

THE WEATHER AND CIRCULATION OF FEBRUARY 1962

A Month With Two Contrasting Regimes Associated With a Sharp Drop in Zonal Index

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1. INTRODUCTION

Two sharply contrasting regimes of weather and circulation in the United States, accompanying the onset of a major cycle in the zonal index, highlighted February 1962. As a result the average monthly weather was not particularly extreme over most of the Nation. The northern half of the country was generally colder than normal while most of the southern half was unseasonably mild. Unusually heavy amounts of precipitation fell in California, while heavy amounts were also observed in the Great Basin, the Northern Plains and Upper Mississippi Valley, the Ohio and Tennessee Valleys, and the Middle Atlantic States. Precipitation was notably deficient in southern portions of the Gulf Coast States, especially Louisiana and Texas. Record amounts of snow accompanied the cold in many areas from the Northern Plains to New England. Much of this fell during the last half of the month when snow depths ranged from 1 to 3 feet.

2. MONTHLY MEAN CIRCULATION

The average circulation at 700 mb. in the western sector of the hemisphere in February 1962 (fig. 1) was characterized by low zonal index. Principal centers of blocking in the Atlantic and Gulf of Alaska were associated with strong ridges and extensive areas of positive height anomaly in the north and negative anomaly in lower latitudes. The strong blocking complex over the North Atlantic extended its influence to eastern North America where its effect was to weaken and displace westward the trough normally found at middle and high latitudes in the East. Another manifestation of blocking was the development of a mean trough along the west coast of the United States. This negatively tilted trough, usually found near Baja California, was deeper than normal, and the associated area of negative height anomaly extended westward into the Pacific and joined with the low-latitude trough near the Hawaiian Islands.

A broad cyclonic flow pattern prevailed in the western Pacific where the Aleutian Low at sea level extended its influence farther south than normal. Sea level pressures in the mid-Pacific averaged as much as 7 mb. below

normal while strong blocking in the northeastern Pacific resulted in surface pressures up to 9 mb. above normal.

Mostly zonal flow existed across Asia (fig. 1), and over Europe the deep trough that extended from Finland to North Africa was supported to some extent by vorticity flux from the strong blocking ridge in the eastern Atlantic.

Intense blocking in the Pacific and Atlantic was also reflected in the pattern of 700-mb. wind speed and its anomaly (fig. 2). In the eastern half of both oceans the westerlies split into two branches, one primary "jet" moving to the north of the block, the other to the south. Since the Atlantic block was centered at a lower latitude than its Pacific counterpart, the southern branch of the Atlantic jet was also displaced southward near 20° N. (not shown). The wind speed anomaly patterns in both areas were also similar. Note particularly (fig. 2B) the large areas of below normal speeds with greatest departures in the southern Gulf of Alaska and over the Azores, and the areas of stronger than normal speeds in the Bering Sea and North Atlantic.

Elsewhere, wind speeds across North America were close to their normal values, with the jet entering the southwestern United States being the strongest with respect to normal (fig. 2). A well-defined westerly jet, somewhat stronger than normal, was observed across Asia.

The intensification and spread of blocking during February were reflected in a sharp drop in the speed of the temperate westerlies (zonal index). In January [1] this index was above normal and averaged 11.8 m.p.s. During February, however, the westerlies diminished rapidly in strength with the onset of a major index cycle. These cycles have been common in recent years (1958, 1960) in late winter. The downward phase of this year's index cycle is well illustrated by the solid curve in figure 3, giving the zonal index at 700 mb. averaged over the western sector of the hemisphere between 35° and 55° N. from a series of overlapping 5-day mean maps prepared three times a week. The effects of this sharp drop in index upon the circulation and weather in the United States will be discussed in later sections.

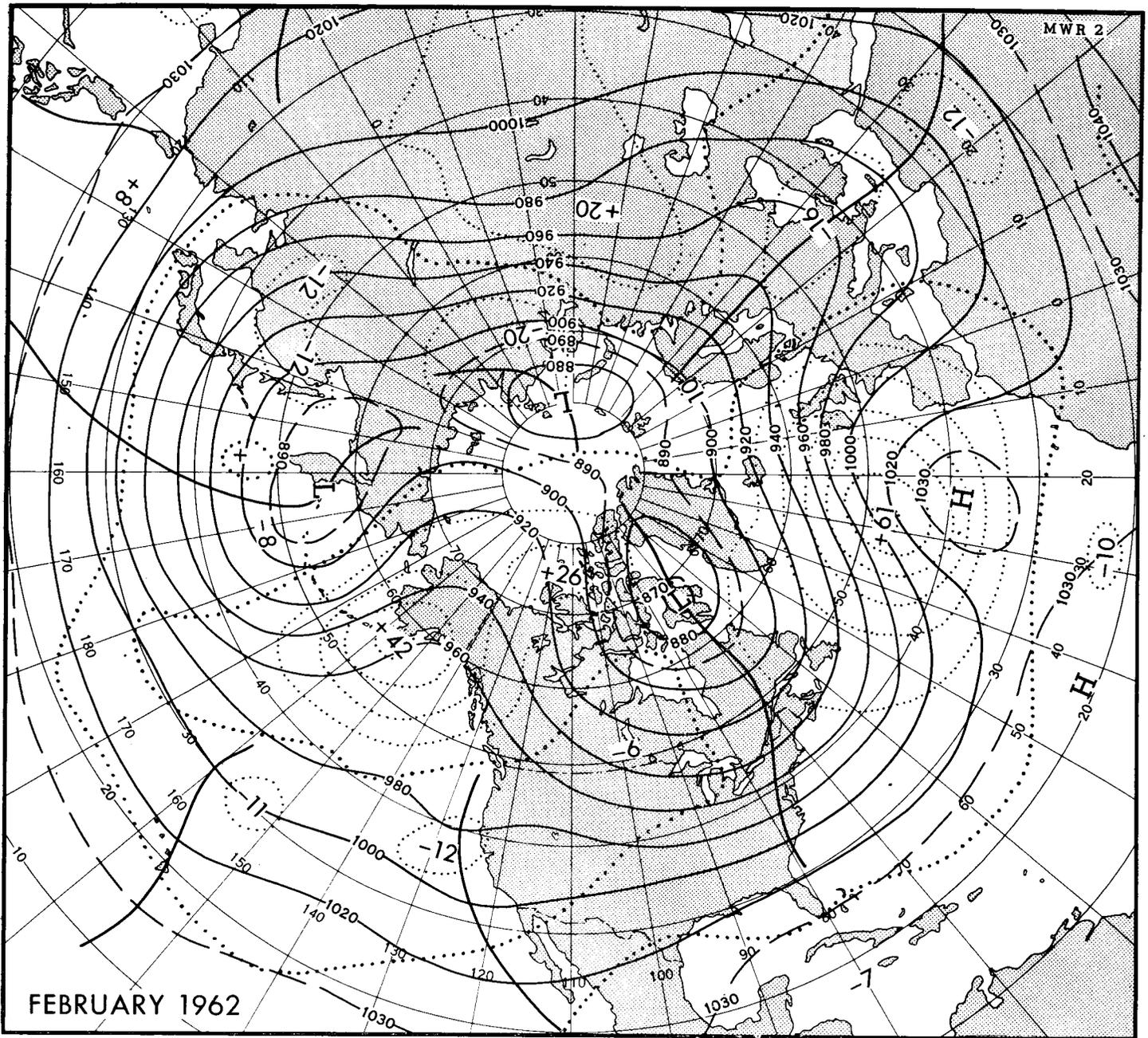


FIGURE 1.—Mean 700-mb. contours (solid) and height departures from normal (dotted), both in tens of feet, for February 1962. Blocking was strong in the Atlantic and Pacific.

3. AVERAGE WEATHER IN THE UNITED STATES

TEMPERATURE

Below normal temperatures dominated the northern half of the Nation in February while above normal temperatures prevailed throughout the southern half (fig. 4). Greatest departures were observed in the Gulf States where much of the area averaged more than 6° F. warmer than normal. Southern Texas was the warmest area with Brownsville reporting its warmest February in a record dating back to 1878.

The strong zonal temperature anomaly gradient from the central Plains to the Atlantic coast (fig. 4) was related to a confluent circulation pattern at 700 mb. (fig. 1). Fast westerlies in the confluent zone (fig. 2) prevented cold Arctic air from penetrating south of the 40th parallel. This is also shown by the tracks in figure 5A: polar anticyclones moved on a primary track north of the Great Lakes, with a secondary track southward through the Northern Plains, the middle Mississippi Valley, and the Ohio Valley.

The 700-mb. height anomaly field (fig. 1) was generally

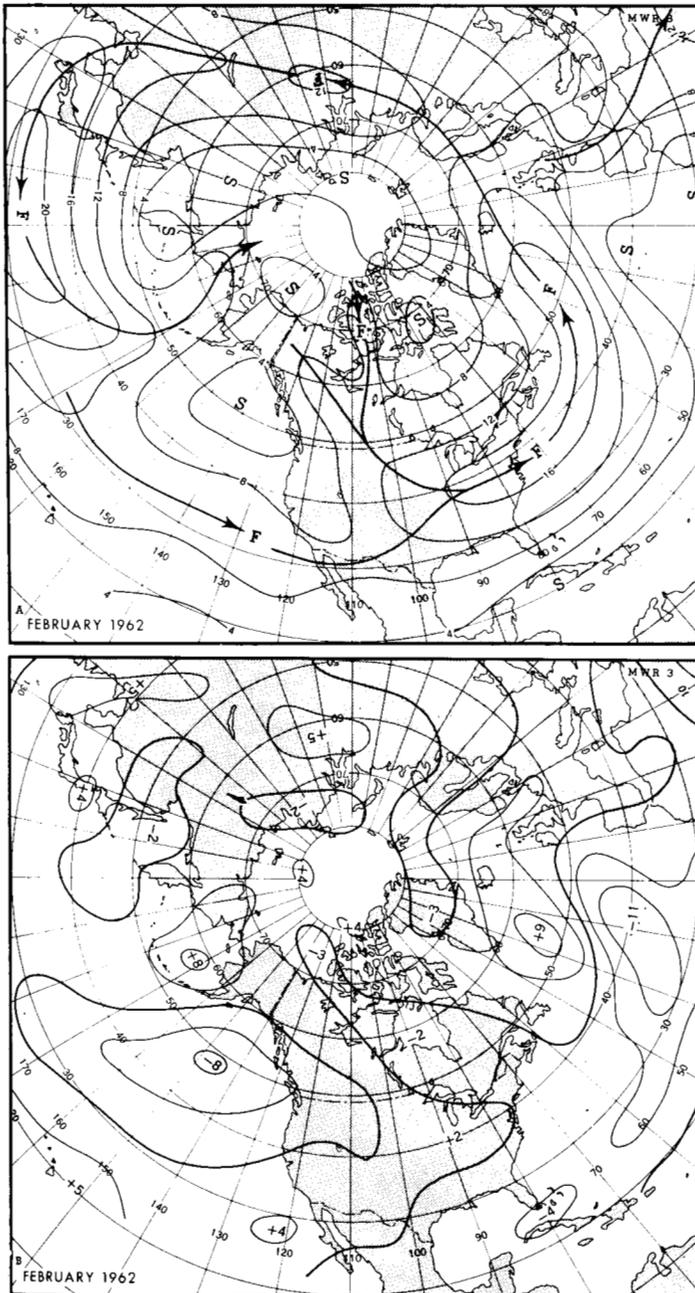


FIGURE 2.—(A) Mean 700-mb. isotachs, and (B) departure from monthly normal wind speed (both in meters per second) for February 1962. Arrows in (A) indicate axes of maximum winds. The split in westerlies over the Pacific and, to a lesser degree, over the Atlantic, illustrates blocking in these areas.

well related to the temperature anomaly pattern (fig. 4). From the Great Lakes to New England, however, temperatures averaged below normal, even though 700-mb. heights were slightly above normal. This was the result of long northwesterly transport of cold air masses over a snow covered surface, thus giving little opportunity for warming.

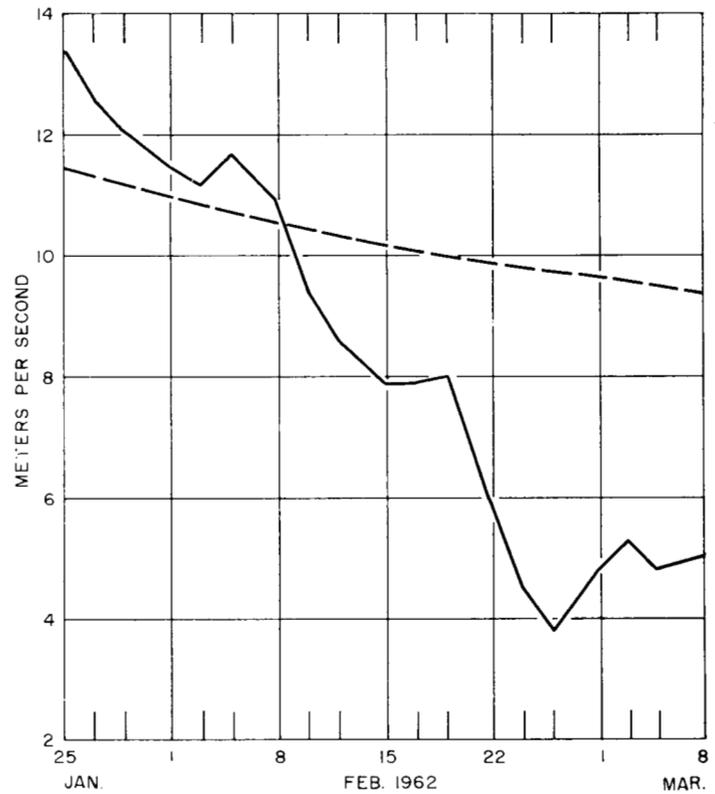


FIGURE 3.—Time variation of zonal index in meters per second (solid) and normal (dashed) for the western sector of the Northern Hemisphere (35° to 55° N.) for February 1962. Indices are 5-day mean values plotted at the middle of each period. Low index was a reflection of widespread blocking.

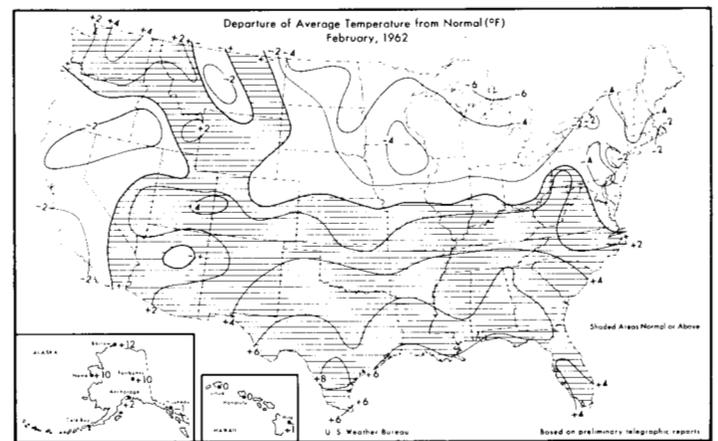


FIGURE 4.—Departure of average surface temperature from normal (° F.) for February 1962. (From [2]).

PRECIPITATION

Precipitation exceeded normal in many areas of the United States, and was more than twice the normal in California, the Great Basin, and in portions of the Northern Plains and the Ohio and Tennessee Valleys (fig. 6). The deep trough along the west coast and strong onshore flow (fig. 1) were responsible for the heavy precipitation

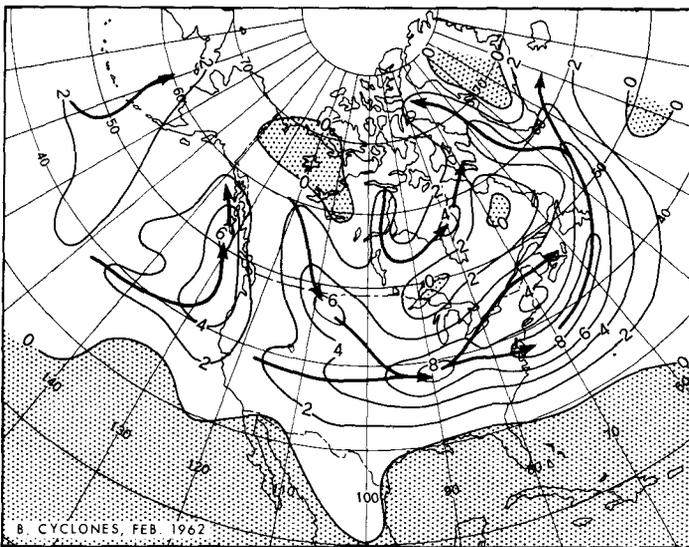
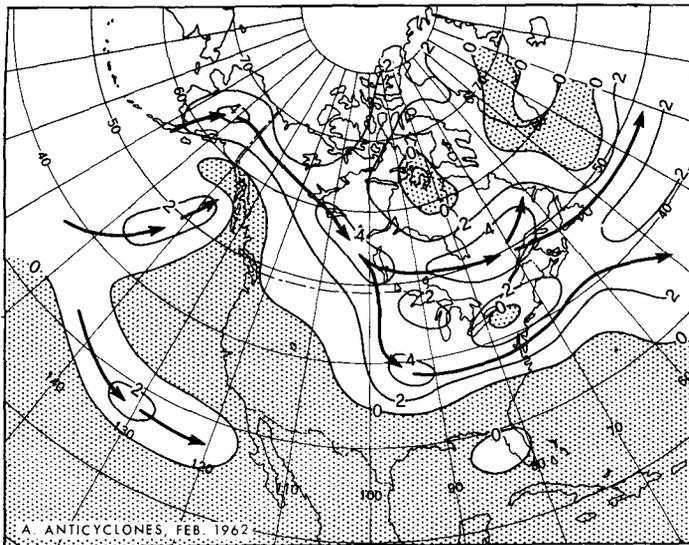


FIGURE 5.—Frequency of (A) anticyclone and (B) cyclone passages (within 5° squares at 45° N.) during February 1962. Principal tracks are indicated by arrows.

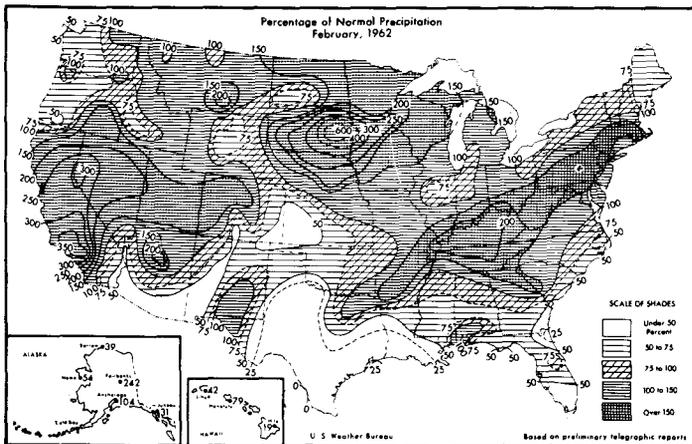


FIGURE 6.—Percentage of normal precipitation for February 1962. (From [2]).

TABLE 1.—Selected snowfall records established in February 1962

City	Total snowfall (inches)	Remarks
Huron, S. Dak.	39.9	Greatest of record for any month.
Sioux Falls, S. Dak.	48.4	Do.
Minneapolis-St. Paul, Minn.	26.5	February record.
Des Moines, Iowa	21.3	Do.
Dubuque, Iowa	24.0	Do.
Escanaba, Mich.	31.7	Do.
Alpena, Mich.	30.1	Do.
Muskegon, Mich.	40.2	Do.
Worcester, Mass.	45.2	Do.
Providence, R.I.	30.9	Do.

in California and the Great Basin. More than three times the normal amounts were reported in southern California where Bakersfield and Santa Maria (both with records to 1900) observed record totals for any February. The primary storm centers associated with this heavy precipitation moved northward off the coast (fig. 5B) with slow moving cold fronts and strong cyclonic flow being responsible for much of the precipitation.

Another primary cyclone track, originating in the Great Basin, joined in the middle Mississippi Valley with a second track of cyclones that lay southeastward through the Northern Plains (fig. 5B). The junction of these tracks was the locus of maximum cyclonic activity in the United States. Furthermore, the two primary westerly wind jets at 700 mb. merged to produce a confluence zone in this same area (fig. 2A). Both of these cyclone tracks, along with the southern track to the Atlantic Coast, were associated with mostly above normal amounts of precipitation, as much as twice the normal in portions of the Ohio and Tennessee Valleys and the Northern Plains (fig. 6). Precipitation in the cold air from the Northern Plains to New England was almost entirely snow, and the passage of frequent storms resulted in record snowfall totals. Some of these records are listed in table 1 for selected cities with long-period station records. Precipitation was generally deficient south of the confluence zone and storm track across the mid-United States (figs. 5B, 6). A fall of 0.70 inch at Baton Rouge, La., was the least there for any February.

Probably the most outstanding features of the month in the United States were the contrasting circulation and weather regimes. These can best be described in terms of half-monthly charts.

4. INTRAMONTHLY CHANGES IN CIRCULATION AND WEATHER

FEBRUARY 1-14, 1962

The circulation over North America during the first half of February was dominated by a ridge over the western half of the continent and a trough over the eastern half (fig. 7A). Both of these large-amplitude systems were near their normal positions for February and both were stronger than normal. The middle-

TABLE 2.—Record high temperatures for February established in 1962

City	Temperature (° F.)	Date in February
Nashville, Tenn.	84	13
Corpus Christi, Tex.	84	9
Birmingham, Ala.	83	13
Montgomery, Ala.	85	13
Evansville, Ind.	79	13
North Platte, Nebr.	79	11
Grand Island, Nebr.	76	11
Valentine, Nebr.	75	12
Casper, Wyo.	65	11
Cheyenne, Wyo.	71	11

latitude westerlies reached their greatest strength at this time with the zonal index averaging close to normal (fig. 3). This can also be seen in figure 8 which compares the zonal wind speed profiles for the western part of the Northern Hemisphere at 700 mb. for both halves of the month.

The zonal index itself does not uniquely define the temperature and precipitation regimes in the United States, but it has been determined empirically that the warmest and driest weather usually occurs near or at the beginning of the downward phase of the index cycle. On the other hand, cold wet weather is most often associated with the minimum phase of the cycle, or the early stages of its recovery. The relation of zonal index and weather in the United States during February 1962 was in agreement with these empirical relationships; the temperature regime corresponded especially well.

Mild and generally dry conditions prevailed in most of the Nation during the first half of February (figs. 7B, 7C). Exceptions were the below normal temperatures in the Northeast and in Florida, and the heavy precipitation in the Far West.

Mild weather was related to the strong ridge over the West (fig. 7A) where temperatures for February 1-14 averaged as much as 15° F. above normal at Rapid City, S. Dak. Two periods of extreme warmth were observed separated by a temporary intrusion of Arctic air. To illustrate the temperature changes in the West the daily maximum and minimum temperature at Havre, Mont., and Denver, Colo., for February 1962, were plotted against time along with their respective normals, as shown in figure 9. It is interesting to note that the minimum temperatures at Havre remained near and even above the normal maximum during the two periods of abnormal warmth. Many daily maximum temperature records were established from the Rockies to the Appalachians during the first half of February. A temperature of 79° F. at Evansville, Ind., on the 13th was the highest temperature ever observed in a winter month in a record dating to 1897. Other selected cities which recorded their highest temperature for any February are listed in table 2.

Temperatures averaged well below normal in the Northeast during the first half of the month, as much as 8° F. at Alpena, Mich. (fig. 7B), as stronger than normal northwesterly flow brought frequent invasions of Arctic air

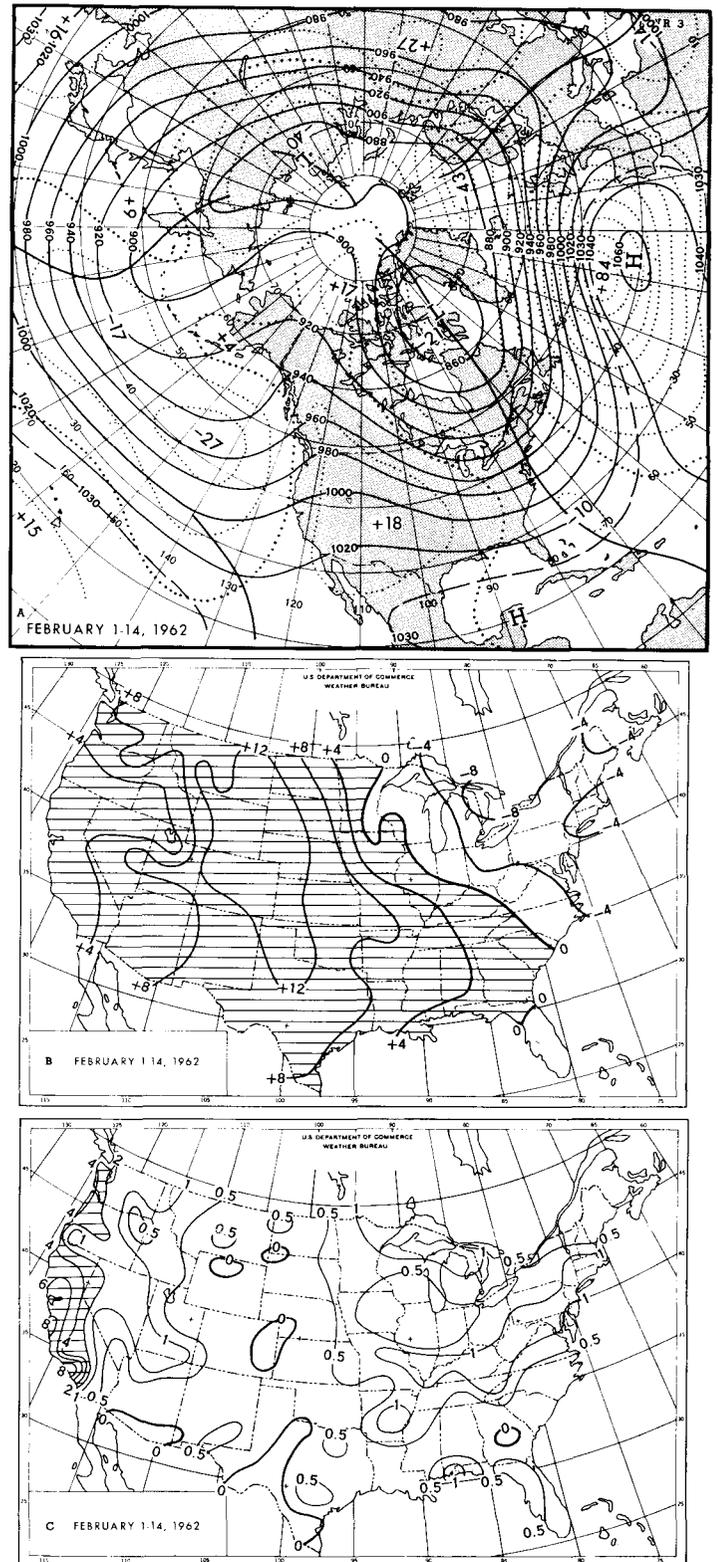


FIGURE 7.—February 1-14, 1962. (A) 700-mb. height (solid) and its departure from normal (dotted) (both in tens of feet). (B) Departure of average surface temperature (° F.) from normal. (C) Total precipitation (inches) (approximate).

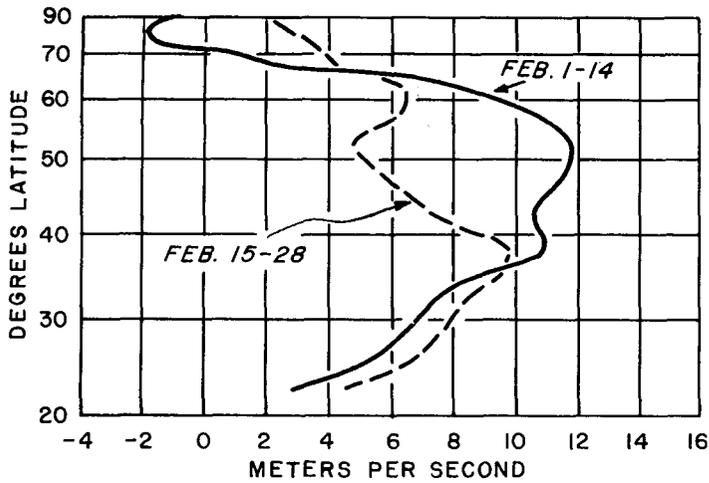


FIGURE 8.—Mean 700-mb. zonal wind speed profiles in the western portion of the Northern Hemisphere for February 1-14 (solid) and February 15-28, 1962 (dashed). Strong blocking displaced the westerlies southward during the latter half of the month.

masses (fig. 7A). The cold was not particularly extreme for this time of year with only Albany, N.Y., reporting a daily minimum temperature record (-18° F. on the 11th).

Precipitation was light over much of the Nation during the first two weeks of February (fig. 7C), a pattern quite typical of the corresponding circulation (fig. 7A). The most notable exception to the dry regime was in the Far West where heavy precipitation fell in connection with the deep trough in the eastern Pacific (figs. 7A, 7C). Most of this occurred during the second week when the trough reached its greatest intensity and strong southwesterly flow prevailed along the coast. Heaviest amounts were reported in California where as much as 8 in. in some coastal areas resulted in damaging floods and landslides near Los Angeles. Twenty-four hour amounts of 4.16 in. at Los Angeles on the 7th-8th and 5.16 in. at Burbank on the 10th-11th were February records.

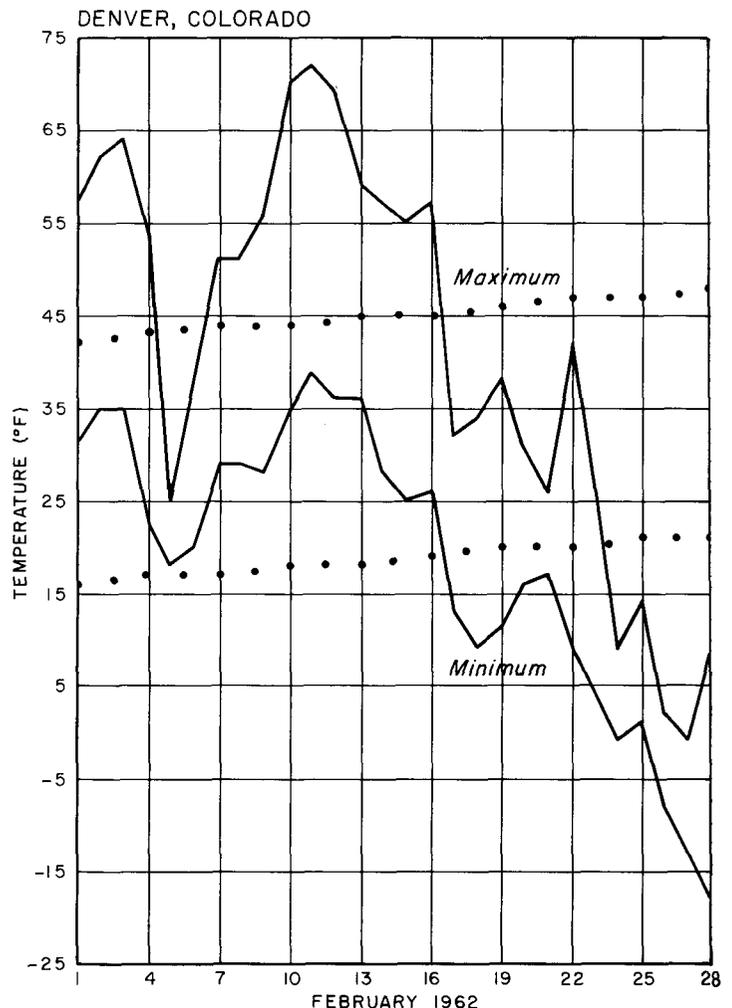
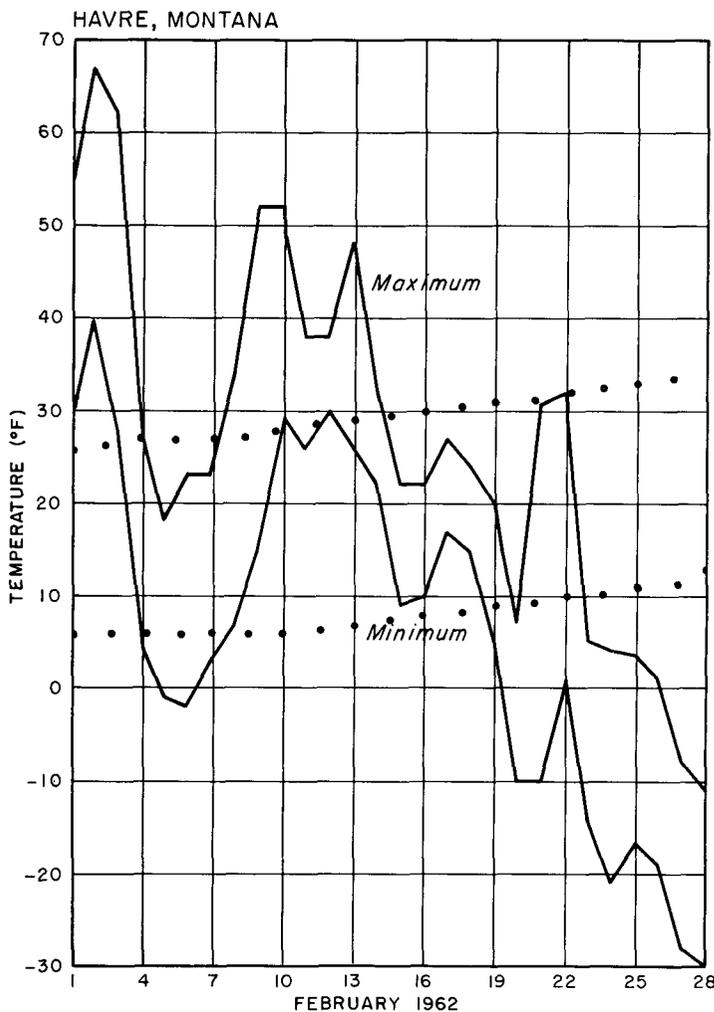


FIGURE 9.—Maximum and minimum surface temperatures ($^{\circ}$ F.) for February 1962 (solid) with corresponding normals (dotted) for Havre, Mont., and Denver, Colo. February was a month of marked temperature contrast in the western United States.

FEBRUARY 15-28, 1962

Pronounced changes in the mid-tropospheric circulation occurred during the latter half of the month as the zonal index continued to fall rapidly (fig. 3), and the middle-latitude westerlies were displaced southward (fig. 8). This evolution of the westerlies accompanied the appearance of strong blocking at higher latitudes and was associated with progression of the planetary wave pattern at low latitudes and retrogression at high latitudes. One of the areas of most pronounced change was the eastern Pacific where a very strong ridge appeared along with 700-mb. heights as much as 780 feet above normal in the Gulf of Alaska (fig. 10A). Development of this ridge resulted from retrogression of the Canadian portion of the North American ridge, and its amalgamation with the weak ridge formerly near the Hawaiian Islands (fig. 7A). At the same time the low-latitude mid-Pacific trough deepened as it moved eastward to replace the ridge previously in that area. This favored northward growth of the ridge and marked amplification followed.

Accompanying these developments was progression of the eastern Pacific trough into the western United States, and its merger with the retrograding Canadian portion of the sheared eastern North American trough (figs. 7A, 10A). The lower portion of the latter trough moved eastward and was replaced by a ridge. As a result of this evolution the circulation over the United States underwent a complete reversal, with a deep trough replacing a strong ridge in the West and a ridge supplanting a trough along the east coast.

The overall magnitude of the mid-month circulation reversal is evident from figure 11 which shows the change in 700-mb. height between the two half-month circulation patterns. The sharp increase in heights at high latitudes (hatched area) is a reflection of strong blocking which dominated the circulation over the entire Northern Hemisphere during the last half of February. Areas of greatest positive change, as much as 800 feet, were observed in the North Atlantic and Gulf of Alaska, while large areas of negative change were observed over the western United States and central Atlantic. The circulation change over North America was accompanied by an abrupt change in weather regime in most of the United States.

In contrast to the mild weather of the first half of the month very cold conditions prevailed during the latter half of February in the western two-thirds of the Nation (figs. 7B, 10B). This change began near mid-month with the most severe cold prevailing at month's end. Temperatures averaged as much as 30° F. lower in portions of the northern and central Great Plains as strong northerly flow in western Canada (fig. 10A) transported cold Arctic air masses into the West. The fluctuations in daily temperature at Havre, Mont. and Denver, Colo. (fig. 9), are representative of temperature changes in the West.

Most stations in the Plains States and Upper Mississippi

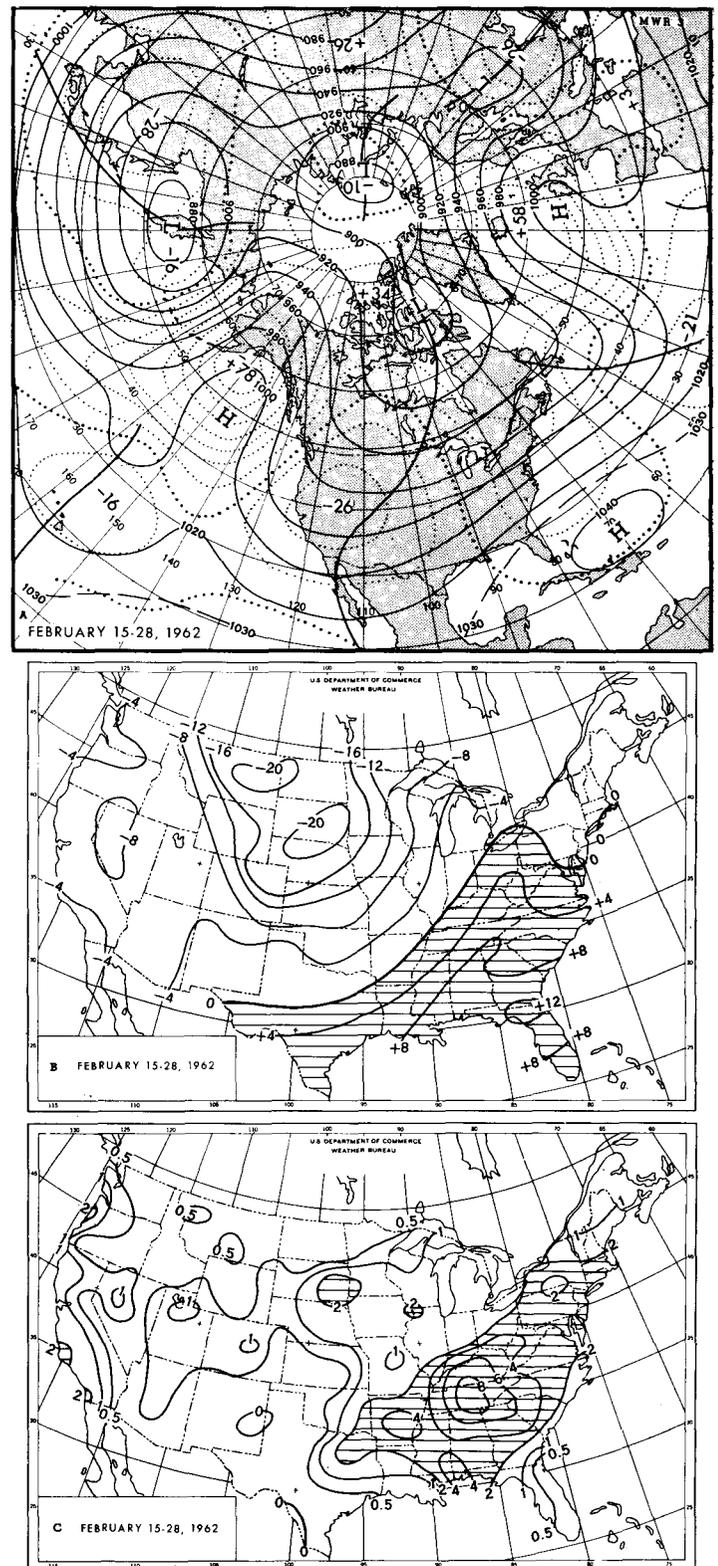


FIGURE 10.—February 15-28, 1962. (A) 700-mb. height (solid) and its departure from normal (dotted) (both in tens of feet). (B) Departures of average surface temperature (° F.) from normal. (C) Total precipitation (inches) (approximate).

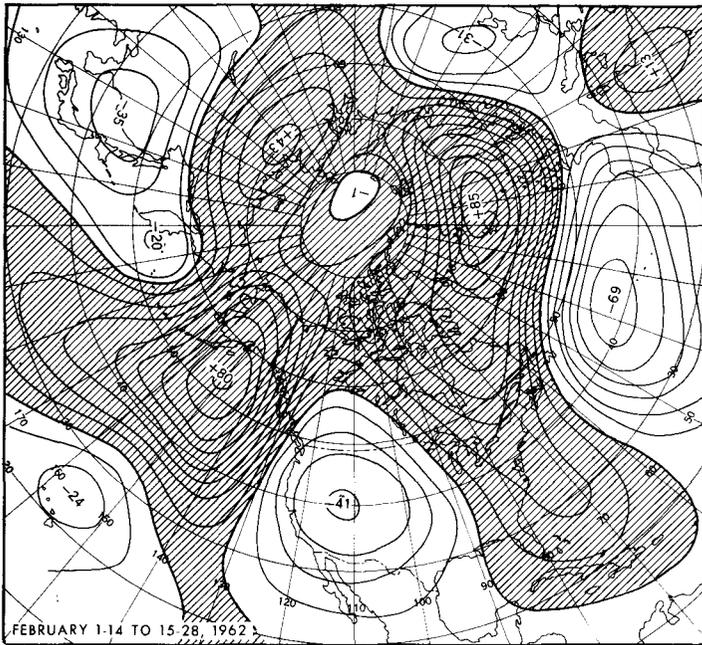


FIGURE 11.—Change in mean 700-mb. height (tens of feet) from February 1-14 to February 15-28, 1962. Strong height rises (hatched) at high latitudes and falls at low latitudes indicate the marked increase in blocking.

Valley reported record low temperatures for the day on February 28. Daily temperature departures were 20° F. to as much as 48° F. below normal on the last three days of the month from the Pacific Coast States to the Mississippi Valley. A temperature of -39° F. on the 28th at Huron, S. Dak., was a February record, while -12° F. at Reno, Nev., equaled the monthly record. In addition, low temperature records for so late in the season were established at Williston, N. Dak., with -41° F. on the 28th, and Medford, Oreg., with 10° F. on the 26th.

Temperatures averaged above normal in the South and most of the East in the last half of February as a reflection of an upper-level ridge and stronger than normal southerly flow (figs. 10A, B). In the Northeast, where 700-mb. heights were well above normal, radiational cooling and a deep snow cover kept temperatures slightly below normal.

Summerlike weather prevailed in the Southeast and South during the last week with temperatures in the 80's in the Carolinas and Georgia and some 90's in Florida near the end of the month. These high temperatures were the highest ever recorded for any February in most sections in the eastern Carolinas and Georgia. Furthermore, 92° F. at Fort Myers, Fla., on the 25th was the highest there for any winter month, while 85° F. at

Wilmington, N.C., was the warmest observed there for the months of November through February in records dating back to 1871.

The extremes of cold in the West and warmth in the Southeast were observed just after the circulation reached its greatest amplification and the zonal index was lowest (fig. 3). During the last week 700-mb. heights averaged 1,000 feet above normal in the Gulf of Alaska. This anomaly and the associated ridge were accompanied by unusual warmth in the northern half of Alaska where daily temperatures at this time were as much as 40° F. above normal.

Eastward motion of the long-wave circulation pattern over the United States from the first to the last half of the month also resulted in a shift eastward of the precipitation pattern (figs. 7, 10). Much less precipitation fell in the Far West as northerly cyclonic flow replaced southwesterly flow, while cloudy, wet weather from the Plains States to the Atlantic coast replaced the generally dry conditions of early February. Heaviest rains fell in the Ohio and Tennessee Valleys, with more than 9 in. at Chattanooga, Tenn. (fig. 10C), and produced considerable flooding late in the month in Kentucky, West Virginia, and Tennessee. Snowfall was frequent and heavy from the Northern Plains to New England. One storm system moving across the Central Plains deposited all-time record 24-hr. snowfall amounts on the 17th and 18th at Huron, S. Dak., (17.5 in.), and Sioux Falls, S. Dak. (26.0 in.).

5. THE SEVERE STORM OF FEBRUARY 16-17, 1962, IN NORTHERN EUROPE

"One of the worst storms of the century" lashed northern Europe with hurricane-force winds and high seas on the 16th and 17th. This storm, located near Iceland on the 15th, deepened rapidly the following day as it moved east-southeastward across southern Scandinavia and into the mean trough over eastern Europe (fig. 1). The lowest pressure reported in the intense storm as it crossed Norway and Sweden was 952 mb. German port cities along the North Sea coast suffered greatly from the high winds and floods, with the final count of fatalities exceeding 300.

REFERENCES

1. L. P. Stark, "The Weather and Circulation of January 1962—A Month With Large Circulation Changes and Widespread Cold", *Monthly Weather Review*, vol. 90, No. 4, April 1962, pp. 167-174.
2. U.S. Weather Bureau, *Weekly Weather and Crop Bulletin, National Summary*, vol. XLIX, No. 10, March 5, 1962.