THE WEATHER AND CIRCULATION OF JULY 1952 [1]

A Month With Drought

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THE DROUGHT

The weather of July 1952 in the United States was similar in many respects to that of the preceding month [1]. Once again temperatures averaged well above normal in the eastern two-thirds of the country (Chart I-B), while precipitation was subnormal in most of this area (Chart III). Such marked persistence between June and July occurs quite often, as noted by Reed in 1925 [2] and more recently by Namias [3].

[1] See Charts I-XV following page 127 for analyzed climatological data for the month.

The combination of high temperatures, insufficient rainfall, and excessive sunshine throughout June and July of this year resulted in serious drought in a dozen States from Maine southward to Georgia and westward to Texas. Tennessee, where rainfall had been deficient every month since April 1952, reported one of the most widespread and devastating droughts in its history with irreparable losses to many crops. In Arkansas and Kansas state-wide precipitation for the three months from May to July 1952 was only 56 percent of normal. This was the driest July on record in Birmingham, Ala., where rainfall totalled less

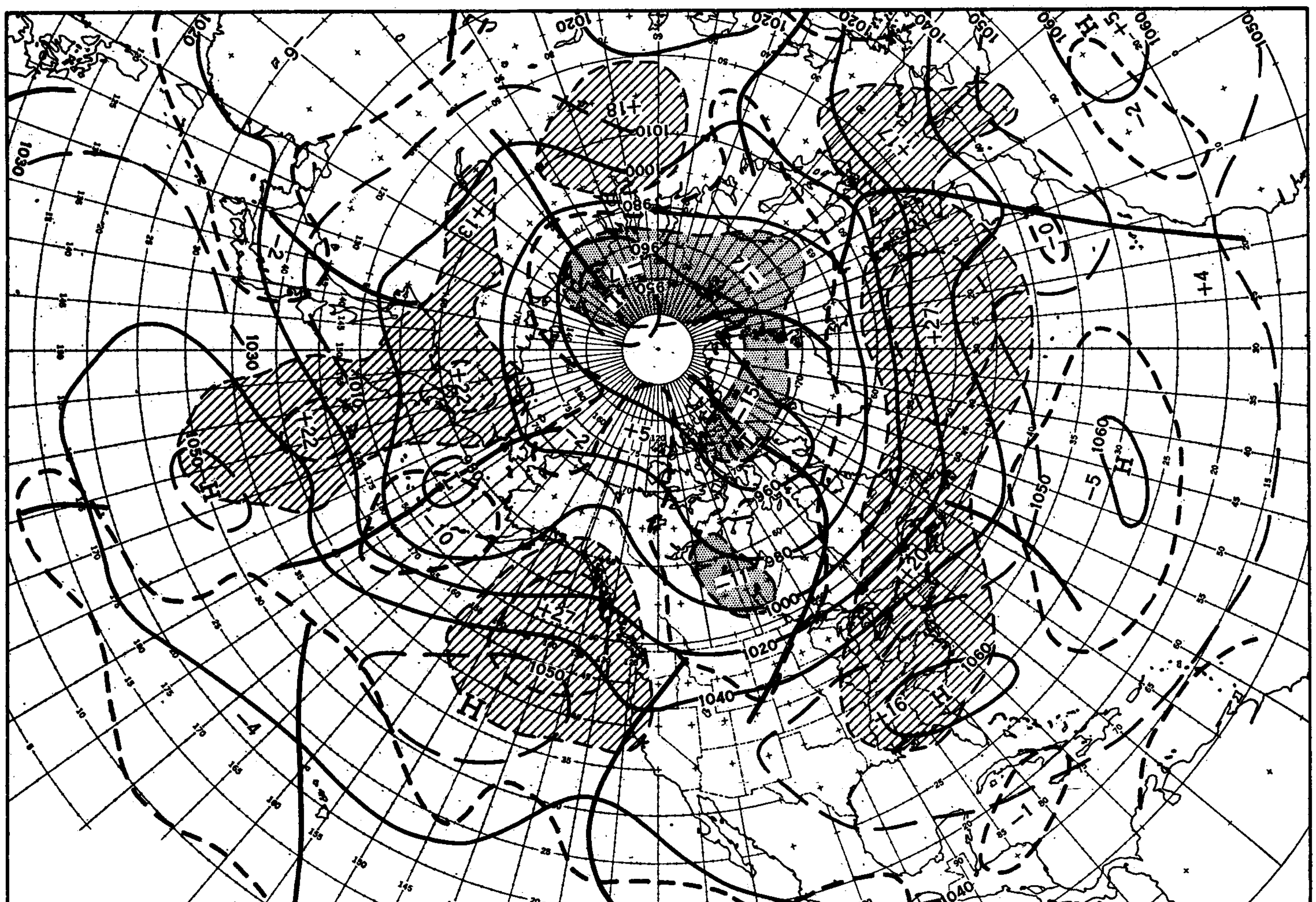

FIGURE 1.—Mean 700-mb. chart for the 30-day period July 1-30, 1952. Contours at 200-ft. intervals are shown by solid lines, intermediate contours by lines with long dashes, and 700-mb. height departures from normal at 100-ft. intervals by lines with short dashes with the zero isopleth heavier. Anomaly centers and contours are labeled in tens of feet. Minimum latitude trough locations are shown by heavy solid lines. Areas with 700-mb. height anomalies in excess of +100 ft. are hatched; areas with anomalies less than −100 ft. are stippled.

than one-fourth of the normal amount. The drought and heat wave were particularly severe during the second half of July, when almost no rain fell in parts of Alabama and Tennessee, and daily high temperatures ranged up to 112° in South Dakota, 110° in Georgia, and 109° in Kansas. During this period Chattanooga had its hottest spell in history when the temperature climbed above 100° on nine consecutive days, culminating in an all-time maximum of 106° F. on the 28th. In New York City the period from July 14 to 23 was the warmest 10-day stretch on record, with an average temperature of 83° F. The month as a whole was the hottest calendar month in New York's recorded weather history, which dates from 1871.

This month's circulation pattern at the 700-mb. level (fig. 1) also resembled that for June 1952. During both months much of the United States was dominated by anticyclonic conditions and above-normal heights aloft with the westward extension of the Bermuda High unusually well developed and centered near Georgia. At the same time heights at 700 mb. were below normal over most of Canada, where cyclonically curved flow prevailed around a deep mean trough located just east of Hudson Bay. A third important feature of the 700-mb. circulation common to both months was the expansion and intensification of the Pacific High, so that heights were above normal throughout the eastern Pacific. The interaction of the Bermuda High, the Canadian Low, and the Pacific High during summer heat waves in the United States was discussed last month [1], while the importance of a somewhat similar interaction during drought has been stressed by Tannehill [4].

The conditions responsible for the drought can be further clarified with the aid of several additional charts. The predominance of anticyclonic circulation in the United States was reflected in the fact that daily anticyclones traversed the country quite frequently (fig. 2A and Chart IX), but migratory cyclones were almost completely absent (fig. 2B and Chart X). In Canada, on the other hand, cyclone tracks were abundant but anticyclones were infrequent. The contrast between the character of the prevailing circulation in the United States and Canada is well illustrated in figure 3A, which shows that the average relative vorticity at 700 mb. during July was anticyclonic throughout the United States but cyclonic in most of Canada. The magnitude of these vorticity values was about twice as great as those computed from the normal 700-mb. chart for July in the eastern United States and western Canada.

The anticyclonic circulation in the United States was separated from the cyclonic circulation in Canada by a strong band of westerly winds at 700 mb., figure 4A. Although the axis of this west wind belt was located close to its normal position, along the border between the United States and Canada, mean wind speeds in the northern United States were almost 50 percent greater than normal. These fast westerlies were effective in

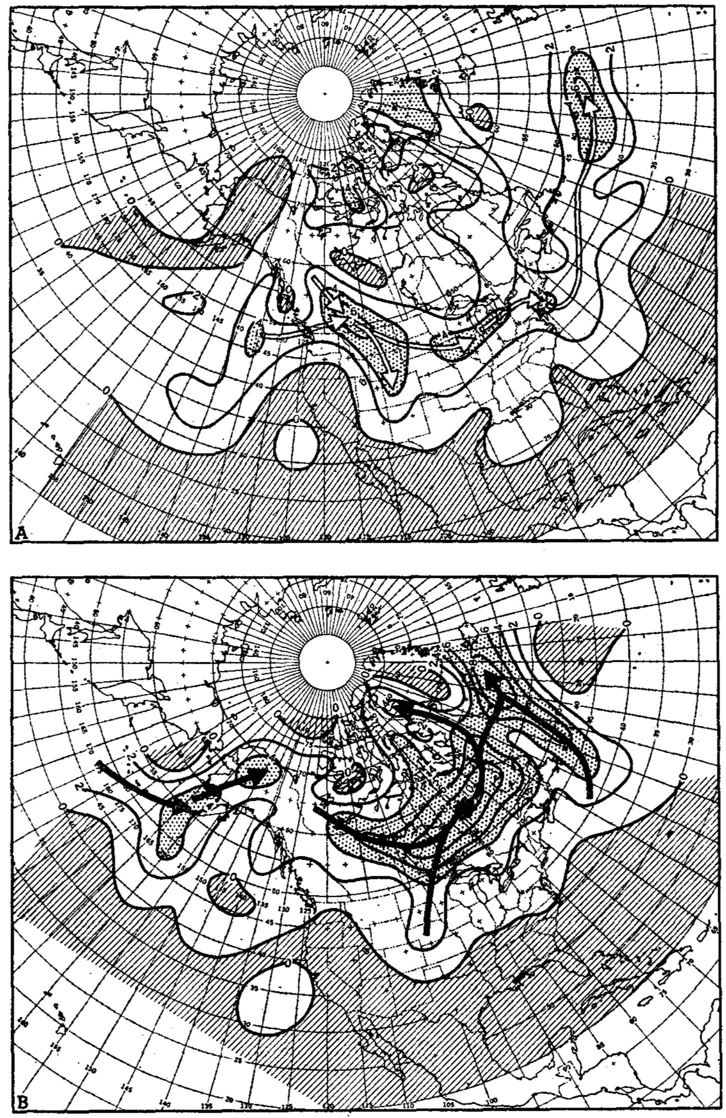

Figure 2.—Frequency of tracks of sea level anticyclones (A) and cyclones (B) observed on daily weather maps during July 1952 within approximately equal-area boxes of size 5 mid-latitude degrees of longitude by 5° of latitude. The isopleths are drawn at intervals of 2. Principal anticyclone and cyclone tracks are indicated by open and solid arrows, respectively. They are broken in areas of maximum frequency and originate in areas of anticyclogenesis and cyclogenesis. Areas of zero frequency are hatched; areas with more than 4 anticyclone or cyclone passages are stippled. All data obtained from Charts IX and X.

preventing any appreciable penetration of cool polar air from Canada and the Arctic into the United States. Precipitation due to forced lifting of warm tropical air by cool polar air was therefore minimized. At the same time, daily cyclones and associated rainfall were infrequent in the region of strong anticyclonic wind shear south of the principal jet stream. This anticyclonic shear was accompanied by unusually strong anticyclonic curvature and presumably by pronounced subsidence [5], thereby desiccating the air and insuring clear skies with abundant sunshine (Charts VI and VII).[2] These conditions were favorable for the combination of scorching heat and in-

[2] For a detailed example of this process see adjoining article by Ross.

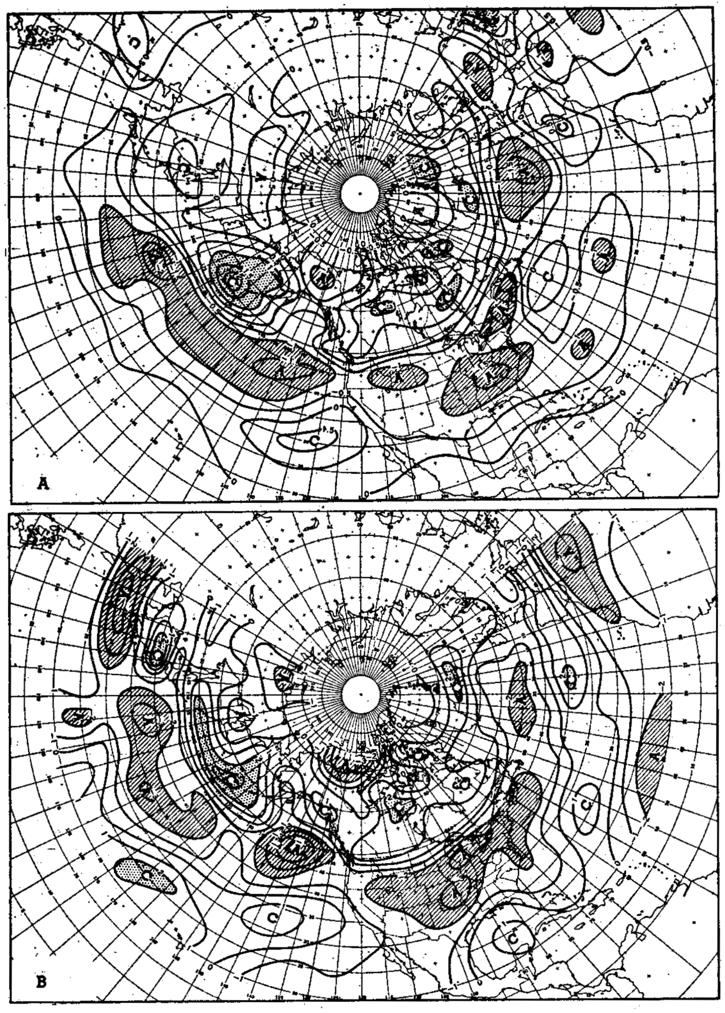

FIGURE 3.—Vertical component of mean relative geostrophic vorticity for the 30-day period July 1–30, 1952, at 700 mb. (A) and 200 mb. (B). Isopleths are drawn at intervals of 0.5×10^{-5} sec^{-1} for (A) (700 mb.) and at intervals of 1.0×10^{-5} sec^{-1} for (B) (200 mb.). Centers of anticyclonic and cyclonic vorticity are labeled "A" and "C" respectively. Areas of cyclonic vorticity in excess of 1×10^{-5} sec^{-1} at 700 mb. and 2×10^{-5} sec^{-1} at 200 mb. are stippled; areas of anticyclonic vorticity less than -1×10^{-5} sec^{-1} at 700 mb. and -2×10^{-5} sec^{-1} at 200 mb. are hatched.

sufficient moisture which produced drought in large portions of the southern and eastern United States.

The drought-producing features of the 700-mb. circulation described above extended to all levels of the observed atmosphere. Monthly mean pressures at sea level were 6 mb. above normal in the Pacific High, 3 mb. above normal in the Bermuda High, and 3 mb. below normal in the Low near Hudson Bay (Chart XI and inset). Similar characteristics were evident at the levels of 850, 500, and 300 mb. (Charts XII to XV). Of special interest is the monthly mean chart for 200 mb., (about 40,000 ft.) illustrated in figure 5, since 200 mb. is close to the average level of the tropopause and the jet stream. The Pacific High, Bermuda High, and Canadian trough are again evident in this figure. The resemblance to 700 mb. is even more striking when the field of relative vorticity is computed from figure 5. Although the mean vorticity at 200 mb. was considerably larger in absolute magnitude than its counterpart at 700 mb., its spatial distribution was generally similar, as indicated by comparing figures 3A and 3B. At both levels anticyclonic vorticity was clearly marked in the United States and east-central Pacific, while cyclonic vorticity prevailed in Canada.

Comparison of figures 1 and 5 reveals that the contour gradient at middle latitudes was much greater at 200 than at 700 mb., a consequence of the normal poleward decrease of temperature along isobaric surfaces in the troposphere. As a result mean geostrophic wind velocities in the vicinity of the principal westerly jet stream at 200 mb. averaged about twice as fast as those in the axis of maximum wind speed at 700 mb., as indicated by comparing figures 4A and 4B. However, the location of the principal axis of maximum wind speed, extending from Japan through the Gulf of Alaska, the Upper Lakes, the North Atlantic, and the North Sea, was practically identical at the two levels. Thus, during this month the field of geostrophic wind speed at 700 mb. furnished a reliable indication of the location of the jet stream at high levels, at least in middle latitudes. It is noteworthy that the strongest monthly mean 200-mb. wind speeds anywhere on the map (and probably in the entire Northern Hemisphere) were found along the northern border of the United States, as much as 60 m. p. h. just north of the Great Lakes. The jet stream is normally located in this region in July but with weaker maximum wind speeds [6]. The relation of this stronger-than-normal jet stream, and its counterpart at 700 mb., to the drought and heat wave has already been mentioned.

OTHER ASPECTS OF THE WEATHER AND CIRCULATION

The region with greatest difference in weather and circulation between July and June 1952 was the West Coast of the United States. Although a mean trough was located in this area during both months, 700-mb. heights were generally above normal in July but below normal in June. Temperatures averaged 1° to 2° F. above normal in most of the Far West during July, where they had been as much as 6° below normal in June. In addition, precipitation was subnormal in the Pacific Northwest but in excess of normal in most of the Southwest, the reverse of the June distribution. Abundant showers in the normally dry regions of the southwestern United States, accompanied by excessive cloudiness (Charts VI and VII) and near normal temperatures (Chart I–B), were produced by an influx of maritime tropical air from the Gulf of Mexico and Caribbean Sea. This moist air was carried at the 700-mb. level by stronger-than-normal southeasterly winds between the Georgia High and the West Coast trough. The axis of this flow is well delineated as a secondary wind speed maximum in figure 4A. Some of the showers in the Southwest may have been associated with upper level divergence (and lower level convergence) as a secondary jet stream at 200 mb. entered this sector (fig. 4B), and the air passed from an area of cyclonic

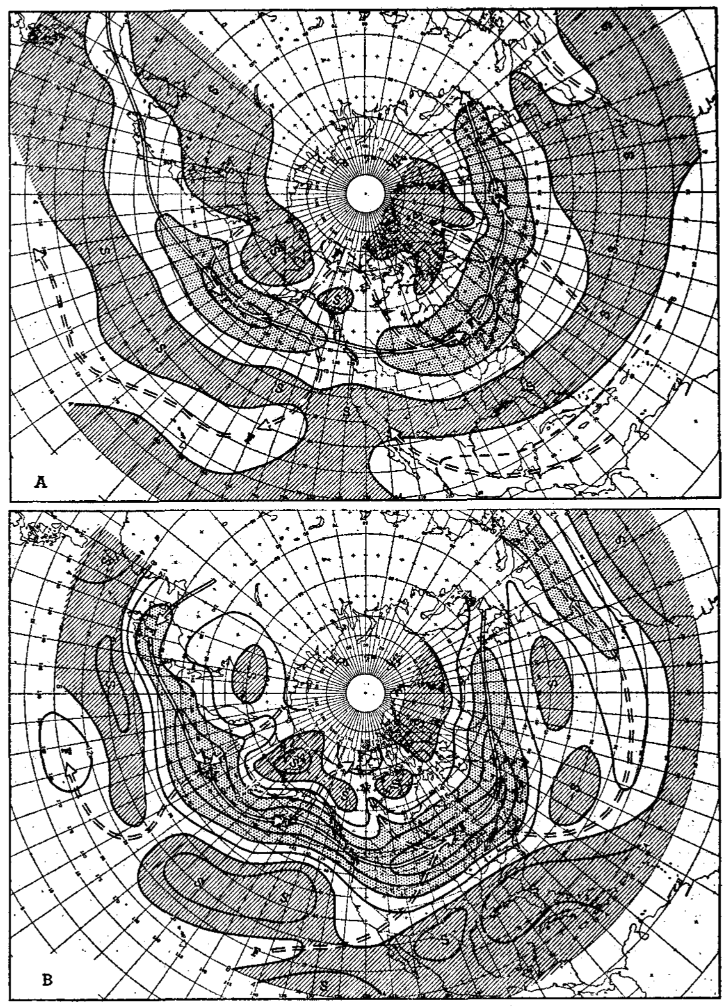

Figure 4.—Mean geostrophic (total horizontal) wind speed for the 30-day period July 1–30, 1952, at 700 mb. (A) and 200 mb. (B). Isotachs at intervals of 4 m/sec are shown by solid lines with intermediate isotachs dashed. The principal westerly jet stream is delineated by open double-arrowed lines, while secondary axes of maximum wind speed are shown by dashed-arrowed lines. Centers of maximum and minimum wind speed are labeled "F" and "S" respectively. Areas with speeds in excess of 8 m/sec at 700 mb. and 16 m/sec at 200 mb. are stippled; areas with speeds less than 4 m/sec. at 700 mb. and 8 m/sec at 200 mb. are hatched.

vorticity in the southeastern Pacific (fig. 3B) into a region of anticyclonic vorticity in the United States [7]. Stronger-than-normal southeasterly flow at 700 mb. was also responsible for above-normal precipitation in Louisiana and southeast Texas. From the 16th to the 18th a Gulf squall which moved into the lower Mississippi Valley caused heavy rains as far north as Missouri.

In most of the country, except the Northeast, monthly mean temperature departures from normal were not as extreme during July as they had been in June. This was particularly true of the Midwest, where temperatures averaged from 4° to 10° above normal during June but only 2° to 4° above in July. This relative cooling was associated with the progressive development of a mean trough at the 700-mb. level in the Great Plains during the month of July. To the rear of this trough, in Montana and portions of adjoining States, temperatures averaged 2° F. below normal. Some Montana stations reported the lowest July temperatures on record on the 7th of the month. In the region of cyclonic curvature east of the trough, in the upper Mississippi Valley and Upper Lakes, total precipitation exceeded seasonal normals. Michigan reported more than twice the normal amount of state-wide rainfall. This precipitation was connected with the principal cyclone track across northern Canada and a secondary track in the Plains States (fig. 2B). It was also related to a split between two centers of anticyclonic vorticity at 700 mb. (fig. 3A). Severe thunderstorms with hail, high wind, torrential rains, and scattered tornadoes occurred in parts of this region on July 2, 22, and 27.

At low latitudes the monthly mean 200-mb. chart for July (fig. 5) differed from the corresponding 700-mb. chart (fig. 1) in several respects, a difference which has been emphasized by tropical forecasters in recent years [8]. The most important difference for the weather of the United States was the existence of a weak trough at 200 mb. in the Southeast directly over a High center at 700 mb. This implies the presence of cold air and a steep lapse rate in the layer from 700 to 200 mb. It is possible that this contributed to the occurrence of scattered areas of above-normal monthly rainfall in the Middle and South Atlantic States. On a hemispheric basis the most striking difference was found in the western Pacific, where the 700-mb. High, centered at 30° N., 167° E., was apparently displaced about 3,000 miles westward to the China Coast near Hong Kong at 200 mb., so that northerly flow prevailed at 200 mb. over southerly flow at 700 mb. A similar westward displacement, but on a smaller scale, may be noted in the United States, where the 700-mb. High near Georgia shifted to west Texas at 200 mb. On the other hand, 700-mb. Highs in the Sahara Desert, eastern Pacific, and central Atlantic suffered little longitudinal displacement at 200 mb.

Several differences are noticeable in the isotach analyses at the two levels (fig. 4). Northeast of the Hawaiian Islands an axis of maximum wind speed from the southwest at 200 mb. lay almost directly over an axis of maximum wind speed from the northeast at 700 mb. In the Atlantic a secondary axis of maximum wind speed at 200 mb., extending from Long Island to Gibraltar, passed directly over a large area of minimum wind speed at 700 mb. This 200-mb. westerly current became a major jet stream in the Mediterranean, where wind speeds averaged about 40 m. p. h., directly over a weaker axis of maximum wind speed at 700 mb. It is interesting to note that a similar Mediterranean jet stream is a normal feature of the summer circulation in the high troposphere [6].

This month the interrelation previously noted [1] between vorticity distribution, wind speeds, and the tracks of anticyclones and cyclones was well marked. The principal westerly jet stream at both 200 and 700 mb. (fig. 4) generally coincided with the line of zero relative vorticity (fig. 3), except in the region of pronounced con-

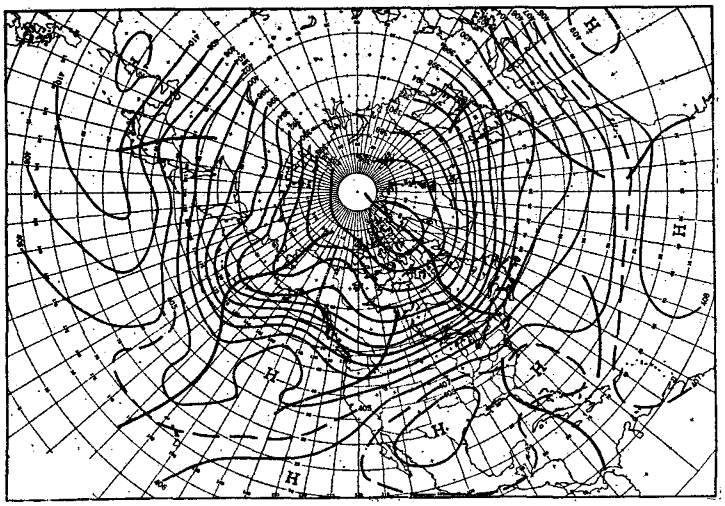

FIGURE 5.—Mean 200-mb. chart for the 30-day period July 1-30, 1952. Contours at 200-ft. intervals are shown by solid lines with intermediate contours dashed. Contours are labeled in hundreds of feet. Minimum latitude trough locations are shown by heavy solid lines.

tour curvature in the Gulf of Alaska. The principal anticyclone track was located for the most part parallel to and to the south of the jet stream, along the axis of greatest anticyclonic vorticity, while cyclones usually traversed the region of maximum cyclonic vorticity to the north of the jet. Likewise, areas of maximum anticyclone frequency were generally located near centers of anticyclonic vorticity, just south of centers of maximum wind speed; while centers of maximum cyclone frequency were close to centers of cyclonic vorticity, just north of centers of maximum wind speed.

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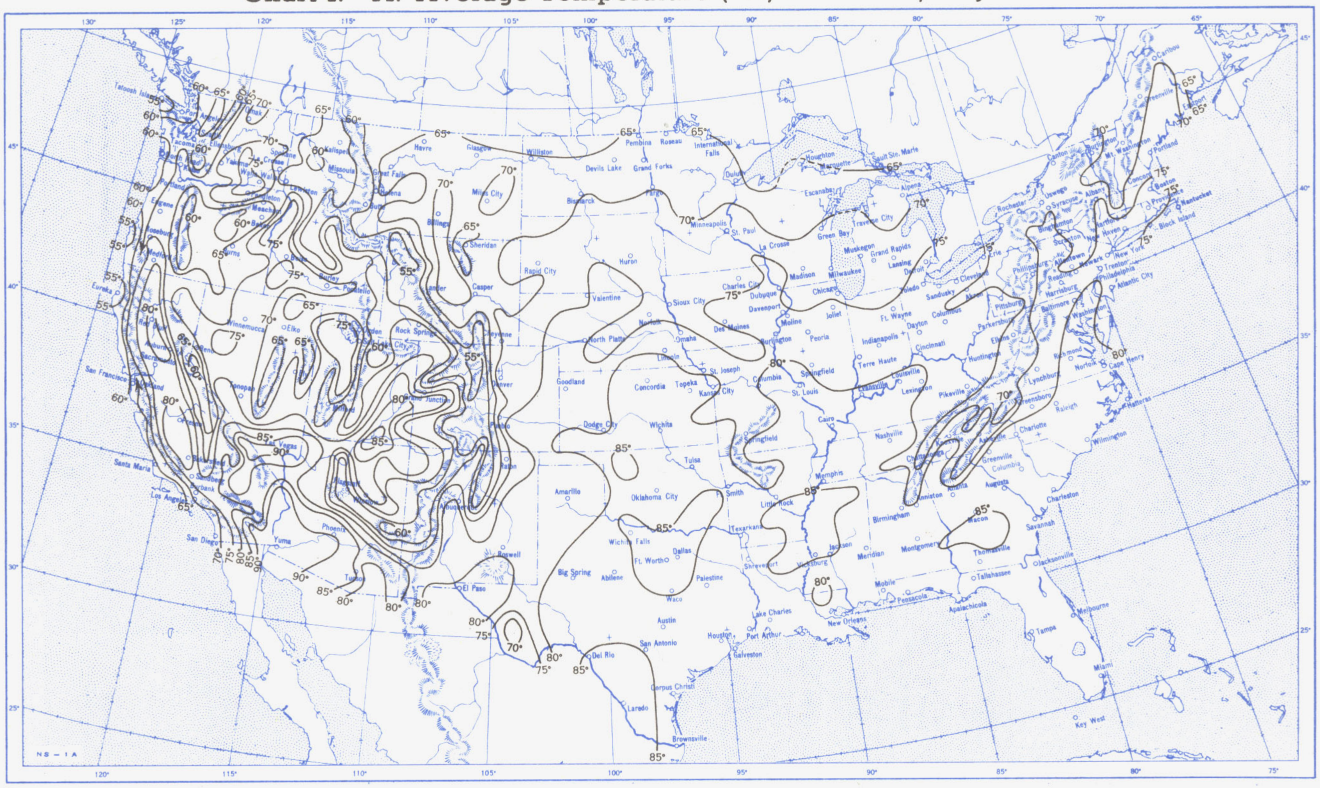
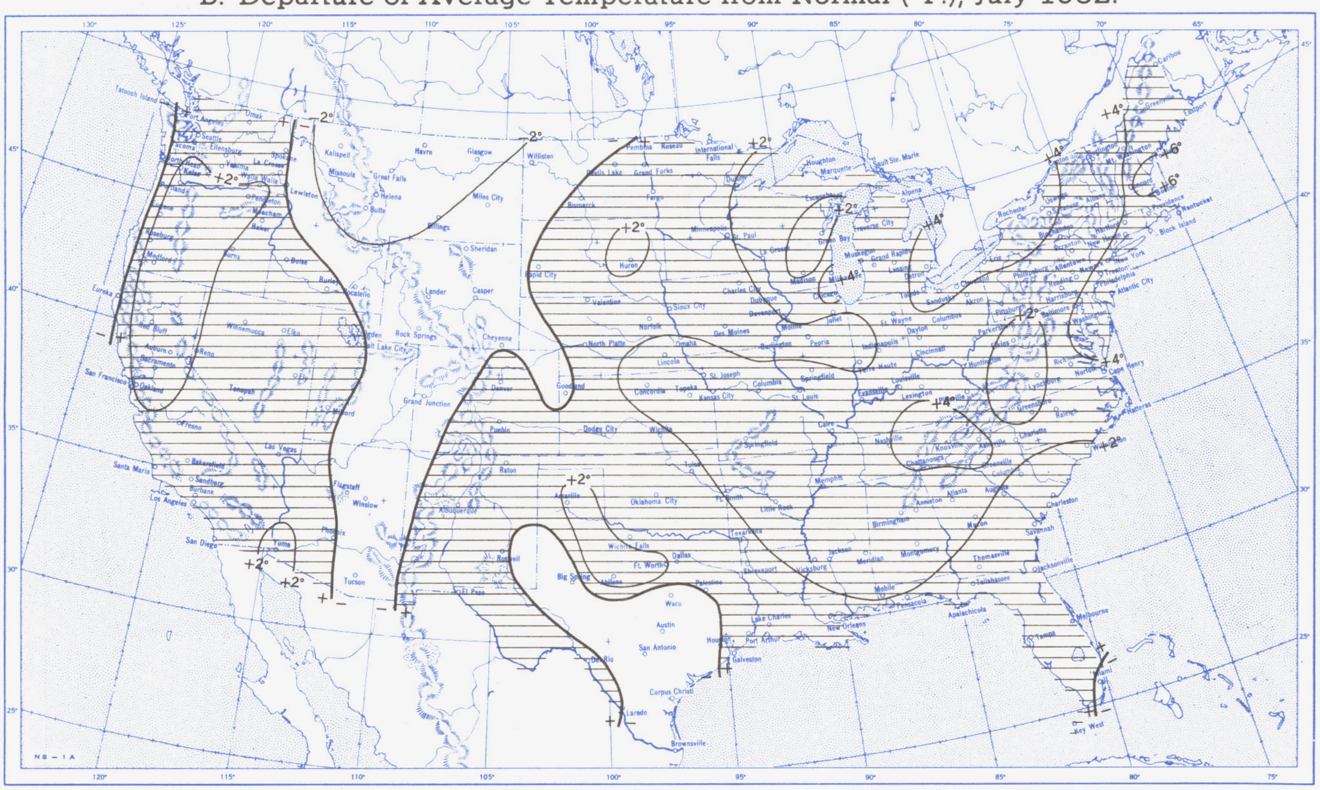
Chart I. A. Average Temperature (°F.) at Surface, July 1952.

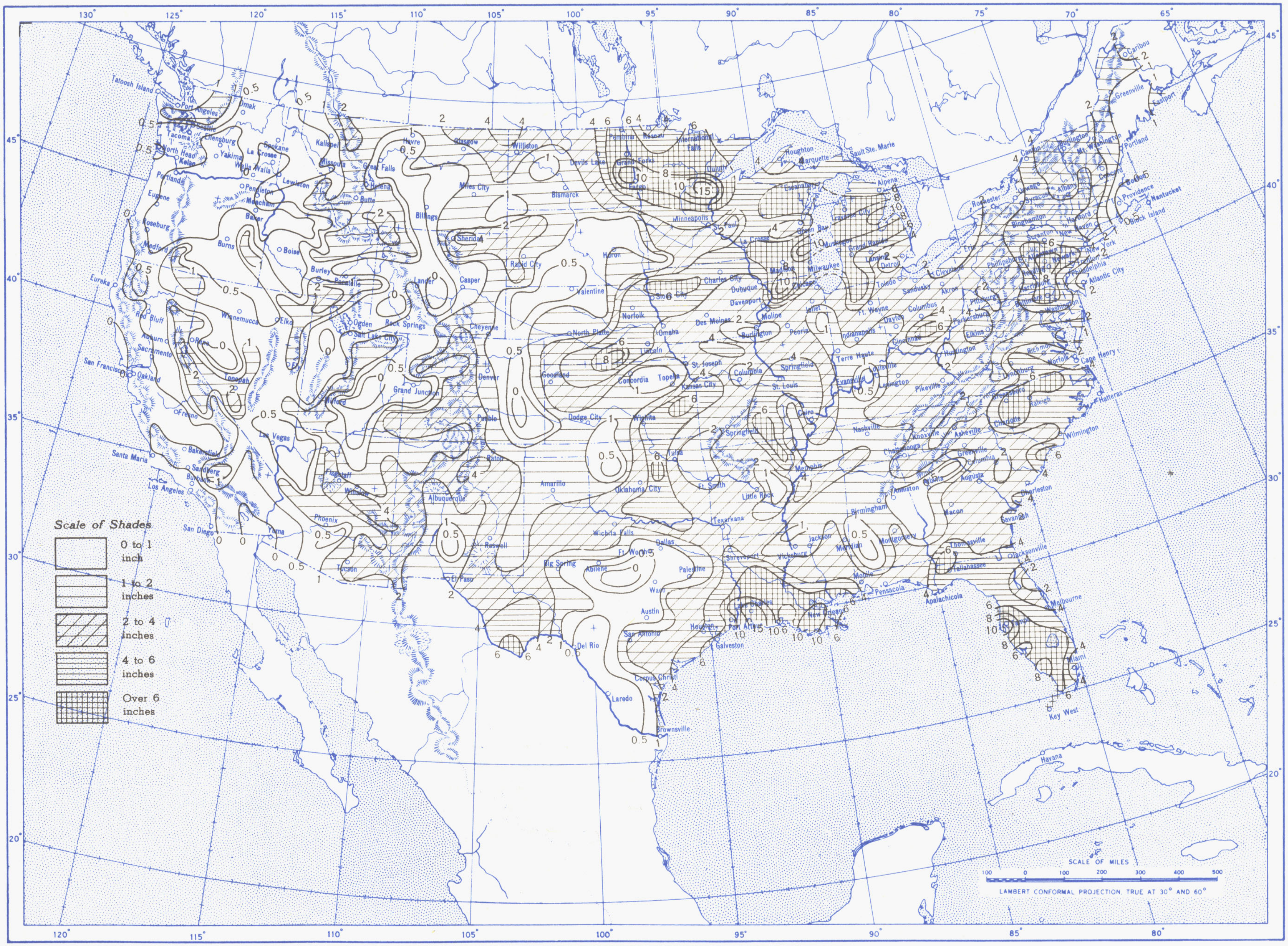


B. Departure of Average Temperature from Normal (°F.), July 1952.



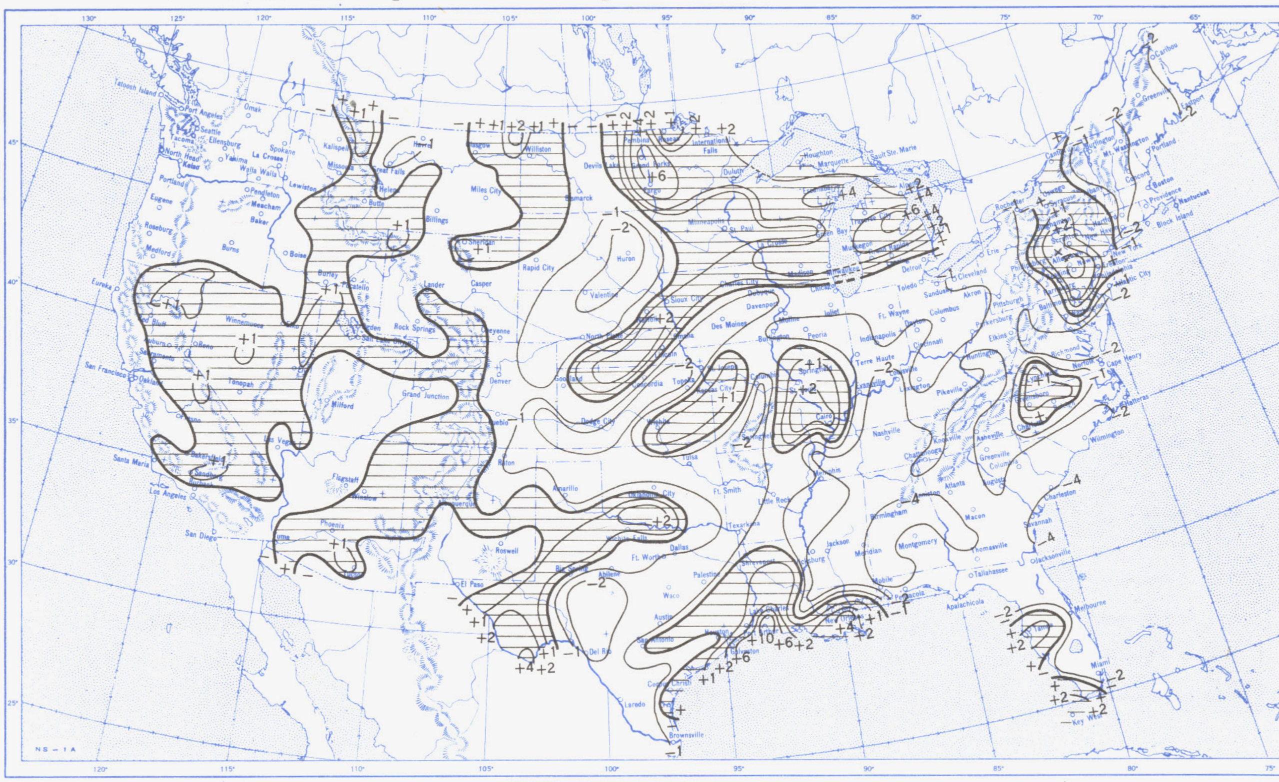
A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), July 1952.

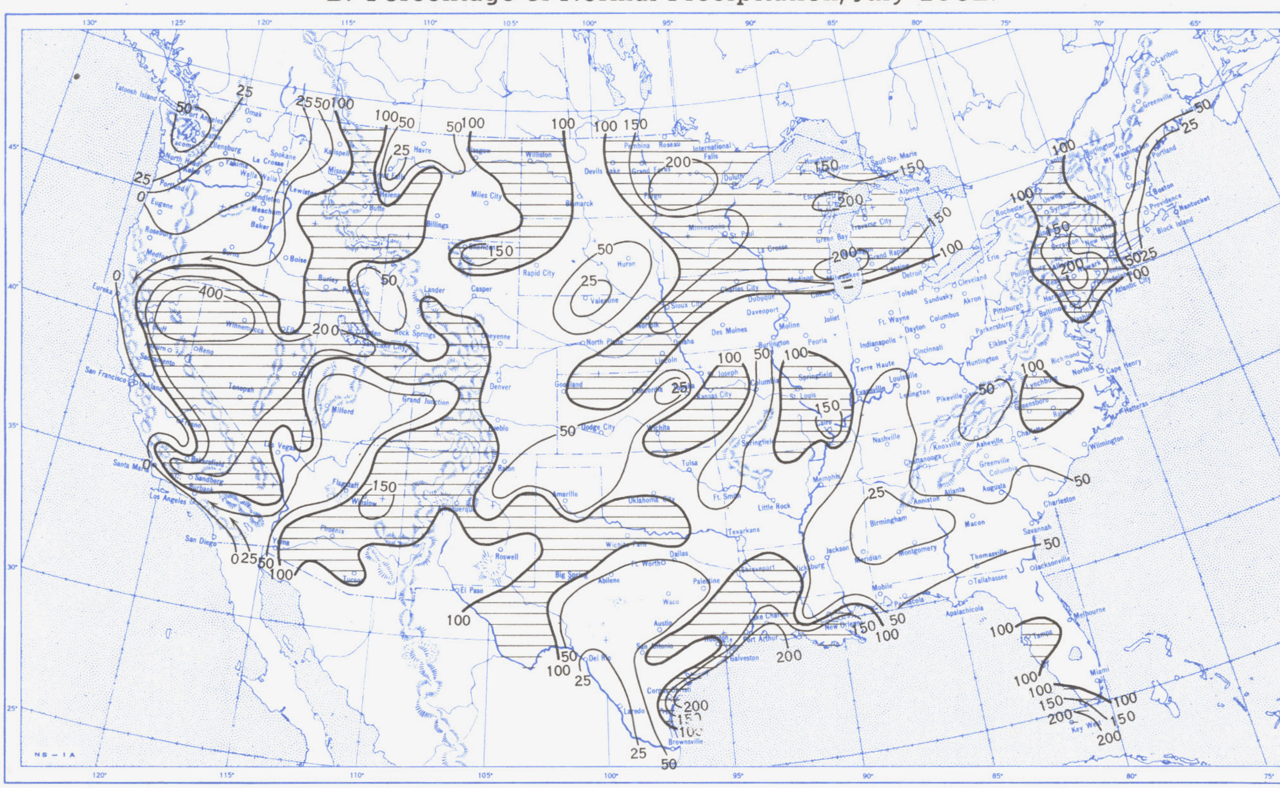


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), July 1952.

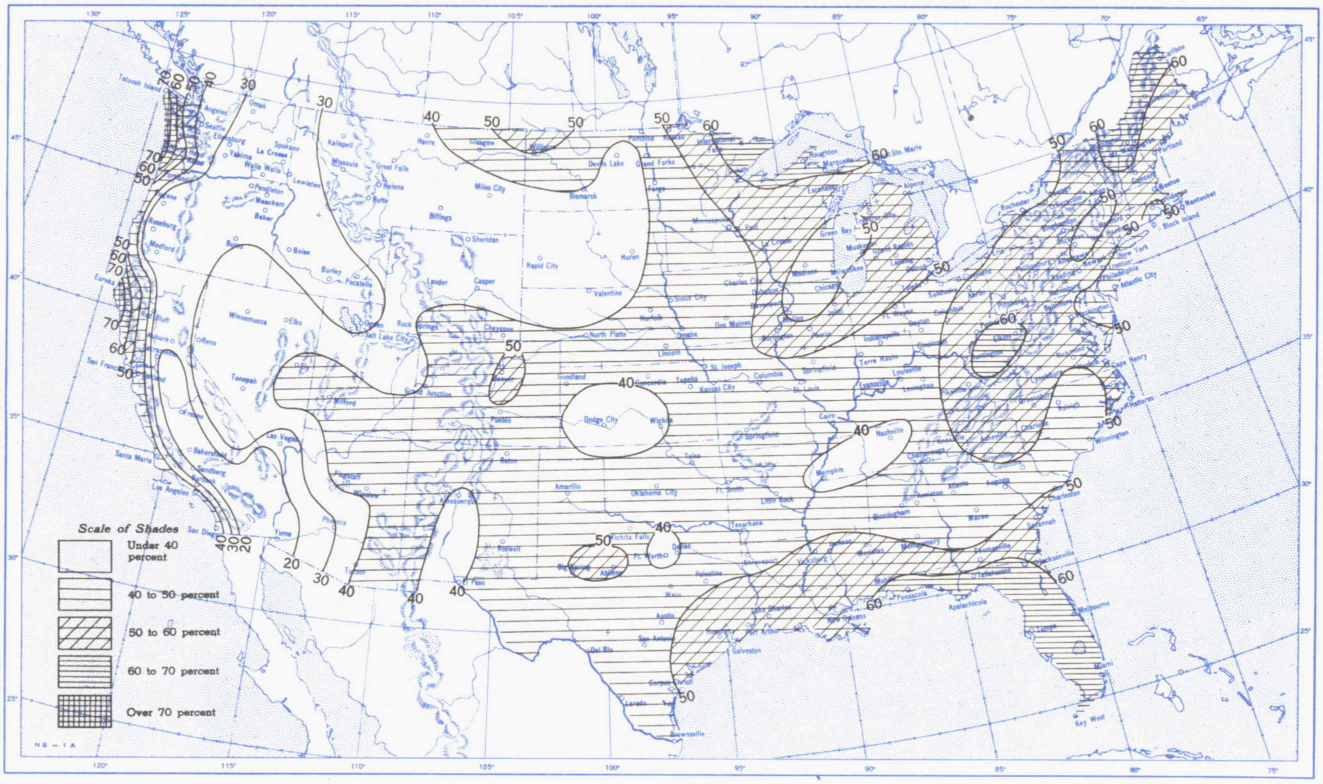


B. Percentage of Normal Precipitation, July 1952.

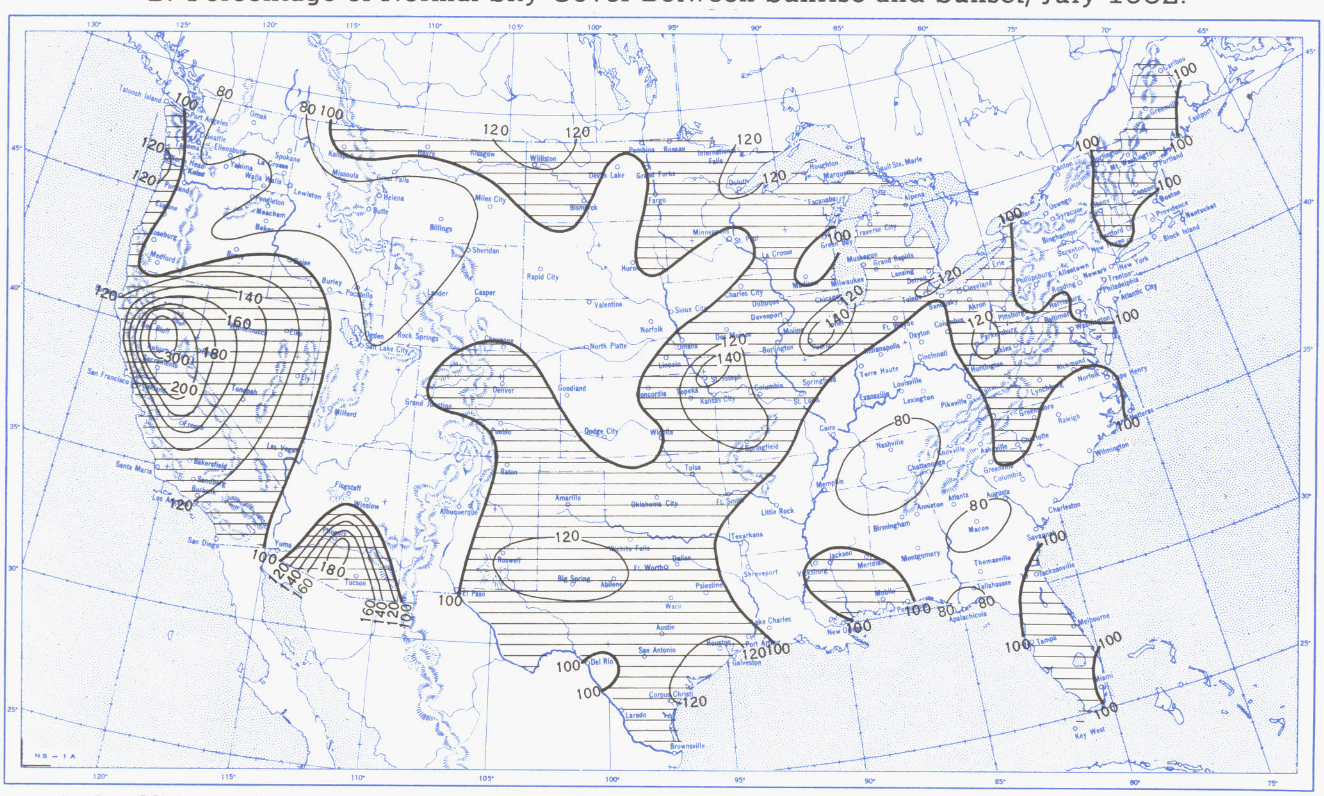


Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, July 1952.

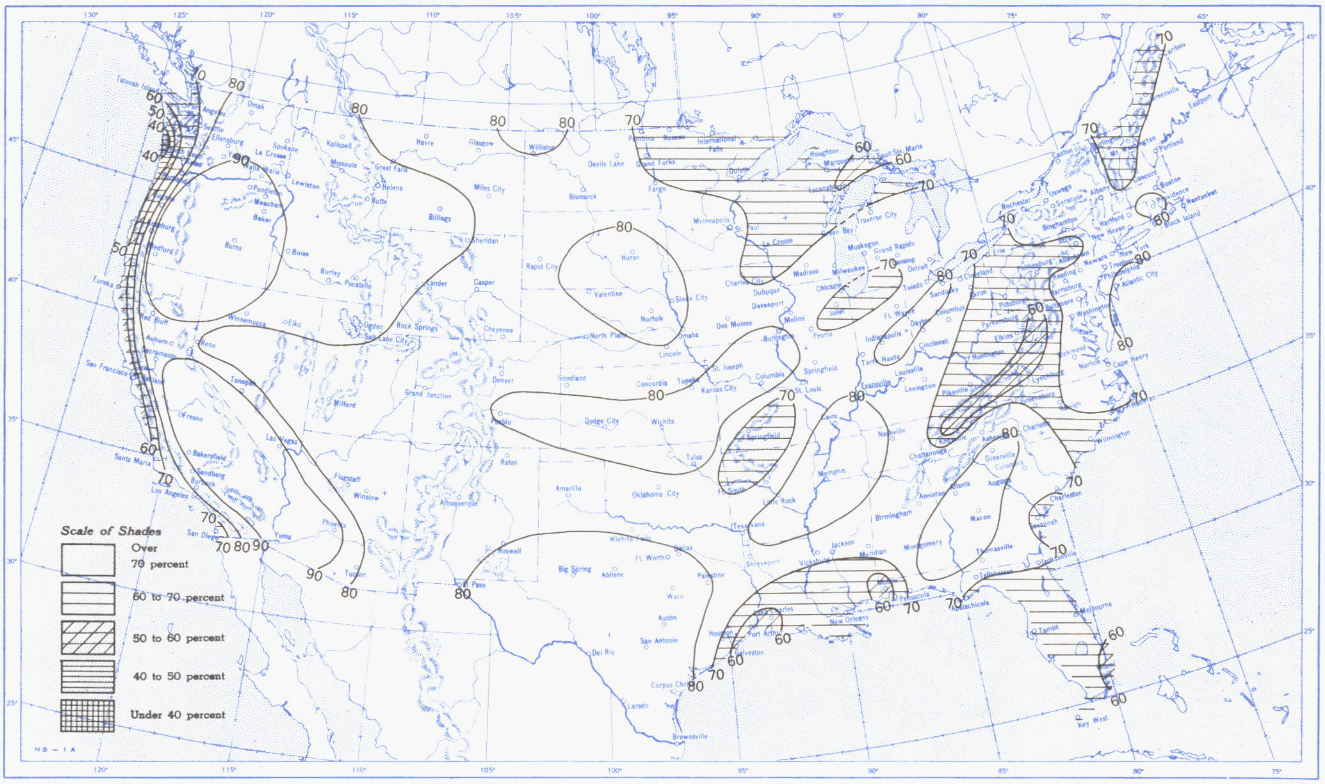


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, July 1952.

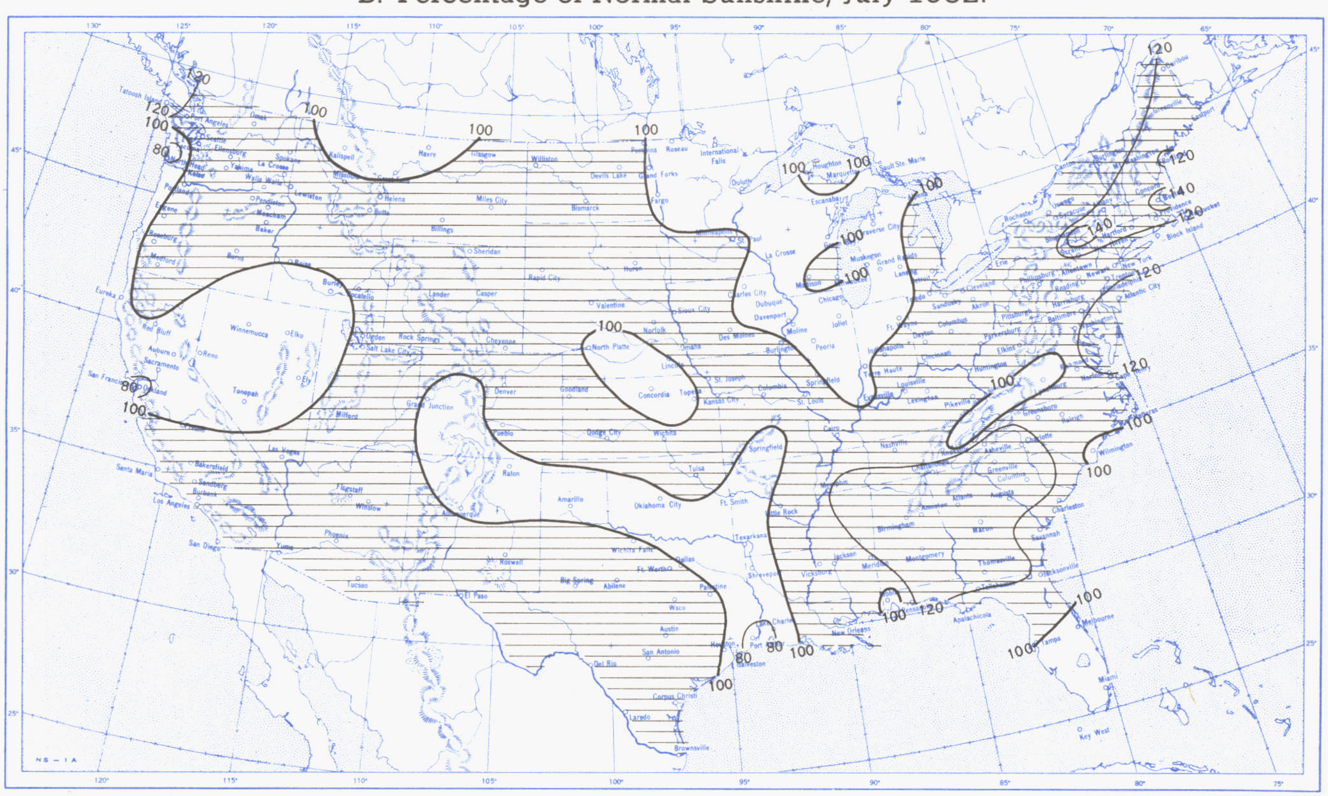


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, July 1952.



B. Percentage of Normal Sunshine, July 1952.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, July 1952. Inset: Percentage of Normal Average Daily Solar Radiation, July 1952.

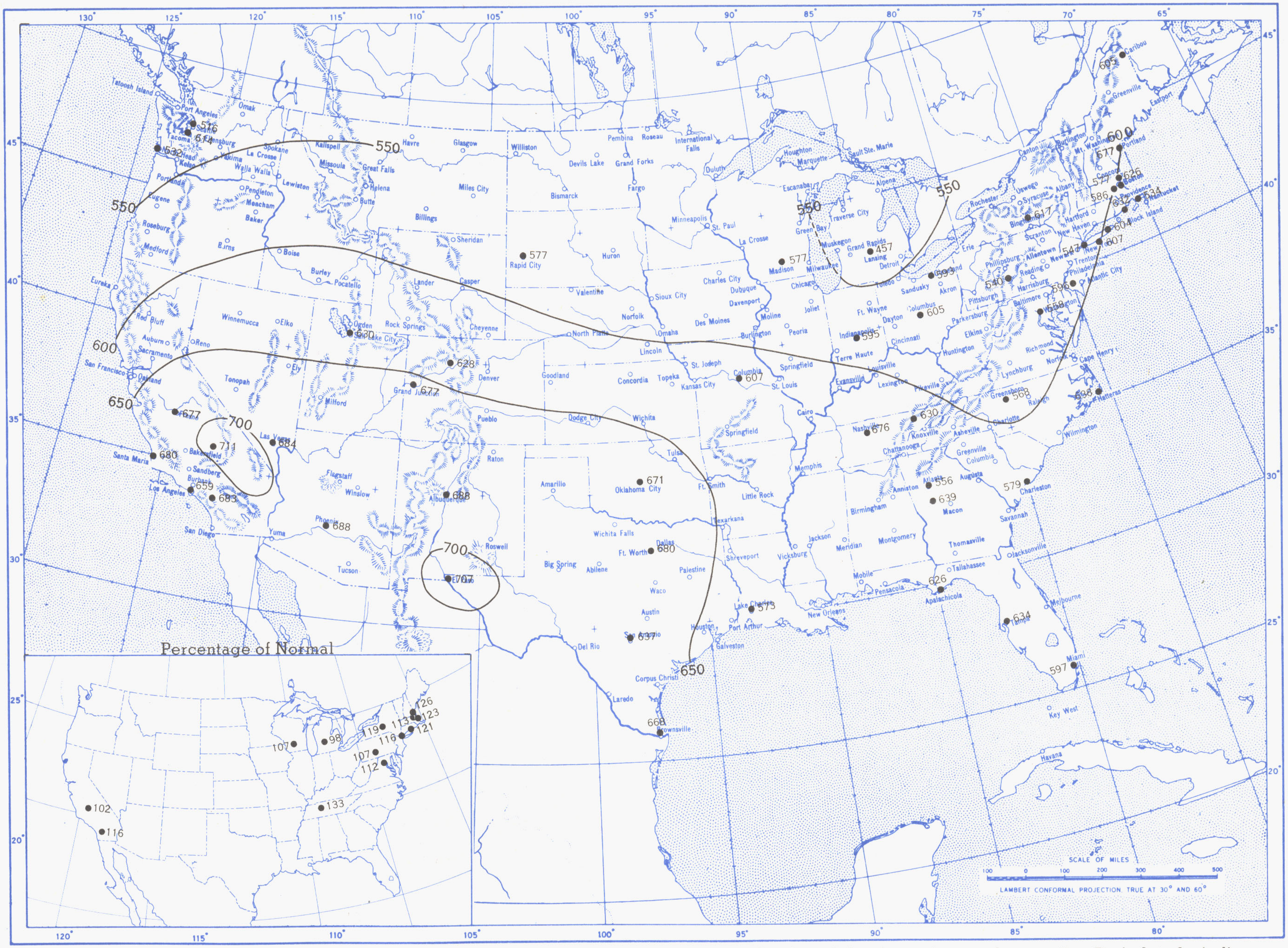
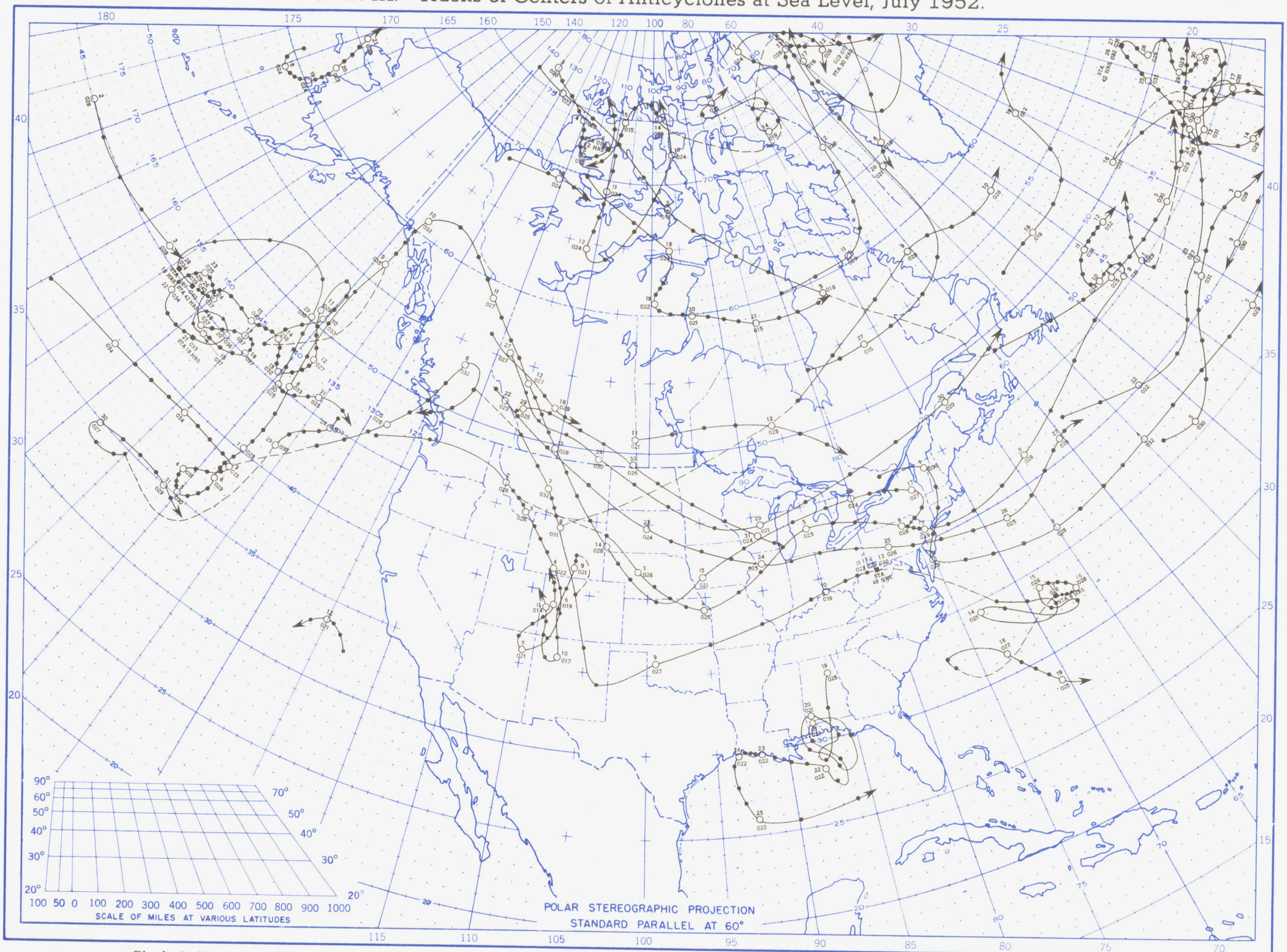


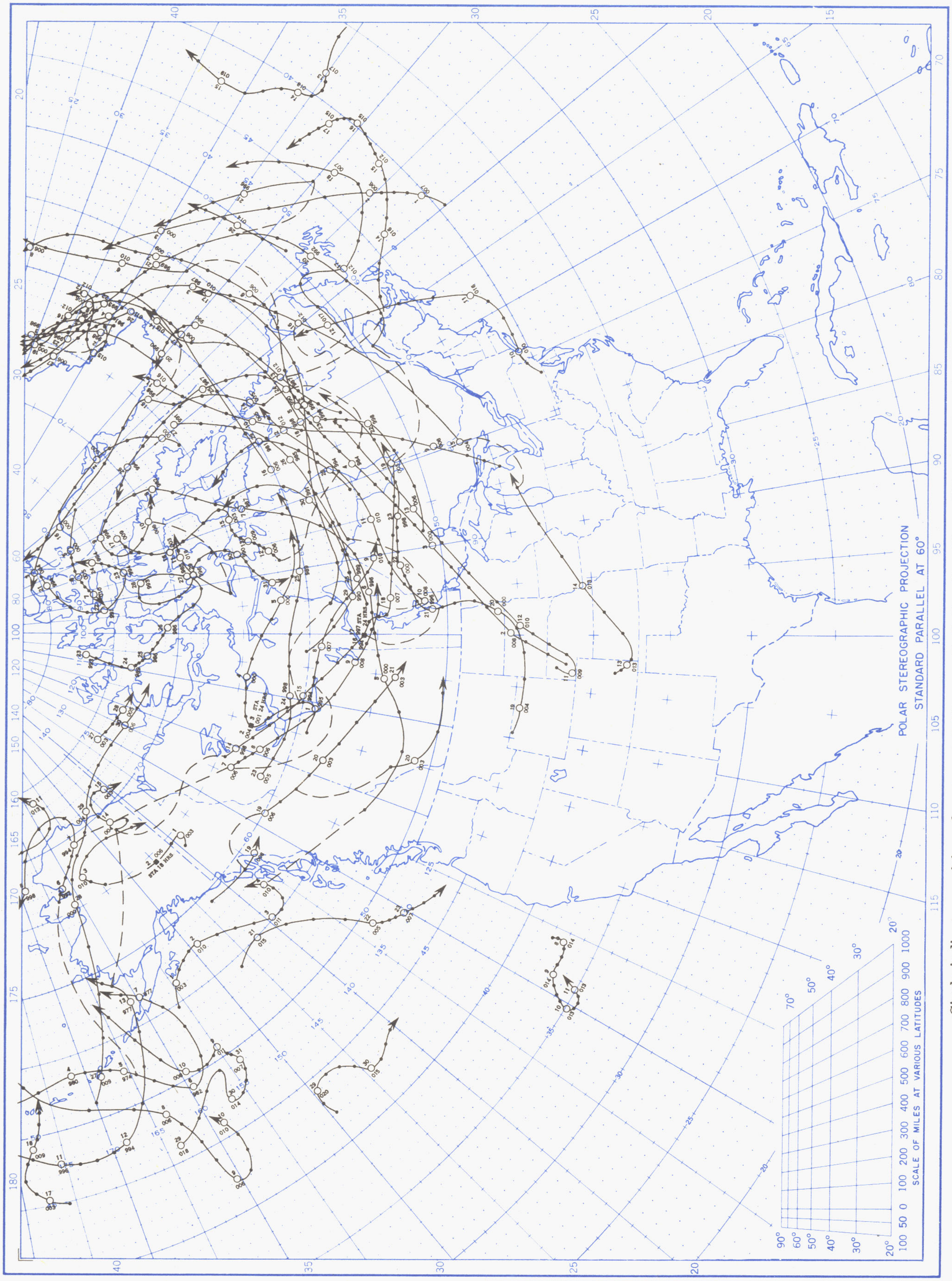
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm. $^{-2}$). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, July 1952.



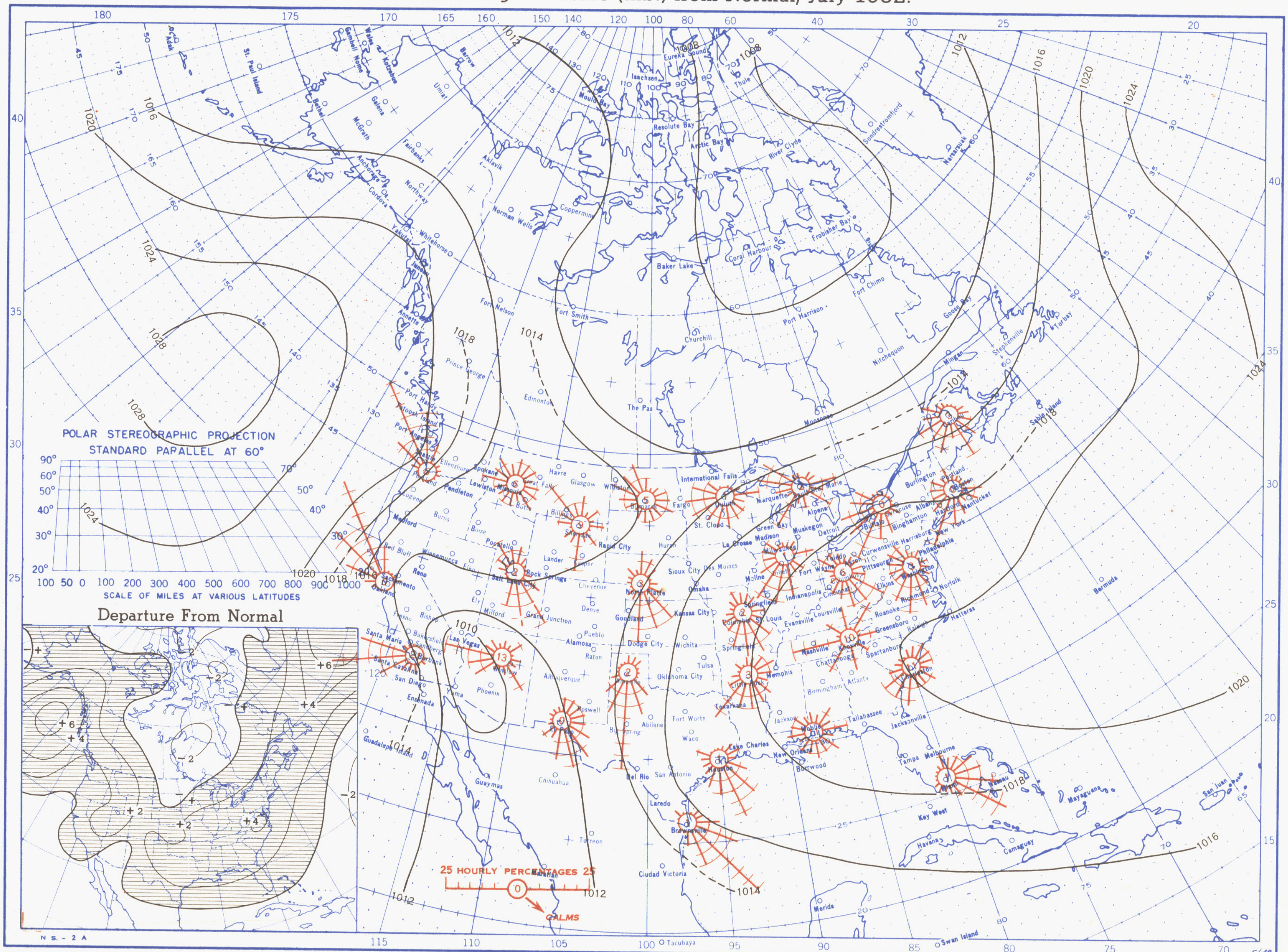
Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, July 1952.



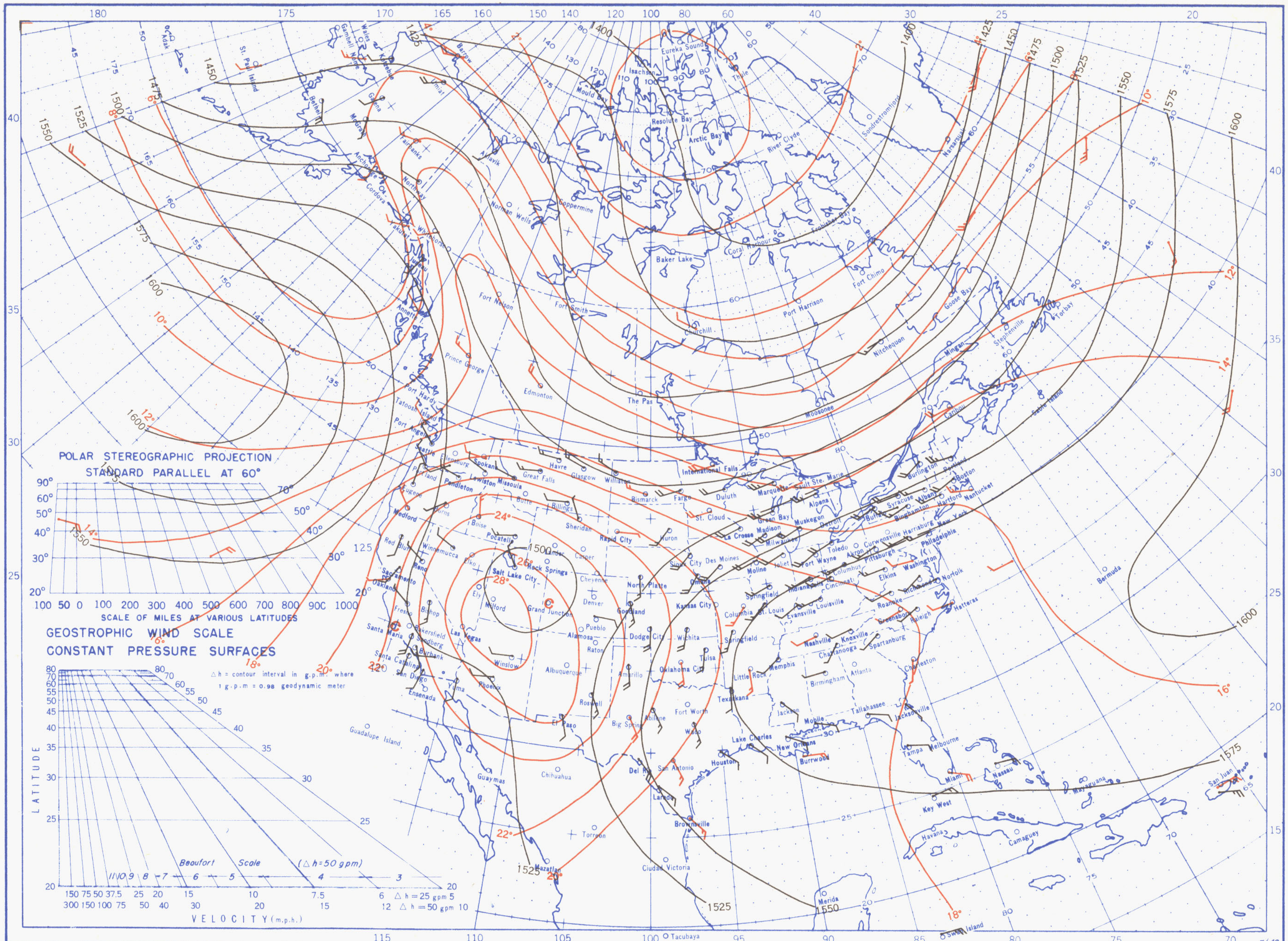
Circle indicates position of center at 7:30 a.m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, July 1952. Inset: Departure of Average Pressure (mb.) from Normal, July 1952.



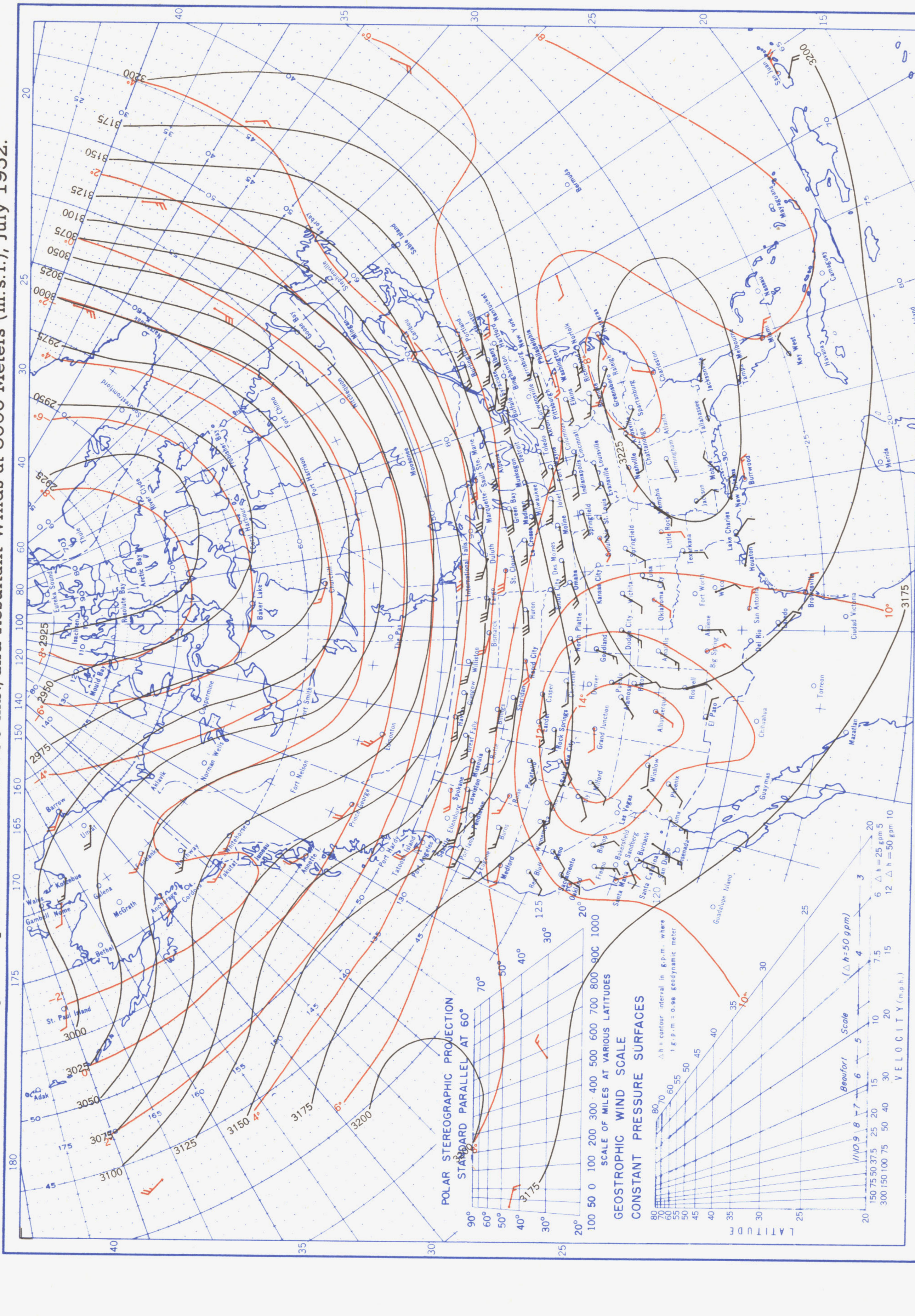
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), July 1952.



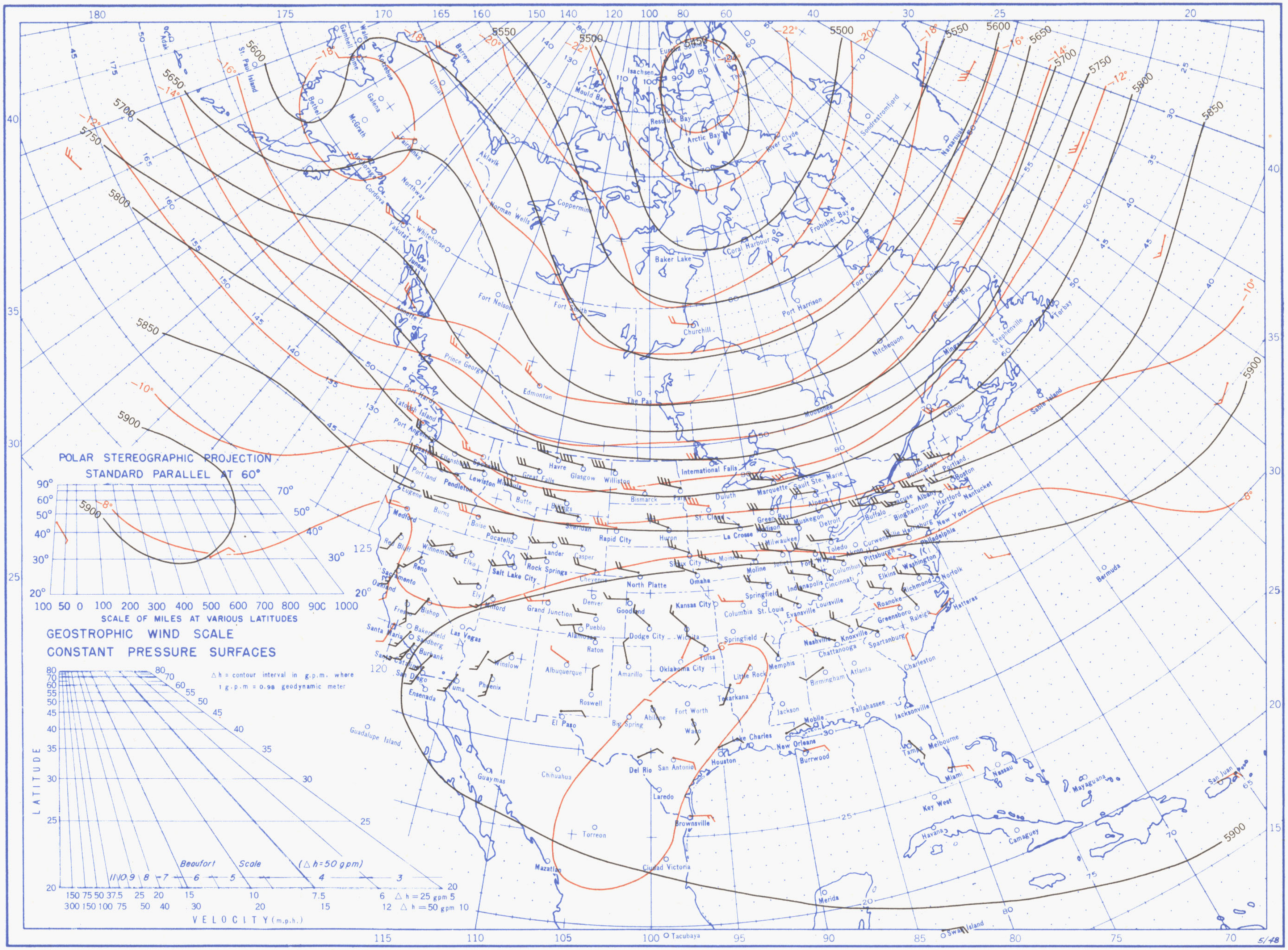
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), July 1952.



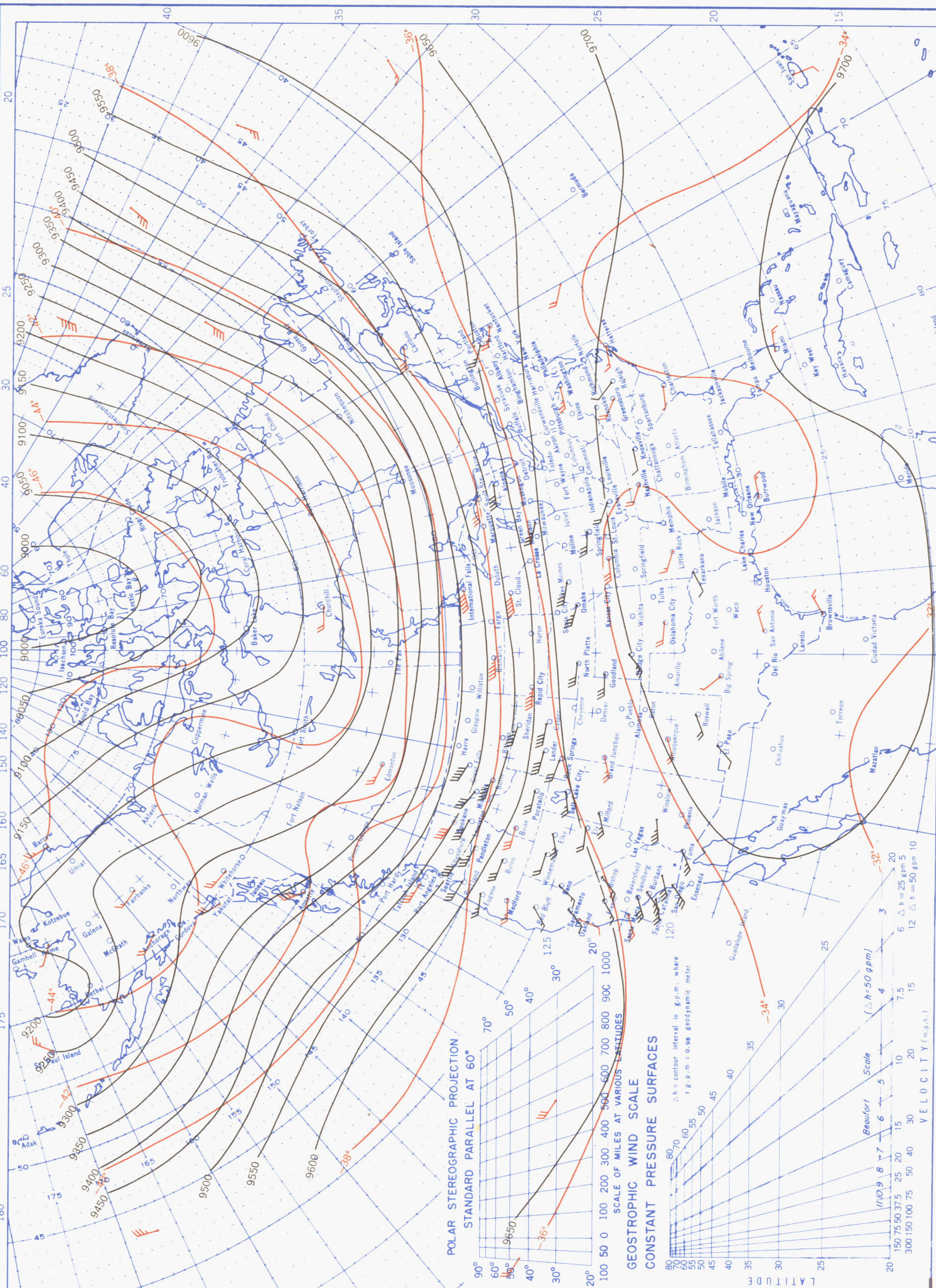
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C. at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), July 1952.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), July 1952.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.