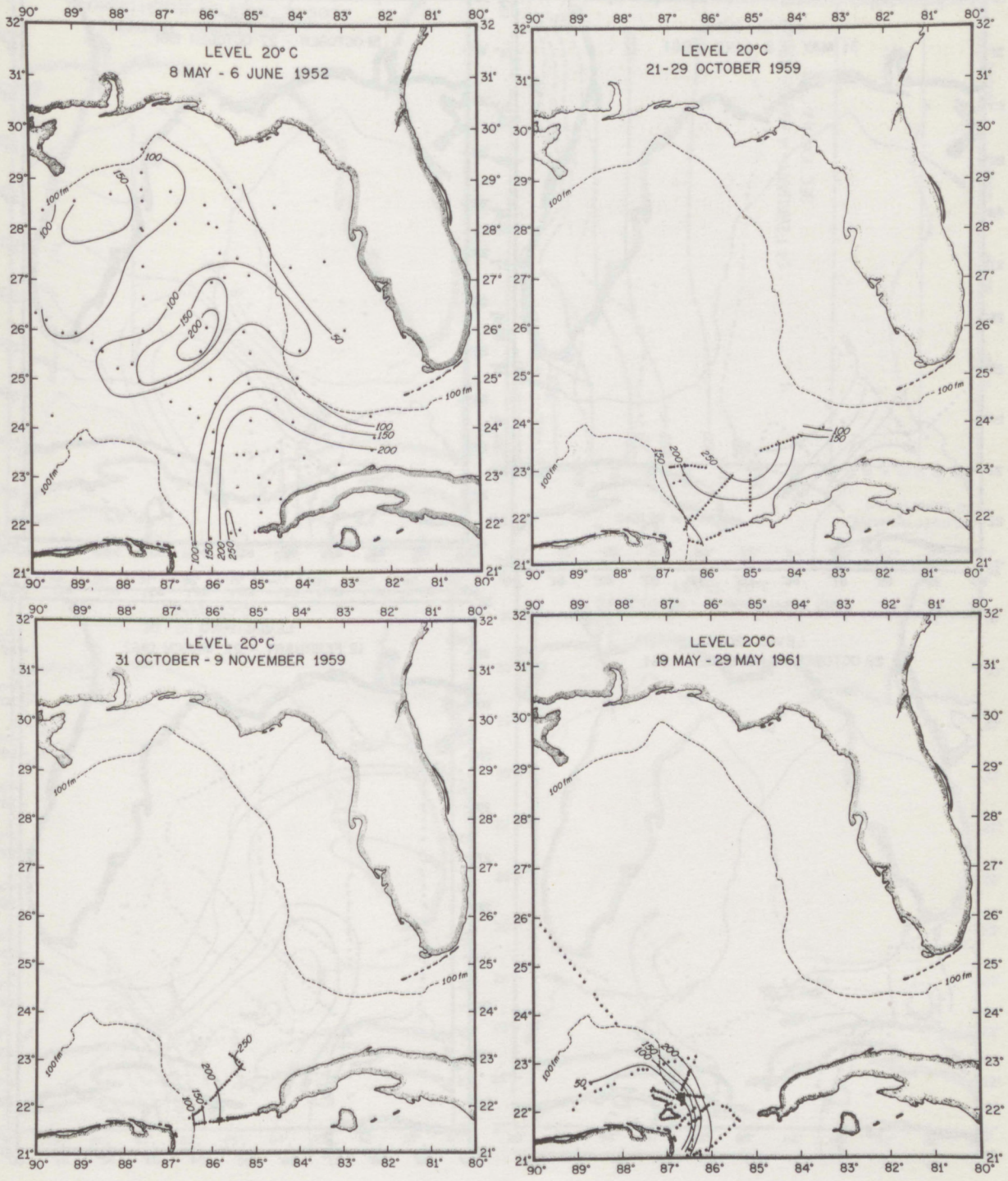
APPENDIX 1. 20°C TOPOGRAPHIES IN THE DEEP BASIN

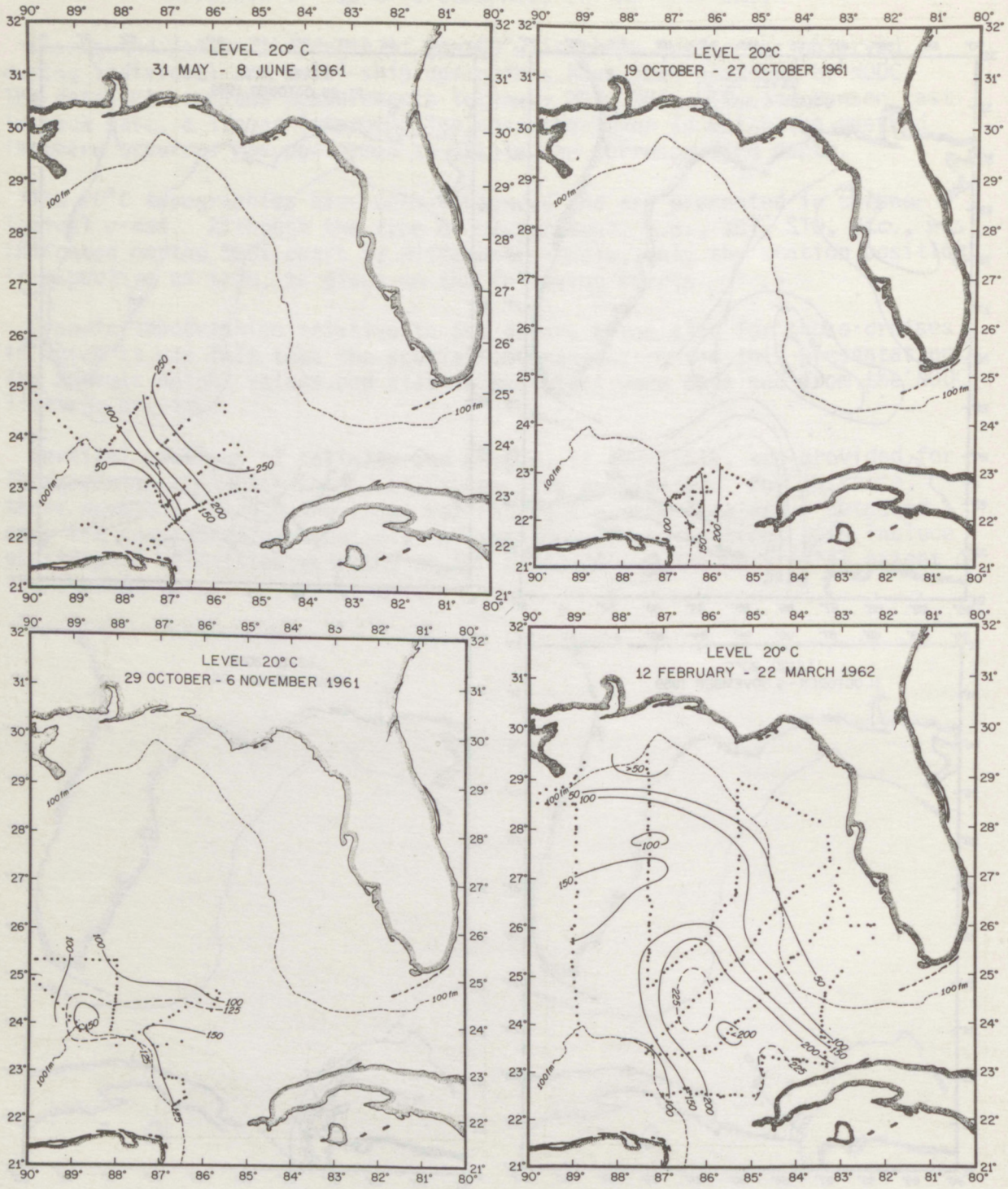
Charts indicating the depth of the 20°C isotherm surface as observed during individual and multi-ship operations have been produced by NODC. The data-sets include measurements taken by MBT, XBT, STD, and Nansen cast. In each case, a linear interpolation over the layer in which the desired isotherm occurred was performed to obtain the corresponding depth.

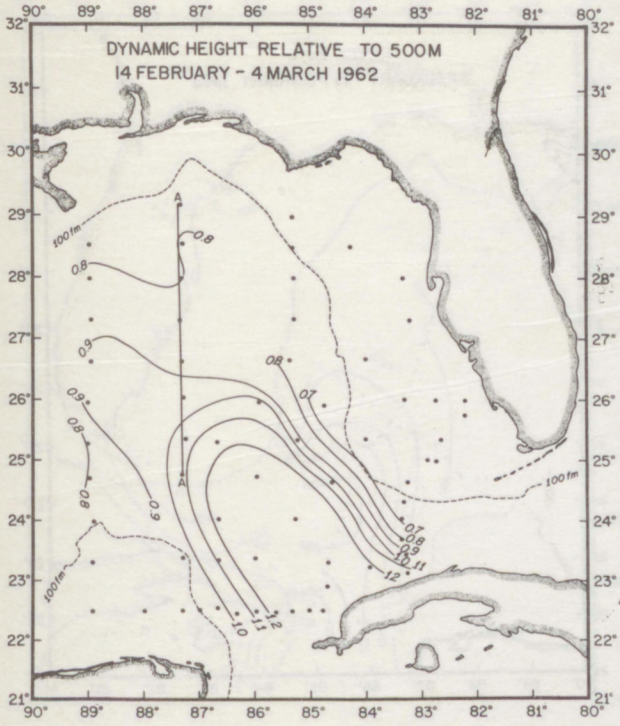
The 20°C topographies have been contoured and are presented in chronological order. Although the type of measurement, i.e., XBT, STD, etc., was indicated on the NODC chart by different symbols, only the station position, irrespective of type, is given on the following charts.

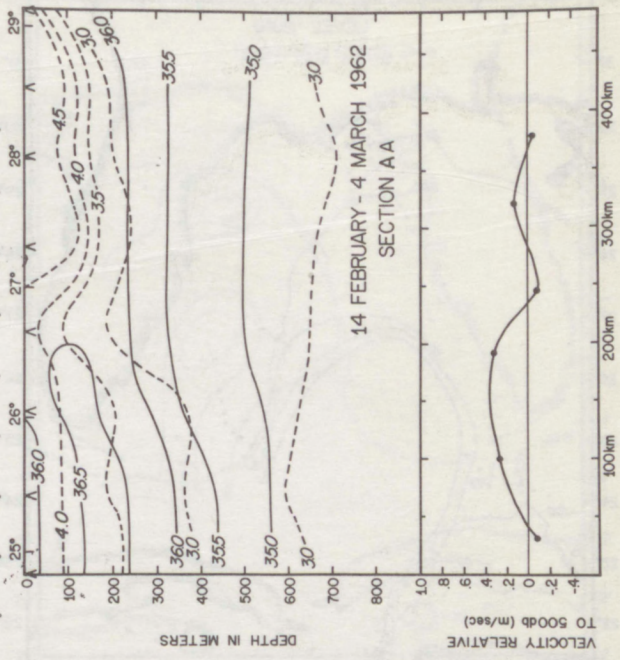
Dynamic topographies relative to 500 db are given also for those cruises in which it was felt that the spatial coverage warranted this presentation. The dynamic height values and station positions were obtained from the NODC listings provided.

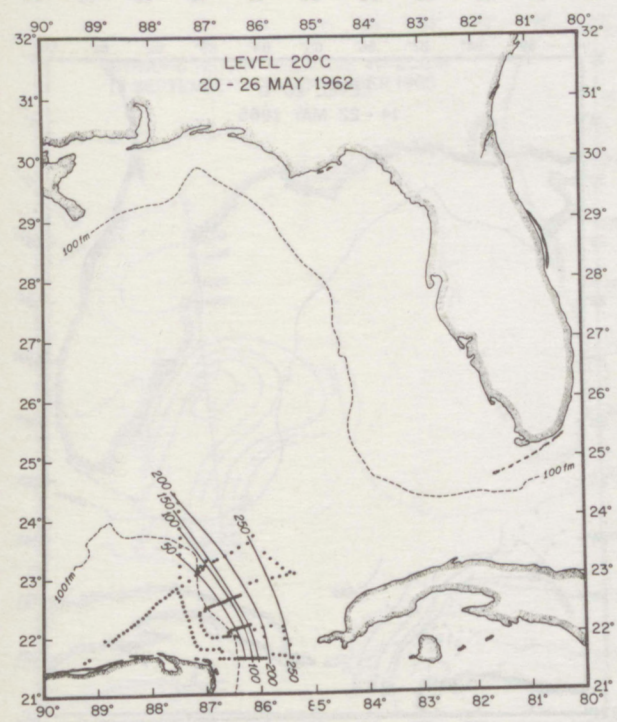
Vertical sections of salinity and oxygen, if available, are provided for those cruises in which specific features were considered. For instance, those sections through the ridge separating the main flow and a detached eddy are considered particularly informative. These sections also include geostrophic velocities relative to 500 db to define the horizontal extent of the current cores.

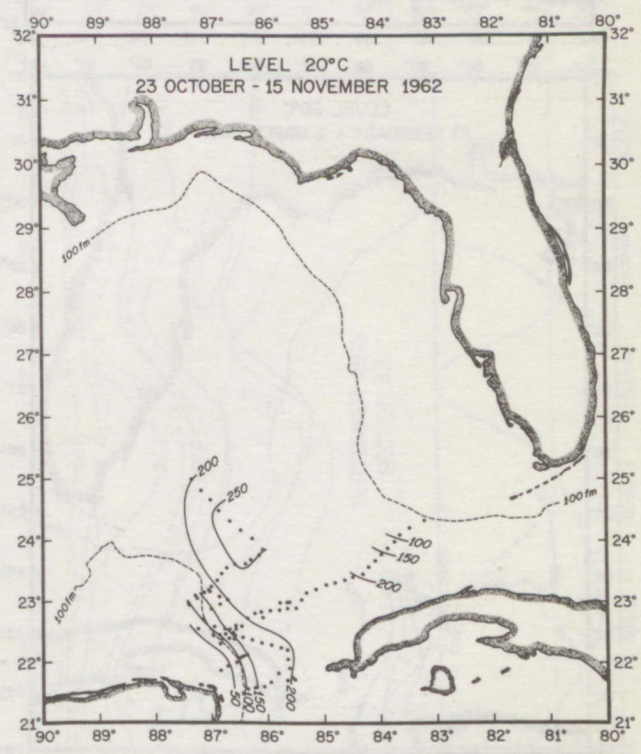

LEVEL 20° C
8 MAY - 6 JUNE 1952
LEVEL 20°C
21-29 OCTOBER 1959
LEVEL 20°C
31 OCTOBER - 9 NOVEMBER 1959
LEVEL 20°C
19 MAY - 29 MAY 1961
100 fm

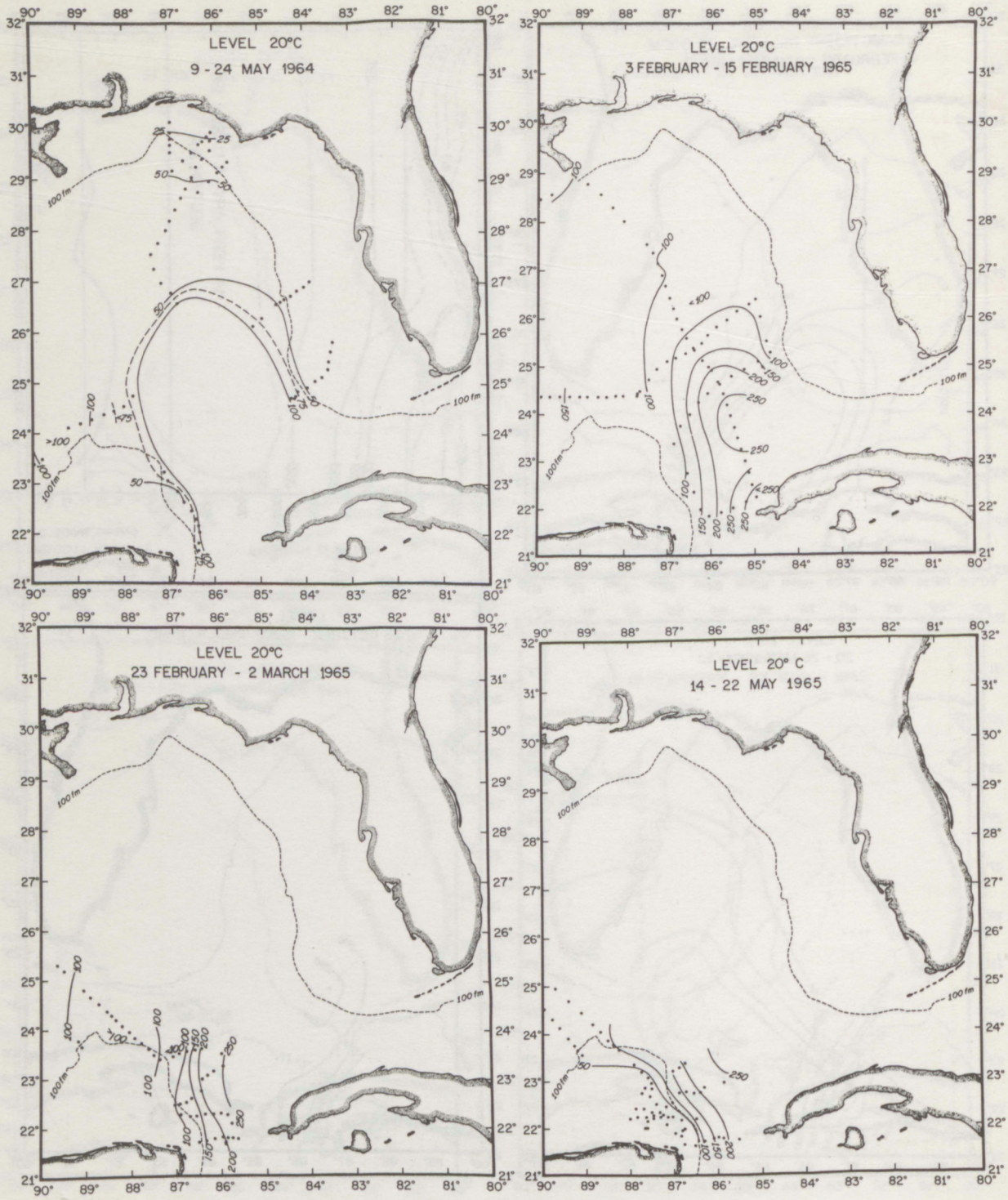

LEVEL 20° C
31 MAY - 8 JUNE 1961
LEVEL 20°C
19 OCTOBER - 27 OCTOBER 1961
LEVEL 20° C
29 OCTOBER - 6 NOVEMBER 1961
LEVEL 20° C
12 FEBRUARY - 22 MARCH 1962
100 fm

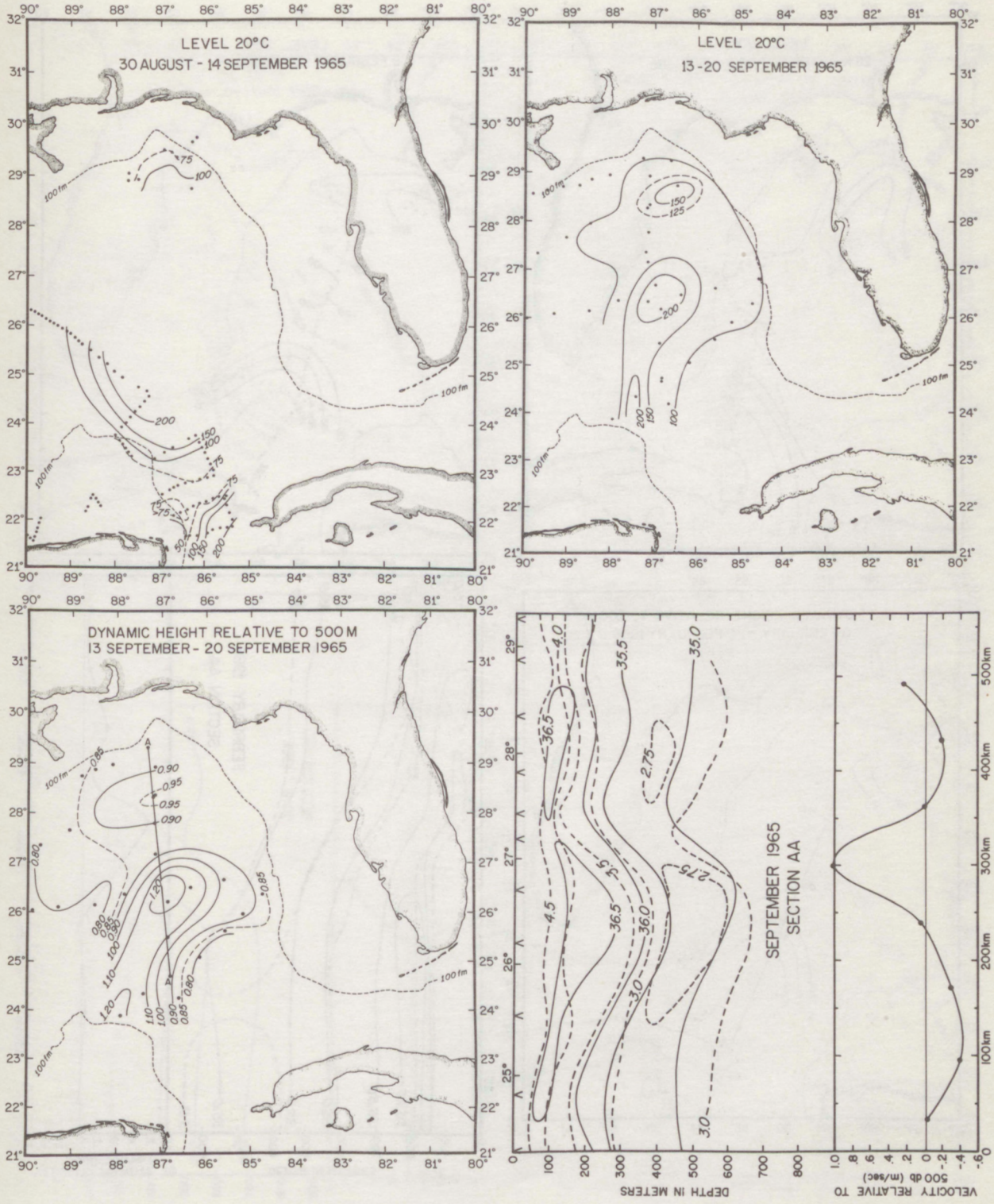

DYNAMIC HEIGHT RELATIVE TO 500M
14 FEBRUARY - 4 MARCH 1962
100 fm

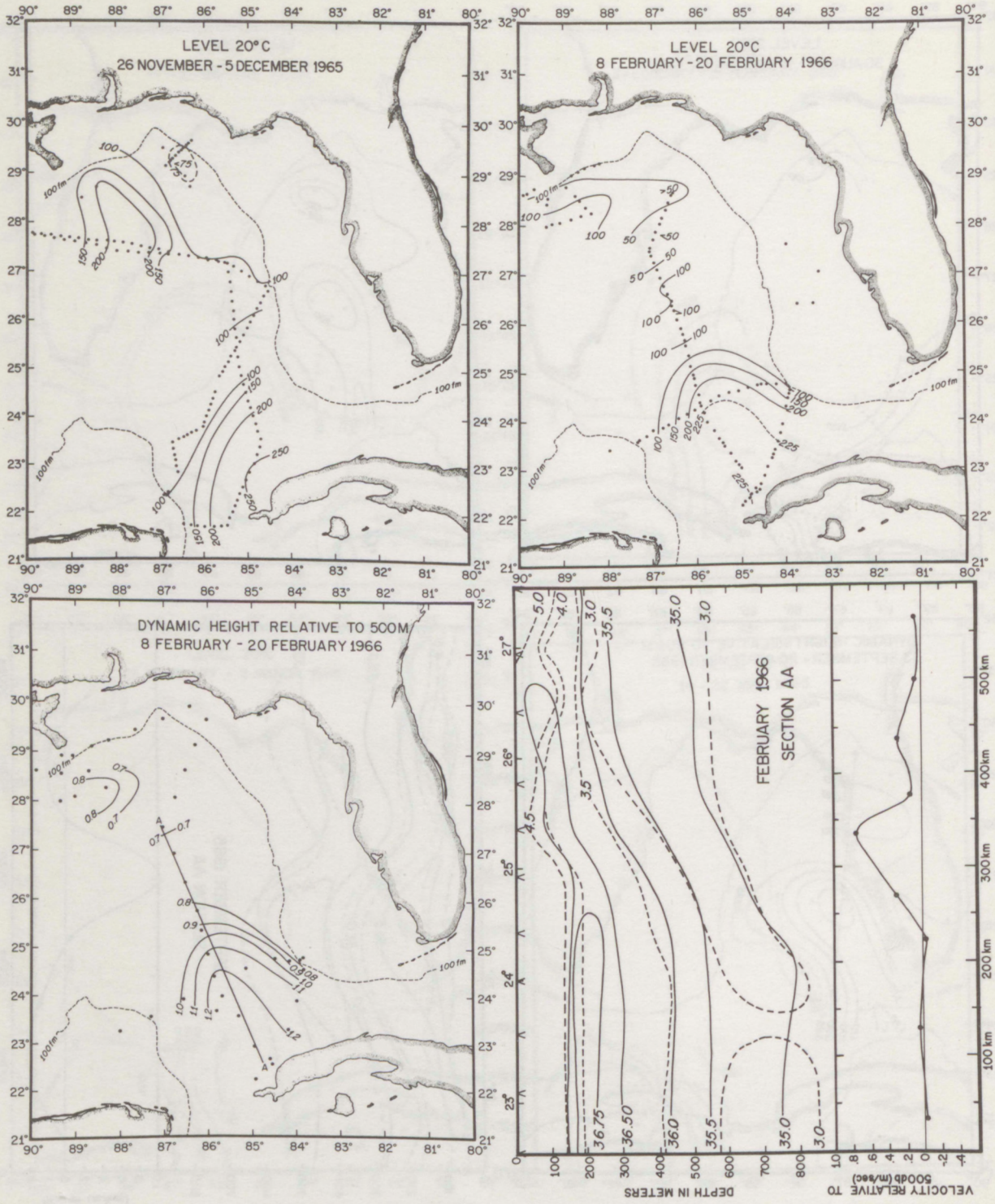

14 FEBRUARY - 4 MARCH 1962
SECTION A A
DEPTH IN METERS
VELOCITY RELATIVE
TO 500db (m/sec)

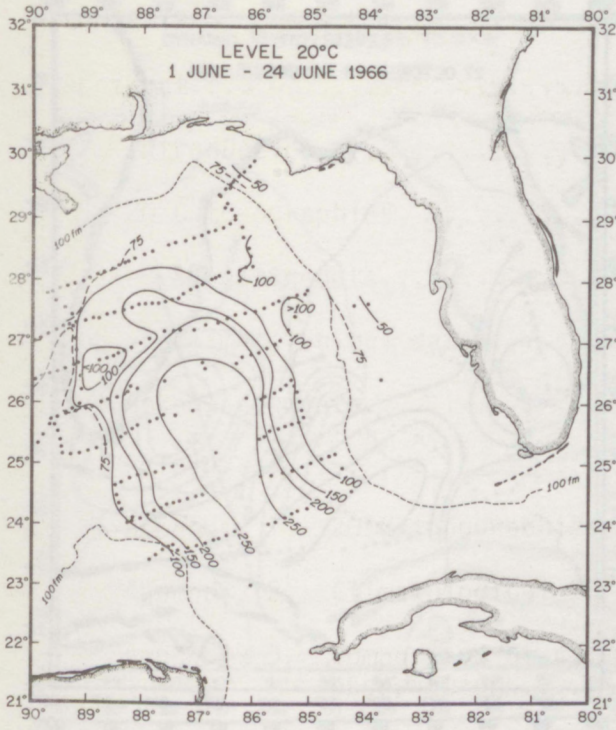

LEVEL 20°C
20 - 26 MAY 1962
100 fm

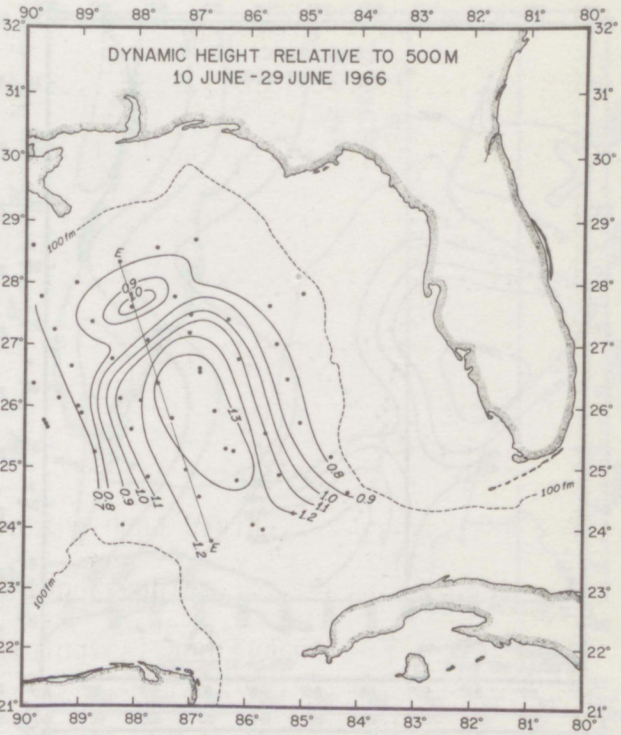

LEVEL 20°C
23 OCTOBER - 15 NOVEMBER 1962
100 fm

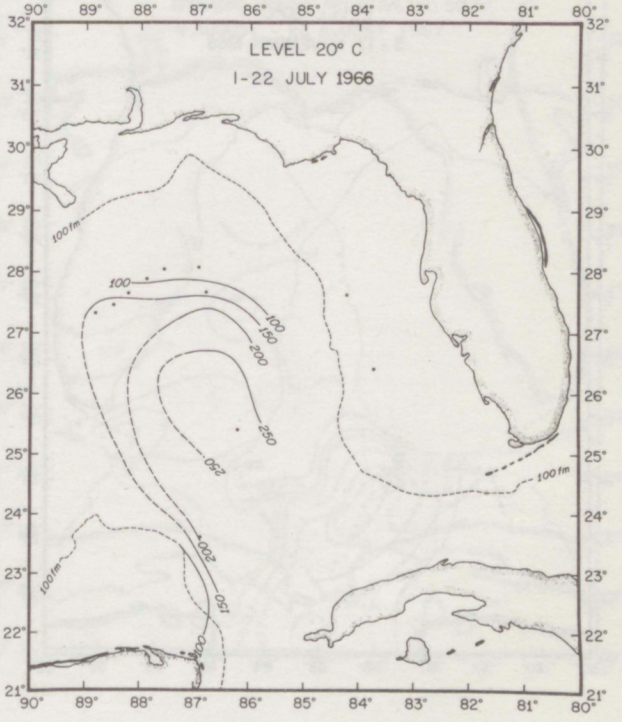

LEVEL 20°C
9 - 24 MAY 1964
LEVEL 20°C
3 FEBRUARY - 15 FEBRUARY 1965
LEVEL 20°C
23 FEBRUARY - 2 MARCH 1965
LEVEL 20° C
14 - 22 MAY 1965
100 fm

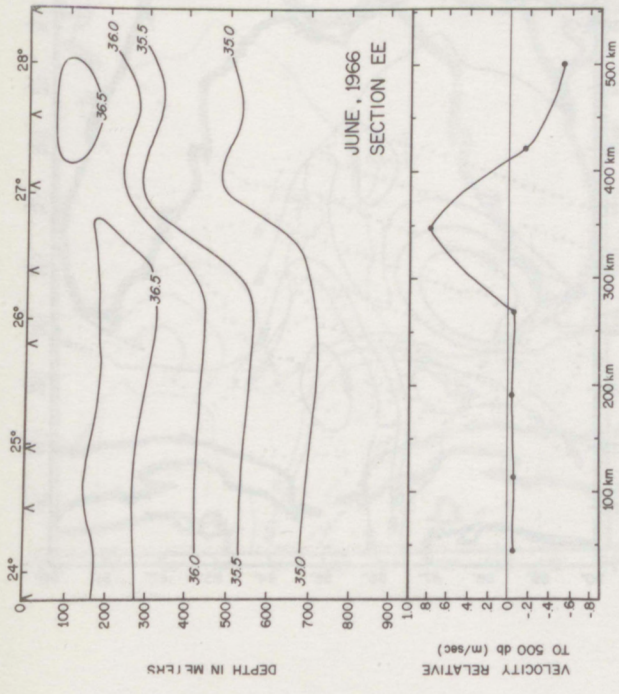

LEVEL 20°C
30 AUGUST - 14 SEPTEMBER 1965
LEVEL 20°C
13 - 20 SEPTEMBER 1965
DYNAMIC HEIGHT RELATIVE TO 500 M
13 SEPTEMBER - 20 SEPTEMBER 1965
SEPTEMBER 1965
SECTION AA
DEPTH IN METERS
VELOCITY RELATIVE TO 500 db (m/sec)

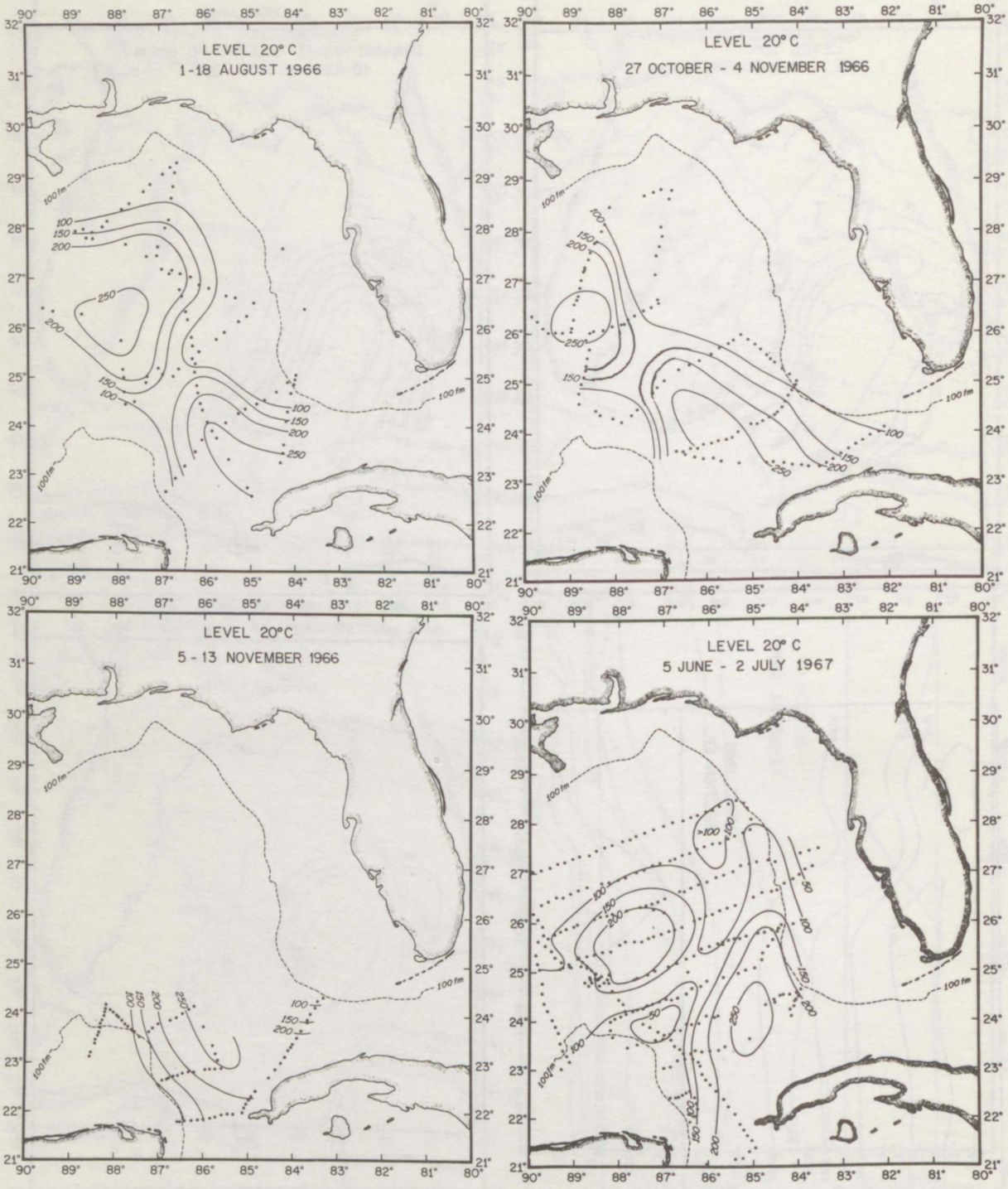

LEVEL 20°C
26 NOVEMBER - 5 DECEMBER 1965
LEVEL 20°C
8 FEBRUARY - 20 FEBRUARY 1966
DYNAMIC HEIGHT RELATIVE TO 500M
8 FEBRUARY - 20 FEBRUARY 1966
FEBRUARY 1966
SECTION AA
DEPTH IN METERS
VELOCITY RELATIVE TO 500db (m/sec)
100 km
200 km
300 km
400 km
500 km

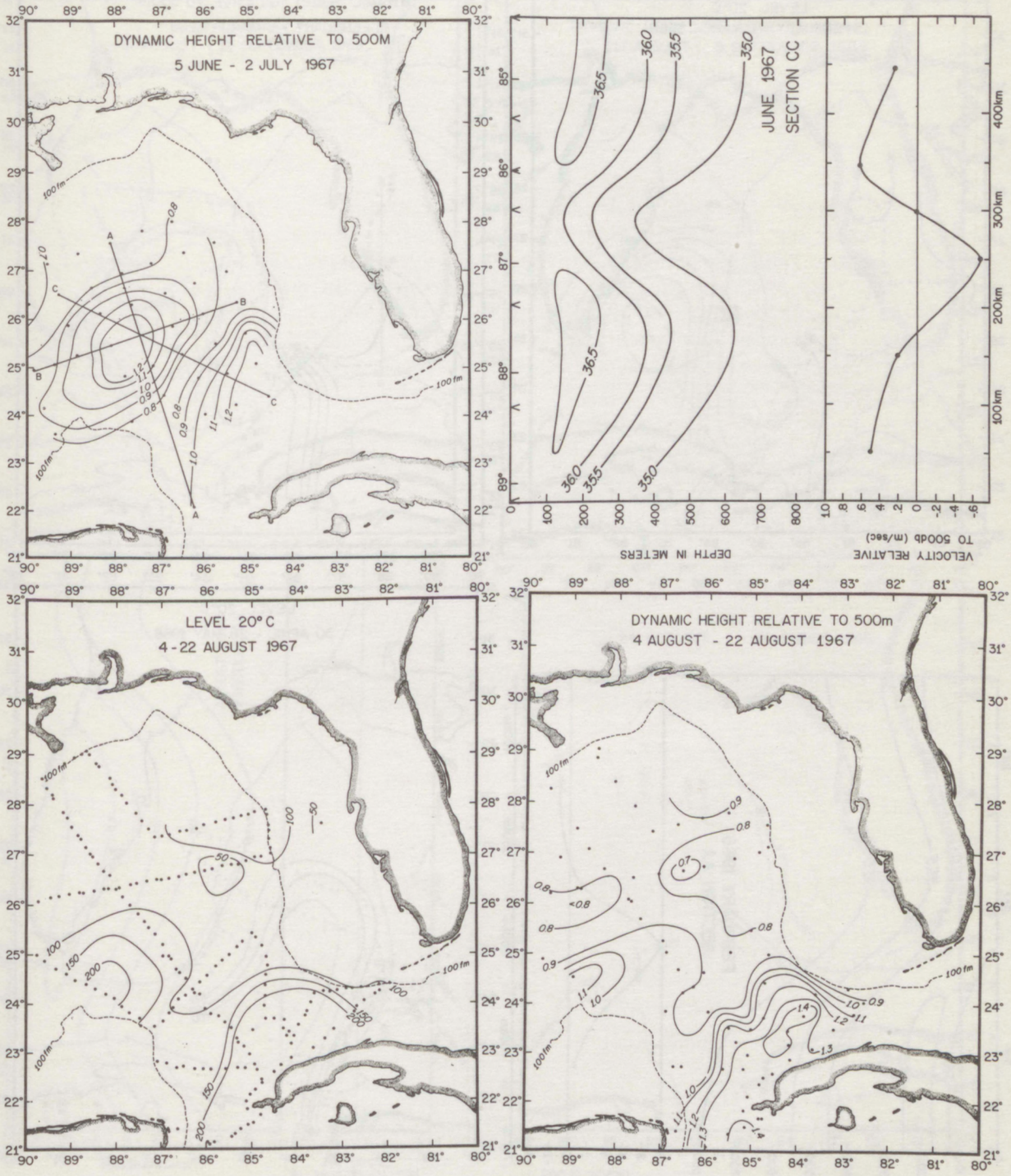

LEVEL 20°C
1 JUNE - 24 JUNE 1966
100 fm

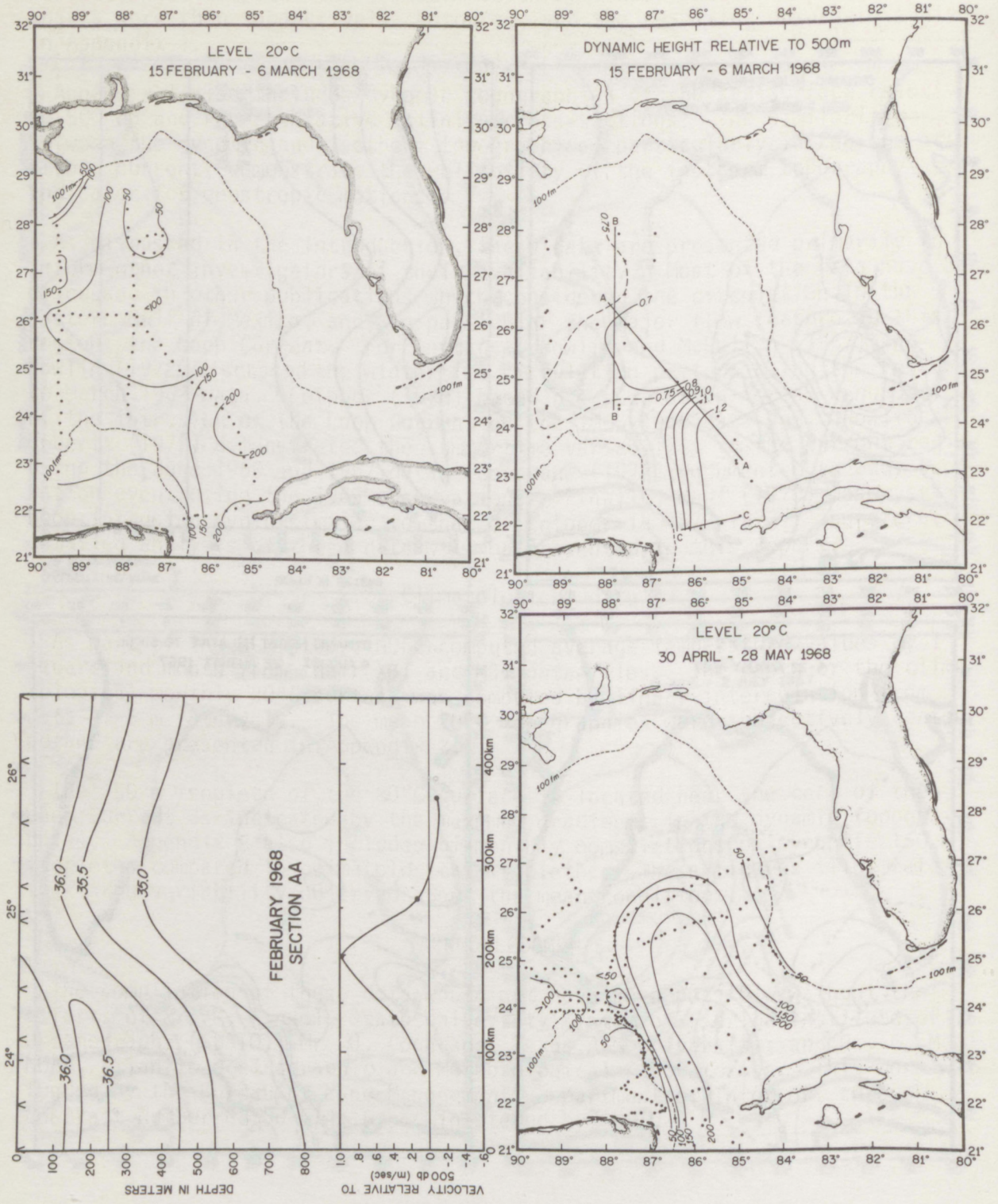

DYNAMIC HEIGHT RELATIVE TO 500 M
10 JUNE - 29 JUNE 1966
100 fm

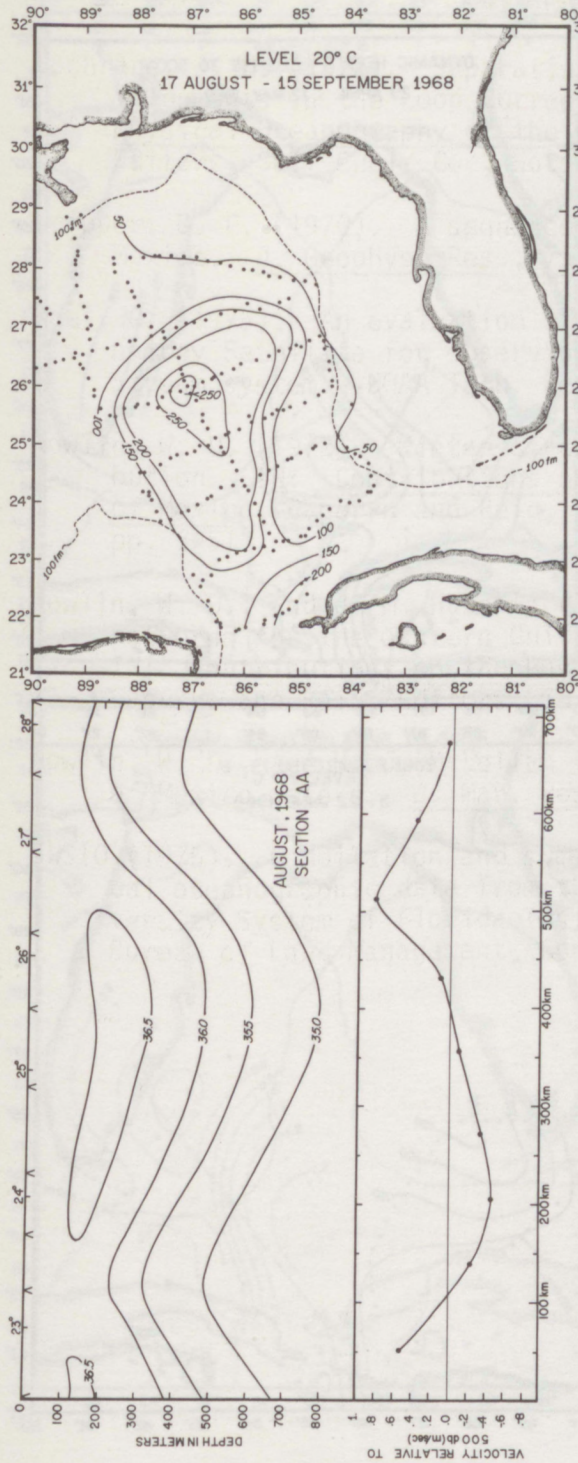

LEVEL 20° C
1-22 JULY 1966
100 fm

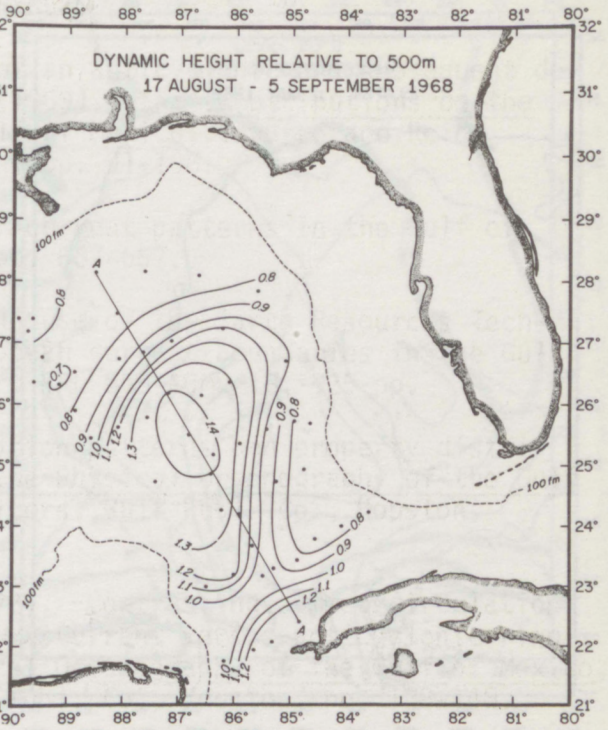

JUNE, 1966
SECTION EE
DEPTH IN METERS
VELOCITY RELATIVE
TO 500 db (m/sec)

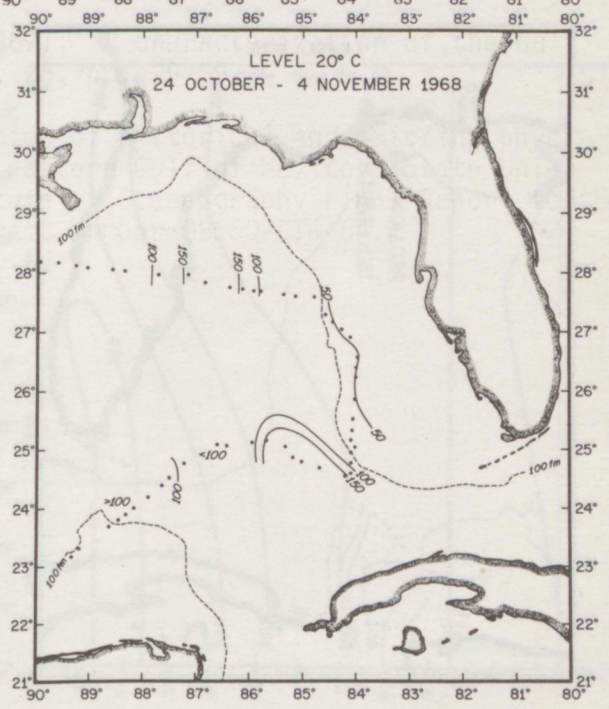

LEVEL 20° C
1-18 AUGUST 1966
LEVEL 20° C
27 OCTOBER - 4 NOVEMBER 1966
LEVEL 20°C
5-13 NOVEMBER 1966
LEVEL 20° C
5 JUNE - 2 JULY 1967
100 fm
100
150
200
250
50


DYNAMIC HEIGHT RELATIVE TO 500M
5 JUNE - 2 JULY 1967
JUNE 1967
SECTION CC
DEPTH IN METERS
VELOCITY RELATIVE
TO 500db (m/sec)
LEVEL 20° C
4 - 22 AUGUST 1967
DYNAMIC HEIGHT RELATIVE TO 500m
4 AUGUST - 22 AUGUST 1967

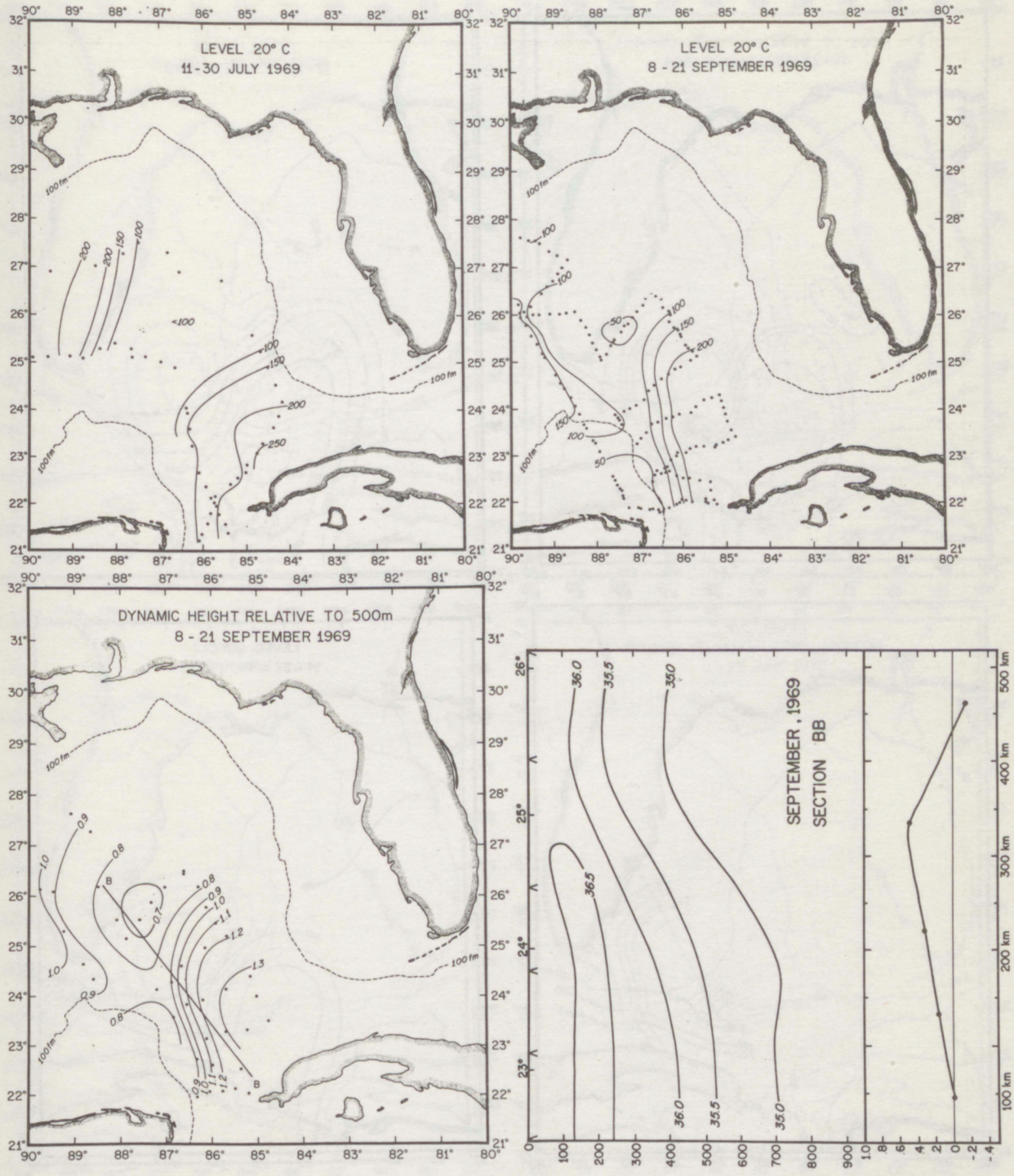

LEVEL 20°C
15 FEBRUARY - 6 MARCH 1968
DYNAMIC HEIGHT RELATIVE TO 500m
15 FEBRUARY - 6 MARCH 1968
LEVEL 20°C
30 APRIL - 28 MAY 1968
FEBRUARY 1968
SECTION AA
DEPTH IN METERS
VELOCITY RELATIVE TO 500 db (m/sec)

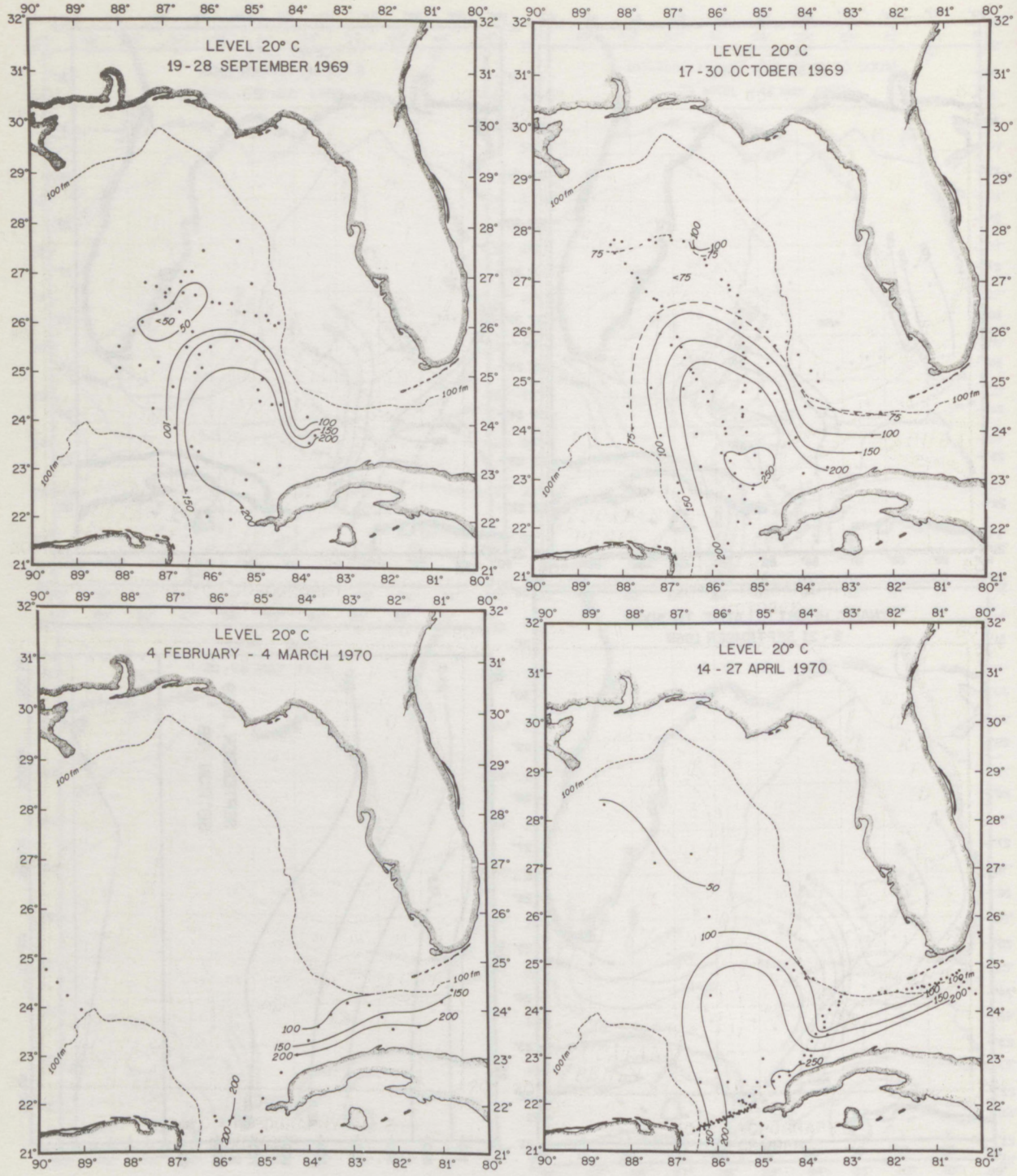

LEVEL 20° C
17 AUGUST - 15 SEPTEMBER 1968
100 fm
AUGUST, 1968
SECTION AA
DEPTH IN METERS
VELOCITY RELATIVE TO
500 db (m/sec)

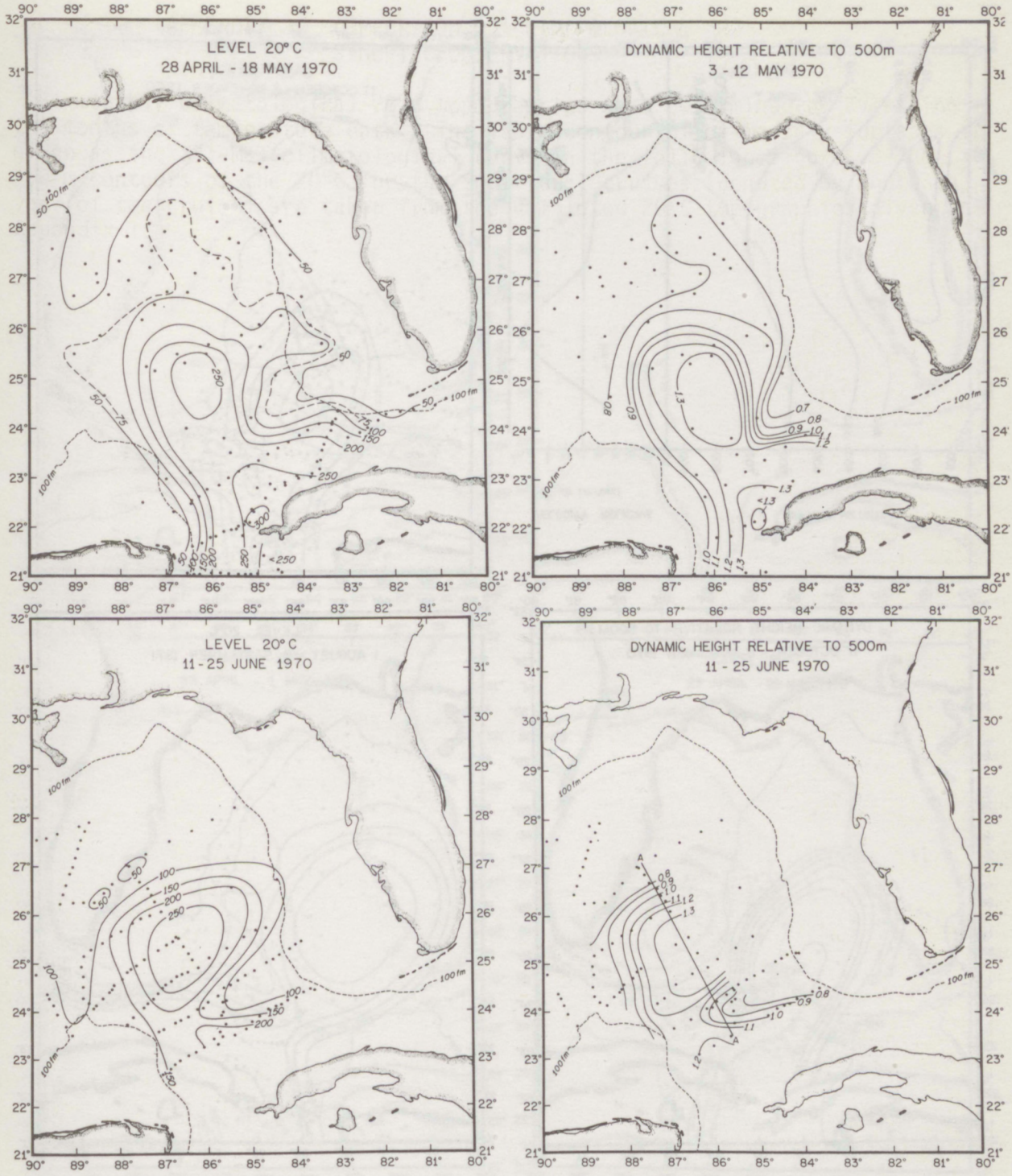

DYNAMIC HEIGHT RELATIVE TO 500m
17 AUGUST - 5 SEPTEMBER 1968
100 fm

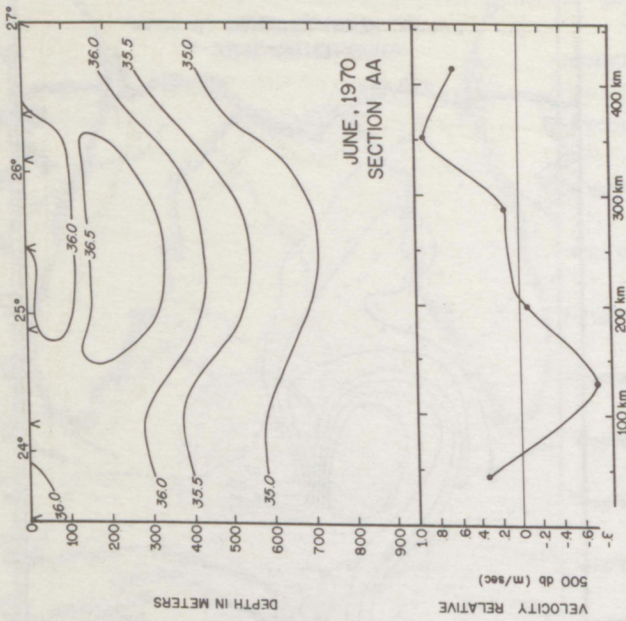

LEVEL 20° C
24 OCTOBER - 4 NOVEMBER 1968
100 fm

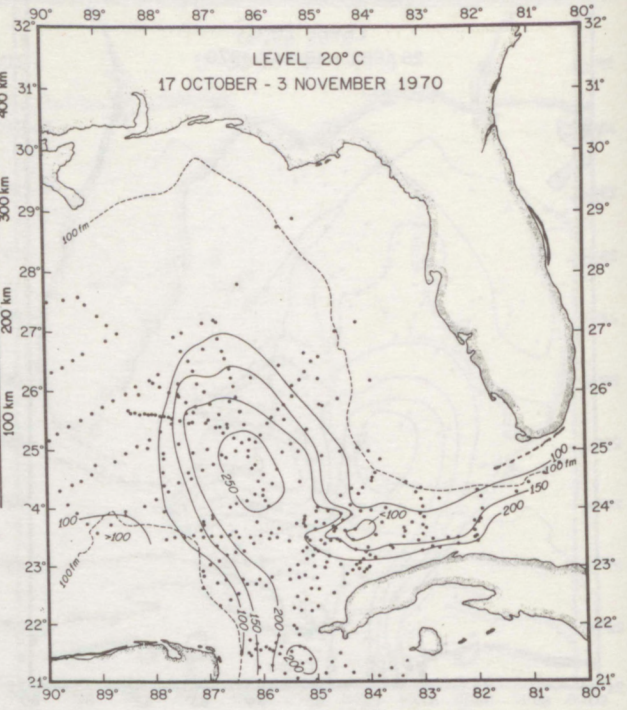

LEVEL 20° C
29 APRIL - 12 MAY 1969
DYNAMIC HEIGHT RELATIVE TO 500M
29 APRIL - 12 MAY 1969
LEVEL 20°C
20 - 28 MAY 1969
LEVEL 20° C
3 - 22 JUNE 1969
100 fm

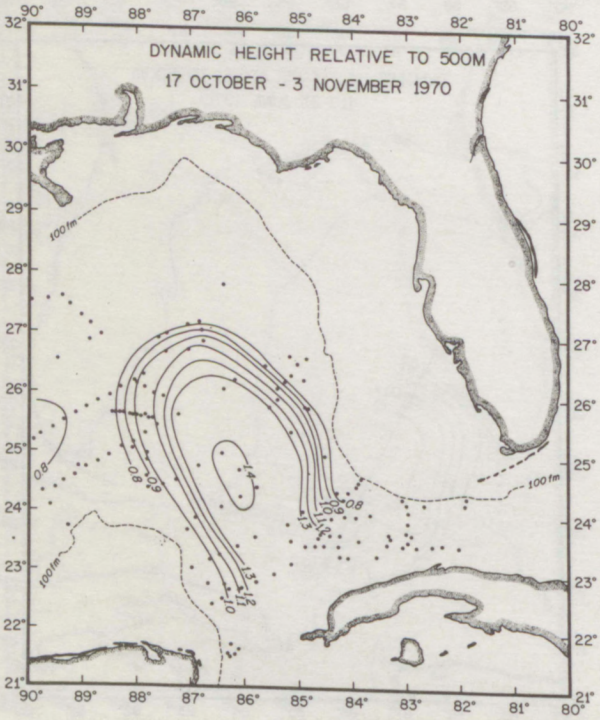

LEVEL 20° C
11 - 30 JULY 1969
LEVEL 20° C
8 - 21 SEPTEMBER 1969
DYNAMIC HEIGHT RELATIVE TO 500m
8 - 21 SEPTEMBER 1969
SEPTEMBER, 1969
SECTION BB
DEPTH IN METERS
VELOCITY RELATIVE
TO 500 db (m/sec)

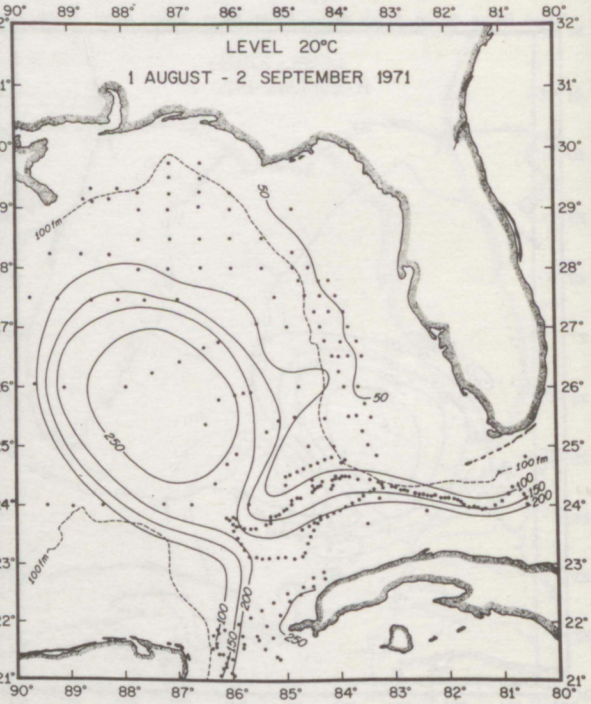

LEVEL 20° C
19-28 SEPTEMBER 1969
LEVEL 20° C
17-30 OCTOBER 1969
LEVEL 20° C
4 FEBRUARY - 4 MARCH 1970
LEVEL 20° C
14 - 27 APRIL 1970


LEVEL 20° C
28 APRIL - 18 MAY 1970
DYNAMIC HEIGHT RELATIVE TO 500m
3 - 12 MAY 1970
LEVEL 20° C
11 - 25 JUNE 1970
DYNAMIC HEIGHT RELATIVE TO 500m
11 - 25 JUNE 1970
100 fm

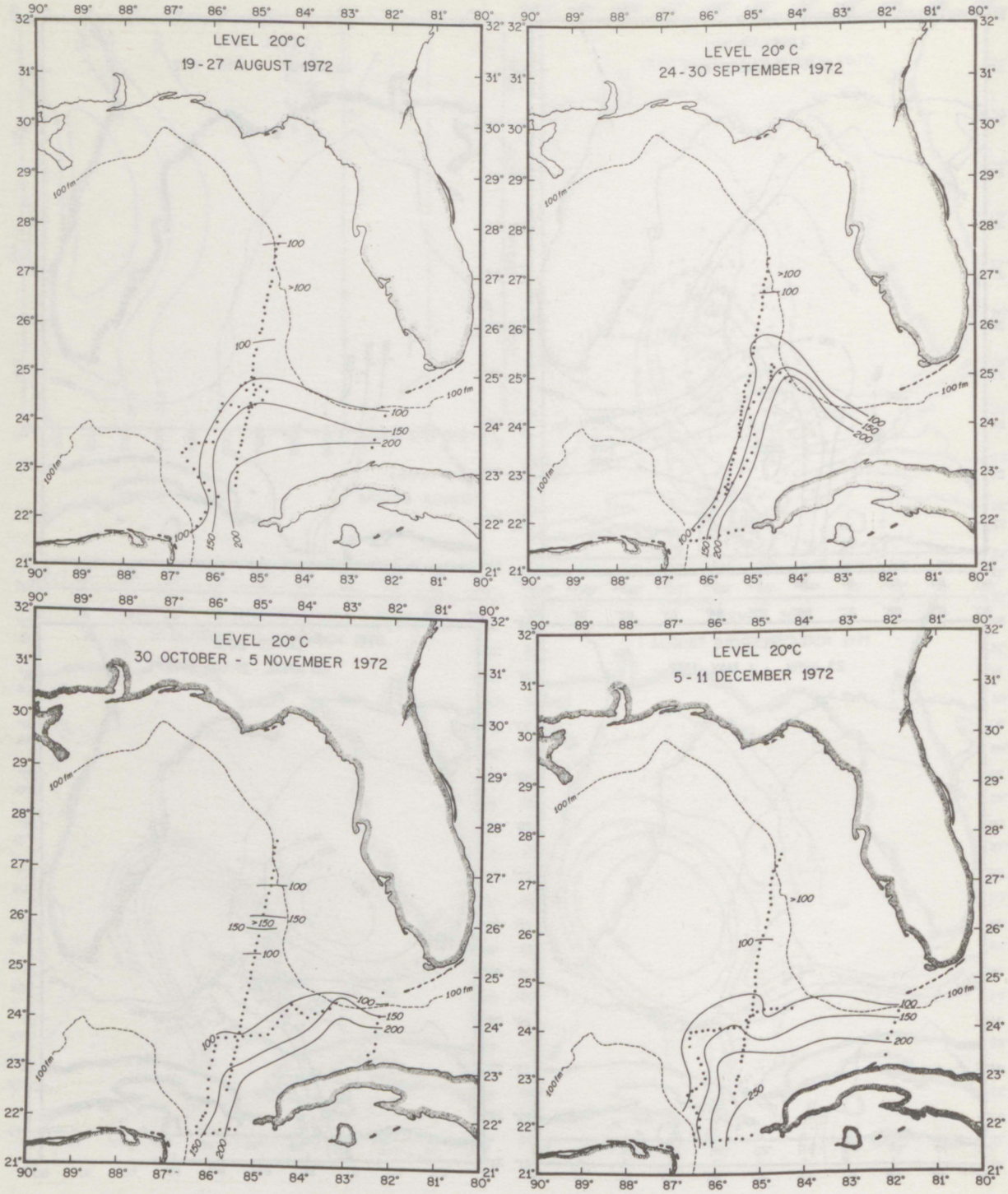

JUNE, 1970
SECTION AA
VELOCITY RELATIVE
500 db (m/sec)
DEPTH IN METERS


LEVEL 20° C
17 OCTOBER - 3 NOVEMBER 1970


DYNAMIC HEIGHT RELATIVE TO 500M
17 OCTOBER - 3 NOVEMBER 1970

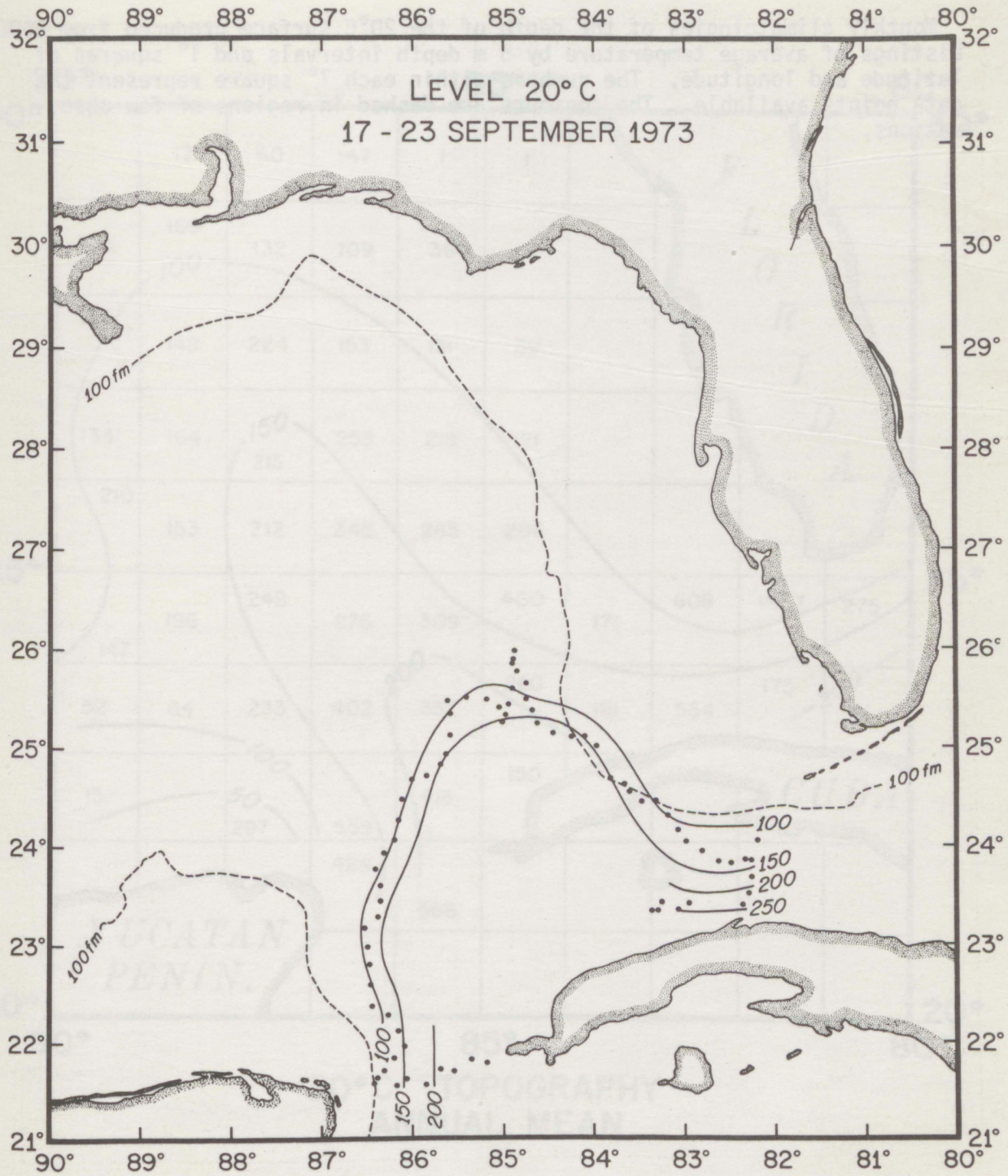

LEVEL 20°C
1 AUGUST - 2 SEPTEMBER 1971


LEVEL 20°C
2-16 NOVEMBER 1971
LEVEL 20°C
25 MARCH - 7 APRIL 1972
LEVEL 20°C
23 APRIL - 1 MAY 1972
LEVEL 20°C
29 APRIL - 29 MAY 1972
100 fm


LEVEL 20° C
19 - 27 AUGUST 1972
LEVEL 20° C
24 - 30 SEPTEMBER 1972
LEVEL 20° C
30 OCTOBER - 5 NOVEMBER 1972
LEVEL 20°C
5 - 11 DECEMBER 1972
100 fm
>100
100
150
200
250

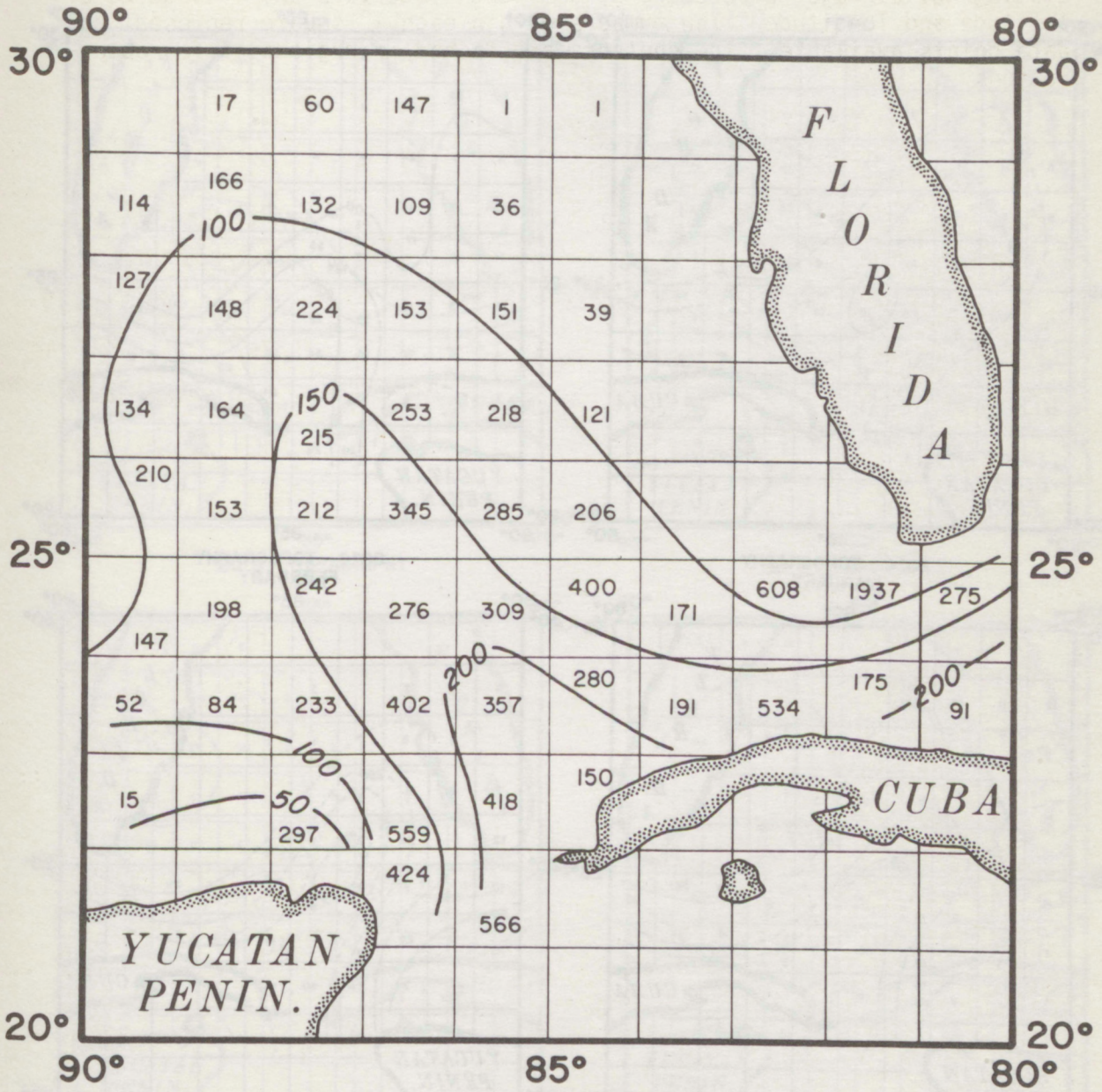

LEVEL 20° C
9-13 JANUARY 1973
LEVEL 20° C
13-19 FEBRUARY 1973
LEVEL 20°C
22-28 MARCH 1973
LEVEL 20°C
26 APRIL - 3 MAY 1973
100 fm
150
200


LEVEL 20° C
15 MAY - 5 JUNE 1973
LEVEL 20°C
1-16 JUNE 1973
LEVEL 20°C
5-14 JULY 1973
LEVEL 20° C
11-20 AUGUST 1973
100 fm
>100
100
150
200
250
50

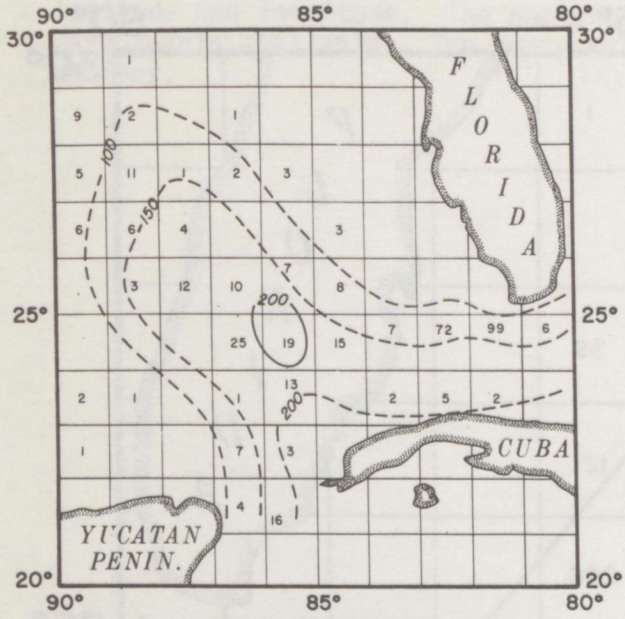

LEVEL 20° C
17 - 23 SEPTEMBER 1973
90° 89° 88° 87° 86° 85° 84° 83° 82° 81° 80°
32° 31° 30° 29° 28° 27° 26° 25° 24° 23° 22° 21°
100 fm
100 fm
100 fm
100
150
200
250
100
150
200

APPENDIX 2. CLIMATOLOGICAL 20°C TOPOGRAPHIES

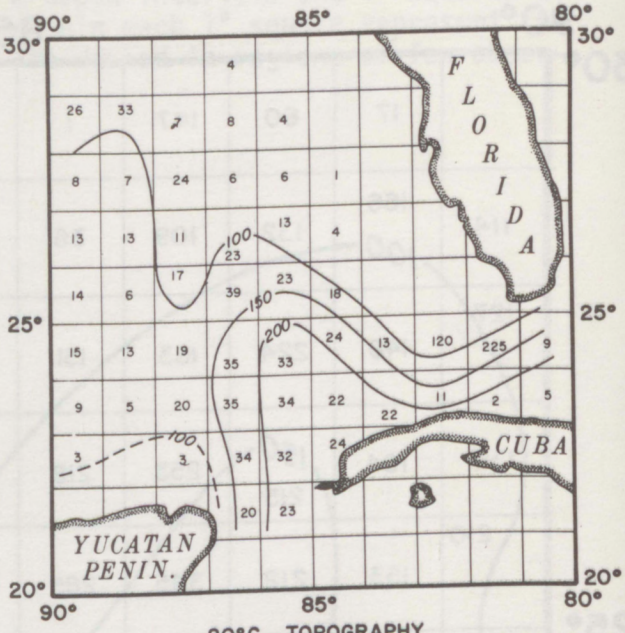
Monthly climatologies of the depth of the 20°C surface produced from NODC Listings of average temperature by 5 m depth intervals and 1° squares of latitude and longitude. The numbers within each 1° square represent the data points available. The contours are dashed in regions of few observations.



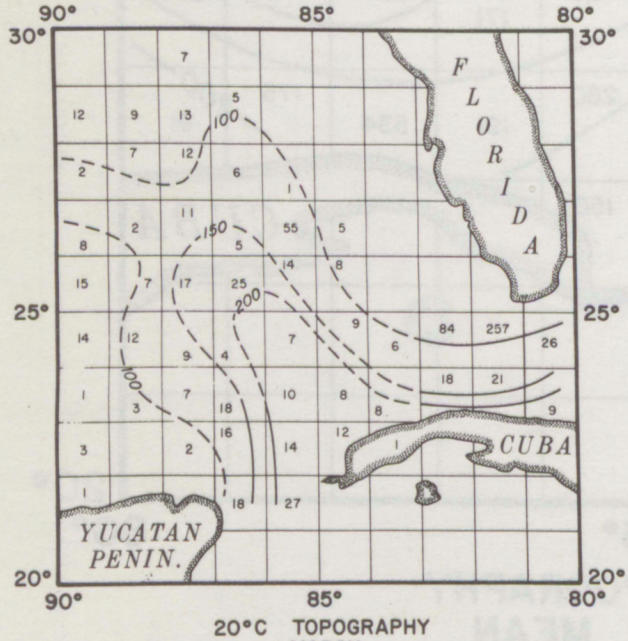
20°C TOPOGRAPHY
ANNUAL MEAN



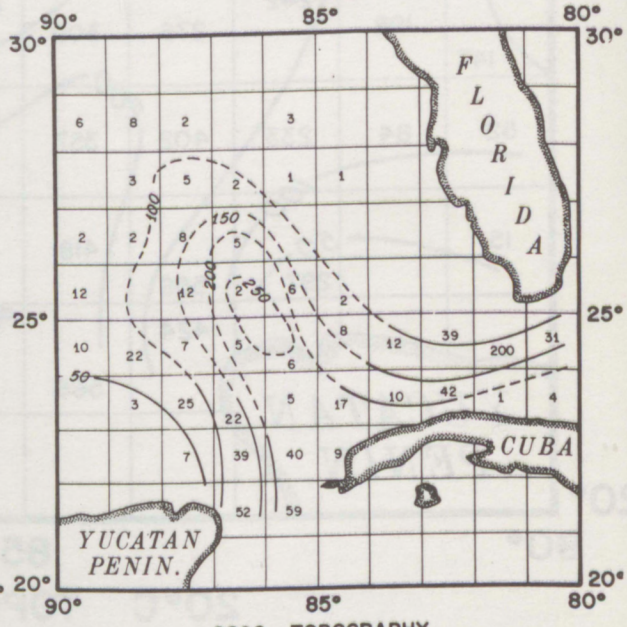
20°C TOPOGRAPHY
JANUARY



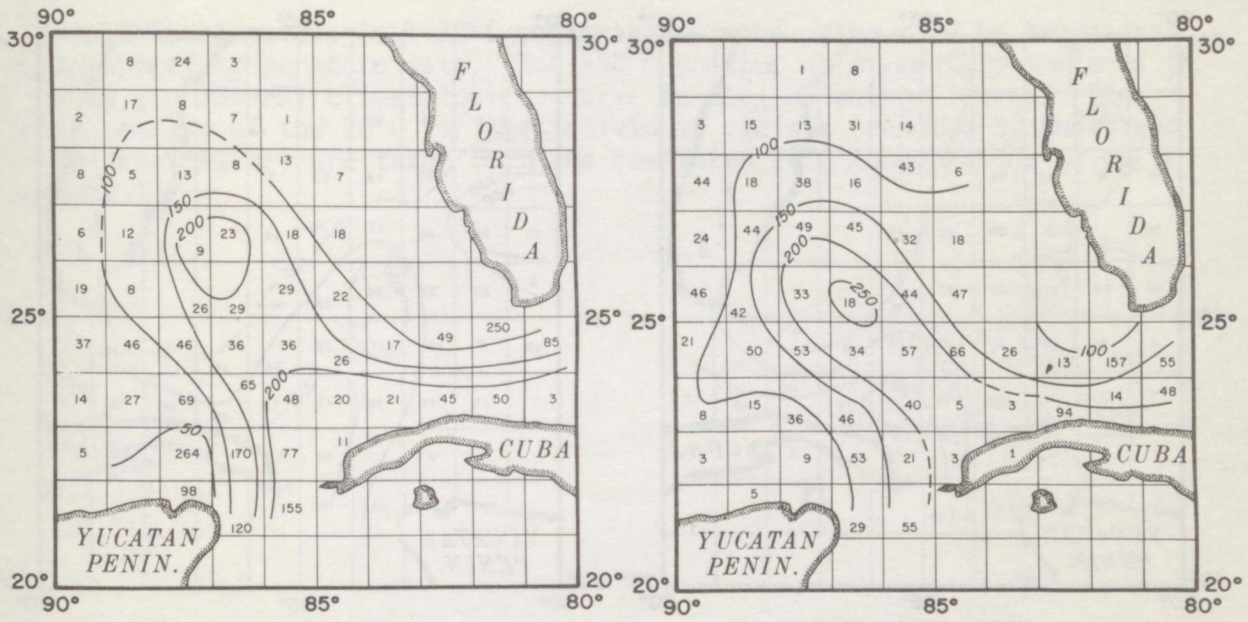
20°C TOPOGRAPHY
FEBRUARY



20°C TOPOGRAPHY
MARCH

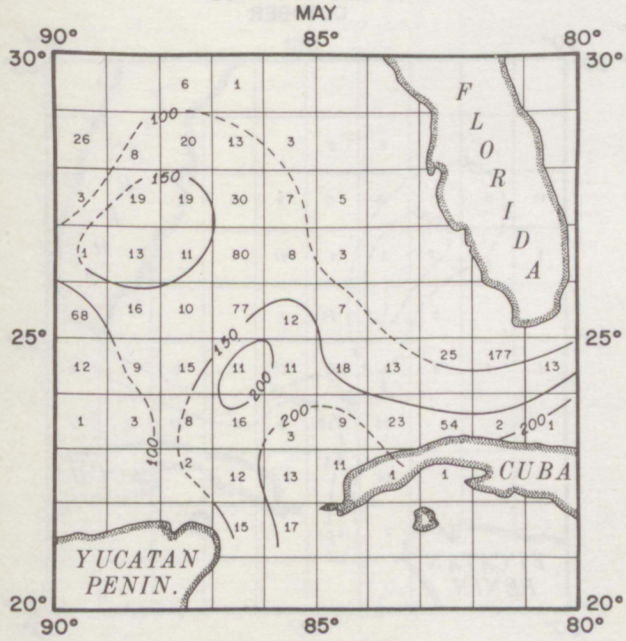


20°C TOPOGRAPHY
APRIL

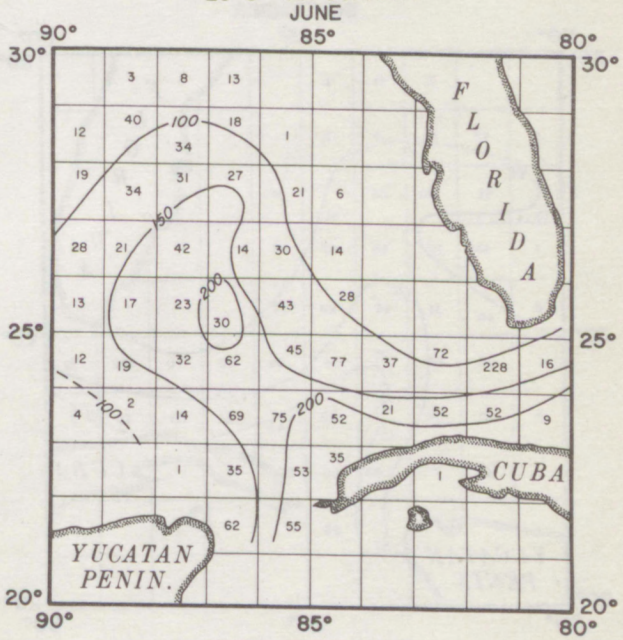


20°C TOPOGRAPHY
MAY

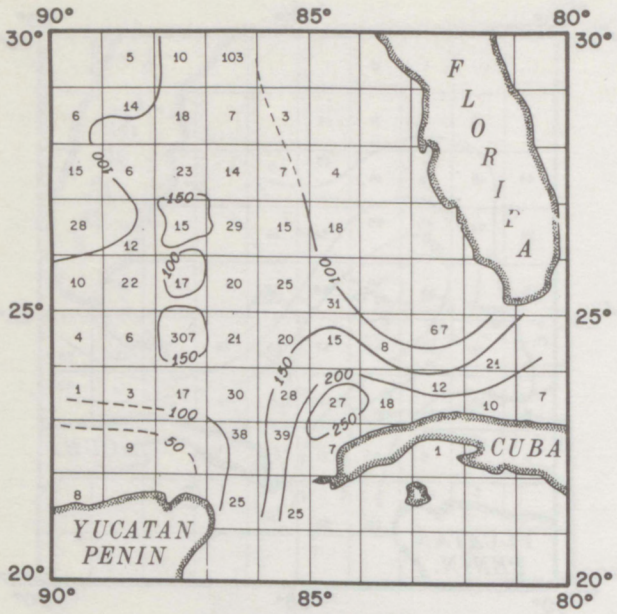
20°C TOPOGRAPHY
JUNE



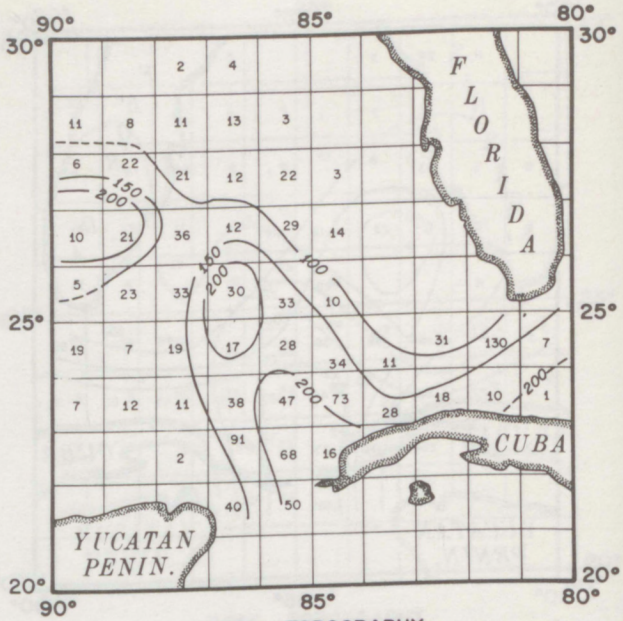
20°C TOPOGRAPHY
JULY



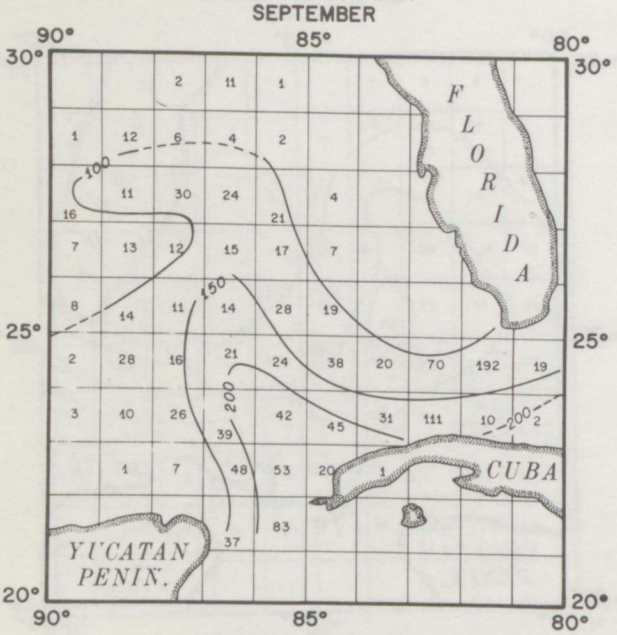
20°C TOPOGRAPHY
AUGUST



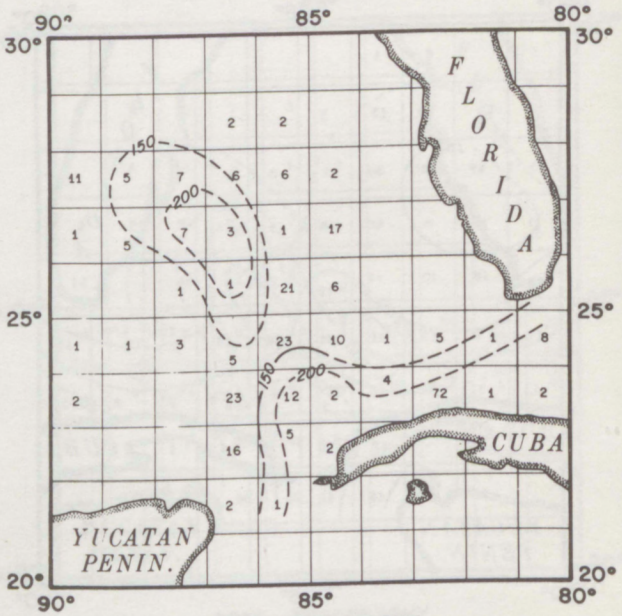
20°C TOPOGRAPHY
SEPTEMBER



20°C TOPOGRAPHY
OCTOBER



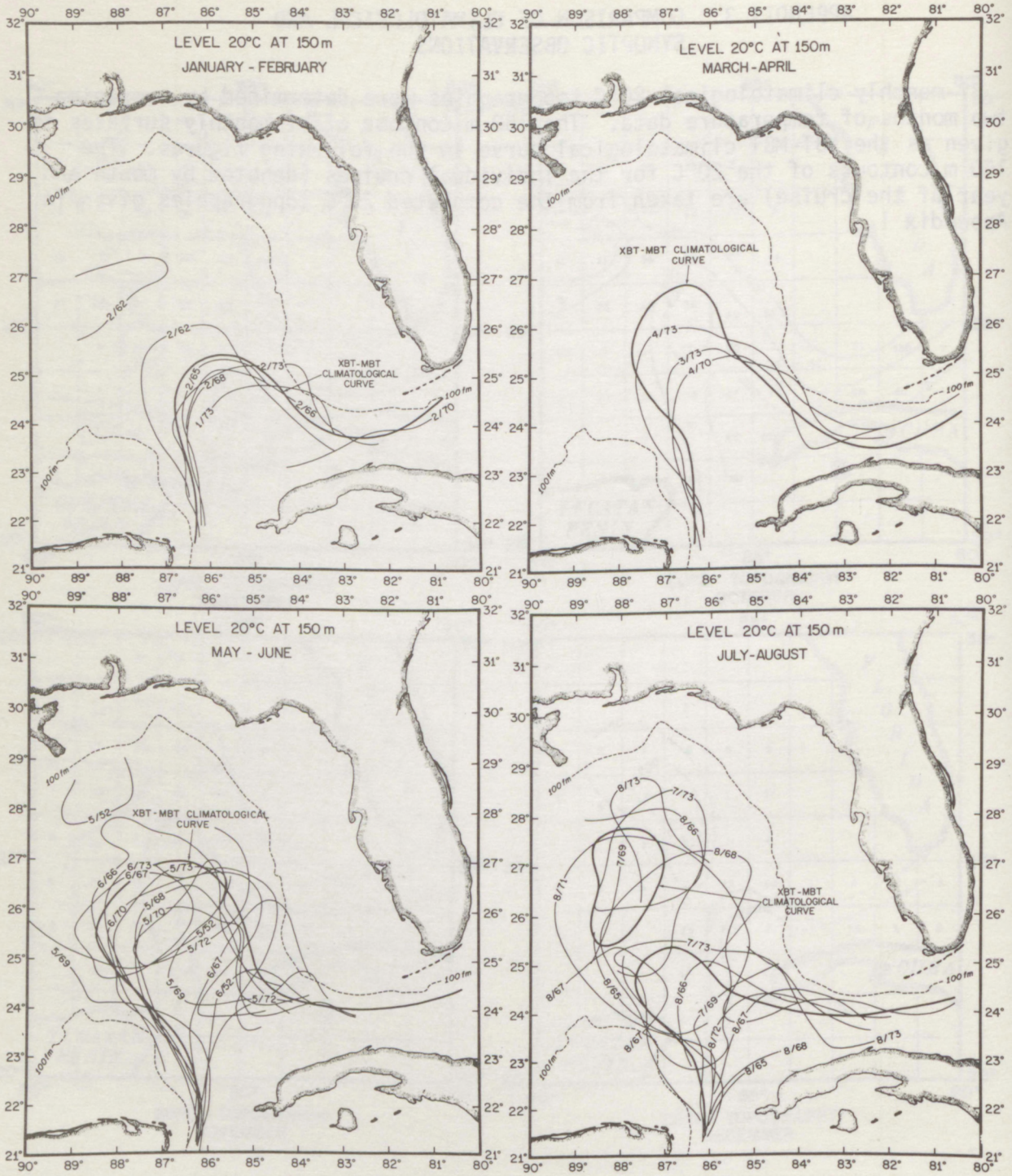
20°C TOPOGRAPHY
NOVEMBER

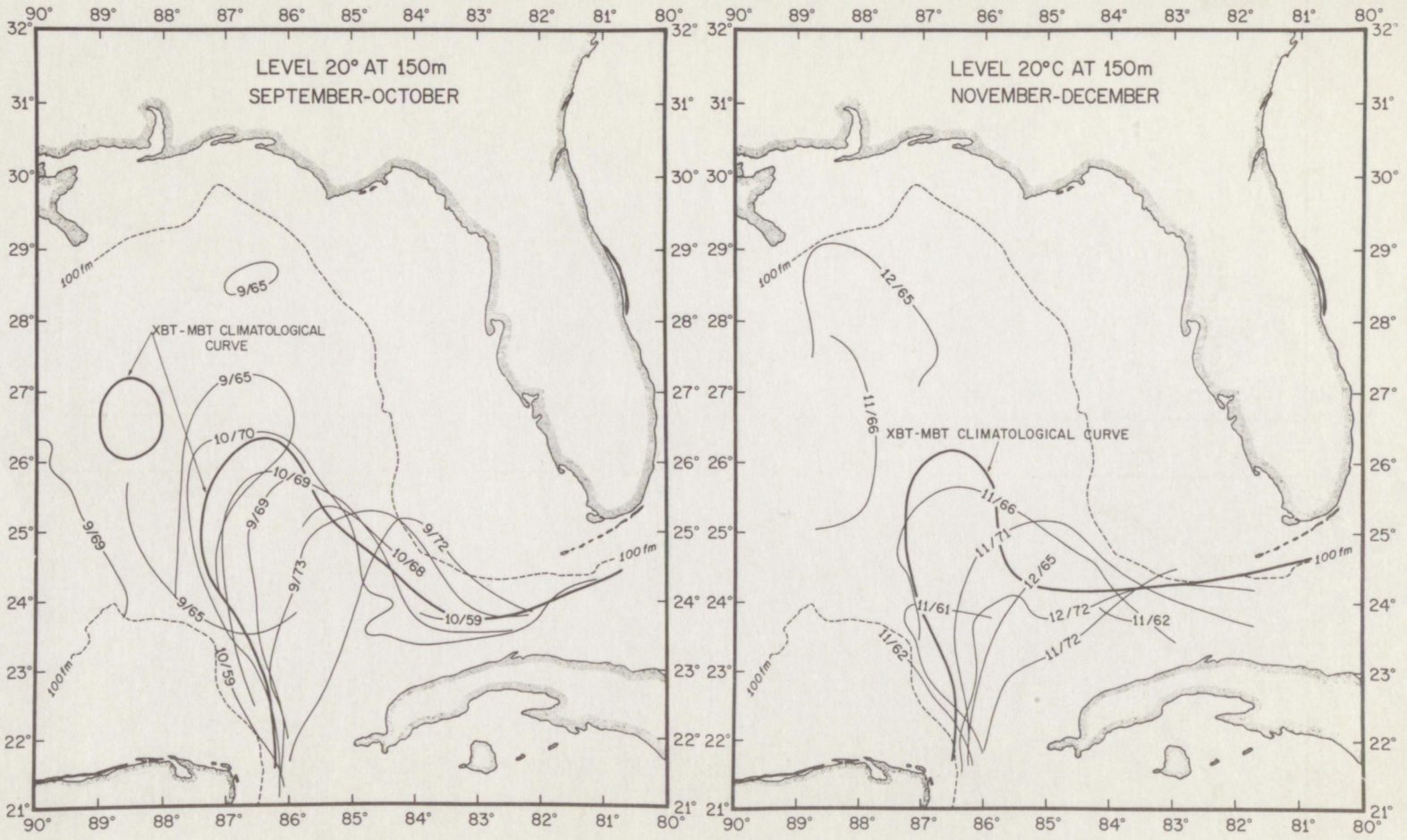


20°C TOPOGRAPHY
DECEMBER

APPENDIX 3. COMPARISON OF CLIMATOLOGICAL AND SYNOPTIC OBSERVATIONS

Bi-monthly climatological 20°C topographies were determined by averaging two months of temperature data. The 150 m contour of bi-monthly surfaces is given as the XBT-MBT climatological curve in the following figures. The 150 m contours of the 20°C for the individual cruises (denoted by month and year of the cruise) are taken from the completed 20°C topographies given in Appendix 1.


LEVEL 20°C AT 150m
JANUARY - FEBRUARY
XBT-MBT CLIMATOLOGICAL CURVE
LEVEL 20°C AT 150m
MARCH - APRIL
XBT-MBT CLIMATOLOGICAL CURVE
LEVEL 20°C AT 150m
MAY - JUNE
XBT-MBT CLIMATOLOGICAL CURVE
LEVEL 20°C AT 150m
JULY-AUGUST
XBT-MBT CLIMATOLOGICAL CURVE
100 fm



☆ U.S. GOVERNMENT PRINTING OFFICE:1977—777-045 / 1251 REGION NO.8