THE WEATHER AND CIRCULATION OF AUGUST 1953[1]

Featuring an Analysis of Dynamic Anticyclogenesis Accompanying Record Heat and Drought

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WEATHER HIGHLIGHTS

The outstanding feature of the weather of August 1953 was the prolonged and widespread dry spell during the latter part of the month. The *Weekly Weather and Crop Bulletin* for the week ending August 31, 1953 reported "A large area extending from the eastern portions of South Dakota, Nebraska, and Kansas eastward over the Main Corn Belt nearly to the Atlantic Coast received less than 25 percent of the normal rainfall during the last three weeks. The major portion of this dry region did not get even 5 percent of the usual amount." No precipitation of consequence fell for 26 days in most of Indiana, 25 days in parts of New York, and 24 days in Pennsylvania before the drought was finally broken by general soaking rains on September 4 and 5.

The development of the drought during the last three weeks of August is illustrated in figure 1, which gives the total precipitation observed during each of three 5-day periods separated by one-week intervals. Note the area of no measurable rain in the Upper Mississippi Valley on the first map of the series and its expansion southward, eastward, and westward on the middle and last maps.

At the beginning of the dry spell temperatures were near to below normal as a large mass of cool polar air from Canada and the Pacific overspread the eastern two-thirds of the United States. Many new early-season low temperature records were set in the Ohio Valley and later in the Southeast. As the air mass stagnated, temperatures gradually rose to record-breaking levels, first in the Northern Plains and then progressively eastward and southward. This transition is well illustrated by the 5-day mean temperature anomalies shown in figure 2. The vast area from the Rockies to the Atlantic Coast covered by much above normal temperature in figure 2c is especially striking when it is recalled that this class normally occurs only one-eighth of the time. The heat was particularly intense between August 30 and September 3 in the heavily populated northeastern quadrant of the country, where many stations reported the hottest weather of the year and the highest temperatures on record for so late in the season. Some of the high temperatures were as follows: 107° F. in Hagerstown, Md.; 106° in Fredericksburg, Va.; 105° in Newark, N. J.; 103° in Louisville, Ky. and Huntington, W. Va.; 102° in New York, N. Y., Evansville, Ind., Cincinnati, Ohio, Pine

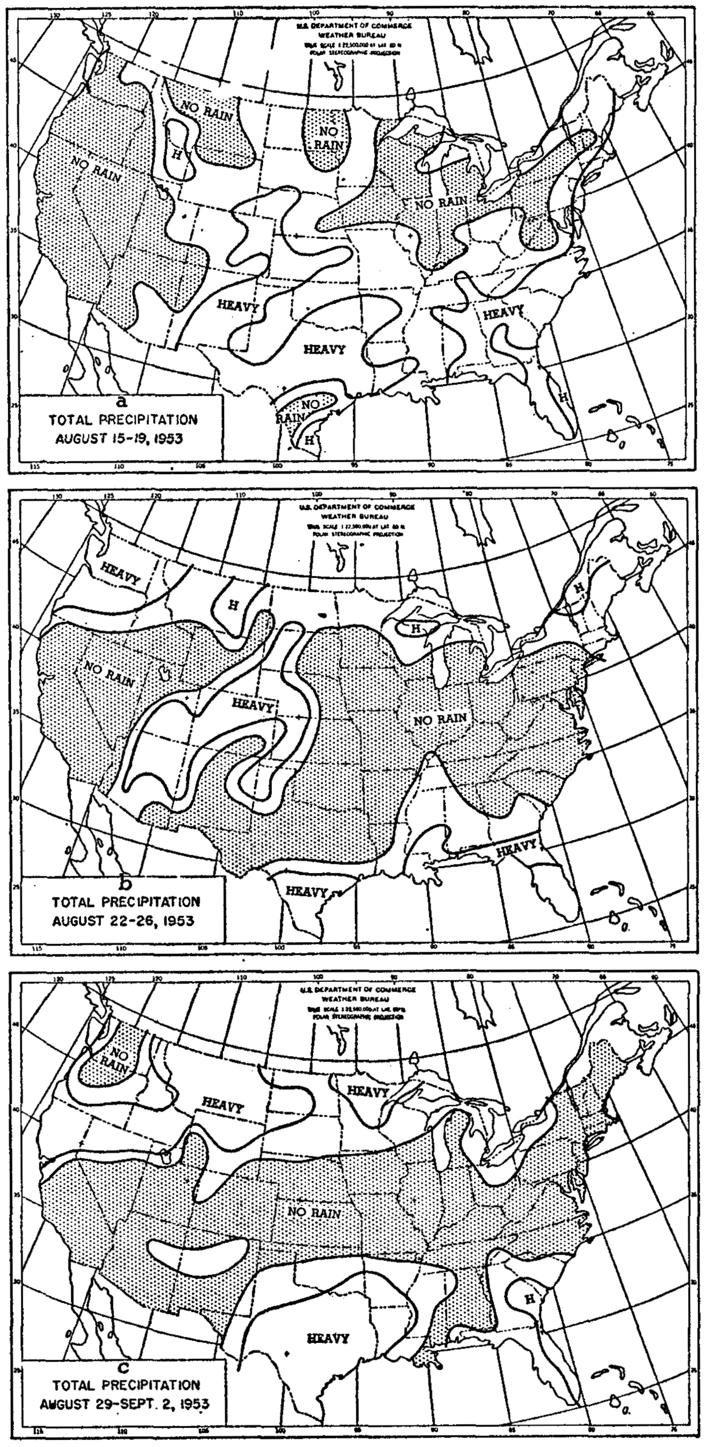

Figure 1.—Total precipitation during three 5-day periods a week apart from August 15 to September 2, 1953. Analysis is in terms of 3 classes; no rain, heavy (which normally occurs one-third of the time), and an intermediate class. Note the vast area without measurable rain in the eastern two-thirds of the country.

[1] See Charts I–XV following p. 265 for analyzed climatological data for the month.

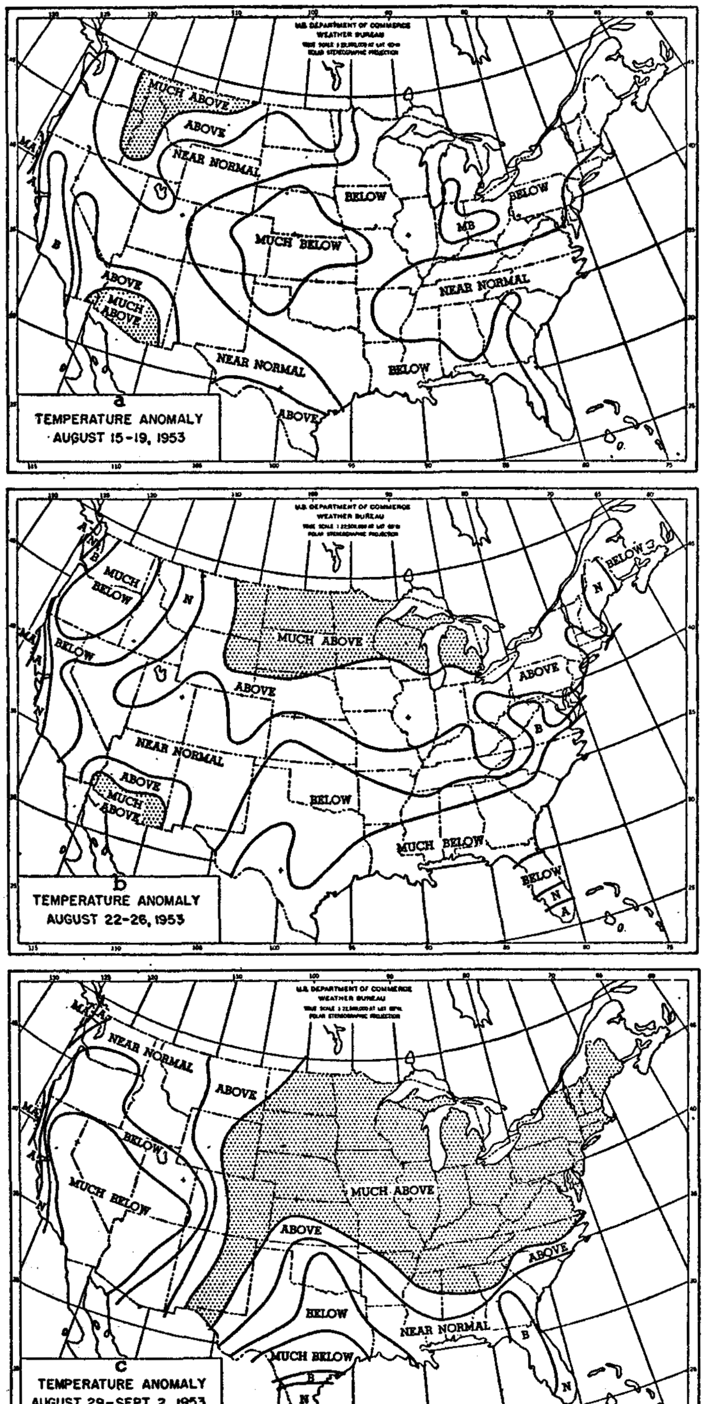

FIGURE 2.—Five-day mean surface temperature anomalies at one-week intervals from August 15 to September 2, 1953. The classes above, below, and near normal occur on the average one-fourth of the time, while much above and much below each occur normally one-eighth of the time. Note the progressive southeastward expansion of the area of much above normal.

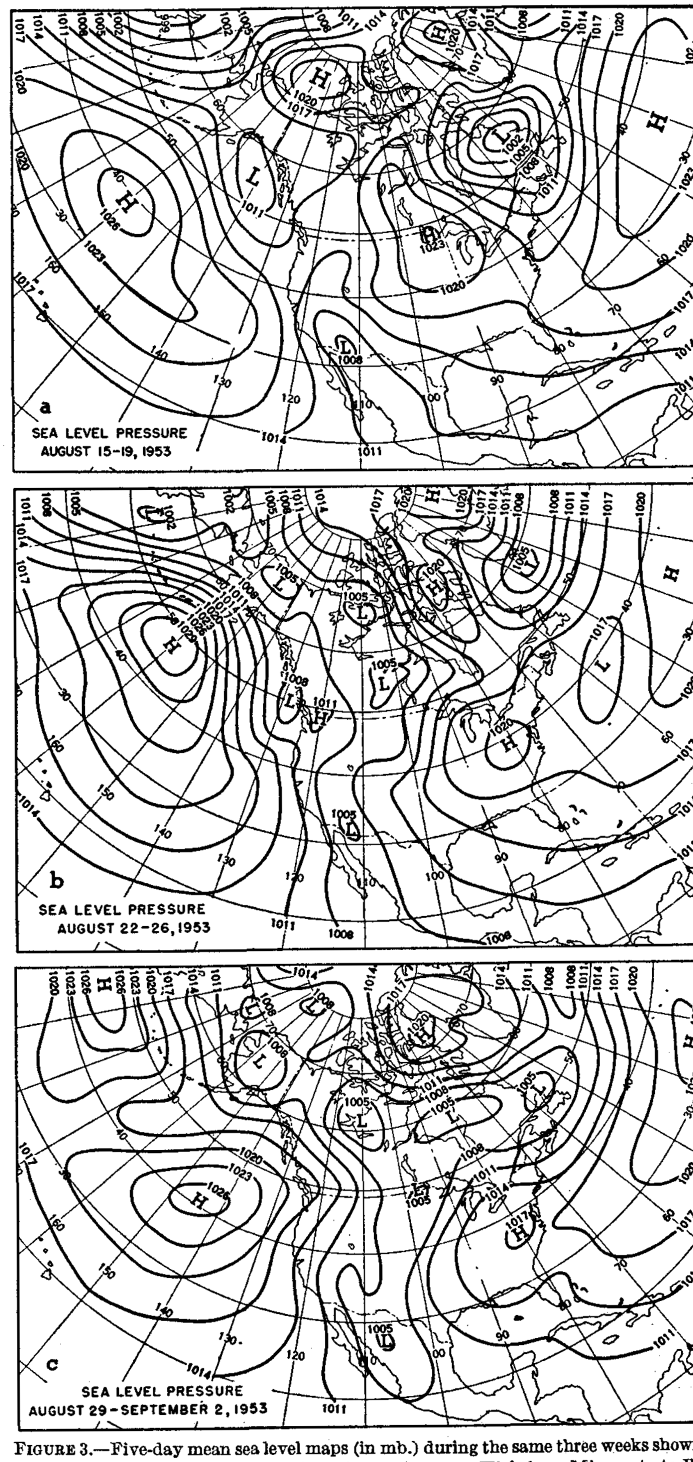

FIGURE 3.—Five-day mean sea level maps (in mb.) during the same three weeks shown in figure 1. Note the southeastward motion of the mean High from Minnesota to West Virginia, and its subsequent stagnation.

River, Wis., and Baltimore, Md.; 101° in Chicago, Ill., Cleveland, Ohio, Philadelphia, Pa., St. Louis, Mo., and Hartford, Conn. The heat wave was unusual not only for its intensity but also for its duration. For example, in Washington, D. C. there were 12 straight days of temperatures above 90° and 7 in a row above 95° between August 25 and September 5, while Richmond, Va., had 5 consecutive days with maxima of 100° or more starting August 29.

THE ANTICYCLONE

During the three weeks of dry weather described above, the eastern half of the United States was dominated by a pronounced anticyclonic circulation at sea level. The

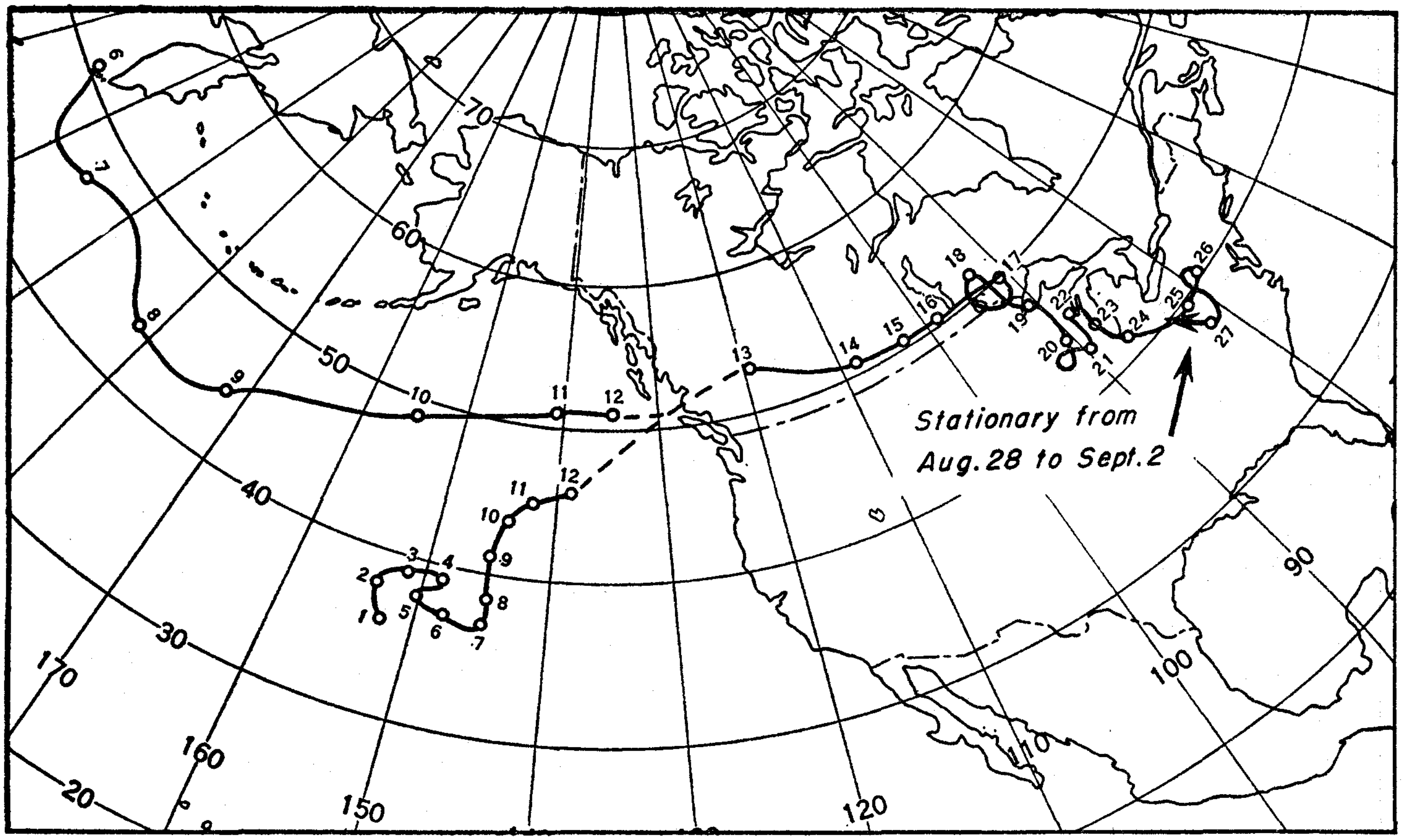

FIGURE 4.—Trajectory of the daily anticyclone at sea level from August 1 to September 2, 1953. Circles locate the center of the anticyclone at 1230 GMT of the day indicated by the number. Dashed portion of the trajectory is region of uncertain continuity.

three 5-day mean sea level maps of figure 3 show that a 1023-mb. mean High centered over Minnesota at the beginning of the period slowly moved southeastward and weakened to a 1017-mb. center over western Virginia at the end of the period. It is customary for a mean High of this sort, extending over a 3-week period, to be made up of several migratory daily anticyclones. In this case however, only a single daily system of moderate intensity made up virtually all of the three 5-day means. The trajectory of this anticyclone is shown in figure 4. It formed in the mountains of Alberta and British Columbia on August 13 as a merger between an offshoot of the quasi-permanent eastern Pacific High, which can be traced back to the first day of the month, and a High which originated in the Sea of Okhotsk on the 6th and then moved rapidly eastward across the northern Pacific. From August 14 to 18 the anticyclone skirted the northern border of the United States before definitively entering the country at the western end of Lake Superior on the 19th. After moving slowly through Wisconsin for four days the anticyclone moved rapidly southeastward through Indiana and Ohio and entered West Virginia on the 25th. Here a most remarkable stagnation occurred. For nine consecutive days, from August 25 to September 2, the High center remained in the West Virginia area. During this period the anticyclonic circulation extended to higher and higher elevations until it finally affected the entire troposphere.

This development can be visualized by comparing the series of 5-day mean sea level maps reproduced in figure 3 with the corresponding maps at 700 mb. (fig. 5) and 200 mb. (fig. 6). The mean High at sea level in Wisconsin from August 15 to 19 had straight flow over it at 700 mb. and cyclonically curved flow at the 200-mb. level. A week later the mean sea level High in West Virginia was almost directly underneath a High center at 700 mb., but at 200 mb. the flow remained sharply cyclonic. During the third week, however, the Highs at sea level and 700 mb. were completely superimposed while a strong anticyclonic center appeared at 200 mb. only 400 miles to the west. This transformation from a relatively shallow cool High to a deep warm or dynamic High was not accompanied by an increase of central pressure at sea level, as is customary in dynamic anticyclogenesis. Instead the sea-level pressure at the center of the High fluctuated slightly around the 1025-mb. level between August 13 and 27. The High then progressively weakened to a 1017 center on September 2, after which its separate identity was lost as it merged with the quasi-permanent Bermuda High. On the 5-day mean sea level charts (fig. 3) the pressure at the center of the High diminished by 6 mb. from the first to the third week of

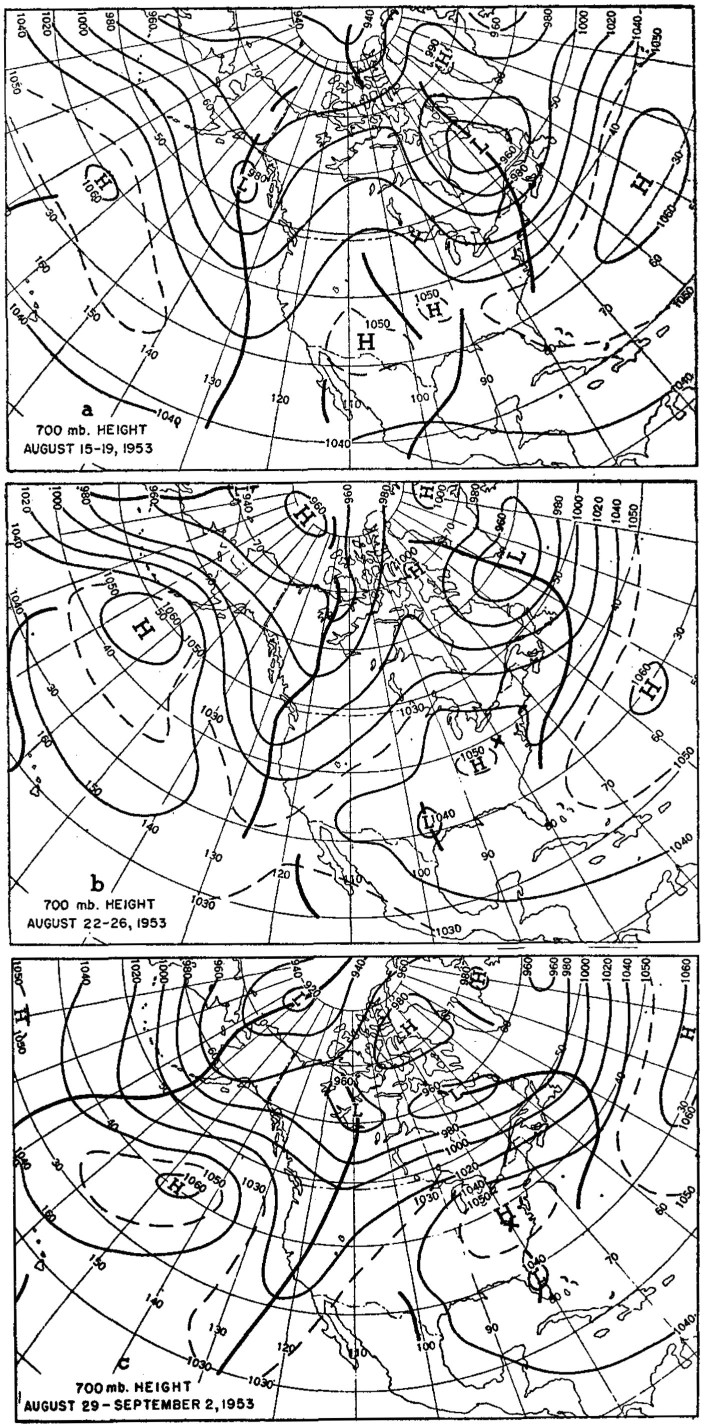

FIGURE 5.—Five-day mean charts at 700 mb. (in tens of feet) during the periods corresponding to figure 1. The center of the 5-day mean anticyclone at sea level, indicated by the crosses, gradually approached the High center at 700 mb.

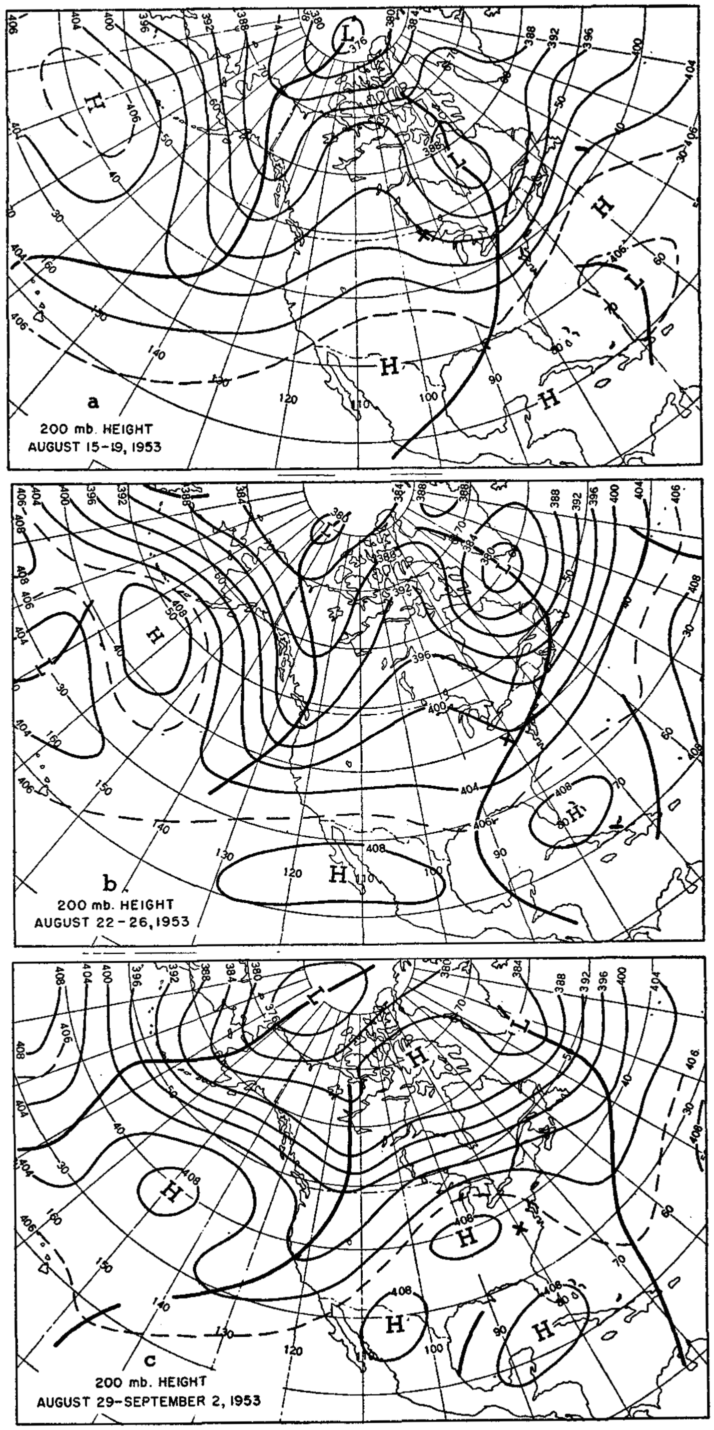

FIGURE 6.—Five-day mean charts at 200 mb. (in hundreds of feet) during the periods corresponding to figure 1. Note the development of the High center in southern Illinois, just west of the sea level anticyclone (indicated by cross) during the third week of the series.

the series. During the same period upper level heights above the center of the sea level anticyclone increased by about 180 feet at 700 mb. (fig. 5) and 1,000 feet at 200 mb. (fig. 6).

AIR MASS TRANSFORMATION

Transformation of the anticyclone is also indicated by comparing the three 5-day mean upper-air soundings at Pittsburgh, Pa., the closest RAOB station to West Virginia. Figure 7 shows that the entire troposphere up to 200 mb. underwent progressive warming from the first to the third week of the series, with the greatest change in the second half of the period. The largest heating (about 10° C.) occurred in the lower levels and also around 400 mb., with lesser warming elsewhere. In the stratosphere, on the other hand, progressive cooling

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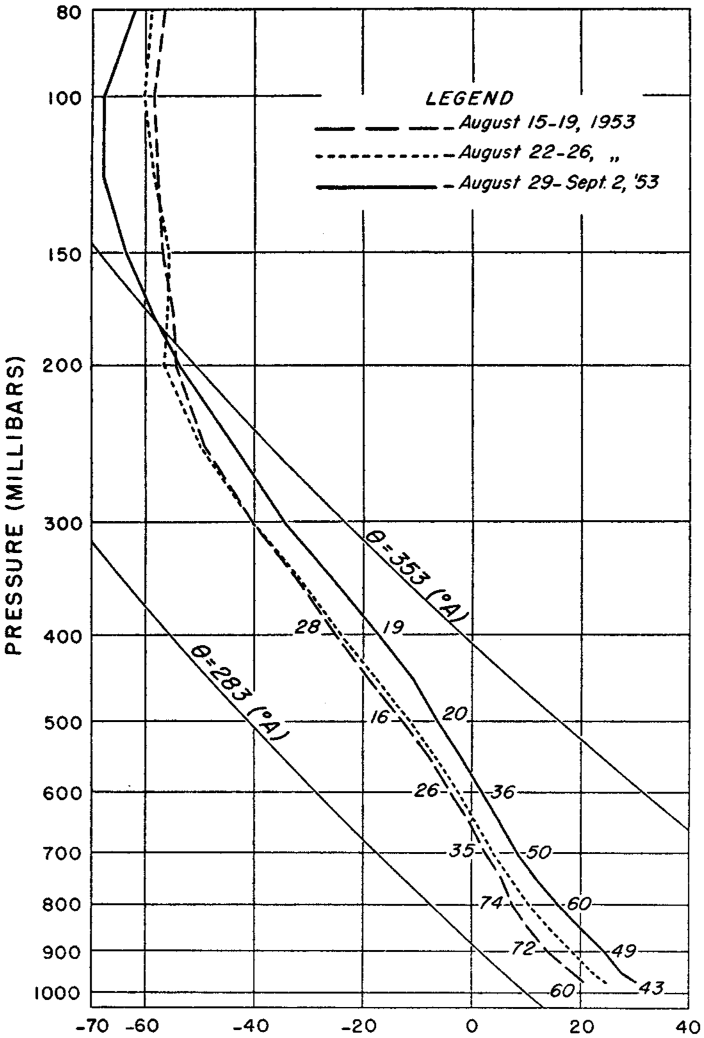

FIGURE 7.—Five-day mean soundings at 1500 GMT for Pittsburgh, Pa., during the periods corresponding to figure 1. The relative humidity, at 100-mb. intervals, is plotted beside the first and third soundings of the series. Two dry adiabats are included for comparison.

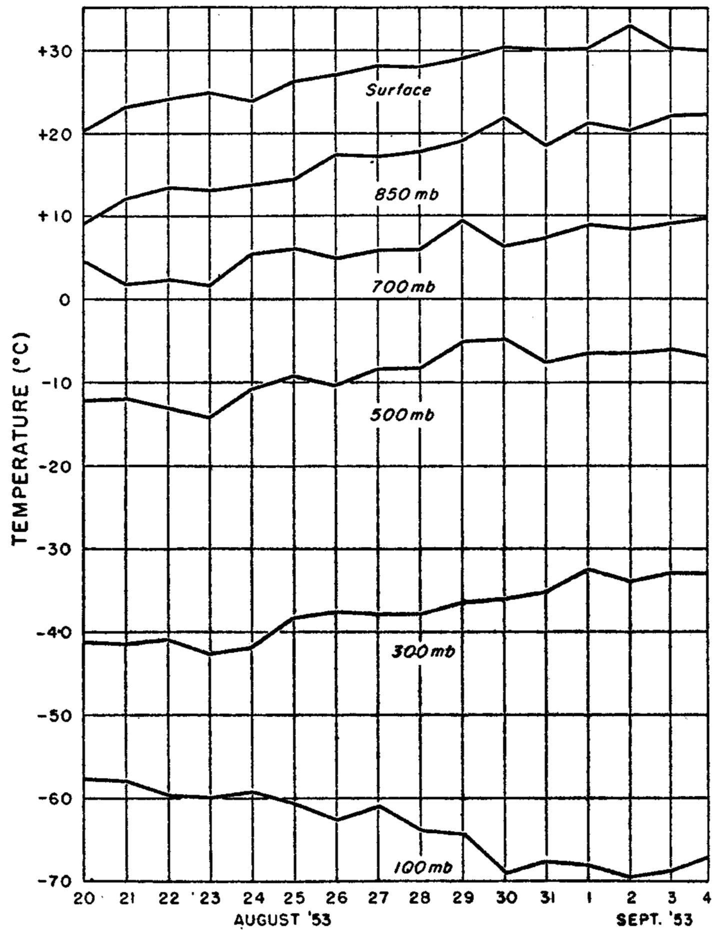

FIGURE 8.—Daily values of 1500 GMT temperature at Pittsburgh, Pa., from August 20 to September 4, 1953, for 6 levels of the atmosphere. Note irregular long-period rise of temperature at all levels of troposphere but fall in stratosphere (100-mb. level).

occurred. This cooling amounted to almost 10° C. at the 100-mb. level and was accompanied by an increase in elevation of the tropopause, a process typical of dynamic anticyclogenesis [*1*]. These temperature changes are also typical of anticyclones with decreasing central pressure at sea level, which, according to Vederman [*2*], are characterized by rising heights above the 850-mb. level, rising temperatures from 1000 to 250 mb., falling temperatures above the 250-mb. level, and a southward component of motion. The behavior of the anticyclone from August 19 to September 2, 1953 conformed quite closely to each of the four criteria listed above.

The exact mechanism responsible for the pressure and temperature changes observed in the anticyclone is difficult to determine. The complexity of the problem is indicated by the apparently irregular day-to-day fluctuations of temperature which occurred, as illustrated by the thermograms of figure 8 for six different levels of the atmosphere at Pittsburgh. The long-period trend, from August 20 to September 4, is quite clearly indicated in the figure, despite the minor oscillations superimposed upon it. The chief factors responsible for this trend were probably vertical motion and radiation. Advection of tropical air apparently played only a minor role in this case since gradients of both temperature and pressure were very weak during most of the period as a single homogeneous air mass stagnated.

It is postulated that large-scale horizontal convergence occurred in the upper troposphere above the High center while divergence went on below, particularly in the layer of frictional outflow. This would produce upward motion, cooling, and ascent of the tropopause above the 200-mb. level. Below this level downward motion or subsidence would result in increasing temperatures since the lapse rate was initially stable. The most striking daily sounding illustrating this process is shown in figure 9, where a sharp decrease in dew point at the subsidence inversion is clearly indicated. On the other hand, many daily soundings made during this period contain little if any evidence of subsidence, nor is subsidence clearly indicated in figure 7. Instead the daily soundings suggest that complicated mixing and convergence processes were responsible for irregular temperature fluctuations of the

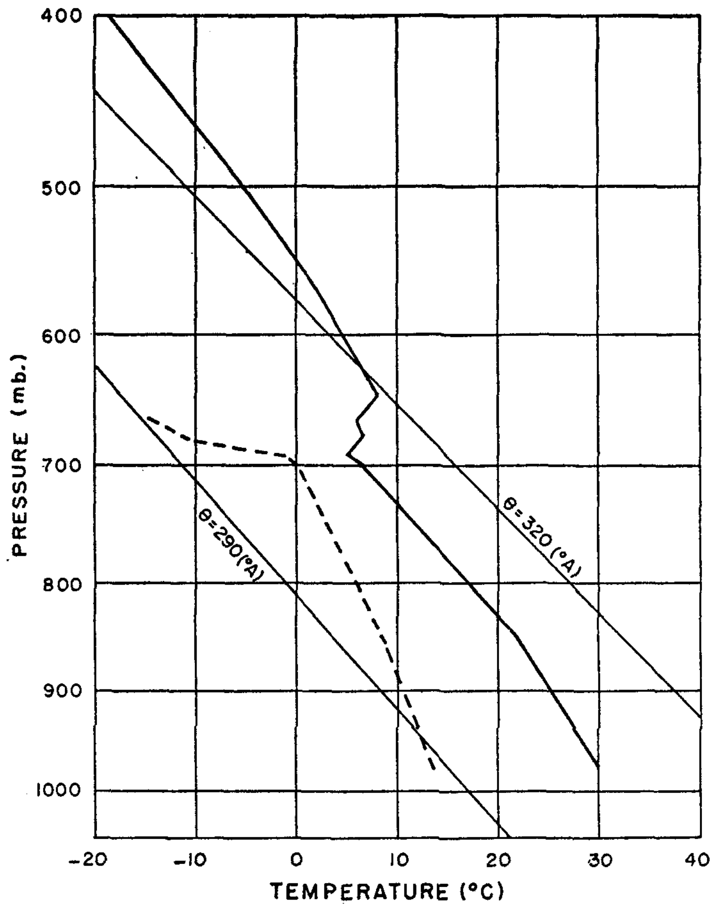

FIGURE 9.—Upper air sounding over Pittsburgh, Pa., at 1500 GMT, August 30, 1953. Note sharp decrease in dew point (dashed curve) and temperature inversion just above 700 mb.

type shown in figure 8. It thus appears that subsidence by itself was neither a continuous process nor a sufficient condition to account for all of the observed temperature change.

However, the indirect effect of subsidence, in conjunction with direct solar heating, was probably of major significance. It is well known that subsidence, by stabilizing the lapse rate and lowering the humidity, inhibits the development of clouds [3]. For this reason, and also because the air mass was initially very dry, clear skies prevailed for practically three weeks. This enabled the sun to heat the ground to an unusual extent. Large quantities of this incoming heat were transported upward through turbulent mixing. The mean soundings (fig. 7) indicate that this process was particularly important in heating the atmosphere below the 700-mb. level. In these layers the lapse rate was practically dry adiabatic, and the net temperature change was almost twice as great as it was in mid-troposphere. It is also probable that excessive surface heating was instrumental in weakening the sea level anticyclone by increasing divergent outflow above the heated layer, in accordance with the mechanism proposed by Priestley [4]. As the temperature of the air column rose the amount of heat lost by long-wave radiation increased rapidly and eventually balanced the incoming short-wave radiation. As a result maximum temperatures became stabilized around the 100° F. mark for several days at the end of the period throughout the Northeast.

STAGNATION IN RELATION TO THE BROAD-SCALE CIRCULATION

The discussion thus far has attempted to show how stagnation of the anticyclone led to prolonged drought and record heat. It remains to examine the more fundamental question of why the anticyclone stagnated in the first place. Although no complete answer can be given, some pertinent associations can be indicated. For this purpose it is helpful to again consider the 5-day mean 700-mb. charts of figure 5 since, as Wexler [1] has stated: "In any discussion of anticyclonic origin, development, movement, dissipation, etc., it is necessary to depart from the narrow confines of the area usually covered by an anticyclone and obtain a broader view of the behavior of the westerlies and their influence on anticyclones both of the polar and warm type."

The first map of the series (fig. 5a) contains a well-marked wave train of large amplitude in North America and the Pacific. The center of the anticyclone on the 5-day mean sea level map during this period was located on the southern edge of the westerlies in a region of weak 700-mb. flow. The daily anticyclone therefore moved rather slowly. Note, however, that the trajectory of the migratory High from August 14 to the end of the month (fig. 4) paralleled the 10,400-ft. contour of figure 5a extremely closely. As the surface High moved southeastward from Wisconsin it passed out of the main belt of westerlies and approached the 700-mb. High which was simultaneously moving east-northeastward from Oklahoma. When both centers subsequently stagnated in West Virginia there was virtually no steering current above the sea level anticyclone to cause it to move. This development can be seen by noting the progressively weaker 700-mb. circulation above the centers of the 5-day mean anticyclone at sea level, located by crosses in figures 5a, b, and c.

During the second week of the period (fig. 5b) the principal features of the long wave pattern shown in figure 5a advanced eastward. This eastward motion was much greater at middle and high latitudes than at low latitudes. As a result the horizontal tilt of the troughs and ridges started to change from north-south or northwest-southeast to northeast-southwest. The latter orientation favored the northward transfer of angular momentum [5], so that the 700-mb. westerlies over North America increased in intensity but in a position well north of the sea level anticyclone in the Ohio Valley.

Acceleration of the westerlies continued during the third week of the series, when an extremely fast zonal flow extended across southern Canada at both 700 mb. (fig. 5c) and 200 mb. (fig. 6c). This westerly jet stream was concentrated in a narrow belt between the warm anticyclone over West Virginia and a blocking High over

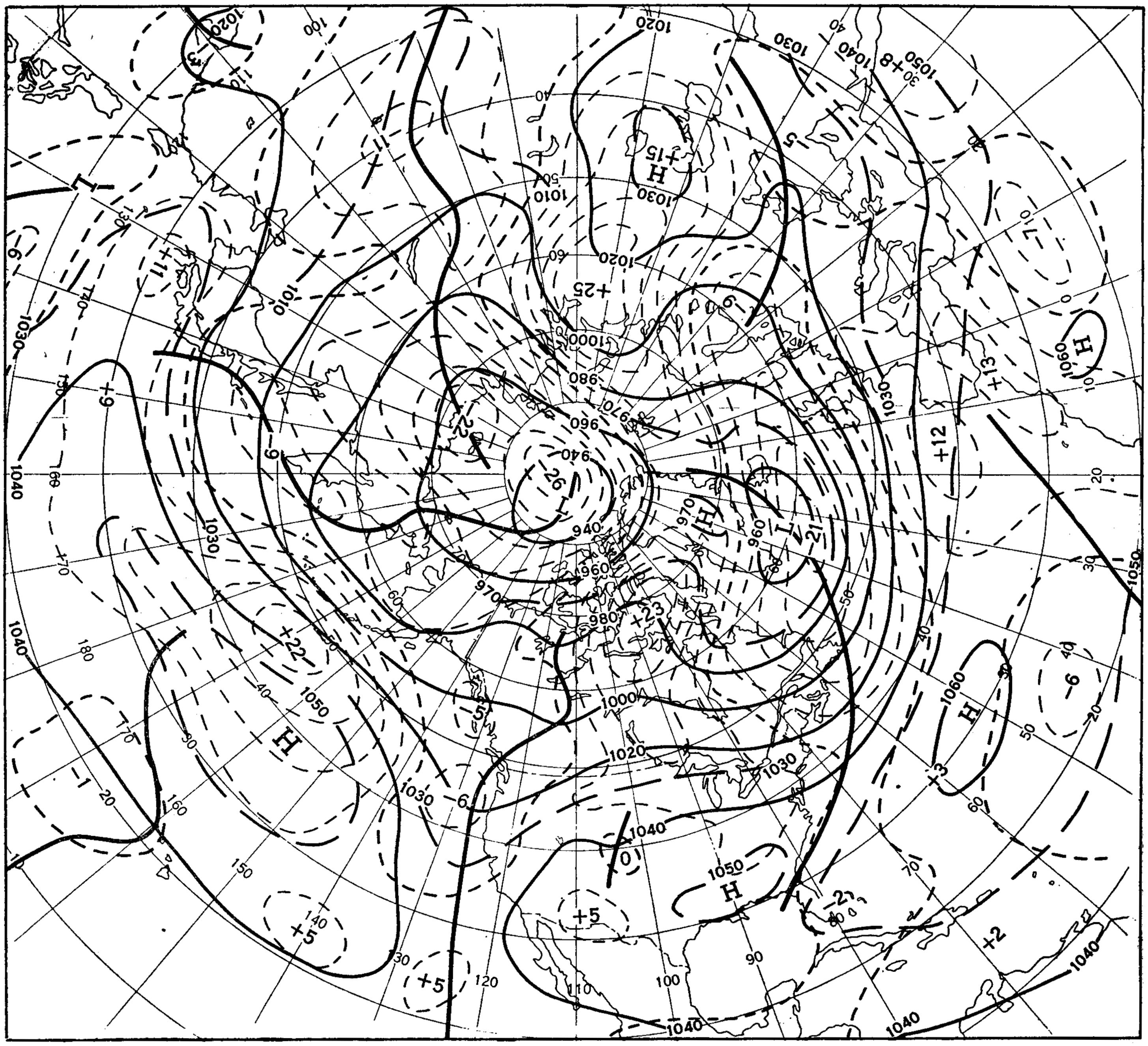

Figure 10.—Mean 700-mb. height contours and departures from normal (both in tens of feet) for August 1–30, 1953. Heights were above normal in all portions of the United State except Florida and the Pacific Coast.

Baffin Bay. The latter can be traced back to a blocking surge which originated in northern Asia and crossed Greenland earlier in the period (fig. 5a and b). Banking to the right of the westerly jet probably contributed to the continued development of the stagnant High over West Virginia, by means of the process described by Rossby in 1938 [6]. The great expansion of the area covered by the 10,500-ft. contour around this High, shown by comparison of figures 5b and c, was directly related to the stagnation of the sea level anticyclone and the accompanying heat wave and drought.

Intensification of the upper level High in the eastern United States may also be attributed to barotropic energy dispersion from the Pacific. From August 15 to 19 marked deepening of a 700-mb. trough in the western Pacific took place. A few days later the ridge in the central Pacific increased greatly in amplitude. Note the northward motion and expansion of the 10,600-ft. contour from figure 5a to figure 5b. Deepening of the west coast trough occurred next in this chain of events, as indicated by the progressive southward displacement of the 10,200-ft. contour from the first to the third 700-mb. maps of the series. Finally the ridge in the eastern United States intensified, attaining its highest heights in figure 5c. Table 1 portrays these events in a more quantitative fashion. It is based upon the series of overlapping 5-day

Table 1.—*Time, place, and intensity of maximum anomalies of 5-day mean 700-mb. height, illustrating progressive intensification downstream*

Date	Latitude	Longitude	Maximum anomaly	Distance between centers	Rate of dispersion
1953	° *N.*		*Ft.*	*Mi.*	*m. p. h.*
August 18	48	153° E.	−450		
				1660	17
August 22	50	170° W.	+720		
				2040	21
August 26	45	124° W.	−270		
				2140	22
August 30	43	80° W.	+240		
				1830	19
September 3	53	42° W.	−500		

mean charts prepared twice-weekly in the Extended Forecast Section showing the distribution of the anomaly of 5-day mean 700-mb. height. By interpolating among these charts, the time when and place where centers of maximum and minimum departure from normal attained their maximum intensity have been determined. The linear distance between these centers divided by the number of days between their occurrence gives a rough idea of the rate of energy dispersion or group velocity. It averaged about 20 m. p. h., only about half as much as the value previously obtained by Carlin [7] in a winter case. Smaller values would be expected since group velocity depends directly on zonal wind speed [8], and the zonal index averaged from 35° to 55° N. and 0° to 180° W. was only about 18 m. p. h. in this case compared to 26 m. p. h. in Carlin's study.

To summarize, the stagnation of the anticyclone with accompanying drought and heat has been attributed primarily to intensification of the long-wave ridge in the eastern United States. This intensification has been ascribed to dispersion of energy from the Pacific and banking to the right of fast westerly flow in southern Canada. It is pertinent to note that the three features of the general circulation previously related to the development of warm Highs in summer in the eastern half of the United States [9, 10] were again present in this situation. These factors, strong ridge in the east-central Pacific, deep trough along the west coast, and fast flat westerlies in southern Canada south of a blocking High, are all evident in figures 5b and c.

THE MONTH AS A WHOLE

The circulation pattern for the entire month of August 1953 strongly reflected the influence of the last two to three weeks described above. Thus the monthly mean charts at sea level (Chart XI), 700 mb. (fig. 10) and 200 mb. (fig. 11) all show a deeper than normal trough off the east coast of Asia, an abnormally strong ridge in the east-central Pacific with a closed High around 40° N, 155° W., an unusually deep trough along the west coast of North America, and a stronger than normal ridge in eastern and central sections of the United States. The monthly mean High associated with the latter ridge had a large vertical tilt, since the sea level center in Ohio was displaced to Mississippi at 700 mb. and to west Texas at 200 mb. The meandering jet stream at 200 mb. is clearly delineated in figure 11 as a continuous axis stretching from Manchuria across the Pacific, United States, and Atlantic into the Mediterranean. Its maximum speed was almost one-third of the peak value observed on monthly mean 200-mb. charts during the winter of 1953.

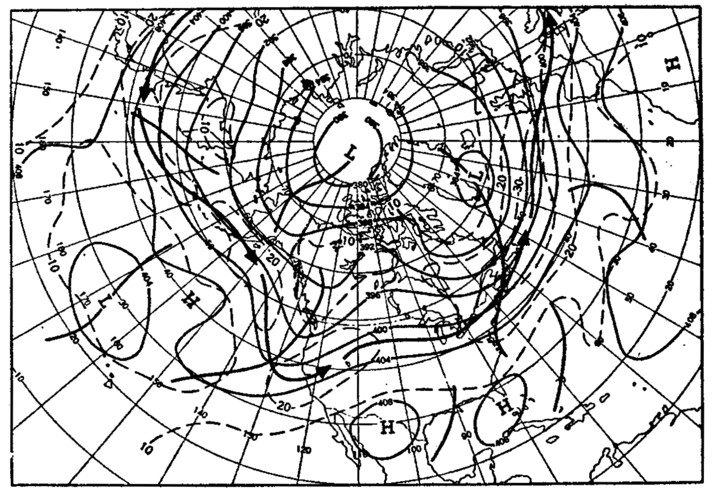

Figure 11.—Mean 200-mb. contours (in hundreds of feet) and isotachs (in meters per second) for August 1–30, 1953. Solid arrows indicate the average position of the jet stream, which was north of the normal August position in the Pacific and stronger than normal in the Atlantic.

The temperature anomalies for the month as a whole were also dominated by the weather of the last two weeks. Chart I shows that temperatures generally averaged above normal in the eastern half of the United States, the Northern Plains, and the Rocky Mountain States, all of which were regions of anticyclonic curvature and above normal heights at 700 mb. (fig. 10). Cool Pacific air flowing around the deep west coast trough produced below normal temperatures throughout the Far West, except for the northern coastal regions where the normal sea breeze was weakened by unusually cool air inland. Below normal temperature also prevailed along the Gulf and South Atlantic Coasts, where sea level and 700-mb. winds were more northeasterly than normal, and in the Southern Plains, where a weak trough in the field of 700-mb. height departure from normal was located.

Total rainfall during the month was subnormal in most of the eastern half of the United States (Chart III). As little as 10 percent of normal precipitation was recorded in southern Indiana, while less than ¼ of the normal amount fell in most of Missouri and parts of adjoining States. This deficiency was accompanied by persistent anticyclonic activity (Chart IX). A virtually complete absence of cyclones between the Appalachians and the Mississippi River is one of the most notable features of Chart X. Not only were cyclones absent but even fronts were unusually scarce. Figure 12 shows that only ⅓ of the days of the month had any surface fronts in the Ohio Valley and Great Lakes Region. The minimum number of days with fronts in this area contrasts sharply with the

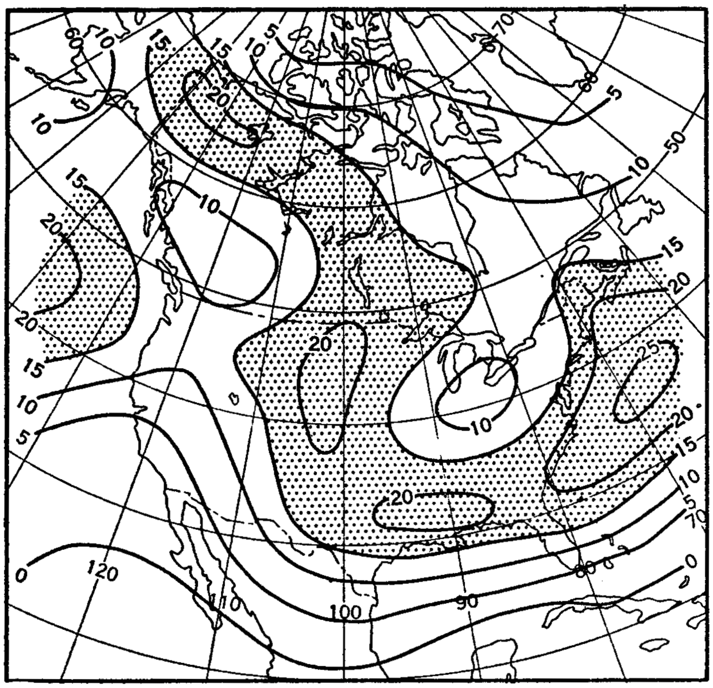

Figure 12.—Number of days with surface fronts (of any type) located within square areas with sides approximately 430 nautical miles during the month of August 1953. Frontal positions were those appearing on printed *Daily Weather Map* for 1830 GMT. Areas where fronts were present on 15 or more days are shaded. Rainfall (see Chart III) was generally above normal in shaded areas and below normal elsewhere, except in the Far West.

normal summer condition, when the axis of maximum frequency of fronts is located between the Great Lakes and the Ohio Valley [11].

On the other hand, figure 12 shows that surface fronts were present on about ⅔ of the days of the month along the Gulf and South Atlantic coasts, where fronts are normally infrequent in summer. As a result, rainfall was generally above average in this region (Chart III). This rain was particularly welcome in drought-stricken Texas, where this month's Statewide precipitation average of 159 percent of normal was the highest for any month since November 1952 and the first above normal average since May 1953. Rainfall in southern Texas was 4 to 6 times the monthly average and greater than the combined totals for all previous months since the beginning of the year. Sinton, just northwest of Corpus Christi, reported 8.33 inches in a 24-hour period during the last week of the month. During this period strong southeasterly flow around the stagnant High in West Virginia transported large quantities of moisture from the Gulf of Mexico (figs. 3c and 5c).

This month's precipitation was also unusually heavy in all of the Pacific Coast States (except extreme southern California), an area which normally experiences very little rain during summer. The 0.76 inch of rainfall at the Sacramento Weather Bureau City Office was the greatest for August in 105 years of record and almost four times as great as the previous record set in 1896. Statewide precipitation in Oregon averaged 361 percent of normal. Most of the moisture for this rainfall was of Pacific origin and was carried by stronger than normal southwesterly flow at all levels of the troposphere. Note the southwesterly jet stream crossing the San Francisco Bay area in figure 11. Release of this moisture through upward vertical motion was effected by an unusual concentration of cyclones (Chart X) and fronts (fig. 12) along the west coast, a region where cyclones and fronts are normally rare in summer. Also indicative of large-scale convergence in this area was the presence of a deep mean trough at 200 mb. (fig. 11) and a trough with below normal heights at 700 mb. (fig. 10). Excessive cloudiness (Charts VI and VII) accompanying the rains contributed to abnormally cool weather in this area (Chart I).

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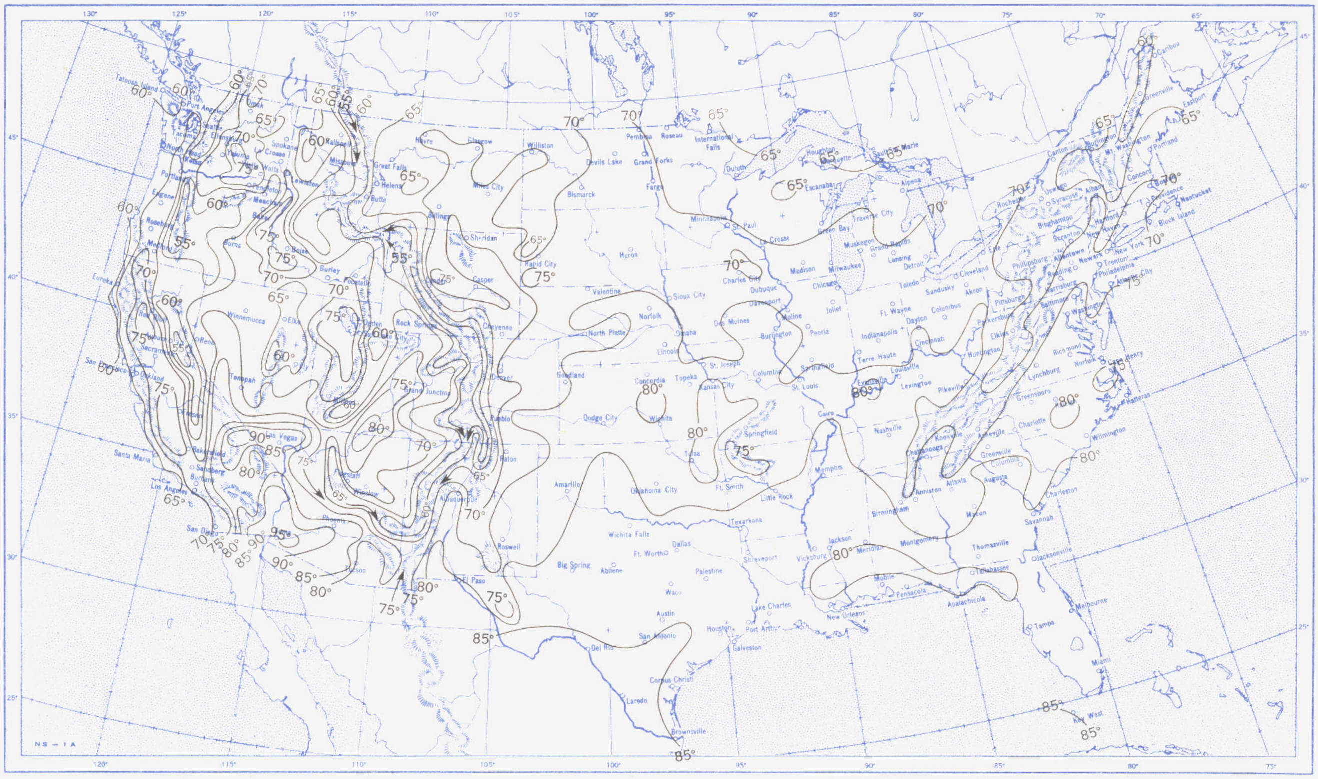
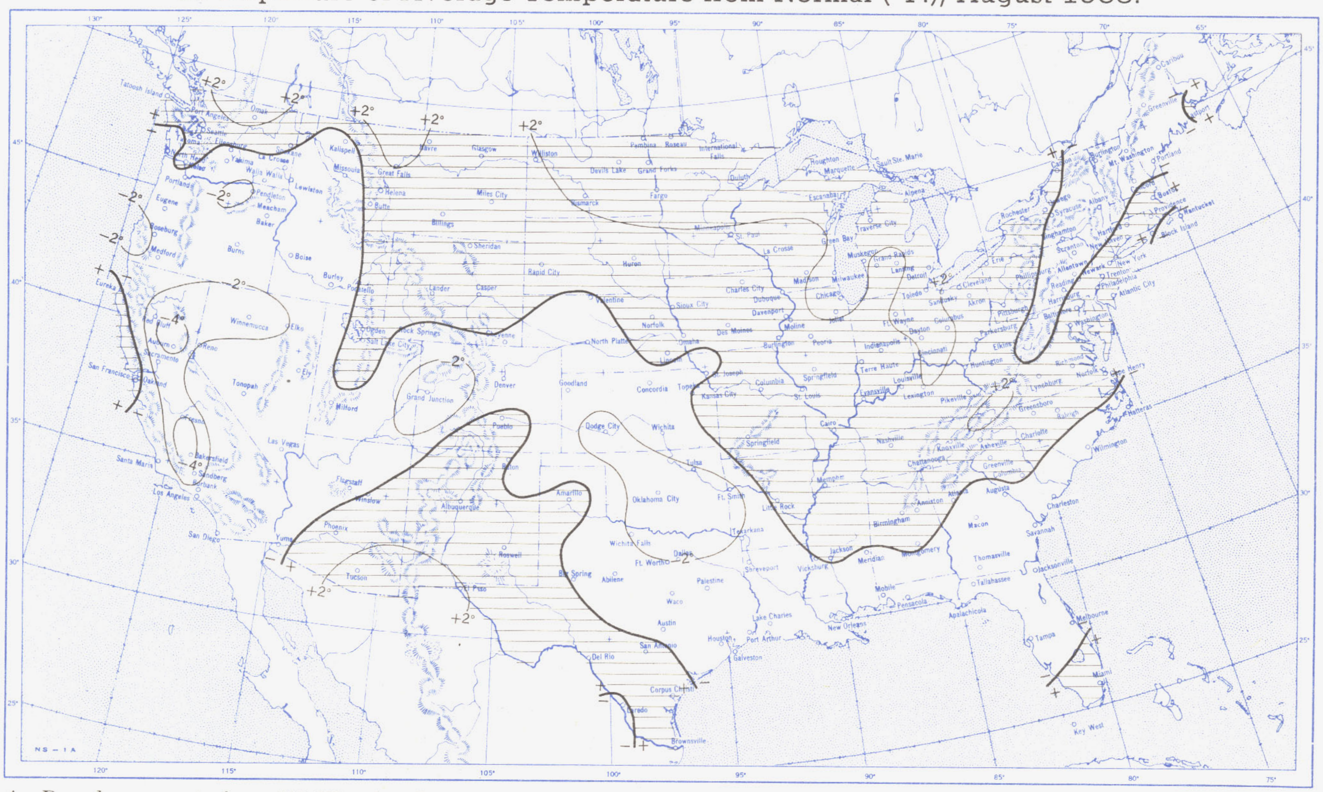
Chart I. A. Average Temperature (°F.) at Surface, August 1953.

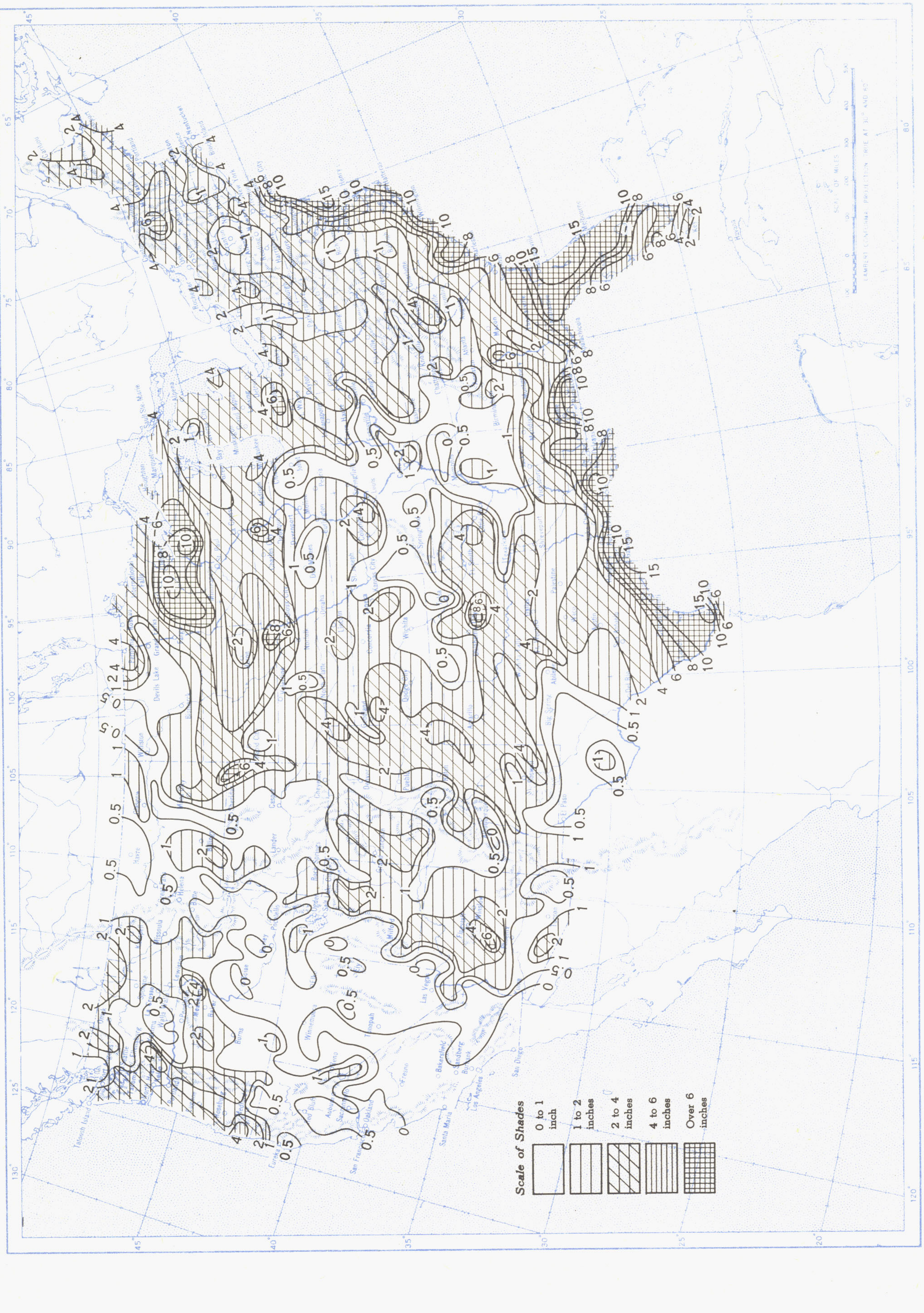


B. Departure of Average Temperature from Normal (°F.), August 1953.



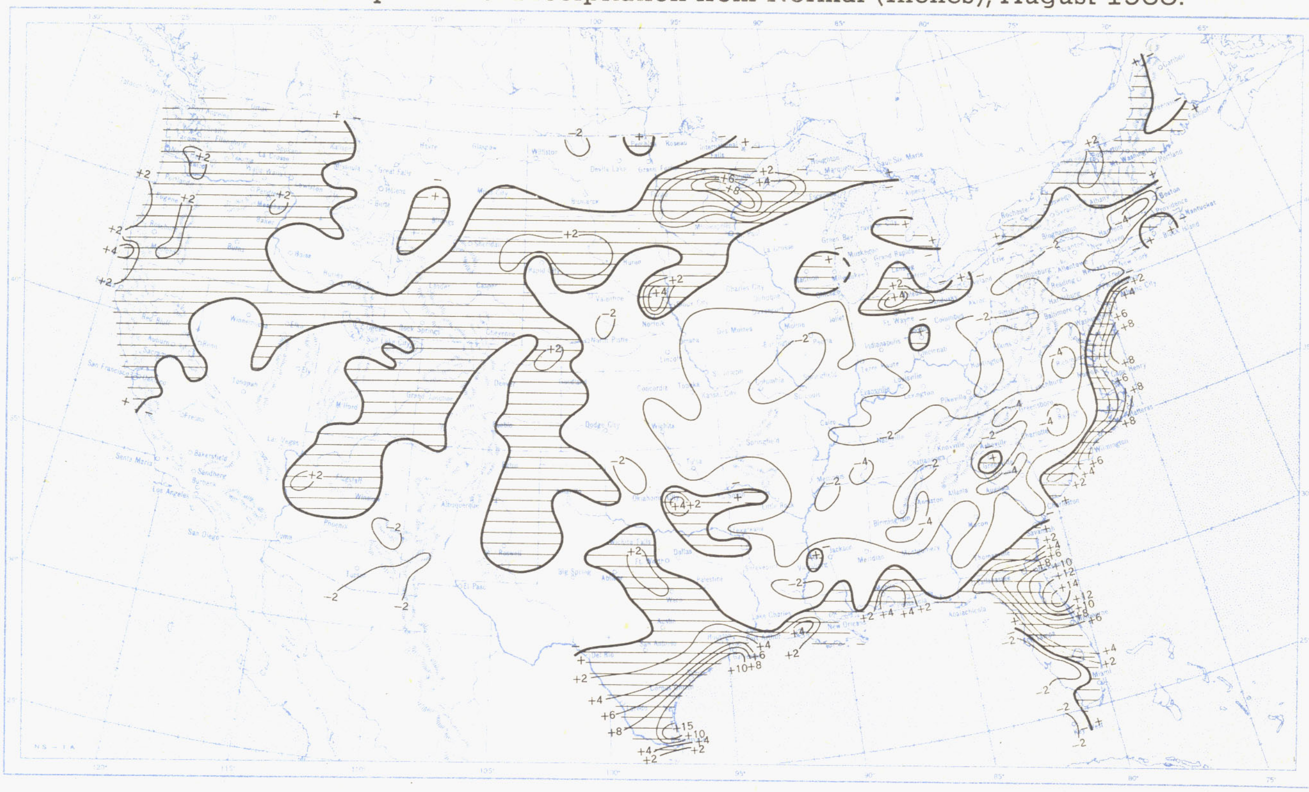
A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.
B. Normal average monthly temperatures are computed for Weather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

Chart II. Total Precipitation (Inches), August 1953.

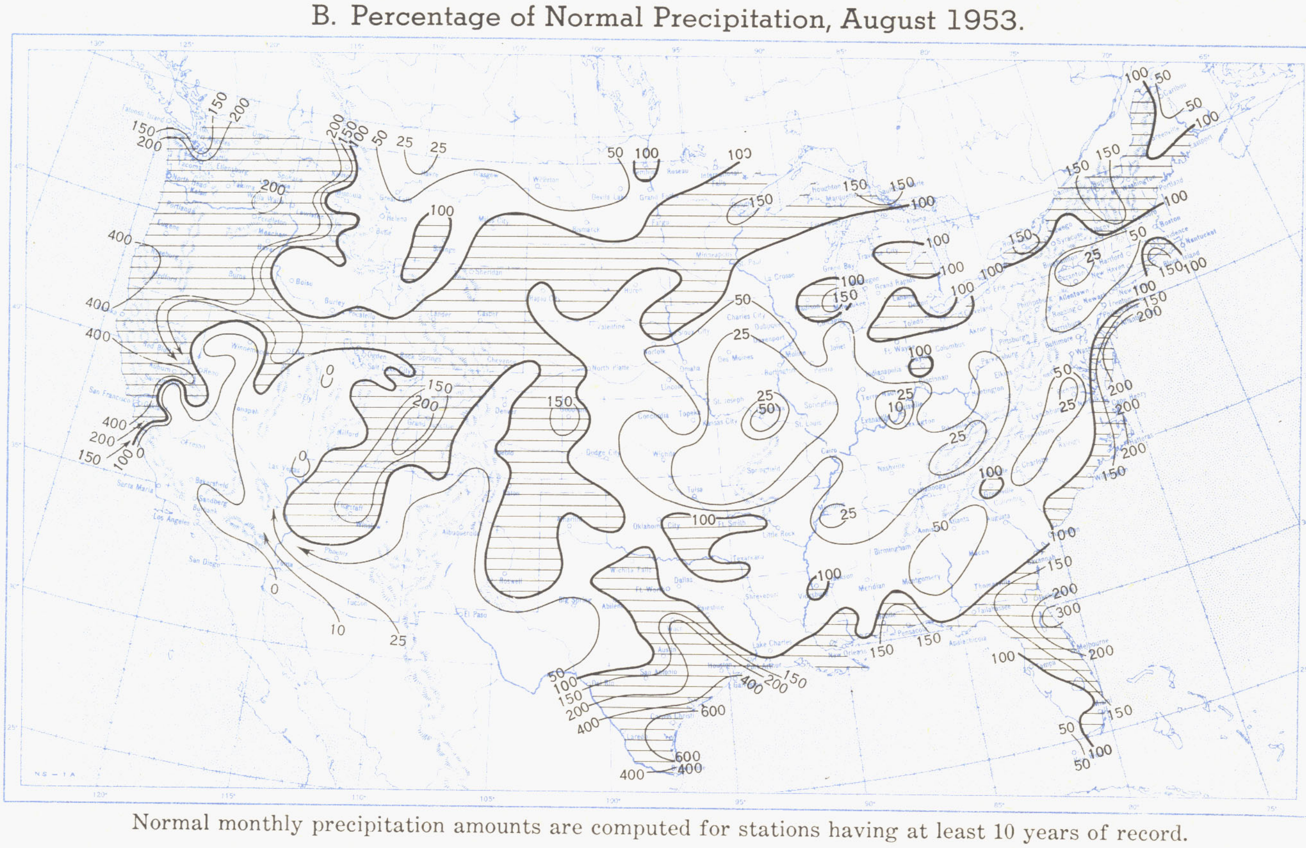


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), August 1953.

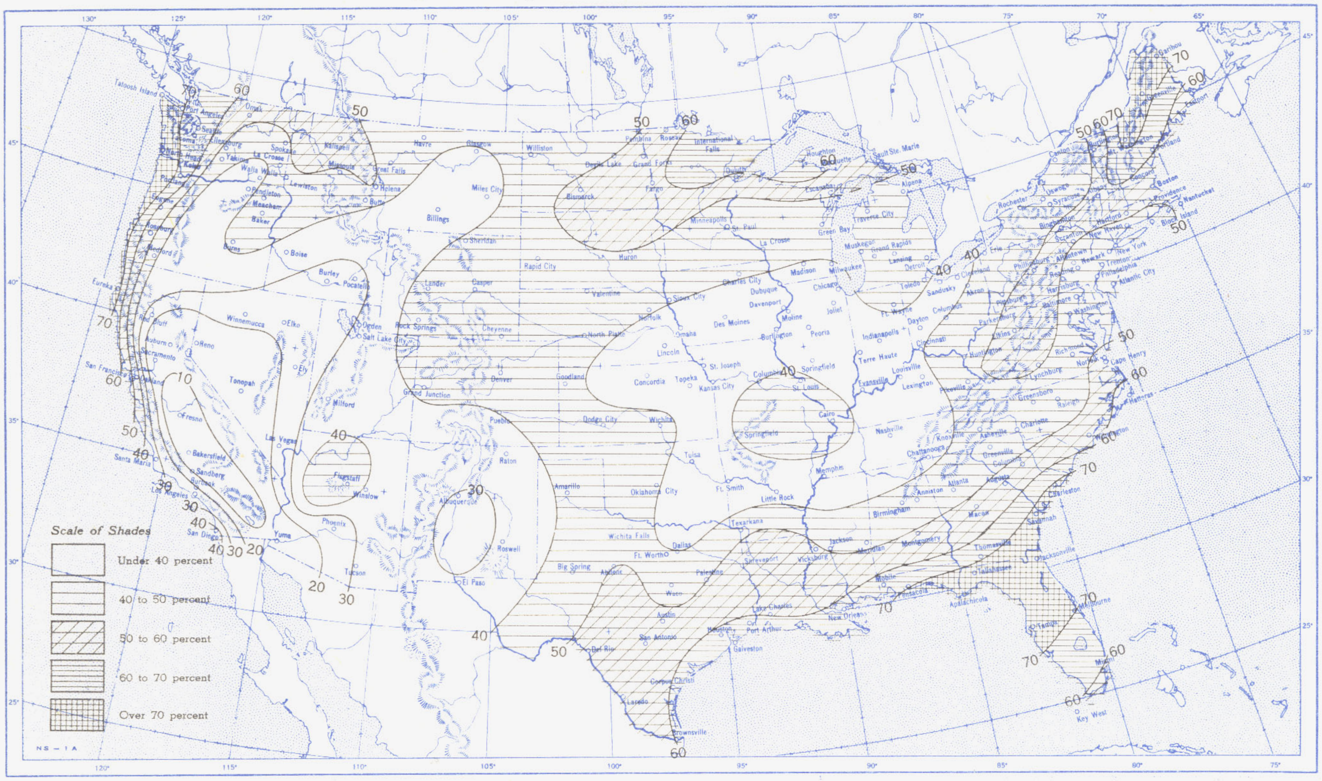


B. Percentage of Normal Precipitation, August 1953.

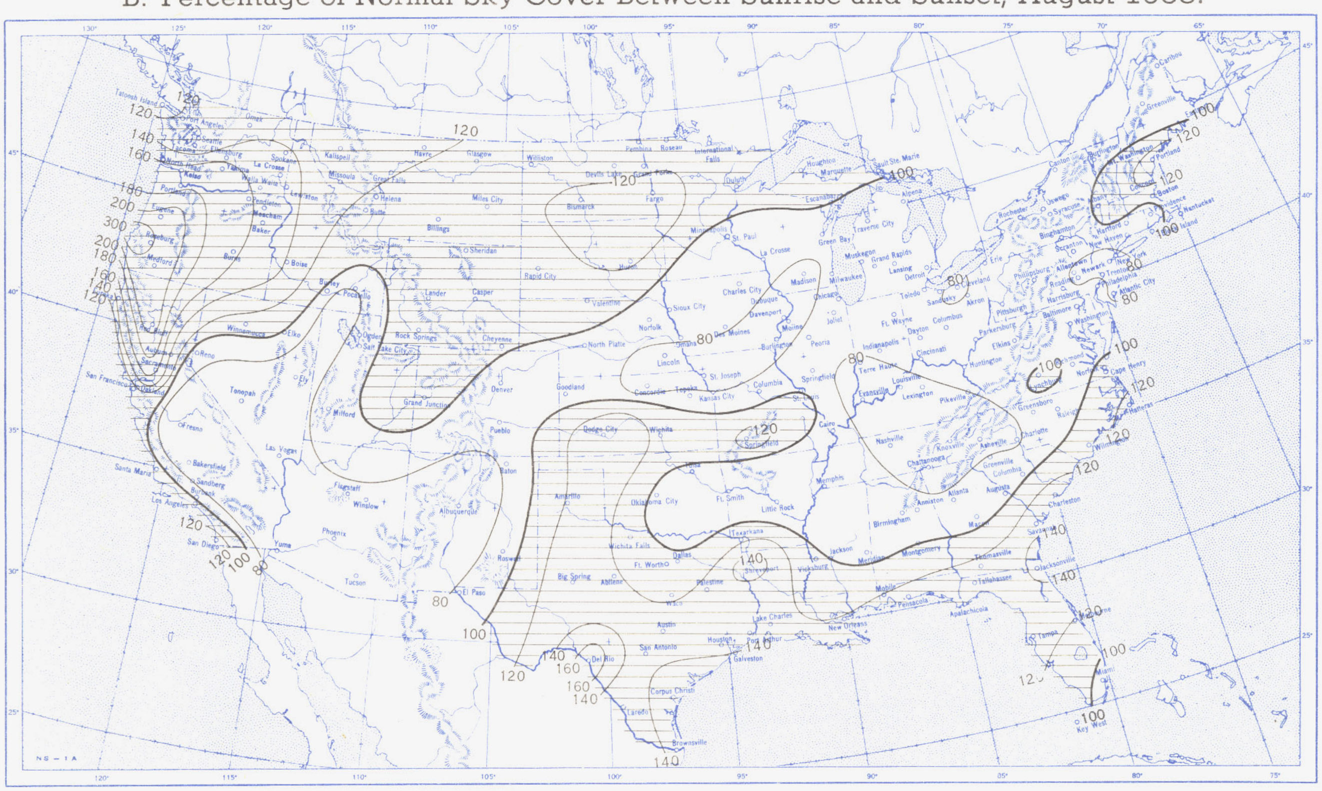


Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, August 1953.



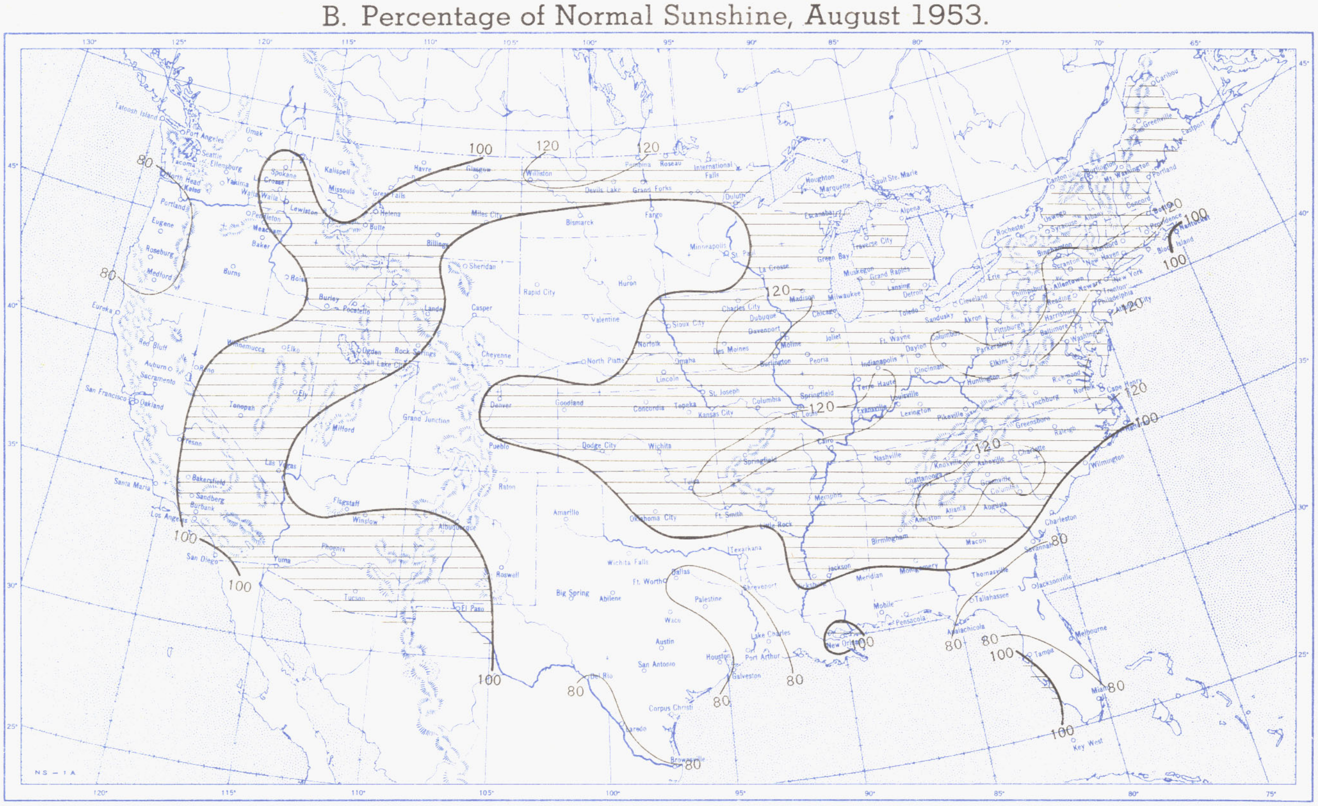
B. Percentage of Normal Sky Cover Between Sunrise and Sunset, August 1953.



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, August 1953.

B. Percentage of Normal Sunshine, August 1953.



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, August 1953. Inset: Percentage of Normal Average Daily Solar Radiation, August 1953.

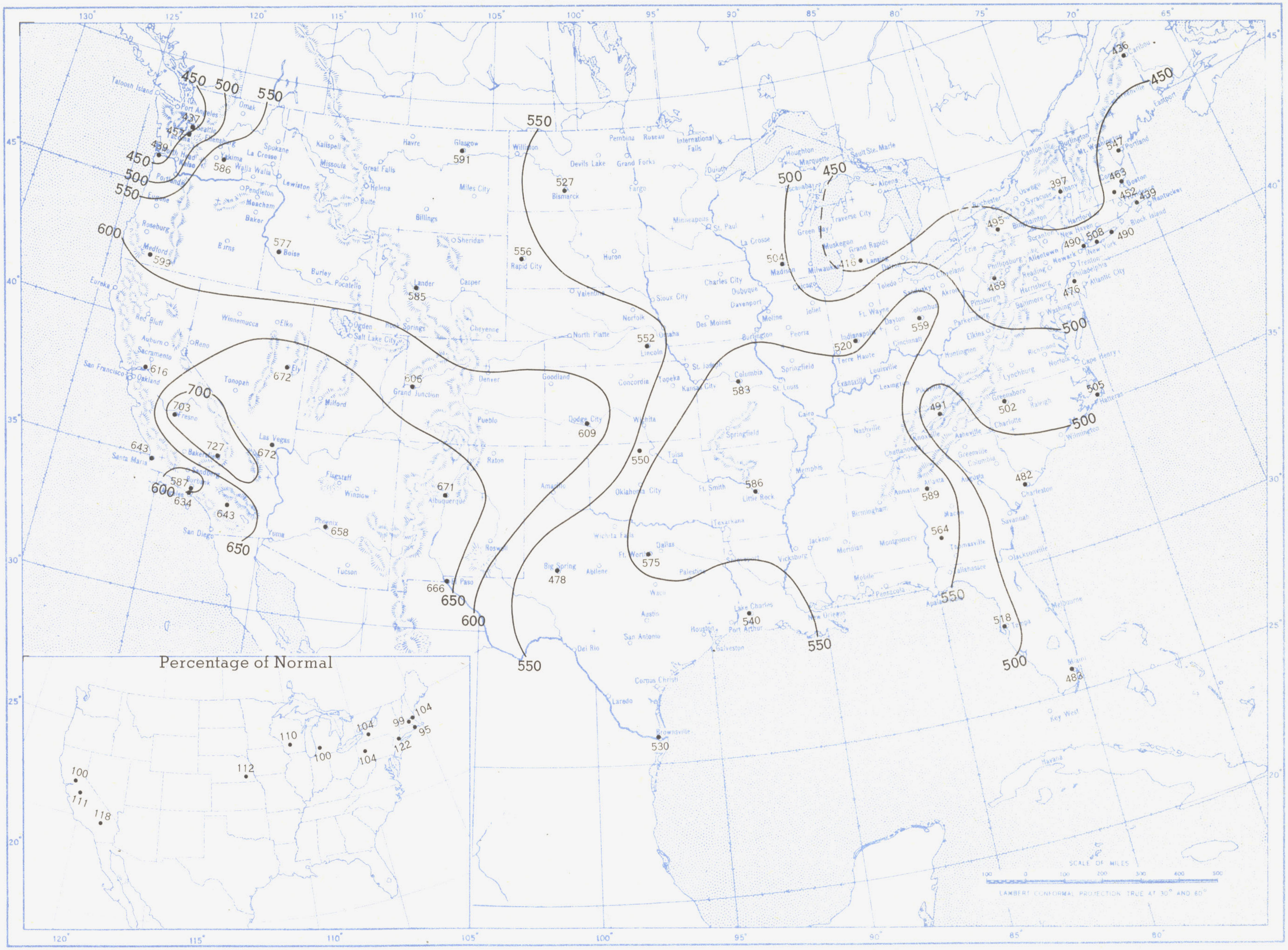
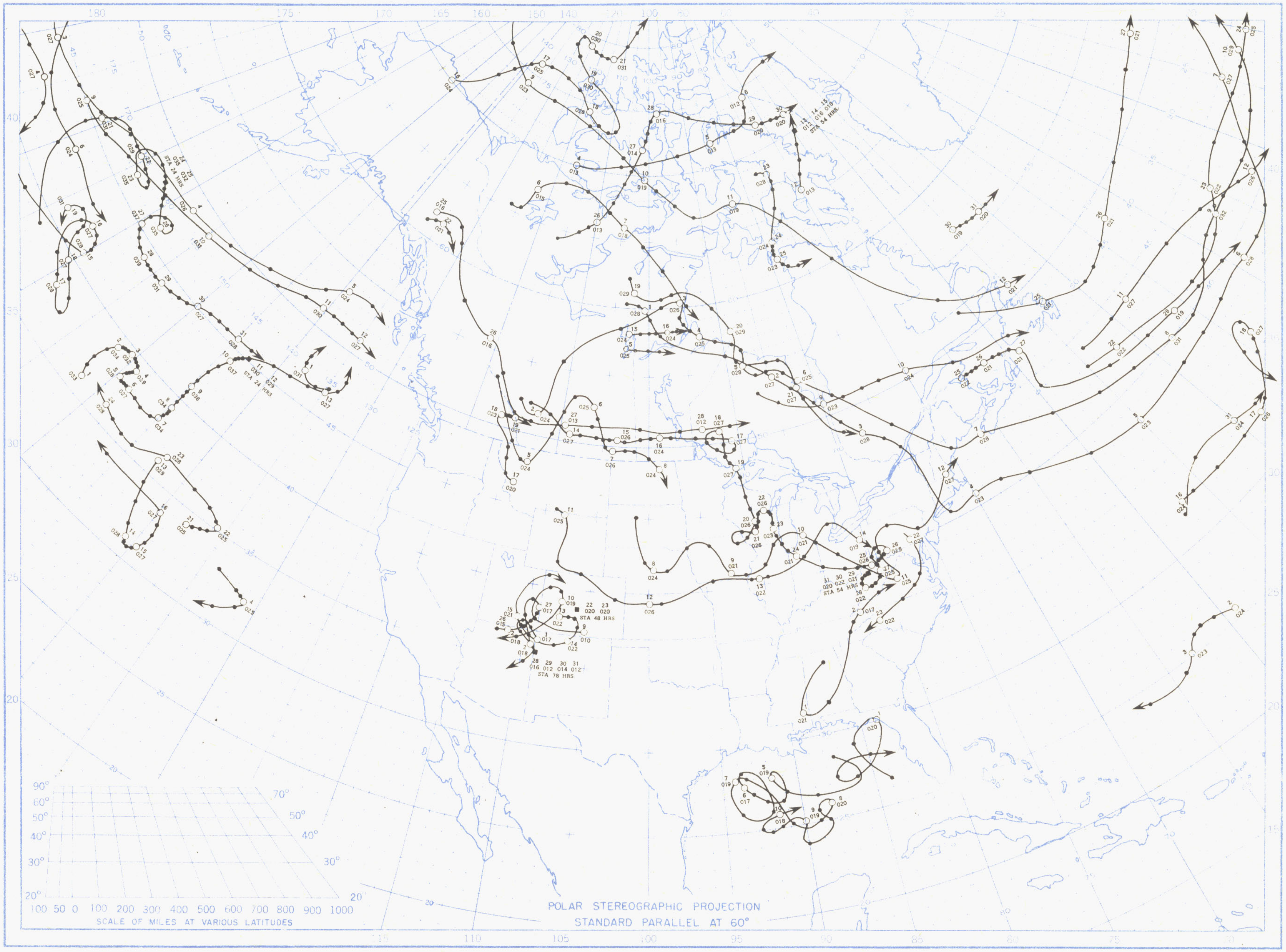


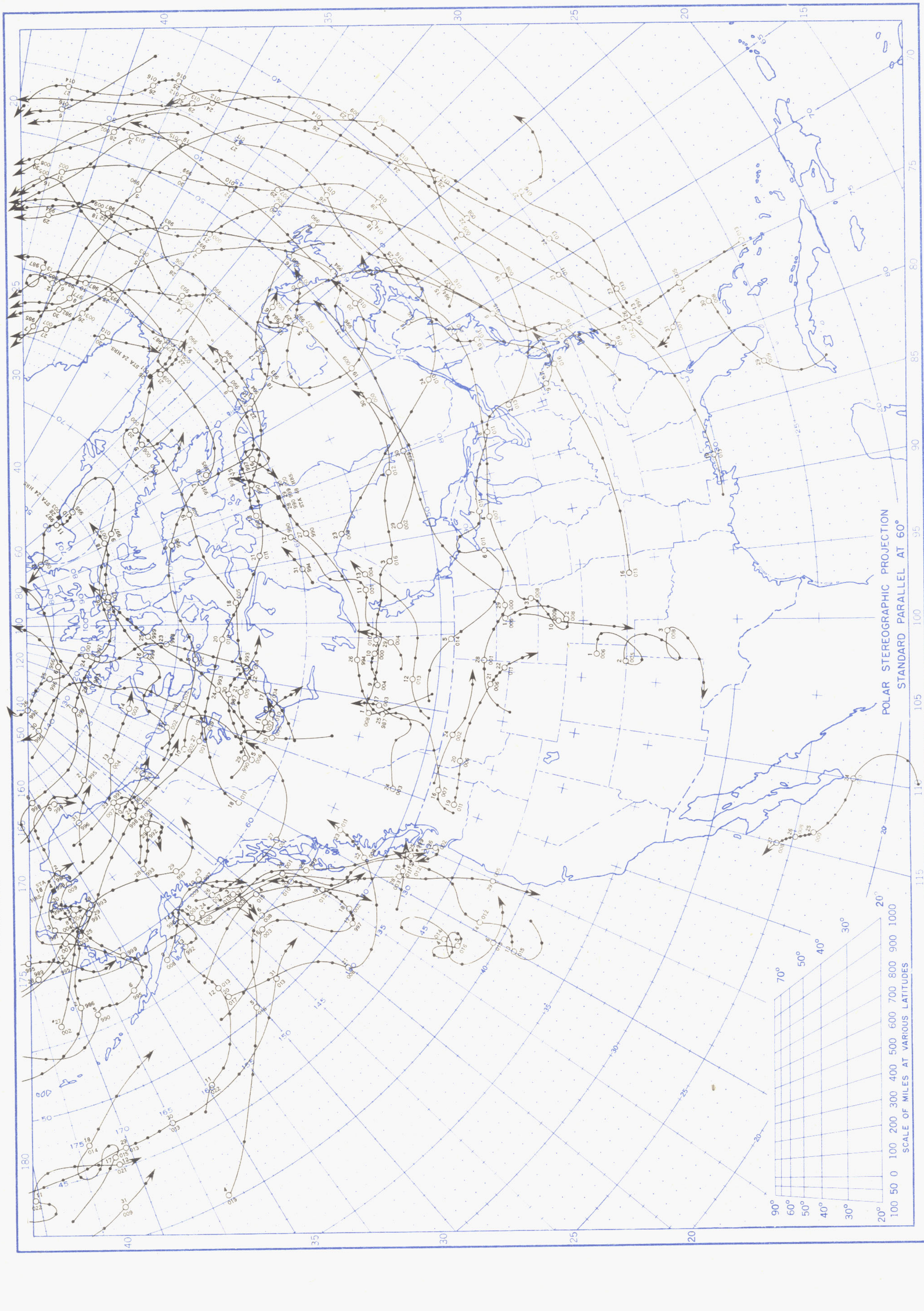
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm.$^{-2}$). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown.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

Chart IX. Tracks of Centers of Anticyclones at Sea Level, August 1953.



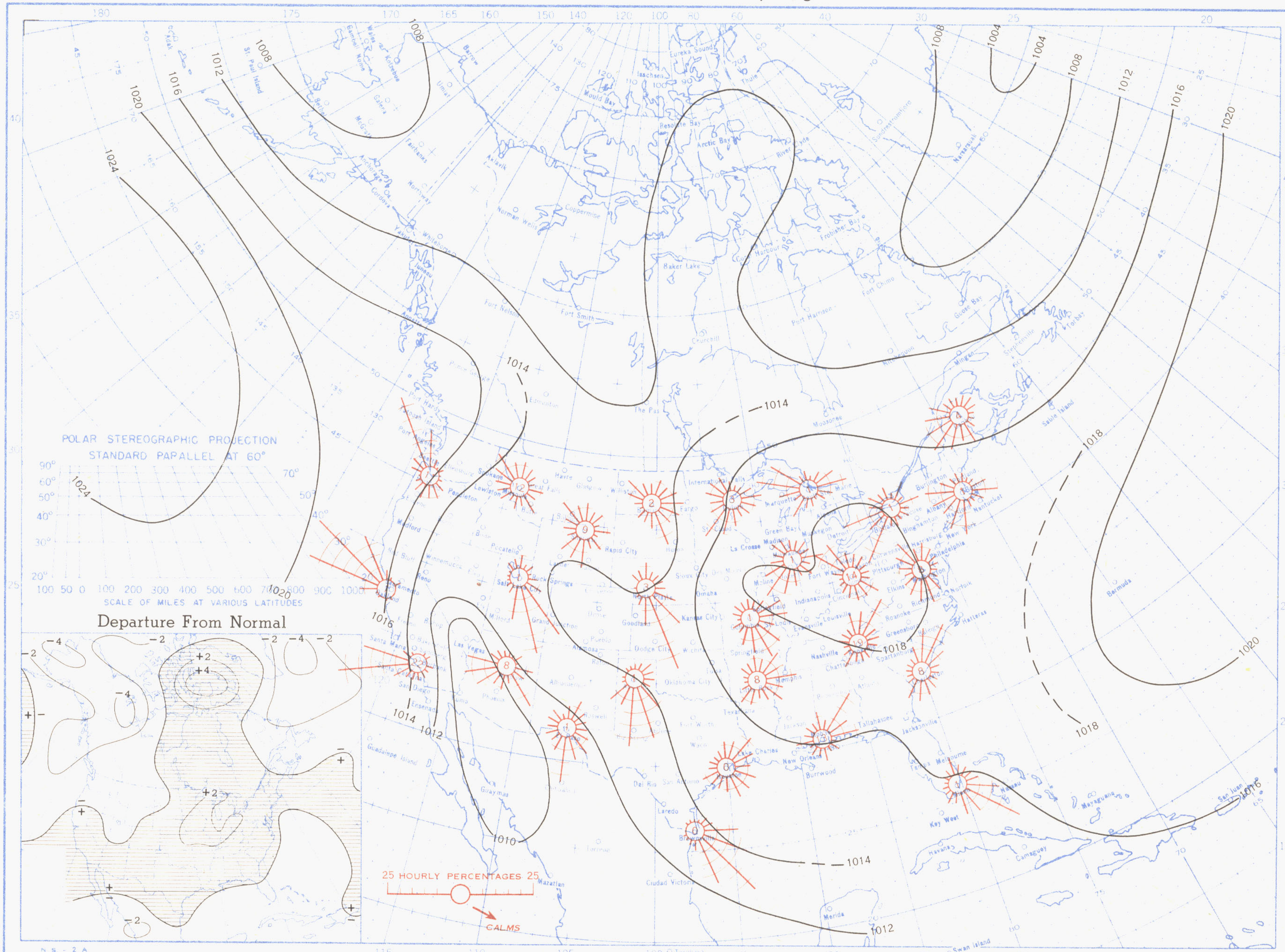
Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position.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

Chart X. Tracks of Centers of Cyclones at Sea Level, August 1953.



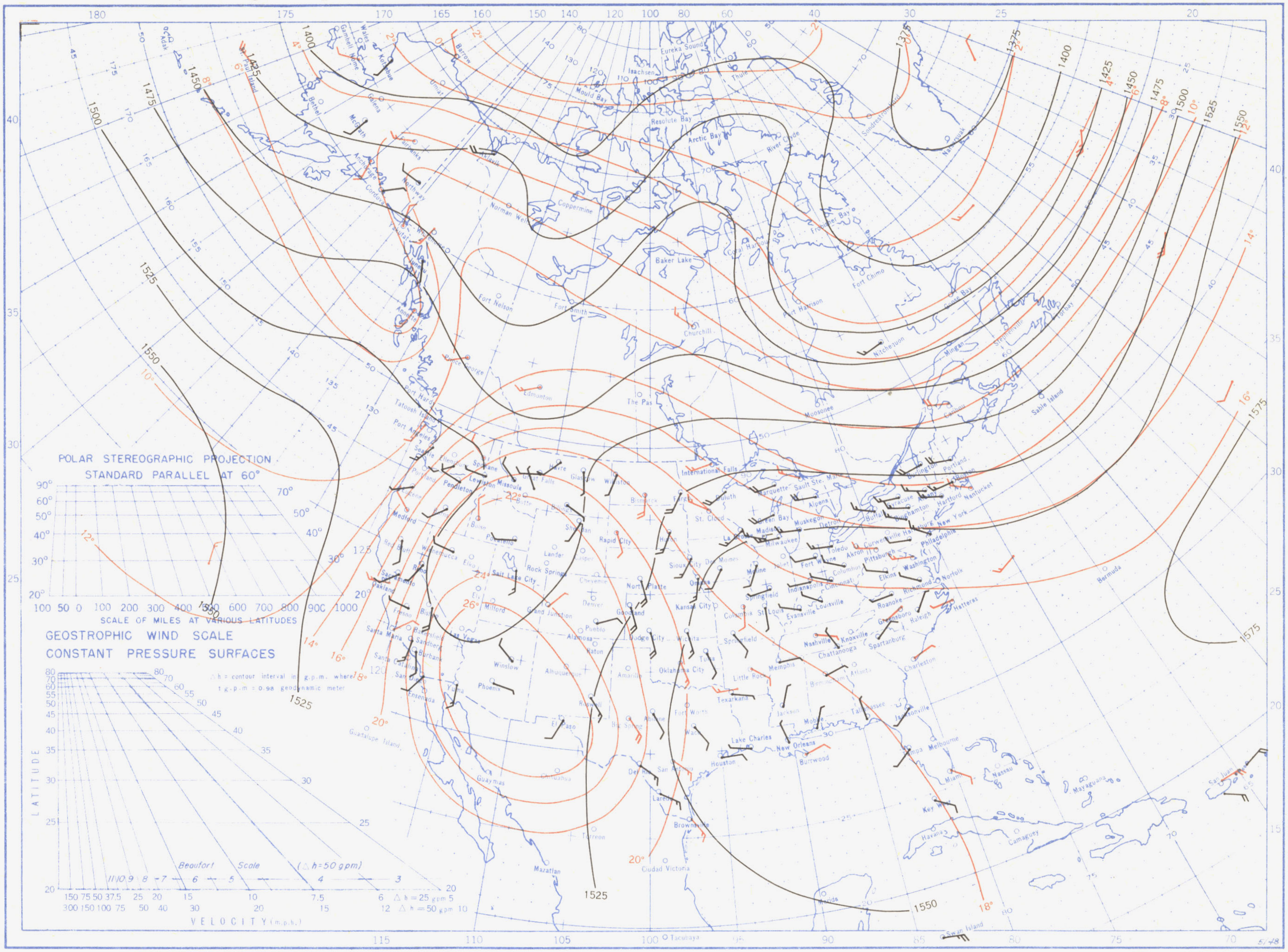
Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, August 1953. Inset: Departure of Average Pressure (mb.) from Normal, August 1953.



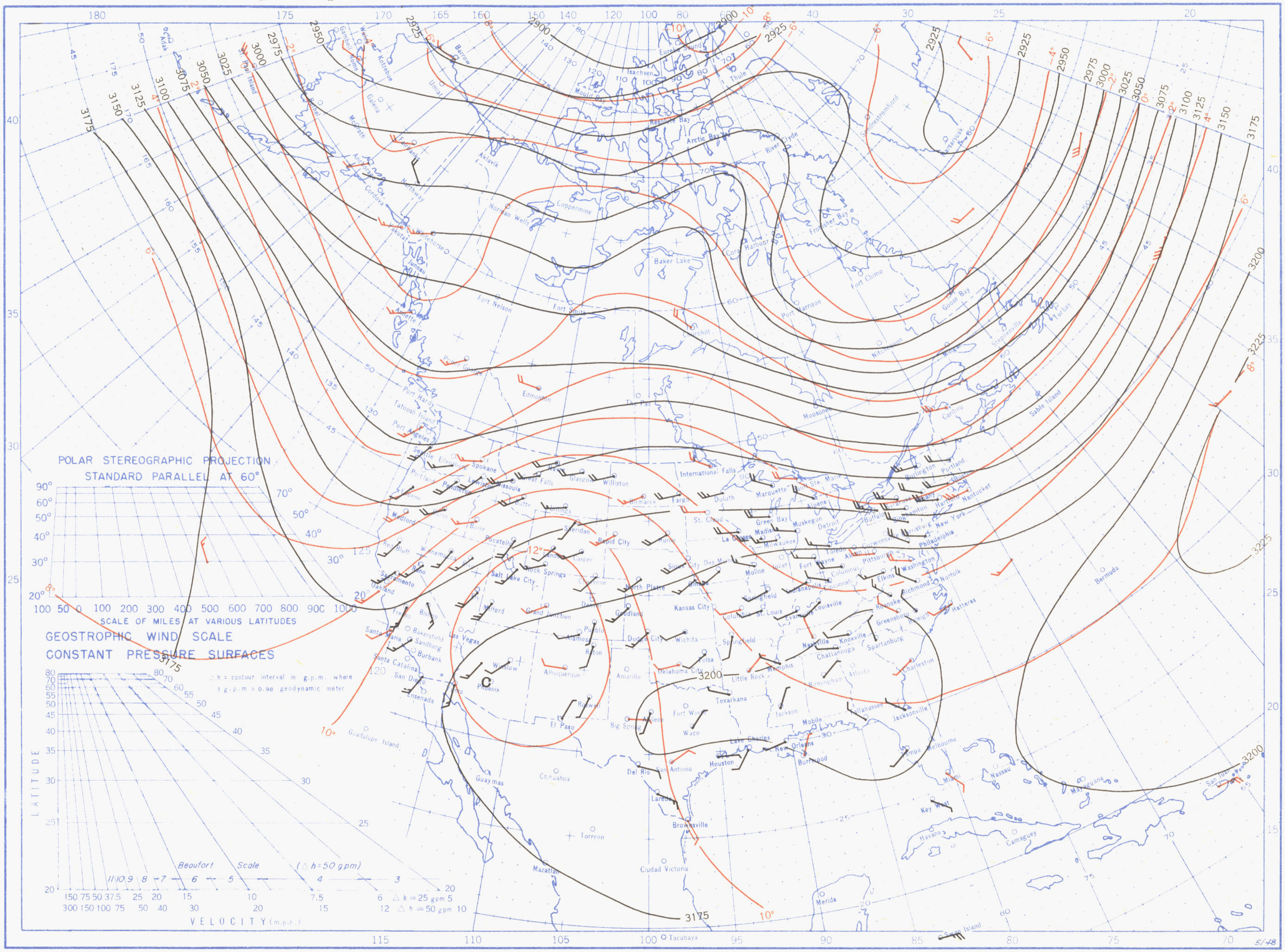
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections 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.), August 1953.



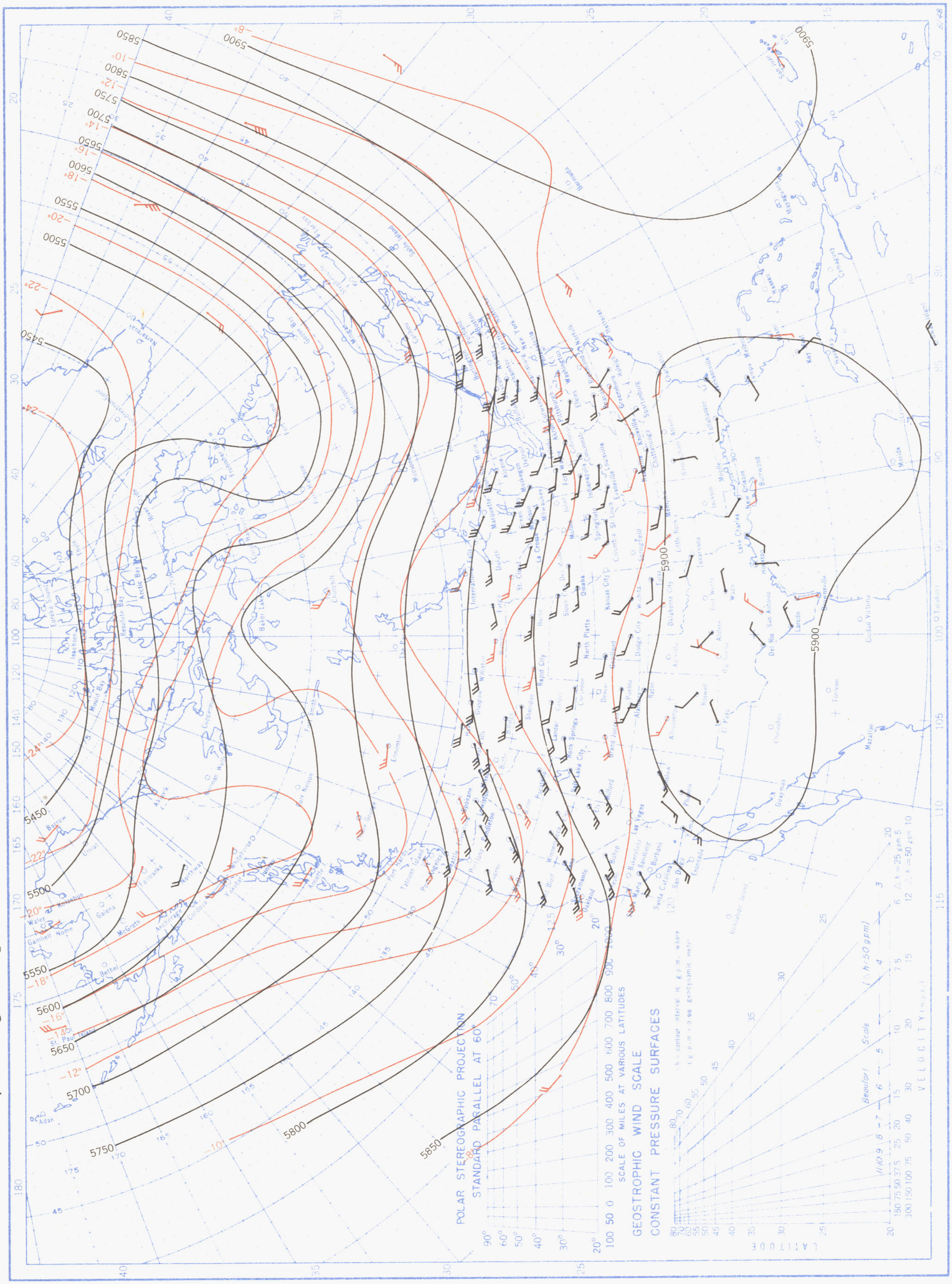
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

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.), August 1953.



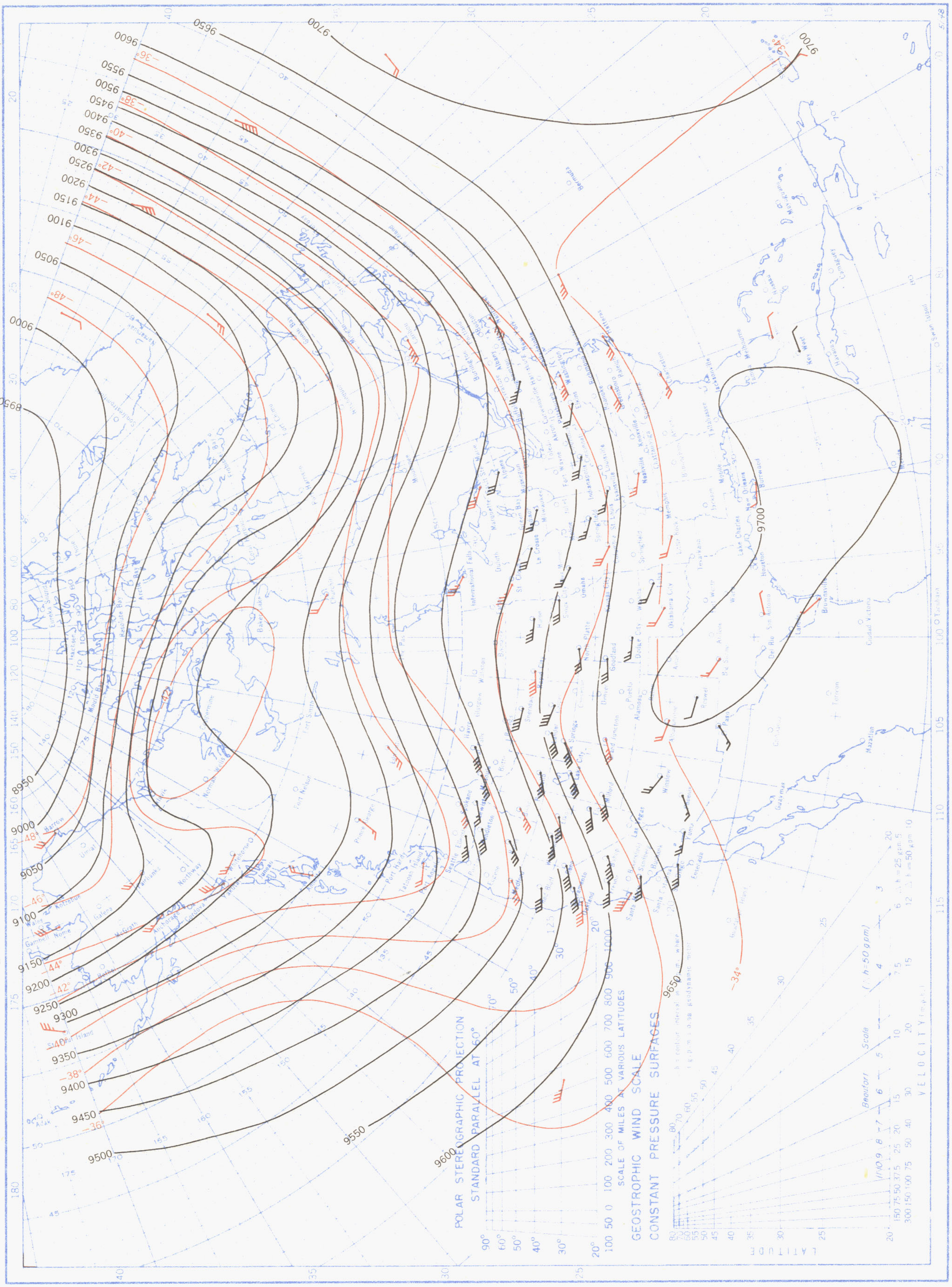
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

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.), August 1953.



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.), August 1953.



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.