THE WEATHER AND CIRCULATION OF MAY 1965

Severe Storms in Mid-Nation and Continued Drought in the Northeast

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1. INTRODUCTION

During May differential motion of high- and low-latitude wave trains caused the alternate amalgamation and shearing of troughs and ridges in the two bands. In the United States the existence of a mean upper trough in the West and a mean ridge in the East with strong southerly transport over mid portions of the Nation brought bountiful precipitation and a series of severe storms to that region. In the Northeast, however, the long-standing drought continued.

2. MEAN CIRCULATION

The relatively orderly mean circulation pattern of April 1965 (fig. 1 of [1]) evolved into a chaotic pattern during May (fig. 1) with high- and low-latitude troughs and ridges out of phase in several areas. One of the most pronounced circulation changes between months occurred in the Atlantic sector. Here the extremely high-index flow of April [1] gave way to a low-index situation during May (figs. 1 and 2) as blocking retrograded from Scandinavia to Greenland. Associated with this retrogression was the development of a deep Low near Novaya Zemlya with trough extending southwestward to join the extant trough over the Mediterranean. With the shift of blocking from Europe, heights rose to above normal from the Caspian Sea through Central Asia, and a deep trough was maintained along the Asiatic Coast.

Over the Pacific, the pronounced blocking situation of April was replaced by moderately high-index flow during May with well developed ridges in both western and eastern Pacific. A semblance of blocking remained, however, in the form of a ridge in northeastern Siberia surmounting a Low in the Sea of Okhotsk. May marked an end of the fairly regular retrogression of the mean blocking ridge which had moved from the western United States in January to the Bering Sea in April.

As the Pacific westerlies increased during May and the south-central Pacific trough built northward, April's west coast trough was propelled eastward to a May position extending from the Northern Plains to Baja California. Similarly, the continental ridge moved eastward to the East Coast States. The out-of-phase nature of the flow pattern over North America resulted in confluent flow and a well developed wind speed maximum over the Great Lakes Region (fig. 3).

The deep trough off the east coast, which this month was related to the blocking ridge over Greenland and the building ridge over eastern North America, has been a persistently recurring circulation feature and is discussed further in section 6.

3. TEMPERATURE

As the western trough moved inland during May, temperatures to its rear dropped below normal (fig. 4). Over the eastern half of the Nation a well-developed ridge over the Appalachians with enhanced southerly wind components to its west brought unseasonably warm weather to most sections. Monthly mean temperatures were the second or third highest of record at widely scattered locations and the highest of record at Muskegon, Mich. and Columbia, S.C. Over the western half of the Nation the insolation-depleting effect of cloudiness upon this springtime temperature regime can be seen in several instances. For example, relatively low temperatures prevailed in the Southern Plateau Region, an area of above normal precipitation. The occurrence of relatively large mean temperature departures is symptomatic of the rather stable circulation pattern which prevailed over the United States during the month.

In Alaska the coldest May of record was reported at Cold Bay, Bethel, and Juneau as a deep upper trough progressed to the Bering Straits area in response to the development of blocking over northeastern Siberia.

4. PRECIPITATION AND TORNADOES

Generally heavy precipitation amounts occurred along and adjacent to the axis of the deep upper trough in the West (fig. 5). This was an area of below normal heights (fig. 2) with enhanced southerly flow in eastern portions. This region of heavy precipitation was related to the series of cyclones which originated near eastern Colorado and proceeded northeastward through Minnesota along the mean frontal boundary implicit in the monthly mean

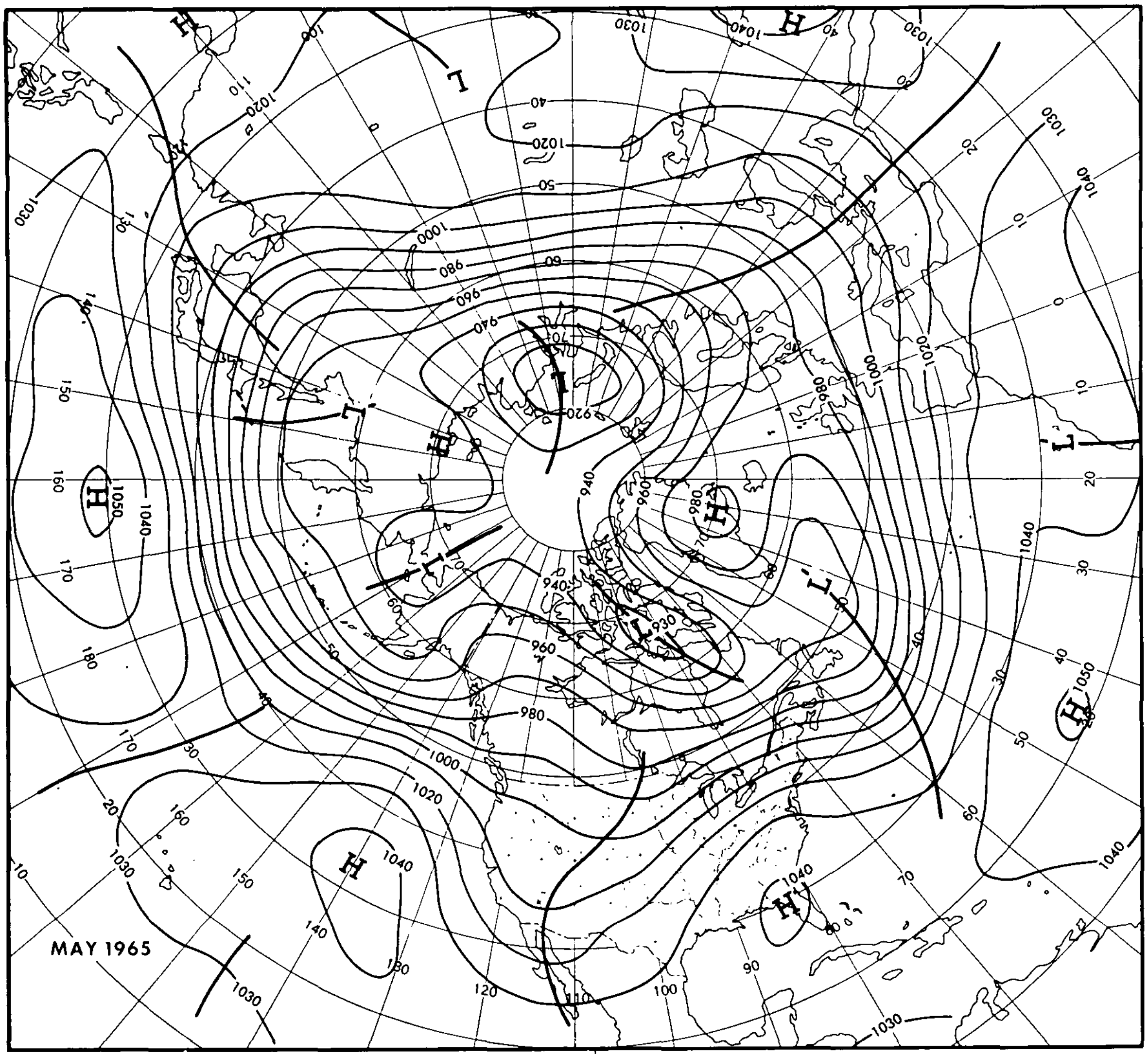

FIGURE 1.—Mean 700-mb. contours (tens of feet), May 1965. High- and low-latitude wave trains were out of phase in several areas.

temperature pattern (fig. 4) to the north of an axis of maximum wind speed aloft (fig. 3). Squall lines associated with these Lows accounted for many of the unusually large number of tornadoes which occurred at intervals during the month. The number of days with tornadoes during this month, together with the long-term May average, is given in figure 6. From this it is apparent that the most excessive tornado frequencies were in the heavy-precipitation regions of Texas and the North Central States.

For portions of the Central Plains the bountiful rainfall this month provided welcome relief from a long-standing drought. However, the drought continued unabated in eastern New Mexico, southeastern Colorado, and parts of the Texas and Oklahoma panhandles where little precipitation occurred. Reference to figure 1 suggests that this was a rain shadow effect resulting from the monthly mean flow being oriented about perpendicular to the mountains just west of the drought area.

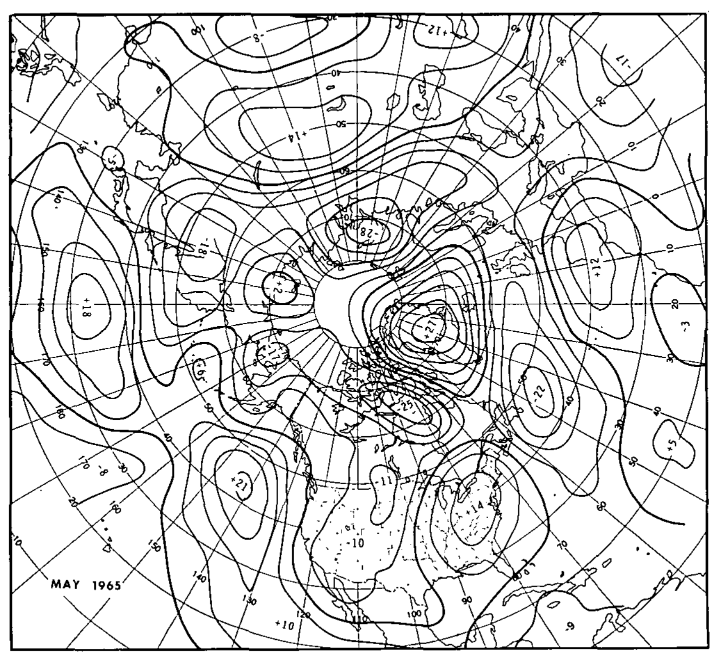

FIGURE 2.—Departure of mean 700-mb. heights from normal (tens of feet), May 1965. Central United States was the site of strongly anomalous southerly flow.

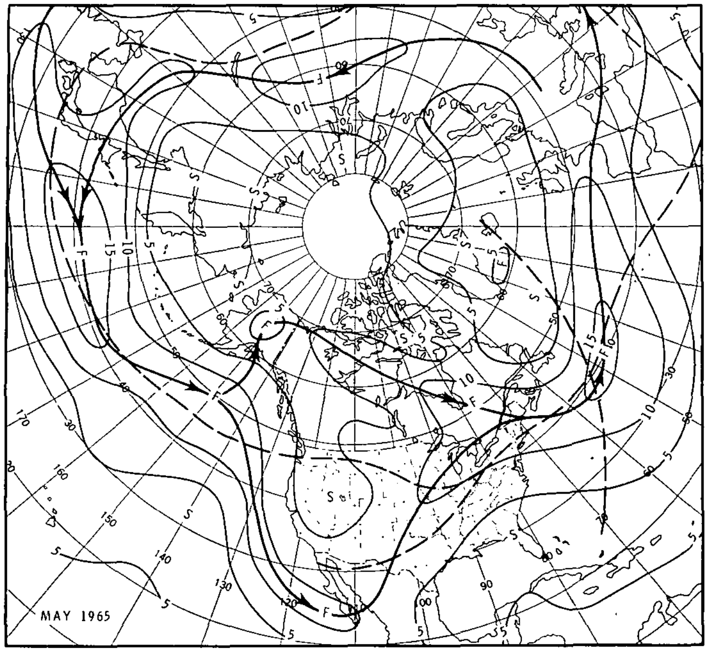

FIGURE 3.—Mean 700-mb. isotachs (meters per second), May 1965. Solid arrows indicate principal axes of maximum wind speed and dashed lines the normal. The southwesterly wind speed maximum traversing the central United States played a part in the generation of severe storms during the month.

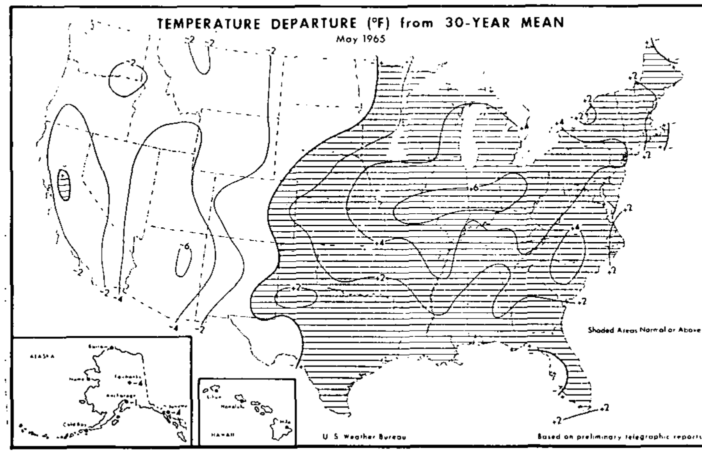

FIGURE 4.—Surface temperature departure from normal (°F.). May 1965 (from [2]).

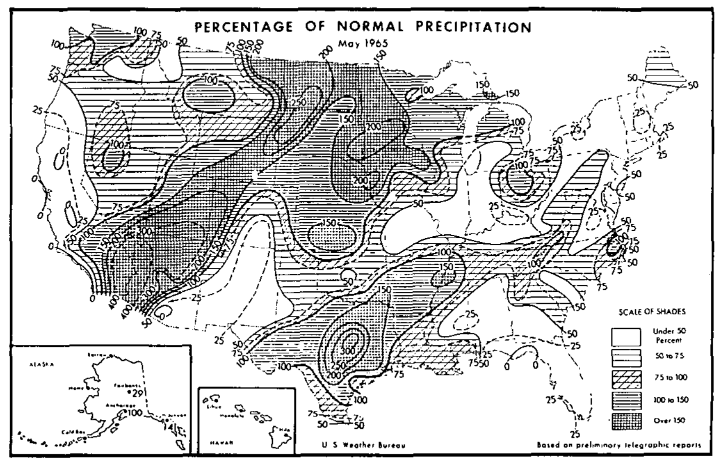

FIGURE 5.—Percentage of normal precipitation (in.), May 1965 (from [2]).

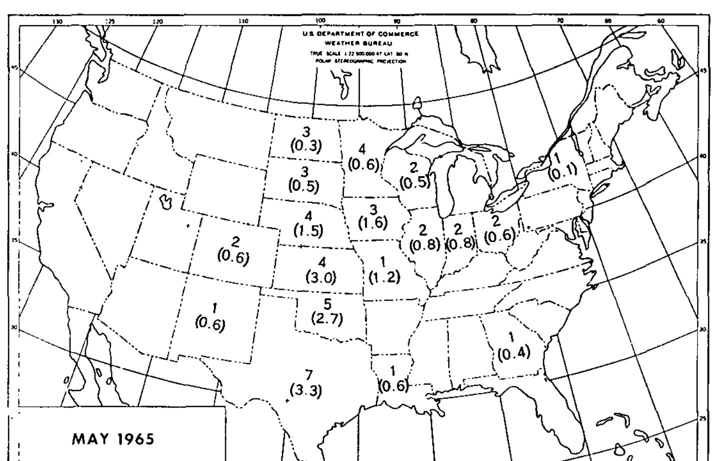

FIGURE 6.—Number of days with tornadoes, May 1965. Number in parenthesis is 1916–58 May average.

Another zone of heavy precipitation was centered over Texas, a region of cyclonic curvature and southerly anomalous flow aloft (figs. 1 and 2).

Generally light precipitation fell along the west coast to the rear of the mean upper-level trough, and also over the eastern quarter of the Nation under the influence of the strong ridge. Thus the drought in the Northeast continued and a new dry area had developed in the Southeast by month's end. The driest May of record was reported at Tallahassee, Jacksonville, and Miami, Fla., while Lakeland, Fla. had its second driest May. In northern portions of the dry area conditions were just as extreme with most locations reporting one of the driest Mays of record. For example, at Cleveland, Ohio this was the driest May of record and at Syracuse, N.Y. and Caribou, Maine it was the driest May in 135 years and 95 years, respectively.

5. VARIABILITY WITHIN THE MONTH

Weekly distributions of temperature and precipitation during the month, accompanied by appropriate 5-day mean 700-mb. maps, are shown in figures 7 through 10.

An outstanding characteristic of this series of mean maps is the tendency toward differential motion of the wave trains at high and low latitudes. At low latitudes circulation features moved rather sluggishly with mean troughs located near the Sea of Japan, the central Pacific, western United States, and the western Atlantic throughout most of the month. At higher latitudes, on the

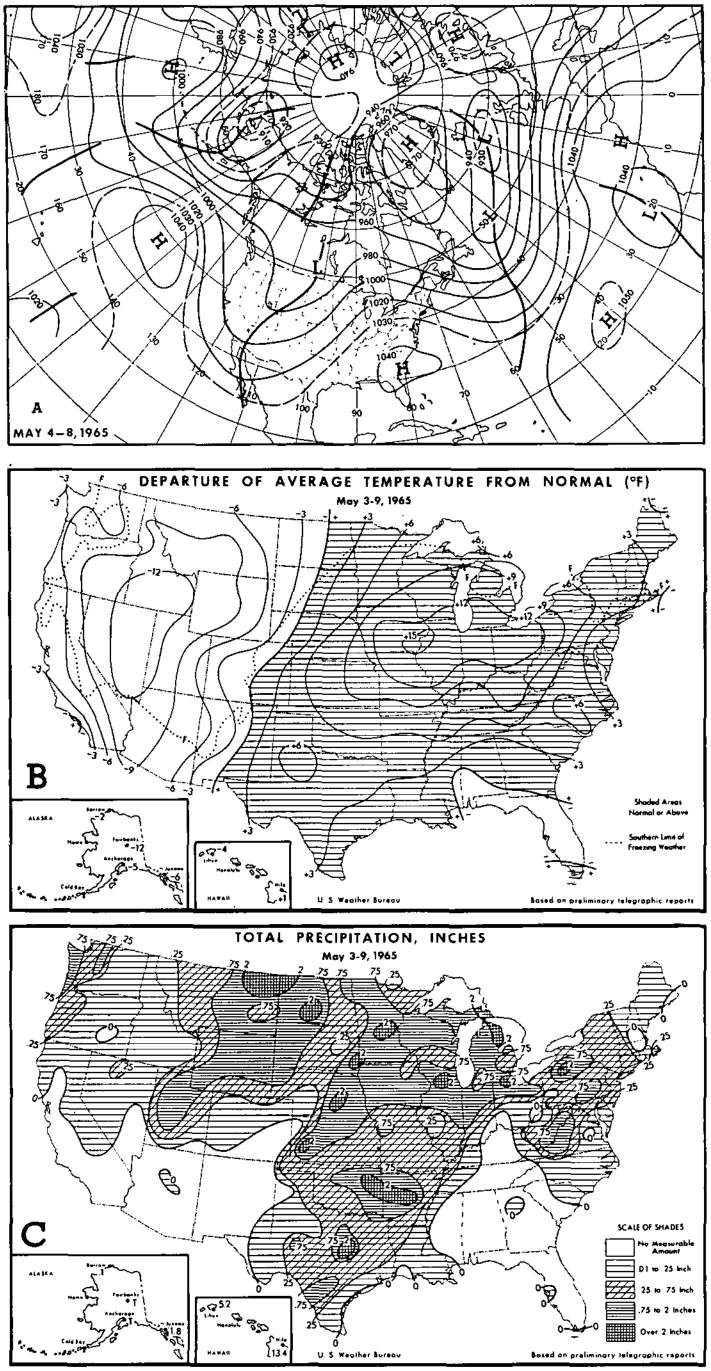

Figure 7.—Week of May 3–9, 1965: (A) 700-mb. contours (tens of feet), May 4–8; (B) surface temperature departure from normal (°F.); (C) total precipitation (in.). (B) and (C) from [2].

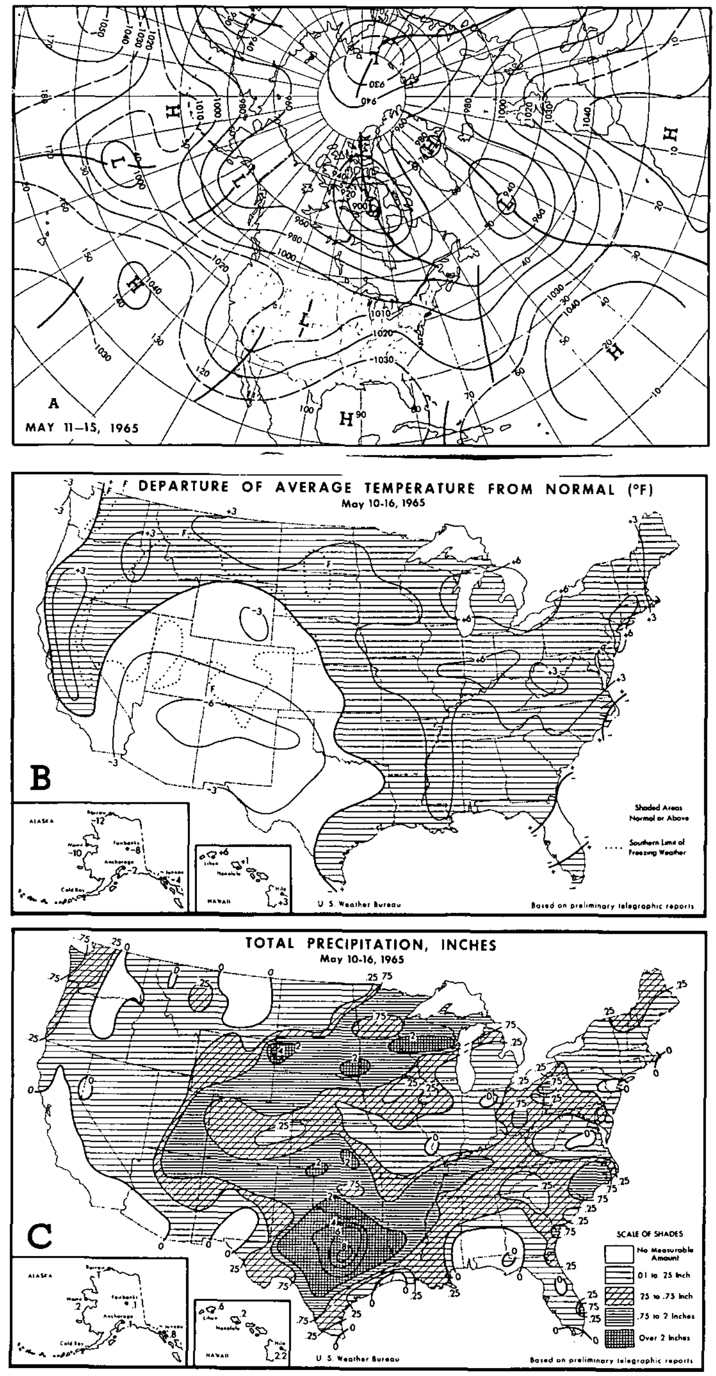

Figure 8.—Week of May 10–16, 1965: (A) 700-mb. contours (tens of feet), May 11–15; (B) and (C) same as figure 7.

other hand, with the exception of the Greenland block, well-defined progression can be noted throughout the month. This resulted in a pulsating mean circulation with trough and ridge amalgamations occurring when high-latitude features overtook their low-latitude counterparts and shearing resulting as they progressed eastward. In the opinion of forecasters at the Extended Forecast Division, differential motion of wave trains at high and low latitudes is a common phenomenon having its maximum frequency during the warm season when the upper westerlies have migrated northward. During this May, the 700-mb. westerlies (Western Hemisphere) were of subnormal strength between 25° N. and 37.5° N. while the westerlies between 37.5° N., and 57.5° N., exceeded normal. This appears to be at least a partial explanation of the observed differential motion.

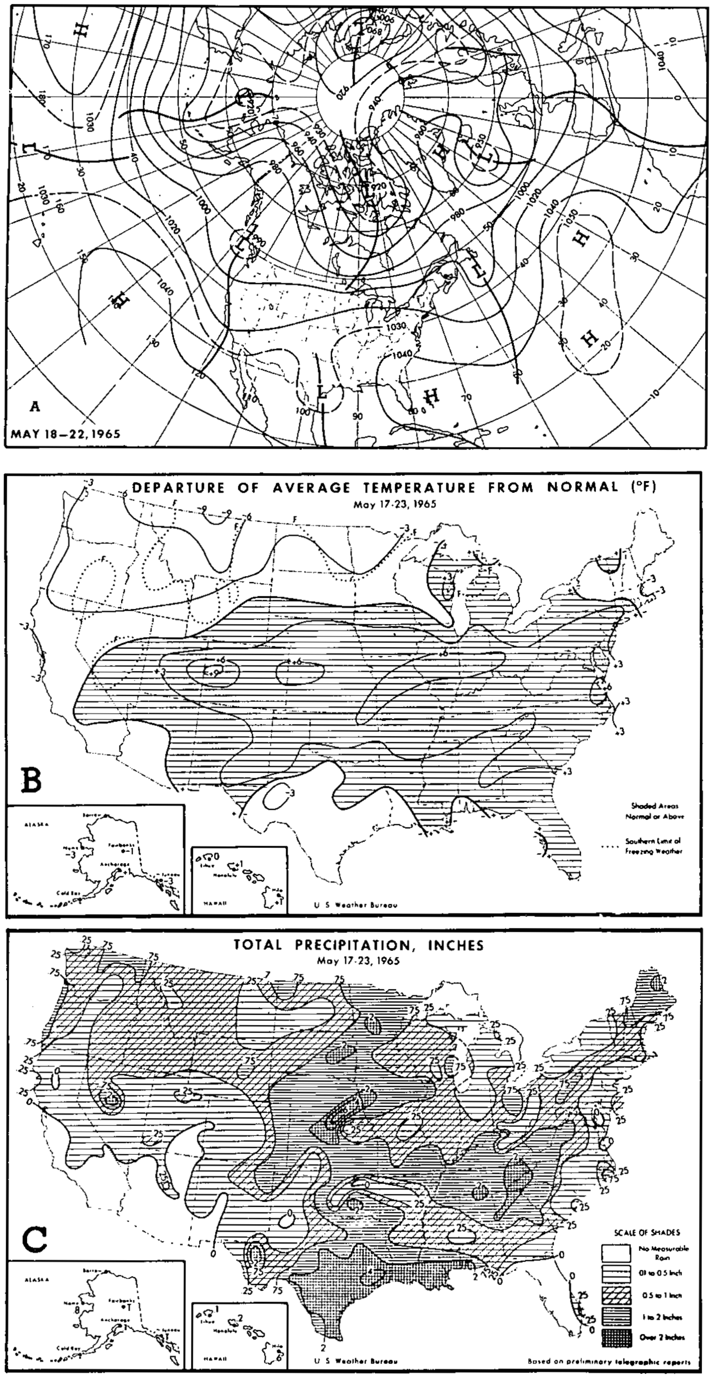

FIGURE 9.—Week of May 17–23, 1965: (A) 700-mb. contours (tens of feet), May 18–22; (B) and (C) same as figure 7.

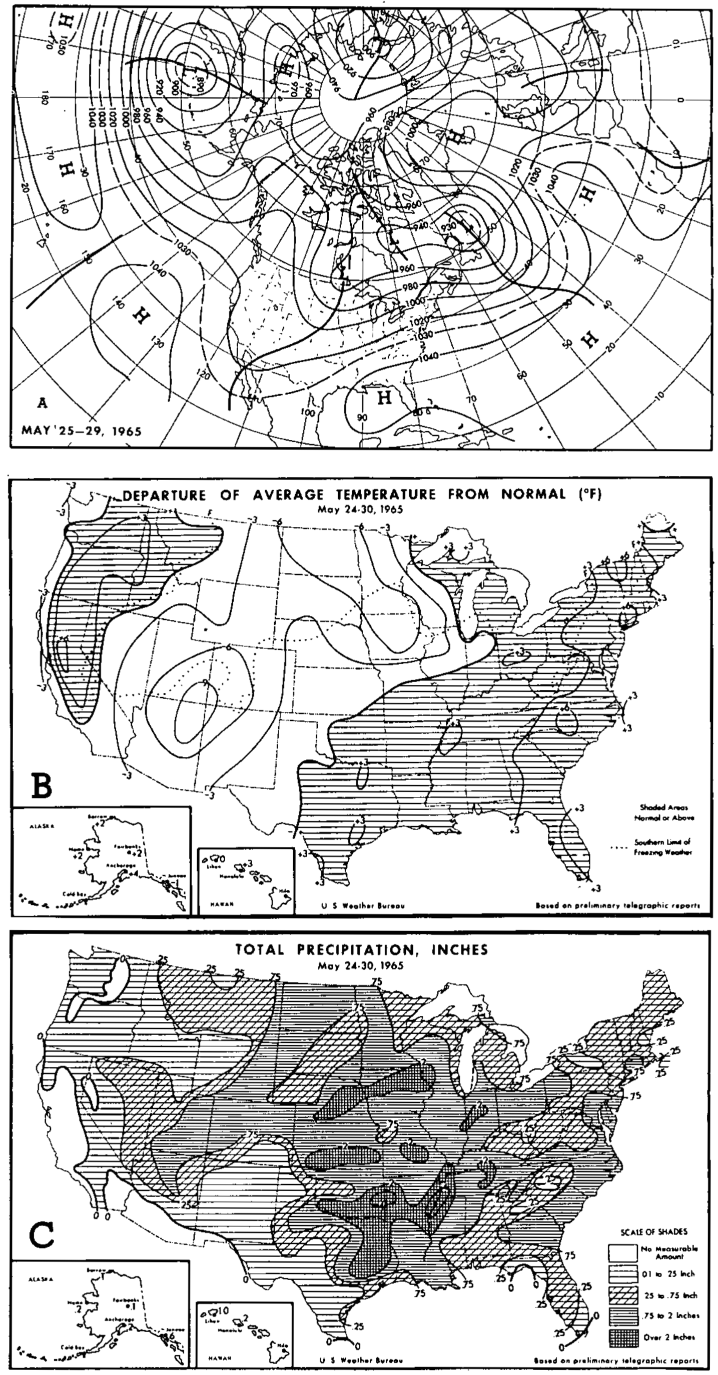

FIGURE 10.—Week of May 24–30, 1965: (A) 700-mb. contours (tens of feet), May 25–29; (B) and (C) same as figure 7.

In the United States, the relative permanence of the eastern ridge was associated with warm conditions throughout the month, as seen by figures 7 through 10. The western cold was less persistent, being replaced by spurts of warm air as progressing upper ridges traversed the area during the second and fourth weeks. The Southwest experienced one warm week (May 17–23) when the mean trough temporarily retrograded to the west coast (fig. 9) and ridge conditions prevailed over the area. During the first week in the month when the western trough was at its greatest strength, record low temperatures for May were observed at Salem, Oreg., Boise, Idaho, Elko, Nev., Salt Lake City, Utah, and Wendover, Utah on May 6; and at Fresno, Calif. on May 7. Lowest temperatures for so late in the spring were also reported from Flagstaff and Phoenix, Ariz. on May 8, and El Paso, Tex. on May 9. During the final week of the month the lowest temperatures for so late in the spring were observed at Albuquerque, N. Mex. on May 26, while at Missoula, Mont., the lowest temperature for so late in the spring was equaled on May 31. These occurred in conjunction with the vigorous western mean trough shown in figure 10.

In view of the relatively persistent nature of the eastern ridge and southern portions of the western trough (figs. 7–10) it is not surprising that the overall precipitation distribution underwent only small changes from week to week. The heavy precipitation over most of the middle portion of the Nation during each week of the period attests to the persistent enhanced southerly flow importing a continuing supply of moist Gulf air. This is especially noteworthy in Texas where heavy rains brought flooding to central portions during the week of May 10–16, and along the coastal plain during the following week. The mechanism for tapping the plentiful moisture supply was a shearing trough during the May 10–16 period and a cut-off Low in southern Texas during the later period.

Precipitation in the eastern quarter of the Nation was quite light, in keeping with the persistent ridge in that area. During the week of May 17–23 (fig. 9), however, some moisture and cyclonic vorticity from the mean trough fragment over southern Texas found its way into parts of the Southeast bringing the heaviest rains of the month to that region.

Tornado activity was scattered throughout the month with the first flurry occurring on May 4, 5, and 6 in advance of a strongly tilted mean trough (fig. 7). Although tornadoes occurred from Texas to the northern border, the greatest concentration was in eastern portions of the Northern Plains and in the northern Mississippi Valley. The next series of tornadoes occurred from May 15 through May 20, a period of shearing and fragmented troughs (figs. 8, 9). These tornadoes, too, were scattered throughout most of the area indicated on figure 6, and were most extensive on May 15 when preliminary reports list seven States as affected. This period accounted for the isolated tornadoes in New York and Georgia. The third group of tornadoes was observed from May 22 through 26 with greatest activity on May 23, 24, and 26 in advance of the progressing western trough shown on figures 9 and 10. The earlier storms of this sequence were mostly in eastern portions of the Northern and Central Plains while those on May 26 occurred primarily in a zone from Kansas through Ohio. The final tornado situation of the month was relatively minor with available reports placing a single tornado in New Mexico on May 31.

There were no tropical storms during the month in the Atlantic, but in the Pacific two typhoons were reported late in the month. Typhoon Amy formed on May 21 to the east of the Philippines south of the stronger-than-normal western Pacific upper-level anticyclone (fig. 9), and moved northeastward passing east of Japan on May 27. Typhoon Babe formed in the South China Sea on May 29 and milled about on a poorly-defined path through June 4. A violent cyclone, first observed in the Bay of Bengal on May 11, moved northward into East Pakistan causing extensive damage. Preliminary reports indicate that over 12,000 persons lost their lives as a result of this storm.

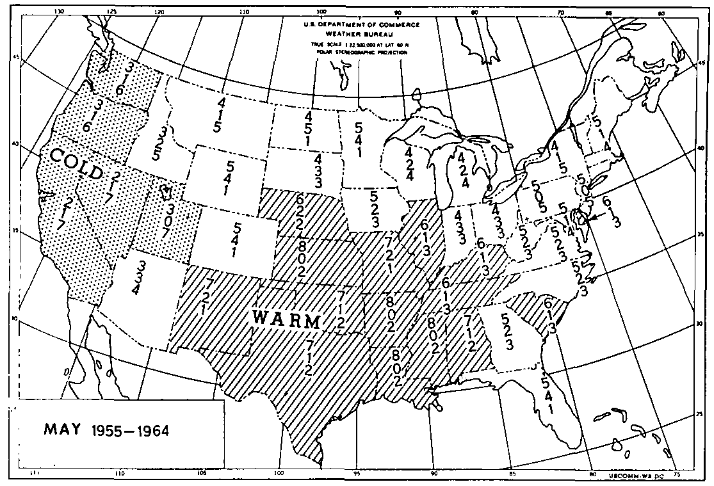

FIGURE 11.—Frequency of May temperature classes, 1955–65. Top numeral refers to above normal classes; middle, to near normal class; and bottom, to below normal classes. See text for definition of temperature classes.

6. MAY'S CIRCULATION AND WEATHER RELATED TO RECENT CLIMATIC TRENDS

The distribution of monthly mean temperature classes (by States except for New England) in May during the past 10 yr., as determined visually from Extended Forecast Division temperature analyses, is shown in figure 11. Here the top numeral in each area indicates the number of Mays having temperatures in the above and much above normal classes; the middle numeral, the frequency of Mays with near normal temperatures; and the bottom numeral, the frequency of Mays with below and much below normal temperatures. These temperature classes are defined to provide a climatological expectancy of 12.5 percent in each of the two extreme classes (much above and much below) and 25 percent in the remaining three classes. Departures from normal during the period were based upon the prevalent 30-yr. normal. The map has been shaded to indicate areas where either the warm or cold categories have occurred in 6 or more of the last 10 yr.

Comparison of the 10-yr. distribution of classes (fig. 11) with the temperature departures of May 1965 (fig. 4) reveals that over a sizable portion of the United States temperature departures of this May were similar to those favored during the past 10 yr. (The thresholds of above and below normal classes on figure 4 are approximately plus and minus 1°, respectively.) Thus low temperatures

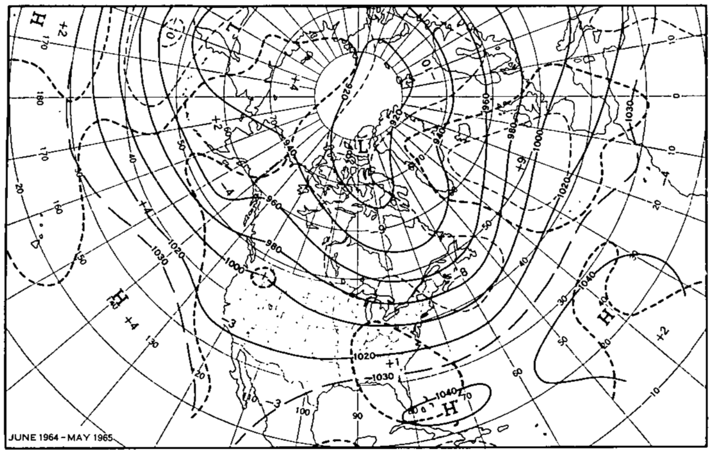

FIGURE 12.—Yearly mean 700-mb. height and departure from normal (both in tens of feet) for June 1964–May 1965.

in the West and high temperatures in much of the central portion of the Nation appear to be a part of a recent climatic trend. In this vein, it is also of interest to note that four of the preceding ten Mays (1955, 1959, 1962, and 1964) displayed a distribution of major circulation anomalies quite similar to that of figure 2. This similarity has been so pronounced, in fact, that the 1955–64 mean May 700-mb. height (not shown) departs from the 17-yr. mean May height (1947–63) decidedly in this direction, displaying a deeper-than-normal trough near the west coast and an amplified ridge near the east coast. Thus, this May's temperature distribution in the United States continues the preference for similar patterns in recent Mays and proceeds hand-in-hand with a preferred mode of circulation.

As might be expected, precipitation during the past 10 Mays has not displayed such marked trends as the temperature. However, in the East, where the upper-level ridge has been stronger than normal, relatively dry conditions have prevailed in Maryland, Delaware, New Jersey, and southern New England during 6 or 7 of the past 10 Mays. Precipitation during this May was notably in accord with the 10-yr. preference in this northeastern coastal region where drought conditions prevailed during the month. Elsewhere, May during the past 10 yr. has shown little partiality for wet or dry conditions except in Oregon, in the vicinity of the deeper-than-normal coastal trough, where precipitation has been above normal in 7 of the 10 Mays. This tendency was not continued during May 1965.

During the past year (through May 1965) seasonal precipitation in much of the Northeast has been subnormal in each season except winter. Some examples of the accumulating dryness are the annual precipitation deficiencies at Caribou, Maine, Albany, N.Y., and Allentown, Pa., which were 17.6, 15.7, and 14.0 in., respectively. The annual mean circulation anomaly at the 700-mb. level associated with this drought situation is shown in figure 12. Reference to this figure makes it quite clear that the northeastern precipitation deficiency has resulted from the persistent recurrence of a deeper-than-normal upper trough off the east coast bringing northwesterly anomalous flow across the drought area. Such a flow is both from the relatively dry continent and of such a nature as to favor subsidence. Also implied in the circulation anomaly of figure 12 is the seaward displacement of the east coast storm track to a position well off the coast. It is notable that the circulation in the vicinity of the United States during this May (figs. 1, 2) has much in common with the mean of the past year. Both the trough off the east coast and that in the West are stronger than normal as is the upper ridge near the east coast, in concert with the annual mean. Thus the drought-inducing circulation anomalies prevalent during the past year were strongly operative during this May.

REFERENCES

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2. U.S. Weather Bureau, *Weekly Weather and Crop Bulletin, National Summary*, vol. 52, Nos. 19–23, May 10, 17, 24, 31, June 7, 1965.

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