THE PROLONGED RAIN PERIOD OVER THE ATLANTIC COASTAL STATES, APRIL 23–29, 1952

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INTRODUCTION

On April 23, 1952, a continental Polar air mass moved eastward and southeastward across the Great Lakes region toward the mid-Atlantic and New England States. The associated cold front, which had been moving eastward with a nearly north-south alignment until this date, accelerated markedly north of the United States-Canadian border and to a lesser extent in portions of Oklahoma and Texas. As a result of the different rates of progression, the cold front was distorted into the form of a wave over Missouri. This wave structure moved slowly eastward and southeastward during the following three days bringing rain to the eastern United States. After the 3d day, a new low center developed over Georgia, within the major trough which had been a part of the weather sequence since the 23d. A new rain area moved northeastward along the Atlantic coast to Virginia and then moved eastward in association with the slow moving wave.

Just what this weather sequence meant to the public is illustrated by the rainfall records from the Washington, D. C., City Office. On April 23, a shower at 3:00 p. m. (EST) marked the start of 137 hours of almost continuous rainfall. Within this period there were 133 hours during which rain was reported during some part, or all, of each hour, and of these, 114 were consecutive hours from 7:00 p. m., April 23 to 1:00 p. m., April 28. The total rainfall recorded at the City Office during the 137 hours amounted to 5.28 in. The rainfall finally ended over the eastern States on the 29th.

SURFACE FRONTAL ACTIVITY AND THE 700-MB. FLOW

The synoptic weather conditions 24 hours before the arrival of the Polar front over the mid-Atlantic States are represented by figure 1. The important features of this map are the retardation of the front over eastern Kansas and the indirect evidence, suggested by its orientation,

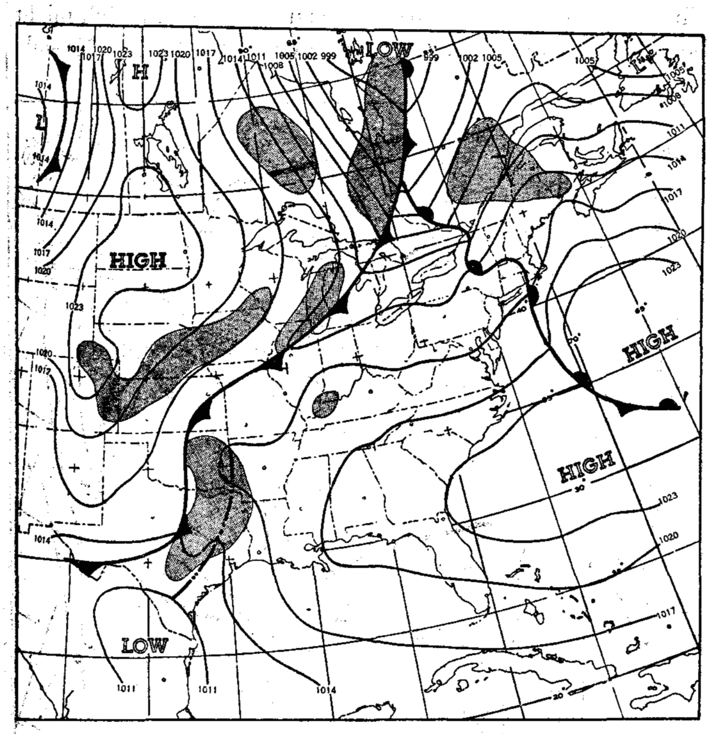

Figure 1.—Surface chart 1830 GMT, April 22, 1952. Shading indicates areas of active precipitation.

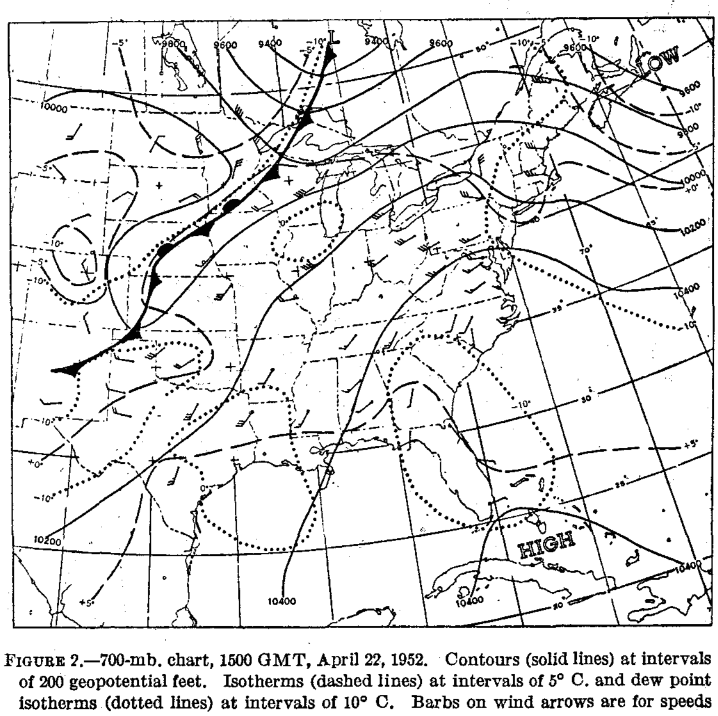

Figure 2.—700-mb. chart, 1500 GMT, April 22, 1952. Contours (solid lines) at intervals of 200 geopotential feet. Isotherms (dashed lines) at intervals of 5° C. and dew point isotherms (dotted lines) at intervals of 10° C. Barbs on wind arrows are for speeds in knots (pennant=50 knots, full barb=10 knots).

that the northern end of the cold front was moving eastward more rapidly than the remaining portion in the United States. The development of rain areas and the retardation of the front presaged slow moving weather conditions.

The surface rain areas of figure 1 were beneath the area of moist air aloft which occupied the East Texas-Oklahoma-Arkansas region and the region between the surface cold front and the 700-mb. front (fig. 2), from Oklahoma northeastward toward James Bay, Canada. A comparison of figures 1 and 2 shows the 700-mb. winds in the moist air were parallel to the surface front. This is generally regarded as favorable for the production of precipitation. Moreover, these two charts studied together give valuable information with respect to the probable 24-hour progress of the surface front. In the 700-mb. air flow above and to the west of the surface cold front there were two strong westerly currents, one generally north of the United States-Canadian border, a second over the southern portion of the cold front (Texas Panhandle). Between these two streams the winds over the Plains States were relatively weak.

As a qualitative estimate the northwest winds over southern Canada were blowing at about twice the speed of the west winds of the southern zone. The west wind component of the northern stream was about 28 knots, of the southern stream about 15 knots. No definite statement can be made about the wind components along the section of the upper cold front from southwest Kansas northeastward to Minnesota, although, it would appear that a small eastward component had existed. These estimates were indicative of the frontal movement during the next 24 hours.

The 1830 GMT map for April 23 (fig. 3) showed that the indicated changes in the frontal position had occurred. Surface data alone suggested that the cold front would continue to move eastward along the northern border but would continue to hold back in the middle of the country. The weather prospects for the eastern States, which might be inferred from this, were given credence by the 700-mb.

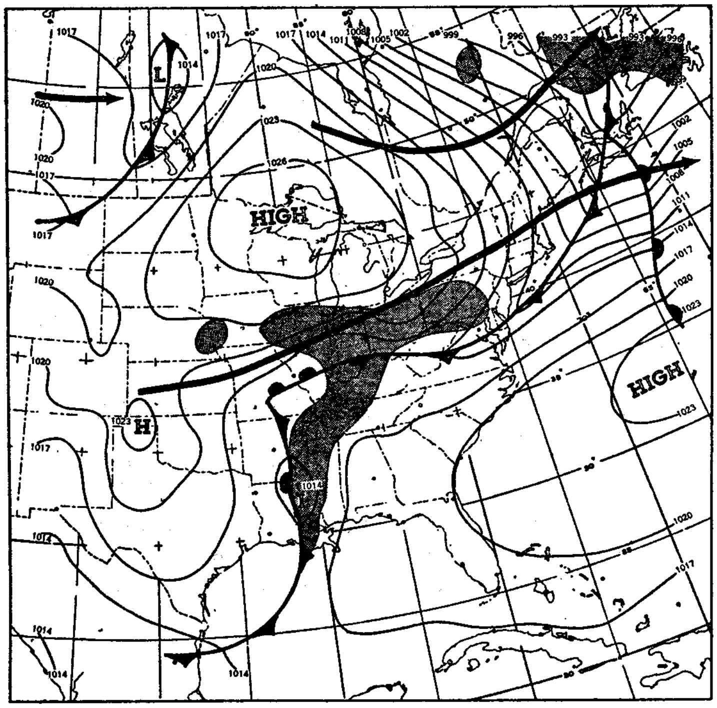

Figure 3.—Surface chart, 1830 GMT, April 23, 1952. Heavy, black arrows indicate superposition of the 300-mb. jet stream axis upon the surface chart.

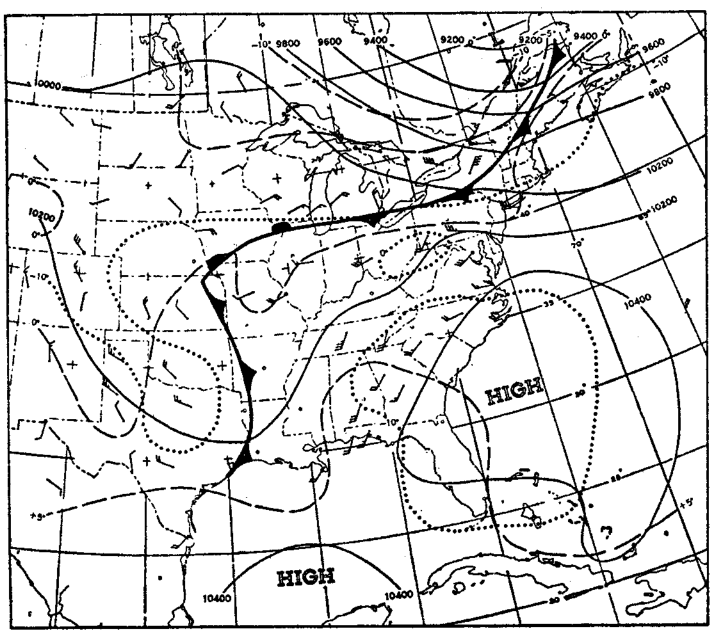

Figure 4.—700-mb. chart, 1500 GMT, April 23, 1952.

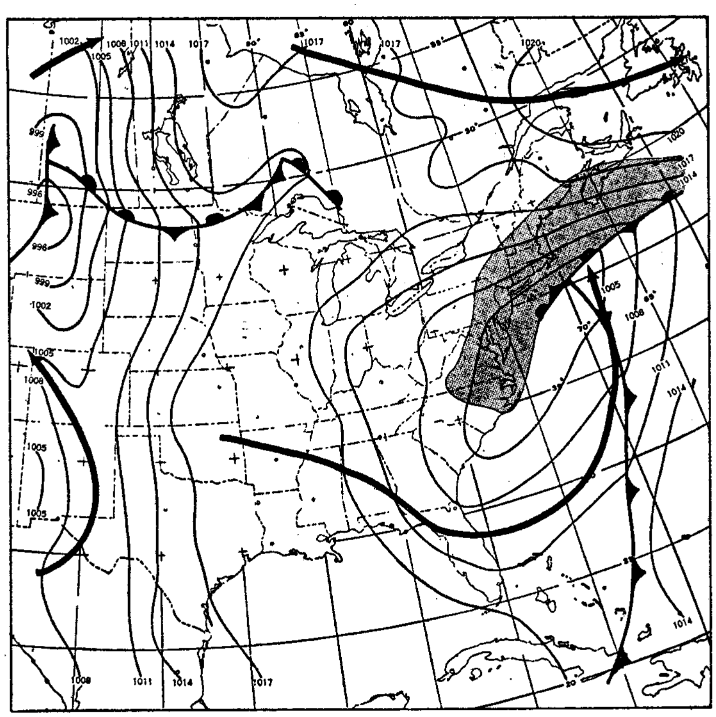

Figure 5.—Surface chart 1830 GMT, April 28, 1952. Heavy, black arrows indicate superposition of the 300-mb. jet stream axis upon the surface chart.

flow at 1500 GMT on the 23d (fig. 4). The flow indicated rapid eastward motion for the section of the cold front extending north of the southern border of New York State, slow eastward movement for the southernmost segment of the cold front, and, in comparison to the previous day, a slightly more rapid movement for the wave. This was the sequence of events during the rain period.

A wave that was at Augusta, Ga., at 1830 GMT on the 26th moved to Norfolk, Va., and deepened 5 mb. in the following 24 hours (fig. 5). In the 24 hours after this map, rain fell along the coastal plain from Maine to South Carolina, although no station in this area reported a 24-hour total as large as 1 in. The area of rain totals exceeding ½ in. included Massachusetts, portions of New Hampshire, Vermont, and the southwestern tip of Maine. On previous days totals of over ½ in. covered many States as, for example, in the 24-hour period ending April 26 (fig. 6).

Figure 7, which shows the essential features of the 700-mb. flow at 1500 GMT on April 28, the last day of widespread rainfall, provides a clue as to the manner in which the moisture supply reached the rain area. During the first half of the rain spell, on the east side of the 700-mb. trough (fig. 4), moist air moved northward in the Mississippi Valley region as a returning anticyclonic flow which spread fanwise over the Lakes region and the northern half of the Atlantic coast area. As the upper trough moved slowly eastward and developed more cyclonic characteristics (fig. 7), the Atlantic coast region came under the

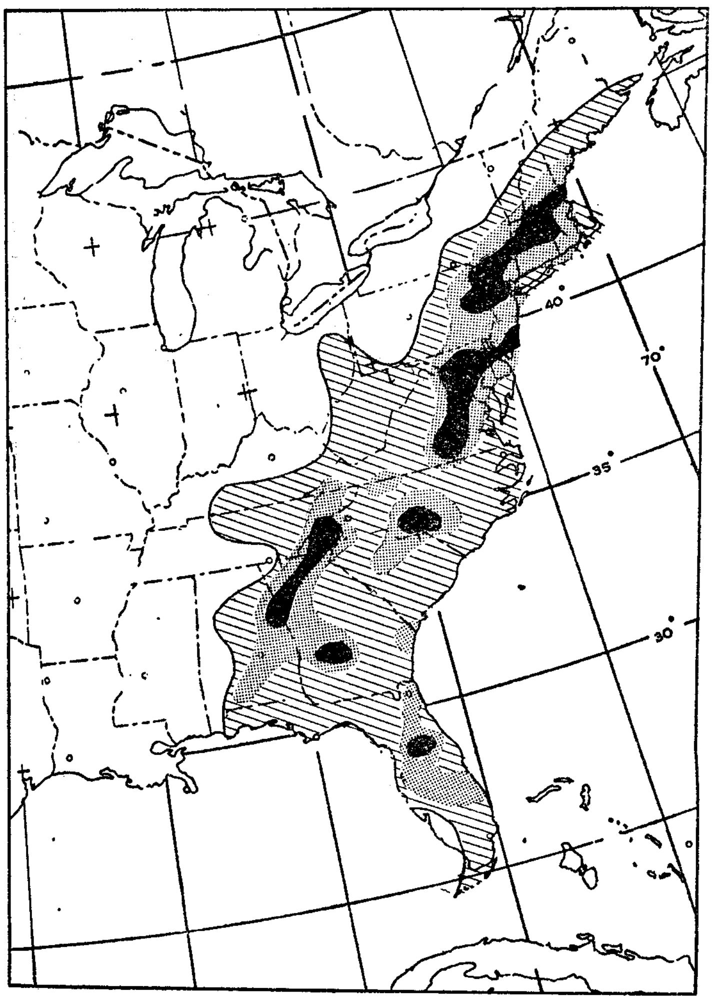

FIGURE 6.—Precipitation chart for 24 hours ending 1230 GMT, April 26, 1952. Slant line indicates Trace to 0.5 in., stipple indicates 0.5 in. to 1 in., and black indicates 1 in. or more.

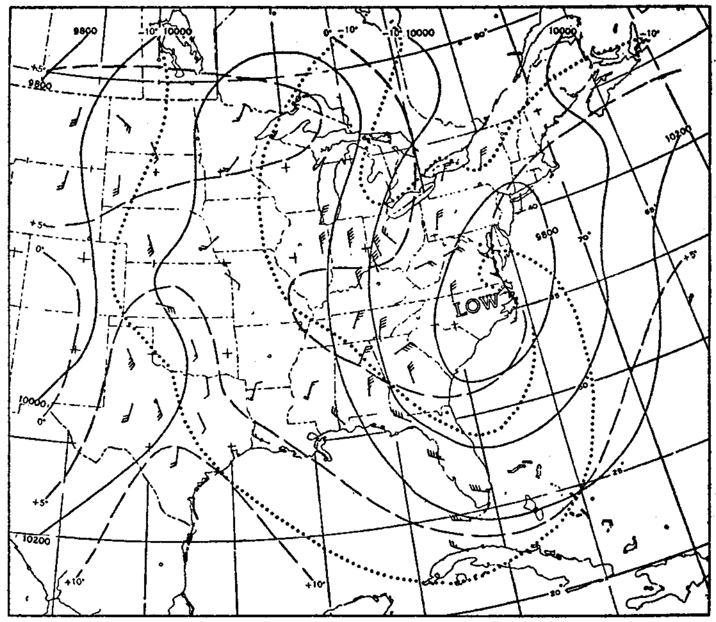

FIGURE 7.—700-mb. chart, 1500 GMT, April 28, 1952.

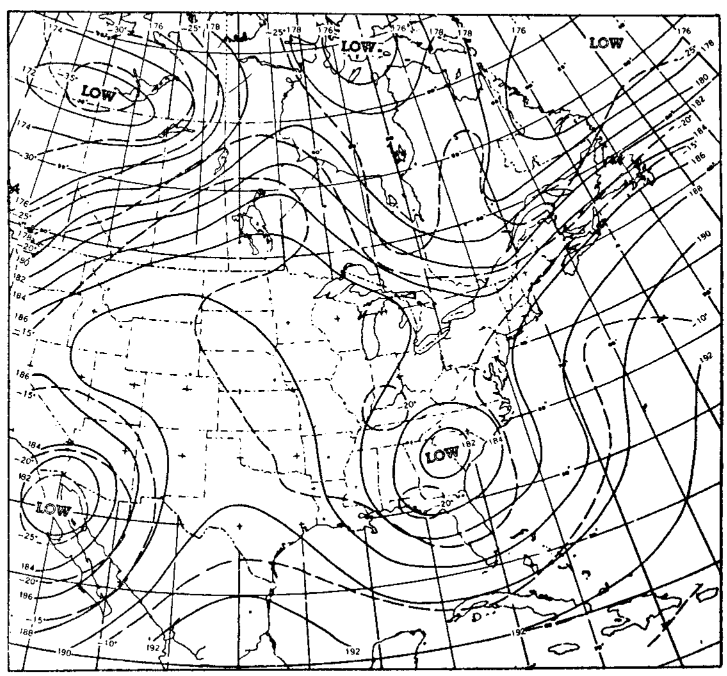

FIGURE 8.—500-mb. chart, 1500 GMT, April 27, 1952. Contours (solid lines) at intervals of 200 geopotential feet. Isotherms (dotted lines) at intervals of 5° C. Barbs on wind arrows are for speeds in knots (pennant=50 knots, full barb=10 knots).

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influence of the circulation of the upper level Low. Easterly winds on the north side of the Low and southerly winds along the coast brought moist air inland from the South Atlantic coastal waters. It can be seen from figure 5 that these winds were moving upslope over cold east-to-northeast surface winds.

By 1500 GMT on the 29th the 700-mb. Low had moved to the Delaware Capes before changing course to an eastward drift. This permitted the dry air from the north-to-northeast to move into the Atlantic coastal regions north of Virginia and to replace the band of moist southerly winds which had moved eastward as part of the upper low system.

MIDDLE TROPOSPHERIC CIRCULATION

From the preceding paragraphs it seems clear that the circulation over the United States must have slowed down from its normal rate. Figure 8 illustrates that this was so. Here the main feature of the 500-mb. circulation on April 27 at 1500 GMT, which is typical of the middle tropospheric air flow during the rain period, is that almost the entire United States was between two streams of strong westerly winds. The air between these two streams tended to follow a winding path between the cyclonic and anticyclonic eddies, over the United States, moving farther in a north-to-south, or south-to-north direction than in a west-to-east direction.

Figure 8 together with figures 1, 3, and 5 fits a situation described by Rossby and Willett [1] as the "lowest sea level index pattern", characterized by:

> "(a) complete breakup of the sea-level zonal westerlies in the low latitudes into closed cellular centers with corresponding breakdown of the wave pattern aloft;
>
> (b) maximum dynamic anticyclogenesis and deep occlusion of stationary cyclones in middle latitudes, and north-south orientation of pressure cells and frontal systems;
>
> (c) maximum east-west rather than north-south air mass temperature contrasts; and
>
> (d) development of strong troughs and ridges in the circumpolar vortex and jet stream, with cutting off of warm Highs in the higher latitudes and cold cyclones in the lower latitudes."

The surface precipitation areas were east and northeast of the 500-mb. Low (fig. 8) centered over South Carolina. This spatial distribution of precipitation with respect to the upper Low was about the same throughout the rain period. Miller [2, 3] and Fleagle [4] in a study of vertical motions in upper troughs and associated surface cyclones found there is usually descending motion on the west side of an upper trough and ascending motion on the east side. Further, they say low level divergence and upper level convergence on the west side contrast with low level convergence and upper level divergence on the east side of the upper trough. So, in this case, the vertical motions described seem to account for the rainfall pattern along the eastern coastal sections and the contrasting lack of precipitation over the central portion of the United States.

REFERENCES

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2. J. E. Miller, "A Study of Vertical Motions in the Atmosphere", Mimeographed paper, New York University, 1946.
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