

THE WEATHER AND CIRCULATION OF JULY 1962

A Cool Month Associated with a Strong Blocking Wave

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1. INTRODUCTION

July 1962 was an unusually cool month in most of the United States, a continuation of the early summer trend. In fact, it was one of the coolest mid-summer months ever observed across the northern half of the Nation. Only the deep South observed above normal temperatures. The cool weather was well related to a strong blocking wave which moved across Canada from the Atlantic and displaced the polar front and storm track southward as the month progressed.

Cloudy, wet conditions with frequent showers and thundershowers accompanied the unseasonable coolness in much of the Nation. Heaviest amounts of precipitation fell quite generally in the Plains States, and in some instances established new July records. By contrast, the deep South was unusually dry, while in portions of the Northeast a continuing deficiency of moisture resulted in severe drought.

2. MEAN CIRCULATION

The average circulation at 700 mb. for July 1962 (fig. 1) was characterized by blocking over much of the hemisphere. This was associated with mostly above normal heights at high latitudes and below normal heights at middle latitudes. As a consequence, the mid-latitude westerlies were weaker than normal and displaced southward (fig. 2). A blocking pattern also prevailed in June [1], but it was much stronger during July and produced a zonal index of 6.0 m.p.s., 1.2 m.p.s. below the seasonal normal.

The area of strongest blocking was centered over Davis Strait where 700-mb. heights were as much as 270 ft. above normal. Sea level pressures were as much as 8 mb. above normal in the same area [2]. As a result of blocking, the Canadian portion of the mean trough normally found over eastern North America was considerably weaker than normal, while the southward extension of this trough off the east coast of the United States was much deeper than normal (fig. 1). Another effect of blocking was westward displacement of the higher-latitude portion of the ridge normally located in western North America. In the United States a weak ridge extended from the Central Plains to a High over the Lower Mississippi Valley. Thus, the circulation

over the United States was more cyclonic than usual in July and accompanied predominantly negative height anomalies.

A height anomaly pattern similar to that in North America also prevailed in the Atlantic (fig. 1). Important circulation features in this region were a weak (except at high latitudes) ridge in the central Atlantic and a deep trough in the east.

At high latitudes the mid-tropospheric circulation was meridional from Greenland to north-central Asia (fig. 1). The deepest full-latitude trough over the hemisphere extended from the polar basin southward through eastern Europe to the Black Sea. This feature was flanked by strong ridges over western Greenland and western Siberia. Stronger than normal northerly flow in the northeastern Atlantic combined with below normal 700-mb. heights and cyclonic flow (fig. 1) to produce a cool, wet, stormy July in all but extreme southern Europe.

Elsewhere in the hemisphere the circulation exhibited blocking characteristics as shown by the distribution of height anomalies over Asia and the Pacific (fig. 1). The planetary wave pattern consisted of a deeper than normal trough at middle and low latitudes in eastern Asia, a full latitude trough extending into the western Pacific from a deep polar Low, a Low in the western Gulf of Alaska, and a strong ridge from the eastern Pacific to Alaska.

The primary axis of maximum west wind (jet) at 700 mb. was displaced south of normal over most of the Northern Hemisphere (fig. 3). Greatest displacement was in the southwestern Atlantic where wind speeds averaged up to 14 m.p.s. near 60° W., some 5 m.p.s. above normal. The strongest hemispheric block was centered along the same longitude over Davis Strait. Furthermore, the area of weakest westerly winds, as much as 6 m.p.s. below normal, was also located near 60° W. over southeastern Canada.

The jet axis across the Atlantic and into central Europe was associated with a band of below normal sea level pressure and a storm track displaced south of normal. Fastest wind speeds with respect to normal were observed south of the jet over Spain and the western Mediterranean. Downstream across Asia and the Pacific the jet continued to be well defined.

A deep polar Low was associated with a sub-polar jet axis (fig. 3) with strongest wind speeds on the Asiatic

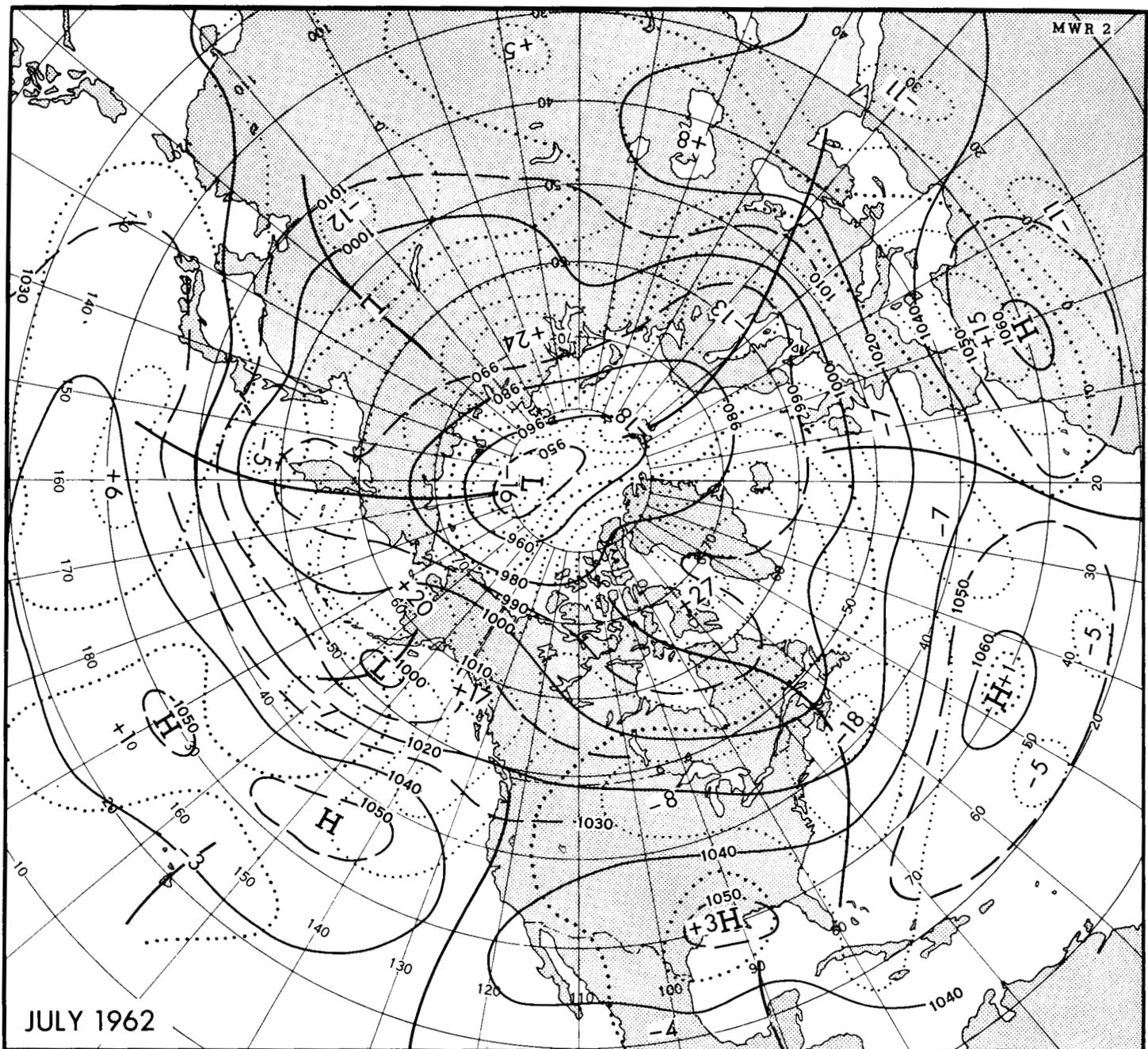


FIGURE 1.—Mean 700-mb. contours (solid) and height departures from normal (dotted) (both in tens of feet) for July 1962. The hemispheric circulation was dominated by blocking.

side of the hemisphere. This jet was generally stronger and better defined than on normal charts, as might be inferred from the height anomaly pattern in figure 1.

3. AVERAGE WEATHER IN THE UNITED STATES

TEMPERATURE

Temperatures averaged below normal in most of the Nation during July 1962 (fig. 4). Greatest departures, more than 4° F., were observed in the Northern Plains States, the Upper Mississippi Valley, and portions of the

TABLE 1.—Monthly mean low temperature records established in July 1962

Station	Temperature (° F.)		Year records began
	Monthly average	Departure from normal	
Burlington, Vt.	64.0	-6.5	1871
Portland, Maine.	64.0	-4.1	1870
Worcester, Mass.	66.0	-3.8	1901
Hartford, Conn.	69.0	-3.2	1905
Wilmington, Del.	72.6	-3.4	1894
Dubuque, Iowa.	68.4	-4.2	1882

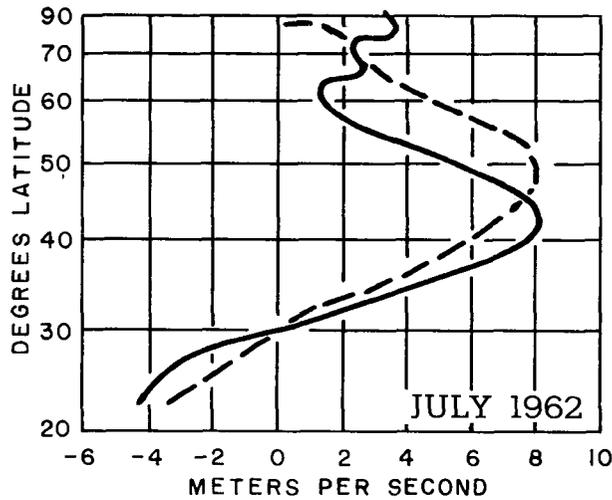


FIGURE 2.—Mean 700-mb. zonal wind speed profiles in the western portion of the Northern Hemisphere for July 1962 (solid) and July normal (dashed). Middle-latitude westerlies were displaced southward.

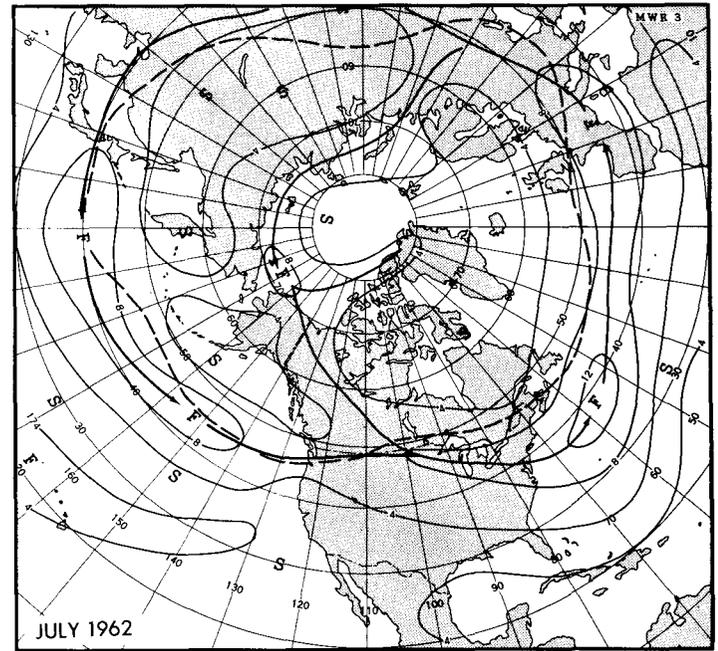


FIGURE 3.—Mean 700-mb. isotachs (meters per second) for July 1962. Solid arrows indicate principal axes of maximum wind speeds, and dashed line their normal July positions. Blocking was important in displacing the temperate latitude jet south of its normal position around nearly the entire hemisphere.

Northeast. At some cities, listed in table 1, this was the coolest July ever observed. In addition, near record coolness prevailed in many other cities across the northern half of the country.

The early summer trend toward cooler can be expressed in terms of temperature class change for 100 nearly evenly distributed cities in the United States. From May to June 62 percent of the country cooled by one or more classes (out of 4), while 60 percent cooled from June to July. Only 20 percent of the Nation warmed during the latter period, while the balance did not change.

The cool weather was closely related to the mean circulation patterns. In general the anomalous flow was northerly in most of the United States at both 700 mb. (fig. 1) and sea level [2]. Furthermore, the anomaly patterns of 700-mb. height (fig. 1) and surface temperature (fig. 4) were well correlated in a positive sense, with the greatest departure being observed in the north. Frequent outbreaks of cool polar air accompanied the passage of anticyclones across the Nation. These Highs moved along a primary track from western Canada southeastward across the Northern Plains, the Ohio Valley, and off the Middle Atlantic Coast (fig. 5A). This track was south of its usual July position and more typical of the cooler months of the year than of summer [3]. Much of the cool weather was the result of unusually low maximum temperatures due to cloudiness and frequent shower activity, particularly in the Northern and Central Plains States.

Except for Alaska, the South Atlantic and Gulf Coast States were the only regions where temperatures averaged above normal (fig. 4). In the South this warmth was related primarily to the upper-level High centered over Louisiana (fig. 1). Most of the warm weather was due to high average maximum temperatures which accompanied

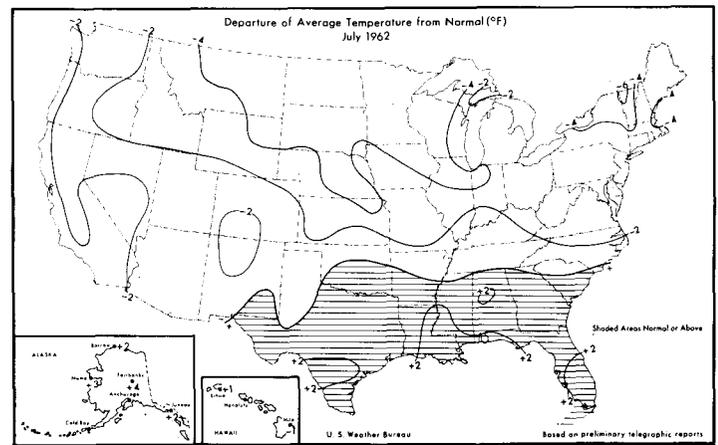


FIGURE 4.—Departure of average temperature from normal ($^{\circ}$ F.) for July 1962. (From [5].)

subnormal amounts of cloudiness and precipitation. Above normal temperatures in Alaska were associated with the strong ridge over that area and gave Fairbanks its warmest July in 44 years.

PRECIPITATION

The precipitation regime for July (fig. 6) was dominated by unusually wet conditions in the Great Plains and Rocky Mountain States. Rainfall amounts exceeded twice the normal over a large portion of the Plains States, with as

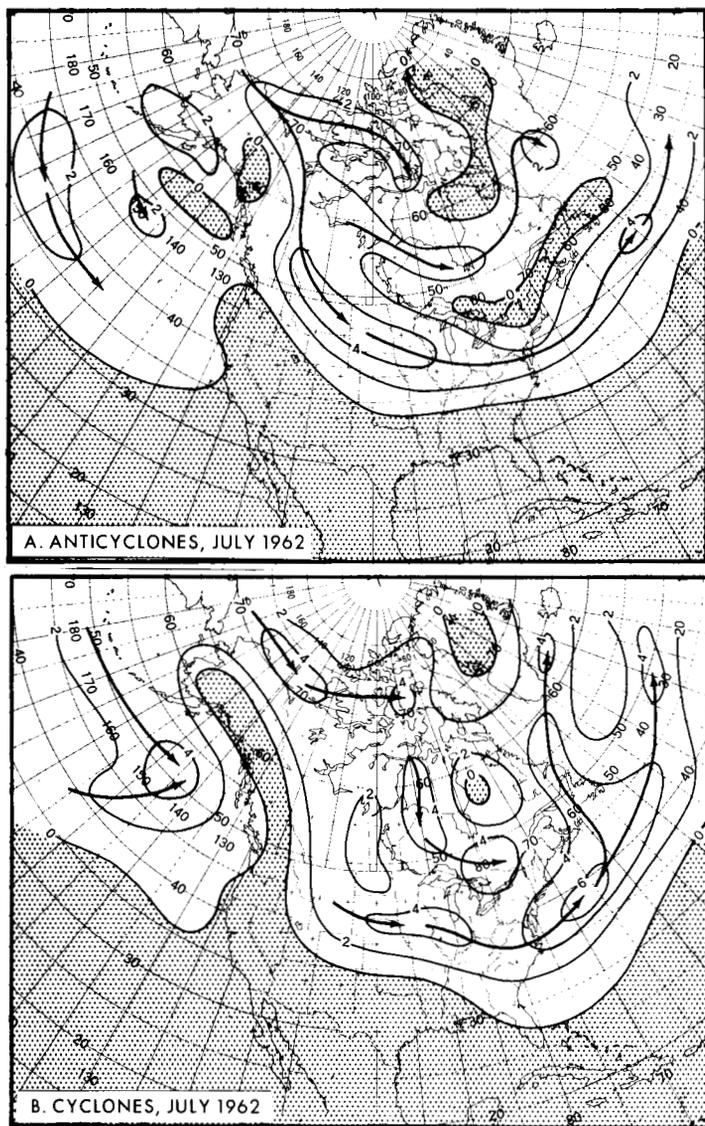


FIGURE 5.—Number of (A) anticyclone passages and (B) cyclone passages within quadrilaterals of 66,000 n. mi.² during July 1962. Primary tracks are indicated by solid arrows. Southward displacement of both anticyclone and cyclone tracks in the United States was more typical of winter than summer.

much as three times the normal in some areas. This was the wettest July on record at Dodge City, Kans. where a thunderstorm or distant lightning was observed on all but three days of the month. Precipitation in the form of showers and thundershowers was generally well distributed elsewhere during July throughout the Plains States. Locally daily heavy amounts resulted in new monthly records at Glasgow, Mont. and Dallas, Tex., while heavy thunderstorm activity at Salt Lake City, Utah on the 12th and 13th broke all July records for excessive, daily, and monthly amounts.

Much of the heavy precipitation in the West was related to increased amounts of cyclonic vorticity, as indicated by negative 700-mb. height anomalies (fig. 1), in an area that is normally anticyclonic. At sea level this vor-

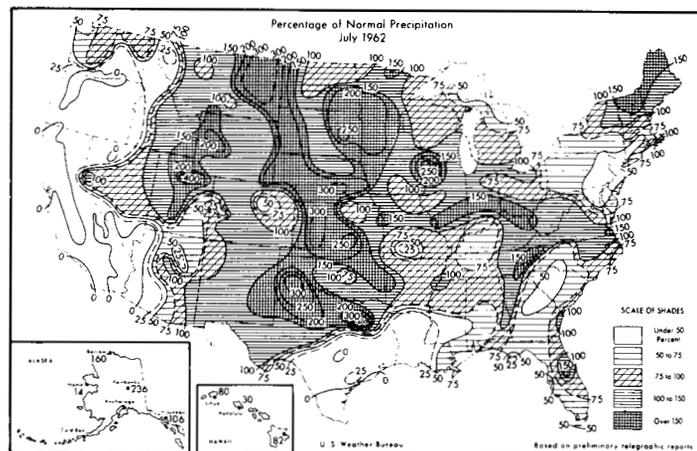


FIGURE 6.—Percentage of normal precipitation for July 1962. (From [5].)

ticity was associated with a major storm track which extended from the northern Rockies east-southeastward to the Atlantic Coast (fig. 5B). This track was displaced far south of the normal July position [3] and lay just to the south of the primary west wind jet at 700 mb. (fig. 3). Precipitation was above normal along the entire length of this storm track in the United States. The frequency of fronts was unusually high in the Kansas, Oklahoma, and northern Texas area where precipitation was very heavy.

Above normal amounts of precipitation also fell in northern New England (fig. 6) which came under the influence of the storm track north of the Great Lakes (fig. 5B). In addition, easterly anomalous flow and proximity of the mean trough along the east coast also favored heavy amounts.

Very dry conditions accompanied the warmth in the South during July with record or near record dryness prevailing in southern portions of the Gulf Coast States. In such Texas cities as Austin, Galveston, Corpus Christi, and Brownsville, there was no measurable rainfall. The unusually dry weather in the South was a reflection of the warm upper-level High and stronger than normal northerly flow between the High and trough off the east coast (fig. 1).

4. DROUGHT IN THE NORTHEAST

Drought conditions developed in portions of the northeastern United States in July. For the three-month period, May through July, total rainfall was only 40 to 50 percent of normal in the dry area. At the end of June [1] this area was centered in eastern New York, northeastern Pennsylvania, and northern New Jersey. During July the driest area shifted southward to include primarily New Jersey and eastern Pennsylvania where precipitation amounts were less than half of normal (fig. 6). At Reading, Pa., only 12 percent of the normal rainfall was observed, a July record (1878). New York, N.Y. observed 17 consecutive days without measureable precipitation, also a record for any July. As a result of

the continued dry weather crop prospects and pastures were very poor in the driest areas.

The planetary wave pattern in July associated with this dry regime was similar to that for June [1] and consisted of a trough off the east coast with stronger than normal northerly flow over the Northeast (fig. 1). This circulation brought cool polar air into the area from a dry continental source region. Furthermore, the tendency for subsidence to occur in northerly flow was unfavorable for much precipitation. The dry area, and its extension into the northern Great Lakes (fig. 6), lay between the two principal cyclone tracks (fig. 5B). The southern track was associated with disturbances traveling along the polar front in westerlies displaced south of normal (fig. 3). Another consideration is the possibility that the earlier prolonged dryness may have been to some extent self-perpetuating [4].

5. WEEKLY EVOLUTION

Consideration of the circulation on a weekly basis illustrates the effect of a strong wave of blocking on weather patterns in the United States. These changes are described by use of a series of 5-day mean 700-mb. charts one week apart, representative of the week's circulation, and the corresponding weekly temperature anomaly and precipitation patterns, as shown in figures 7 to 10.

FIRST WEEK

A strong blocking ridge over the North Atlantic featured the circulation early in the month (fig. 7A). This ridge, and the magnitude and extent of the area of positive height anomaly associated with it, were instrumental in development of a closed Low over the Maritime Provinces and a deep trough at middle and low latitudes in the western Atlantic. A meridional circulation pattern prevailed upstream with a full-latitude ridge-trough system over the eastern Pacific and western North America.

Over the Nation as a whole this was the warmest week of the month as hot summer weather dominated interior sections (fig. 7B). The heat was not extreme with temperatures averaging 3° to 5° F. above normal. The East and Pacific Northwest, on the other hand, experienced a very cool week as northerly flow brought repeated invasions of cool polar air (fig. 7A, B). Light winds and radiational cooling aided in establishing new all-time July minimum temperature records at Portland, Maine on the 3d (40° F.) and at Hartford, Conn. on the 2d (44° F.). Similar conditions at Burlington, Vt. produced daily record low temperatures for six consecutive days, from the 2d through the 7th. In sections of the Northwest temperatures in the 30's established new July records in western Oregon, eastern Washington, and northwestern Montana. Damaging frosts were reported in some areas.

Considerable storminess and heavy precipitation extended in a broad zone from the Northern Plains through

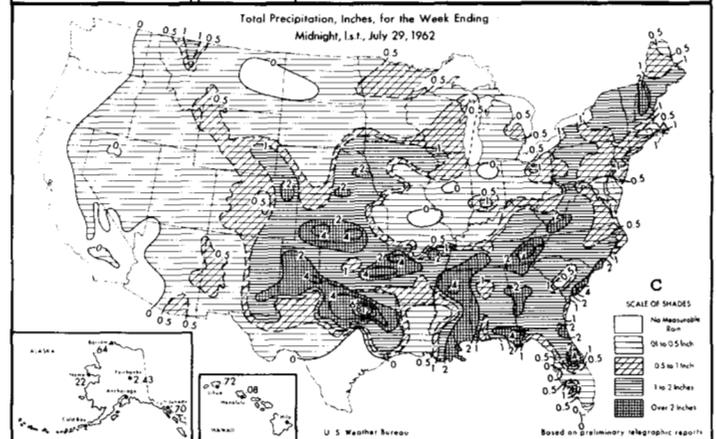
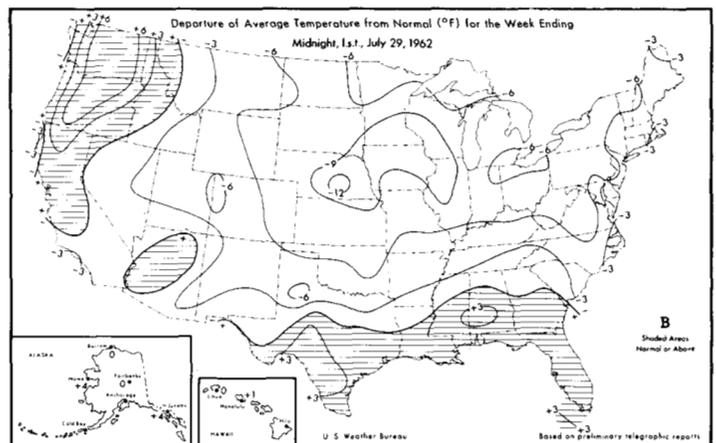
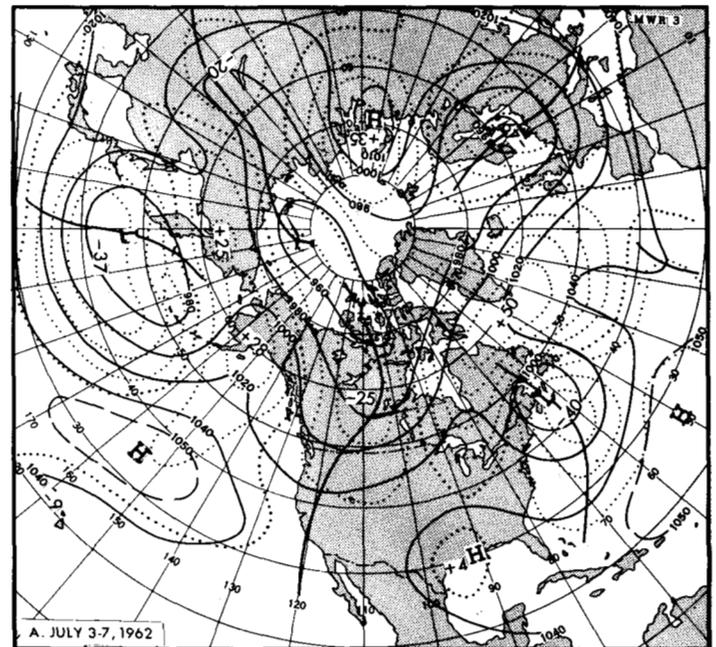


FIGURE 7.—(A) Five-day mean 700-mb. contours (solid) and height departures from normal (dotted) (both in tens of feet) for July 3-7, 1962; (B) departure of average temperature from normal (° F.), and (C) total precipitation (inches), both for the week ending July 8, 1962.

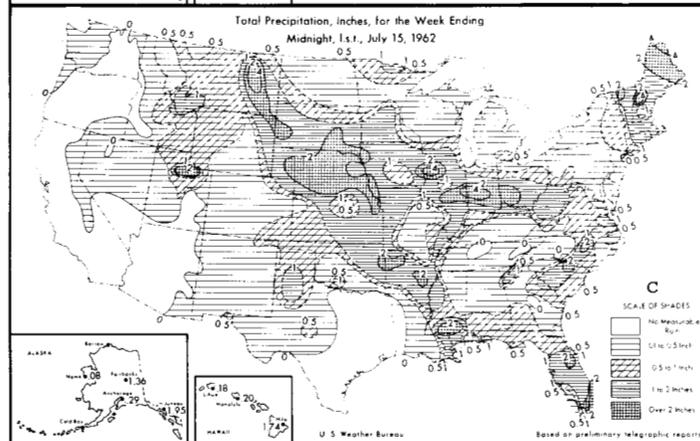
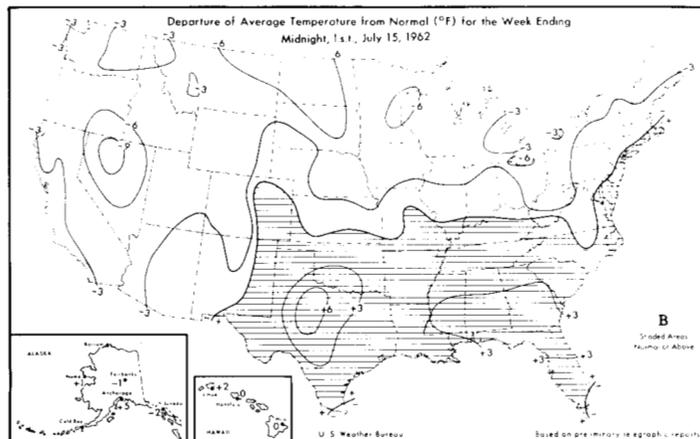
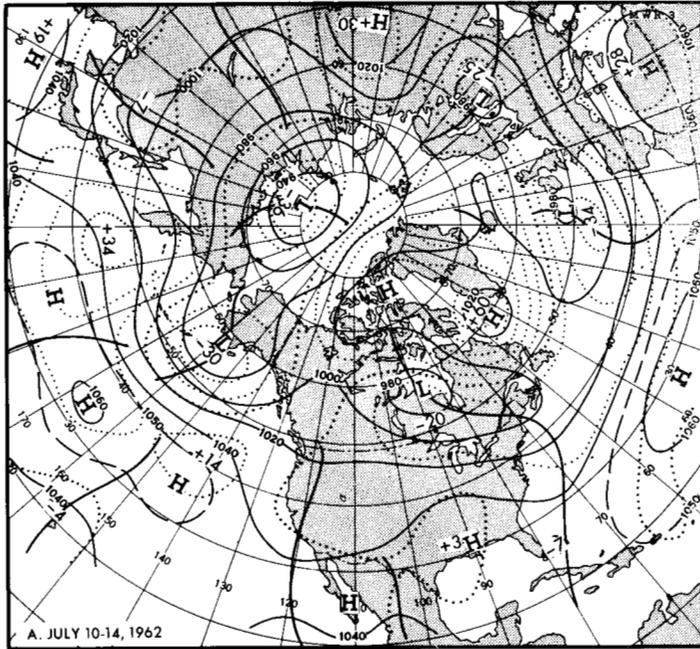


FIGURE 8.—(A) Five-day mean 700-mb. contours (solid) and height departures from normal (dotted) (both in tens of feet) for July 10-14, 1962; (B) departure of average temperature from normal ($^{\circ}$ F.), and (C) total precipitation (inches), both for the week ending July 15, 1962.

the South Atlantic Coastal States (fig. 7C). Much of this precipitation was related to a frontal zone which occupied the area much of the time.

SECOND WEEK

Blocking continued to dominate the circulation during the second week as it intensified and spread westward across Canada (fig. 8A). The Atlantic ridge retrograded into northern Canada and the trough over western Canada moved rapidly eastward to join with the trough in the western Atlantic (figs. 7A, 8A). The resulting cellular flow pattern was typical of strong blocks. At the same time the circulation in the eastern Pacific became zonal while a band of strong westerlies, displaced well south of normal, prevailed across the eastern United States and the Atlantic (fig. 8A).

These circulation changes pushed the polar front southward in the United States, thus bringing a trend to cooler in many areas. Temperatures averaged below normal across the northern half of the country and the entire Far West, while hot, humid weather dominated the South (fig. 8B). More westerly flow in the Northwest and Northeast resulted in some warming from the previous week, although temperatures continued to average below normal.

The polar front separating cool polar air to the north and warm tropical air to its south (fig. 8B), was responsible for much of the week's precipitation (fig. 8C). Locally heavy thundershowers occurred along this frontal zone, some accompanied by tornadoes mostly in the Central Plains and middle Mississippi Valley. Frequent rains accompanied the trough in northern New England where Caribou, Maine had 4.67 inches for the week.

THIRD WEEK

Gradual relaxation of blocking in the Atlantic during the third week allowed the westerlies to move slowly northward. Over North America, however, blocking reached its greatest strength with the entire Canadian region dominated by a huge area of positive height anomaly (fig. 9A). The "omega" circulation pattern previously in the Atlantic and eastern Canada (fig. 8A), had now developed over Canada. In the United States there was a general increase in heights and slight retrogression of the Midwestern and Far West trough.

Cool polar air masses continued to dominate the Nation while the southward displacement of the polar front further diminished the area of above normal temperatures in the South (figs. 8B, 9B). As in the previous week, greatest departures were observed at higher latitudes, more than -6° F. in some areas of Montana and the northwestern Great Lakes.

Heaviest rainfall occurred in the Upper Mississippi Valley and Central Plains where amounts exceeding 2 inches were common (fig. 9C). The southward advance of the polar front was not generally accompanied by a corresponding shift of the precipitation pattern. This

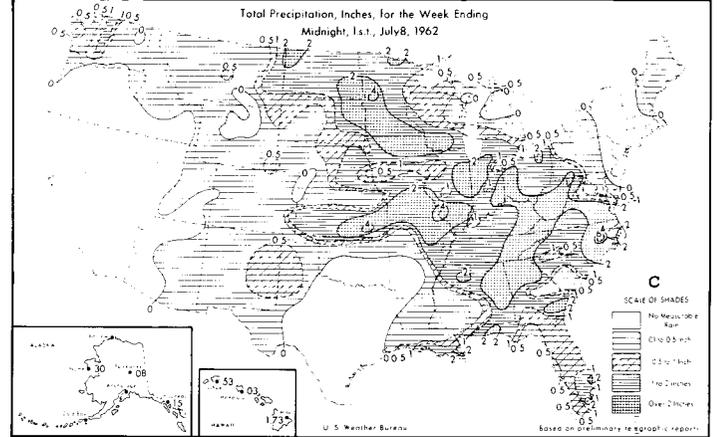
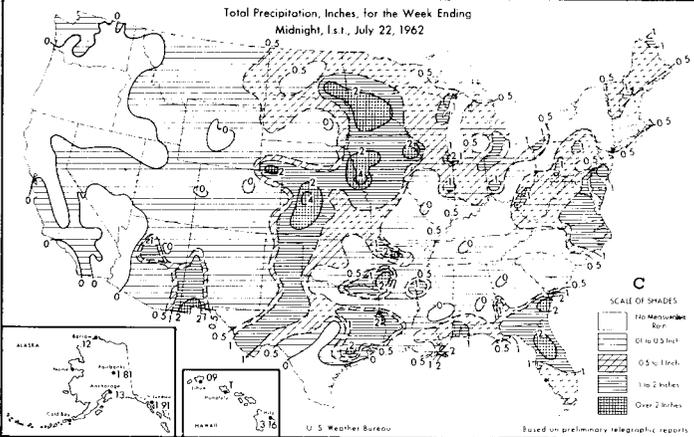
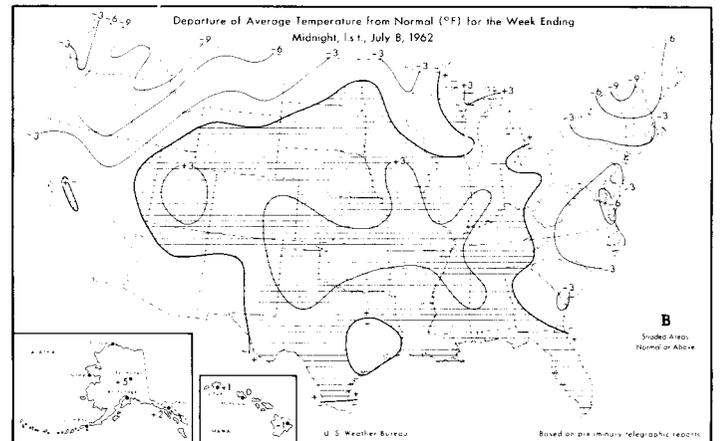
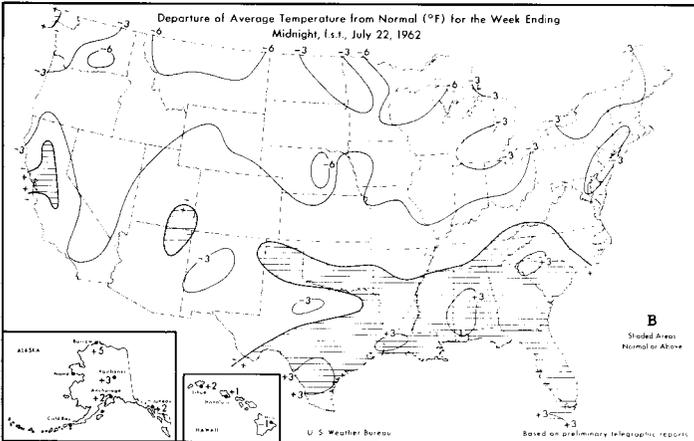
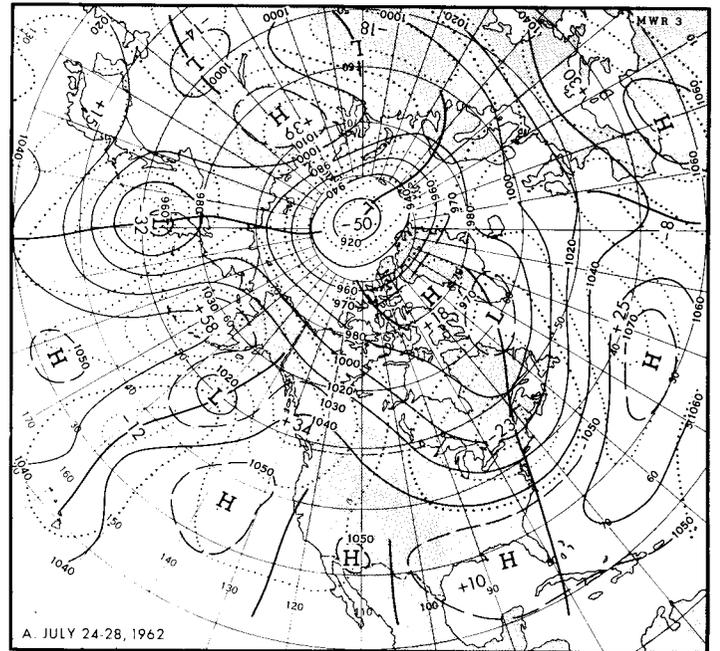
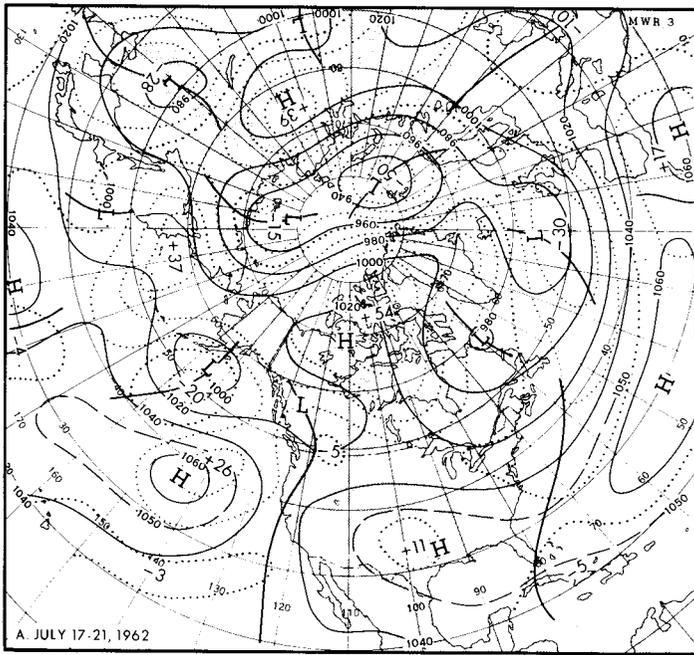


FIGURE 9.—(A) Five-day mean 700-mb. contours (solid) and height departures from normal (dotted) (both in tens of feet) for July 17-21, 1962; (B) departure of average temperature from normal (° F.) and (C) total precipitation (inches) both for the week ending July 22, 1962.

FIGURE 10.—(A) Five-day mean 700-mb. contours (solid) and height departures from normal (dotted) (both in tens of feet) for July 24-28, 1962; (B) departure of average temperature from normal (° F.), and (C) total precipitation (inches), both for the week ending July 29, 1962.

was because of stronger than normal northwesterly flow over the Southeast not only at 700 mb. (fig. 9A), but also at sea level.

FOURTH WEEK

Further retrogression of the blocking wave was related to marked amplification of the circulation in the Pacific and over North America (fig. 10A). The strongest area of positive height anomaly had now shifted to the Bering Sea where a pronounced ridge was observed. This resulted from amalgamation of the retrograding northwestern Canadian ridge with the ridge developing northward in the western Pacific. At the same time the trough previously over western North America (fig. 9A) continued to weaken and was replaced by a strong ridge (fig. 10A). A shortened wavelength effected retrogression of the deepening east coast trough.

Strong northwesterly flow across North America (fig. 10A) kept much of the Nation unseasonably cool, with the cool air continuing to push into the deep South (fig. 10B). Temperatures for the week averaged as much as 14° F. below normal at Grand Island, Nebr. The coolest weather occurred from the 26th to the 28th as numerous stations from the Great Plains to the Atlantic Coast reported new daily record low temperatures. New all-time low temperature records for July were established at St. Louis, Mo. on the 27th (51° F.) and Raleigh, N.C., on the 28th (52° F.).

A pronounced change to warmer occurred in the Northwest where temperatures rose as much as 12° F. from the previous week to average more than 6° F. above normal in the interior of Washington and Oregon (fig. 10B). The warming was associated with the upper-level ridge over the west coast (fig. 10A).

Precipitation was heavy along the polar front through the Gulf States as more cyclonic flow prevailed than during the previous week (figs. 10A, C). Heavy rains in Kansas, Arkansas, and northern and central Texas were responsible for local flooding. Amounts as much as 15 inches were reported in the Dallas area, most of which occurred on the 26th and 27th.

REFERENCES

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5. U.S. Weather Bureau, *Weekly Weather and Crop Bulletin, National Summary*, vol. XLIX, No. 32, August 6, 1962.

CORRECTIONS

Vol. 90, No. 9, September 1962:

Table of Contents: In entry for pages 414-418, change the subtitle from "A Continuation of Strong Blocking in the Pacific," to "A Generally Cool Month."

Vol. 90, No. 8, August 1962:

Page 362, in caption on figure 1: change 1962 to 1961.