

# WEATHER AND CIRCULATION OF SEPTEMBER 1971

## Cool in the West and Warm in the East, A Reversal From August

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### 1. MONTHLY MEAN CIRCULATION

The mean 700-mb circulation for September 1971 (figs. 1 and 2) differed from that of August in many parts of the Northern Hemisphere. This was particularly true at midlatitudes from the eastern Pacific across North America to Asia as the wave train this month was out of phase with the August pattern. Troughs replaced ridges and ridges replaced troughs. Changes in the height anomaly from August to September (fig. 3) show this wave reversal rather well, especially when compared with the height anomaly for August (Green 1971).

In the Pacific, a mean Low was established over the Bering Sea as blocking in Siberia continued to weaken

(fig. 1). Development of this Low was enhanced by remnants of typhoon Wendy which entered the region about the middle of the month. Anomalous heights increased by more than 100 m over the eastern Pacific (fig. 3) as a broad ridge replaced the sharp trough of August.

Although the principal jet axis across the Pacific was within 5° latitude of its normal position (fig. 4), wind speeds along the jet were stronger than normal along its entire length. The peak speed was over the mid-Pacific where winds averaged about 16 m/s, more than 6 m/s above normal.

Upper level heights over North America in September were generally below normal with positive height anomalies limited to Alaska and an area centered over New

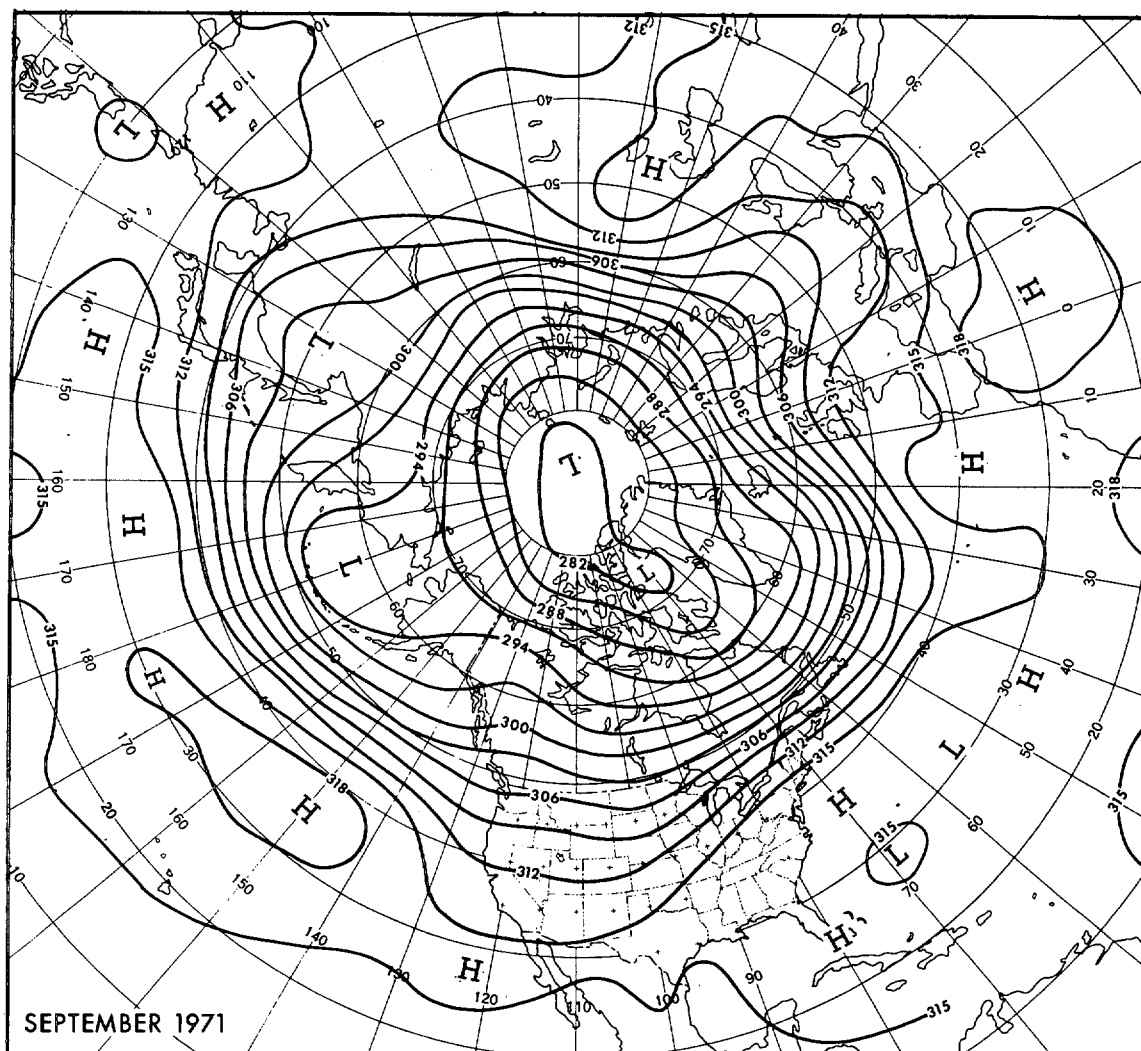


FIGURE 1.—Mean 700-mb contours in dekameters (dam) for September 1971.

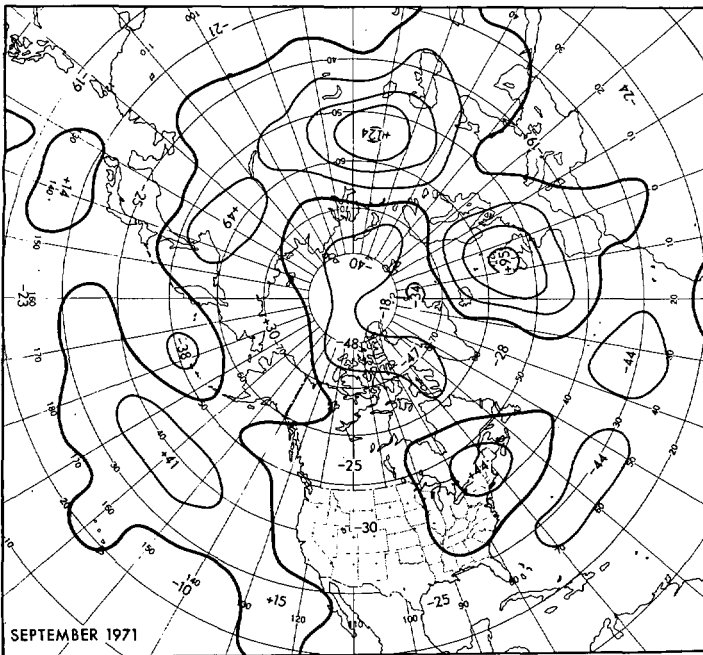


FIGURE 2.—Departure from normal of mean 700-mb height in meters (m) for September 1971.

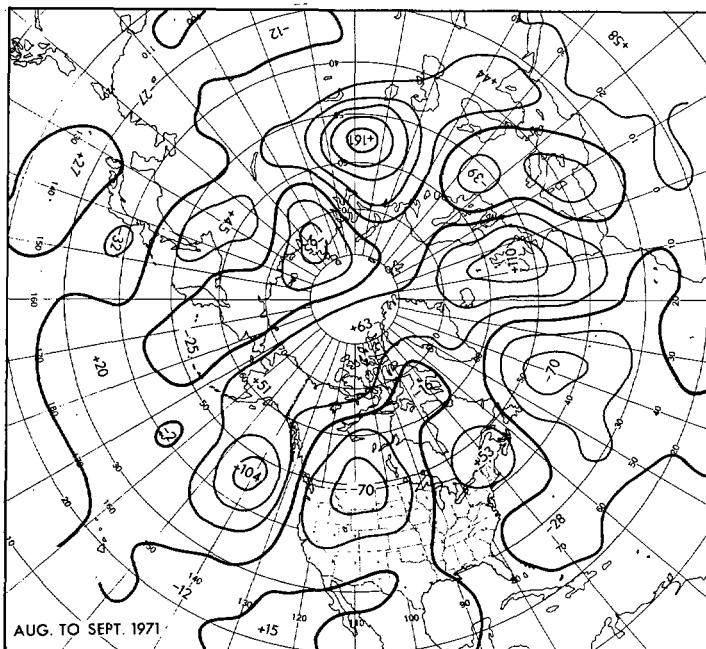


FIGURE 3.—Mean 700-mb height anomaly change (m) from August to September 1971.

England (fig. 2). Height departures fell as much as 70 m over the northwestern United States as the strong August ridge gave way to generally cyclonic flow with a weak trough along the West Coast and another over the Great Plains.

The ridge over the Northeast was a dominant feature of the 700-mb circulation throughout the month. It was supported both by wavelength considerations, with a trough upstream, and by interaction with hurricane Ginger which meandered over the western Atlantic from September 10 to the end of the month.

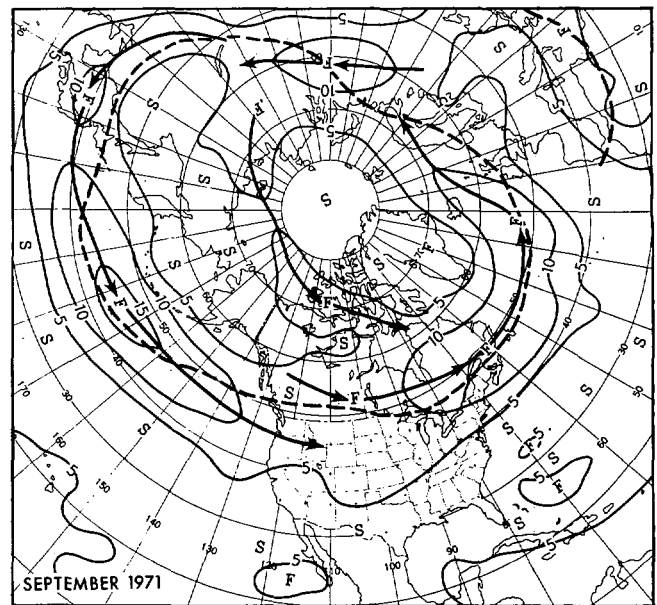


FIGURE 4.—Mean 700-mb wind speed (m/s) for September 1971. Heavy solid arrows show the principal axes of observed wind speed, and dashed lines, the normal.

The trough that had been over eastern North America during August moved into the Atlantic in September resulting in 70-m negative height anomaly changes south of Greenland. The greatest negative departures from normal, however, were in the subtropical areas of the Atlantic.

Strong ridging occurred along the west coast of Europe as height anomalies increased by 110 m over England. Heights averaged up to 95 m above normal there, and the 700-mb jet was pushed north of its normal September position. A weak negative center (fig. 3) was observed over the Mediterranean Sea where the observed jet axis was ill-defined.

Both the largest height anomaly and anomaly change occurred in western Russia as a strong ridge replaced a trough. Anomalous heights there rose by as much as 161 m from those of August and averaged more than 120 m above normal. Expansion of the polar Low into northern Asia helped to diminish high latitude blocking over Siberia as the stronger positive anomaly was observed west of the Sea of Okhotsk.

## 2. MONTHLY TEMPERATURE

Mean surface temperatures in the United States during September were generally below normal in the West and above normal in the East (fig. 5). This pattern corresponded well with the 700-mb mean circulation and was a distinct reversal from the temperature anomaly of August.

Temperatures averaged at least 3°F above normal over most of the northeastern quarter of the Nation while they were more than 3°F below normal over a large area of the West. In a portion of the Northern Rocky Mountains, temperatures averaged more than 6°F lower than normal, in sharp contrast to the record warmth of August.

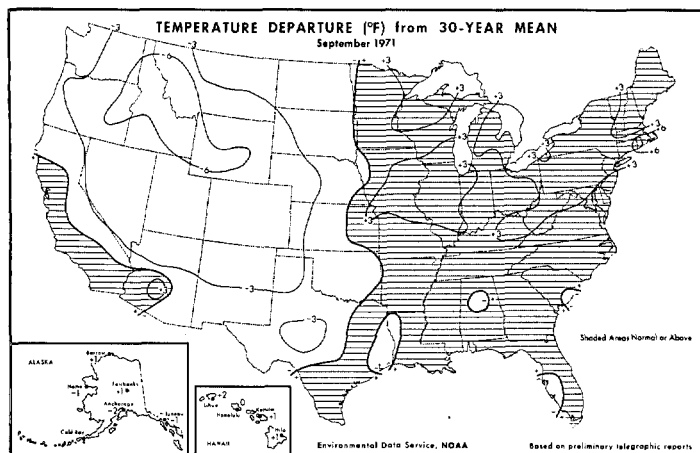


FIGURE 5.—Departure from normal of average surface temperature ( $^{\circ}$ F) for September 1971 (from Environmental Data Service and Statistical Reporting Service 1971).

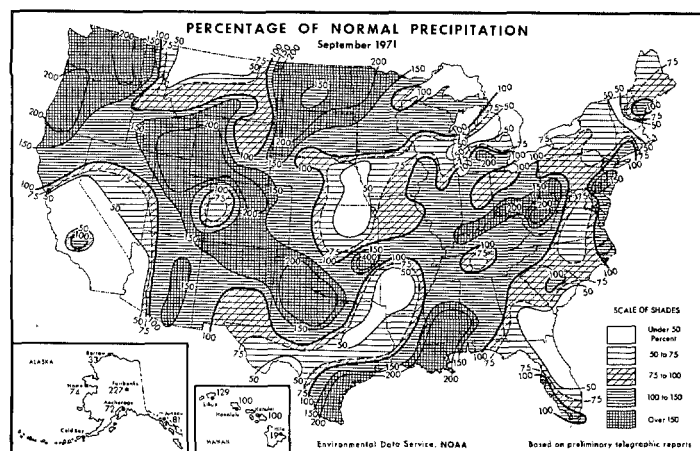


FIGURE 6.—Percentage of normal precipitation for September 1971 (from Environmental Data Service and Statistical Reporting Service 1971).

This September was the warmest one on record at Long Beach, Calif., where the mean temperature was  $76.1^{\circ}$ F. In the Central States, Rockford, Ill. ( $68.1^{\circ}$ F), Dubuque, Iowa ( $64.9^{\circ}$ F), and Milwaukee, Wis. ( $64.9^{\circ}$ F), all reported that this month was the warmest September since 1948.

This September was the coldest since 1912 at Flagstaff, Ariz., where the mean temperature was  $53.0^{\circ}$ F; and it was the second coldest at Pendleton, Oreg., with a mean of  $59.1^{\circ}$ F. The coldest September of record at Pendleton was in 1970, when the mean temperature anomaly pattern over the United States was very similar to that of this year, particularly in the West (Taubensee 1970).

### 3. MONTHLY PRECIPITATION

Although the precipitation pattern for September was somewhat chaotic, the heavier amounts, relative to normal, did tend to occur in the West, while the East was generally drier (fig. 6). More than twice the normal precipitation fell in several areas of the West, associated

primarily with the 700-mb mean troughs; whereas the heavier than normal rainfall along the Gulf Coast was due mainly to tropical activity. Parts of coastal Texas and Louisiana received more than 12 in. of rain during the month. Drier areas of the country included portions of the far Southwest, Montana, the Central Plains, the Lower Mississippi Valley, and the Southeast. In these areas, precipitation totals were less than half the normal September values.

This was the wettest month on record at Tulsa, Okla., where 18.81 in. of rain fell. The previous record was 18.00 in. during May 1943. This was the wettest September ever at Abbe Observatory in Cincinnati, Ohio, as rainfall there totaled 8.68 in. Elkins, W. Va., had its wettest September since 1911 with 6.29 in. of rain.

Some September snowfall records were established in the West with Ely, Nev., reporting 2.2 in., Sexton Summit, Oreg., 3.1 in., and Salt Lake City, Utah, 4.0 in.

## 4. WEEKLY WEATHER

### AUGUST 30–SEPTEMBER 5

The trend toward reversal of the 700-mb circulation over the United States began during the first week of September as fast zonal flow across the Pacific resulted in increased cyclonic activity in the West (fig. 7A). Likewise, the ridge that had been over the Rocky Mountains the previous week (Green 1971) progressed to a position near the East Coast.

Mean temperatures for the week responded to the circulation change as below normal temperatures were observed west of the Rocky Mountains and above normal values to the east (fig. 7B). A band of cooler air did remain over portions of the South and Southeast, however. Warmest temperatures relative to normal occurred to the west of the mean ridge, where departures reached  $+12^{\circ}$ F in Minnesota.

Weekly precipitation totals exceeded 2 in. over the Northwest and in numerous areas from the Dakotas to the Gulf Coast States where some localized totals exceeded 4 in. (fig. 7C). The greatest reported total for the week, 8.67 in., fell at New Orleans, La., due mostly to a weak tropical depression near the end of the week. Areas of the Southwest, Texas, and the Middle Atlantic States, however, had no rain during this period.

The week began cool in the Northeast as a large High pushed eastward from Canada. However, the High stalled off the East Coast and southerly flow to the rear brought strong warming to most of the eastern two-thirds of the Nation. By September 2, maximum temperatures over  $100^{\circ}$ F were recorded in the Dakotas.

Many showers and thunderstorms occurred in the Central States as gulf moisture streamed northward in the mean southerly flow to the west of the 700-mb ridge. By the end of the week, a slow moving cold front was causing some heavy precipitation as it moved through the Great Plains into the Mississippi Valley. In Oklahoma, Hobart received 4.75 in. of rain in 6 hr on the 4th and Tulsa, with 7.82 in. beginning on the 3rd and ending on

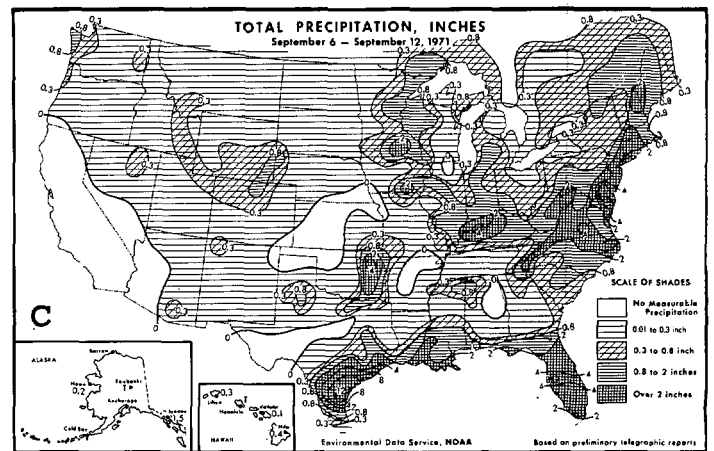
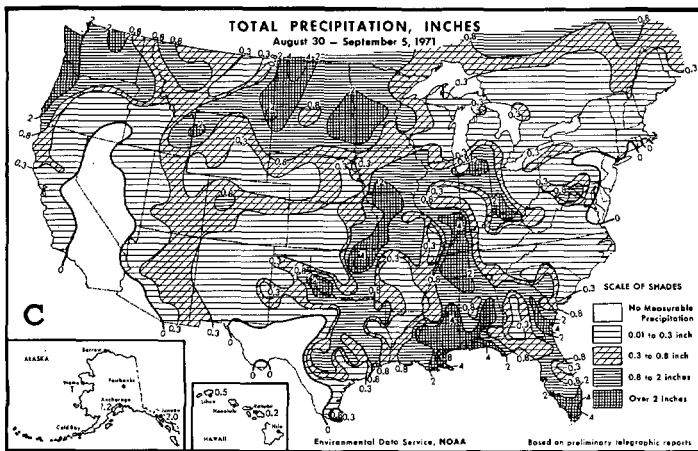
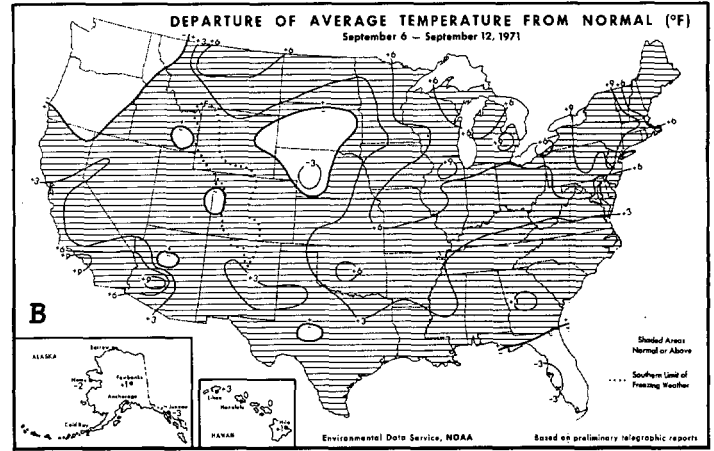
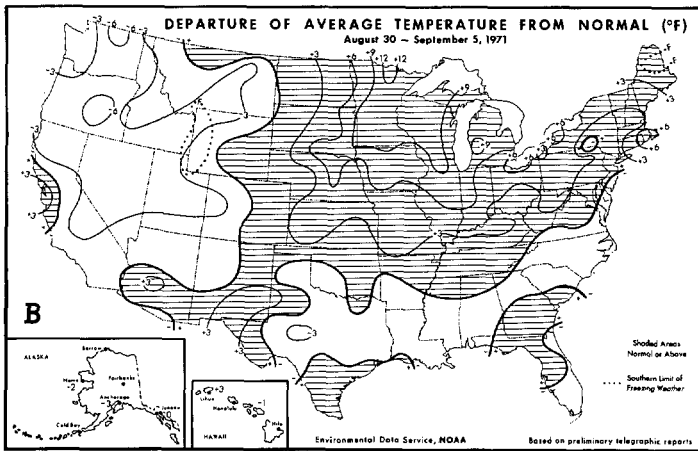
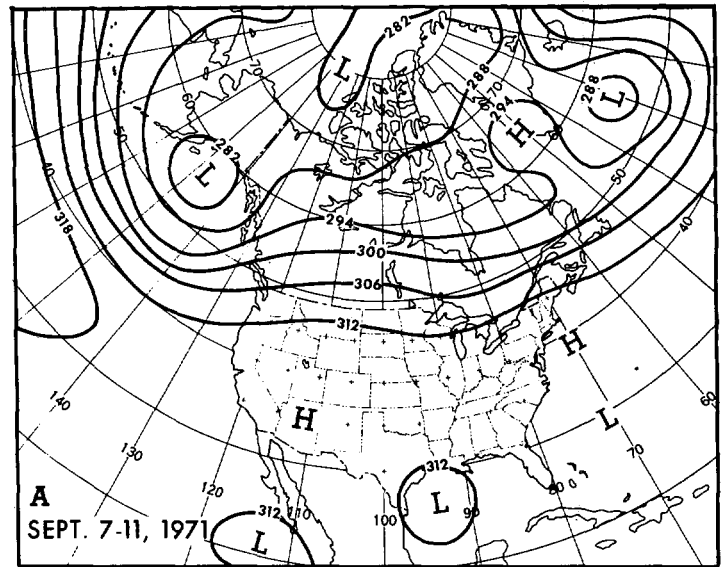
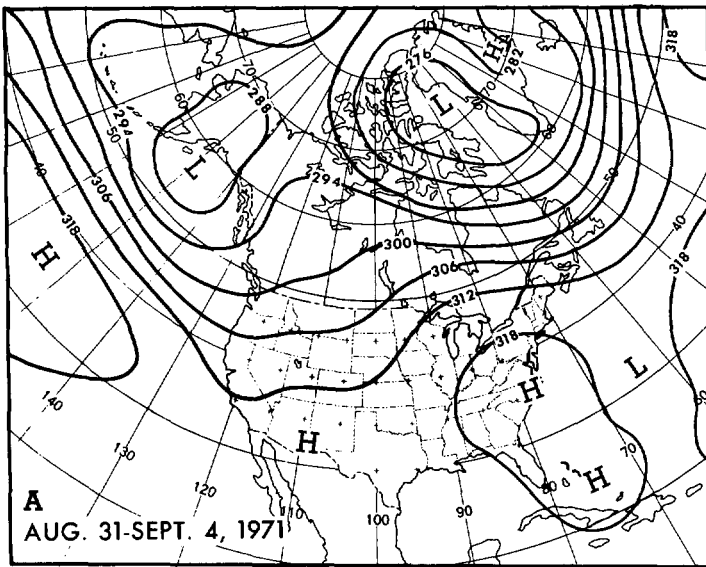


FIGURE 7.—(A) mean 700-mb contours (dam) for Aug. 31-Sept. 4, 1971; (B) departure from normal of average surface temperature (°F), and (C) total precipitation (in.) for Aug. 30-Sept. 5, 1971 (from Environmental Data Service and Statistical Reporting Service 1971).

FIGURE 8.—Same as figure 7, (A) for Sept. 7-11, 1971; (B) and (C) for Sept. 6-12, 1971.

the 6th, had flooding. Florida rainfall was primarily due to the passage of three weak tropical disturbances.

**SEPTEMBER 6-12**

A strong Gulf of Alaska Low was the primary feature of the 700-mb circulation this week (fig. 8A) as heights there averaged more than 200 m below normal. Down-

stream over North America the flow pattern showed little amplitude, and heights were above normal over most of the United States.

Mean temperatures for the period also were above normal over most of the Nation (fig. 8B). Departures reached at least 9°F above normal in portions of the Great Lakes, the Northeast, and in the far Southwest. September 12 was the warmest day of the year at Yuma, Ariz., with a maximum of 114°F. Temperatures were below normal

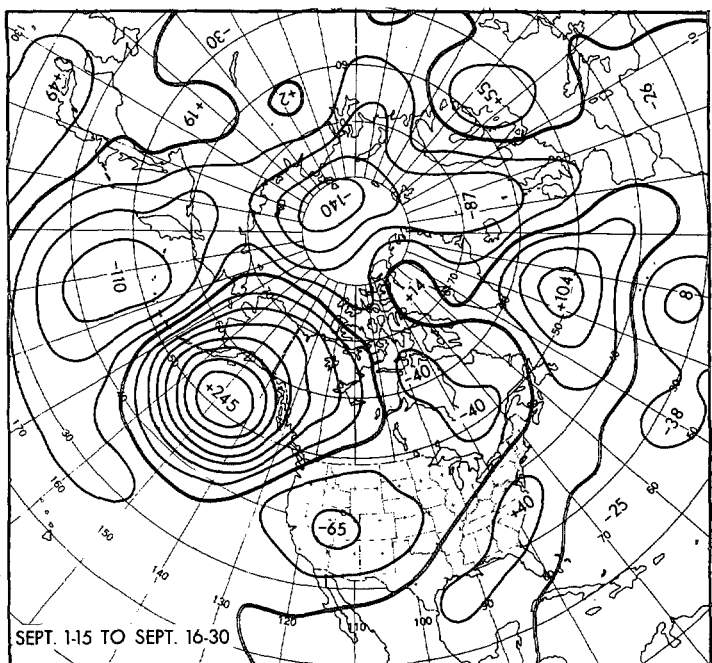


FIGURE 9.—Change in half-monthly mean 700-mb height (m) from Sept. 1-15 to Sept. 16-30, 1971.

in the far Northwest, part of the Northern Great Plains, and in Florida.

Weekly precipitation totals were greatest along the Gulf Coast and the Atlantic Coast during this period (fig. 8C). Hurricane Fern dropped more than 12 in. of rain on southern Texas, with at least one reported total of more than 20 in. Goliad, Tex., received 10.75 in. during a 24-hr period ending on September 11, and Tampa, Fla., had 8.37 in. for the week as nearly all parts of Florida experienced daily showers.

The front that was moving across the central United States at the end of last week lost its strength this week and ceased to be much of a weather maker. But similar to last week, daily temperatures reached their maxima about the middle of the period with 100°F readings in the Central Great Plains on the 7th, ahead of another cold front.

This cold front continued eastward and strengthened in the Great Lakes region as it received support from still another front and a sharp 700-mb trough. This system spread showers and thunderstorms eastward to the Atlantic Coast and, augmented by some moist tropical air, caused heavy rain along the coast, particularly in Maryland. There, precipitation, unofficially totaling up to 10 in. over the 11th and 12th, caused some flooding.

SEPTEMBER 13-19

The mean 700-mb circulation changed abruptly as the zonal flow of the first two weeks gave way to an amplified pattern that continued for the rest of September. The change between the mean 700-mb height of the first half of the month and that of the amplified pattern of the second half is shown in figure 9. The change in the mean circulation is also evident in the 700-mb zonal westerlies,

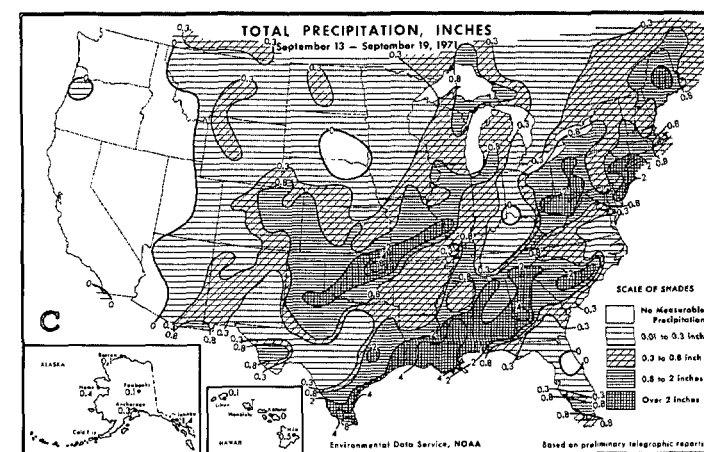
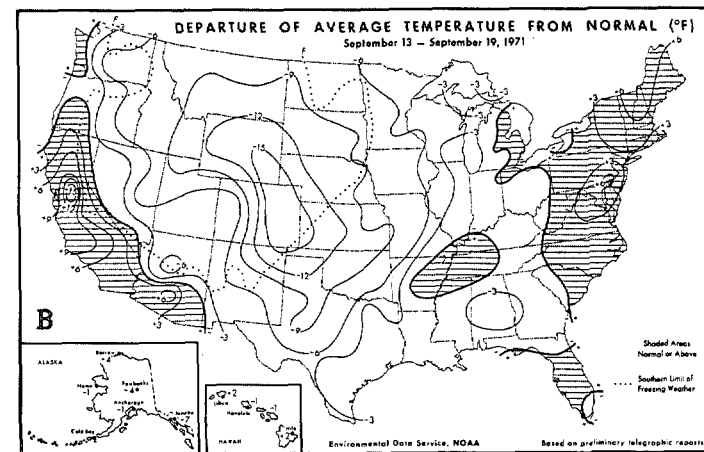
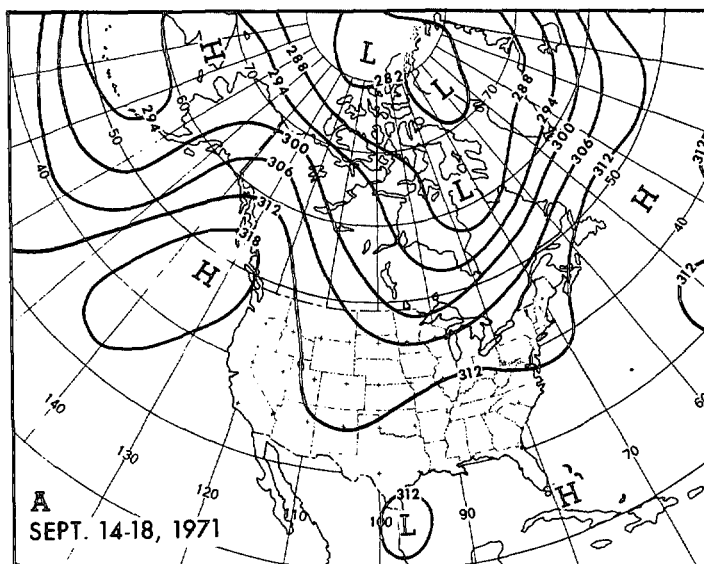


FIGURE 10—Same as figure 7, (A) for Sept. 14-18, 1971; (B) and (C) for Sept. 13-19, 1971.

which averaged 9.6 m/s for the Western Hemisphere during the first half and only 6.0 m/s for the second half.

The extratropical remnant of typhoon Wendy moved into the Bering Sea by the middle of the third week in September, helping to establish a mean trough there. A strong ridge was observed over the eastern Pacific, and a trough covered much of North America east of the Rocky Mountains (fig. 10A). The southeastern United States remained under the influence of a weak ridge.

Mean temperatures over the United States were almost everywhere lower than those of the previous week, averaging below normal over much of the Nation (fig. 10B). Lowest temperatures relative to normal were along the eastern slopes of the Central Rocky Mountains where departures exceeded  $-15^{\circ}\text{F}$ .

Higher than normal temperatures prevailed over most of the East Coast States and in the far West where readings above  $100^{\circ}\text{F}$  were quite common throughout the week in Arizona and California. The temperature at San Francisco reached  $103^{\circ}\text{F}$  on September 14, the highest September temperature on record.

Weekly precipitation totals exceeded 2 in. over portions of the East from the western Gulf Coast States to New England (fig. 10C). Little precipitation occurred west of the Rocky Mountains as northerly winds predominated at 700 mb during the week. Precipitation in the Northeast was mostly associated with the lingering Low of the previous week along with moisture from weakening tropical storm Heidi which lost its identity over the Atlantic south of Maine on the 14th. Severe flooding in southeastern Pennsylvania caused 13 known deaths and property damage estimated at \$7.5 million.

The heavier precipitation amounts in the Southeast came from hurricane Edith which crossed the Louisiana coast on the 16th, accompanied by heavy rains and a few tornadoes. There was relatively little damage, however, and no known loss of life.

Cold Canadian air began moving into the Northern Rocky Mountains early in the period, and, as it pushed southward, up to 2 ft of snow fell in eastern Colorado with some stations reporting record snowfall for so early in the season. At the end of the week, the bulk of the cold air was located over the Central Rocky Mountains. A minimum temperature of  $20^{\circ}\text{F}$  at Denver, Colo., set a new September record there, while freezing temperatures,  $31^{\circ}\text{F}$  on the 18th and  $30^{\circ}\text{F}$  on the 19th, were observed at Grand Junction for the first September since 1908.

At the end of the week, rain was falling from the Great Lakes southwestward to Texas as a surface Low was developing over Illinois with a frontal wave to the south.

**SEPTEMBER 20-26**

This week the circulation returned to basically the monthly pattern, with a trough in the West and a ridge in the East (fig. 11A). Mean temperatures for the period remained rather low, however, as only in the Southeast did temperatures average significantly above normal (fig. 11B). The coolest air with respect to normal was in the Texas Panhandle region where temperatures averaged more than  $12^{\circ}\text{F}$  below normal.

Precipitation was on the lighter side, as amounts in excess of 2 in. were limited primarily to the Central and Southern Great Plains and to several isolated areas near the Ohio Valley (fig. 11C). Most of the precipitation in the Texas-Oklahoma region was associated with a stationary front that lingered south of the area. Much of the Southwest received no measurable precipitation during the week.

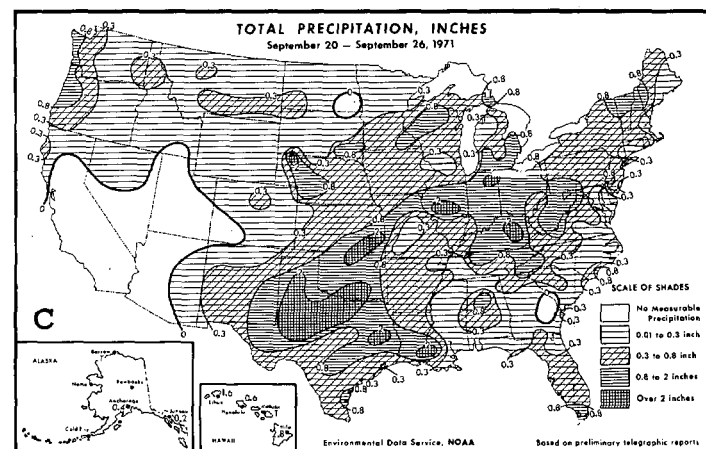
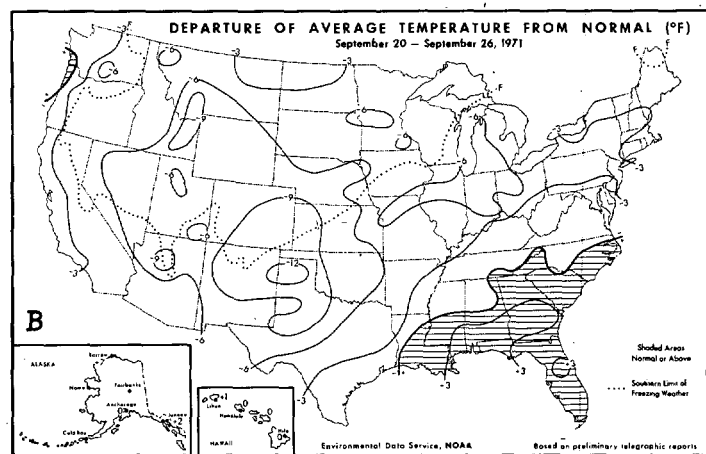
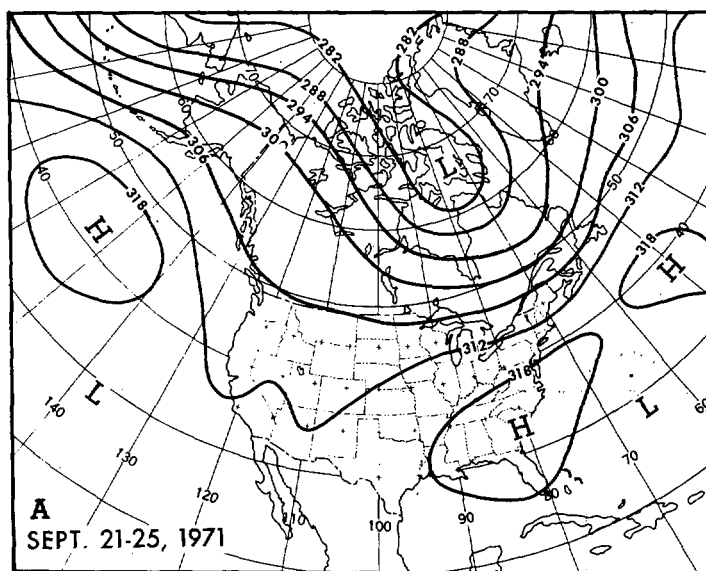


FIGURE 11.—Same as figure 7, (A) for Sept. 21-25, 1971; (B) and (C) for Sept. 20-26, 1971.

The week began as a cold one in the Southern Rocky Mountains as record-equaling September minima were observed at Roswell, N. Mex. ( $33^{\circ}\text{F}$ ), and El Paso, Tex. ( $44^{\circ}\text{F}$ ), on September 20. Meanwhile, rain fell over much of the East as a frontal system moved out of the Ohio Valley.

A new intrusion of cold air began moving into the Northern Rocky Mountains on the 20th. The cold front moved steadily eastward and southward until it became



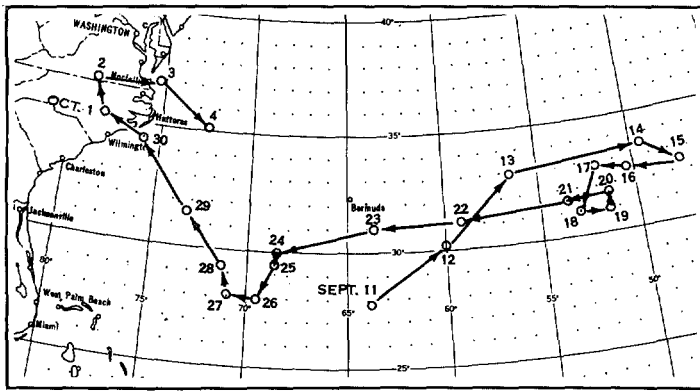


FIGURE 12.—Track of hurricane Ginger from Sept. 11–Oct. 4, 1971. Daily positions, indicated by circles, taken from National Meteorological Center 1200 GMT Northern Hemisphere surface analyses.

stationary over the South, where it dissipated by the end of the week.

During the last few days of the month, temperatures over the Nation from the Great Plains eastward began to rise as the 700-mb ridge strengthened over the East. By the 30th, strong warming was occurring ahead of a front that stretched from the Dakotas to a Low in the Central Rocky Mountains. Maxima of 90°F or higher were observed in the Mississippi Valley as far northward as Iowa and Illinois, while snow was falling over the Rocky Mountains.

On the last 2 days of September, the Nation felt the effects of two tropical systems. Beginning on the 29th, parts of Arizona and New Mexico had more than 2 in. of rain due principally to moisture brought northward from tropical storm Olivia which was then weakening

over Baja California. At approximately the same time, hurricane Ginger began to affect the North Carolina Coast. The hurricane moved inland on the 30th, accompanied by heavy rains and winds that gusted to 90 mi/hr along the coast. The weakening storm caused rain over the East Coast from the Carolinas northward to Pennsylvania during the first few days of October, until it moved back over the Atlantic on the 4th.

Both Olivia and Ginger were notable storms. Olivia developed from the remains of Atlantic hurricane Irene, which had lost its strength while crossing the mountains of Central America on the 19th. Hurricane Ginger, lasting 28 days, was the longest-lived Atlantic tropical cyclone on record. It reached hurricane intensity on the 11th, south of Bermuda, and maintained its strength as it moved eastward until the 15th. The storm then reversed direction, moving westward in response to easterly flow south of a building 700-mb blocking High. It continued moving generally westward, reaching the United States on the 30th (fig. 12). Ginger was a target for seeding experiments on the 26th and 28th.

#### REFERENCES

- Environmental Data Service, NOAA, U.S. Department of Commerce, and Statistical Reporting Service, U.S. Department of Agriculture, *Weekly Weather and Crop Bulletin*, Vol. 58, Nos. 36–41, Sept. 6, 13, 20, 27, and Oct. 4 and 11, 1971.
- Green, Raymond A., "Weather and Circulation of August 1971—Warm and Dry in the Northern Plains, Cool and Wet in the Southern Plains, Recurrent Tropical Rainfall Along the Atlantic Coast," *Monthly Weather Review*, Vol. 99, No. 11, Nov. 1971, pp. 889–894.
- Taubensee, Robert E., "The Weather and Circulation of September 1970—Warm in the East and Cool in the West With Heavy Precipitation in Many Central Areas," *Monthly Weather Review*, Vol. 98, No. 12, Dec. 1970, pp. 938–943.