

WEATHER AND CIRCULATION OF OCTOBER 1981— A Month with Strong High-Latitude Blocking

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1. Mean circulation

The pronounced trend toward high-latitude blocking that was well under way in September (Taubensee, 1981) culminated in early October over eastern Canada. Neither the monthly mean 700 mb contours (Fig. 1) nor their departure from normal (Fig. 2) is sufficient to portray the extreme intensity of this phenomenon. This is largely because the blocking disappeared from eastern Canada rather rapidly during mid-month, although it persisted elsewhere.

Fig. 3a, which shows the mean 700 mb height departure from normal for the period 1–15 October only, is a better illustration of the intensity of the block over eastern Canada. A negative anomaly of -78 m near Nova Scotia is surmounted by a much larger positive anomaly of 193 m directly to the north over Baffin Island—a differential of 271 m! This is sufficient to yield a net mean easterly geostrophic flow in that area. That intense anomaly did not persist, and Figs. 3a and 3b together reveal the large

circulation changes that occurred over that region and over the North Atlantic between the two halves of October.

Elsewhere around the hemisphere, fluctuations within the month were not as dramatic. Consequently, the monthly mean conditions represented by Figs. 1 and 2 are more meaningful. Strong high-latitude blocking is depicted for all quadrants and was quite prevalent over Asia throughout the month. This is unusual for October. Overall, the observed high-latitude monthly mean pattern is a striking departure from that of August (Wagner, 1981b), which featured a deep polar low surrounded by strong ridges.

As in August, the monthly mean height anomalies at high latitudes (Fig. 2) are large. The three positive centers over the Soviet Union, the Arctic, and the Bering Sea are all approximately three standard deviations above the mean. However, these are based on only 23 years of record (1948–70). Even the $+99$ m anomaly near the southern tip of Greenland,

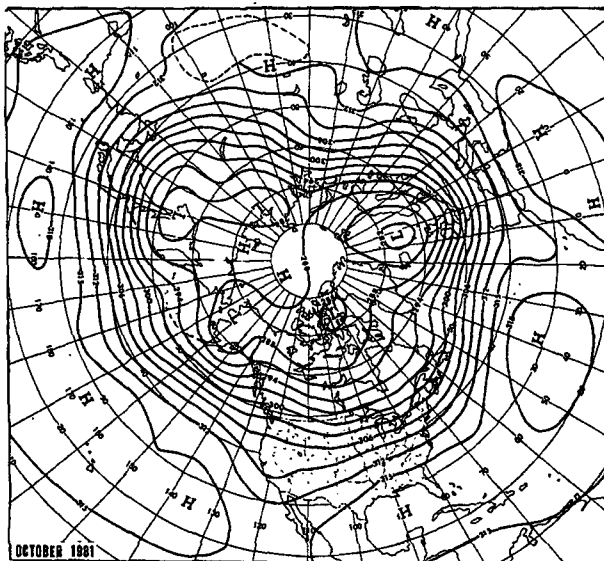


FIG. 1. Mean 700 mb height contours (dam) for October 1981.

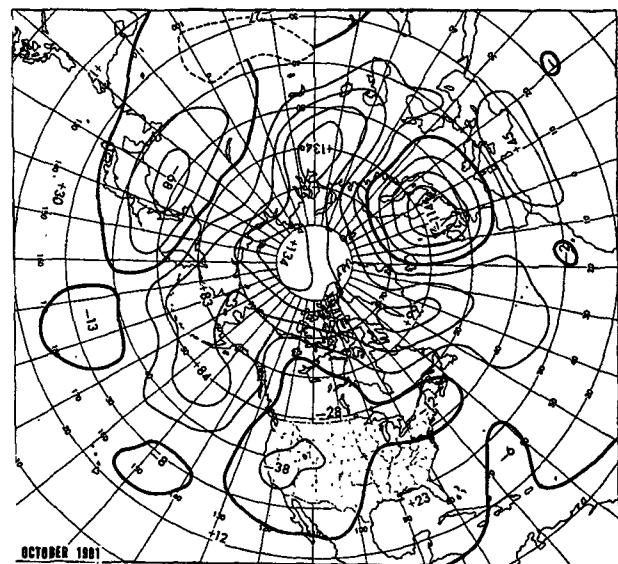


FIG. 2. Departure from normal of mean 700 mb height (m) for October 1981.

which was largely accounted for by only the first half of the month, represents a normalized deviation of nearly 2.

At middle and lower latitudes, mean circulation anomalies were generally smaller than those at high latitudes. Over the contiguous United States, the pattern was quite different between the two halves of October (Fig. 3), but with only moderate mean departures from normal (Fig. 2). Early in the month, the southern branch of the westerlies was depressed southward, undercutting the blocking pattern. With the disappearance of the Canadian block during the month, the westerlies over North America and the Atlantic broadened and shifted northward, and weather systems generally became more progressive.

To the east, a rather deep mean low was centered over the Norwegian Sea, with a broad trough extending southward over western Europe. Those features represented a modest eastward advance of the mean September pattern (Taubensee, 1981). Under the broadly cyclonic westerly flow, most of central and western Europe experienced a wet month with near-normal temperatures.

Farther to the east, the large positive height anomaly over the Ural Mountains continued a pattern that had existed, with some fluctuations, since midsummer (Taubensee, 1981; Wagner, 1981b). With the disappearance of the Canadian blocking during mid-month, some of the Arctic height anomaly shifted toward northwestern Siberia and the Urals, reinforcing the mean ridge in that region and giving it some eastward movement.

As Autumn advanced, the mean ridge near the Urals was accompanied by downstream formation and advection of cold air masses over central and eastern Asia. In turn, these helped to strengthen and maintain a strong mean baroclinic zone and a deeper-than-normal mean trough near the Asian east coast. A stronger-than-normal jet stream also prevailed over that region. These factors plus two typhoons recurving east of the mean trough provided the ingredients for some intense offshore cyclogenesis and helped make October a relatively stormy month in the northwestern Pacific.

2. Temperature

Temperatures averaged somewhat below normal over nearly all of the contiguous United States (Fig. 6). For the eastern half of the country this was a continuation of the trend established in September (Taubensee, 1981). Although the circulation (and the causes of the below-normal temperatures) changed markedly during October, the mean wind pattern for the month—showing a southward displacement of the 700 mb maximum wind axis over the eastern United States (Fig. 4)—is in qualitative agreement with below average temperatures.

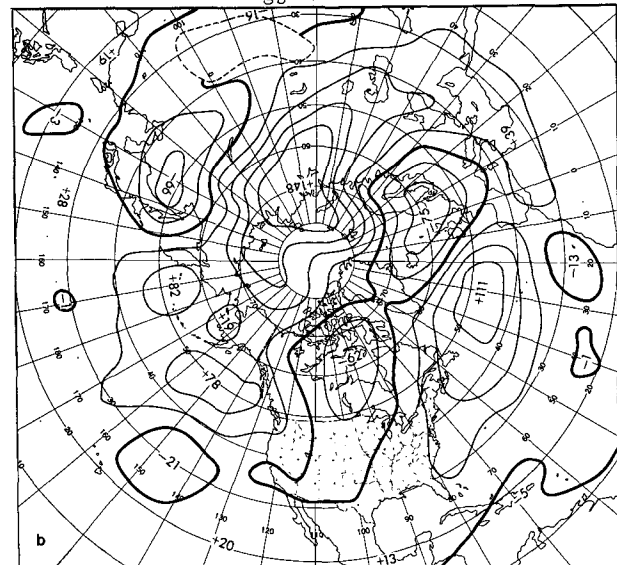
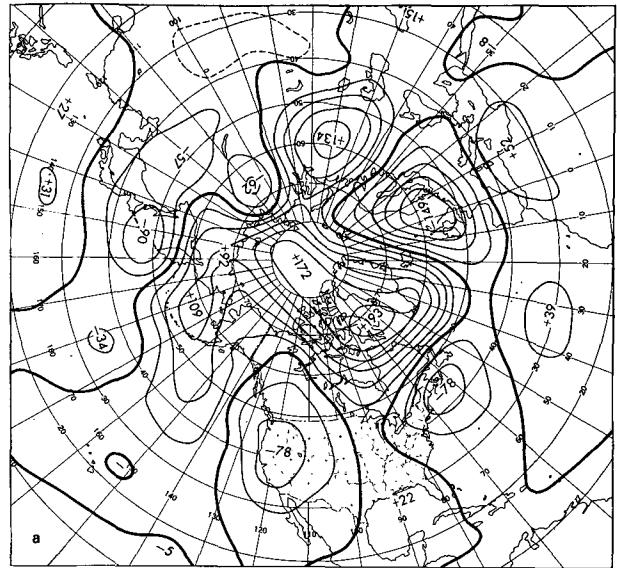


FIG. 3. As in Fig. 2 except for (a) 1-15 October only and (b) 16-31 October only.

Monthly departures from normal were largest over the Great Lakes region and southern New England. Even there, however, they were not extreme, averaging -5 to -6°F (Fig. 6). Negative departures elsewhere were mostly under 4°F . Near or slightly above normal temperatures were recorded only for the Florida peninsula, portions of the Gulf States, and small areas near Cape Hatteras, the Rockies and in the Far West. The overall pattern of mean temperature is in general agreement with the mean monthly thickness departure from normal (Fig. 5).

Temperatures over most of Alaska averaged near normal. An exception was the interior, where warm southerly flow in the latter part of the month caused

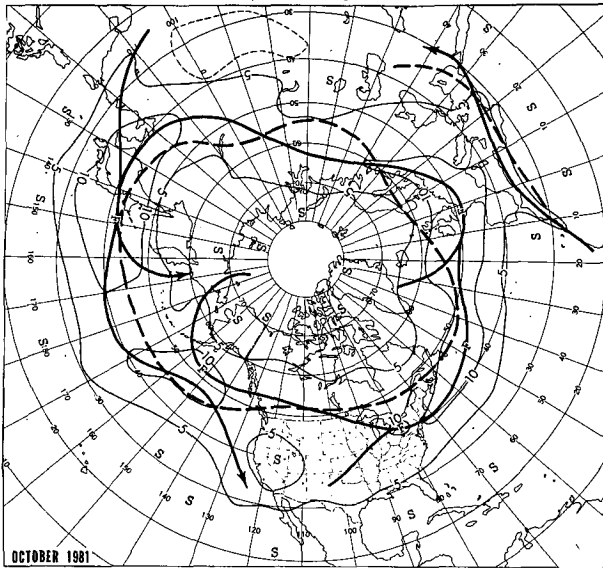


FIG. 4. Mean 700 mb geostrophic wind speed ($m s^{-1}$) for October 1981. Solid arrows indicate observed axes of maximum wind speed and dashed lines, the normal.

temperatures to average above normal. Fairbanks recorded a mean departure of $+5^{\circ}F$ for the month. Over the Hawaiian Islands temperatures were near normal.

3. Precipitation

Precipitation was above average over most of the United States (Fig. 7). Only small scattered areas showed less than 50% of normal, while large sections of New England, the South, the upper Great Lakes and the Far West all exceeded 150%. A few stations

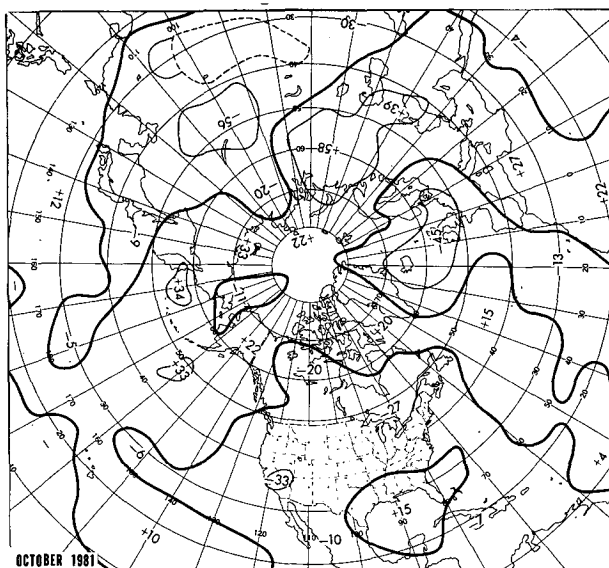


FIG. 5. Departure from normal of mean 1000-700 mb thickness (m) for October 1981.

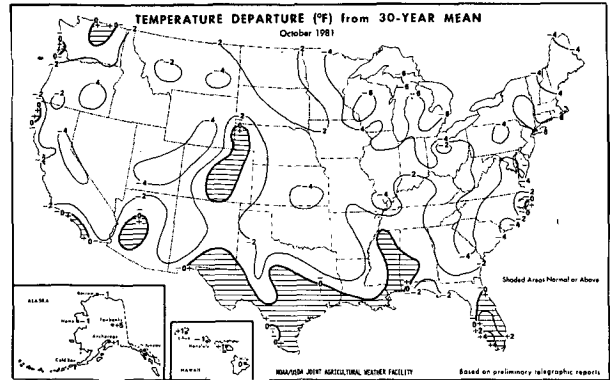


FIG. 6. Departure from normal of average surface air temperature ($^{\circ}F$) for October 1981 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service and World Agricultural Outlook Board, 1981).

reported record amounts (Table 1). However, because October is normally a relatively dry month for most parts of the Nation, the monthly totals were excessive only in parts of Texas and Oklahoma, a small area of New England, and along the Pacific Northwest coast.

Circulation features associated with the above-normal precipitation were quite varied. The blocking pattern over Canada, described earlier, was accompanied by several cyclones and their associated precipitation shields tracking eastward across the Great Lakes and New England. In the South, much of the rainfall was directly or indirectly associated with the remnants of three eastern Pacific tropical cyclones that crossed Mexico into Texas at various times during the month (see Sections 4 and 5). Rainfall was especially heavy over Texas and Oklahoma, where abundant Gulf moisture was available, and where some intense convective storms occurred. Over the intermountain plateau and the Far West, more than the usual number of cyclonic invasions from the Pa-

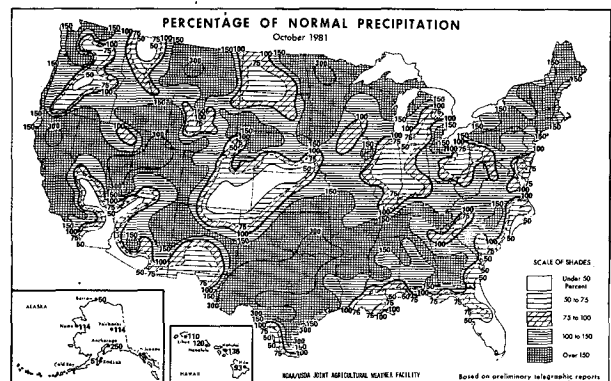


FIG. 7. Percentage of normal precipitation for October 1981 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service and World Agricultural Outlook Board, 1981).

cific contributed to the above-normal precipitation totals.

Despite the generally above-normal rainfall this month, scattered areas of the country still suffer from long-term drought. These include small areas of the central and southern Appalachians, and parts of the southeastern states, the Northern Plains, the Rockies and the far Southwest. As noted by Wagner (1981b), most of the nation has been receiving beneficial rainfall since May 1981; and the long-term drought in the aforementioned areas is largely the result of accumulated deficits beginning in spring or summer 1980 which have since been reduced but not eliminated. However, recent dryness has again aggravated conditions in some local areas. For example, Richmond, VA, Asheville, NC, and Jacksonville, FL, all have just concluded three consecutive months of sub-normal rainfall.

Although a high percentage of the nation's rainfall undoubtedly has been beneficial, a few areas have been excessively wet in recent months. These include portions of Texas, Oklahoma, Missouri, and the Great Lakes region.

Over Alaska, October precipitation was generally above normal except in the north, where blocking over the Arctic apparently helped to keep cyclones away from that region. Rainfall over Hawaii averaged near or slightly above normal.

4. Weekly variability

a. 28 September–4 October

The high-latitude blocking pattern intensified markedly this week, with a separate 700 mb anti-cyclone center forming over southern Greenland (Fig. 8a). To the south, a low deepened over the Gulf of St. Lawrence. In response to this pattern, surface cyclones developed and moved eastward across the Great Lakes, New England and southeastern Canada, with cool wet weather prevailing in those regions (Figs. 8b, 8c).

Upstream, a 700 mb low over the Gulf of Alaska also deepened, with a separate weak low center and trough along the California coast. The former brought some moderate-to-heavy rains to coastal areas of Washington and British Columbia, while the latter

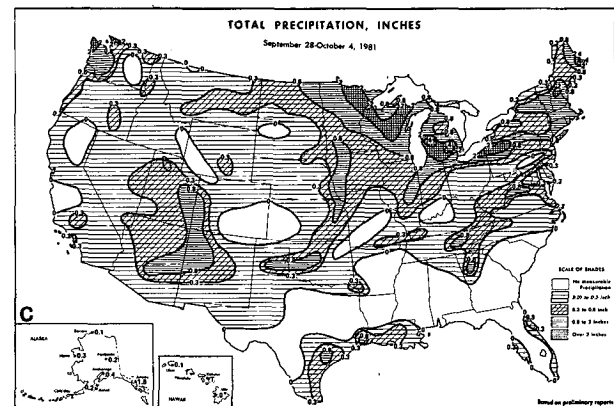
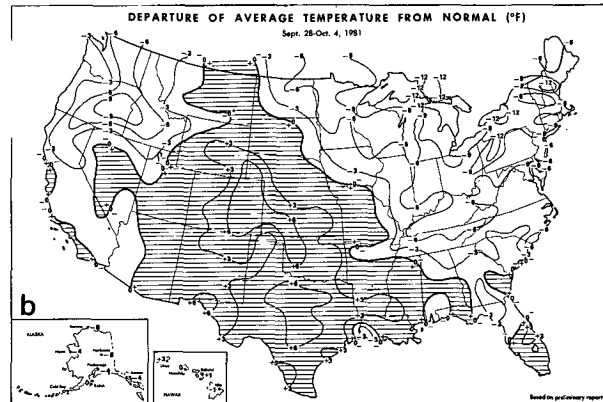
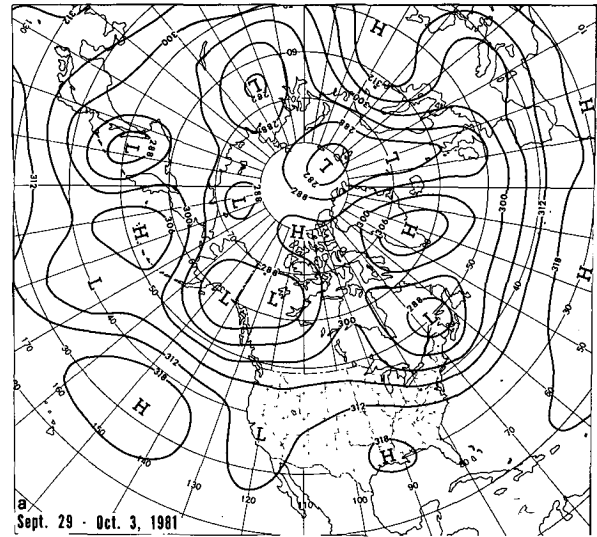


TABLE 1. Record and near-record monthly precipitation totals observed over the United States during October 1981.

Station	Total (inches)	Anomaly (inches)	Remarks
Abilene, TX	10.68	+8.08	2nd wettest October (since 1899)
Fort Worth, TX	14.18	+11.50	Wettest month (since 1899)
San Angelo, TX	8.68	+6.82	Wettest October since 1941 ¹
Concord, NH	6.51	+3.83	5th wettest October
Ely, NV	3.67	+3.07	Wettest month
Salt Lake City, UT	3.91	+2.75	Wettest October

¹ Since before 1907 if unofficial observations are included.

FIG. 8. (a) Mean 700 mb contours (dam) for 29 September–3 October 1981, (b) departure from normal of average surface air temperature (°F), and (c) total precipitation (inches) for week of 28 September–4 October 1981 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service and World Agricultural Outlook Board, 1981).

was associated with slowly moving frontal systems and showers over the intermountain plateau to the southeast.

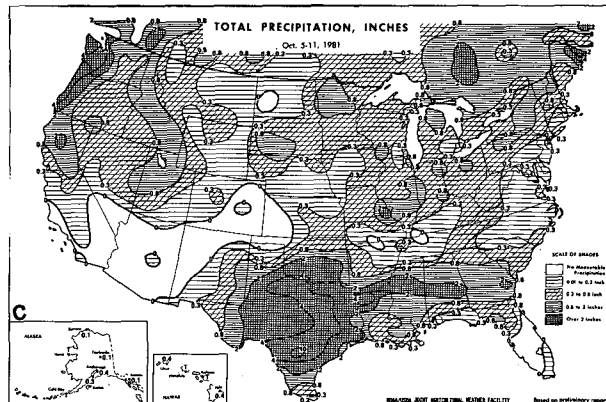
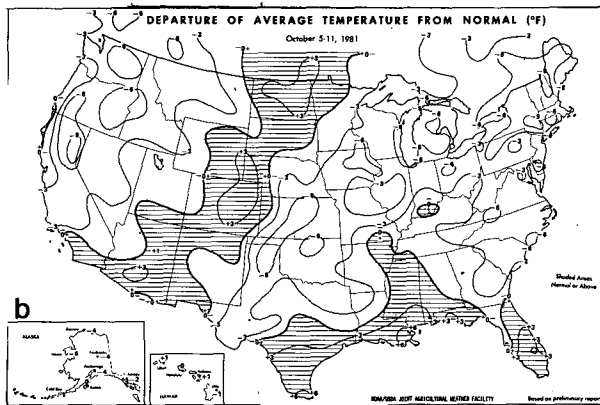
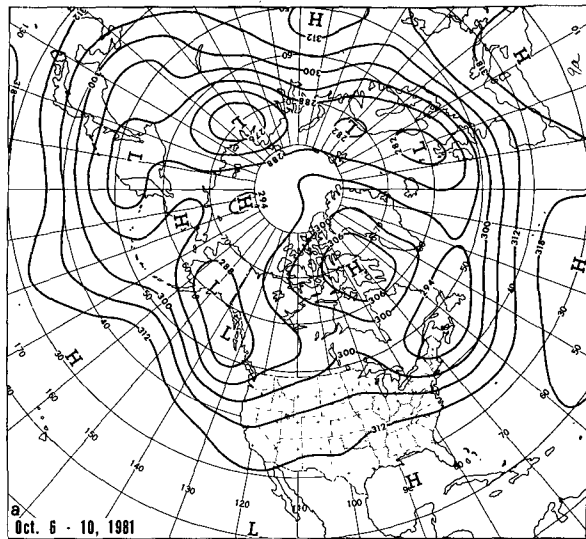


FIG. 9. As in Fig. 8 except for (a) 6–10 October 1981, and (b) and (c) week of 5–11 October 1981.

Over the central part of the nation, warm air surged northward during midweek. On 30 September, maximum temperatures reached into the nineties as far north as Iowa and Illinois. The warmth in that area was short-lived, however, as a vigorous

cold front pushed southeastward, lowering daily maxima by 20–25°F. Light snow covered northern Minnesota on 1 October. But in advance of the cold front on 1 October, maximum temperatures were again in the low nineties across much of the deep South. The front swept eastward to the coast on the 2nd, but caused little rainfall over the southeastern states (Fig. 8c).

Temperatures tumbled behind the front. By the morning of 3 October cold air had overspread nearly all of the eastern United States, and below-freezing minima were noted at many stations in the Great Lakes region and Ohio Valley. Tallahassee, FL, reported a minimum of 42°F—the lowest so early in the season.

Over the southern Great Plains, the warm air was more persistent. Temperatures reached the nineties over parts of Texas on every day of the week, with weekly mean anomalies as much as +6°F (Fig. 8b). Most of the Rockies also averaged above normal. The interior Pacific Northwest was cooler than normal, under the influence of maritime air invasions from the west and northwest.

Alaskan temperatures and precipitation both averaged somewhat below normal. Over Hawaii, above-average shower activity occurred at some windward locations such as Hilo, but only light showers elsewhere. Temperatures were near normal.

b. 5–11 October

The blocking pattern over North America reached maximum intensity during this week. The high-latitude 700 mb anticyclone retrograded from southern Greenland to Baffin Island, with strong and anomalous easterly geostrophic flow over Labrador (Fig. 9a). To the south, the low that had been over the Gulf of St. Lawrence continued in that region, with a trough extending southward off the U.S. East Coast. Troughs also continued over northwestern Europe and along the west coast of North America. The negative height anomalies associated with the latter trough expanded southeastward from their location of the previous week, with the trough extending into the low latitudes of the eastern North Pacific.

The elongated eastern Pacific trough apparently helped to steer Tropical Storm Lidia northward into western Mexico on 7–8 October (see Section 5). At least several fatalities reportedly occurred in western Mexico, along with heavy rains, local floodings, and considerable crop damage. The remains of the storm crossed the Mexican highlands into Texas, where heavy rains had already occurred in connection with a slowly moving frontal system. Over much of Texas, weekly rainfall totals ranged between four and ten inches (Fig. 9c), causing local floods. The rains

spread eastward over some drier areas of Mississippi, Alabama and Georgia, and were very beneficial in those areas.

Rainfall was also heavy over coastal sections of Washington and Oregon, largely due to an intense cyclone early in the week. Over most remaining areas of the nation, precipitation was either moderate or light.

Temperatures nationwide were mostly below normal (Fig. 9b), but without the large fluctuations of the previous week. No extremes were reported. Alaska continued relatively cool and dry, as Pacific cyclones remained largely south of that state. Hawaii had near normal temperatures, with only light showers.

c. 12-18 October

The blocking regime over eastern Canada disappeared very rapidly this week. The process apparently began near the end of the previous week with the formation of a weak low over the Arctic near northeastern Greenland. That low may have been a poleward extension of the cyclonic area over Britain and the Norwegian Sea. The low deepened rapidly and moved westward to the Canadian Arctic (Fig. 10a), occupying almost the same position as did the blocking high a week earlier (Fig. 9a). That high, now disappeared, had weakened and divided, with one portion of the anomaly moving toward Siberia and the other drifting southward.

As these high-latitude changes were occurring, middle-latitude waves became more progressive. The 700 mb ridge in the eastern Pacific advanced to the coast of British Columbia (Fig. 10a). The trough that had been over the West Coast was shunted southeastward, and the ridge in the central United States moved eastward and merged with a portion of the anticyclonic anomaly that had moved southward from Baffin Island. The low over the Gulf of St. Lawrence was displaced eastward and weakened rapidly. A residual trough remained off the southeast U.S. coast (Fig. 10a).

Over Europe and Asia, the middle-latitude wave pattern also advanced. The ridge over the Urals amplified. Blocking continued over eastern Asia.

The southwesterly mean flow over Mexico and the adjacent Pacific (Fig. 10a) again helped to steer a tropical cyclone into Mexico and its remnants into Texas. Heavy convective rains again fell over Texas, but as in the previous week, the rains were partly related to a slowly moving frontal system and abundant low-level moisture already in the area. A number of Texas localities reported 24 h totals of 3-7 inches on 12-13 October, with local flooding. Heavy rains also occurred over parts of Oklahoma, Arkansas and Missouri (Fig. 10c).

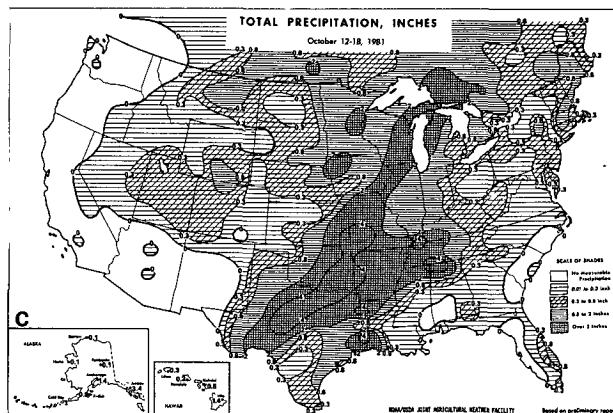
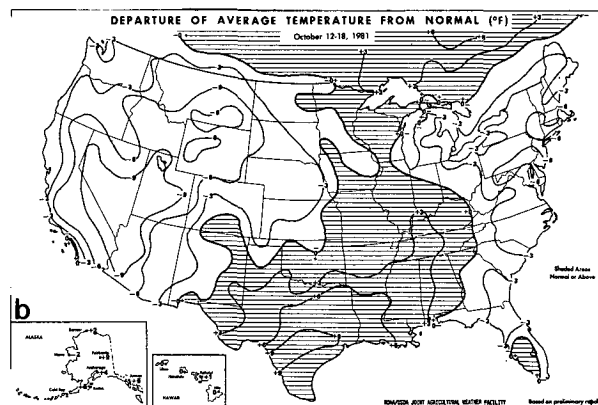
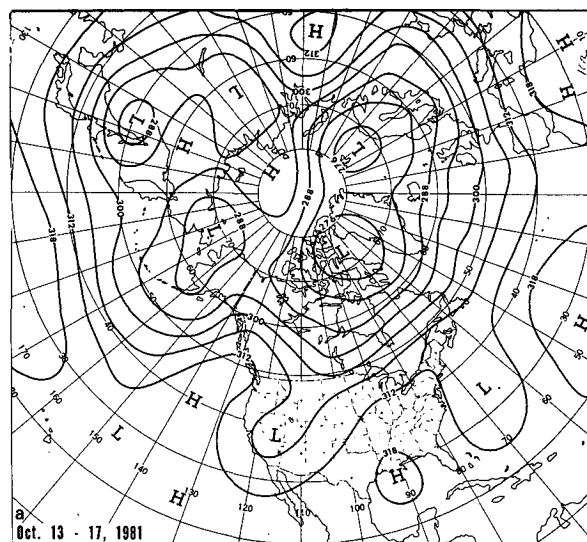


FIG. 10. As in Fig. 8 except for (a) 13-17 October 1981, and (b) and (c) week of 12-18 October 1981.

As the blocking disappeared from Canada, a well-developed surface anticyclone moved southward from Hudson Bay and temporarily stagnated over the northeastern states, bringing clearing skies, light

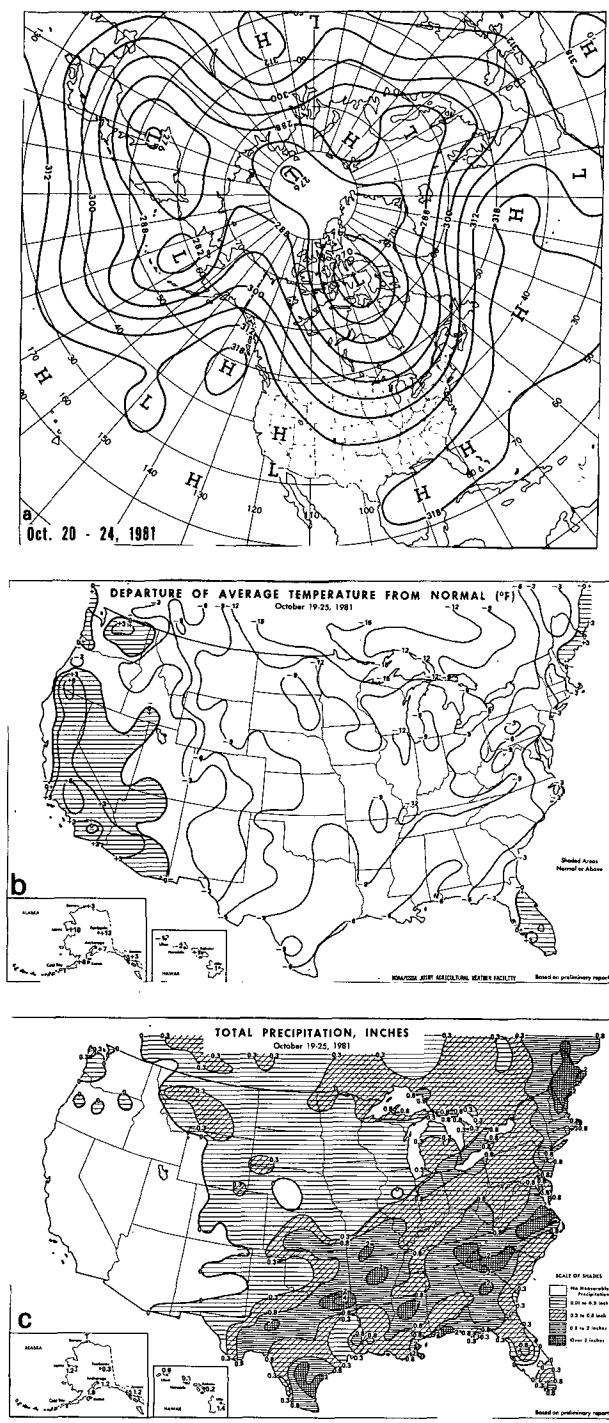


FIG. 11. As in Fig. 8 except for (a) 20–24 October 1981, and (b) and (c) week of 19–25 October 1981.

winds and below-normal nighttime temperatures to that region. Providence, RI, reported a minimum of 22°F on the 13th—the lowest so early in the season. Anticyclonic conditions also dominated the south-

eastern states, which had mostly near normal temperatures and light rainfall.

The 700 mb ridge that moved to the coast of British Columbia (Fig. 10a) was accompanied by a surface anticyclone and drying conditions over the Pacific Northwest. Temperatures were below normal over the West (Fig. 10b), in response to the mean northerly component along the coast. On the western side of the ridge, southerly flow and above-normal temperatures returned to Alaska. Precipitation was light in the interior but above normal along the south coast. Hawaii temperatures continued normal, with light shower activity.

d. 19–25 October

The 700 mb wave pattern amplified and strengthened this week (Fig. 11a). A deep cyclone was positioned just north of Hudson Bay with a trough directly southward across the Great Lakes and the east-central United States. Strong ridges were located upstream just west of British Columbia and downstream over the central Atlantic.

In response to this pattern and to the large mean northerly component over western North America, cold Arctic air invaded much of the country. On 23 October, numerous stations in Iowa, Illinois, Nebraska, Minnesota and Wisconsin reported record minimum temperatures for the date. This was repeated the following day in Wisconsin, Illinois and the Ohio Valley. Indianapolis, IN, Milwaukee, WI, and Little Rock, AR, also reported their lowest temperatures so early in the season. Weekly departures from normal of -9 to -12°F covered a large area (Fig. 11b). No monthly records were reported, however.

Precipitation was moderate over most areas east of the Rockies (Fig. 11c) but was very light in the West. The far Southwest, under anticyclonic conditions, was sunny, mild and dry.

In Alaska, temperatures were above normal, especially in the interior, as mean southerly flow intensified over that state. Precipitation was moderate. Hawaii had light showers and near normal temperatures.

The general amplification of the 700 mb pattern, mentioned earlier, was associated with some important events over east Asia and the western Pacific. As the strong ridge over the Urals moved eastward and merged with a portion of the Arctic anticyclonic anomaly, a vigorous cyclonic impulse moved southeastward from central Asia on 22 October and into the deepening mean trough along the Asian east coast. Additionally, a vast reservoir of cold air covered Siberia, and Typhoon Gay was approaching Japan and the strong cold front moving out of Asia. Explosive cyclogenesis occurred on 23 October. Min-

imum sea-level pressure over Sakhalin fell below 950 mb. The mean upper-level westerly flow over Japan and the North Pacific increased markedly during and after these events, with subsequent rearrangement of the long-wave pattern.

e. 26 October–1 November

Over the North Pacific, the increased westerly flow early in the week led to the elimination of the mid-Pacific trough. The southern part of that trough became a cutoff low. A ridge developed over the western Pacific and a trough deepened over the eastern Pacific (Fig. 12a). These changes were rapid and dramatic and are not well inferred from a simple displacement of 5-day mean systems between Figs. 11a and 12a. The resultant pattern over the eastern Pacific and North America (Fig. 12a) was almost a phase reversal of that of the previous week.

East of the Rockies, temperature trends were also quite marked, with a pronounced warming in many areas (Fig. 12b). The northern Great Plains experienced a change in weekly anomalies from approximately -9°F to $+9^{\circ}\text{F}$. Warming over the Ohio Valley and Middle Atlantic States was less pronounced but still substantial. In the West, temperatures averaged near or slightly above normal and were not greatly changed from the previous week.

Precipitation over the country showed three widely separated swaths of moderate to heavy amounts. In the east, a slowly moving cyclone tracked northeastward from the Gulf Coast to New England on 26–28 October, giving welcome rainfall to the Appalachian region and the Middle Atlantic states. Over portions of Texas and Oklahoma, the remnants of yet another eastern Pacific tropical cyclone contributed to heavy showers on 30–31 October. And in the Pacific Northwest, the increasing cyclonic activity associated with the developing east Pacific trough led to a resumption of moderate-to-heavy precipitation near the coast.

Colder, drier weather returned to Alaska as the mean cyclone became reestablished over the Gulf of Alaska. Average temperatures for the week were near normal. Hawaii had near-normal temperatures but above-normal shower activity, as a surface anticyclone strengthened in the mid-Pacific and tradewinds increased.

5. Tropical activity

At the beginning of the month, Hurricane Irene was moving rapidly northeastward over the open waters of the central North Atlantic. The weakening storm maintained its identity until it neared the Spanish coast. On 3 October it became absorbed into a large extratropical cyclone over western Europe. Also at the beginning of the month, a tropical depres-

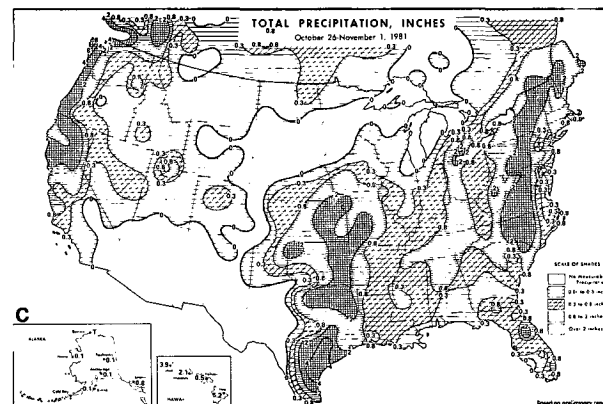
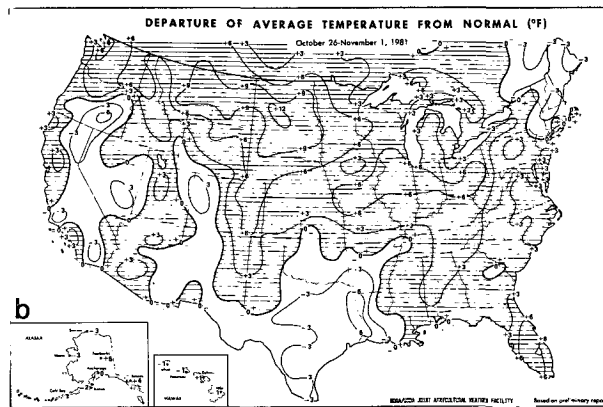
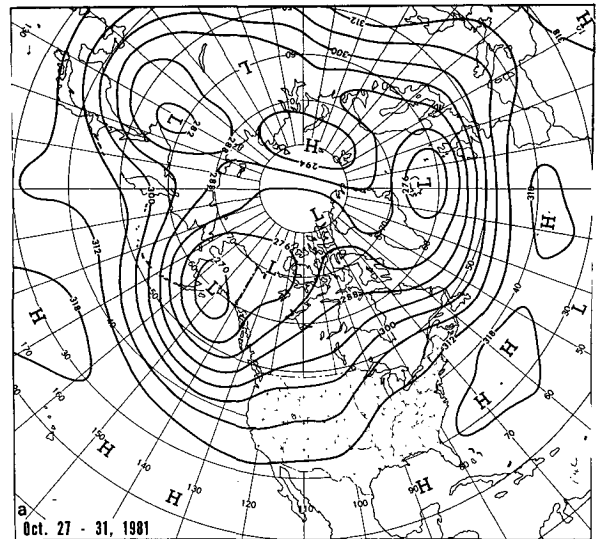


FIG. 12. As in Fig. 8 except for (a) 27–31 October, and (b) and (c) week of 26 October–1 November 1981.

sion moved across the Lesser Antilles and into the eastern Caribbean where it subsequently dissipated. No further Atlantic tropical cyclones formed until 30 October, when Tropical Storm José, again in mid-

ocean, was named. However, even this was not to be the final Atlantic storm of a tropical season that had begun unusually early on 7 May (Wagner, 1981a). Thus, the North Atlantic tropical cyclone season became extraordinarily long in 1981.

In the eastern North Pacific, no fewer than three of the four named October tropical cyclones entered Mexico (Lidia on 7–8 October, Norma on 12 October, Otis on 29 October), collectively causing several dozen fatalities and considerable crop damage in some western provinces. The remnants of all three cyclones crossed the Mexican highlands and entered the United States, contributing to additional heavy rains and local floods in portions of Texas, Oklahoma and Missouri (see Section 4). Tropical Storm Max, the only eastern Pacific tropical cyclone not to enter Mexico, had a short life and a short northward track on 8–10 October.

In the western North Pacific, two strong typhoons three weeks apart narrowly missed Japan as they recurved into the westerlies (Elsie on 1–2 October, Gay on 22–23 October). After recurvature, each of these typhoons became associated with intense extratropical cyclogenesis over the northwestern Pacific, occurring just east of the deeper-than-normal

mean trough (Fig. 1), and the strongly baroclinic region near the Asian east coast. These intense cyclonic developments, in turn, were associated with the autumnal increase in mid-latitude westerly flow over the North Pacific.

The only other western Pacific tropical cyclone in October was Fabian—a relatively weak low-latitude storm. Fabian moved westward across the South China Sea and entered South Vietnam during mid-month.

REFERENCES

- National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and Statistical Reporting Service and World Agricultural Outlook Board, U.S. Department of Agriculture, 1981: *Weekly Weather and Crop Bulletin*, **68**, Nos. 40–44 (6, 14, 20 and 27 October and 3 November, 1981).
- Taubensee, Robert E., 1981: Weather and Circulation of September 1981—Cool in the East and warm in the West with widespread dryness. *Mon. Wea. Rev.*, **109**, 2542–2548.
- Wagner, A. James, 1981a: Weather and Circulation of May 1981—A generally cool and wet month with substantial drought relief in some areas. *Mon. Wea. Rev.*, **109**, 1817–1823.
- Wagner, A. James, 1981b: Weather and Circulation of August 1981—Record-breaking heat wave in the West. *Mon. Wea. Rev.*, **109**, 2405–2413.