THE WEATHER AND CIRCULATION OF DECEMBER 1967

Temperature Reversal Associated With Intramonthly Amplification

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1. NOTABLE WEATHER

In the Southwest the weather of December 1967 seemed more typical of January or February. East of the Mississippi River mildness prevailed and numerous new daily maximum temperature records were established from the western Great Lakes to the Middle Atlantic States. All this changed the last week when snow fell as far south as northern Mississippi while Arctic air reached from the Rocky Mountain States to the east coast. The West warmed. Several new daily maximum temperature records were reported in northern California and new daily minimum records at several cities in the Midwest.

Record December snowfall (see table 1) came mostly in one prolonged period of storminess near mid-month with the appearance of a Southwest Low. Snow fell on 8 consecutive days at Flagstaff, Ariz., and nearby areas. Yuma, Ariz., had a trace of snow for the first time in 30 yr. Snow fell for the first time at La Jolla, Calif., and a trace was noted at San Diego for only the second time. Three major storms late in the month caused heavy snowfall in portions of the Northeast. Burlington, Vt., had 12 in. and Boston, Mass., reported 20–30 in. in outlying areas.

Tornadoes were frequent from east Texas to Georgia with a few reported in Illinois and Indiana as cold fronts strengthened in the Mississippi Valley. Low level moisture and warmth were provided by the southerly mean sea level flow (chart X of [1]) from the Gulf of Mexico.

2. MEAN CIRCULATION

Changes in the 700-mb. circulation from November to December 1967 (fig. 1) resulted in an unusual flow over the United States (figs. 2 and 3). Anomalous height changes from mid-Pacific to mid-Atlantic reflect the evolution in which a new long wave trough formed over North America, derived from the trough formerly off California. This was a consequence of marked changes in the Pacific as a new trough also formed there.

In November (fig. 1 of [2]) the circulation was composed of one broad trough over most of the Pacific and a ridge along the west coast of North America to the north of a small trough off California. In December (fig. 2) two troughs formed in the Pacific. The westernmost trough was the stronger and lay along the Asian coast. This trough was apparently the onset of the winter climato logical through that responds to the increased land-sea temperature differences in the colder months. Blocking over Siberia also contributed to deepening of this trough that was more than 200 ft. below normal in the Sea of Japan. The second trough in the Pacific was most intense northwest of Hawaii and probably deepened because of the amplification upstream. Heights at 700 mb. in December were 300 ft. less than in November (fig. 1) midway between Hawaii and Alaska.

Over and near North America the evolution was similar to that in the Pacific—one broad trough in November replaced by two troughs and a ridge in December. The insertion of a new trough resulted when the trough in the East in November moved into the Atlantic. As the wave spacing increased the weak trough formerly off California moved into the Plains and deepened. The ridge along the east coast was less than 100 ft. above normal, but represents an increase of 300 ft. in anomalous height from November to December.

In the Atlantic the trough kept the same depth relative to normal as in November when it was along the east coast, but heights fell 500 ft. as the trough moved eastward and replaced a ridge. This ridge became stronger as it moved eastward and extended toward Iceland. This increased the blocking to give a strong omega pattern in the 700-mb. contours from mid-Atlantic to Europe. Increased blocking helped the trough over eastern Europe and western Russia become the strongest trough in the Nothern Hemisphere as northerly anomalous flow reached from the North Pole to the Mediterranean Sea. The extensive sea level Low associated with this trough was 13 mb. lower than normal for the month in central Russia. The ridge over Siberia increased slightly this month and sea level pressure was 10–12 mb. above normal as

TABLE 1.—*Record December snowfall established in 1967*

City	Amount (in.)
Flagstaff, Ariz.	86.0
Winslow, Ariz.	*39.6
Lander, Wyo.	26.3
Casper, Wyo.	17.8
Grand Junction, Colo.	16.7
Pueblo, Colo.	15.3

*Also record for any month.

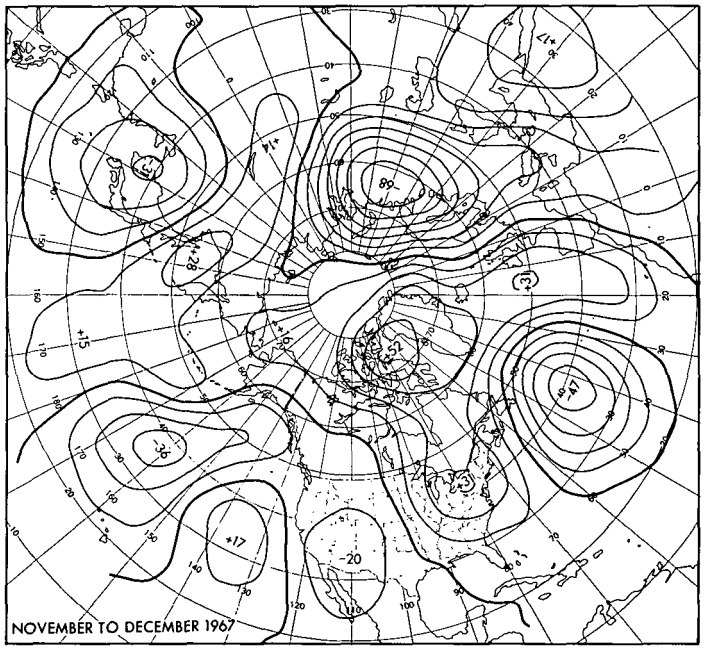


FIGURE 1.—Mean 700-mb. height anomaly change (tens of feet) from November to December 1967.

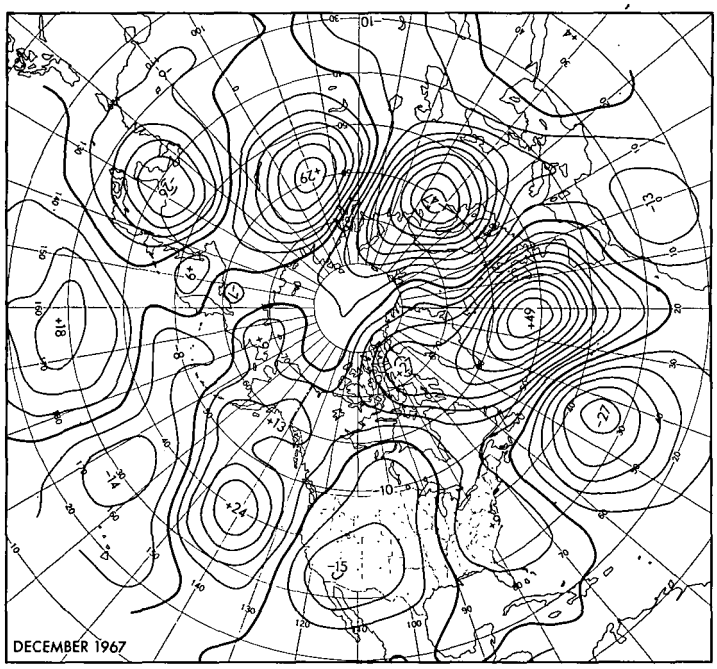


FIGURE 3.—Departure from normal of mean 700-mb. height (tens of feet) for December 1967.

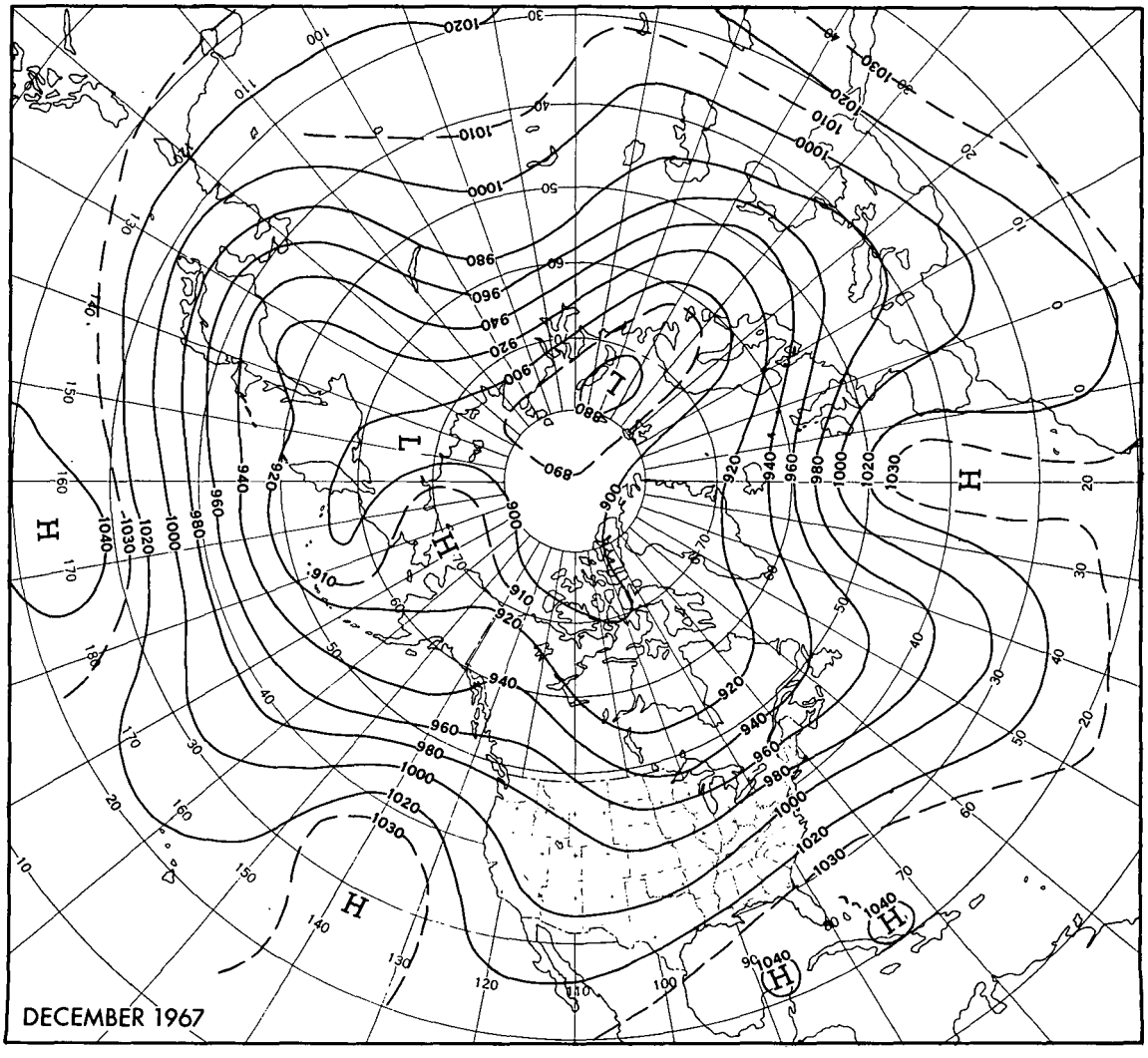


FIGURE 2.—Mean 700-mb. contours (tens of feet) for December 1967.

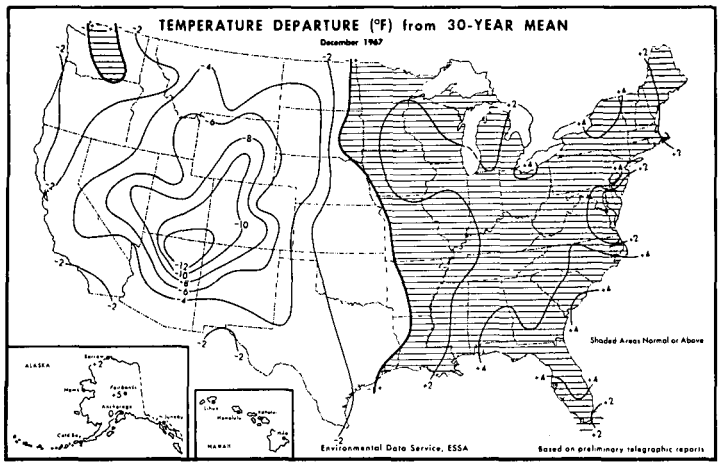


FIGURE 4.—Departure from normal of average surface temperature (°F.) for December 1967 (from [4]).

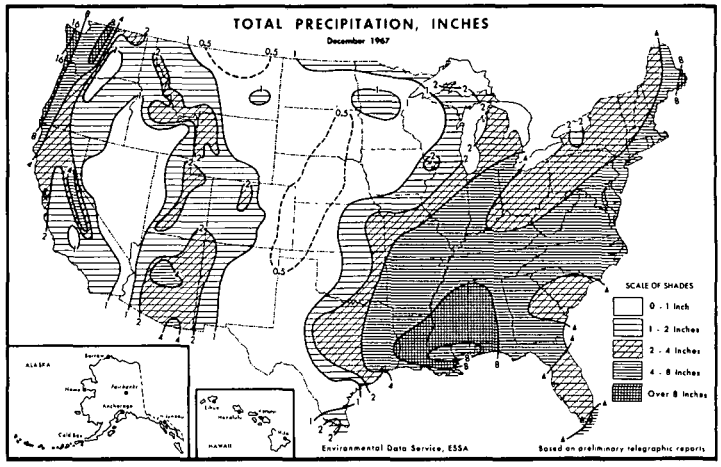


FIGURE 5.—Total precipitation (in.) for December 1967 (from [4])

continental high pressure dominated the eastern two-thirds of Eurasia.

3. MEAN TEMPERATURE

As large changes marked the mean flow this month, large changes also appeared in a comparison of mean temperatures. In November [2] temperatures were above normal in the West and below in the East; in December the distribution of anomalous temperature was reversed and for the first month in the last six, temperatures were below normal in the West and above in the East (fig. 4).

Temperature was most persistent in the central portions of the Nation in which temperature anomaly classes changed by one class or none at 37 cities (out of 100 across the United States). (Usually 66 percent of the 100 cities are in this category from November to December [3].) The remaining 63 percent changed by two or more classes with many four class changes in the Southwest. Strong cooling occurred over most of the West as the circulation amplified. The addition of widespread snow cover and frequent Great Basin sea level Highs helped maintain temperatures here 10°F. or more below normal. Monthly temperature averages produced new low records at Flagstaff, Ariz. (23.1°F.), Milford, Utah (19.6°F.), and the airport at Casper, Wyo. (17.4°F.); at Grand Junction, Colo., 18.3°F. was the lowest since 1919.

Temperatures in the eastern one-third of the Nation increased by three classes over most of the area as anomalies changed from below and much below to much above or above. Temperatures of 2°–4°F. above normal predominated during the month but in the last week very cold air replaced the warmth. The freezing line reached the Gulf Coast and well into Florida where Tampa reported a minimum of 30°F. on the 24th. Some daily maximum temperature created new records in the eastern half of the United States but monthly mean temperatures did not.

4. PRECIPITATION

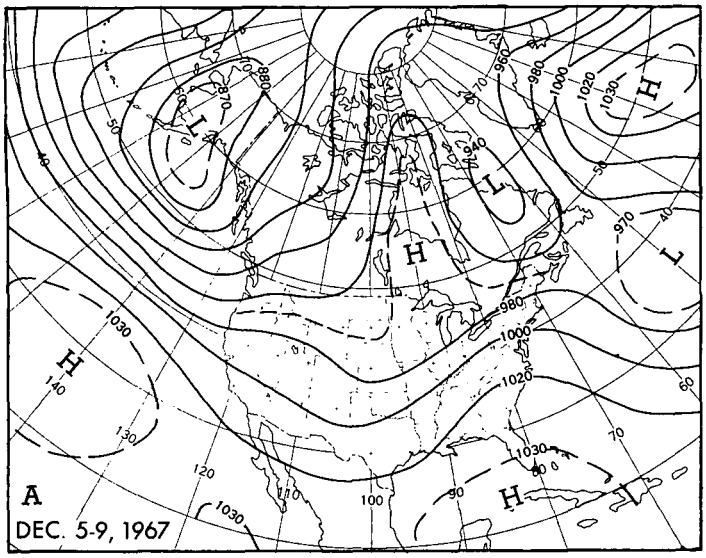
Heavy precipitation in the Southwest and Rocky Mountain States, related to the deep 700-mb. trough, was two to four times normal this month. This was 2–4 in. over most of the West (fig. 5) except Nevada, the lee of the Rockies, and the Plains where precipitation was 1 in. or less. The record snowfall of 86 in. at Flagstaff, Ariz., equalled 7.30 in. of water. This was 5.65 in. heavier than normal and the second wettest December of record. Phoenix, Ariz., with 3.98 in. of rain (and a trace of snow) reported the wettest December of record. Other places with precipitation of more than an inch were northern California and higher elevations of the West Coast States. In contrast there was a large area of less than 1 in. over interior portions of the West. Pendleton, Oreg., had only 0.45 in. in December which was the 11th consecutive month with less than normal precipitation and the driest year (6.77 in.) since records began in 1890.

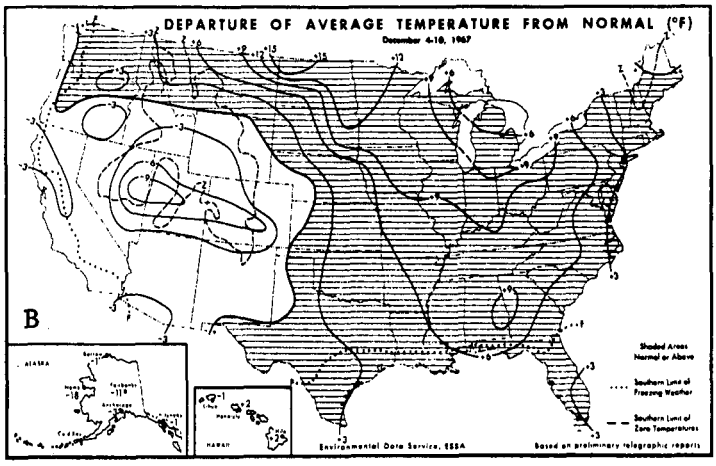
In the East 2–6 in. of precipitation fell with some totals above 10 in. At Washington, D.C., this was the wettest December (5.93 in.) since 1901 and at Greensboro, N.C. (6.34 in.), December was the wettest month of 1967. Precipitation was heaviest at Lake Charles, La., with 13.27 in. which was 7.51 in. above normal and a new December record. Precipitation in the eastern half of the Nation was east of the boundary between warm and cold air from the eastern Dakotas to the Texas Gulf Coast. Southwest upper flow (figs. 2 and 3) and southerly anomalous flow contributed to the widespread heavy precipitation. Rain in the South and freezing rain in the Plains predominated. The East received rain until late in the month when snow became widespread.

5. WEEKLY WEATHER RELATED TO 5-DAY CIRCULATION

DECEMBER 4–10

During the first week of December 1967 the 700-mb. flow in the United States was dominated by a deep mean Low in the Gulf of Alaska (fig. 6A) in which heights were 600 ft. below normal. Very strong blocking prevailed over North America with heights 800 ft. above normal near Baffin Island. The flow associated with these two great centers resulted in the transport of warm air to very high latitudes east of the Rockies. Temperatures were 6°–9°F. above normal (fig. 6B) over the eastern two-thirds of the Nation. Mildness extended westward across the





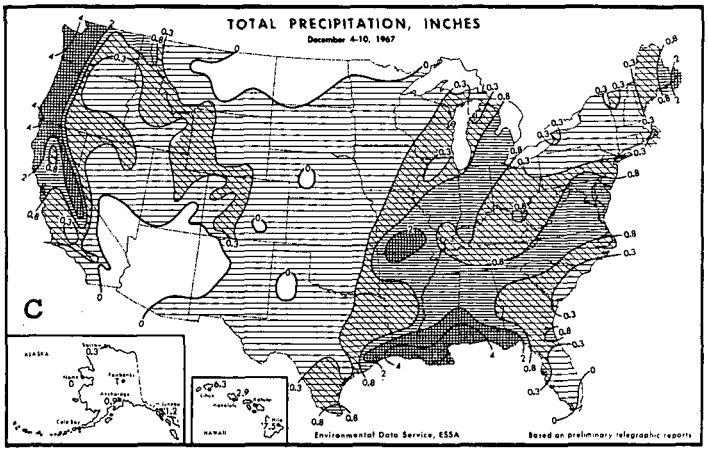
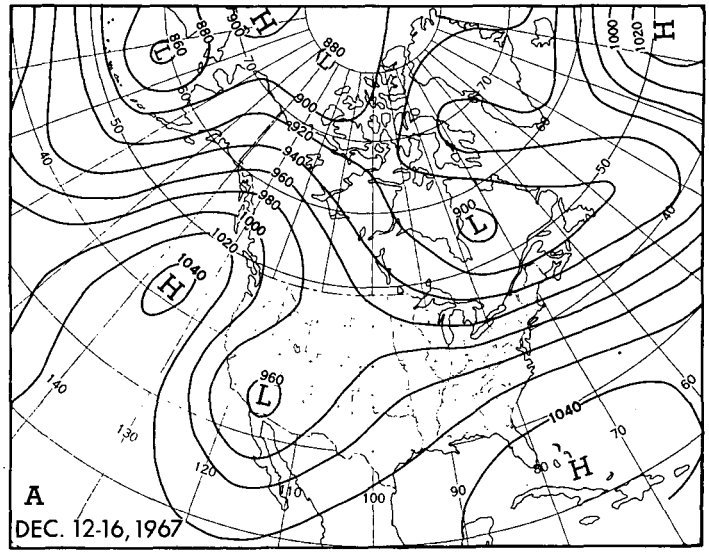
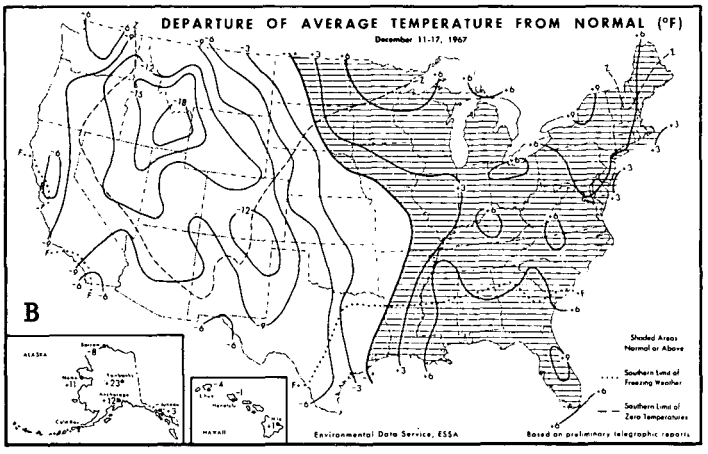


FIGURE 6.—(A) Mean 700-mb. contours (tens of feet) for December 5–9, 1967; (B) temperature departure from normal (°F.) for December 4–10, 1967 (from [4]); (C) total precipitation (in.) for December 4–10, 1967 (from [4]).





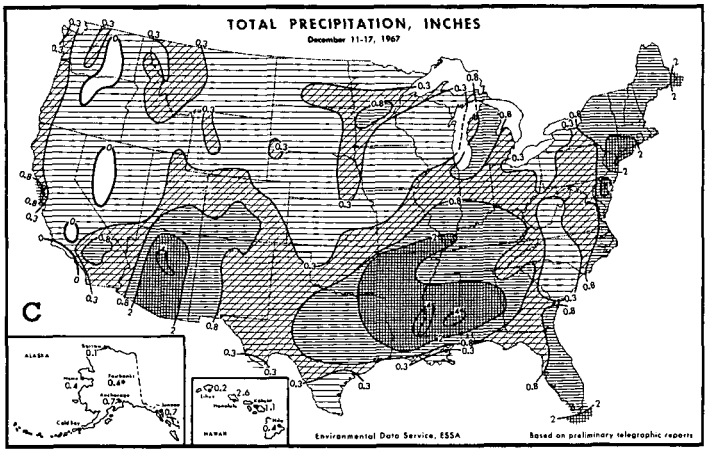
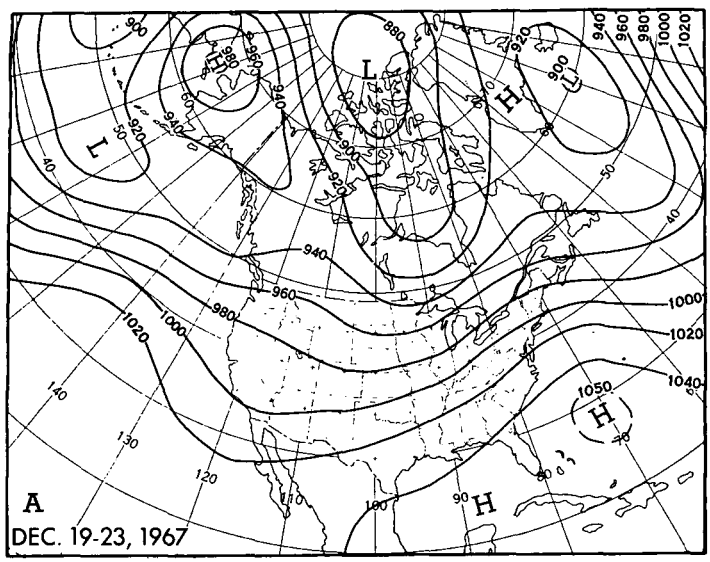


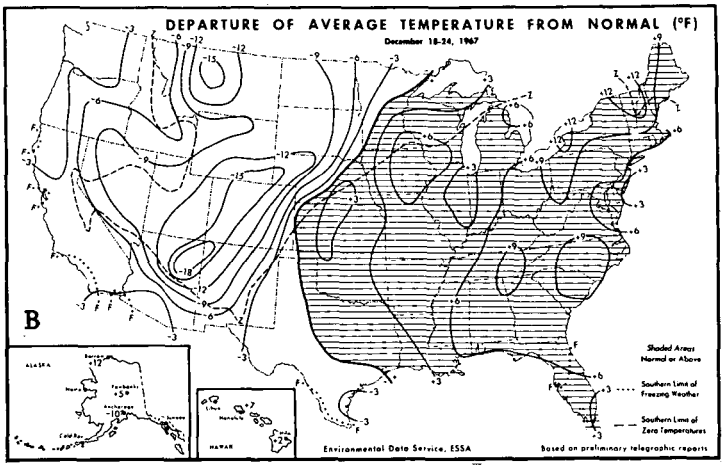
FIGURE 7.—(A) Same as figure 6 for December 12–16, 1967; (B) and (C) same as figure 6 for December 11–17, 1967.

Border States with temperatures to 15°F. above normal in North Dakota. Coolness occurred in the central and southern Rockies with temperatures 6°–9°F. below normal in a small area as Pacific Highs moved into the West.

Storminess this week affected most of the Nation as one storm came through in northerly latitudes and a second on a *southerly track*. Strong westerly flow aloft was accompanied by as much as 5 in. of rain along the West Coast (fig. 6C) but with 2–4 in. more general west of the Cascades and the Sierra Nevada Mountains. Heavy precipitation fell along the Gulf Coast when the second storm of the week slowed down enough to allow moisture from the Gulf of Mexico to spread over the East.

A strong cold front moved through the Hawaiian Islands on December 8–10 and accounted for most of the heavy rainfall this week. On Kauai 6.3 in. fell at Lihue, 2.9 in. at Honolulu, and at normally wet Hilo on Hawaii the total was 7.5 in.





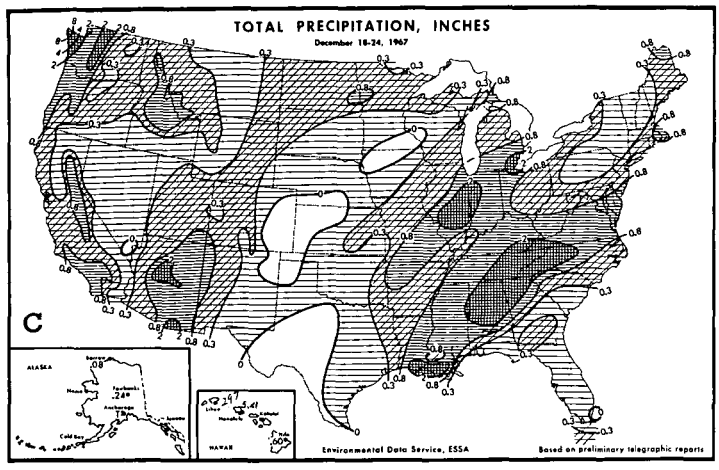
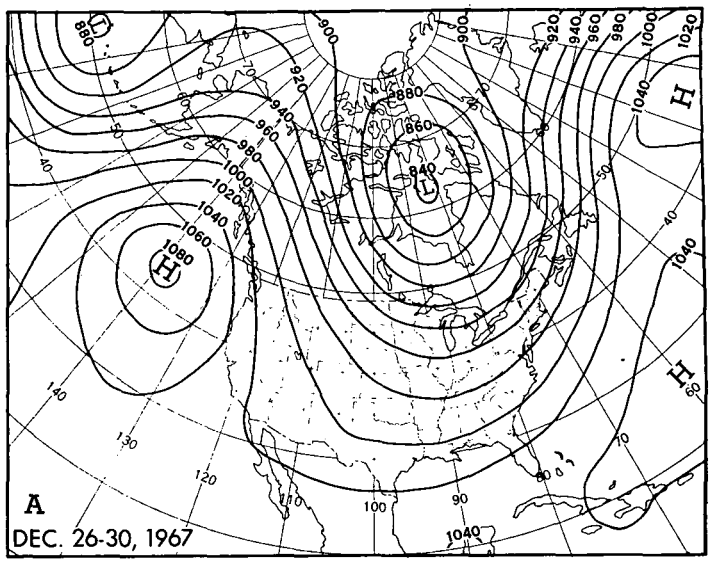
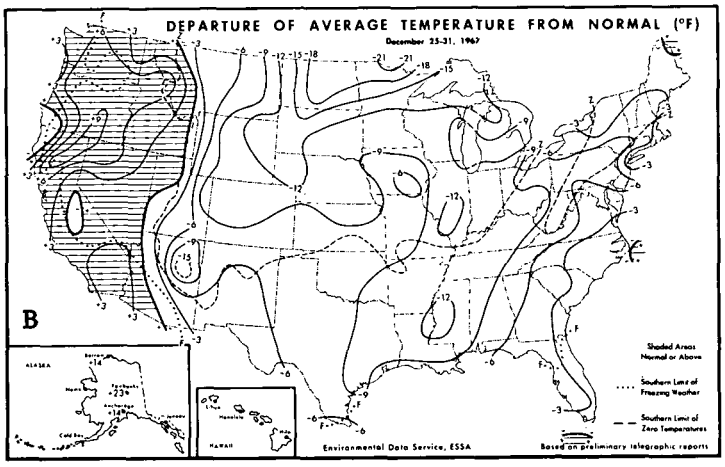


FIGURE 8.—(A) Same as figure 6 for December 19–23, 1967; (B) and (C) same as figure 6 for December 18–24, 1967.





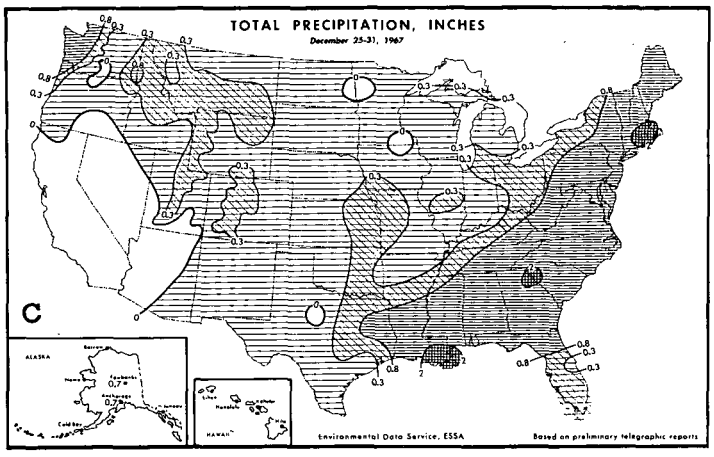


FIGURE 9.—(A) Same as figure 6 for December 26–30, 1967; (B) and (C) same as figure 6 for December 25–31, 1967.

DECEMBER 11–17

The second week of December 1967 brought record snowfall to portions of the Southwest with a remarkable change in the 5-day mean 700-mb. circulation (fig. 7A). During the prior week the zonal index in temperate latitudes was near normal but this week the index dropped to more than 3 m.p.s. below normal. This was a result of the strong meridional flow that developed in the eastern Pacific and western North America. As a trough formed east of Hawaii, an extension of the central Pacific trough, the ridge to its east strengthened. Heights increased in the Gulf of Alaska to 600 ft. above normal from 600 ft. below normal the previous week. Meanwhile the concentration of cyclonic vorticity formerly in the Gulf of Alaska plunged into the West and a Low formed over southern California with 5-day mean 700-mb. heights more than 500 ft. below normal.

Temperatures were lower than normal over the western half of the United States with maximum departures (15°–20°F.) over the northern Rockies (fig. 7B). Mild weather continued this week over the eastern half of the country with temperatures 3°–6°F. above normal as strong southwesterly flow dominated the mean circulation. Freezing temperatures reached to northern portions of the Gulf States and the 0°F. isotherm for the week enclosed the Northern Plains and the Rockies as far as southwestern New Mexico.

As the upper level disturbance moved very slowly, southwesterly flow aloft carried moisture from the Pacific off Baja California over cold air in the Plateau. This produced heavy precipitation over the southern Rockies (fig. 7C) and particularly over the southern Plateau where snow fell on 8 consecutive days. Gusty winds caused drifts to 9 ft. and made surface travel impossible. Helicopters were necessary to reach isolated families and communities with food and supplies. At Flagstaff, Ariz. (elevation 6,993 ft.), 54 in. of snow fell this week with maximum temperatures in the 20's and minimum temperatures 10°F. or lower. Heavy precipitation also fell as rain from east Texas to the lower Ohio Valley, but over much of the Great Plains the rain froze on impact. Cold air from Canada swept southward east of the Rockies on Thursday and caused severe weather along its leading edge from Texas to northern Florida. Early in the week rains of 1–2 in. decreased local drought conditions in Florida.

DECEMBER 18–24

Blocking weakened over eastern North America and became strong over Alaska (fig. 8A) as the mid-Pacific trough deepened between Hawaii and Alaska. The strong ridge formerly in the eastern Pacific flattened as westerlies increased to the south of the block and the weak trough in the northeastern Pacific replaced the meridional flow of last week. The 5-day mean flow in the United States shows a trough shearing as stronger winds to the north carried a portion of the trough into the Northern Plains while the southern portion of the trough remained in the Southwest. Heights in the West increased by about 400 ft. compared with the 5-day mean chart that represented the previous week. The ridge over the Southern Plains in the second week moved to the east coast accompanied by an increase in the southerly anomalous flow.

Weather remained mild in the eastern half of the Nation until the end of this week and averaged 6°–9°F. above normal over much of this area (fig. 8B). Record maximum temperatures were reported at Wilmington, N.C. (81°F.), and Savannah, Ga. (83°F.). Meanwhile a new Pacific storm entered the West and was followed by a strong outbreak of cold air. This, combined with radiational cooling for a portion of the week, produced temperatures of 9°–15°F. below normal from the Southwest to the Northern Plains. Warming spread over the West by the weekend as westerlies increased. Missoula, Mont., had a mean temperature of 17°F. above normal on December 24 after it was 19°F. below normal on December 21. At Cutbank, Mont., the temperature ranged from −20°F. to 41°F. on Friday.

The new storm that entered the West on Tuesday caused severe weather as it moved from northern California to Colorado and eastward. Heavy snow fell in mountain areas near Los Angeles then spread to the southern Rockies. Flagstaff, Ariz., received 30 in. of new snow and measured 83 in. on the ground by December 20. As the cold front moved eastward precipitation fell over most of the country east of the Plains States. Many tornadoes and thunderstorms formed along this front from Illinois to east Texas to Alabama. In Hawaii rains were heavy this week as the tradewind flow was interrupted by south and southwesterly flow.

DECEMBER 25–31

The mean 700-mb. flow amplified strongly this week (fig. 9A) over the western portion of the Northern Hemisphere. High latitude blocking that was over the Bering Sea last week drifted eastward. As the central Pacific deepened the low latitude ridge in the eastern Pacific and the blocking combined to make one ridge from the Tropics to the Polar Basin with heights more than 1,000 ft. above normal. Most of North America was under cyclonic flow aloft as the trough from northern Greenland to the Gulf of Mexico deepened strongly over Hudson Bay.

Strong real and anomalous flow transported the coldest air of the season from the Arctic to all areas from the Rockies eastward. Average temperatures were 12°–20°F. below normal for the week in the Dakotas and Minnesota (fig. 9B) and 6°–10°F. below normal over the rest of the eastern two-thirds of the Nation except 3°F. below normal along most of the east coast. Record temperatures for December were established at Bismarck, N. Dak. (−43°F.) and Aberdeen, S. Dak. (−39°F.). Mild weather prevailed west of the Rockies, related to the positive heights and the northeasterly anomalous flow.

Most precipitation this week (fig. 9C) fell from New England to the Gulf Coast States with snow from 4 in. in northern Mississippi to a foot or more from West Virginia to Maine. In Elkins, W. Va., an 18-in. snowfall on the 28th was a new 24-hr. record.

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2. R. A. Green, "The Weather and Circulation of November 1967—Strong Middle-Latitude Ridges, Continued Warm in the Far West and Cool in the East," *Monthly Weather Review*, vol. 96, No. 2, Feb. 1968, pp. 127–132.
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