

WEATHER AND CIRCULATION OF JULY 1981

Widespread, Beneficial Rains

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1. Mean circulation

During July the mean wave pattern over the Pacific amplified and its wavelength shortened (Figs. 1 and 2) as the mean Pacific westerlies markedly declined from the extreme values of June (Livezey, 1981) and moved northward (Fig. 3). The eastern Pacific ridge retrograded at middle latitudes and strengthened substantially, leading to a rejuvenation of the West Coast trough.

The westerlies over North America also moved northward as the subtropical high strengthened

over the central United States and the previously strong Hudson Bay low moved northeastward to Baffin Island. A weak but significant break in the subtropical ridge continued over western Texas. A moderately deep trough dipped southward from the Baffin Island low along the east coast of North America and supported a strengthened mean ridge over the eastern Atlantic.

Although the mean trough over Europe remained almost stationary, the downstream ridge and trough both retrogressed. The mean 700 mb westerlies were displaced well north of normal as they passed

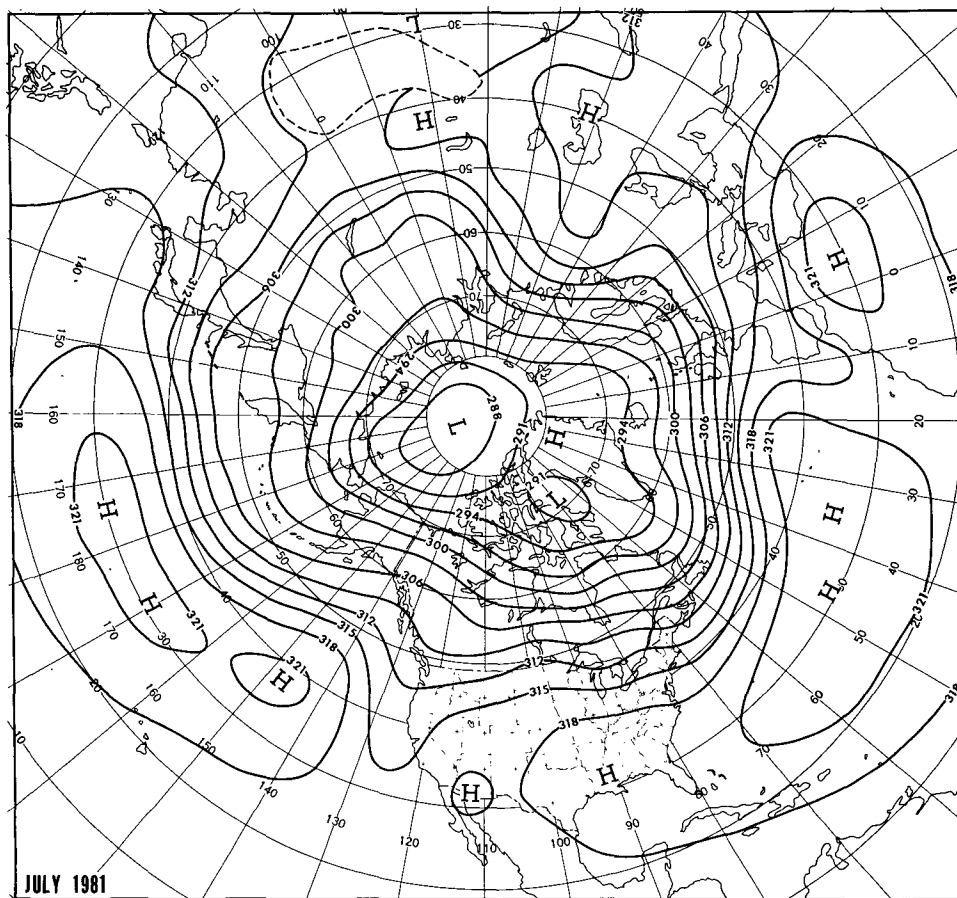


FIG. 1. Mean 700 mb height contours (dam) for July 1981.

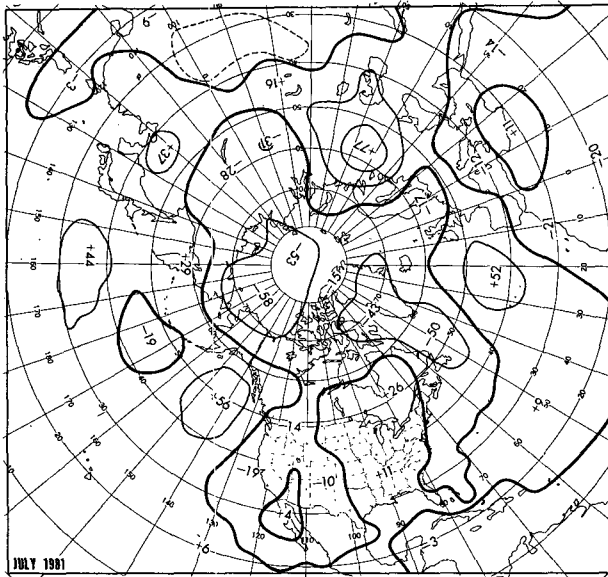


FIG. 2. Departure from normal of mean 700 mb height (m) for July 1981.

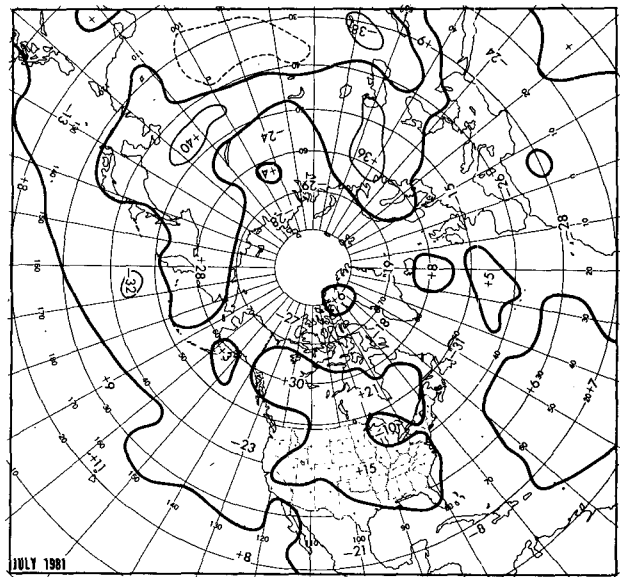


FIG. 4. Departure from normal of mean 1000-700 mb thickness (m) for July 1981.

through the northern reaches of this strong and very warm ridge (Figs. 1-4). As the mean trough retrogressed to central Asia, warm air was advected over east Asia and a ridge emerged near the Asian coast.

At high latitudes a strong mean 700 mb high north of Alaska in June was replaced in July by a deep low near the Pole. Between this cold low and the warm ridges bordering the Arctic, the baroclinic field was strong and the westerlies exceeded

normal from north of Scandinavia to northern Canada.

2. Temperature

Despite changes in the mean 700 mb circulation anomalies from June to July, there were very few changes in the sign of the mean temperature anomalies over the United States. The intensifying ridge over the eastern Pacific provided an altered but still enhanced advection of cool air to the Pacific Northwest (Fig. 5). Likewise, continued cloudy weather over parts of Texas kept relatively cool weather there. Elsewhere mean temperatures continued generally above normal as the westerlies moved northward and a ridge dominated the mean circulation over the middle of the country. The

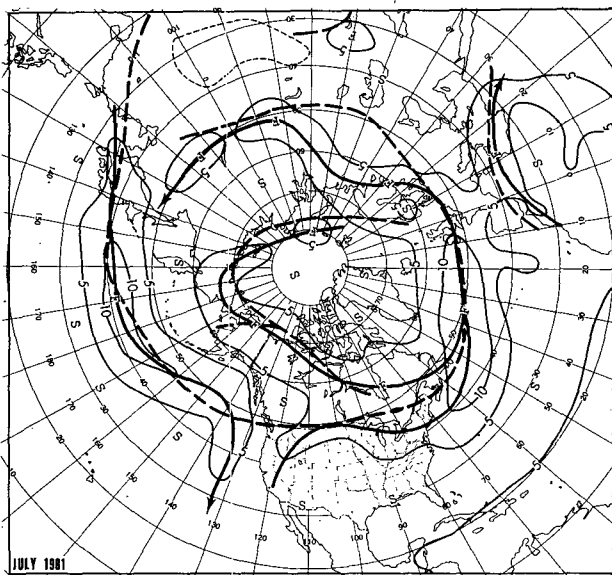


FIG. 3. Mean 700 mb geostrophic wind speed ($m s^{-1}$) for July 1981. Solid arrows indicate observed axes of maximum wind speed and dashed lines, the normal.

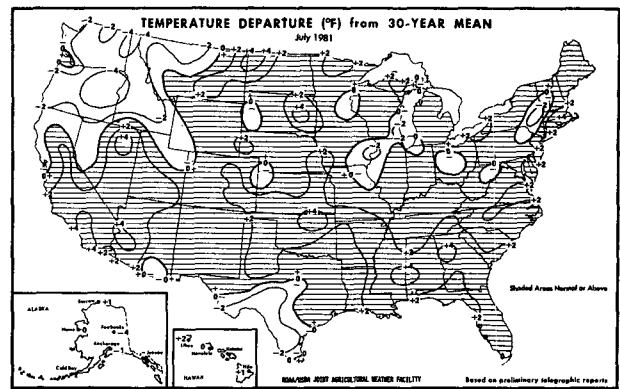


FIG. 5. Departure from normal of average surface air temperature ($^{\circ}F$) for July 1981 (from National Oceanic and Atmospheric Administration and Economics and Statistics Service, 1981).

atmospheric circulation was variable enough, however, that the earlier extreme mean temperature anomalies in the Southwest and in parts of the Southeast moderated. In the only reported approaches to record setting, West Palm Beach, FL, had its second hottest July and Phoenix, AZ, had a tie for second hottest. This was in sharp contrast to the heat wave of last July (Livezey, 1980) when several July and all time high temperature records were set.

Most of Alaska experienced below-normal average temperatures in connection with the cold Arctic low. Exceptions were in the south, where the cold air did not penetrate, and the north coast, where mean surface winds had a component from the south. Temperatures in Hawaii were generally somewhat above normal, as were mean 700 mb heights.

3. Precipitation

Again, in contrast to last July, rainfall was generally well distributed between the Rocky and Appalachian Mountain ranges (Fig. 6). Moisture from both Mexico and the Gulf of Mexico entered the country west of the upper level high, becoming available to frequent transient waves in the westerlies that produced widespread and substantial rainfall. The rains were generally beneficial in helping to alleviate previous water shortages, except for the excessive amounts of 8–12 inches over and near Missouri. The Great Lakes, located to the north of the moist flow circulating about the continental high, were generally quite dry this month. It was also dry in much of the Southeast east of the retreating subtropical high, and the drought there became more severe.

Greater-than-normal precipitation also fell near the mean trough over the Northwest and in east coast states from the Carolinas northward. The

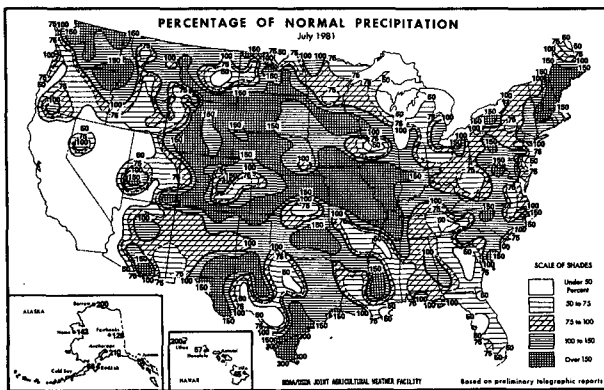
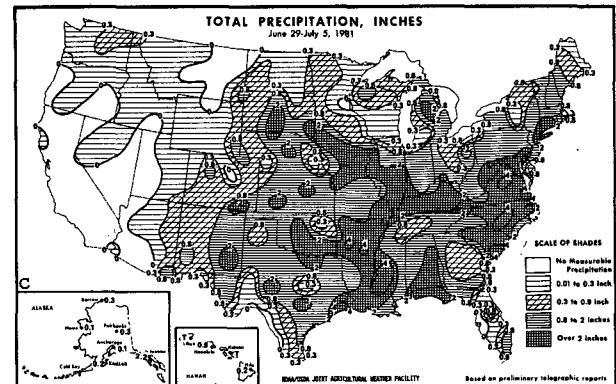
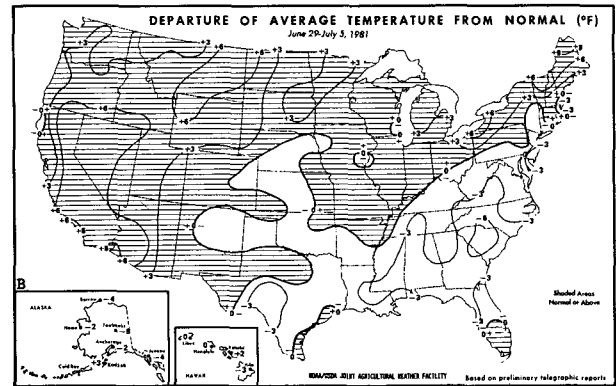
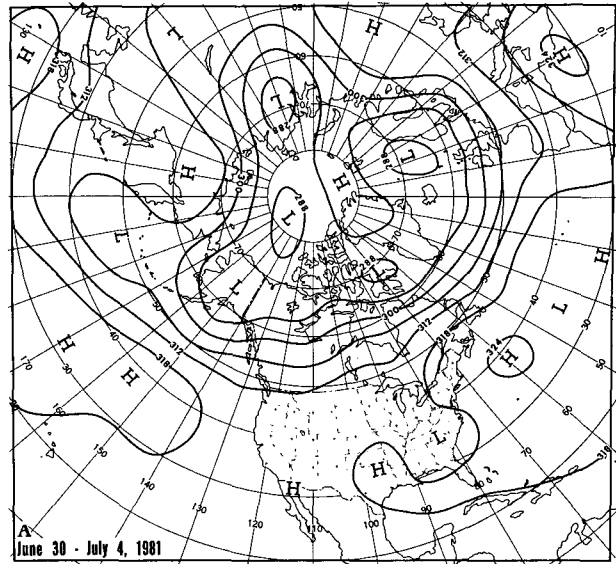


FIG. 6. Percentage of normal precipitation for July 1981 (from National Oceanic and Atmospheric Administration and Economics and Statistics Service, 1981).

FIG. 7. (A) Mean 700 mb contours (dam) for 30 June–4 July 1981; (B) departure from normal of average surface air temperature (°F) and (C) total precipitation (inches) for week of 29 June–5 July 1981 (from National Oceanic and Atmospheric Administration and Economics and Statistics Service, 1981).

eastern rainfall was not very well related to the monthly mean circulation.

It was the wettest July of record at Springfield, IL (10.76 inches), the wettest July in the last 44 years

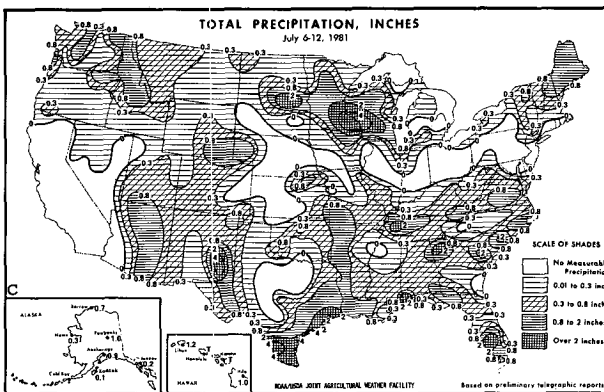
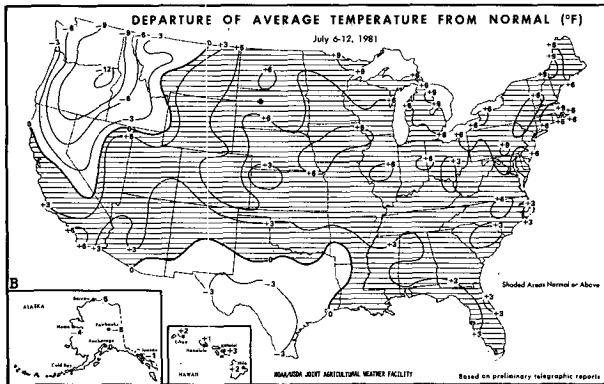
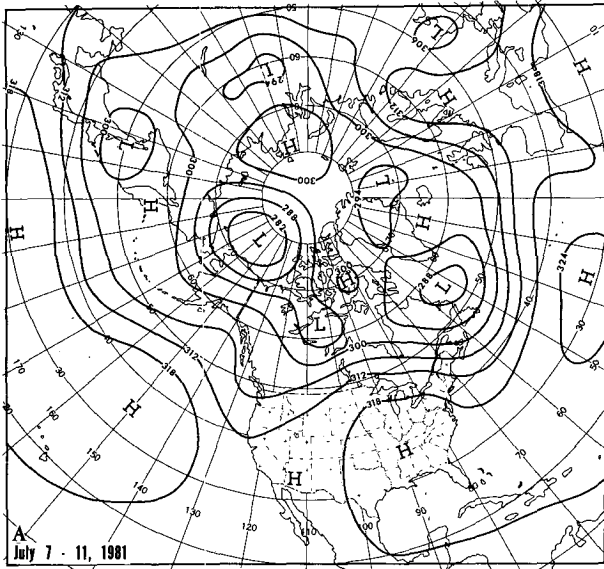


FIG. 8. As in Fig. 7 except for (A) 7-11 July 1981, and (B) and (C) week of 6-12 July 1981.

nearby subtropical ridge weakened but continued stronger than normal. Hilo reported its fourth driest July of record (4.32 inches) and tenth consecutive month with subnormal rainfall.

4. Variability within the month

a. 29 June-5 July

By early July, the westerlies had already shifted northward over North America (Fig. 7), and the east coast was under the influence of a midlatitude blocking ridge with an interacting tropical storm trough to the south. Short-lived Tropical Storm Brett contributed to the heavy precipitation over the middle Atlantic states as it moved over southeastern Virginia on 1 July and dissipated. A subsequent weak low, forming in the tropical air in the wake of Brett and moving from northern Florida to New England, produced generally greater rainfall amounts than had Brett. Heavy rainfall also occurred westward to the Mississippi Valley as several weak waves in the upper level westerlies amalgamated with the circulation aloft that survived Brett.

Temperatures averaged above normal over most of the country and continued well above normal in parts of the West. By the end of the week maxima of 100°F or greater were observed as far north as central Oregon. On 7 July Elko, NV, recorded a temperature of 107°F, which equaled the all-time high at that location. Temperatures along the middle Atlantic coast and the Southeast, under a cloudy, rainy regime, averaged below normal.

b. 6-12 July

The long waves in the vicinity of North America grew in amplitude bringing strong mean ridges to the eastern Pacific and the Mississippi Valley and deep mean troughs to the West Coast and off the East Coast (Fig. 8). The latter feature replaced a blocking ridge of the preceding week.

Rainfall amounts decreased sharply over the southeastern quarter of the country near and east of the growing ridge. They increased, however, near the trough over the Northwest as well as in some areas peripheral to the continental anticyclone. On 11 July, Rochester, MN, received 7.47 inches of rainfall in 24 h, an all-time record for that location.

Development of the West Coast trough brought an end to the hot spell in most of the West and displaced much of the hot air to northern and central portions of both the Great Plains and the Mississippi Valley. The air moving over the Northwest was quite cold, producing record low July temperatures at both Spokane, WA (37°F), and Pocatello, ID (34°F). The broad and strengthening ridge over the East not only continued the warm regime in the Northeast, but also brought above-normal temperatures to the Southeast. The cloudy

at Milford, UT (1.57 inches), and the third wettest July since 1892 at Worcester, MA (7.90 inches).

Most of Alaska, located in advance of a mean trough, received above-normal precipitation. However, extreme southeast Alaska, under a moderately strong mean ridge, was an exception. To the south, most of Hawaii got less-than-normal rainfall as the

and cool regime of the previous week persisted only over Texas.

c. 13-19 July

A broad mean 700 mb ridge stretched from the Gulf of Alaska to Hudson Bay, surmounting a zonally oriented trough near the U.S.-Canada

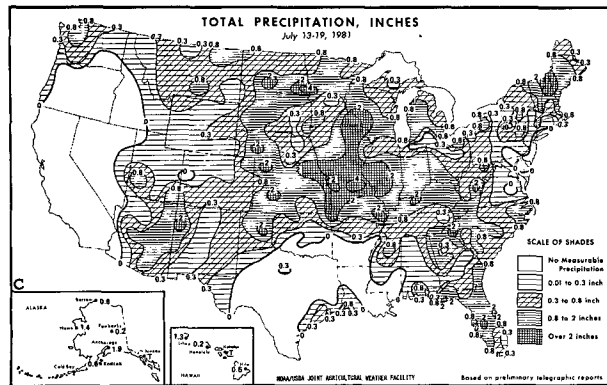
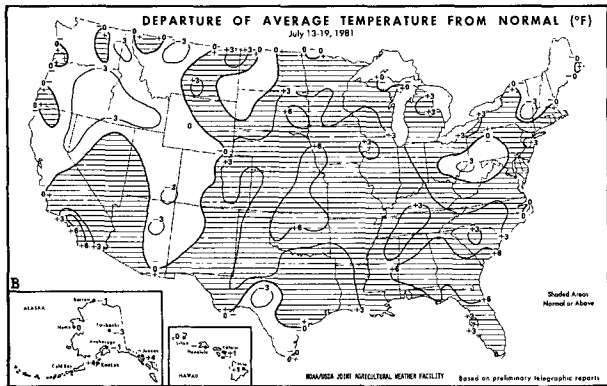
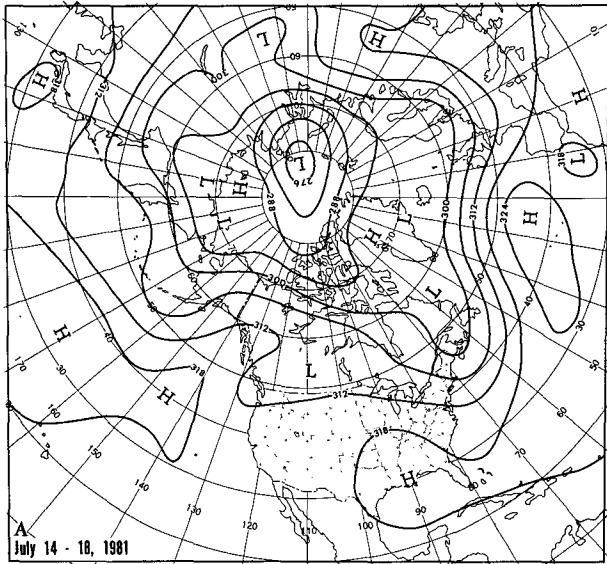


FIG. 9. As in Fig. 7 except for (A) 14-18 July 1981, and (B) and (C) week of 13-19 July 1981.

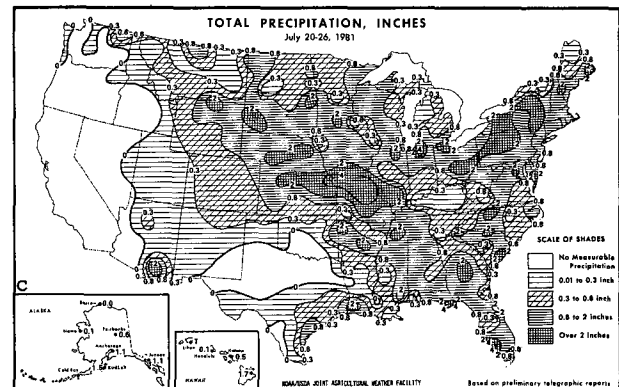
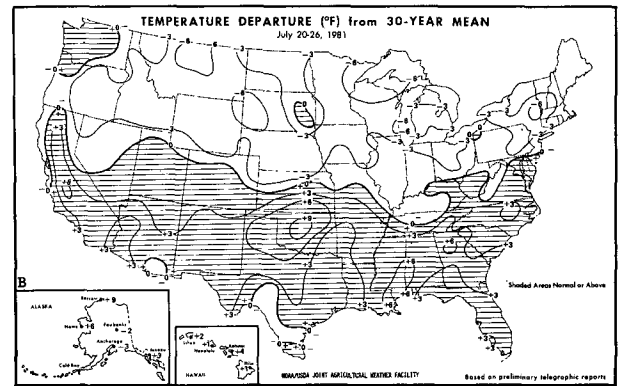
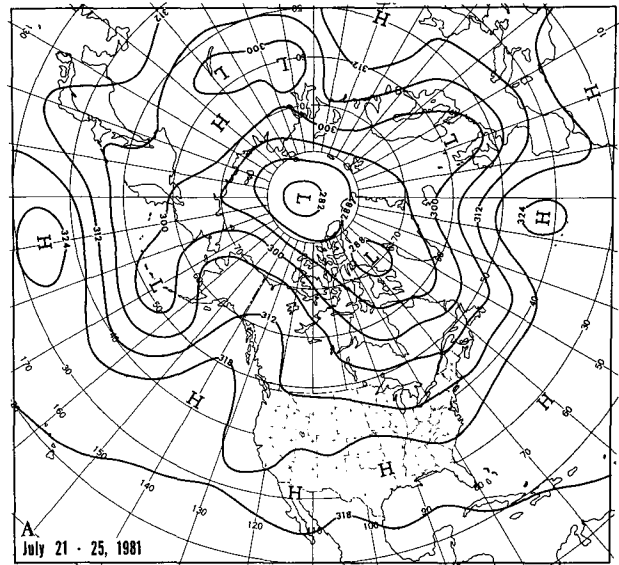


FIG. 10. As in Fig. 7 except for (A) 21-25 July 1981 and (B) and (C) week of 20-26 July 1981.

border (Fig. 9). This development was accompanied by an erosion of heights over the West and a southward movement of the westerlies over the eastern half of the United States as they flowed into a still-deep trough along the east coast.

Weak storm systems moving in the southward-displaced westerlies drew on the flow of moisture

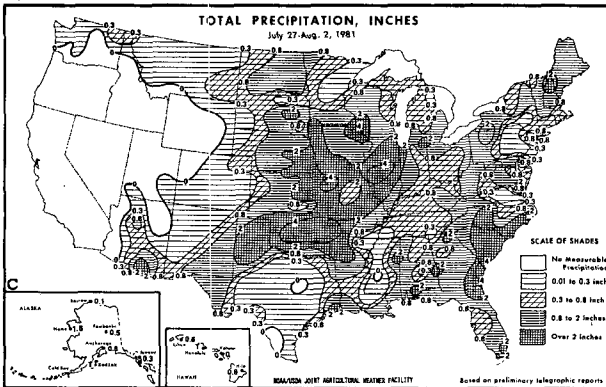
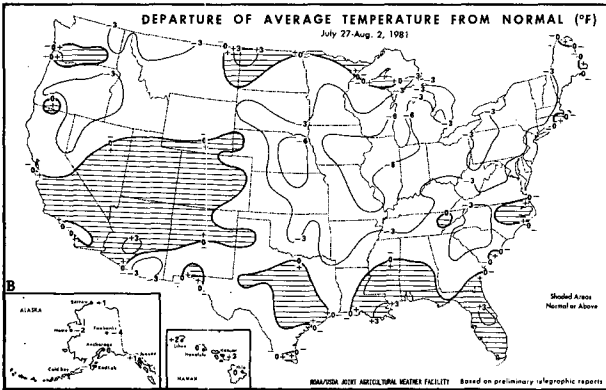
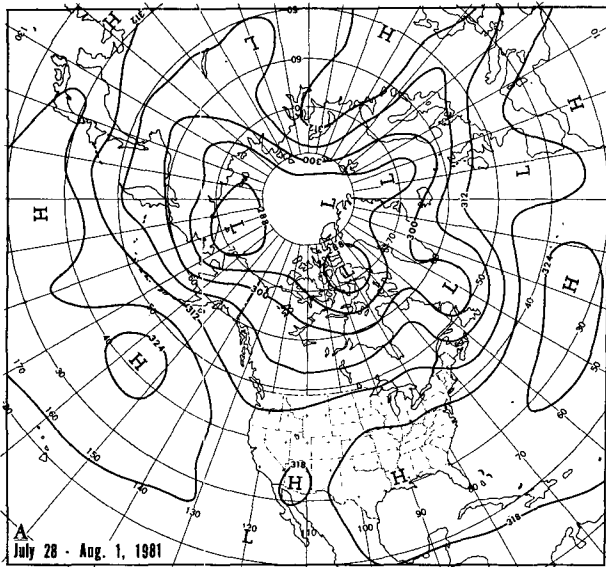


FIG. 11. As in Fig. 7 except for (A) 26 July–1 August 1981 and (B) and (C) week of 27 July–2 August 1981.

about the mean high to spread substantial rains eastward from the Great Plains. Conditions were quite dry in the vicinity of the mean 700 mb high, which moved southward to the Gulf coast.

Although mean temperatures continued above normal over most of the country, the warmth

moderated considerably along the northern border as the southward displaced westerlies were accompanied by a southward displacement of the mean frontal zone. Portions of the central Great Plains, largely unaffected by air mass changes, remained quite warm. Below-normal mean temperatures were largely limited to parts of the Northwest, where influx of maritime air continued and in the vicinity of the southwest moist tongue.

d. 20–26 July^a

The mean waves again increased in amplitude in the vicinity of North America as the east Pacific ridge strengthened over Alaska and the mean trough to its east deepened southward across the Great Lakes (Fig. 10). In essence, that deepening represented a retrogression of the mean trough which had been off the coast. The mean 700 mb high along the Gulf Coast also developed westward, and was bordered by a broad band of fairly strong westerlies to its north.

Quite cool air thrust southward by the east Pacific-Alaska ridge was largely confined to the zone of westerlies over the northern half of the country, while high temperatures prevailed in the stagnant conditions to the south. Temperatures of 100°F or more were common over the southern Great Plains on each day of this week. The all-time maximum of 106°F was equalled at Pueblo, CO, on the 21st, and the July maximum of 101°F equalled at New Orleans, LA, on the 23rd.

Traveling storm systems and precipitation were largely concentrated in the westerly band east of the Rocky Mountains. An exception was the significant precipitation that accompanied the mean trough over the Southeast.

e. 27 July–2 August

The eastern Pacific mean ridge retrogressed, leading to a restrengthening of both the western trough and the eastern ridge over the United States and the displacement of the eastern trough (Fig. 11).

A cold high-pressure system, dislodged from the Arctic by the amplified long-wave pattern of the previous week, affected the eastern half of the country during much of this week. Weak lows traveling on the fringes of this cold high provided most of the heavy precipitation totals. The coldest weather relative to normal was concentrated in areas of substantial precipitation. Temperatures over the Northwest mostly remained subnormal near and west of the strengthened upper trough.

5. Tropical activity

One Atlantic tropical storm, Brett, formed off Norfolk on 1 July and immediately moved inland

across southeastern Virginia where it weakened. Its effects are discussed in Section 4.

Four tropical cyclones occurred over the eastern Pacific this month. Hurricane Beatriz, which formed in June, was south of Baja California on 1 July. It moved northwestward, becoming a tropical storm on the 3rd and a depression on the 4th. The three storms that formed during July were Calvin (5 July), Dora (11 July) and Eugene (18 July). Of these, only Calvin reached hurricane intensity and lasted for more than a few days.

There appear to have been five tropical storms or typhoons in the western Pacific this month. Tropical Storm Kelley formed in June and was east of Viet Nam on 1 July. It rapidly strengthened to typhoon intensity, then weakened to a tropical storm near Hainan and moved inland on 4 July. Tropical Storms Lynn and Maury formed near the Philippines

on 3 and 18 July, respectively, and moved across the China coast. Tropical Storm Ogden developed south of Japan on 29 July and crossed the southern tip of Japan on 30 July. The western Pacific "N" storm, while difficult to document, appears to have been a short-lived tropical storm that crossed the China coast on 23 July.

REFERENCES

- Livezey, R. E., 1980: Weather and Circulation of July 1980—Climax of a historic heat wave and drought over the United States. *Mon. Wea. Rev.*, **108**, 1708–1716.
- Livezey, R. E., 1981: Weather and Circulation of June 1981—A return to coast-to-coast warmth and continuing drought in the West. *Mon. Wea. Rev.*, **109**, 2046–2052.
- National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and Economics and Statistics Service, U.S. Department of Agriculture, 1981: *Weekly Weather and Crop Bulletin*, **68**, Nos. 27 to 32 (7, 14, 21 and 28 July and 4 and 11 August 1981).