WEATHER AND CIRCULATION OF JANUARY 1981
Record Warmth in the West, Record Cold in the Southeast and Widespread Severe Drought

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1. Mean Circulation

The January 1981 mean circulation was characterized by a deep polar vortex and a strongly amplified planetary wavenumber 3 (Fig. 1). This represents a change from the predominantly wavenumber 4 pattern of December and was accomplished by loss of the high-latitude block that had been over eastern Siberia (Taubensee, 1981) and consolidation of the troughs near Japan and over the east-central Pacific into one broad, intense trough that occupied most of the Pacific north of 30°N.

Considerable amplification of the ridge over western North America occurred from December to January in response to loss of the Siberian block and the changes over the Pacific. The mean trough over eastern North America also amplified and progressed at most latitudes, leading to further building of the ridge over the eastern Atlantic, which remained nearly stationary. Magnitudes of all the principal

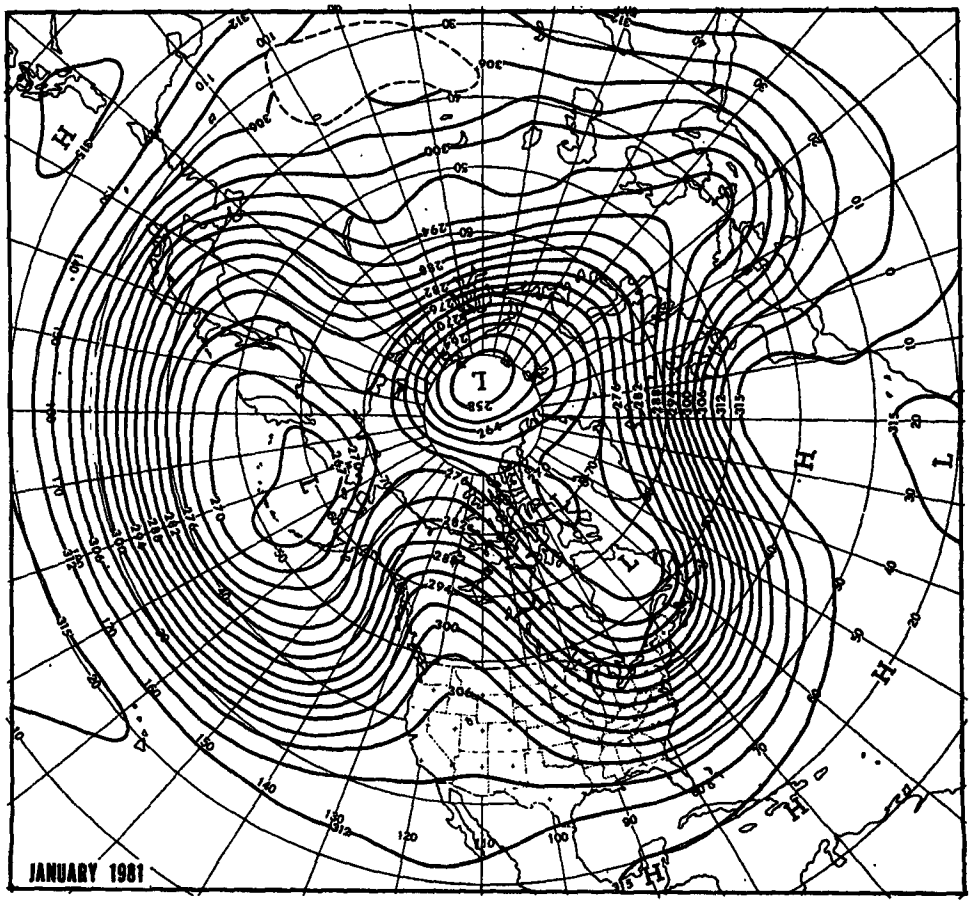


FIG. 1. Mean 700 mb height contours (dam) for January 1981.

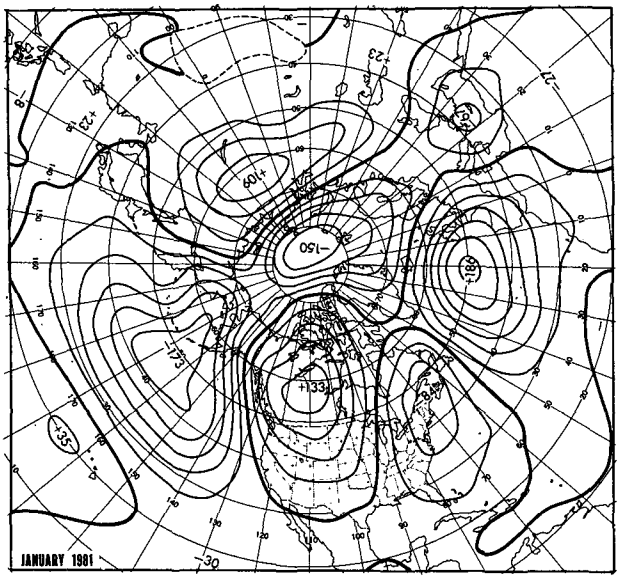


FIG. 2. Departure from normal of mean 700 mb height (m) for January 1981.

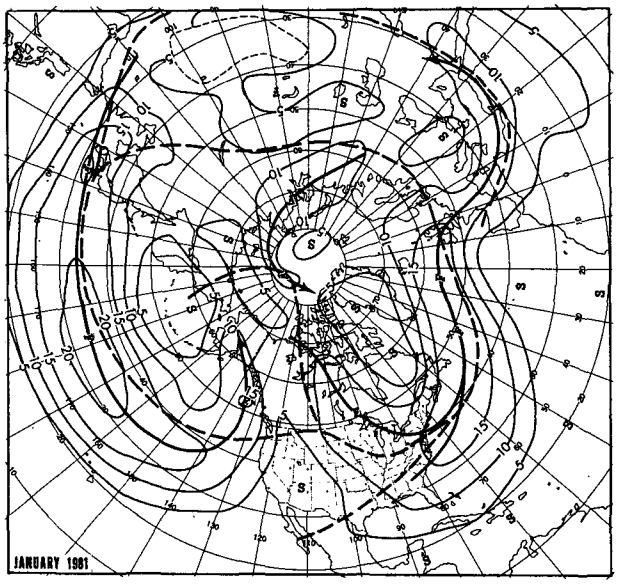


FIG. 3. Mean 700 mb geostrophic wind speed (m s^{-1}) for January 1981. Solid arrows indicate observed axes of maximum wind speed and dashed lines, the normal.

anomalies associated with the circulation pattern were quite intense (Fig. 2), ranging from around two standard deviations for the troughs over the Pacific and eastern North America to three standard deviations for the ridges over northern Asia and the eastern Atlantic. The positive anomaly over Canada was calculated at over four standard deviations, which is believed to be mainly a reflection of the shortness of the data sample (1948–70) on which the calculations are based. There may well be a nonhomogeneity in the population samples in that area, as also three years ago (Wagner, 1978) there was a huge monthly mean circulation anomaly in the same general area, where even 5-day mean circulation anomalies were rare during part of the period of record (O'Connor, 1969, pp. 2, 3, 92).

The wind speed maxima at the 700 mb level (Fig. 3) were approximately double the normal over the two oceans, being south of the normal position over the central Pacific and north of normal over the central and eastern Atlantic. The ridge over western North America was so intense that the Pacific wind maximum moved northwestward into Alaska, instead of entering the Pacific Northwest as it normally does. This pattern is quite similar to that of January four, and to a lesser extent, three years ago (Wagner, 1977, 1978). As will be seen later in this article, the temperature and precipitation patterns over all the United States, including Alaska and Hawaii, also bore a close resemblance to January and February 1977 when storms failed to enter the mainland United States from the Pacific (Dickson, 1977).

The thickness anomaly map (Fig. 4) is most noteworthy for the large areas of extreme warmth over northwestern Canada and northern Asia associated with the ridges in those areas. The thickness anomaly center over western Canada also was close to four standard deviations from the 1948–70 mean, and was in fact stronger than the associated height anomaly in a numerical sense, indicating that sea level pressures were actually slightly *below* normal in the area. The relative weakness of the thickness anomalies compared to the height anomalies over the oceans is related to the fact that the 700 mb heights were largely compensated by the sea level pressure in those areas.

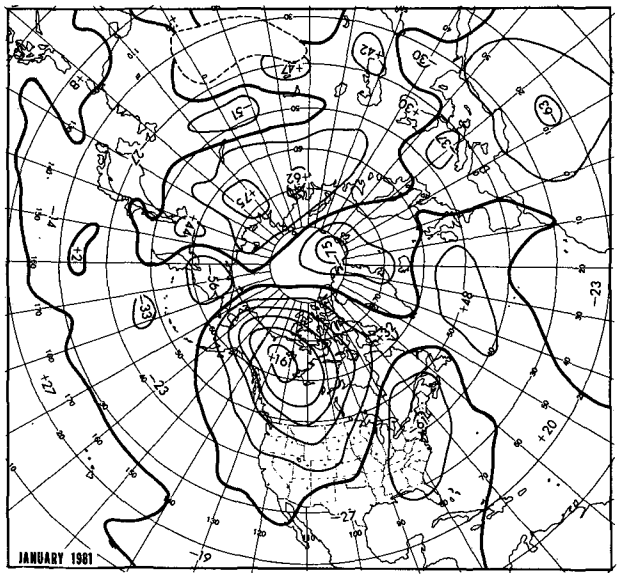


FIG. 4. Departure from normal of mean 1000–700 mb thickness (m) for January 1981.

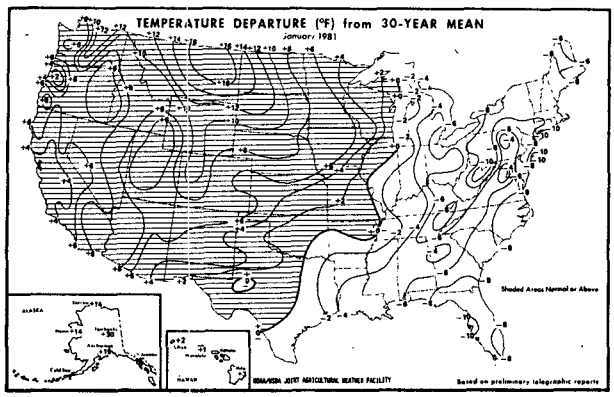


FIG. 5. Departure from normal of average surface air temperature (°F) for January 1981 (from National Oceanic and Atmospheric Administration and Economics and Statistics Service, 1981).

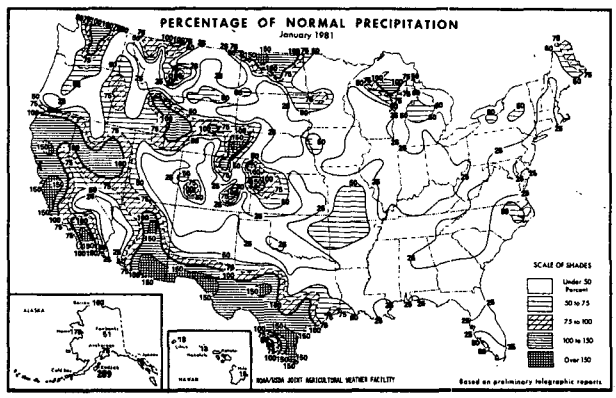


FIG. 6. Percentage of normal precipitation for January 1981 (from National Oceanic and Atmospheric Administration and Economics and Statistics Service, 1981).

2. Temperature

In consonance with the thickness anomaly pattern, the highly amplified circulation gave a strong monthly mean temperature anomaly pattern over the United States with record warm temperatures persisting over the West (Taubensee, 1981) and record or near-record cold at a few locations in the Southeast and East (Fig. 5 and Table 1). Were it not for the pronounced and prolonged "January thaw" during the last 10 days of the month, many cities in the Northeast would have had the coldest January on record. For example, Worcester, MA reported temperatures averaging 14°F below normal for the first 18 days of the month.

The magnitude of the warmth in the West was diminished at some locations where persistent fog, often augmented by urban pollution, developed in strong low-level inversions that formed under the warm air aloft in the strong ridge. Heavy fog was observed for a record 23 consecutive days at Medford, OR beginning in December and ending on 17 January when a Pacific front of sufficient vigor finally broke the inversion. Salt Lake City, UT had 11 days with heavy fog and only 10 days without at least light fog.

In the Pacific sector, the mean circulation that gave rise to strong southerly flow across Alaska and reduced trade winds with locally anticyclonic conditions over Hawaii produced abnormally warm weather in both states, as in the two years previously mentioned that had similar circulation patterns (Wagner, 1977, 1978). This year Fairbanks had one of the largest monthly mean temperature anomalies ever recorded anywhere in North America, as January 1981 was a record 30°F above normal. Several other stations in Alaska that did not have record warmth in January 1981 set a record in January 1977 that still stands.

TABLE 1. Record and near-record monthly mean temperatures observed over the United States during January 1981.

Station	Temperature (°F)	Anomaly (°F)	Remarks
Fairbanks, AK	18.1	+30.0	Warmest January on record
Anchorage, AK	31.5	+19.7	2nd warmest January on record
Barrow, AK	−0.9	+13.8	Warmest January since 1930
Glasgow, MT	25.3	+16.1	Warmest January since 1919
Billings, MT	36.0	+14.1	2nd warmest January on record
Havre, MT	28.5	+17.2	3rd warmest January on record
Great Falls, MT	33.8	+13.3	Warmest January since 1958
Missoula, MT	29.5	+8.7	3rd warmest January on record
Sheridan, WY	32.4	+11.4	Warmest January on record
Casper, WY	31.4	+8.2	2nd warmest January on record
Cheyenne, WY	33.4	+6.8	4th warmest January on record
Grand Junction, CO	36.8	+10.2	Warmest January on record
Flagstaff, AZ	36.2	+8.3	Warmest January on record
Phoenix, AZ	59.2	+8.0	Warmest January on record
Yuma, AZ	61.9	+6.5	Warmest January on record
Eureka, CA	52.5	+5.2	Warmest January on record
Mt. Shasta, CA	39.4	+5.8	4th warmest January on record
Portland, OR	43.9	+5.8	2nd warmest January on record
Yakima, WA	39.9	+12.4	Warmest January on record
Key West, FL	61.3	−9.4	Coldest January on record
West Palm Beach, FL	58.7	−6.8	Tied 2nd coldest January
Orlando, FL	51.3	−9.0	3rd coldest January on record
Daytona Beach, FL	48.8	−9.6	Coldest January since 1940
Wilmington, NC	37.5	−8.9	3rd coldest January on record
Wilmington, DE	25.4	−6.6	6th coldest January on record
Albany, NY	14.0	−7.5	5th coldest January on record
Concord, NH	12.5	−8.1	4th coldest January on record
Youngstown, OH	18.4	−7.3	5th coldest January on record

3. Precipitation

This was one of the driest Januarys on record nationwide, with only portions of the Southwest and scattered small areas elsewhere receiving more than the normal amount of precipitation. Were it not for a storm that moved inland from the West Coast to the Great Plains the last three days of the month, January would have been a close rival with October 1952 for the driest month on record over the conterminous United States (Winston, 1952). The strong mean ridge in the West deflected Pacific storms northward to Alaska, while Colorado and Gulf Coast cyclones were fewer and weaker than normal.

Extensive sections of the country, particularly the Ohio Valley and upper Midwest, as well as an area extending northeastward from the southern Piedmont through the Middle Atlantic States to New England, had less than one-quarter of the usual January total (Fig. 6). Over a dozen cities in these areas reported the driest January on record, while numerous other locations had near-record dryness (Table 2).

Following a December with record dryness (Taubensee, 1981), the lack of precipitation in January led to a severe to extreme drought condition over many of the southeast and north Atlantic States (Fig. 7). Although a midwinter drought has little immediate impact on agriculture, the effects were felt in severely depleted municipal water supplies in much of the Northeast, where some reservoirs were down to only a few weeks' supply and mandatory restrictions were put into effect in many jurisdictions. In the Midwest, the principal effect of the drought was on river barge traffic, which was restricted and hampered by unusually low water levels. Overall, many areas normally receiving several inches of precipitation in both December and January failed to get as much as an inch during December 1980 and January 1981 *combined*. A storm on the last day of the month broke the longest period without measurable precipitation on record (35 days) at Kansas City, MO and ended a 38-day dry spell at Sioux City, IA.

TABLE 2. Record and near-record monthly precipitation totals observed over the United States during January 1981.

Station	Amount (inches)	Anomaly (inches)	Remarks
Concord, NH	0.48	−2.19	3rd driest January on record
Hartford, CT	0.38	−2.90	Driest January on record
Albany, NY	0.59	−1.61	3rd driest January on record
Newark, NJ	0.45	−2.46	Driest January on record
Trenton, NJ	0.35	−2.41	2nd driest January on record
Wilmington, DE	0.52	−2.33	Driest January on record
Erie, PA	0.87	−1.60	Driest January since 1944
Parkersburg, WV	0.17	−2.91	Driest January on record
Huntington, WV	0.64	−2.51	Driest January on record
Beckley, WV	0.57	−2.89	Driest January on record
Roanoke, VA	0.29	−2.45	Driest January on record
Columbia, SC	0.84	−2.60	Driest January since 1935
Athens, GA	0.64	−4.12	Driest January on record
Atlanta, GA	0.84	−3.50	Driest January on record
West Palm Beach, FL	0.43	−2.17	2nd driest January on record
Baton Rouge, LA	1.20	−3.20	2nd driest January since 1928
Lexington, KY	0.37	−3.58	Driest January on record
Louisville, KY	0.45	−3.08	Driest January on record
Cincinnati, OH	0.57	−2.77	Driest January on record
Columbus, OH	0.70	−2.17	3rd driest January on record
Youngstown, OH	0.75	−2.19	Driest January on record
Evansville, IN	0.51	−2.89	2nd driest January on record driest since 1887
Indianapolis, IN	0.36	−2.50	2nd driest January on record
Lansing, MI	0.39	−1.52	2nd driest January on record
Madison, WI	0.14	−1.11	2nd driest January on record driest since 1903
Green Bay, WI	0.12	−0.97	Driest January since 1900
Medford, OR	0.54	−3.00	4th driest January on record
Portland, OR	1.47	−4.41	3rd driest January on record
Stampede Pass, WA	2.61	−10.28	Driest January on record

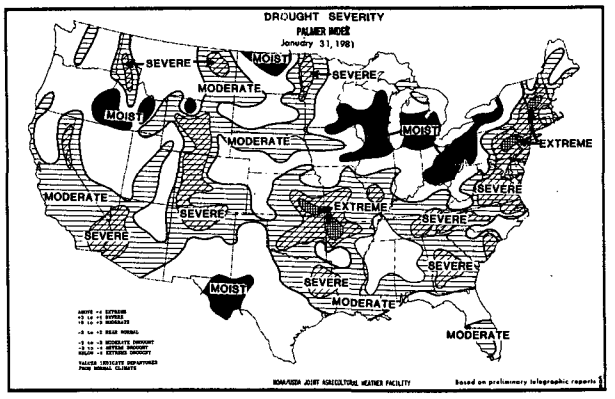


FIG. 7. Palmer Drought Severity Index as of 31 January 1981 (from National Oceanic and Atmospheric Administration and Economics and Statistics Service, 1981).

As with circulation and temperature, precipitation over Alaska and Hawaii was similar to that observed in January 1977 and 1978. Alaska, particularly the south coast, was generally wetter than normal, due to frequent northward-moving Pacific storms and strong southerly flow. The interior, nevertheless, was rather dry due to the inability of southerly winds to carry moisture across the high mountains near the south coast. A few storms moving through the Bering Strait area provided moisture for the western and northern coasts. Hawaii was quite dry due to the proximity of a stronger-than-normal subtropical ridge.

4. Variability within the month

a. 29 December–4 January

The mean circulation prevailing during the first few days of 1981 was quite similar to the monthly mean (Figs. 1 and 8A) except for a blocking high near the North Pole. Strong northwesterly flow from northern Canada brought record cold into the Great Lakes area and the Northeast while most areas west of the Mississippi River basked in unseasonable warmth (Fig. 8B). Record daily high maximum temperatures near 60°F were observed the first five days of the month at Albuquerque, NM, while new record daily low minimum temperatures were occurring over the Northeast from the 3rd to the 5th. A maximum temperature of −11°F on 3 January and a minimum of −32°F the next morning both equaled the lowest ever observed during January at Sault Ste. Marie, MI. A minimum of −29°F the same morning at Lansing, MI was the lowest January temperature ever observed there. Daily record temperatures as low as −27°F at Caribou, ME and −18°F at Portland, ME were also observed on 4 January. It took one more day for readings of 6°F at both Richmond, VA and Raleigh, NC to establish new daily records.

Precipitation was scanty over most of the country,

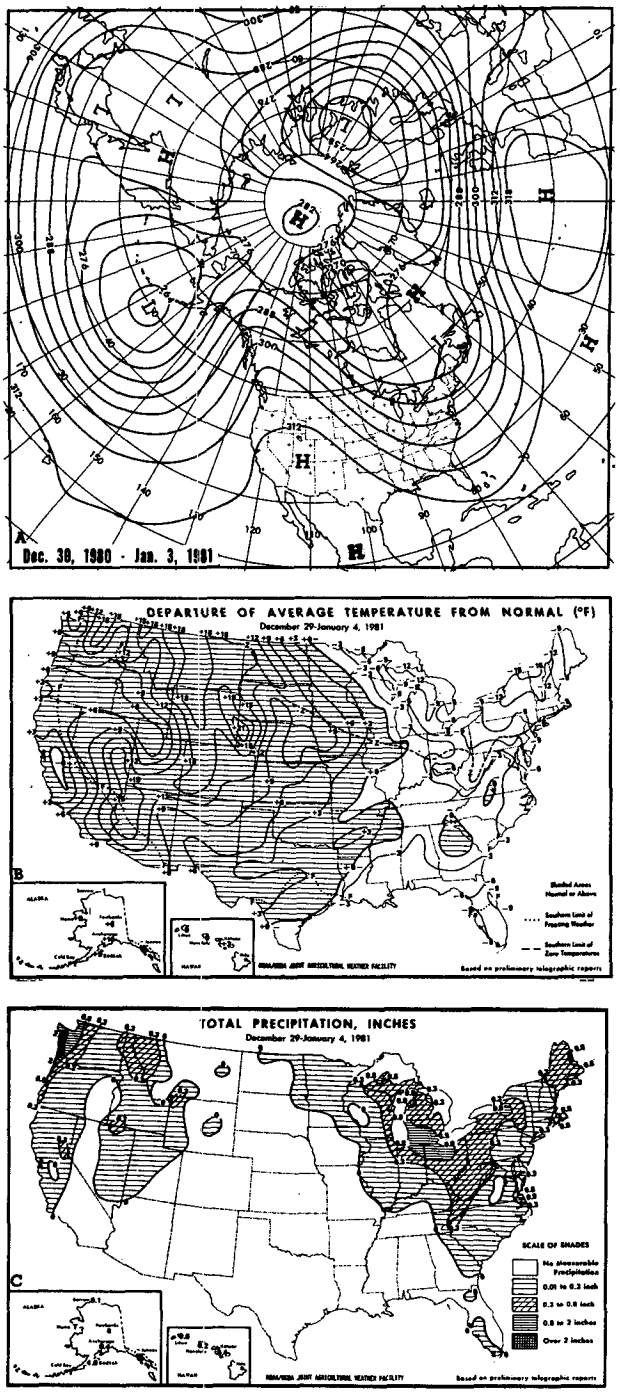


FIG. 8. (A) Mean 700 mb contours (dam) for 30 December 1980–3 January 1981; (B) departure from normal of average surface air temperature (°F); and (C) total precipitation (inches) for week of 29 December 1980–4 January 1981 (from National Oceanic and Atmospheric Administration and Economics and Statistics Service, 1981).

with most of the South and the Great Plains receiving no measurable amounts. A small disturbance on the closing days of 1980 produced heavy rain along the North Pacific coast, while moderate totals over the Great Lakes and Appalachians were associated with weak disturbances on the Arctic front augmented by convective instability from the Lakes that extended to the crest of the Appalachian Mountains.

b. 5–11 January

The 5-day mean circulation (Fig. 9A) and its anomalies were similar to those of the previous week

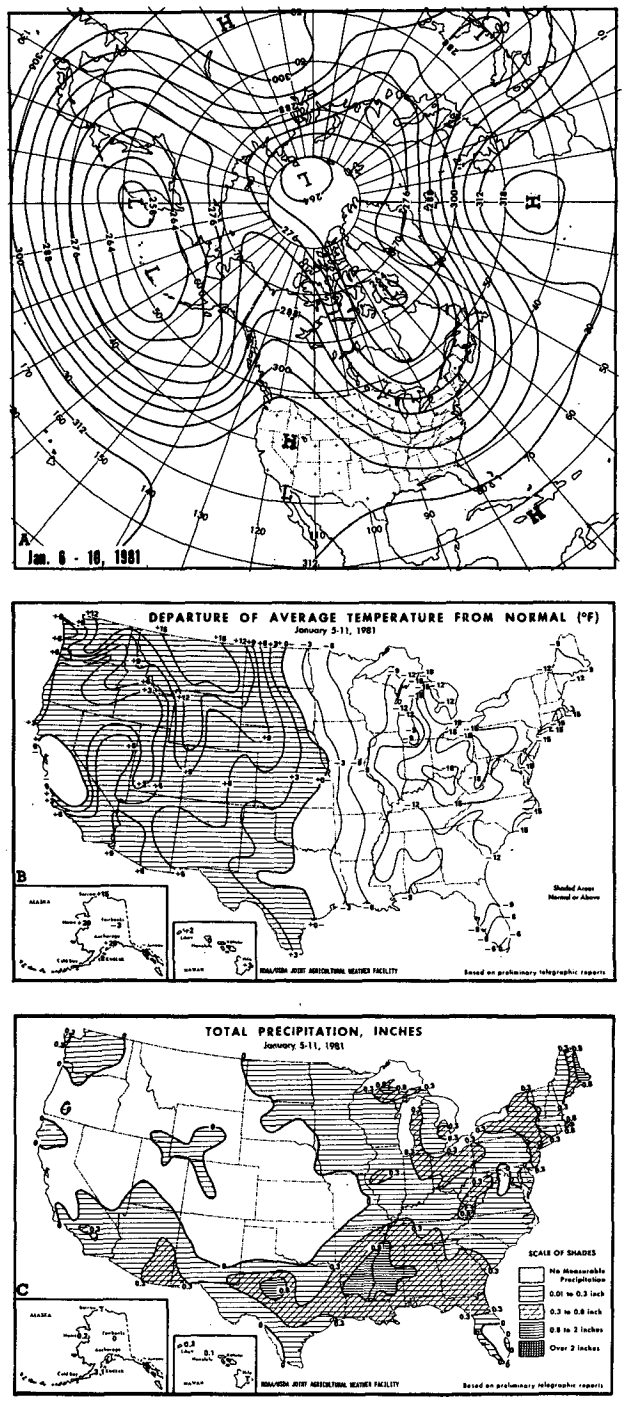
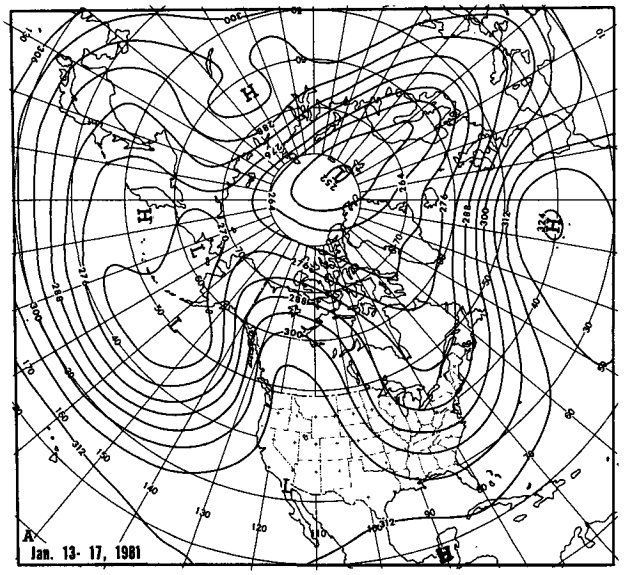
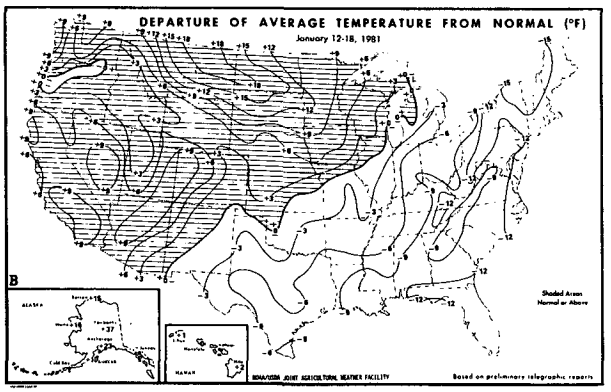


FIG. 9. As in Fig. 8 except for (A) 6–10 January 1981, and (B) and (C) week of 5–11 January 1981.

and the month as a whole. Subtle changes over North America such as slight progression and weakening of the United States portion of the western ridge and slight retrogression and deepening of the eastern trough along with more of a connection of the ridge to the Arctic led to a dimunition of the positive temperature anomaly in the West and a strengthening and enlarging of the negative temperature anomaly in the Midwest (Fig. 9B). The coldest temperatures relative to normal were in the Ohio Valley, similar to January four years ago (Wagner, 1977). Additional daily record-low minimum temperatures were observed in the Great Lakes area on the 8th.





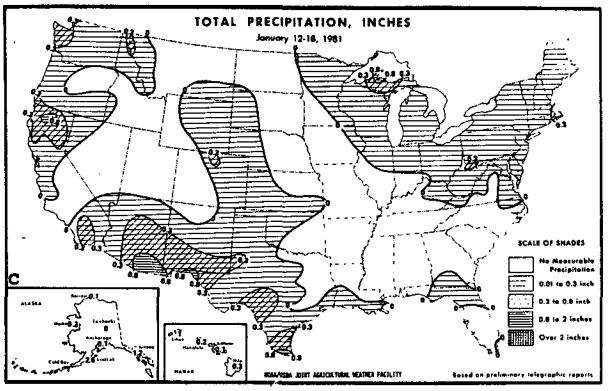


FIG. 10. As in Fig. 8 except for (A) 13–17 January 1981, and (B) and (C) week of 12–18 January 1981.

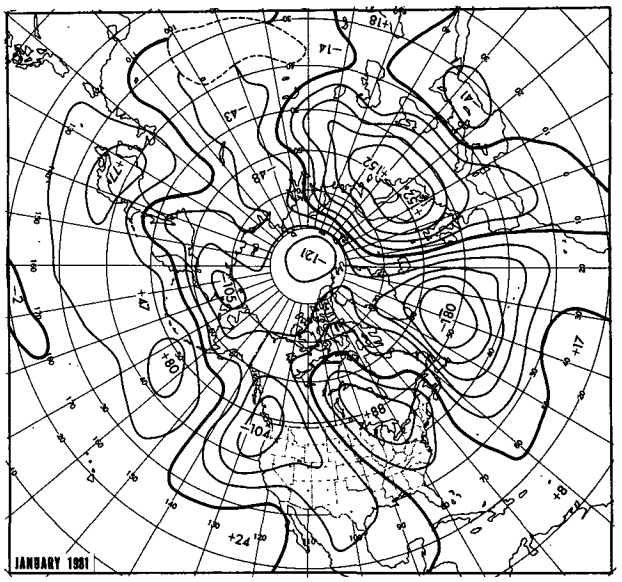


FIG. 11. Mean 700 mb height change from first half to second half of January 1981.

Precipitation was again relatively light over the country as a whole, although the area with no measureable total diminished and a noticeable increase in precipitation occurred across the southern border in response to a weak mean low near southern California (Fig. 9A) that helped feed moisture into a fairly vigorous middle-latitude storm system that plunged southeastward into the United States from central Canada. The same storm brought an unimpressive 1-inch snowfall to the twin cities of Minneapolis-St. Paul on 6 January, which was a noteworthy event because this was the latest date on record for the first snowfall of the season totaling at least one inch.

c. 12–18 January

The 5-day mean 700 mb circulation pattern (Fig. 10A) continued to be qualitatively similar to those related to the previous two weeks. Changes associated with shifts in the temperature anomaly pattern were a lowering of heights from the Bering Sea across the Arctic to northern Scandinavia, an increase in strength and progression of the Canadian portion of the western North American 700 mb ridge, and a deepening of the lower portion of the eastern North American 700 mb trough over the southeastern United States.

Corresponding changes in the temperature anomaly pattern included an increase in the magnitude and eastward spread of the warmth in the northern Great Plains and strengthening of the cold in the

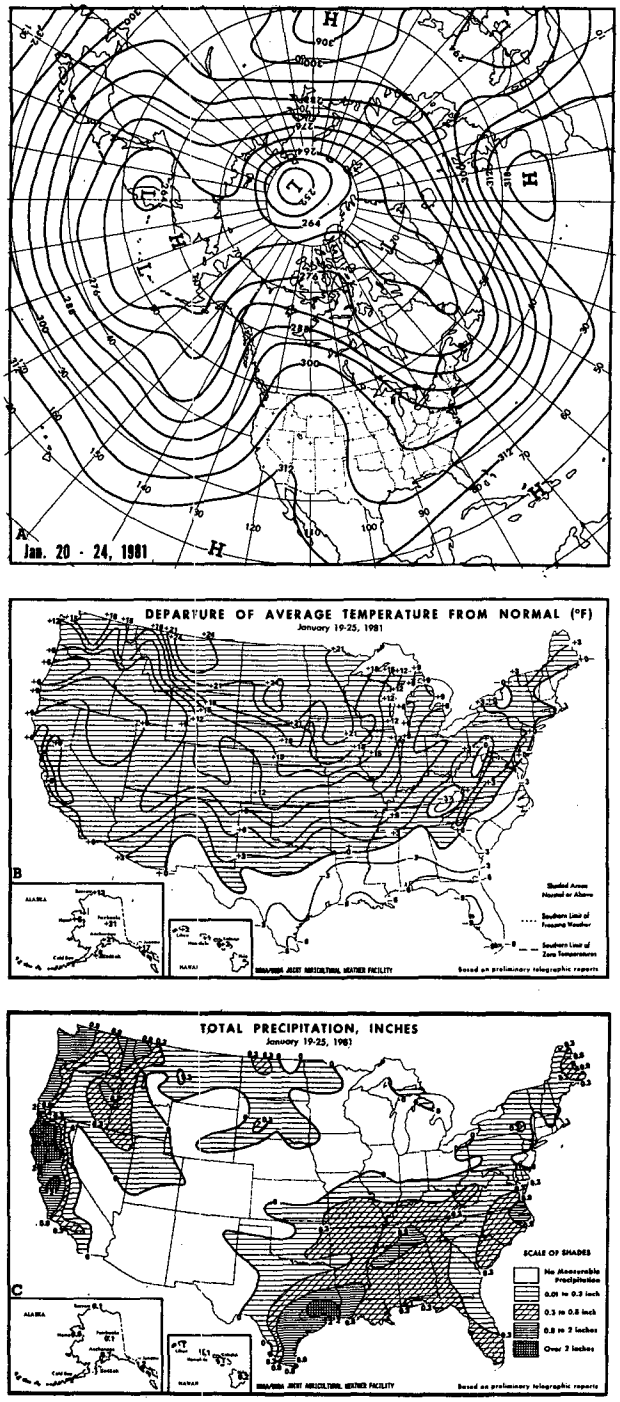


FIG. 12. As in Fig. 8 except for (A) 20–24 January 1981 and (B) and (C) week of 19–25 January 1981.

East (Fig. 10B). The loss of the ridge connection from northwestern Canada to the Arctic and breakthrough of Pacific storms into the Arctic Basin through the Bering Strait flooded Alaska and northwestern Canada with what was essentially foehn-modified maritime Pacific air. The temperature at Fairbanks averaged 37°F above normal for the week, and rose to a high of 50°F on the 15th. On that day even the minimum of 33°F was above freezing and the daily mean temperature was 55°F above normal!

Again, as in January 1977, extreme unseasonable warmth in Alaska was closely related in time to unusually cold weather events in Florida (Wagner, 1977). On 12 and 13 January 1981 numerous daily minimum temperatures records of as low as −21°F at Concord, NH were set throughout the East from New England to Florida, and in the latter area on the 13th readings of 8°F at Tallahassee, 14°F at Jacksonville, 22°F at Tampa and 41°F at Key West were also the lowest temperatures ever observed during January. The next day a 20°F minimum temperature at Orlando also was a new January record for cold. Considerable damage was done to Florida citrus and vegetable crops, with the freeze being classified as severe in many areas, comparable to those of January 1977 and December 1962.

Precipitation remained generally light or non-existent across more of the country (Fig. 10C). Moderate amounts continued to fall in the interior Southwest and Rio Grande Valley as the weak mean low persisted over northern Baja California.

d. 19–25 January 1981

The quantity of cold air over the United States diminished considerably during the last two weeks of the month, and circulation changes leading to this amelioration of the extreme cold observed earlier in the month are shown in Fig. 11. Height falls occurred in most ridges and height rises in the troughs, indicating considerable deamplification of the strongly persistent pattern. The height change pattern over

TABLE 3. Record and near-record high temperatures for the month of January observed during January 1981.

Station	Temperature (°F)	Date	Remarks
Seattle, WA	64	20	
Medford, OR	71	21	Equaled highest January temperature
Eureka, CA	75	21	Equaled highest January temperature
Elko, NV	63	22	
Great Falls, MT	62	22	
Cheyenne, WY	65	23	
Bismark, ND	62	23	
Sioux Falls, SD	66	24	
Norfolk, NE	71	24	
Grand Island, NE	72	24	
Sioux City, IA	70	24	
St. Cloud, MN	56	24	
Rochester, MN	55	24	2nd highest January temperature

the United States can be readily interpreted as a decrease in the anomalously northerly component to the flow that characterized the month as a whole (Fig. 2). In addition, strongly falling heights over the Arctic are usually associated with increasing containment of polar air masses.

The 5-day mean height pattern shows the beginning of deamplification over the North American area, as well as some progression of systems from the eastern Pacific to western Europe (Fig. 12A). Even though the flow was still northwesterly from higher latitudes into the United States, warmer-than-normal temperatures covered all of the country except for the Gulf coast and south Atlantic states, where Florida had additional, but less severe, freezes (Fig. 12A). The rapid warming of the country in the face of a normally cold circulation pattern was due to the unusually warm air associated with the ridge as it progressed into Canada. A similar situation occurred at the end of the cold winter of 1977 (Dickson, 1977).

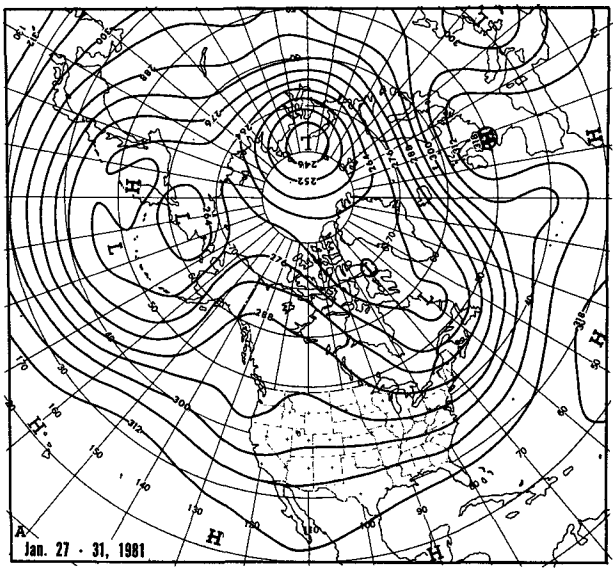
Some of the unseasonably warm air was of subtropical Pacific origin, as the increasing southerly component of flow into the eastern Pacific brought both mild air and moisture to most of the West Coast. Rather heavy rains fell over northern California as a vigorous short-wave trough moved over the area (Fig. 12C). As much as 3.21 inches of rain fell at Eureka, CA on the 22nd. Most of the precipitation across the South was from a slowly moving storm system that moved along the Gulf and south Atlantic coasts earlier in the week.

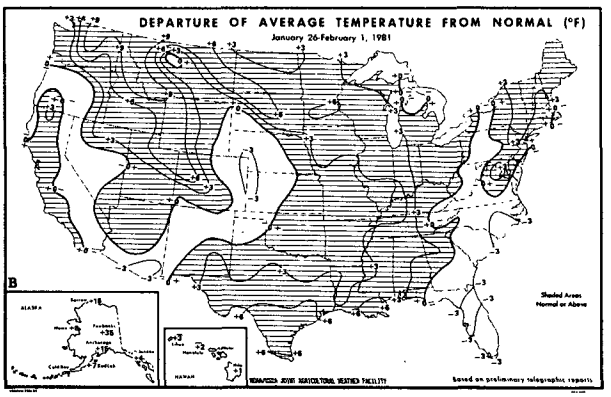
Record daily maximum temperatures spread across the western two-thirds of the country in advance of the Pacific trough. Some representative values, which also were new record-high temperatures for the month of January, are shown in Table 3. A large region consisting of the central Great Plains and some adjacent areas set new daily high temperature records on both 23 and 24 January. Values were generally in the 60's and 70's.

e. 26 January–1 February 1981

Although the warm ridge remained over western Canada and troughs remained over the central Pacific and eastern North America, the progression of the eastern Pacific trough to the California Coast was associated with a noticeable increase in the westerlies across the southern United States (Fig. 13A).

Temperatures remained near or slightly above normal over most of the United States, but unseasonable warmth continued in Alaska (Fig. 13B). The big change was in the precipitation, with substantial amounts falling over nearly the entire Nation (Fig. 13C). During the latter half of the week, a vigorous short wave moved from the Pacific Coast where it produced heavy precipitation in northern California,





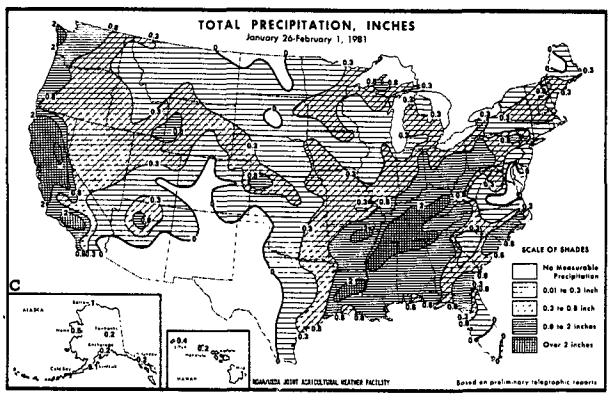


FIG. 13. As in Fig. 8 except for (A) 27–31 January 1981 and (B) and (C) week of 26 January–1 February 1981.

through the Rocky Mountains and into the Great Plains. There the system phased with an amplifying Canadian trough, bringing an end to a long dry period over much of the central United States on the

last day of January, and getting February off to a wet start in the Tennessee and Ohio Valleys as moisture from the Gulf of Mexico was rapidly drawn into the sharpening trough.

REFERENCES

Dickson, Robert R., 1977: Weather and circulation of February 1977—Widespread drought. *Mon. Wea. Rev.*, **105,** 684–689.

National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and Economics and Statistics Service, U.S. Department of Agriculture, 1981: *Weekly Weather and Crop Bulletin*, **68,** Nos. 1–6 (6, 13, 20 and 27 January, and 3 and 10 February 1981).

O'Connor, James F., 1969: Hemispheric teleconnections of mean circulation anomalies at 700 millibars. U.S. Department of Commerce, ESSA Tech. Rep. WB 10.

Taubensee, Robert E., 1981: Weather and Circulation of December 1980—A generally dry month with record warmth in the West. *Mon. Wea. Rev.*, **109,** 2100–2106.

Wagner, A. James, 1977: Weather and Circulation of January 1977—The coldest month on record in the Ohio Valley. *Mon. Wea. Rev.*, **105,** 553–560.

——, 1978: Weather and Circulation of January 1978—Cold with record snowfall in the Midwest and Northeast, mild and wet in the West. *Mon. Wea. Rev.*, **106,** 579–585.

Winston, Jay S., 1952: The Weather and Circulation of October 1952—The driest month on record in the United States. *Mon. Wea. Rev.*, **80,** 190–194.