WEATHER AND CIRCULATION OF AUGUST 1980
Eastward Spread of Heat Wave and Drought

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1. Mean circulation

The remains of blocking that had been over the Arctic Ocean (Livezey, 1980) retrograded and moved into northeastern Siberia, joining and further strengthening the strong ridge in that area. An unusually deep mean low developed over the Polar Basin in the course of August, moving from the European side of the Pole to the Alaskan side. The monthly mean anomaly centers associated with these two systems were close to three standard deviations (1948–70 data) from the mean (Figs. 1 and 2).

At midlatitudes from eastern Asia to the central Atlantic, the flow pattern was somewhat more amplified, and the westerlies were a little weaker than had been the case during July. The strong ridge over the eastern Pacific maintained its strength and moved northward along the 150°W meridian, resulting in an even stronger positive anomaly located farther north than in July. Retrogression of the blocking ridge that had been in northwest Canada to

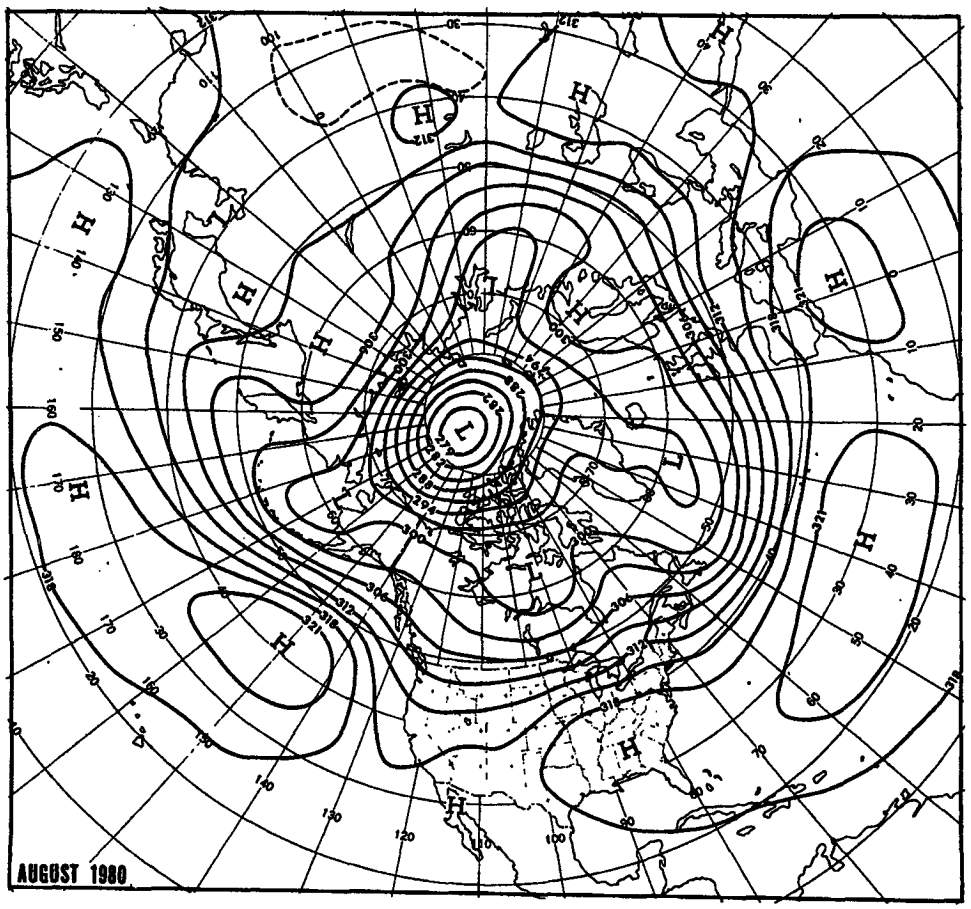


FIG. 1. Mean 700 mb height contours (dam) for August 1980.

join with the eastern Pacific ridge allowed 700 mb heights to fall considerably over southwestern Canada and the northwestern United States, weakening and displacing eastward the 700 mb high center and its anomaly associated with the heat wave. The deepening trough in south-central Canada contributed to amplification of a ridge over northeast Canada and a trough over the northwest Atlantic. The anomaly centers associated with these features were all approximately two and one-half standard deviations from the mean.

The positive anomaly center associated with the Canadian ridge can be viewed as a retrogression, in a monthly mean sense, of a portion of the blocking that had been in Scandinavia during July. A blocking ridge was still over Scandinavia in August, although it was weaker and somewhat farther north than it had been earlier in the summer. Progression of the mean trough to the west-central Atlantic allowed the westerlies to move northward to close to their normal position during August over western Europe (Fig. 3), reducing but not entirely eliminating the abnormally cold and wet weather of the early part of the summer.

The westerlies were still well south of normal over eastern Europe and western Russia in response to the Scandinavian blocking ridge. The strong ridge over eastern Siberia completely eliminated the normal wind maximum across eastern Asia, but wind maxima were in evidence associated with zones of enhanced baroclinicity over the Arctic Ocean and across southern Japan well south of the normal position (Figs. 3 and 4). The wind maximum connected with the Arctic low was 11 m s^{-1} stronger than normal, and the magnitudes of the wind speed maxima across the Pacific and from the central Atlantic to eastern Europe were from 3 to 6 m s^{-1} above normal.

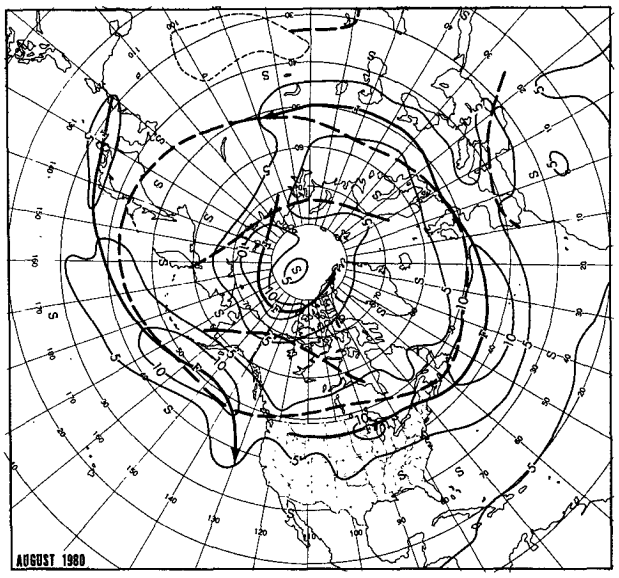


FIG. 3. Mean 700 mb geostrophic wind speed (m s^{-1}) for August 1980. Solid arrows indicate observed axes of maximum wind speed and dashed lines, the normal.

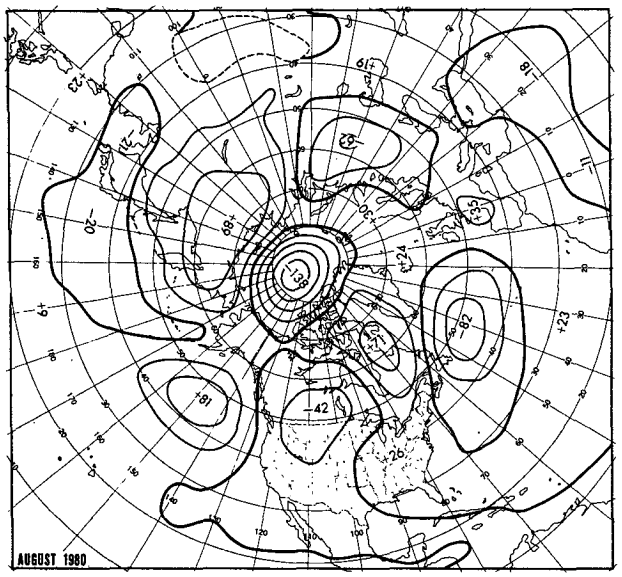


FIG. 2. Departure from normal of mean 700 mb height (m) for August 1980.

2. Temperature

The basic temperature anomaly pattern changed little over the United States between July and August, except for an expansion of the colder than normal area from the Northwest eastward over the northern Great Plains and a noticeable eastward and northward extension of the heat wave (Fig. 5). For the second consecutive month, a large number of cities reported record or near-record monthly mean temperatures (Table 1). It is interesting to note that at many localities the all-time record hot Augusts were in 1954, 1947, and various years in the 1930's. The first of these listed, 1954, was a year in which the location, magnitude, inception and duration of the heat wave were quite similar to the current situation (Livezey, 1980; Winston, 1954).

Although diminished in magnitude at the core, the area affected by monthly mean temperature anomalies of +4°F or more was still quite extensive in August, and included a substantial portion of the Northeast, while temperatures fell to near normal levels over the Rio Grande Valley and western portions of the central and southern Great Plains. Maximum temperatures of 100°F or higher were observed somewhere east of the Continental Divide every day of the month except for the 28th and 29th.

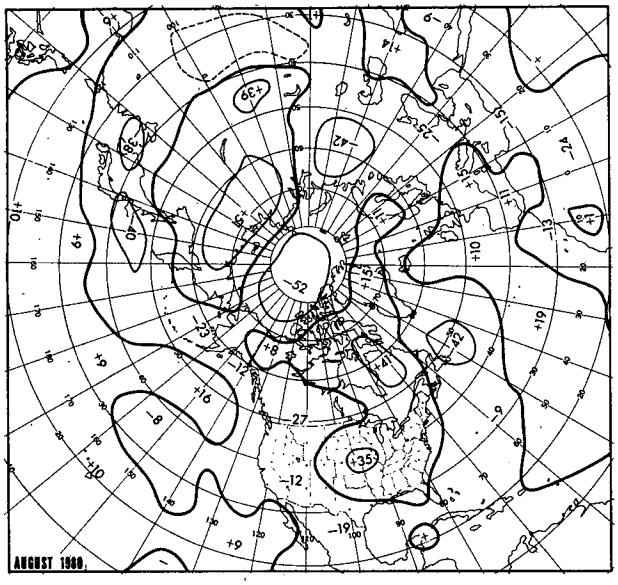


FIG. 4. Departure from normal of mean 1000–700 mb thickness (m) for August 1980.

The eastward shift of the heat wave and the sharp cooling in parts of the northern Great Plains can be directly attributed to the deepening and broadening of the mean trough in the West together with substantial height falls over southern Canada, and the eastward displacement of the mean ridge in the Southeast. The progression of the eastern trough to the western Atlantic and rising heights over eastern Canada cut off the northwesterly flow that had favored frequent transit of cool Canadian air over the Northeast early in the summer (Dickson, 1980; Livezey, 1980).

Temperatures were near or slightly below normal over Alaska in response to occasional influxes of air from the cold Arctic Ocean and cloudiness from storms associated with the trough over the Bering Sea. Temperatures in Hawaii averaged close to normal.

3. Precipitation

The drought continued over eastern portions of the southern Great Plains and the lower Mississippi Valley, and expanded into portions of the Southeast and northward as far as southern New York east of the Appalachian Mountains (Figs. 6 and 7). Most of the records for unusual dryness were being set in the Southeast (Table 2), where extreme negative values of the Crop Moisture Index began to appear during late July and August for the first time this summer.

Frequent thunderstorm activity along and south of the mean frontal zone associated with the cooling over the northern Great Plains and portions of the upper Mississippi Valley led to heavier than normal rainfall over most of the area between the Rocky Mountains and the Appalachian Mountains as far south as the Missouri and Ohio Rivers (Fig. 6). Several localities in the Midwest and West Virginia reported record or near-record totals (Table 2). The eastward and southward shift of the unusually sharp boundary between light and heavy precipitation brought welcome drought relief to some places in the middle of the country; for instance, Sioux City, IA reported nearly twice its normal August rainfall following a record dry spell in June and July. Nevertheless, most areas still needed more rain (Fig. 7) and crop and livestock losses were estimated to be over 10 billion dollars nationwide by the middle of August, a figure which, it was estimated, could add a whole percentage point to the Nation's inflation rate.[1]

Precipitation was highly variable over Alaska due to lack of strongly anomalous flow and variability of circulation regimes within the month. Perhaps most noteworthy was the relatively high percentage of normal precipitation at Barrow, due to the strong cyclonic flow over the Arctic Basin that at times impinged on the north slope of Alaska. Rainfall over Hawaii was somewhat below normal at most stations in response to generally above normal heights.

4. Variability within the month

a. 4–10 August

A massive, stronger than normal subtropical ridge extended from the central United States eastward across the Atlantic to the Mediterranean and North Africa (Fig. 8A). The 700 mb ridge over the central Pacific was located somewhat north of its usual position and had a strong extension northeastward into the Gulf of Alaska, joining with an area of blocking

[1] Reported in article by Rick Atkinson, *Washington Post*, Tuesday, 12 August 1980, p. E1.

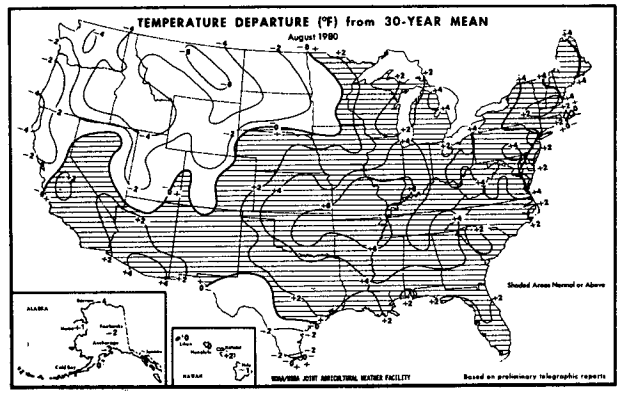


FIG. 5. Departure from normal of average surface air temperature (°F) for August 1980 (from National Oceanic and Atmospheric Administration and Economics, Statistics and Cooperatives Service, 1980).

TABLE 1. Record and near-record monthly mean temperatures observed over the United States during August 1980.

Station	Temperature (°F)	Anomaly (°F)	Remarks
Wichita Falls, TX	88.8	+3.3	26 days with max ≥ 100°F
Dallas-Ft. Worth, TX	88.5	+3.6	21 days with max ≥ 100°F
Oklahoma City, OK	88.0	+6.9	Hottest August since 1936, 2nd hottest since 1900
Tulsa, OK	89.7	+8.3	Hottest August since 1936, 2nd hottest since 1900
Wichita, KS	85.2	+5.5	Hottest August since 1954
Topeka, KS	80.7	+3.5	Hottest August since 1954
Springfield, MO	82.9	+5.8	Hottest August since 1938, 3rd hottest since 1900
Columbia, MO	81.7	+5.7	Hottest August since 1947
St. Louis, MO	83.5	+6.3	Hottest August since 1947, 4th hottest since 1900
Cairo, IL	83.1	+3.9	Hottest August since 1947
	84.5	—	Hottest July–August on record
Evansville, IN	81.6	+5.4	Hottest August since 1936, 4th hottest on record
Louisville, KY	81.0	+5.0	Tied August 1947 for 5th hottest
Ft. Smith, AR	85.6	+4.2	Hottest August since 1954, tied August 1938 for 5th hottest
Little Rock, AR	86.4	+5.9	2nd hottest August on record
Memphis, TN	87.2	+6.8	Hottest August since 1900
Nashville, TN	81.7	+3.2	Hottest August since 1954
Chattanooga, TN	82.2	+4.2	Hottest August since 1900
Knoxville, TN	81.7	+4.4	Hottest August since 1900
Jackson, MS	84.7	+3.5	5th hottest August on record
Meridian, MS	83.6	+2.9	Hottest August since 1954, tied August 1930 for 3rd hottest
Atlanta, GA	83.8	+6.3	Hottest August on record
Wilmington, NC	82.2	+2.7	2nd hottest August on record
Norfolk, VA	80.9	+4.0	3rd hottest August on record, record 19 days max ≥ 90°F
Richmond, VA	80.7	+4.4	2nd hottest August on record, record 24 days max ≥ 90°F
Washington, DC	82.8	+5.7	Hottest August on record
Philadelphia, PA	80.0	+5.2	Hottest August since 1900
Avoca, PA	75.2	+5.2	Hottest August on record
Allentown, PA	78.2	+6.5	Hottest August on record (since 1923)
Trenton, NJ	78.2	+4.3	Hottest August on record
New York, NY (Central Park Observatory)	80.3	+5.4	Hottest August on record
Boise, ID	67.2	−5.0	Coldest August since 1900
Pocatello, ID	65.2	−4.3	3rd coldest August since 1899
Havre, MT	62.3	−5.7	Tied record 2nd coldest August

Note: In cases where it is now not known whether there were more extreme monthly mean values in earlier station records prior to 1900, the words "since 1900" rather than "on record" are used in both tables in this article.

over northern Canada. Mean lows were located over the Bering Sea and Hudson Bay, and a strong low was found near the Pole just north of Spitzbergen.

The weekly mean temperature pattern (Fig. 8B) was remarkably similar to the monthly mean (Fig. 5), although anomaly values were somewhat stronger in most locations. Daily record highs were set at a number of locations in the Great Plains and

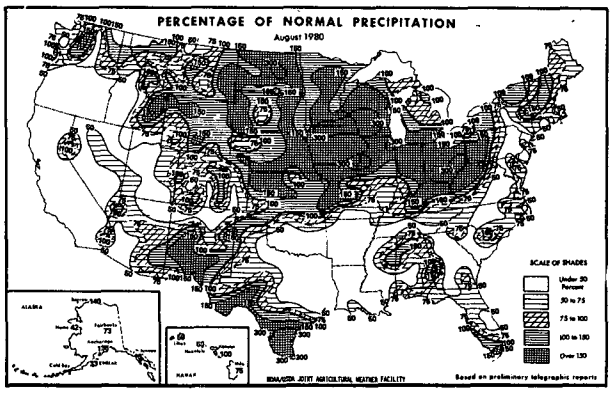


FIG. 6. Percentage of normal precipitation of August 1980 (from National Oceanic and Atmospheric Administration and Economics, Statistics and Cooperatives Service, 1980).

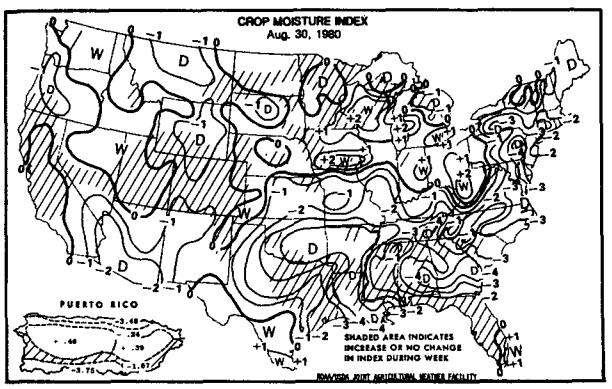


FIG. 7. Crop moisture index for the period ending 30 August 1980 (from National Oceanic and Atmospheric Administration and Economics, Statistics and Cooperatives Service, 1980).

TABLE 2. Record and near-record monthly rainfall totals observed over the United States during August 1980.

Station	Amount (inches)	Anomaly (inches)	Remarks
Dallas-Ft. Worth, TX	*T*	−2.26	Tied several other years for driest
Little Rock, AR	0.07	−2.76	Driest August on record
Baton Rouge, LA	1.32	−3.35	3rd driest August since 1900
Augusta, GA	0.65	−3.56	Driest August since 1925, 2nd driest on record
Savannah, GA	1.02	−5.45	Driest August since 1900
Charleston, SC	0.73	−5.71	Driest August since 1900
Baltimore, MD	0.82	−3.10	3rd driest August since 1900
Philadelphia, PA	0.80	−3.31	3rd driest August since 1900
Avoca, PA	1.23	−1.98	Driest August since 1953
Allentown, PA	0.93	−3.25	Driest August on record (since 1923)
Fargo, ND	4.24	+1.39	4th wettest August since 1945
Omaha, NE	7.72	+3.71	5th wettest August on record
Green Bay, WI	7.31	+4.69	3rd wettest August on record
Madison, WI	9.49	+6.44	Wettest August on record
Moline, IL	9.09	+5.72	2nd wettest August on record (since 1927)
Indianapolis, IN	8.34	+5.54	Wettest August on record
Charleston, WV	10.32	+6.64	2nd wettest August on record
Elkins, WV	10.40	+6.38	2nd wettest August since 1911
Corpus Christi, TX	14.79	+11.59	Wettest August on record

Pueblo, CO equaled its record high for August with 104°F on the 7th. The strong westward extension of the Bermuda High favored the abnormal warmth over the eastern part of the country, whereas the combination of the Gulf of Alaska ridge–northern Canadian block and the low over Hudson Bay favored the introduction of Canadian air into the nothwestern quarter of the United States.

Heavy precipitation was confined to the central and northern Mississippi Valley and extreme southern Texas (Fig. 8C). The northern area of precipitation was due mainly to thunderstorms developing near the active frontal zone over the north central states, while the rain in Texas was due to the passage of Hurricane Allen on 9–10 August. Nearly nine inches of rain fell within a 24 h period on those days at Corpus Christi, TX. Although some crops and land were damaged by flooding, in addition to the usual wave and storm surge damage in coastal areas, substantial beneficial effects were realized as part of the drought area received its first good soaking rain in months, making soil conditions suitable for fall planting.

b. 11–17 August

The circulation pattern became less amplified over the Pacific, while the Canadian block progressed to northern Hudson Bay, pushing the low that had been over the southern portion of the Bay into southeastern Canada, where it became absorbed in a deepening North Atlantic trough (Fig. 9A). The strong subtropical high across the Atlantic maintained strength from the central United States to North Africa.

Temperatures remained above normal over most of the drought and heat wave area, although it was not quite so hot as the previous week (Fig. 9B). Lower temperatures spread into the Northeast in

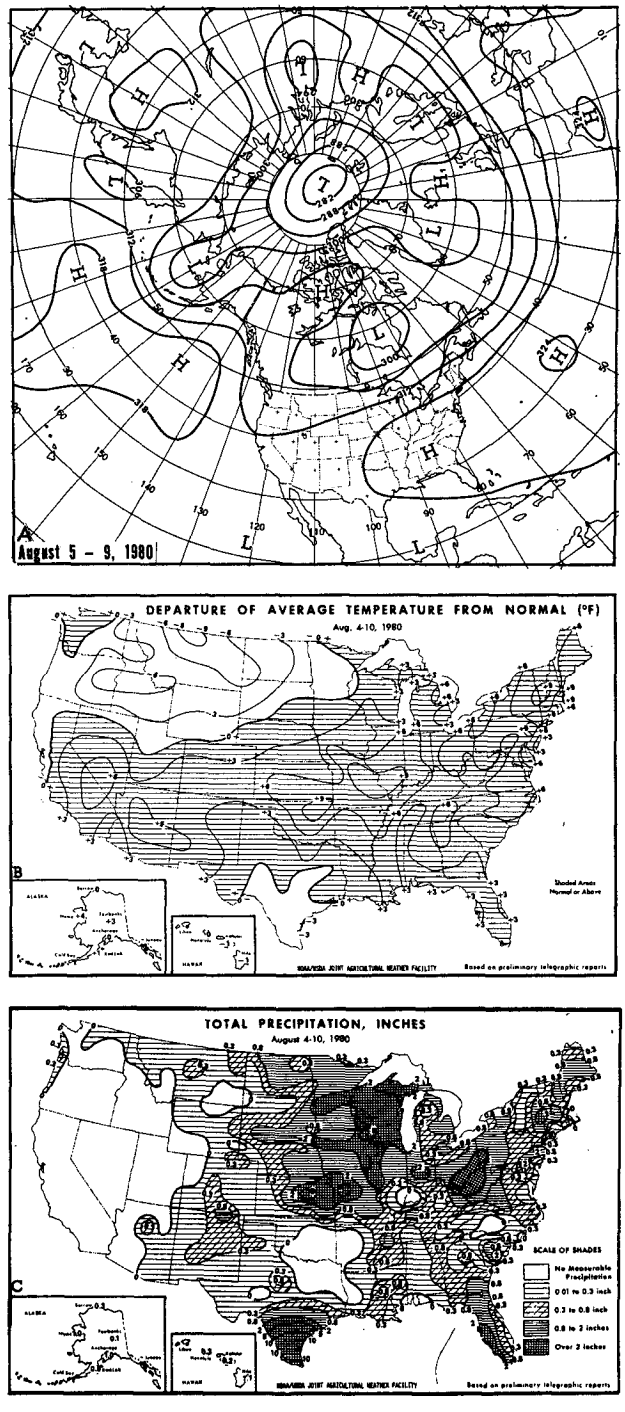
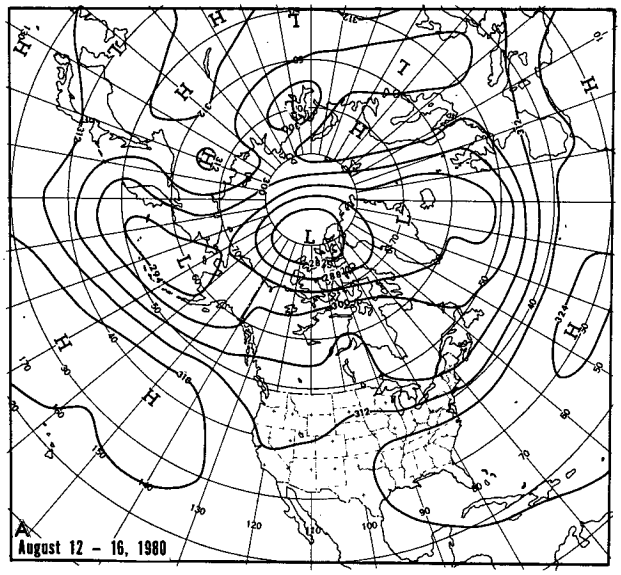
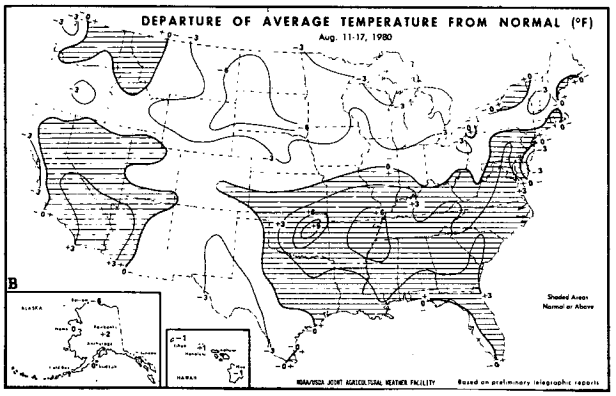


FIG. 8. (A) Mean 700 mb contours (dam) for 5–9 August 1980; (B) departure from normal of average surface air temperature (°F) and (°C) total precipitation (inches) for week of 4–10 August 1980 (from National Oceanic and Atmospheric Administration and Economics, Statistics and Cooperatives Service, 1980).

response to the changes in circulation over Canada mentioned above, while continued rains and cloudiness in the Rio Grande Valley from the remains of Hurricane Allen contributed to cooling there (Fig. 9C). Albuquerque, NM reported a 24 h total of 1.75 inches on the 13th and 14th, a new August record.





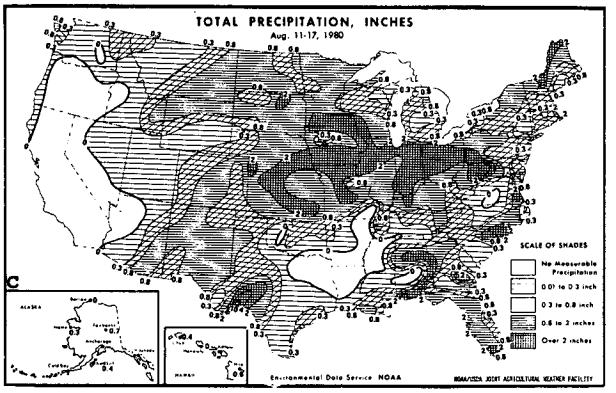


FIG. 9. As in Fig. 8 except for (A) 12–16 August 1980, and (B) and (C) week of 11–17 August 1980.

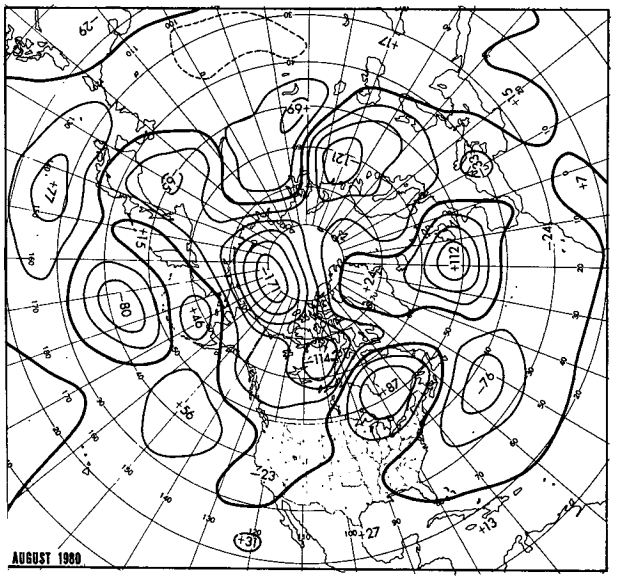


FIG. 10. Mean 700 mb height change (m) from first half to second half of August 1980.

Heavy rains from thunderstorms spread from the Midwest eastward across the Ohio Valley into southwestern Pennsylvania and West Virginia, causing flash floods in some localities. The core of the drought area centered over northeast Texas and Arkansas remained absolutely dry for the third consecutive week.

c. 18–24 August

The intense Arctic low deepened further and shifted to the Beaufort Sea side of the Pole, while 700 mb heights fell over western Canada and rose over eastern Canada during the latter half of the month (Figs. 10 and 11A). The wave pattern again became more amplified over the Pacific, while substantial height falls over the western Atlantic signaled the progression of a trough to that area. The entire Atlantic subtropical ridge weakened while a mid-latitude ridge amplified over the eastern Atlantic in response to the deepening trough further west. Drier, but still rather cool weather moved into western Europe as a result.

In the United States, most of the country east of the Rocky Mountains except for the Atlantic Coast had above normal temperatures (Fig. 11B). The latter area was under the influence of a shallow, northeasterly maritime flow in response to the slowly-moving trough and a developing surface low that later became Hurricane Charley. Reintensification of the 700 mb high over the lower Mississippi Valley advected continental air over the eastern Gulf States. On 22 August Orlando, FL set a new high for the month of August with 100°F, and New Orleans, LA equaled its all-time record high with

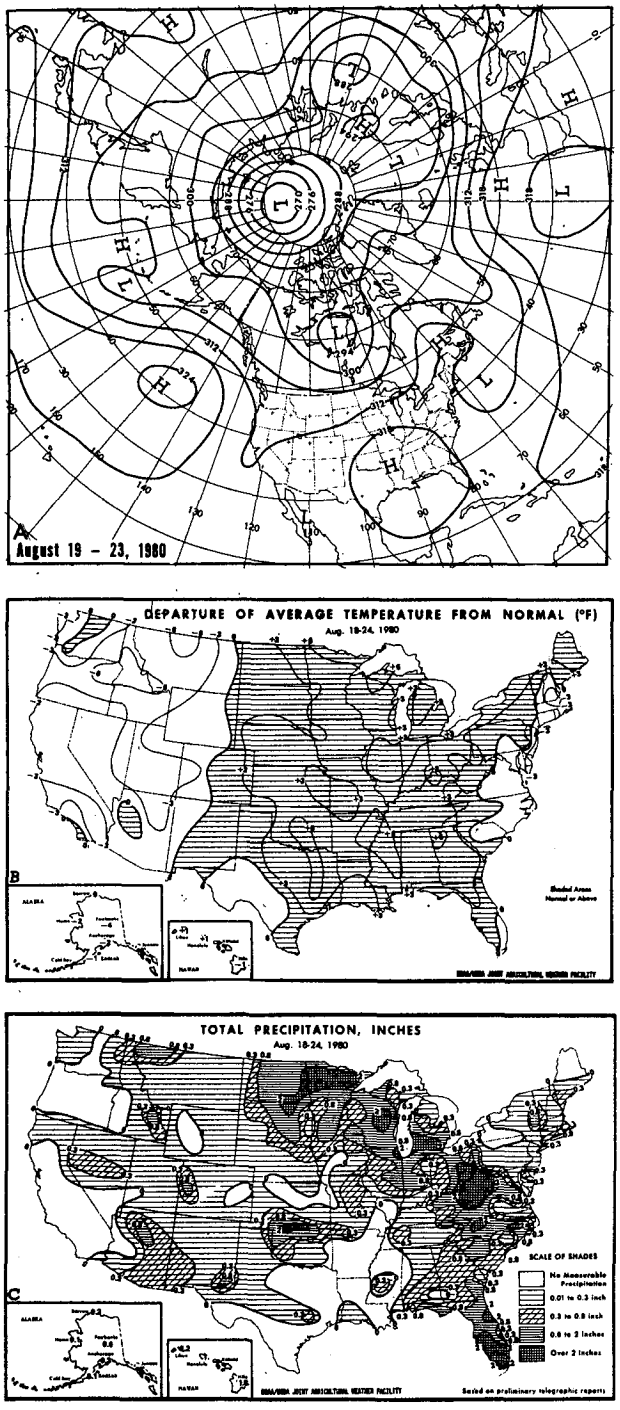


FIG. 11. As in Fig. 8 except for (A) 19–23 August 1980, and (B) and (C) week of 18–24 August 1980.

102°F. Temperatures were below normal over the West in response to the continued upper trough there. Most of the country had some precipitation, but the core of the drought area, which continued to experience maximum temperatures over 100°F, remained dry for the fourth consecutive week (Fig. 11C). Continued heavy rains for the third consecutive week in West Virginia were accompanied by severe flash floods in some counties.

d. 25–31 August

Continued amplification of the eastern Pacific ridge near the area that had been its average location throughout most of the summer led to a reamplification of the portion of the subtropical ridge over the eastern United States (Fig. 12A). The new mean location of the ridge associated with the heat wave was farther east than it had been, probably due to increasing strength of the westerlies at middle latitudes over the Pacific and North America.

Temperatures were substantially below normal over the Northwest, but positive anomalies increased again over the East in response to the strengthening 700 mb ridge (Fig. 12B). Missoula, MT reported its first freeze and frost of the season with a minimum of 30°F and Pendleton, OR had the lowest temperature ever observed in August with 40°F, both occurring on the 29th.

Except for a few isolated heavy thundershowers, it was mostly dry across the southern half of the country (Fig. 12C). Heavy rains continued to fall in portions of the upper Midwest in the active mean frontal zone. The middle and South Atlantic coasts had no rain at all.

5. Tropical activity

The first named tropical disturbance of the season in the Atlantic sector was Allen, which reached storm intensity on 1 August near 11°N, 43°W and deepened rapidly to become a hurricane with 110 kt winds gusting to 130 kt two days later east of the Antilles. Throughout most of its lifetime, Allen moved west-northwestward at an unusually fast pace of 20–25 kt. This rapid speed and steady path were due largely to the unusually strong subtropical ridge in the lower troposphere extending from Africa to the southeastern United States early in the month (Fig. 8A).

Allen passed into the Caribbean after crossing the southern tip of St. Lucia about 50 km north of Barbados early on 4 August. Winds reached 150 kt with gusts to 170 kt when the storm was located southeast of Jamaica, but Allen weakened temporarily as it passed a short distance north of Jamaica early on the 6th. The storm redeepened to a central pressure of 899 mb and attained maximum intensity while passing over the warm waters of the Yucatan Strait on 7 August. Winds were then estimated to be 160

kt with gusts to 180 kt, ranking this storm as one of the most severe Atlantic hurricanes of all time.

Allen slowed to ~15 kt forward speed while crossing the Gulf of Mexico, and additional retardation and weakening occurred prior to its making landfall just north of Brownsville, TX early on 10 August. The storm weakened rapidly over land and the last evidence of a closed circulation center at the surface was about 250 km southwest of Del Rio, TX on the 11th. An area of heavy showers persisted for another few days over west Texas and southern New Mexico.

There was no further significant activity in the Atlantic until 14 August when tropical storm Bonnie was detected near 21°N, 38°W. Becoming a hurricane the next day, this storm moved on a slow, irregular northward path near the 40°W meridian throughout its lifetime. Peak intensity was 85 kt with gusts to 105 kt. Bonnie accelerated rapidly early on the 19th before weakening and becoming extratropical later the same day.

Charley developed from a disturbance that formed under a cold low aloft that in turn had its origin in a sharp trough that moved off the middle Atlantic Coast on 20 August. Going through subtropical and tropical phases rather gradually, the storm rapidly deepened to hurricane intensity on the 23rd close to the Guld Stream near 38°N, 66°W. Moving slowly eastward, the storm weakened to tropical storm intensity the next day, before being absorbed in the circulation around a deepening extratropical low to the north.

The paths of Bonnie and Charley reflected the change in circulation over the Atlantic after the middle of the month (Figs. 10 and 11A). Both storms spent their lives nearer the midlatitude westerlies than the subtropical easterlies, and the closed low of extratropical origin that triggered the development of Charley is reflected in Fig. 11A.

Three tropical storms, all of which attained hurricane intensity, developed over the eastern Pacific during August. Howard and Isis came in quick succession early in the month, and Javier was active during the final week of August. None of these storms made landfall, although Isis came within ~300 km of the southern tip of Baja California on the 8th.

Over the western Pacific, Typhoon Lex was moving slowly westward near 24°N, 144°E at the beginning of the month. It made a slow recurvature to the northeast after reaching peak intensity of 80 kt with gusts to 100 kt on the 3rd. The storm weakened to tropical storm intensity on the 6th, became extratropical the next day, and ended near Kamchatka on the 10th after turning northward.

Tropical storm Marge formed near 14°N, 157°E on 8 August. Moving northwestward, it became a typhoon on the 10th, reaching a peak intensity of 110 kt with gusts to 135 kt. After slow recurvature, it weakened to tropical storm intensity again on the

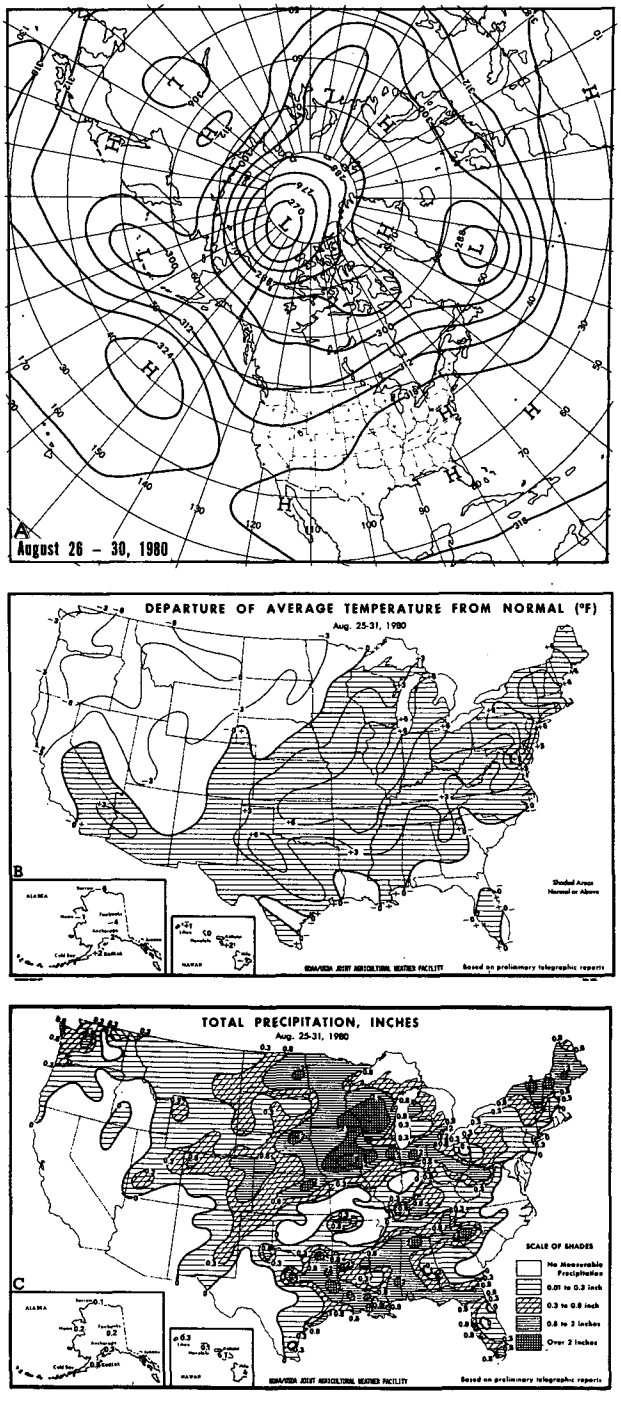


FIG. 12. As in Fig. 8 except for (A) 26–30 August 1980 and (B) and (C) week of 25–31 August 1980.

14th, eventually moving more rapidly to the northeast as an extratropical storm and striking western Alaska on the 18th.

Two tropical depressions that failed to reach storm intensity were active near the Philippines just after the middle of the month, and a third depression that formed on the 24th became tropical storm Norris the next day. Briefly attaining typhoon intensity on the 27th about 400 km east of Taiwan, Norris moved northwestward and then more to the west, brushing the northern end of Taiwan on the 28th and then crossing the coast of mainland China later the same day while rapidly weakening.

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