FISHERMEN'S ATLAS OF MONTHLY SEA SURFACE TEMPERATURES FOR THE GULF OF MEXICO

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES

Circular 300

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By

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Contribution No. 58, Ichthyological Laboratory and Museum

Department of Biology, University of Miami, Coral Gables, Fla. 33124

Circular 300

Washington, D.C.
November 1968

CONTENTS

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By

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Bureau of Commercial Fisheries Exploratory Fishing and Gear Research Base
Pascagoula, Miss. 39567

ABSTRACT

This atlas was prepared in response to interest expressed by the Gulf fishing industry for surface temperature information. It shows that sea surface temperatures fluctuate greatly seasonally and latitudinally with a yearly average of 77° F. This temperature fluctuation causes a seasonal fluctuation in the composition of the shallow-water fauna in the northern Gulf. The atlas also shows that surface temperatures extend deeper in winter than in summer and that upwelling occurs along the north coast of Yucatan during summer. In addition to monthly maps for mean surface isotherms, monthly maps for maximum, minimum, and average surface temperatures are also given.

INTRODUCTION

The increasing interest in the fisheries and marine biology of the Gulf of Mexico, especially since the report of Galtsoff (1954), has created a demand for environmental data. This demand is especially strong for sea surface temperatures and their variation in time and space as they affect the occurrence and habits of many marine organisms. No detailed monthly charts of sea surface isotherms for the Gulf of Mexico, for the entire year, have been published. The present atlas is intended to fulfill this need.

A great interest in sea-water temperatures of the Gulf has been shown by the many requests to the Bureau of Commercial Fisheries for data that could be used easily by

fishermen. To date fishermen have made little effort to use temperature information to predict or take advantage of fish concentrations. The available bottom temperature data are inadequate to prepare a meaningful summary, but the surface temperatures shown in this atlas indicate the trends in the shallower coastal waters. The warming and cooling trends shown should help fishermen interpret their own temperature observations.

FLUCTUATIONS IN SURFACE TEMPERATURES

The fluctuating surface temperatures indicate that the Gulf of Mexico is one of the most complex bodies of water in the world. This complexity is caused mainly by its configuration, climatic position, and hydrology.

Surface temperatures vary greatly in a latitudinal direction during the fall, winter, and spring. In January and February, the coldest months, a difference of 16° F. exists between Mississippi Sound (61°) and the area north of the Yucatan Channel (77°) along a straight line distance of 345 nautical miles. This represents an average temperature drop of 1 degree per 21 or 22 nautical miles. During these same months a similar, but less sharp, north-south temperature gradient occurs in the western Gulf between Sabine Bank and the Gulf of Campeche. In the summer, especially during July, the surface temperatures are nearly uniform at 83° F. (81-84°) throughout the Gulf. Considerable deviations from the average isotherms may occur during abnormal periods as indicated in the monthly charts for maximum and minimum temperatures.

These seasonal temperature patterns reflect known climatological and hydrological factors that influence the oceanography of the Gulf of Mexico. The colder temperatures in the northern Gulf, which contrast sharply with warmer temperatures in the southern portion during late fall through early spring, are certainly caused in the north by the concurrent influence of "northers" and rivers and in the south by the Caribbean Current.

The marked fluctuation in sea surface temperature between summer and winter in the northern Gulf causes a seasonal fluctuation in the composition of the fauna in shallow water. This variation is particularly true of thermophilic (warm-water) organisms which generally avoid temperatures below 75° F. These faunal fluctuations are well-illustrated by several species of warm-water fishes that live in the shallower waters of the northern Gulf during the summer but are absent, or nearly so, in the winter. For example, the Spanish mackerel *(Scomberomorus maculatus)* is most abundant in the northern Gulf from April to September and very scarce from October to March (Gunter, 1945; Klima, 1959). The same is true of other warm-water fishes such as the tarpon *(Megalops atlantica),* scaled sardine *(Harengula pensacolae),* Atlantic cutlassfish *(Trichiurus lepturus),* and several others.

Most tropical meteorologists accept the hypothesis that sea surface temperatures below 80° F. are unfavorable to the development of hurricanes. Further confirmation of this hypothesis is found in the present atlas because no hurricanes have ever been known to form or occur in the Gulf during

January through April. During these months the highest average surface temperatures are about 77° to 79° F. in the southern portion and much lower in the northern. On the other hand, hurricanes form most frequently in August and September when the average surface temperatures remain above 80° F. (81-84°) throughout the Gulf.

Leipper (1954: 90) reported that the average annual surface temperature of the Gulf is 78° F. (77° in this study) whereas that of comparable areas at the same latitude is 76° F. in the western Atlantic, 73° F. in the eastern Atlantic, and 68° F. in the eastern Pacific.

VERTICAL EXTENT OF SURFACE TEMPERATURES

According to Leipper (1954: 134, fig. 43) in the central Gulf, surface temperatures remain about the same down to depths of about 7 to 50 fathoms in winter and from just below the surface to about 15 fathoms in the summer. In other words, February surface temperatures indicate similar thermal conditions at depths of at least 7 fathoms; however, July surface temperatures may extend down only a fathom or so. Data from the BCF (Bureau of Commercial Fisheries) Exploratory Fishing Base, Pascagoula, Miss., indicate that in the southern and northern Gulf surface temperatures extend to depths of at least 25 fathoms in the winter. In the summer, however, the average difference between the surface and an average depth of 20 fathoms is 10° F. in the southern Gulf and 15° F. in the northern portion.

UPWELLING

Along the north coast of the Yucatan Peninsula upwelling is indicated from May to October with a peak in June. During this period the prevailing winds are from the east and southeast in that area. Such offshore winds would push the surface water away from the coast and produce upwelling. In the winter, however, the prevailing winds are more northeasterly, and no upwelling would be expected during that period as shown in the maps.

The average depth within 30 nautical miles from the north coast of Yucatan is 10 fathoms, and as already indicated above, the water temperature drops significantly and increasingly below 1 or 2 fathoms in the summer. Upwelling would bring this colder water to the surface and produce the thermal pattern shown in the maps (May to October).

SOURCE OF DATA

This atlas is based on data from the files of the NODC (National Oceanographic Data Center) and the BCF Exploratory Fishing Base, Pascagoula, Miss. The NODC data comprise 81,979 observations from merchant and navy ships during 1949-61. The BCF data comprise 5,278 observations from the exploratory fishing vessels *Oregon, Silver Bay,*

Combat, Pelican, Hernan Cortez, and *George M. Bowers* during 1951-65. The working data from both the NODC and BCF were furnished, as printed tabulations, by 1-degree quadrangles according to the Marsden Square method of recording. The 87,257 observations represent an average of 529 observations per 1-degree quadrangle and an average of 44 monthly observations per 1-degree quadrangle.

The density of observations is greatest in heavily traveled shipping lanes, especially through and from the Straits of Florida and the Yucatan Channel to and from Progreso, Coatzacoalcos, Veracruz, Tampico, Galveston, and New Orleans.

RELIABILITY AND ACCURACY OF DATA

Pyle (1962: 1) and Saur (1963: 417) reported that sea-water temperature observations are of unknown accuracy. Observations by commercial ships tend to be less accurate than those taken by research vessels. In the large number of observations available from merchant ships for long periods, however, the systematic errors tend to cancel each other and the resulting averages are not far from the true mean. Franceschini (1955) found that averages of commercial vessel temperature reports are reliable for certain short periods (18 or 19 days) in the Gulf of Mexico. Saur (1963) has shown that sea temperature observations made by merchant ships vary considerably in quality and that the average surface temperatures thereby obtained, such as those presented in this atlas, should be interpreted as representing values within plus or minus 1.6° F. In other words, the isotherm of, say, 82° F. for July should be interpreted as representing a value of as high as 83.6° or as low as 80.4° F. Furthermore, diurnal variations of surface temperatures at any given location in the Gulf can reach a magnitude of 2.2° F., as shown by observations from the weather sea buoy NOMAD (lat. 25° N., long. 90° W.) that were kindly furnished by the U.S. Weather Bureau.

The isotherms presented in this atlas are in general agreement with, but more detailed than, those presented by other workers (Fuglister, 1947; Leipper, 1954, after Fuglister). For example, Fuglister gives only one isotherm (84° F.) for August whereas in the present work the 83° and 84° F. isotherms each cover considerable portions of the Gulf.

METHODS OF ANALYSIS AND PRESENTATION

The monthly mean surface temperatures were recorded, by 1-degree quadrangles, on 12 maps. After this a nonruled map was superimposed on the mean temperature map, for each month, and the isotherm analysis was made on a drafting light-table. The isotherms were constructed by connecting the centers of quadrangles of equal mean temperature or by linear interpolation. Because the average values were consistent, little smoothing was necessary to draw reasonable isotherm patterns.

The monthly maps for maximum, minimum, and average surface temperatures present the information for each of seven arbitrarily selected portions of the Gulf and for the entire Gulf. The latter are presented in the lower right-hand corner of the map.

ACKNOWLEDGMENTS

This study was done at the BCF Exploratory Fishing Base, Pascagoula, Miss. The following Base personnel helped in various ways with the preparation of this atlas: Harvey R. Bullis, Jr., Base Director; Johnny A. Butler, Supervisory Fishery Methods and Equipment Specialist; Richard B. Roe, Fishery Biologist; Judith C. Gatlin, ADP Technician; and Betty J. King, Secretary. Thomas S. Austin, Director; M. C. Ingham, Research Oceanographer; A. C. Jones, Assistant Director; and J. P. Wise, Fishery Biologist of the BCF Tropical Atlantic Biological Laboratory, Miami, Fla., and Robert E. Stevenson, Assistant Director, BCF Biological Laboratory, Galveston, Tex., gave many helpful comments and criticisms.

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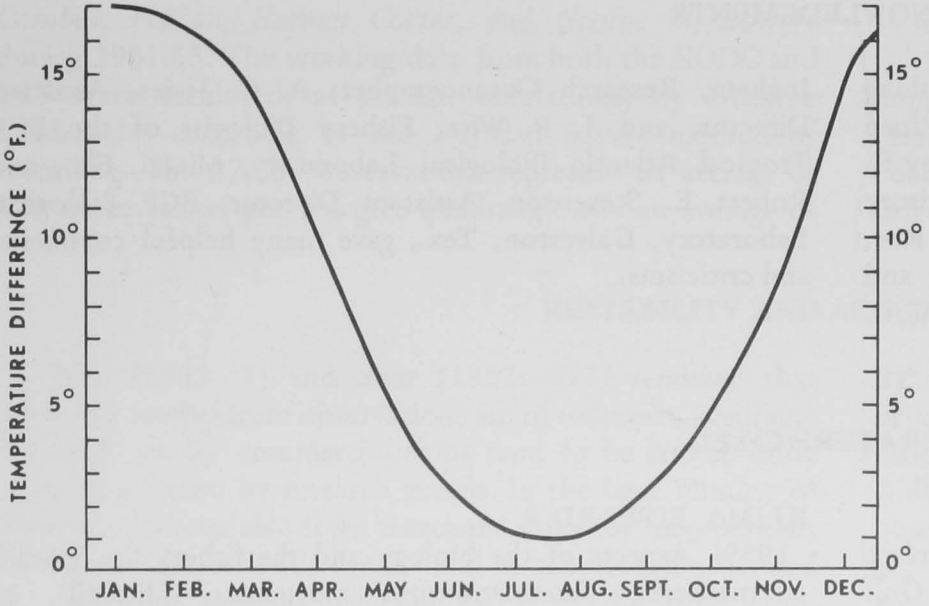


FIGURE 1.—Monthly temperature difference between Mississippi Sound and Yucatan Channel.

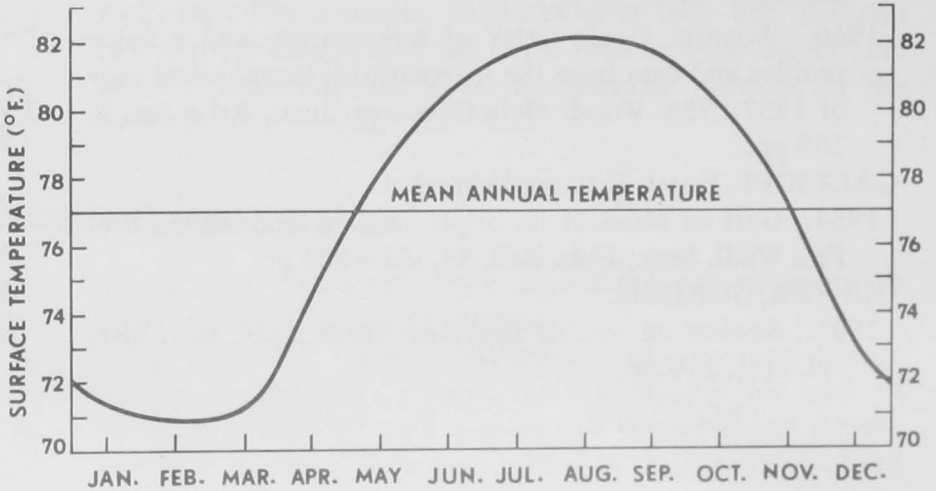
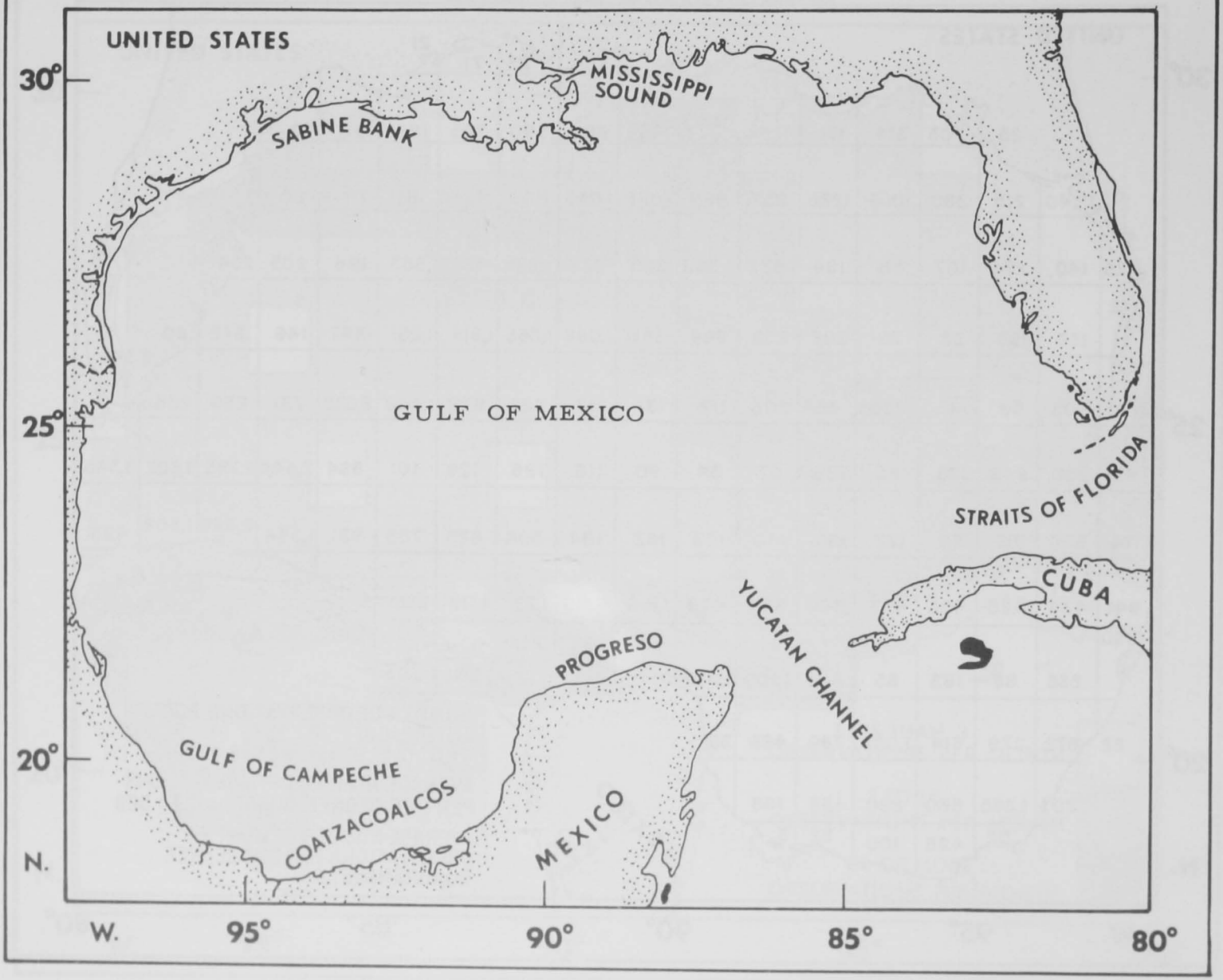
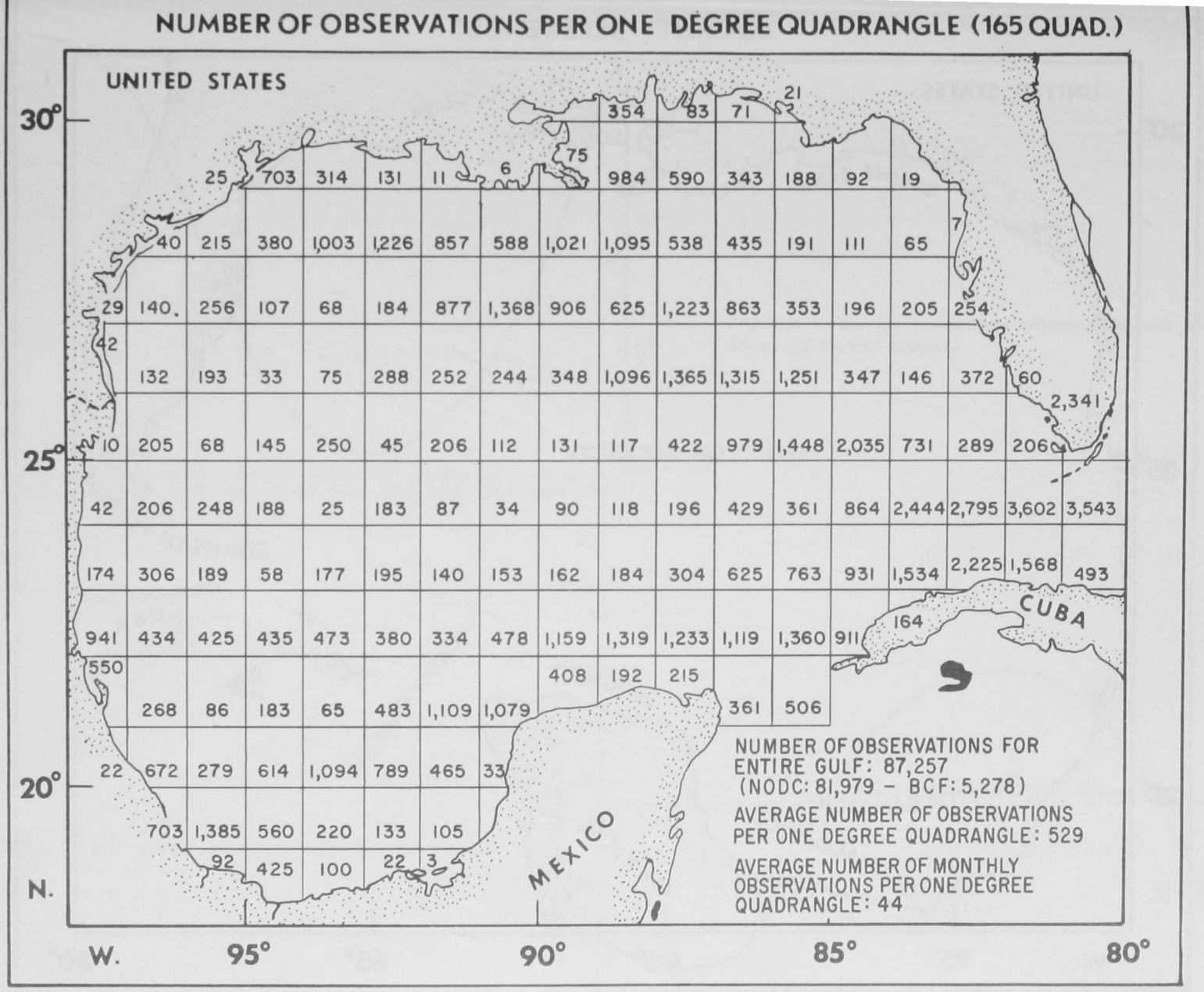
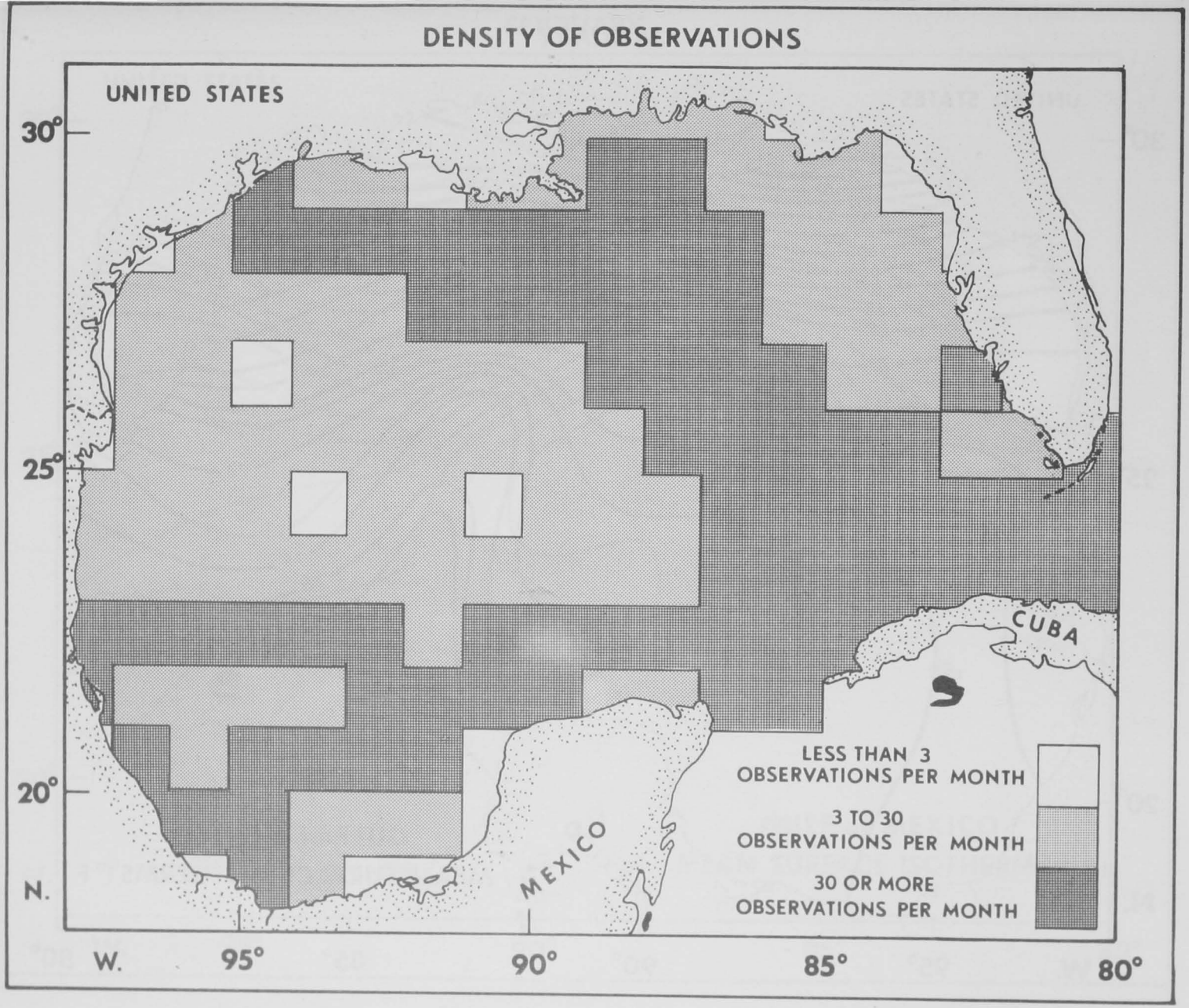


FIGURE 2.—Monthly average sea surface temperature for the Gulf of Mexico.

LOCALITY REFERENCES




NUMBER OF OBSERVATIONS PER ONE DEGREE QUADRANGLE (165 QUAD.)
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MEXICO
CUBA
NUMBER OF OBSERVATIONS FOR ENTIRE GULF: 87,257
(NODC: 81,979 – BCF: 5,278)
AVERAGE NUMBER OF OBSERVATIONS PER ONE DEGREE QUADRANGLE: 529
AVERAGE NUMBER OF MONTHLY OBSERVATIONS PER ONE DEGREE QUADRANGLE: 44


DENSITY OF OBSERVATIONS
UNITED STATES
30°
25°
20°
N.
W.
95°
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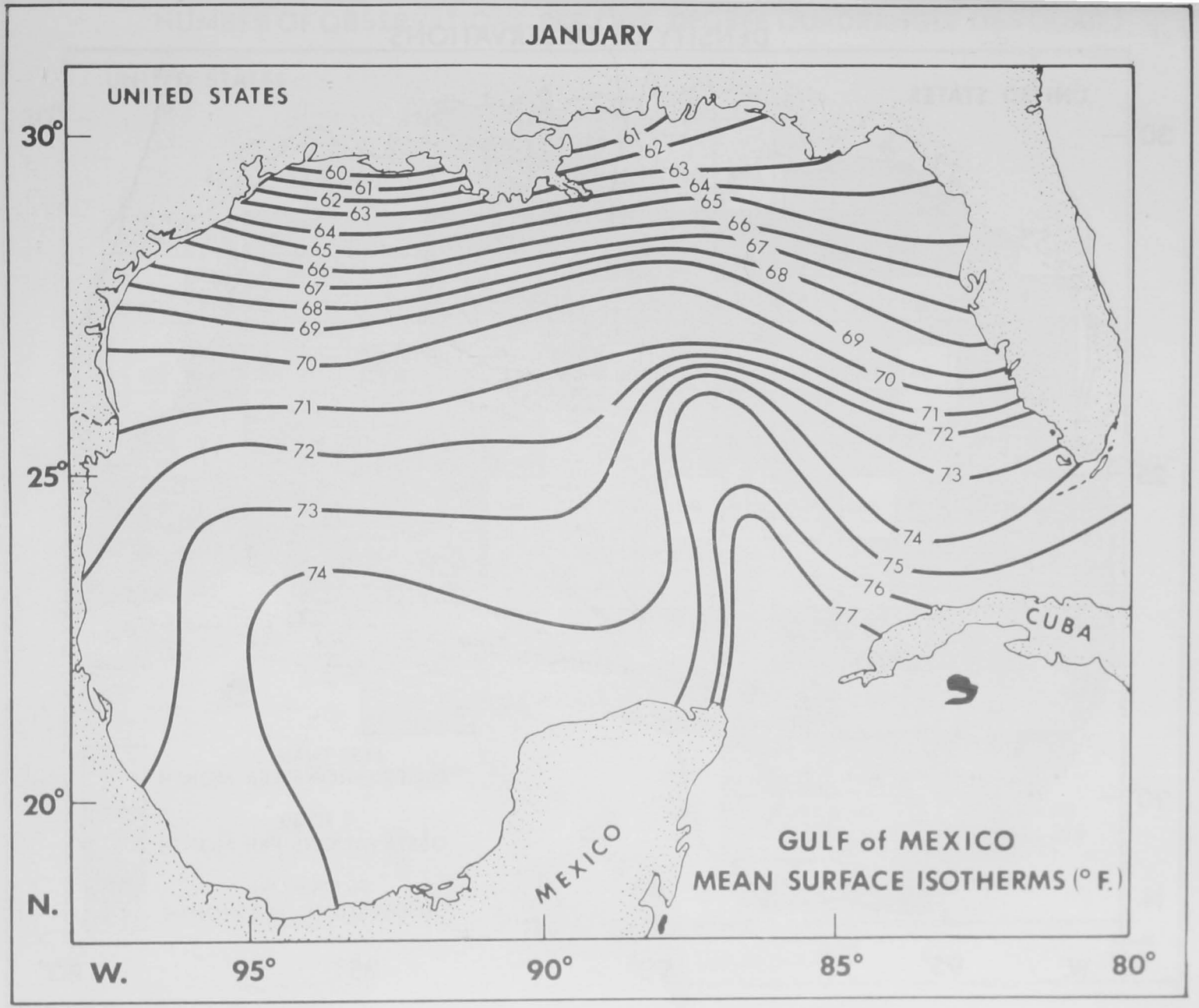
80°
CUBA
MEXICO
LESS THAN 3 OBSERVATIONS PER MONTH
3 TO 30 OBSERVATIONS PER MONTH
30 OR MORE OBSERVATIONS PER MONTH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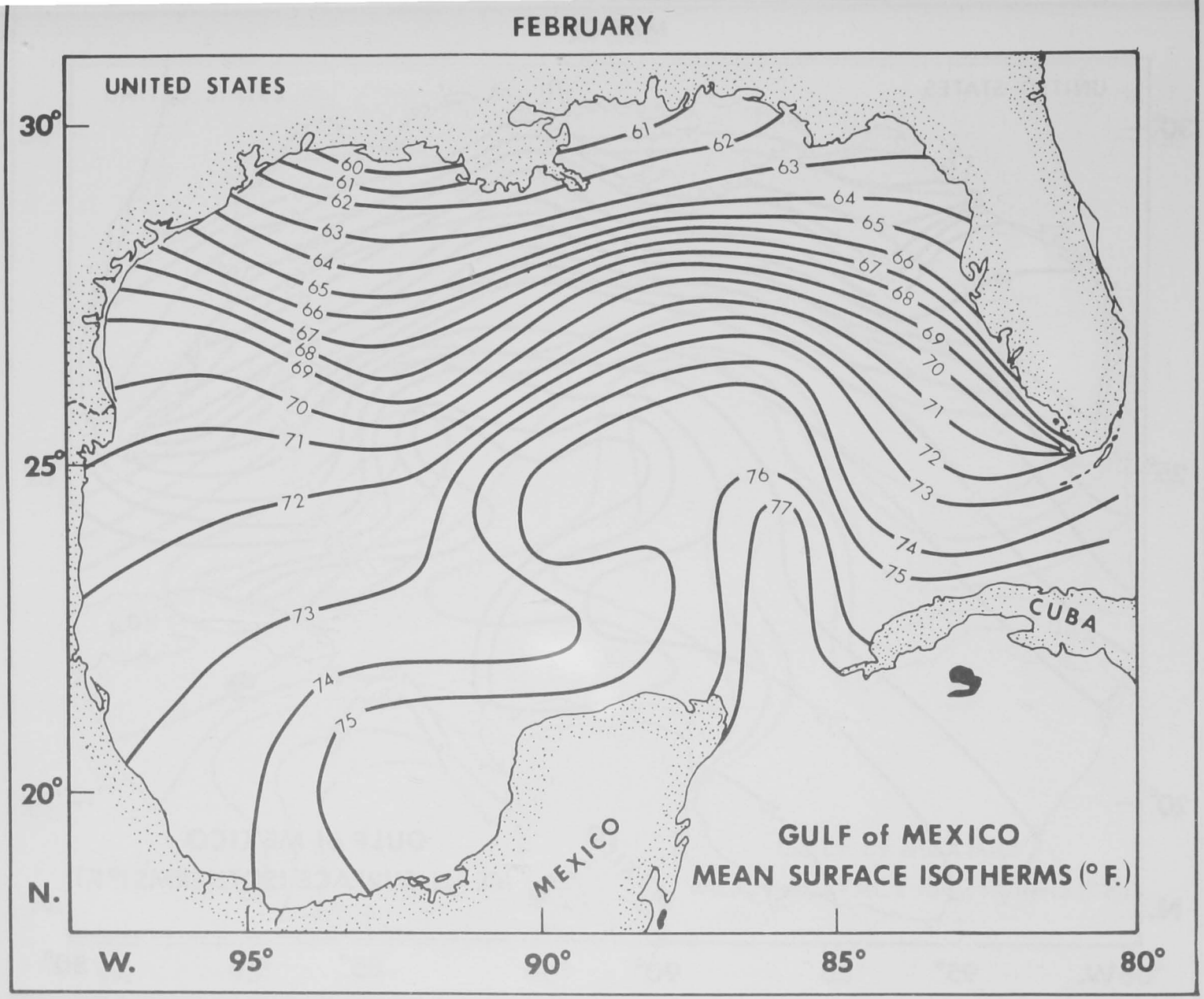
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)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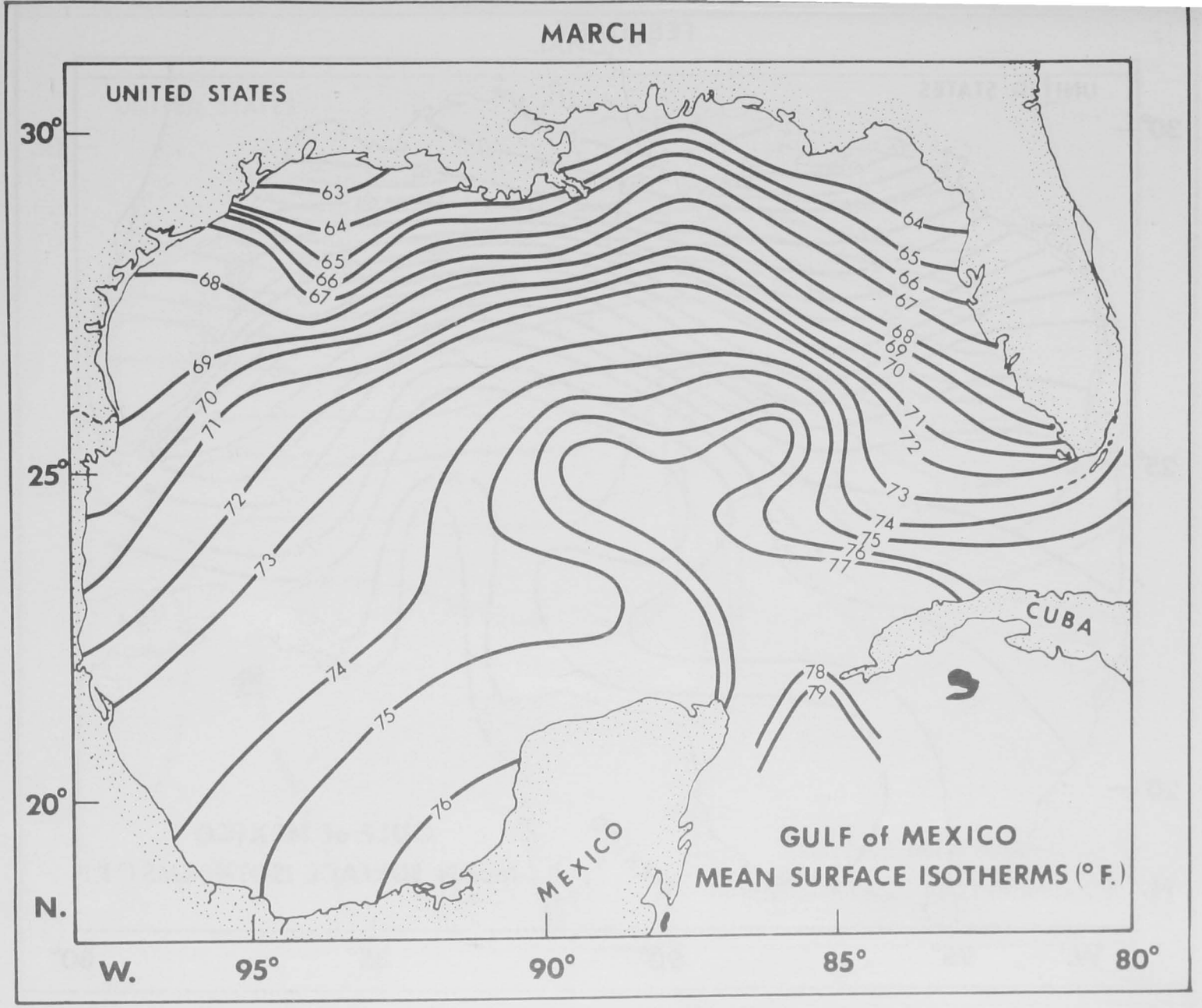
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)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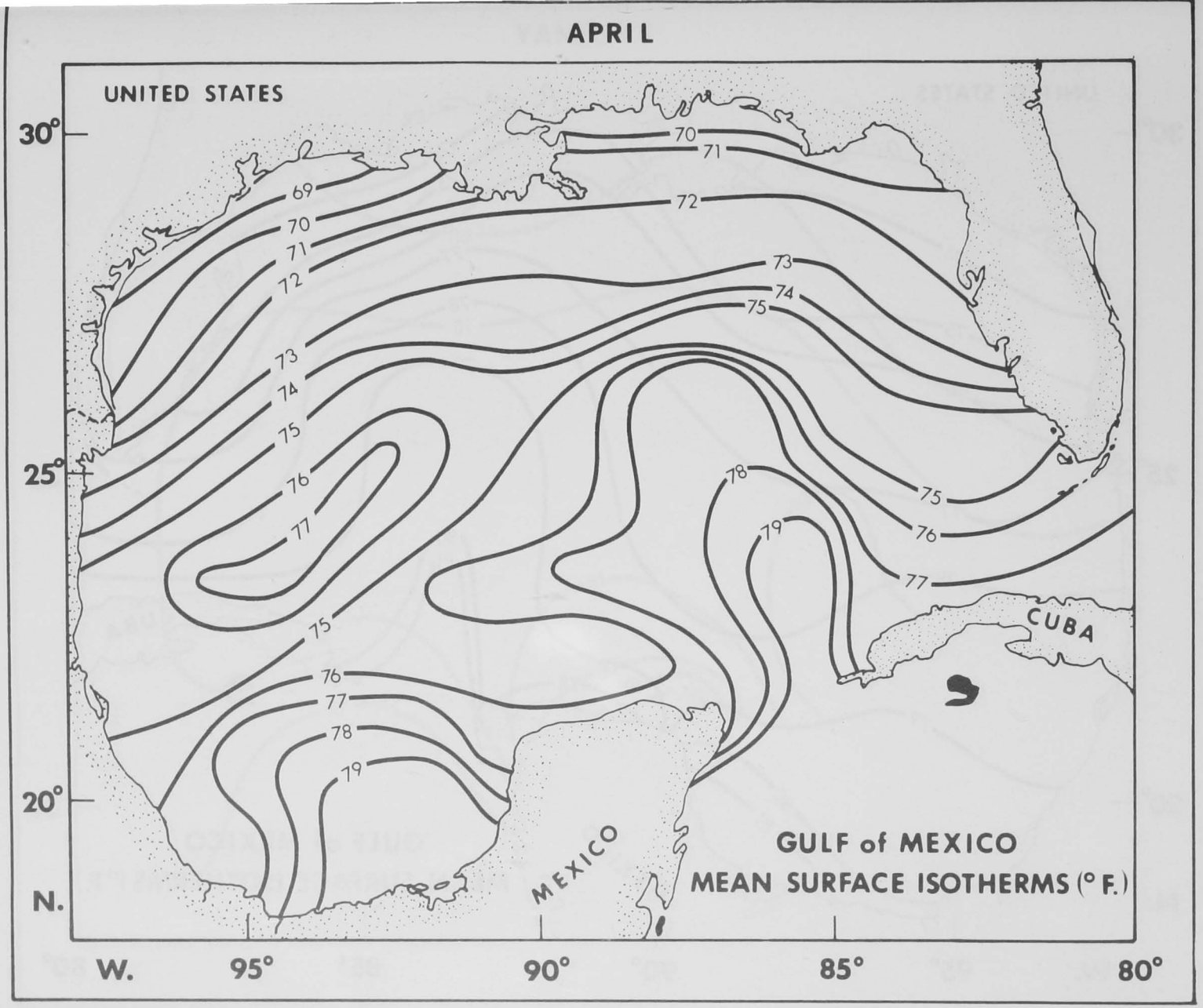
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)


APRIL
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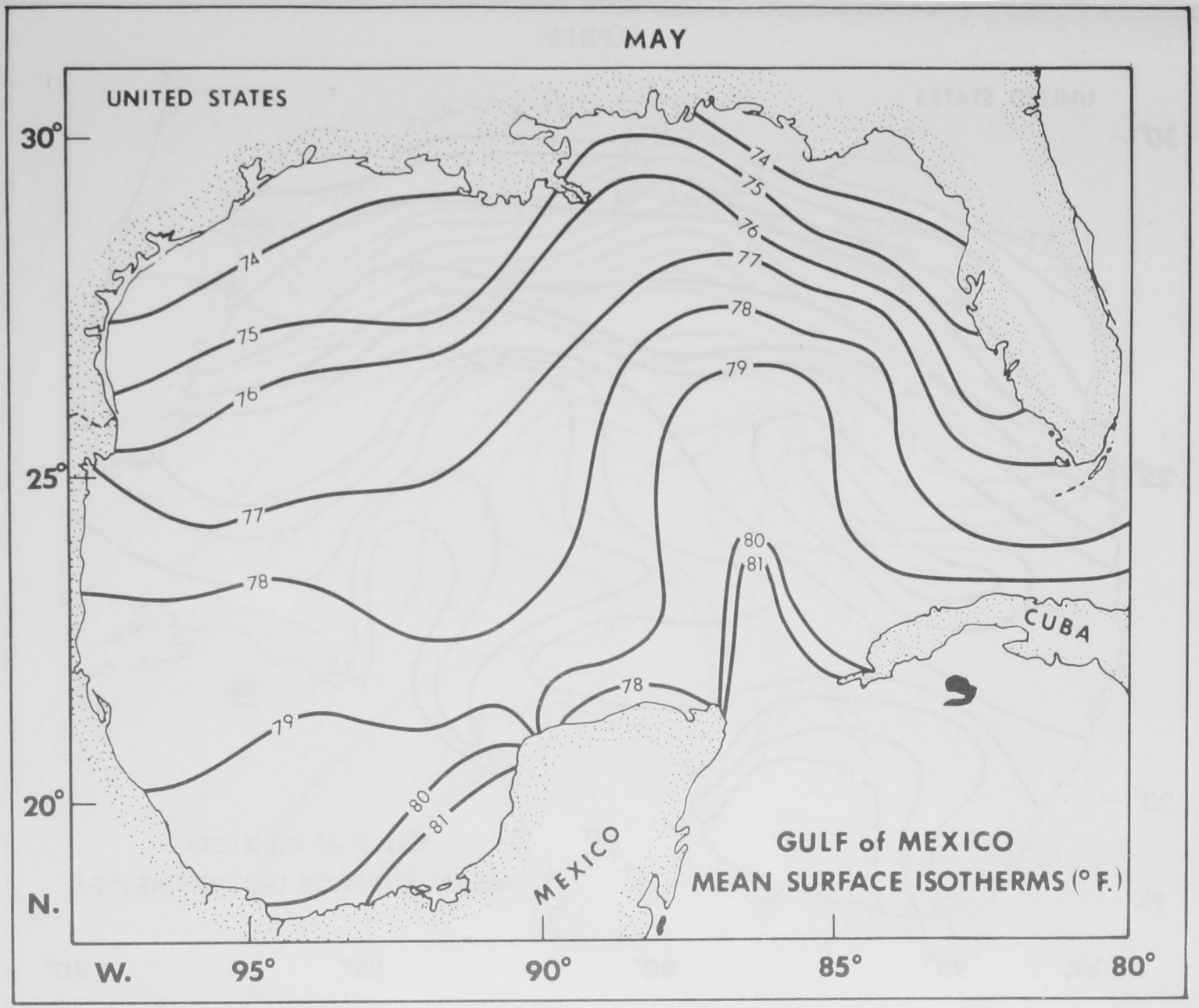
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)


MAY
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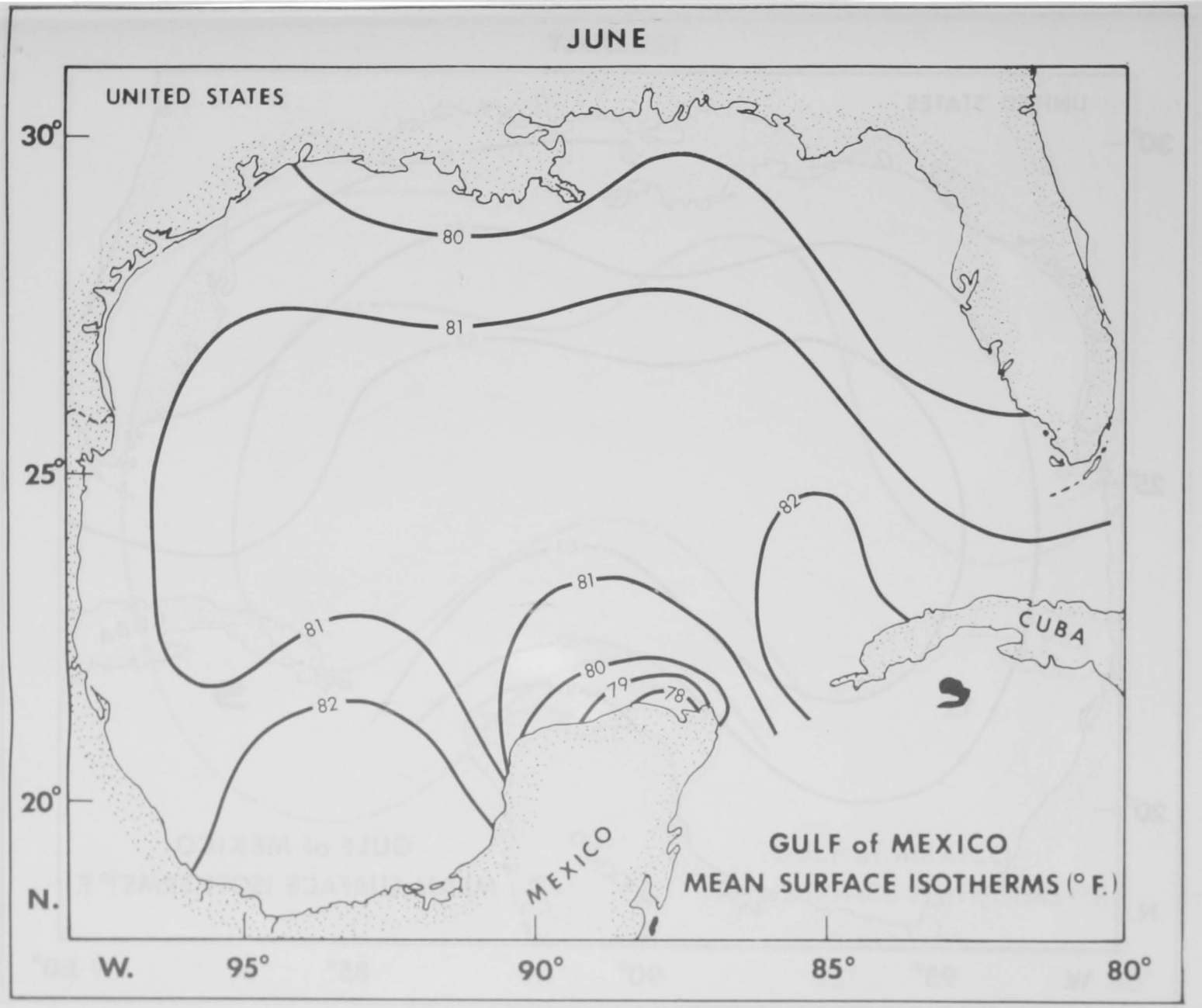
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)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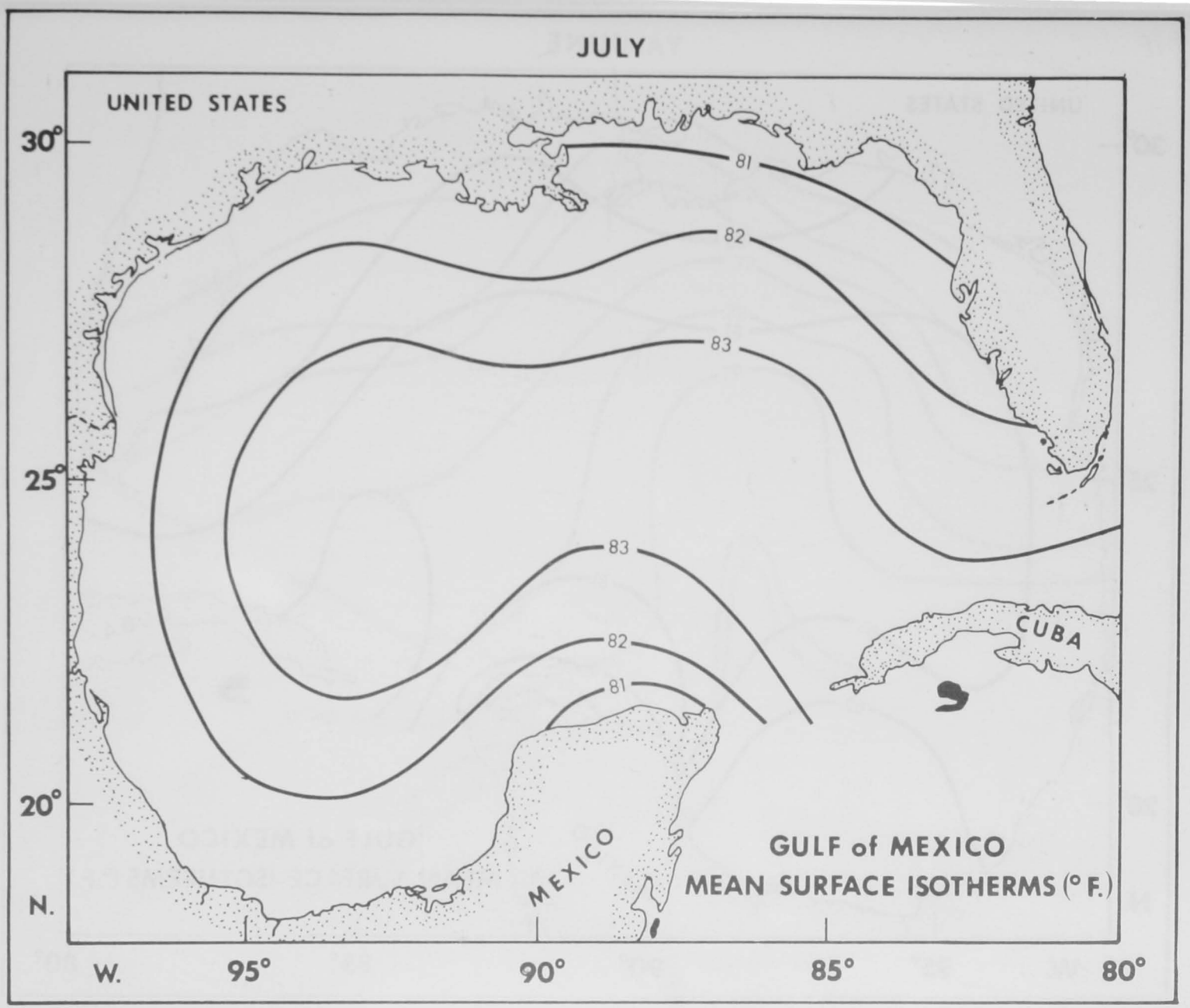
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)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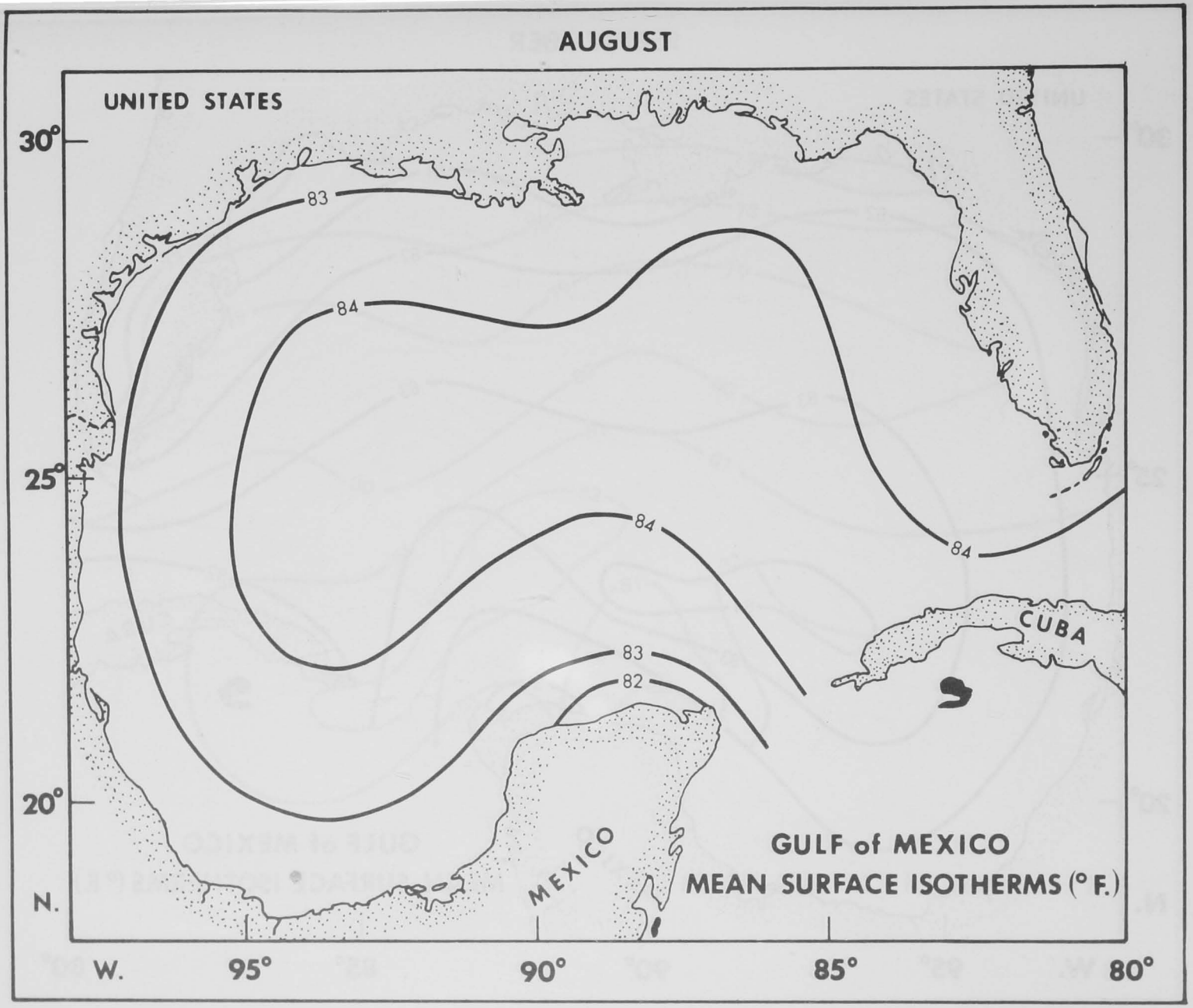
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)


AUGUST
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CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)
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95°
90°
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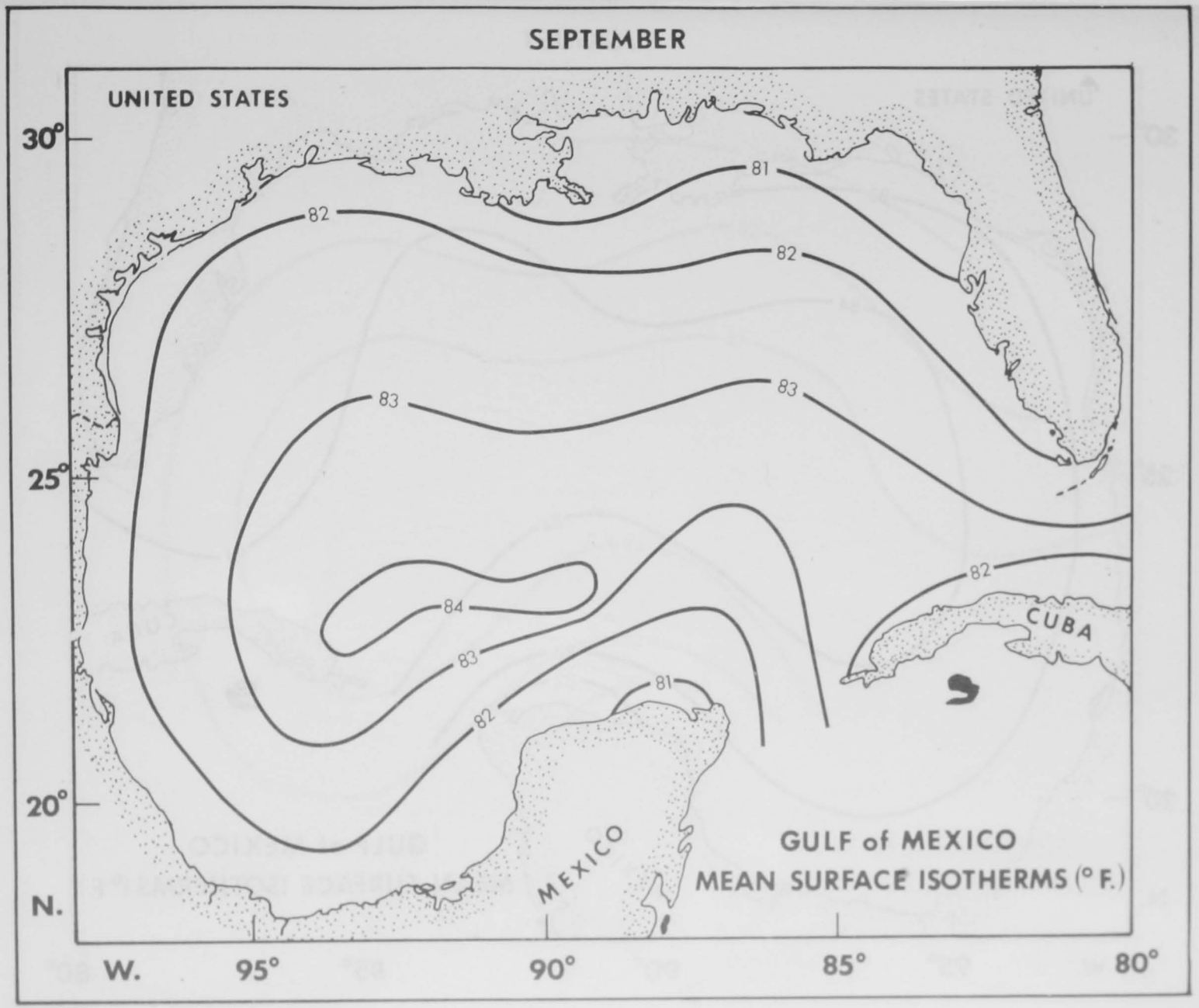
80°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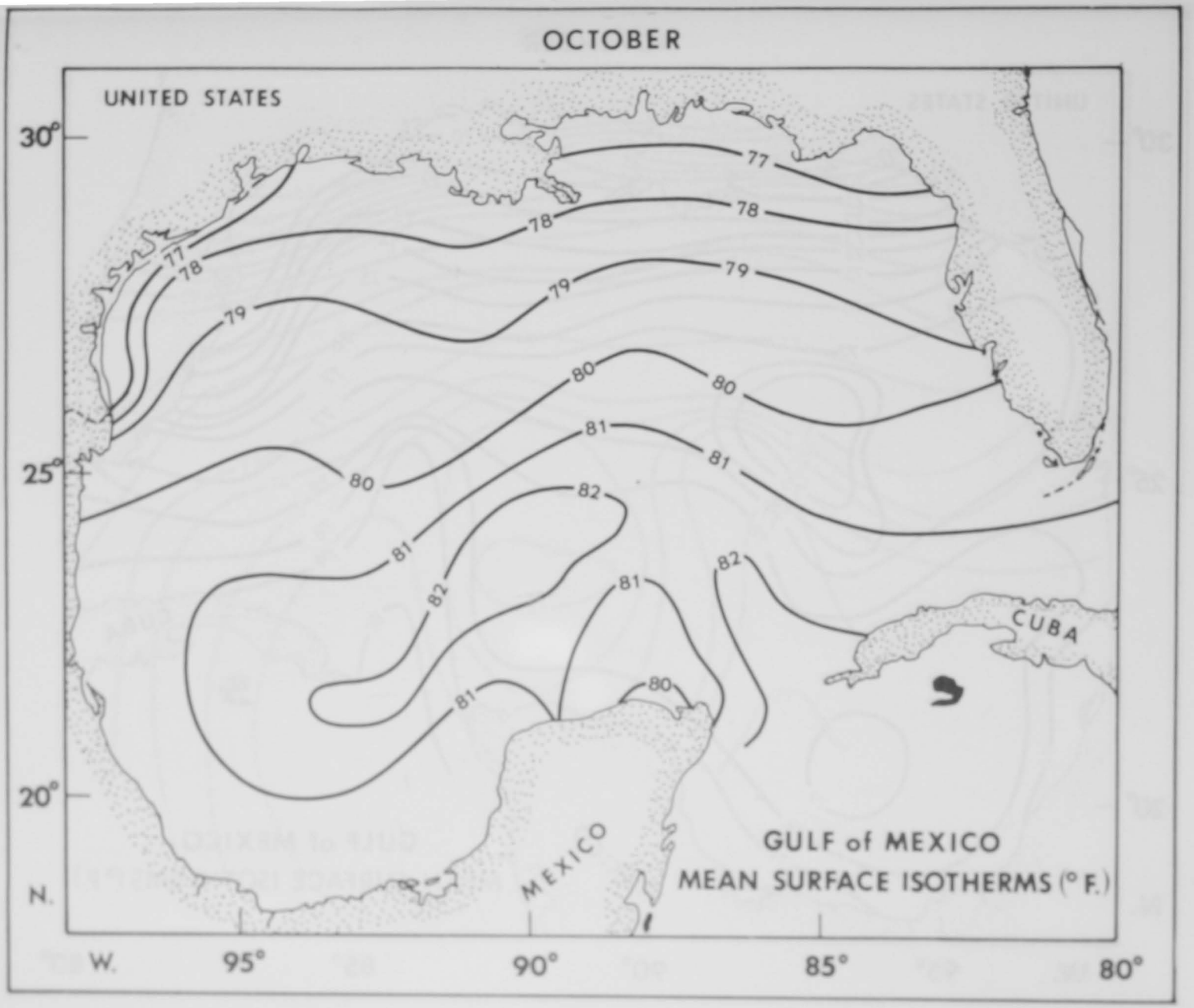
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)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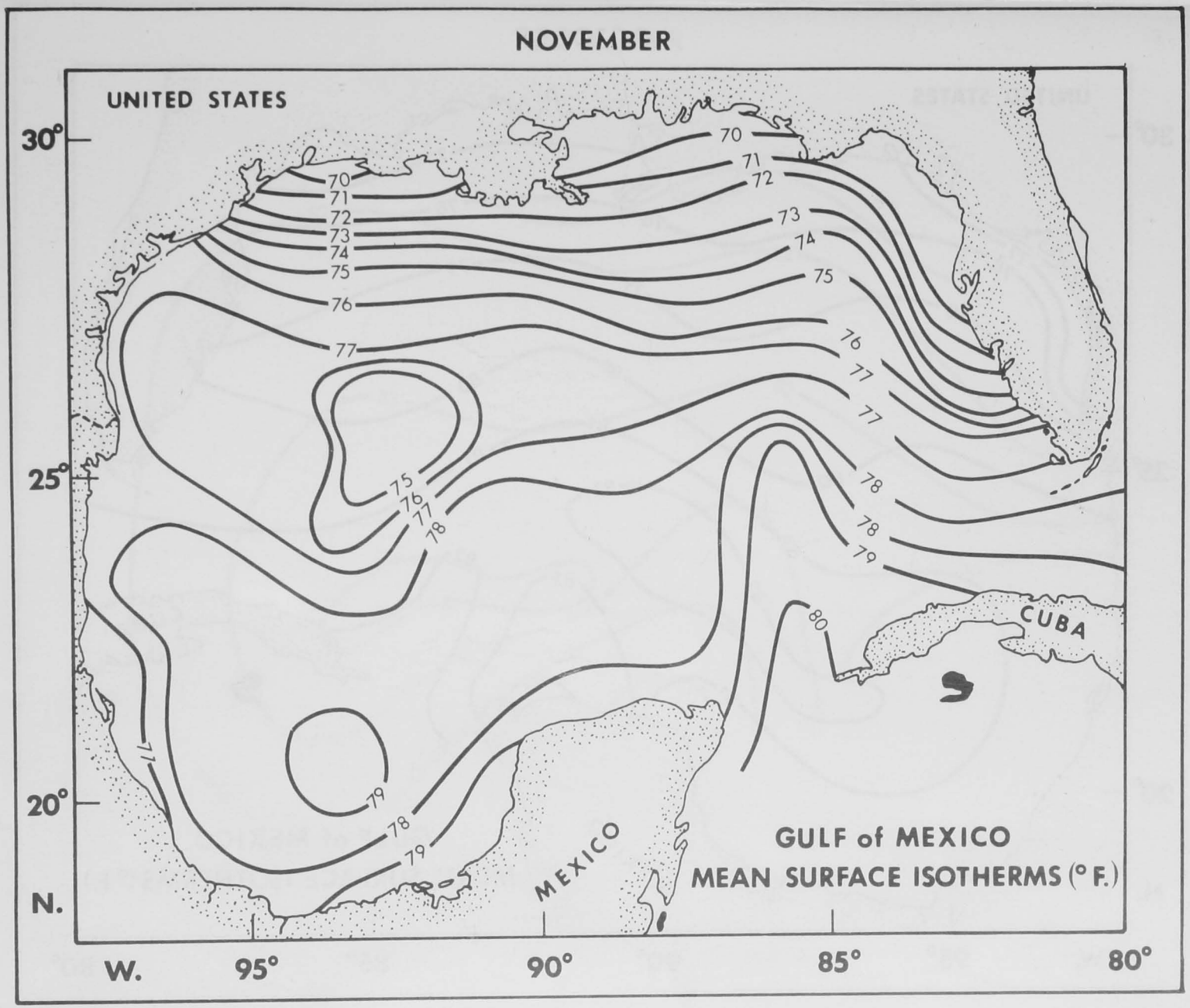
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)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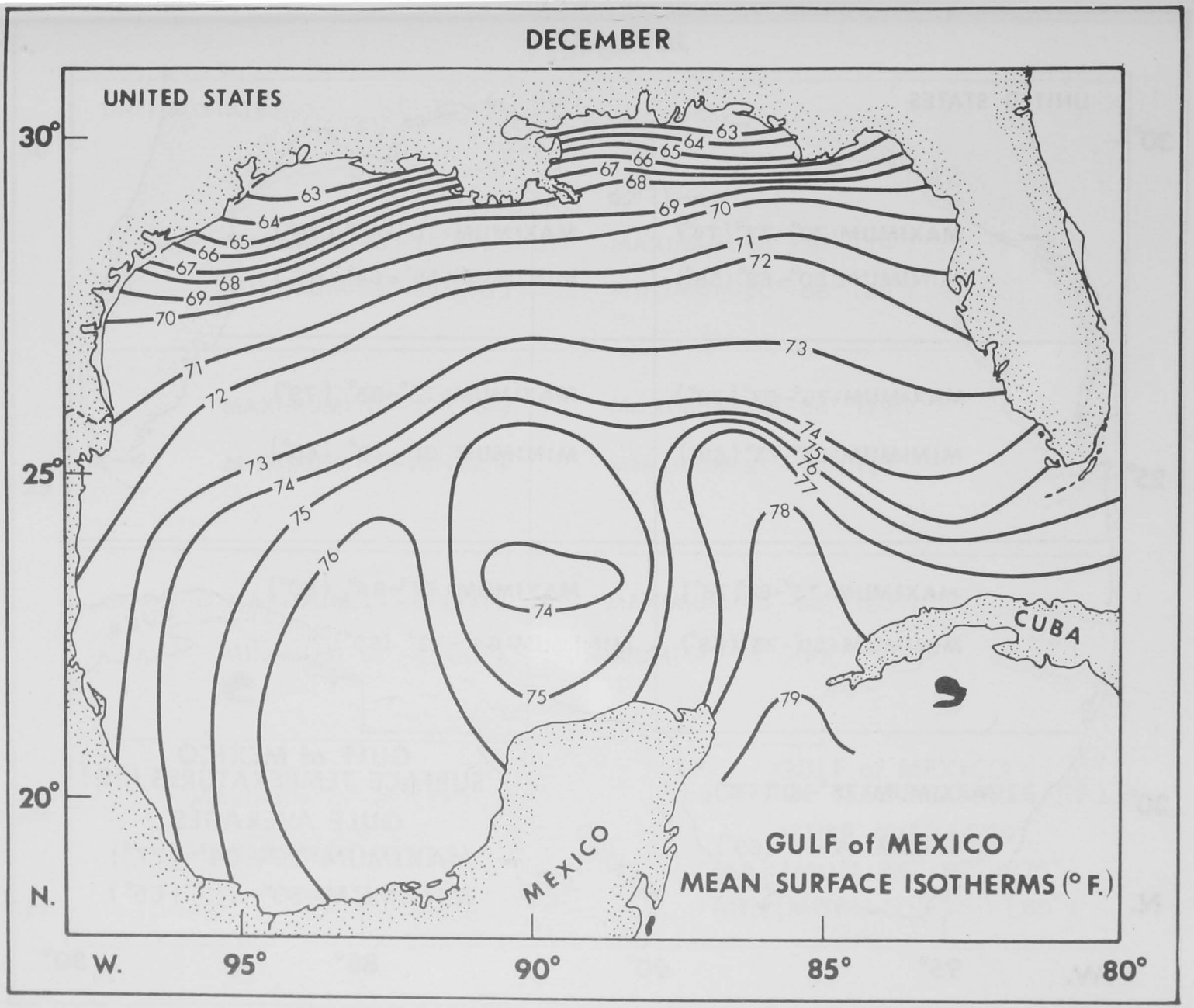
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)


DECEMBER
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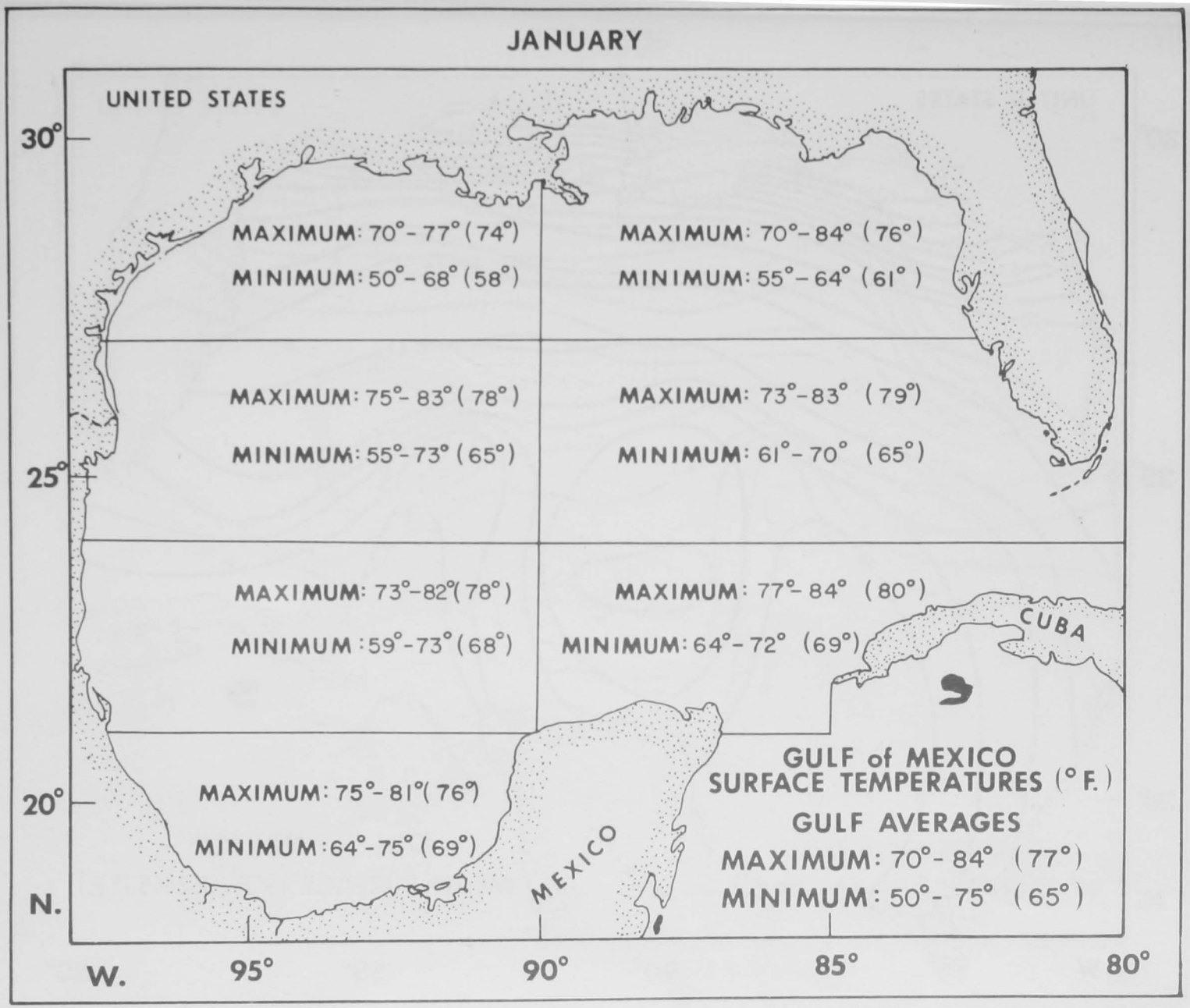
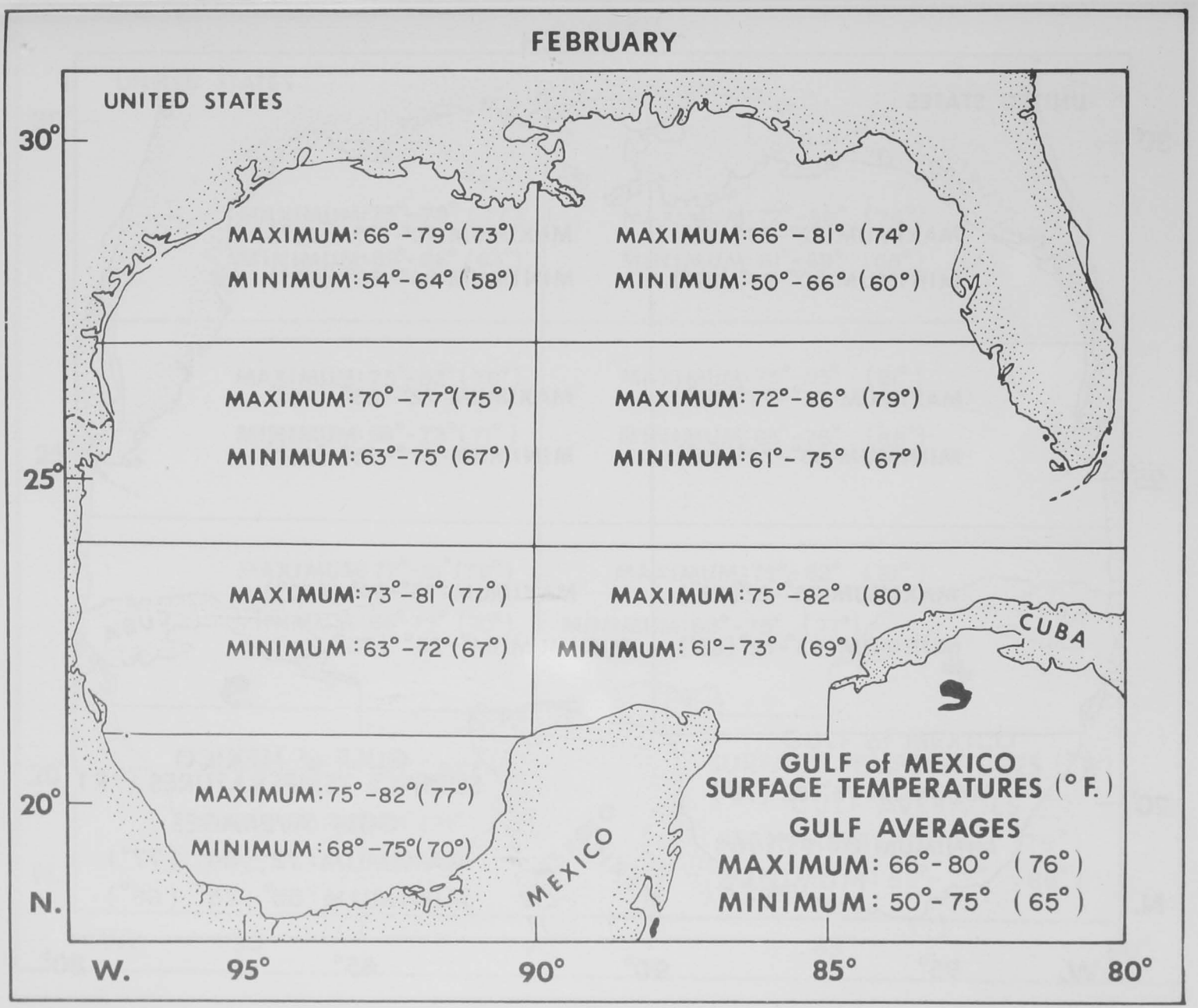
CUBA
MEXICO
GULF of MEXICO
MEAN SURFACE ISOTHERMS (° F.)


JANUARY
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 70°- 77° (74°)
MINIMUM: 50°- 68° (58°)
MAXIMUM: 70°- 84° (76°)
MINIMUM: 55°- 64° (61°)
MAXIMUM: 75°- 83° (78°)
MINIMUM: 55°- 73° (65°)
MAXIMUM: 73°- 83° (79°)
MINIMUM: 61°- 70° (65°)
MAXIMUM: 73°- 82° (78°)
MINIMUM: 59°- 73° (68°)
MAXIMUM: 77°- 84° (80°)
MINIMUM: 64°- 72° (69°)
CUBA
MAXIMUM: 75°- 81° (76°)
MINIMUM: 64°- 75° (69°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 70°- 84° (77°)
MINIMUM: 50°- 75° (65°)


FEBRUARY
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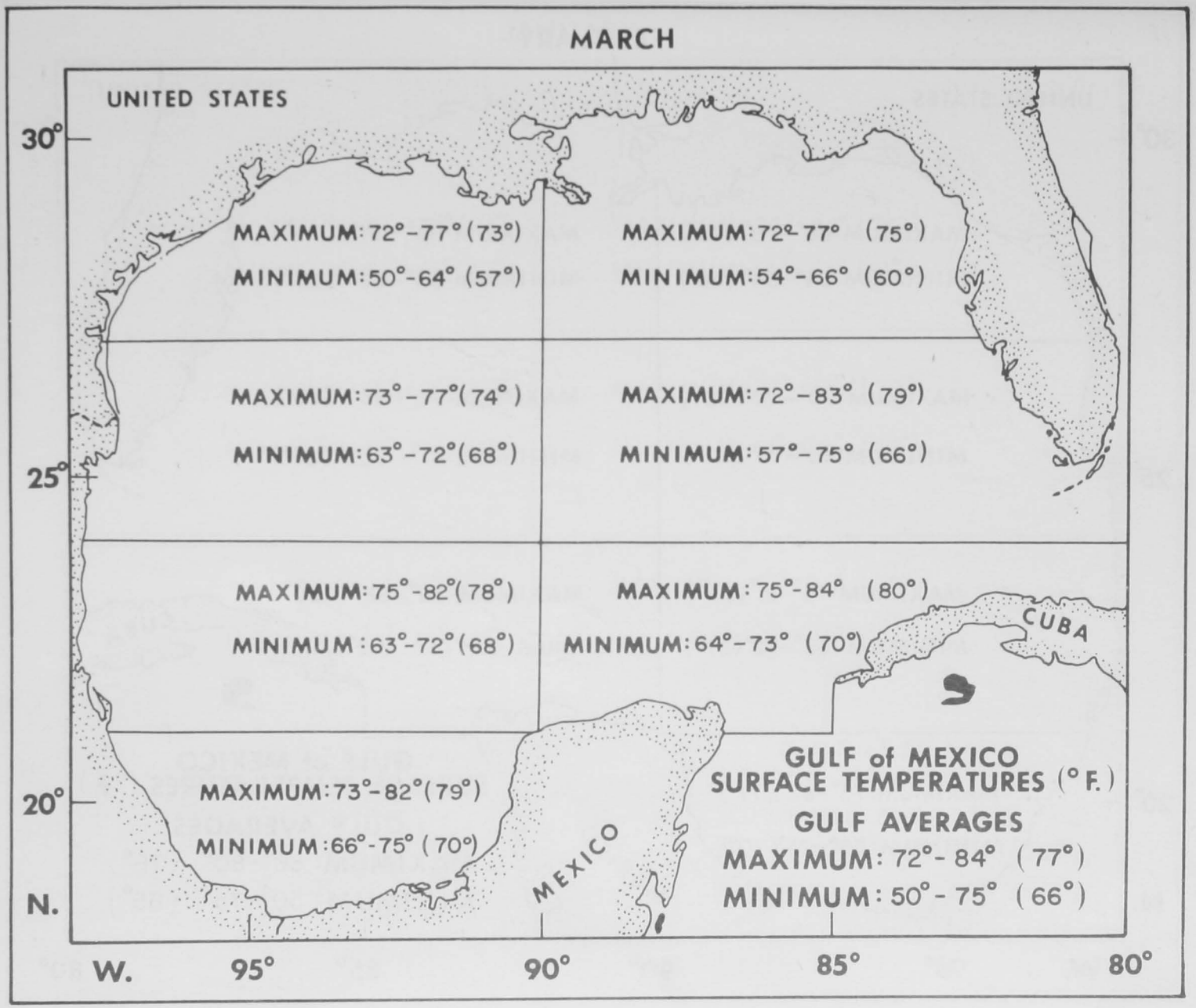
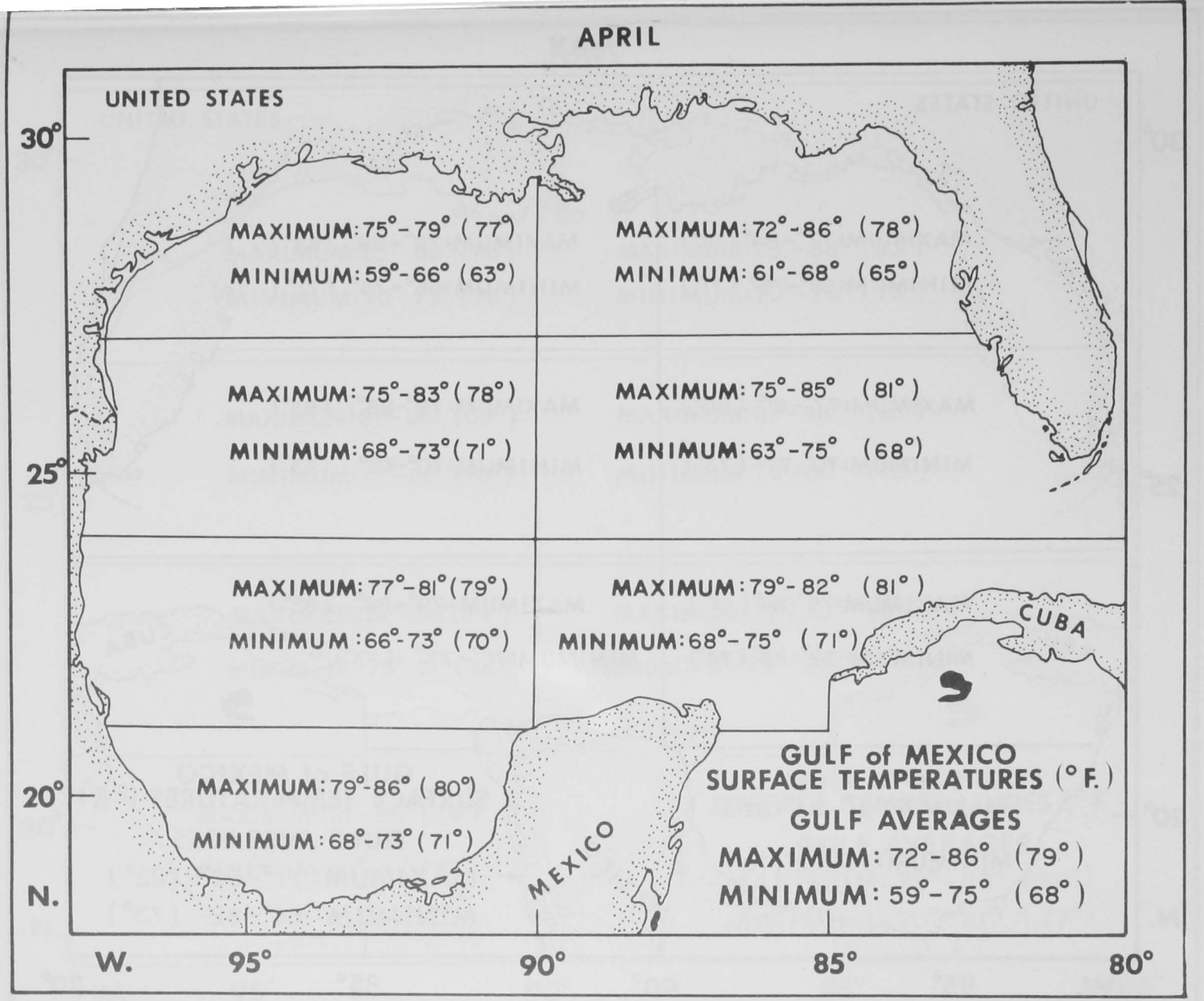
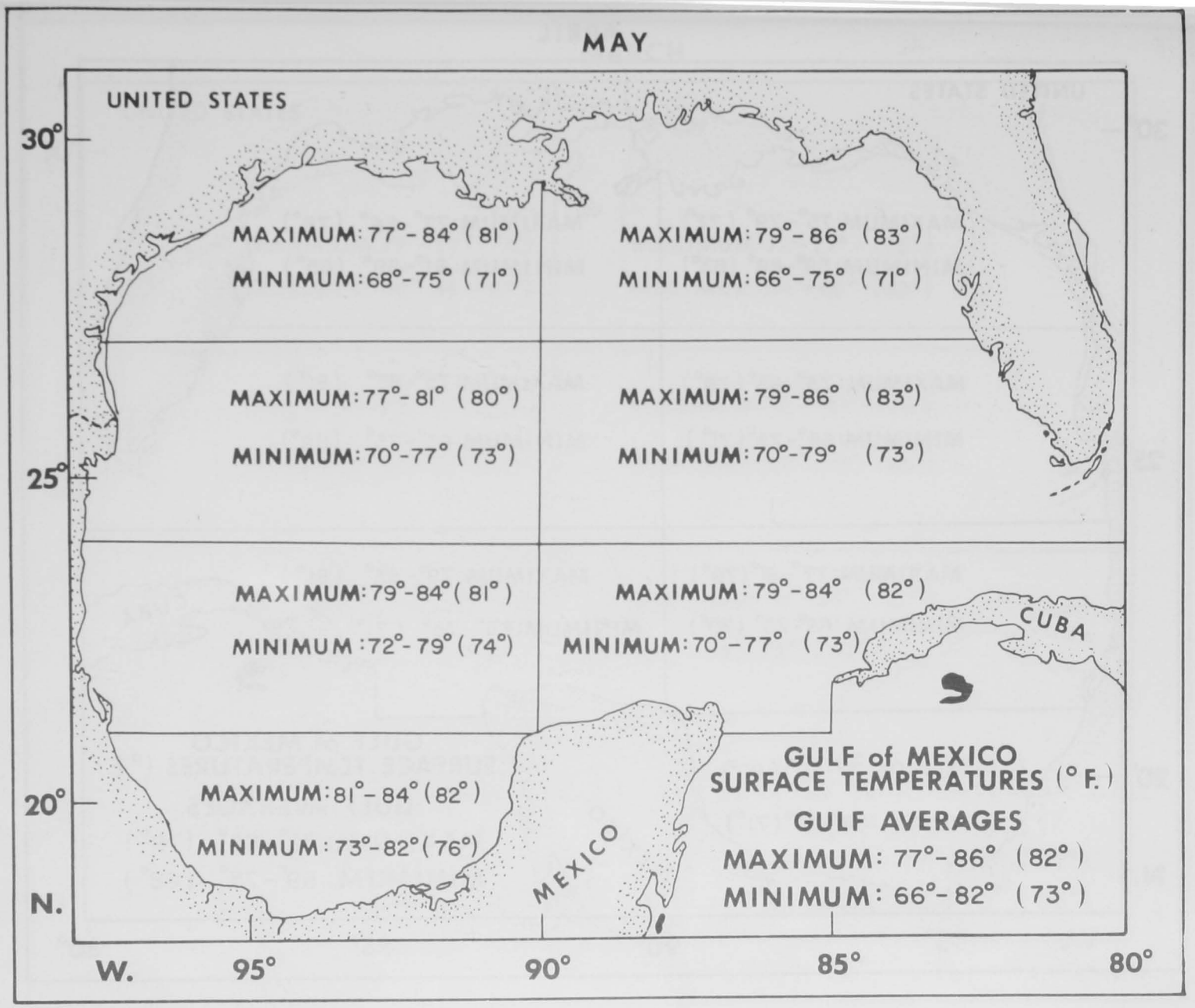
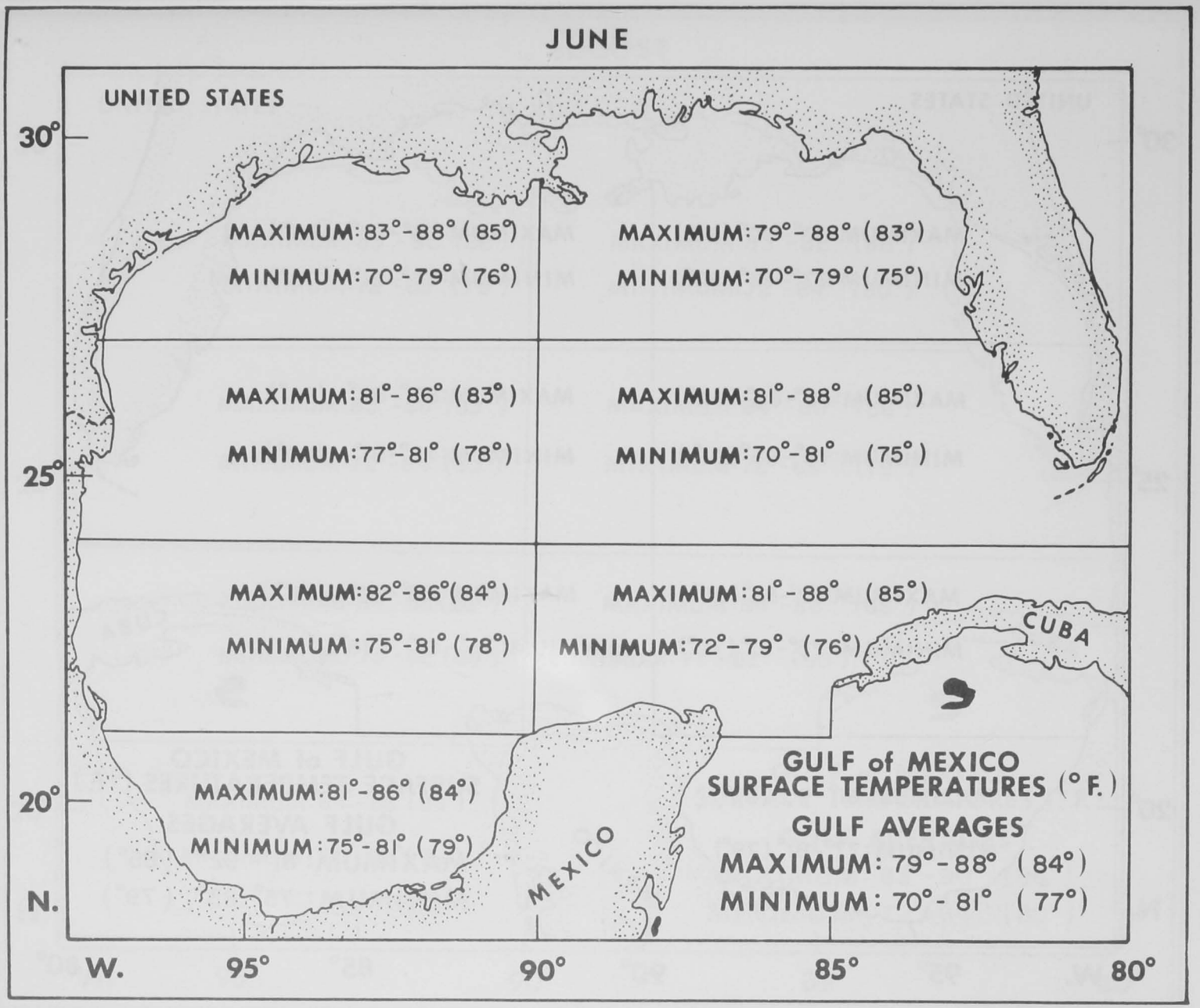
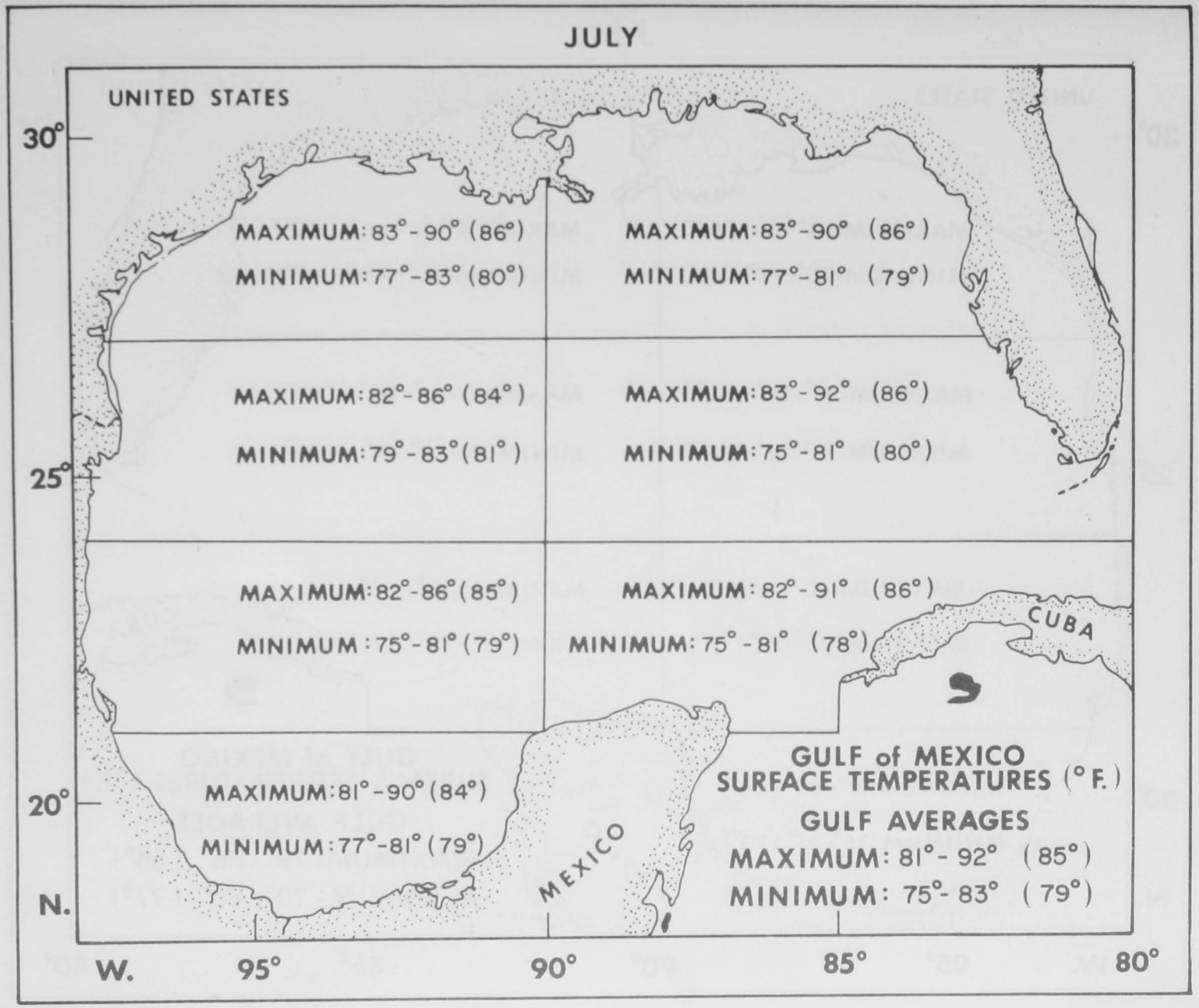
80°
MAXIMUM: 66°-79° (73°)
MINIMUM: 54°-64° (58°)
MAXIMUM: 66°-81° (74°)
MINIMUM: 50°-66° (60°)
MAXIMUM: 70°-77° (75°)
MINIMUM: 63°-75° (67°)
MAXIMUM: 72°-86° (79°)
MINIMUM: 61°-75° (67°)
MAXIMUM: 73°-81° (77°)
MINIMUM: 63°-72° (67°)
MAXIMUM: 75°-82° (80°)
MINIMUM: 61°-73° (69°)
CUBA
MAXIMUM: 75°-82° (77°)
MINIMUM: 68°-75° (70°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 66°-80° (76°)
MINIMUM: 50°-75° (65°)

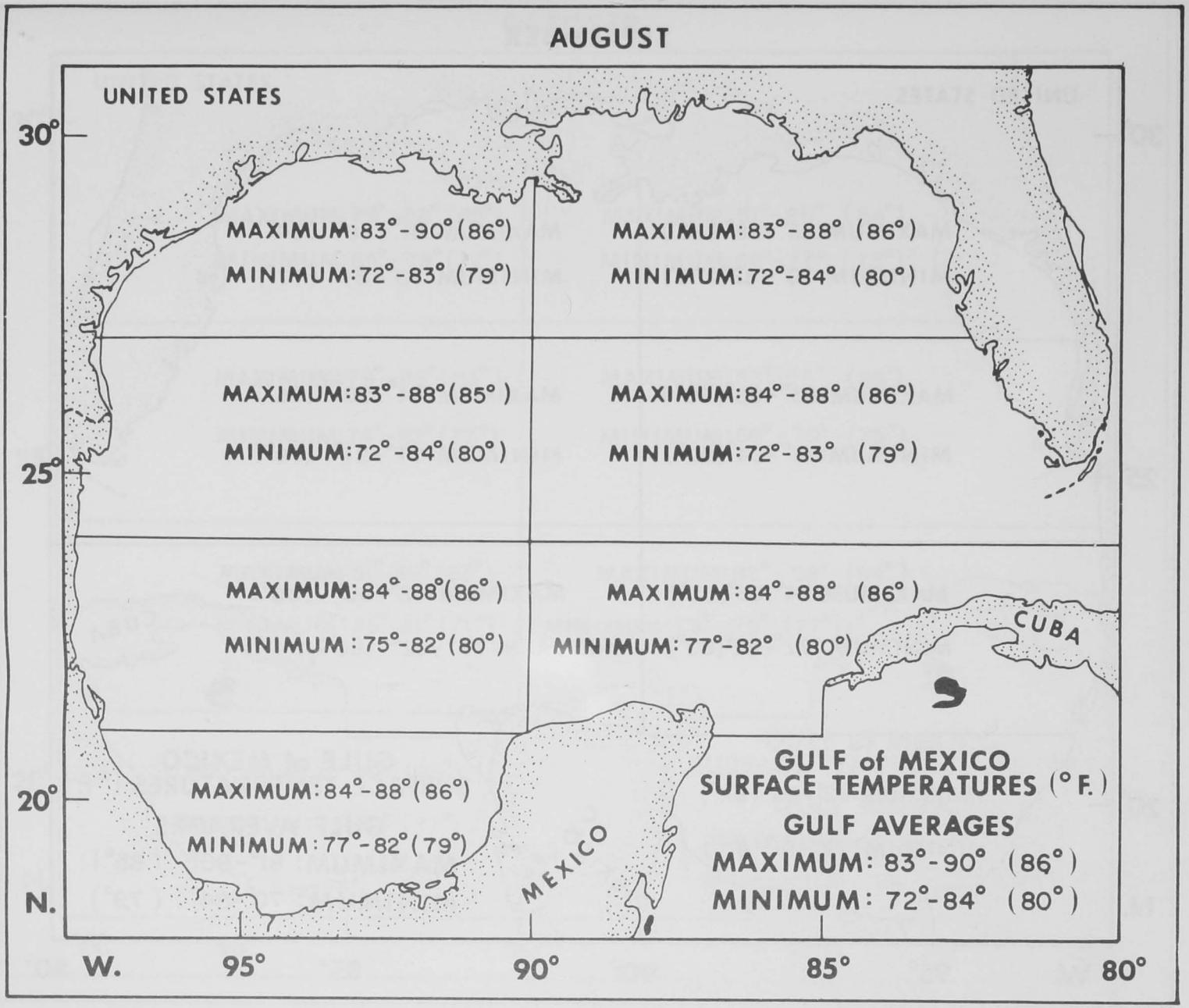

MARCH
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 72°-77° (73°)
MINIMUM: 50°-64° (57°)
MAXIMUM: 72°-77° (75°)
MINIMUM: 54°-66° (60°)
MAXIMUM: 73°-77° (74°)
MINIMUM: 63°-72° (68°)
MAXIMUM: 72°-83° (79°)
MINIMUM: 57°-75° (66°)
MAXIMUM: 75°-82° (78°)
MINIMUM: 63°-72° (68°)
MAXIMUM: 75°-84° (80°)
MINIMUM: 64°-73° (70°)
CUBA
MAXIMUM: 73°-82° (79°)
MINIMUM: 66°-75° (70°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 72°-84° (77°)
MINIMUM: 50°-75° (66°)

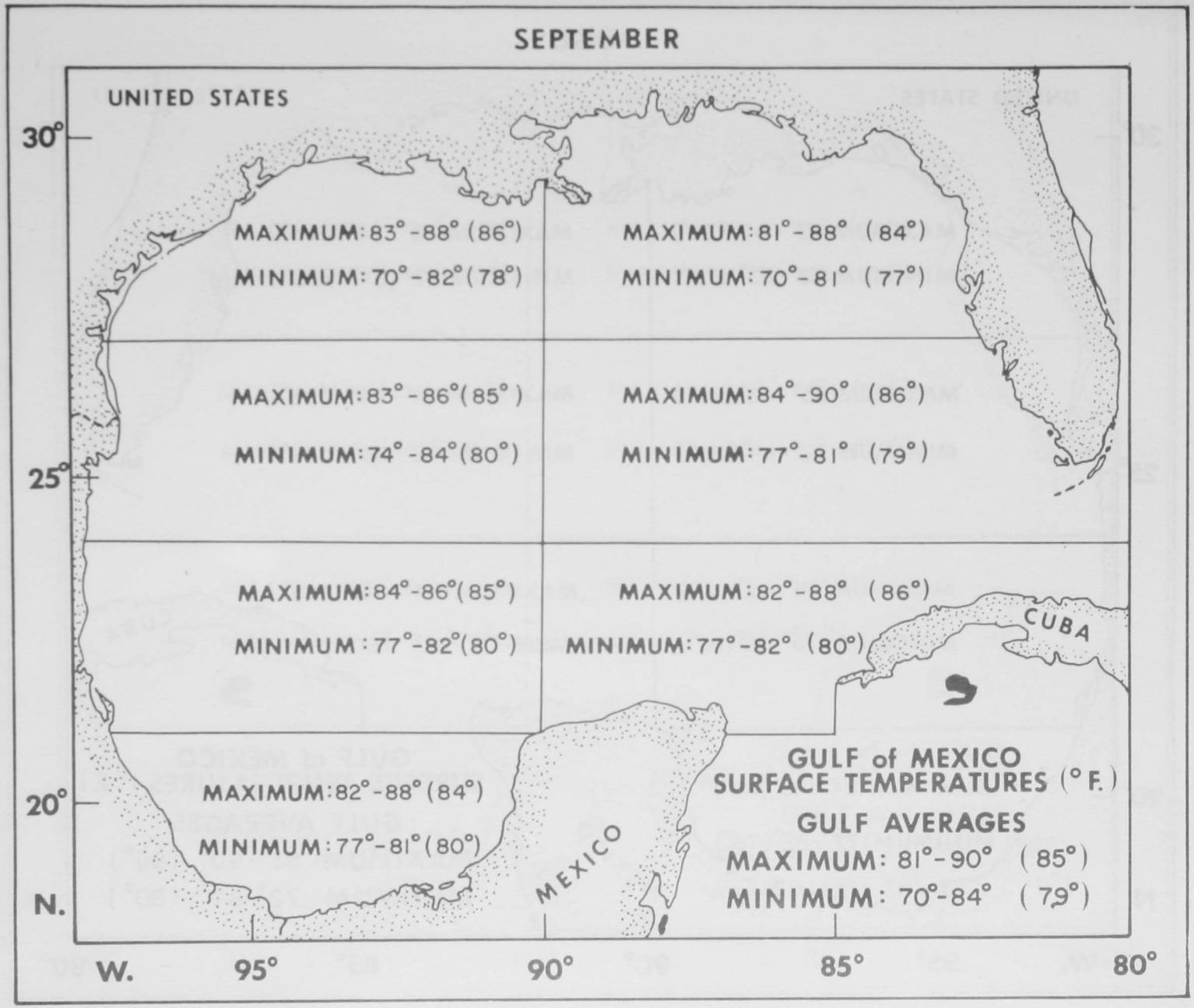

APRIL
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 75°-79° (77°)
MINIMUM: 59°-66° (63°)
MAXIMUM: 72°-86° (78°)
MINIMUM: 61°-68° (65°)
MAXIMUM: 75°-83° (78°)
MINIMUM: 68°-73° (71°)
MAXIMUM: 75°-85° (81°)
MINIMUM: 63°-75° (68°)
MAXIMUM: 77°-81° (79°)
MINIMUM: 66°-73° (70°)
MAXIMUM: 79°-82° (81°)
MINIMUM: 68°-75° (71°)
CUBA
MAXIMUM: 79°-86° (80°)
MINIMUM: 68°-73° (71°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 72°-86° (79°)
MINIMUM: 59°-75° (68°)

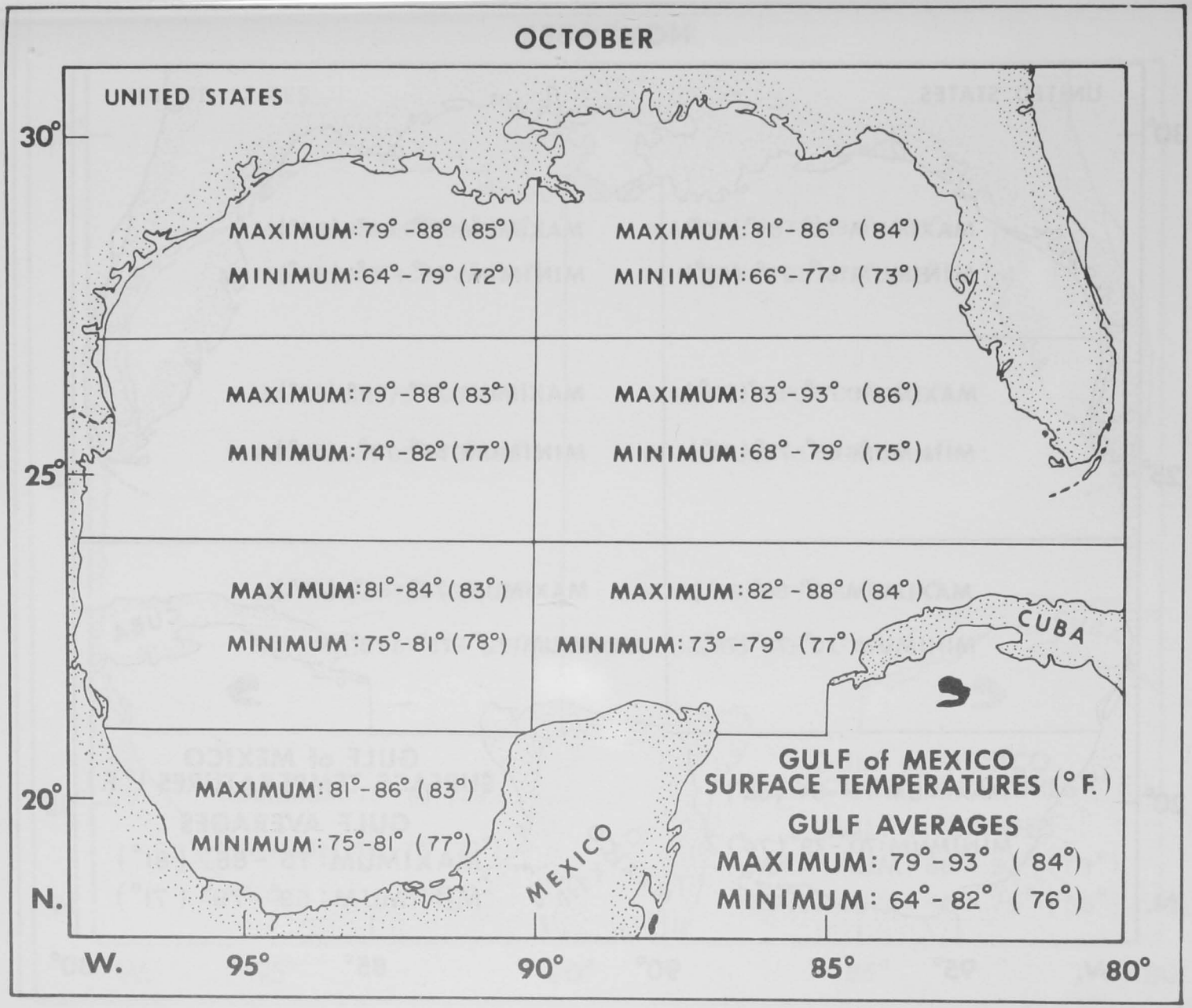

MAY
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 77°- 84° (81°)
MINIMUM: 68°- 75° (71°)
MAXIMUM: 79°- 86° (83°)
MINIMUM: 66°- 75° (71°)
MAXIMUM: 77°- 81° (80°)
MINIMUM: 70°- 77° (73°)
MAXIMUM: 79°- 86° (83°)
MINIMUM: 70°- 79° (73°)
MAXIMUM: 79°- 84° (81°)
MINIMUM : 72°- 79° (74°)
MAXIMUM: 79°- 84° (82°)
MINIMUM: 70°- 77° (73°)
CUBA
MAXIMUM: 81°- 84° (82°)
MINIMUM: 73°- 82° (76°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 77°- 86° (82°)
MINIMUM: 66°- 82° (73°)

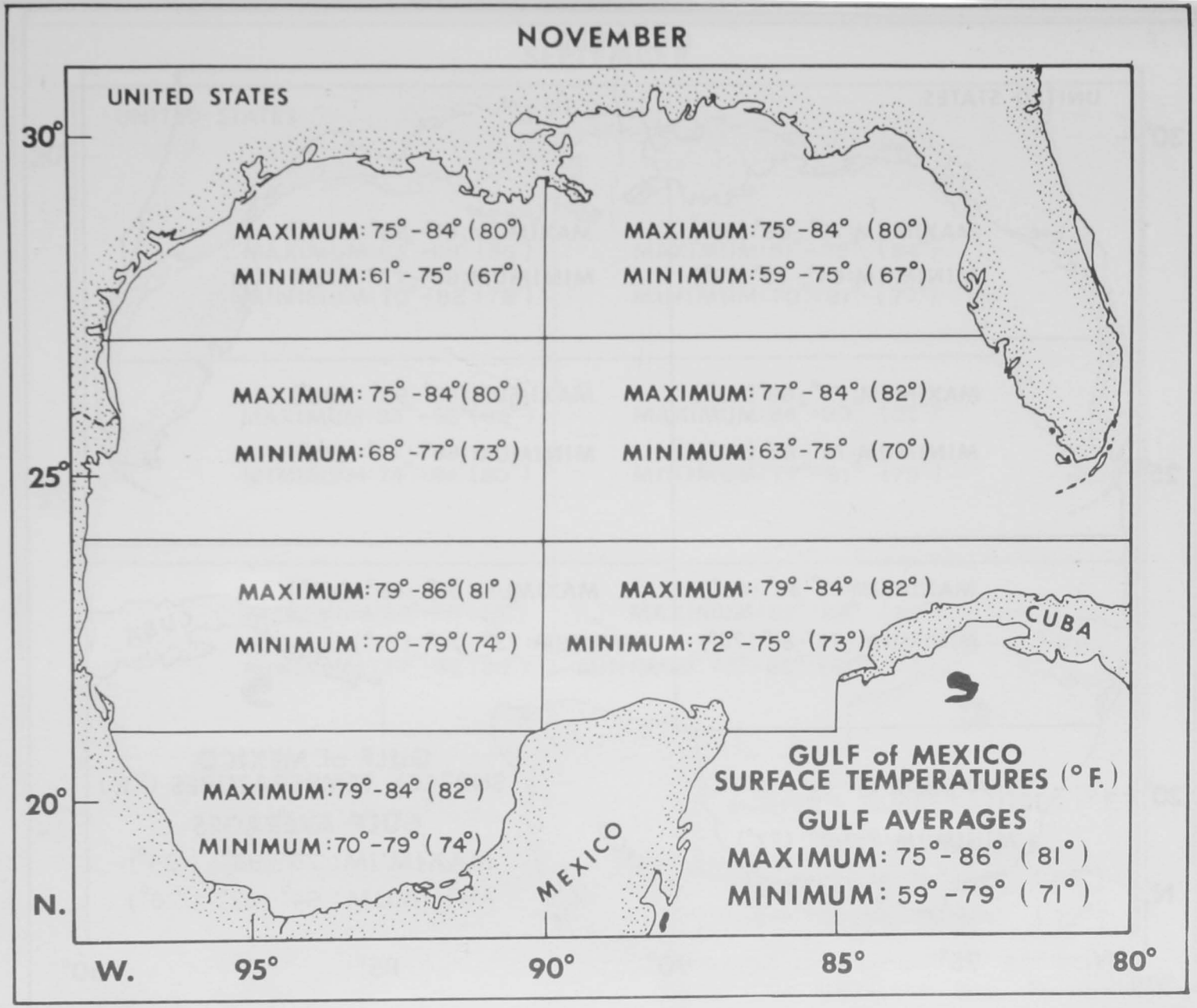

JUNE
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 83°-88° (85°)
MINIMUM: 70°-79° (76°)
MAXIMUM: 79°-88° (83°)
MINIMUM: 70°-79° (75°)
MAXIMUM: 81°-86° (83°)
MINIMUM: 77°-81° (78°)
MAXIMUM: 81°-88° (85°)
MINIMUM: 70°-81° (75°)
MAXIMUM: 82°-86° (84°)
MINIMUM: 75°-81° (78°)
MAXIMUM: 81°-88° (85°)
MINIMUM: 72°-79° (76°)
CUBA
MAXIMUM: 81°-86° (84°)
MINIMUM: 75°-81° (79°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 79°-88° (84°)
MINIMUM: 70°-81° (77°)

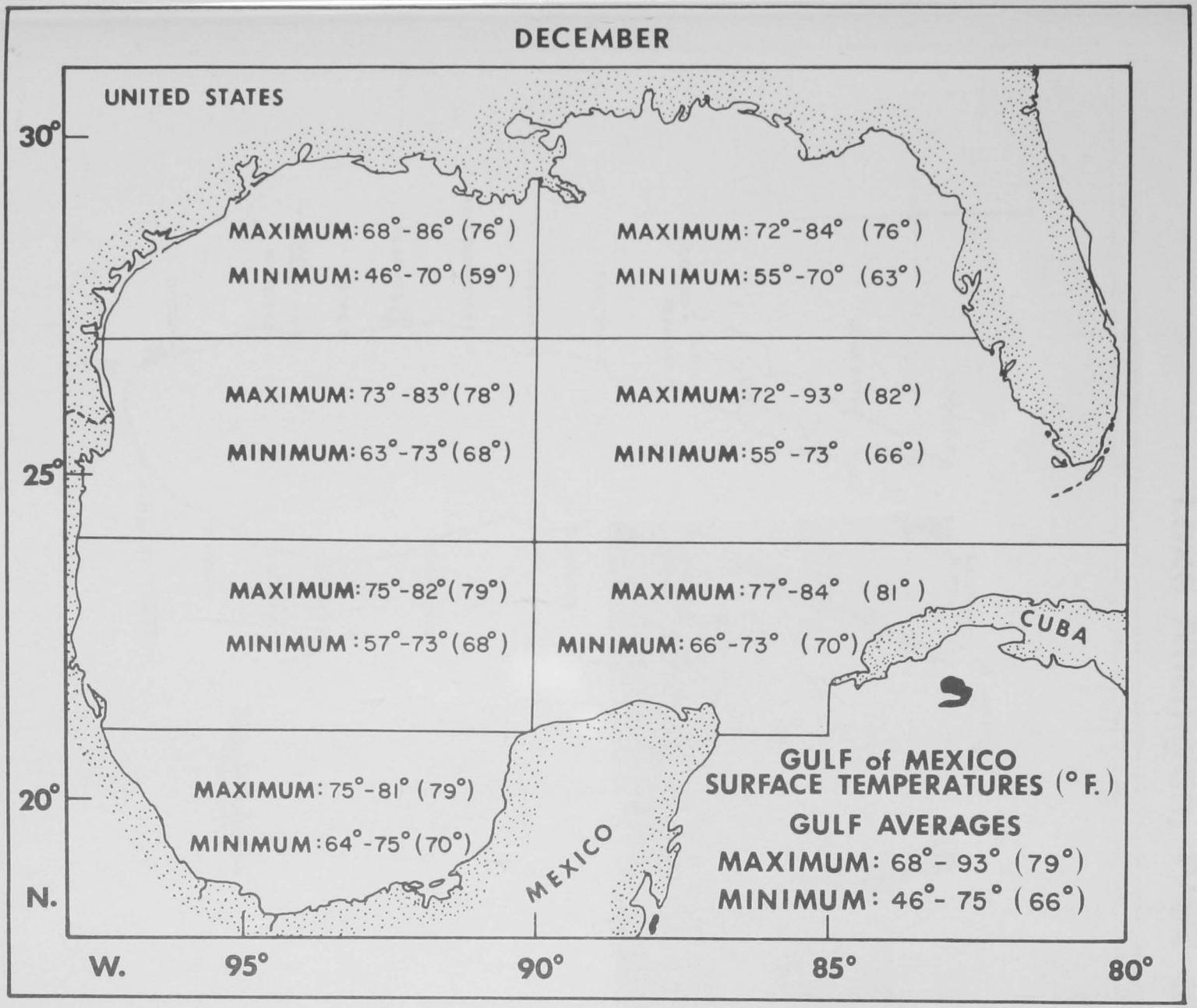

JULY
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 83°-90° (86°)
MINIMUM: 77°-83° (80°)
MAXIMUM: 83°-90° (86°)
MINIMUM: 77°-81° (79°)
MAXIMUM: 82°-86° (84°)
MINIMUM: 79°-83° (81°)
MAXIMUM: 83°-92° (86°)
MINIMUM: 75°-81° (80°)
MAXIMUM: 82°-86° (85°)
MINIMUM: 75°-81° (79°)
MAXIMUM: 82°-91° (86°)
MINIMUM: 75°-81° (78°)
CUBA
MAXIMUM: 81°-90° (84°)
MINIMUM: 77°-81° (79°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (°F.)
GULF AVERAGES
MAXIMUM: 81°-92° (85°)
MINIMUM: 75°-83° (79°)


AUGUST
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 83°-90° (86°)
MINIMUM: 72°-83° (79°)
MAXIMUM: 83°-88° (86°)
MINIMUM: 72°-84° (80°)
MAXIMUM: 83°-88° (85°)
MINIMUM: 72°-84° (80°)
MAXIMUM: 84°-88° (86°)
MINIMUM: 72°-83° (79°)
MAXIMUM: 84°-88° (86°)
MINIMUM: 75°-82° (80°)
MAXIMUM: 84°-88° (86°)
MINIMUM: 77°-82° (80°)
CUBA
MAXIMUM: 84°-88° (86°)
MINIMUM: 77°-82° (79°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 83°-90° (86°)
MINIMUM: 72°-84° (80°)


SEPTEMBER
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 83°-88° (86°)
MINIMUM: 70°-82° (78°)
MAXIMUM: 81°-88° (84°)
MINIMUM: 70°-81° (77°)
MAXIMUM: 83°-86° (85°)
MINIMUM: 74°-84° (80°)
MAXIMUM: 84°-90° (86°)
MINIMUM: 77°-81° (79°)
MAXIMUM: 84°-86° (85°)
MINIMUM: 77°-82° (80°)
MAXIMUM: 82°-88° (86°)
MINIMUM: 77°-82° (80°)
CUBA
MAXIMUM: 82°-88° (84°)
MINIMUM: 77°-81° (80°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 81°-90° (85°)
MINIMUM: 70°-84° (79°)


OCTOBER
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 79° -88° (85°)
MINIMUM: 64° - 79° (72°)
MAXIMUM: 81° - 86° (84°)
MINIMUM: 66° - 77° (73°)
MAXIMUM: 79° - 88° (83°)
MINIMUM: 74° - 82° (77°)
MAXIMUM: 83° - 93° (86°)
MINIMUM: 68° - 79° (75°)
MAXIMUM: 81° - 84° (83°)
MINIMUM: 75° - 81° (78°)
MAXIMUM: 82° - 88° (84°)
MINIMUM: 73° - 79° (77°)
CUBA
MAXIMUM: 81° - 86° (83°)
MINIMUM: 75° - 81° (77°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 79° - 93° (84°)
MINIMUM: 64° - 82° (76°)


NOVEMBER
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 75° - 84° (80°)
MINIMUM: 61° - 75° (67°)
MAXIMUM: 75° - 84° (80°)
MINIMUM: 59° - 75° (67°)
MAXIMUM: 75° - 84° (80°)
MINIMUM: 68° - 77° (73°)
MAXIMUM: 77° - 84° (82°)
MINIMUM: 63° - 75° (70°)
MAXIMUM: 79° - 86° (81°)
MINIMUM: 70° - 79° (74°)
MAXIMUM: 79° - 84° (82°)
MINIMUM: 72° - 75° (73°)
CUBA
MAXIMUM: 79° - 84° (82°)
MINIMUM: 70° - 79° (74°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 75° - 86° (81°)
MINIMUM: 59° - 79° (71°)


DECEMBER
UNITED STATES
30°
25°
20°
N.
W.
95°
90°
85°
80°
MAXIMUM: 68°-86° (76°)
MINIMUM: 46°-70° (59°)
MAXIMUM: 72°-84° (76°)
MINIMUM: 55°-70° (63°)
MAXIMUM: 73°-83° (78°)
MINIMUM: 63°-73° (68°)
MAXIMUM: 72°-93° (82°)
MINIMUM: 55°-73° (66°)
MAXIMUM: 75°-82° (79°)
MINIMUM: 57°-73° (68°)
MAXIMUM: 77°-84° (81°)
MINIMUM: 66°-73° (70°)
CUBA
MAXIMUM: 75°-81° (79°)
MINIMUM: 64°-75° (70°)
MEXICO
GULF of MEXICO
SURFACE TEMPERATURES (° F.)
GULF AVERAGES
MAXIMUM: 68°- 93° (79°)
MINIMUM: 46°- 75° (66°)

MS. #1702