

## WEATHER AND CIRCULATION OF OCTOBER 1977

### Cool in the East and Warm in the West

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#### 1. Mean circulation

Large changes in the positions of the monthly mean troughs and ridges occurred between September and October as the mid-latitude westerlies increased in strength from below normal to above normal over the western part of the Northern Hemisphere. The most spectacular change took place over the northern Pacific where an anomalously strong warm ridge located near the Aleutians (Taubensee, 1977) was replaced by a deep trough in the Gulf of Alaska (Figs. 1 and 2). This de-

velopment may have been aided by the eastward spread of fast westerlies from Asia and the supply of available potential energy represented by the contrast between the preexisting warm Aleutian ridge with associated warmer than normal sea surface temperatures, and the large supply of colder than normal air over the Arctic and northern Siberia. Some of the individual cyclones contributing to the Gulf of Alaska deepening were of tropical origin also, and probably contributed additional amounts of eddy available potential energy in the form of sensible and latent heat.

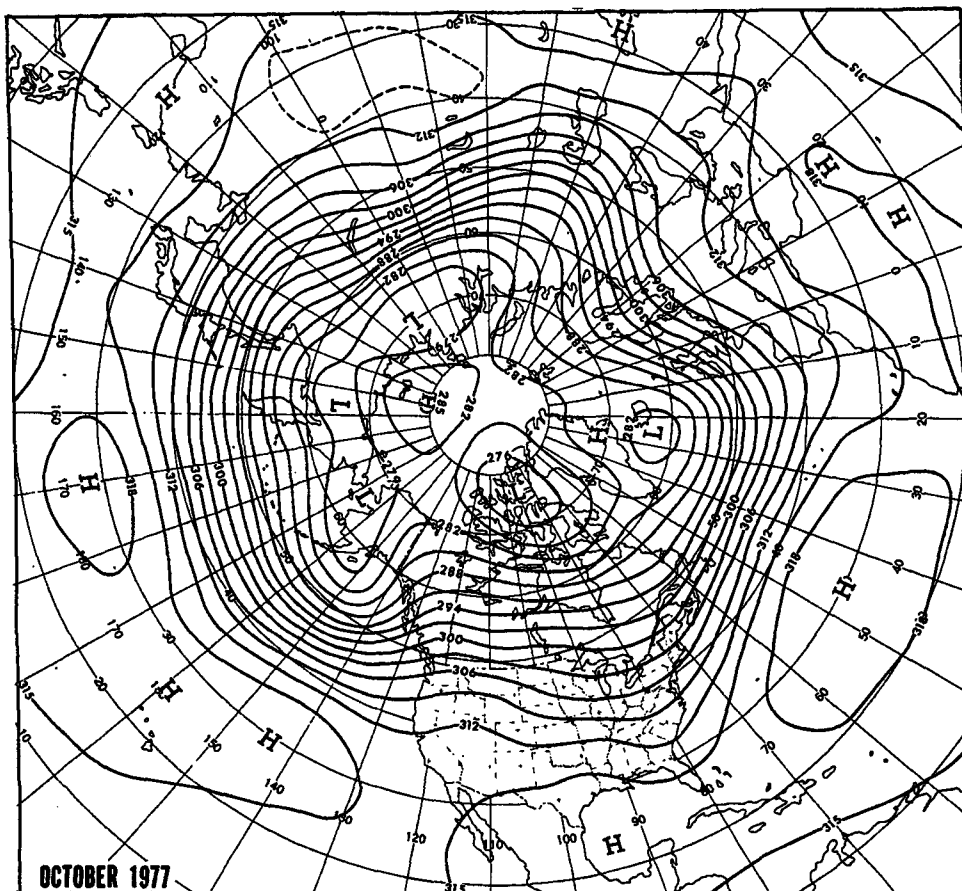


FIG. 1. Mean 700 mb contours (dam) for October 1977.

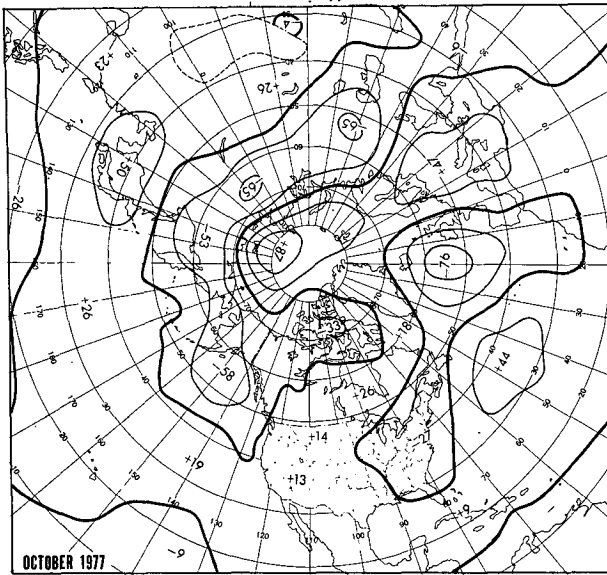


FIG. 2. Departure from normal of mean 700 mb height (m) for October 1977.

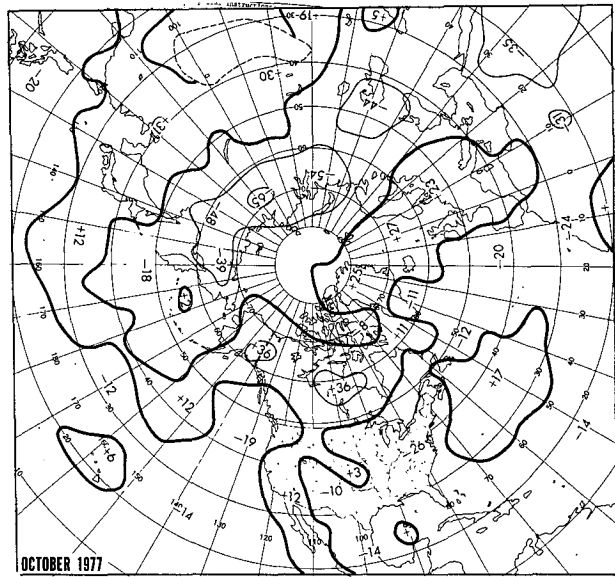


FIG. 4. Departure from normal of mean 1000-700 mb thickness (m) for October 1977.

The Gulf of Alaska development led to a readjustment of the wavetrain downstream over North America and the Atlantic. A strong ridge formed over the Rocky Mountains while the trough just off the west coast filled except for a weak remnant off California. The strong blocking anomaly over Hudson Bay disintegrated, leaving weak remnants north of Lake Superior and over the Davis Strait. The development of a trough along the east coast of North America from southern Labrador to Florida led to ridging over the central Atlantic and the development of a deep trough west

of the British Isles. The ridge which had been near the west coast of Europe during September progressed to central Europe while the downstream trough moved from the Black Sea area to the Caspian Sea.

An unusually strong ridge near Korea associated with warmer than normal lower tropospheric temperatures extending across much of the Pacific kept the westerlies stronger than normal and north of their usual position during October (Figs. 3 and 4). The maritime air entering southwestern Canada east of the strong Gulf of Alaska trough spread mild conditions as far east as Hudson Bay. A separate core of the lower troposphere westerlies began in the east coast trough and then extended across the Atlantic and Europe in an amplified pattern, generally south of the normal location.

A blocking high formed over the Arctic north of Siberia. This development was associated with the replacement of some of the colder than normal air that had left the Arctic and contributed to the Gulf of Alaska cyclogenesis with milder air advected northward over Alaska in advance of the deepening north Pacific cyclones.

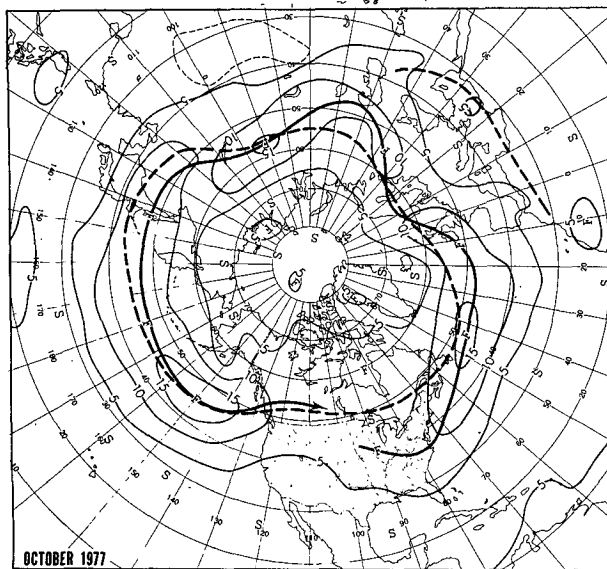


FIG. 3. Mean 700 mb geostrophic wind speed ( $m s^{-1}$ ) for October 1977. Solid arrow indicate observed axes of maximum wind speed; dashed lines show the normal.

## 2. Temperature

The amplified circulation pattern consisting of a ridge in the Rocky Mountains and a trough near the East Coast resulted in generally warmer than normal conditions over the West and cooler than normal weather over the East (Figs. 1 and 5). Since the pattern was less amplified than during October 1976 and southern Canada was covered with generally mild air of Pacific origin in October 1977 (Fig. 4), the severity and extent of the cold weather was considerably reduced

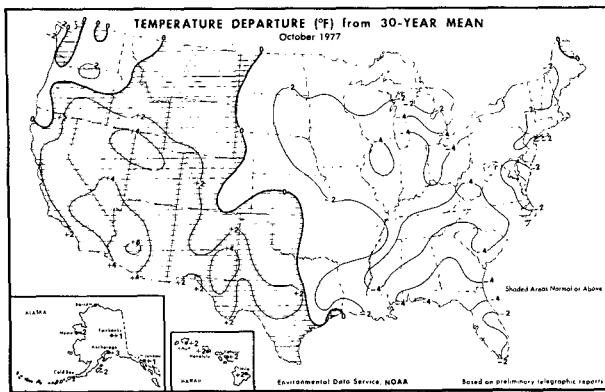


FIG. 5. Departure from normal of average surface temperature (°F) for October 1977 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service, 1977).

over the previous year, when many records were set (Wagner, 1977).

Nevertheless, temperatures averaged as much as 4°F below normal over much of the Midwest and Southeast. The greatest warmth was in the Southwest, where Phoenix, Ariz., had its warmest October on record, averaging 78.7°F, 6.5°F above normal. Grand Junction, Colo., reported its fifth warmest October averaging 58.2°F, 3.3°F above normal.

Temperatures at the principal reporting stations in Hawaii averaged 2°F above normal under the somewhat stronger than normal subtropical ridge. Alaskan temperatures were influenced by the deep trough in the Gulf of Alaska, which advected mild maritime air northward over the eastern coastal areas and into the interior around Fairbanks. Cooler than normal temperatures prevailed over western Alaska near the core of the trough and its parent low near the Bering Strait.

### 3. Precipitation

Most of the north central and eastern parts of the country had normal or greater than normal precipita-

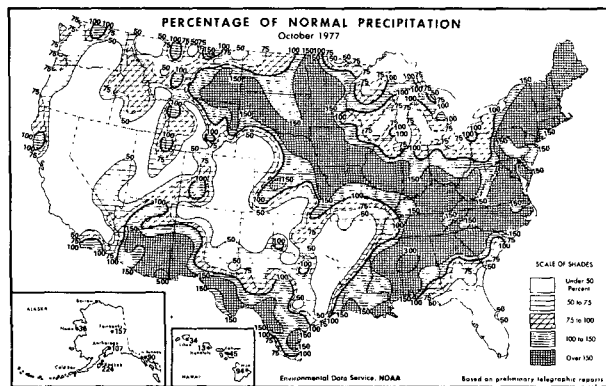


FIG. 6. Percentage of normal precipitation for October 1977 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service, 1977).

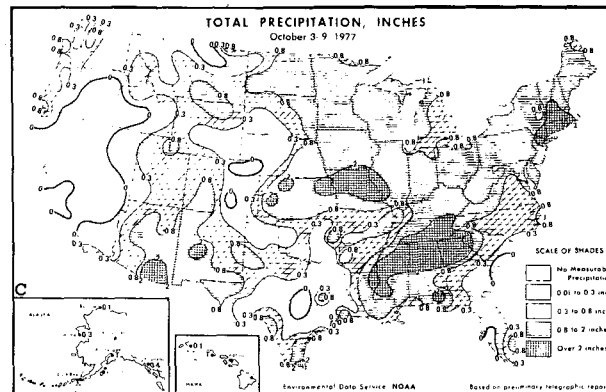
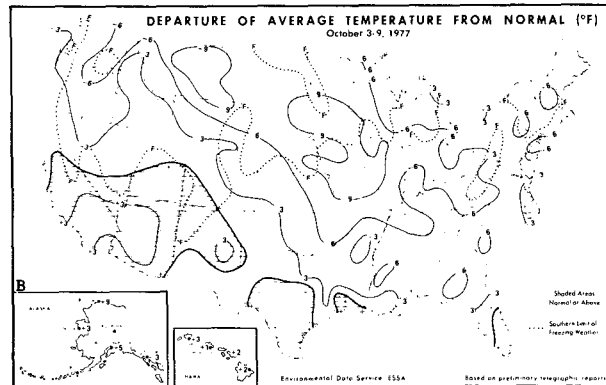
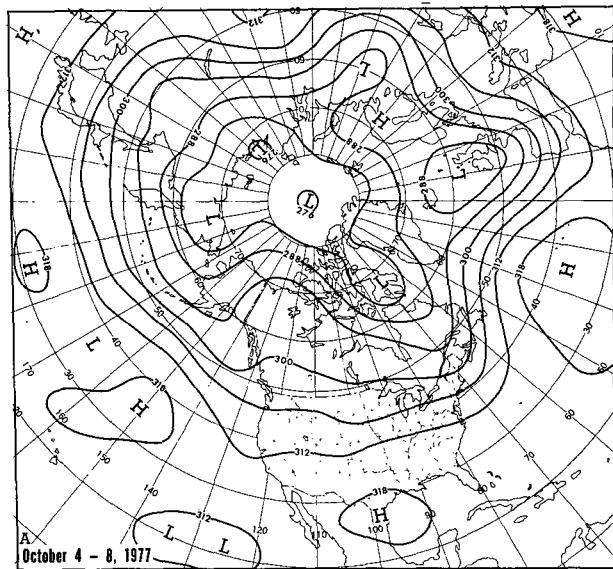


FIG. 7. (A) Mean 700 mb contours (dam) for 4-8 October 1977; (B) departure from normal of average surface temperature (°F); and (C) total precipitation (inches) for week of 3-9 October 1977 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service, 1977).

tion, under the influence of short-wave disturbances moving into the eastern mean trough (Figs. 1 and 6). Few records were established; only St. Joseph, Mo., reported a record wet October, with 8.22 inches of rain. Southeastern Arizona had up to five times its normal

October rainfall, mainly due to moisture from a hurricane off Baja California.

Most of the West and much of the southern and central Great Plains were drier than normal; portions of these areas, as well as most of Florida, had less than half the normal amounts. It was the driest October on record at West Palm Beach, Fla., with only 2.01 inches rainfall, and the fifth driest at Fort Myers, Fla., with only 0.43 inches. Pueblo, Colo., had its second driest October with only a trace of precipitation. Some locations in the Southwest continued rather dry. Elko, Nev., received only 0.01 inches compared to a normal October total of 0.66 inches, and even though Phoenix, Ariz., received slightly above normal rainfall in October, it was still the fourth driest year on record there to date.

Rainfall was less than normal at the principal reporting stations in Hawaii, under the influence of the subtropical ridge. Precipitation was heavier than normal over those portions of Alaska just east of the trough; the panhandle area averaged close to normal while the western coast had less than the normal precipitation.

4. Weekly variability

a. 3-9 October

The westerlies were located south of normal across the northern and central United States with troughs near the west and east coasts (Fig. 7A), similar to the pattern of the previous week (Taubensee, 1977). Although a portion of the subtropical ridge remained over southern Texas, the record high temperatures in that area ended on the last day of September. Nearly the entire country had below normal temperatures, averaging as much as 9°F below normal over the north central states (Fig. 7B). The development of a broad mean 700 mb ridge in northwest Canada (Fig. 7A) probably contributed to the frequent outbreaks of Canadian air into the United States during the week.

Precipitation was widespread across the Nation as cyclonic disturbances affected most areas. Moisture outflow from Hurricane Heather, which moved slowly northwest off Baja California contributed to the extensive area of heavy rainfall over the Southwest. A storm that moved across the north central states to the Great Lakes later in the week produced most of the precipitation in the eastern half of the country.

b. 10-16 October

The initial development of the deep mean trough in the Gulf of Alaska led to a downstream amplification of the wavetrain with strong ridges over the West and western Atlantic and a deep trough extending southward from a low over northern Canada to the eastern Gulf Coast (Fig. 8A).

Although the highs affecting the United States were of Pacific origin, the strong northwest flow between the

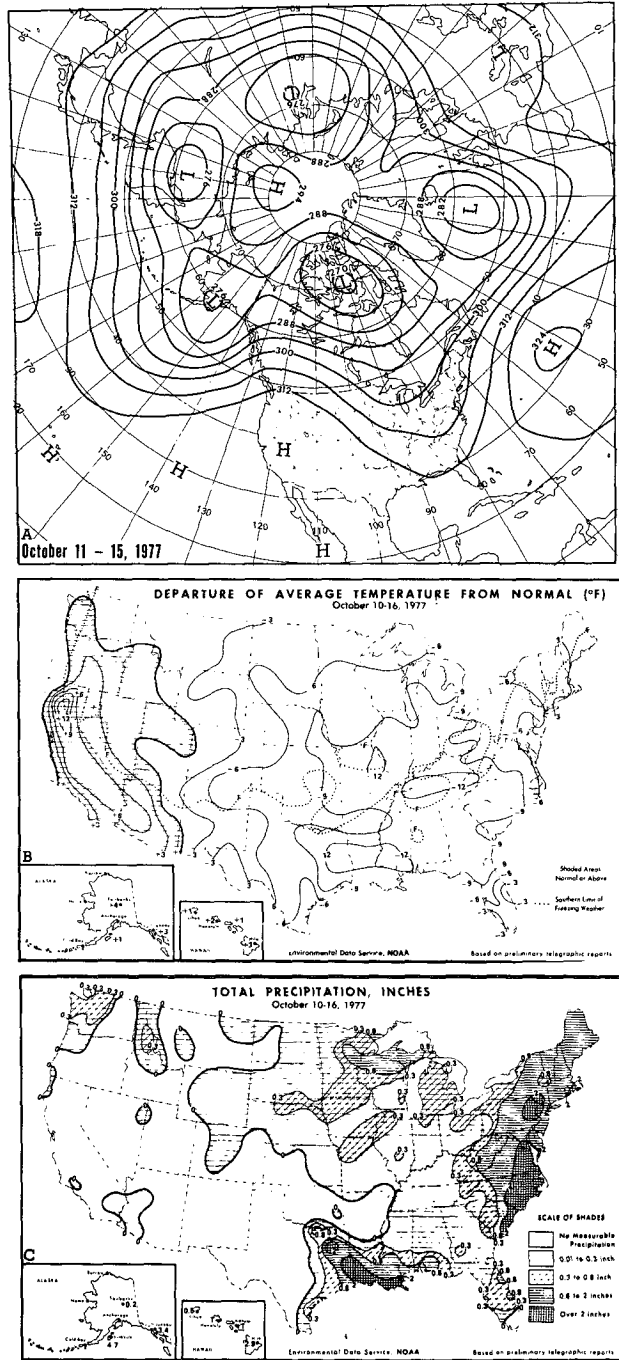


FIG. 8. As in Fig. 7 except for (A) 11-15 October 1977 and (B) and (C) week of 10-16 October 1977.

western ridge and eastern trough contributed to colder than normal temperatures everywhere east of the Continental Divide (Fig. 8B), while it became quite warm under the strong ridge in the West. Weekly mean temperatures averaged as much as 12°F below normal in parts of the South. Shreveport, La., Jackson, Miss., and Mobile, Ala., all had record low temperatures for so early in the fall on the 13th, and the next day

Tallahassee, Jacksonville, West Palm Beach and Tampa also had record early-season lows. Record low temperatures for so early in the season were again reported at Tallahassee, Tampa and West Palm Beach on the 15th.

Most of the United States was rather dry, with little measurable precipitation occurring west of the Continental Divide (Fig. 8C). Heavy rains fell along the Louisiana coast and much of the east coast in response to a slowly-moving sharp trough that developed a closed center over the Southeast before moving north-eastward near the coast.

c. 17-23 October

The trough in the Gulf of Alaska continued to deepen, but became somewhat broader so that features downstream progressed farther eastward. These changes are shown both by the height changes between the first and second half of October and the mean circulation for the third week of the month (Figs. 9 and 10A). Height rises in the Great Lakes area during the latter half of the month were indicative of a marked weakening of the eastern North American trough.

As the flow became more westerly, milder than normal temperatures spread eastward as far as the Mississippi River (Fig. 10B). Lingering cold in the Southeast was mainly due to a second sharp cold front early in the week which produced more record early-season low temperatures at Jacksonville and Tallahassee on the 17th and 18th. The temperature reached the freezing point at Tallahassee on 18 October, and the previous day record lows for so early in the season were also observed at Cincinnati and Dayton, Ohio, and at Detroit, Mich.

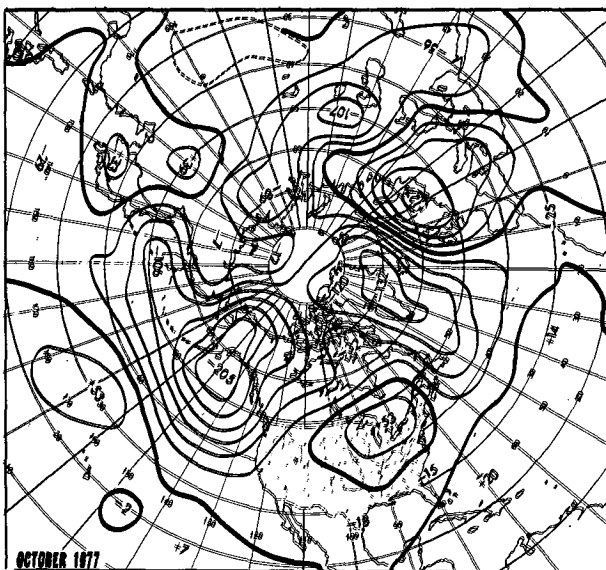


FIG. 9. Mean 700 mb height change (m) from first half to second half of October 1977.

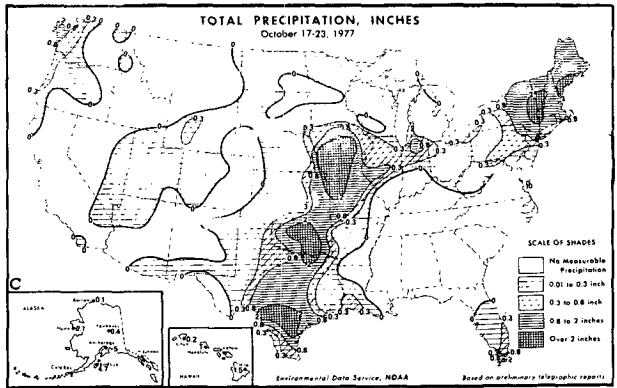
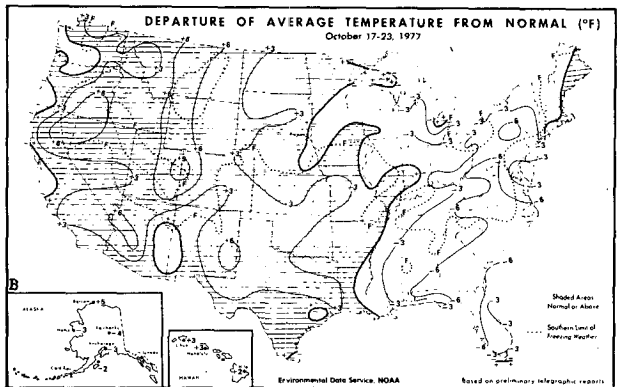
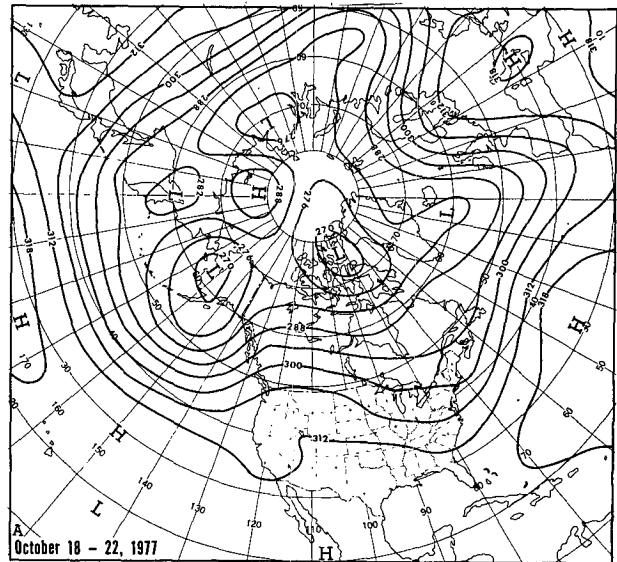


FIG. 10. As in Fig. 7 except for (A) 18-22 October 1977 and (B) and (C) week of 17-23 October 1977.

Rainfall was light over most of the country except for the eastern Great Plains and New England (Fig. 10C). Most of the time it was dry, as the New England precipitation was from a slowly moving occluded low at the beginning of the week. Some snow fell in the mountains of Pennsylvania, New York and New England. The rain in the central states was from a weak

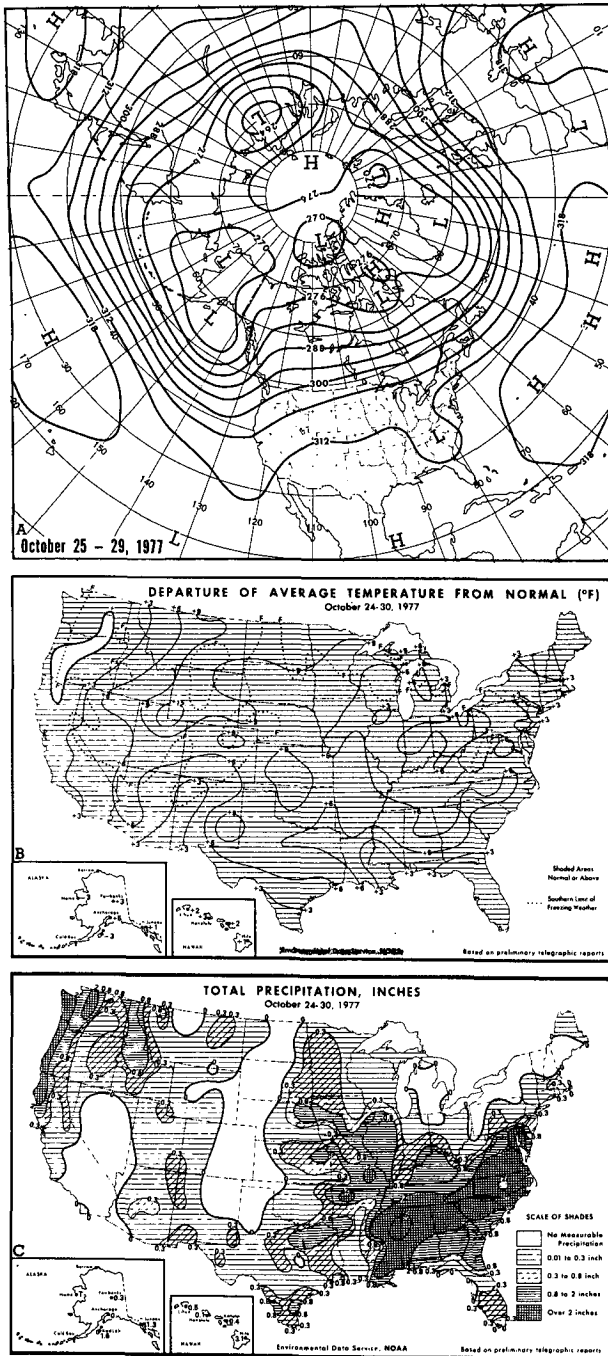


FIG. 11. As in Fig. 7 except for (A) 25-29 October 1977 and (B) and (C) week of 24-30 October 1977.

but slowly-moving trough which developed extensive overrunning of moist Gulf air at the end of the week.

d. 24-30 October

The flow over the entire Northern Hemisphere from the western Pacific to Europe became less amplified

during the last week of October (Fig. 11A). Fast zonal westerlies across southern Canada confined Arctic air to north of the border and the entire United States enjoyed warmer than normal temperatures as the warm air generated in the western ridge spread across the country (Fig. 11B). Temperatures in most areas averaged more than 6°F above normal. Walla Walla, Wash., and Pendleton, Ore., equaled their highest temperature for so late in the season on the 24th, both with 80°F. Boise, Idaho, and Cheyenne, Wyo., set new records for late-season warmth on the 25th with 79° and 74°F, respectively, and Salt Lake City with 80°F on the 26th had its highest reading for so late in the season. A temperature of 83°F equaled the record for late-season warmth at Denver, Colo., that same day.

The increasing westerly flow brought good rains of over 2 inches along the Pacific Northwest coast (Fig. 11C). Precipitation was light over most of the remainder of the country except for the Southeast, where a slowly-moving cutoff low gave as much as 5 inches of rain and caused floods in some areas. The low was sufficiently deep and slow-moving to be reflected in the 5-day mean circulation (Fig. 11A).

5. Tropical activity

The generally inactive nature of the 1977 tropical storm season continued through October. Two named storms developed in the Atlantic-Caribbean sector. A tropical depression which formed on 14 October south of Bermuda moved northward in the warm sector of an extratropical low drifting slowly northeastward along the Atlantic coast. The tropical low was briefly classified as Hurricane Evelyn just before grazing the eastern end of Nova Scotia the morning of the 15th. Rapid dissipation occurred thereafter.

A tropical depression which formed over the western Caribbean was briefly Tropical Storm Frieda on 17 October before weakening to a depression again as it moved westward to the coast of Belize on the 18th.

Over the eastern Pacific, a tropical depression which formed near 15°N, 108°W late on 3 October became Tropical Storm Heather the next day and deepened to hurricane strength on the 5th. It moved slowly northwest off the west coast of Baja California. Moisture from Heather gave heavy rains and thunderstorms to parts of Arizona as the storm weakened to tropical storm intensity on the 6th and then a depression the next day before breaking up a few hundred kilometers south of San Diego.

The stronger than normal ridge south of Japan (Figs. 1 and 2) favored somewhat more activity over the western Pacific. Gilda developed near 17°N, 154°E on 5 October and while alternating between tropical storm and typhoon strength, eventually recurved northeastward and became extratropical on the 10th. This storm eventually became part of the deep Gulf of Alaska low.

Tropical Storm Harriet formed near 14°N, 135°E on 16 October, and recurved slowly northeastward south of Japan the next few days, where it weakened and became extratropical. The remains moved eastward and subsequently redeepened in the Gulf of Alaska.

Two other storms, Ivy and Jean, formed in the same general area during the last week of the month and eventually drifted northeastward. Both reached typhoon strength for part of their lifetime. None of the western Pacific storms struck land during October.

## REFERENCES

- National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and Statistical Reporting Service, U.S. Department of Agriculture, 1977: *Weekly Weather and Crop Bulletin*, 64, Nos. 41-45 (12, 18 and 26 October and 1 and 8 November 1977).
- Taubensee, Robert E., 1977: Weather and Circulation of September 1977—A warm month across much of the country. *Mon. Wea. Rev.*, **105**, 1619-1625.
- Wagner, A. James, 1977: Weather and Circulation of October 1976—Record cold over the South and Midwest. *Mon. Wea. Rev.*, **105**, 121-127.