THE LIFE HISTORY OF A GREAT BASIN ANTICYCLONE

An Aerological Analysis from a Hemispheric Point of View

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INTRODUCTION

Most of the synoptic studies in this series of articles for the *Monthly Weather Review* have been concerned with some aspect of cyclonic activity such as rapid deepening, widespread precipitation, and sudden temperature change. Very little has been published about anticyclones and, indeed, the same applies to meteorological literature in general. From a broader point of view the study of anticyclones deserves more attention because, as Starr [1] has shown anticyclones are of primary importance in providing kinetic energy for the general circulation.

Because the Great Basin High directly affects the weather of the western United States and indirectly affects that of much of the eastern United States, it is the purpose of this article to (1) examine the hemispheric features of the circulation aloft associated with the increase and decrease of the Great Basin High of December 16–24, 1954, and (2) explore its vertical structure, especially the variations of the temperature and wind fields.

According to statistics presented by Petterssen [2] the Great Basin area of the western United States has, in winter, the maximum frequency of centers of anticyclones and the maximum frequency of anticyclogenesis for the entire Northern Hemisphere.

SURFACE SYNOPTIC FEATURES

At 0630 GMT December 16, 1954 (fig. 1) a High, which on the previous day was located in the Pacific Ocean near 41° N., 139° W. with a central pressure of 1026 mb., arrived over the Northwest Pacific States with a central pressure of 1032 mb. It is the structure and development of this anticyclone that is here investigated.

The first elements examined were the broadscale, hemispheric features of the sea level chart. An intense storm was located over Kamchatka. A deep trough extended from a Low to the north of Alaska southward to the Hawaiian Islands. Ahead of this trough the low-level flow was from the south-to-southwest over the longitude band 140° W.–155° W. and from latitude 25° N. to 80° N. To the east, troughs were located in central North America, along the east coast of North America, and in the Atlantic Ocean near 20° W.

By 0630 GMT December 19 (fig. 2), 3 days later, some interesting changes had taken place. Note, first, that the general pressure rise in the western Pacific had greatly weakened the Kamchatka Low. An elongated trough persisted near longitude 145° W. The strong flow from the south off the west coast of North America was associated with a remarkably intense anticyclone in western United States. The Great Basin High had reached its peak intensity with a central pressure near 1048 mb. According to Sheridan [3] a Great Basin anticyclone with central pressure as high as 1045 mb. occurs about once in ten Decembers. Comparing the surface chart of the 19th with that of the 16th it was found that anticyclogenesis had taken place over most of North America as well as off the coast of Newfoundland. The Low over New England on the 16th had filled as it moved eastward, the only remnant being the weak cyclone near 37° N., 42° W. However, the Low over Kansas on the 16th deepened as it moved northeastward, with the result that a trough was maintained near the east coast of the United States. Intense cyclogenesis had taken place in northwestern Europe to the north of the blocking High in southern Europe.

Many of the features of the December 19 chart were also evident at 0630 GMT December 22 (fig. 3). As a result of cyclogenesis over Japan, the Pacific High had moved eastward so that its axis lay near 165° W. The trough along 150° W. persisted but the extensive flow from the south ahead of it had been wiped out completely. This change in wind flow appeared to have weakened the Great Basin High sufficiently (central pressure 1033 mb.) to allow frontal systems to enter the Northwest Pacific States. Cyclonic activity persisted in New England as did a trough off the east coast. Retrogression and anticyclogenesis had given rise to a well developed High in the mid-Atlantic.

Looking over the hemispheric picture, it appears that the development which was "ultimately" responsible for the weakening and breakdown of the Great Basin High was the cyclogenesis near the Japanese Islands. This shortened the wavelength in the Pacific so that the trough in the eastern Pacific gradually moved to the west coast of North America. The mechanism for the breakdown of the High was established at the same time that the High reached its peak intensity. The process becomes clearer on the next chart (fig. 4).

By 0630 GMT December 24 (fig. 4) little remained of the once enormous High which dominated the western United States for the previous week. In response to the cyclonic activity in the western Pacific, the Low, which on the 22d had been near 40° N., 147° W., had deepened and moved to the British Columbia coast. This produced the first strong push of cold air in more than a week into the western United States. As a result of shallow radiation inversions, the air near the ground in the warm sector was colder than the cold air from the Pacific behind the cold front. The ridge line had moved into central North America but trough conditions still dominated the east coast of the continent. The upstream changes had apparently not had time to cause much change in the circulation pattern of the Atlantic and western Europe. With this broad sketch of the sea level picture, an attempt will be made to interpret the changes in the Great Basin High in terms of what took place aloft. But first a brief summary of the weather.

THE WEATHER

During the week in which the Great Basin High existed, its effects on the United States weather were quite marked. In the Northern Plains temperatures averaged 15° F. or more above normal because of the invasion of mild Pacific air moving around the northern side of the High. In the southeastern United States temperatures ranged from 5° to 10° F. below normal as the trough near the east coast, both at the surface and aloft, brought air into the Southeast with a long trajectory from the north. Radiation was responsible for sub-zero temperatures in the Great Basin and upper Rocky Mountain region where surface winds were light and anticyclonic conditions made for dry, clear weather. Except for a narrow band along the Northwest Pacific coast, little or no precipitation fell in the western two-thirds of the country as the storm track was pushed far to the north. However, cyclonic activity dominated the east and precipitation was near normal in that region [4].

It may be profitable to discuss the weather in terms of "weather types." According to Blewett and Paulhus [5] this synoptic situation is a Bn type, of which they say, some of the outstanding features of the weather associated with the Bn winter types in the United States are:

> The stagnation of high pressure over the Great Basin throughout the [6 day] period brings dry weather to the Pacific Coast States, except for an occasional shower on the Oregon and Washington coasts as the fronts move in to the north. The Plateau states south of Montana also receive little or no precipitation. The most marked feature of the Bn in the central and eastern portions of the United States is the severe polar Canadian outbreak. . . .

THE CIRCULATION AT THE 500-MB. LEVEL

It may seem strange at first glance that in the discussion of a High covering a small portion of North America reference should be made to synoptic events over most of the Northern Hemisphere. However, the idea that circulation changes in one part of the hemisphere have important effects at great distances is not new, although it has received more attention in recent years. A half century ago Garriott [6] wrote,

> When the great continental [Siberian] high area extends westward over west-central Europe and the British Isles it checks the succession of North Atlantic storms, and finally affects the rate of progression of high and low areas over the United States.

For several days preceding 0300 GMT December 16, 1954 (fig. 5), the 500-mb. flow was chiefly zonal with a series of troughs of small amplitude and short wavelength. But on the 16th a change took place in the basic circulation pattern. The zonal flow began to change to meridional flow; troughs slowed down and deepened at more southerly latitudes while ridges built up in more northerly latitudes. The intensification of the ridges on December 16 was especially pronounced; for example, the 500-mb. heights rose about 800 feet in 24 hours over central England and about 1,000 feet in 24 hours along the coast of British Columbia. It is interesting to note that the blocking ridges developed simultaneously in areas separated by 4,000 miles. Apparently the unstable westerly flow aloft on December 15 broke down at more than one place so that the effect was felt in distant portions of the hemisphere at once. The process may be thought of as analogous to the change from laminar flow of water in a pipe to the sudden onset of turbulence all through the pipe when the speed of the current is increased beyond a critical limit.

The presently described development is quite different from the case where a blocking High is set up, for example, in the eastern Atlantic and its effects are gradually propagated westward, first across North America and then into the Pacific. It is not clear what the physical mechanism is that causes the breakdown in the zonal flow, and no empirical rules are available to aid the forecaster, but Wexler [7] says,

> There is definite evidence that the beginning of the mechanism that transforms a . . . zonal flow pattern into a . . . meridional flow pattern is the appearance of a "blocking action" in some portion of the westerlies which effectively obstructs the normal eastward motion of waves in the upper westerlies. . . .

Berggren, Bolin, and Rossby [8] suggest that

> At least superficially the sharp break in the zonal current at the western boundary of the . . . blocking wave . . . resembles the standing wave or hydraulic jump which develops in open channel flow when the depth of the water current drops below a certain critical depth.

Other interesting aspects of the flow on December 16 are (1) the strong advection of warm air in western Canada which points to rising heights in that region, (2) the strong flow from north-northwest in northwestern United States into the difluent trough near the Continental Divide, which indicates slow motion and deepening of the trough, (3) the confluent trough in northeastern United States, which might be expected to fill rapidly.

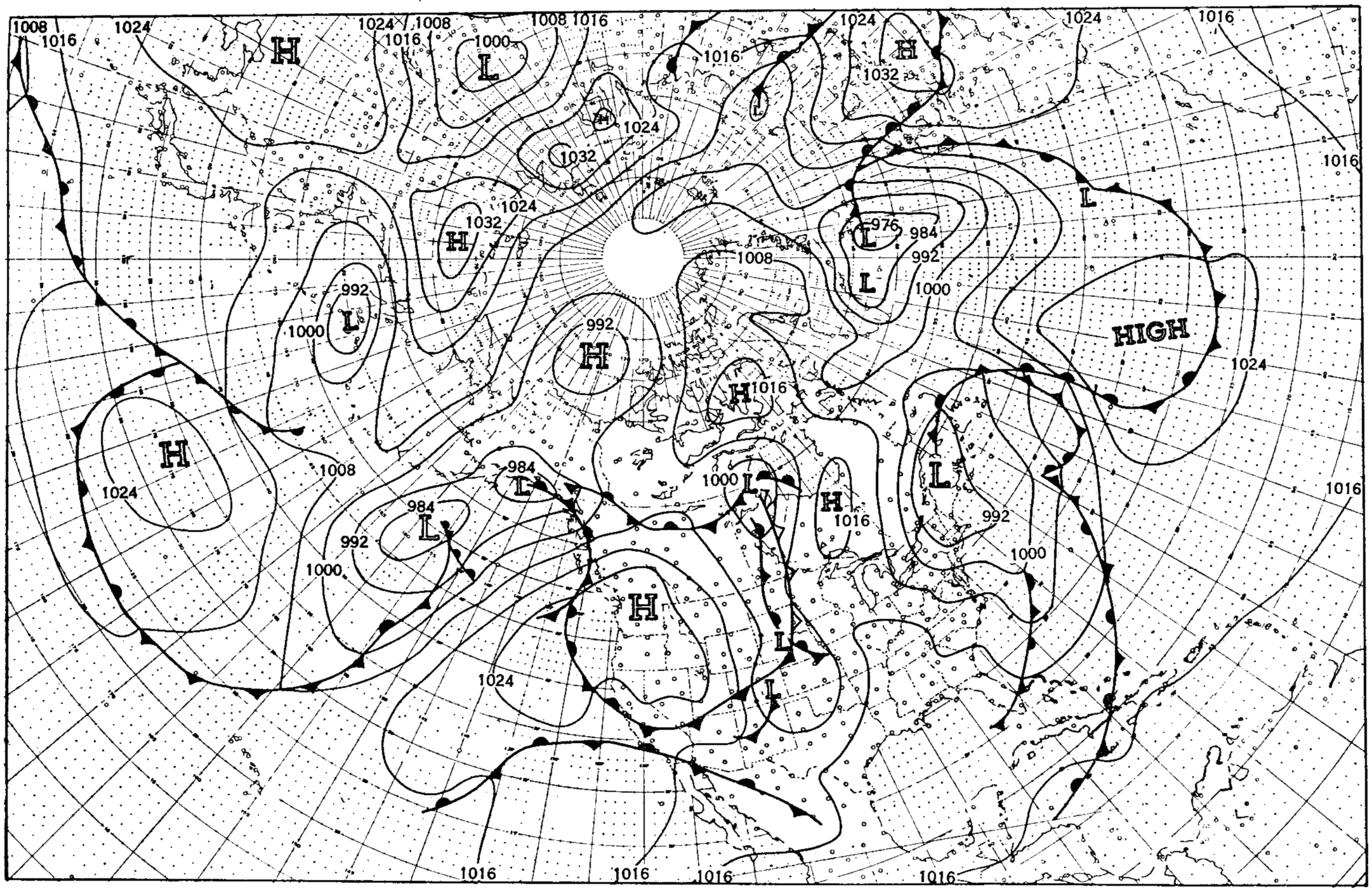

FIGURE 1.—Surface weather chart for 0630 GMT, December 16, 1954.

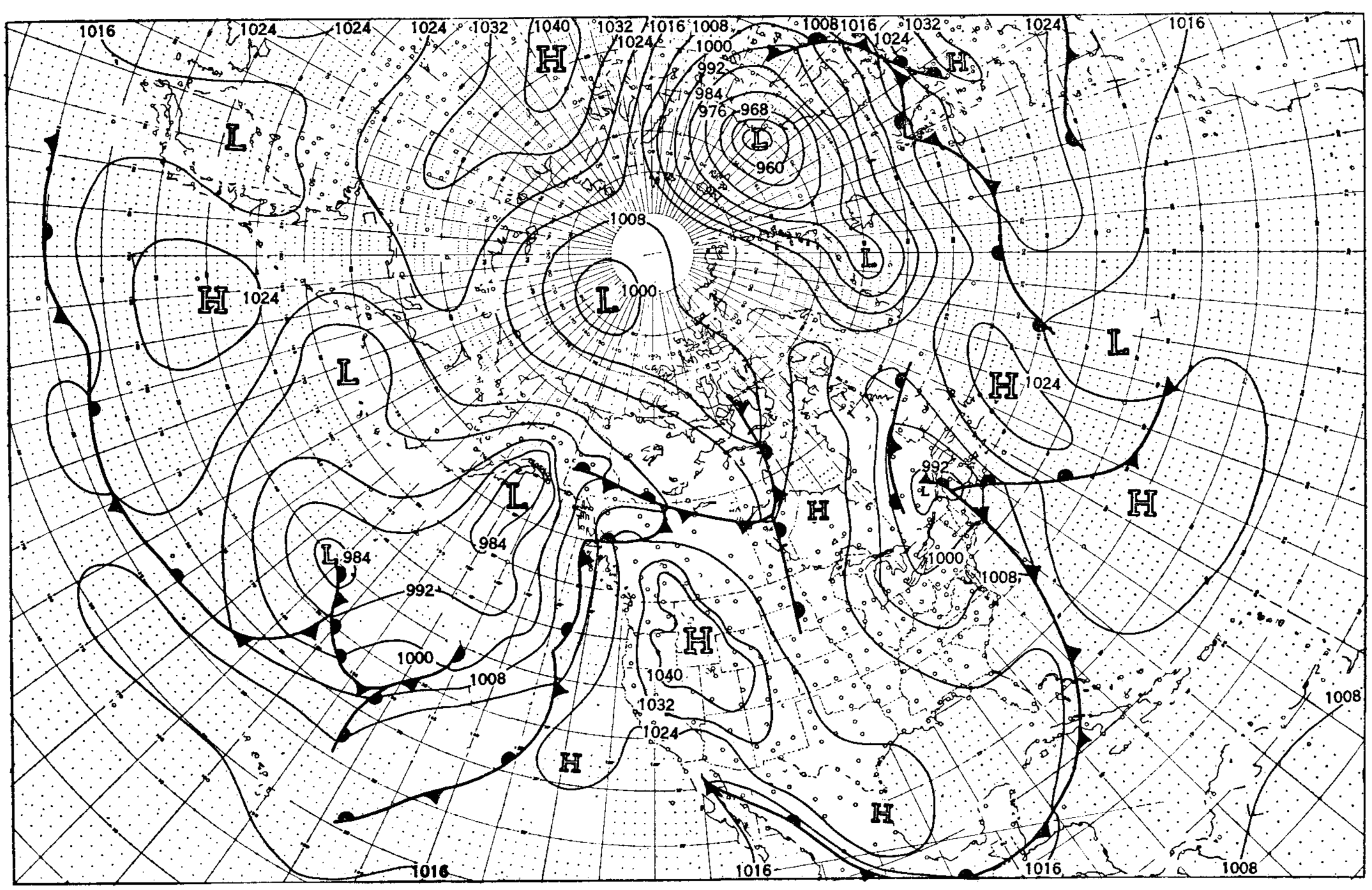

FIGURE 2.—Surface weather chart for 0630 GMT, December 19, 1954.

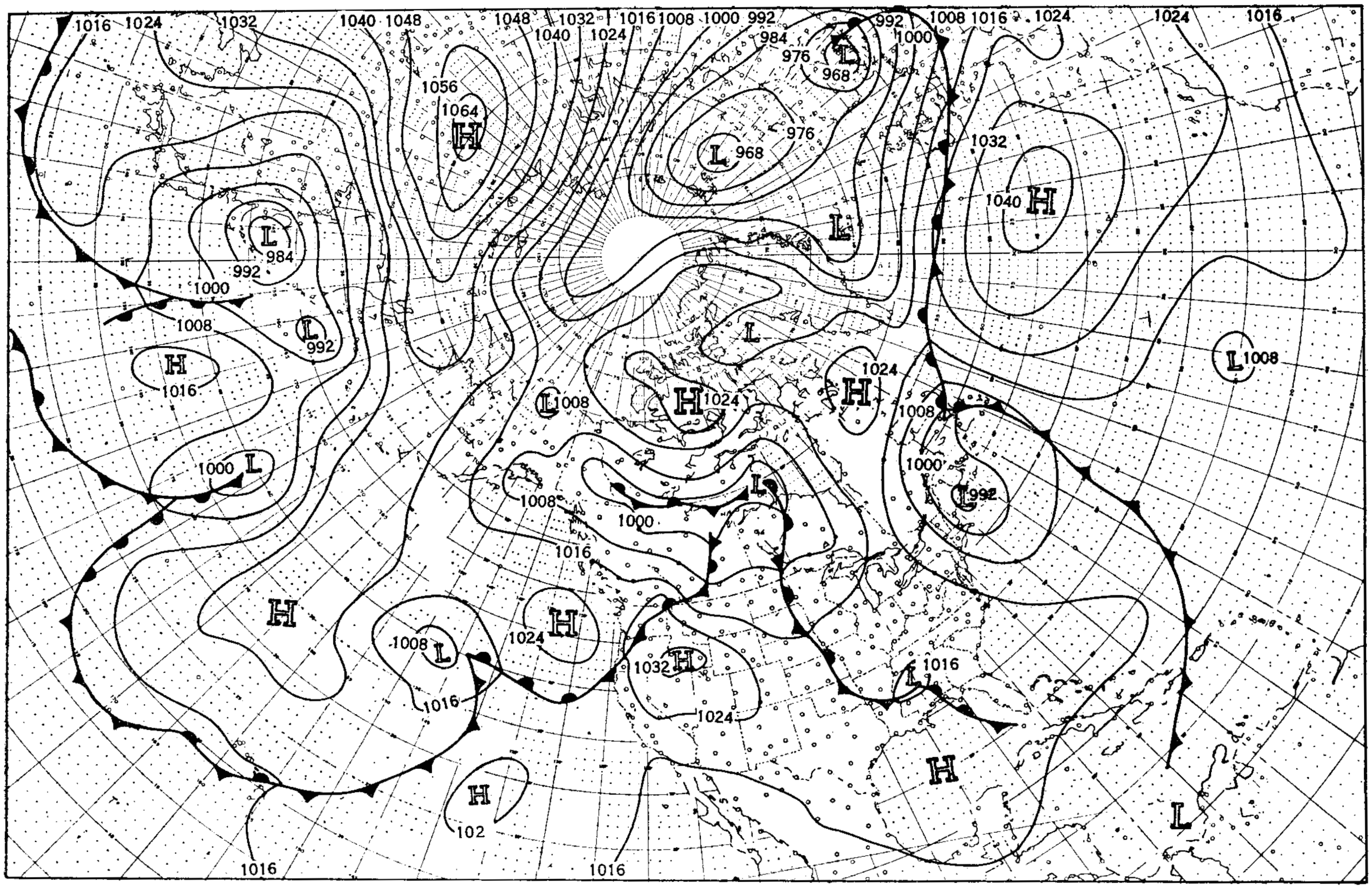

FIGURE 3.—Surface weather chart for 0630 GMT, December 22, 1954.

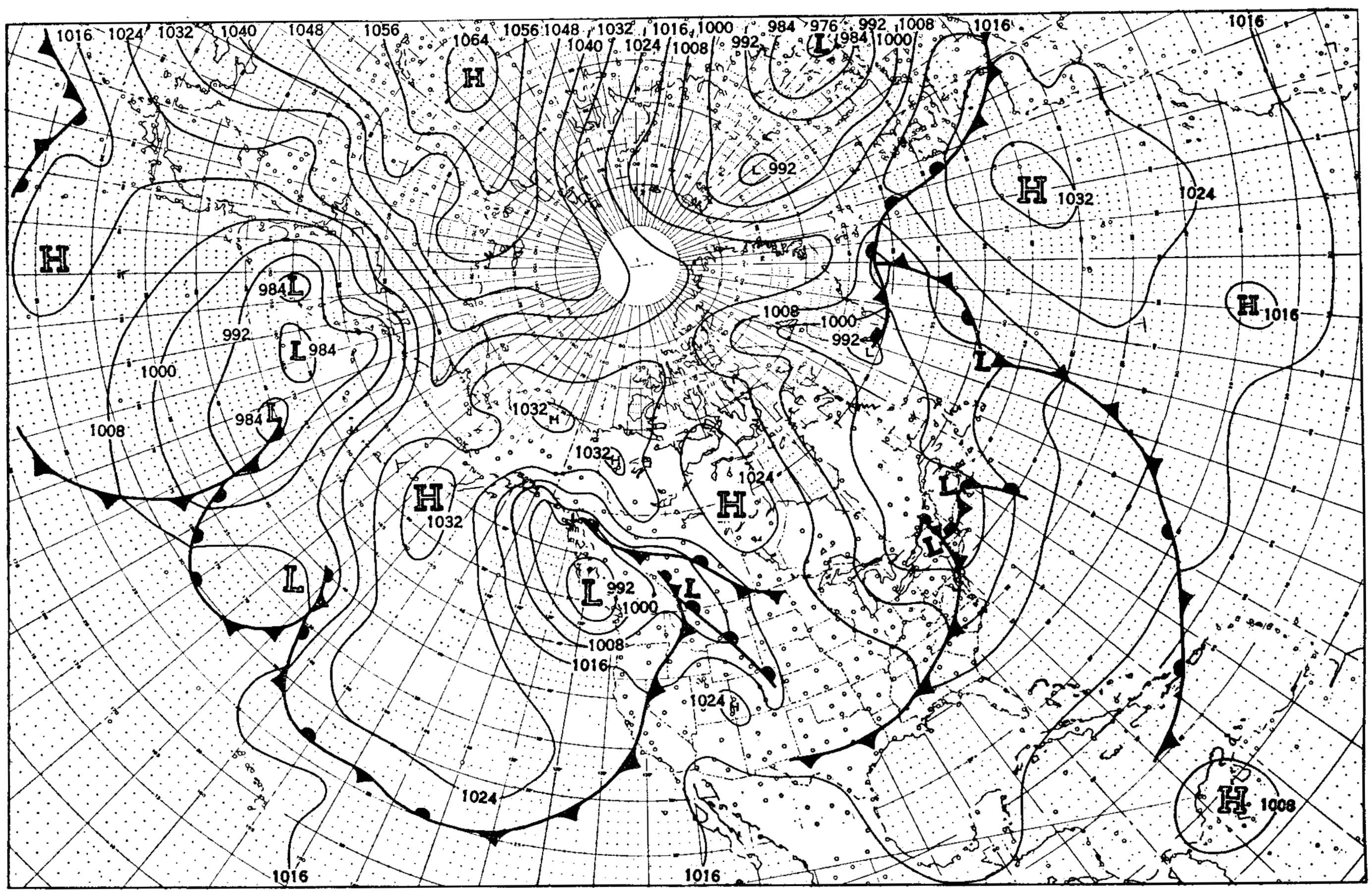

FIGURE 4.—Surface weather chart for 0630 GMT, December 24, 1954.

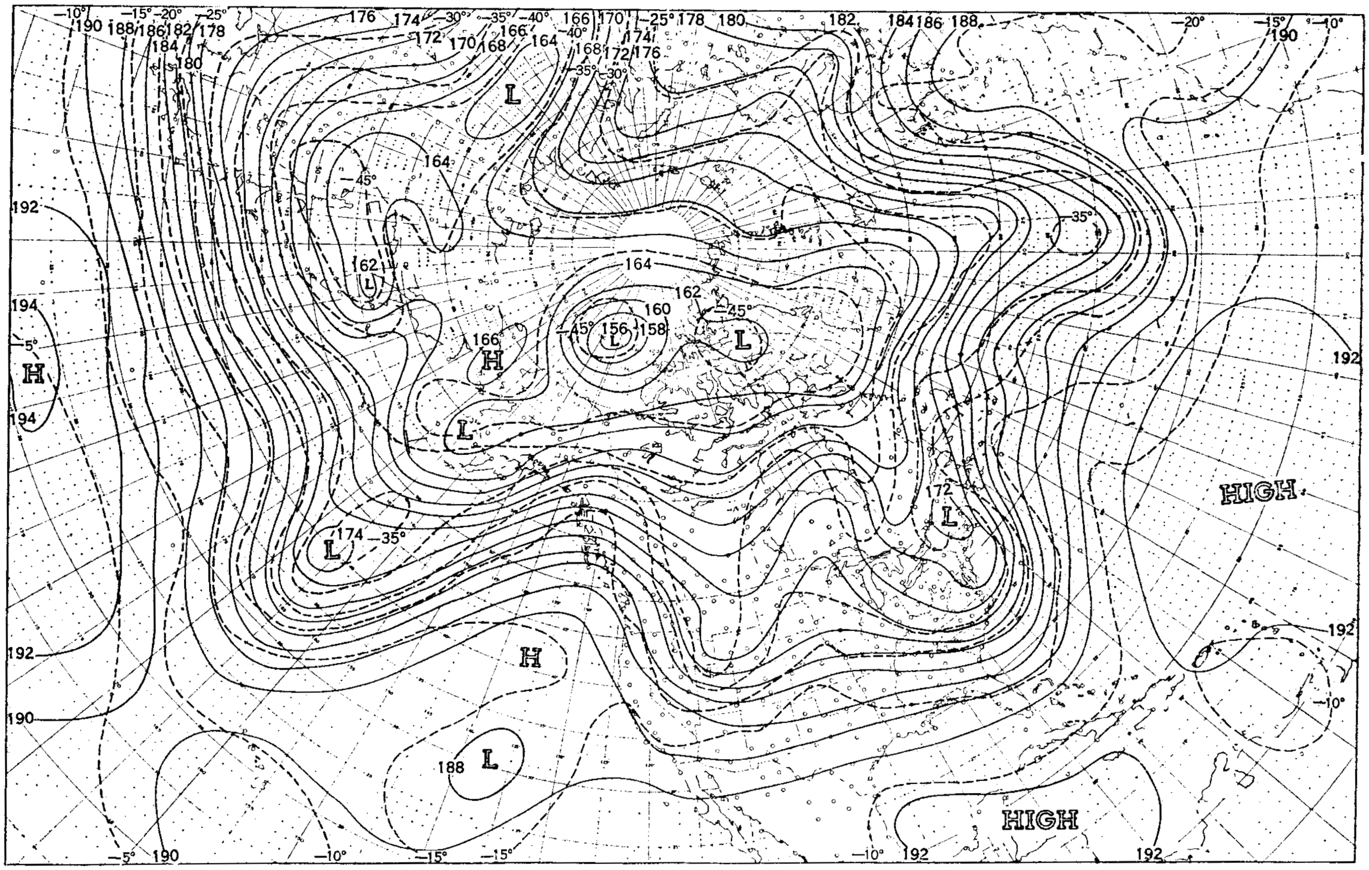

FIGURE 5.—500-mb. chart for 0300 GMT, December 16, 1954. Contours (solid lines) are in hundreds of geopotential feet; isotherms (dashed lines), in ° C.

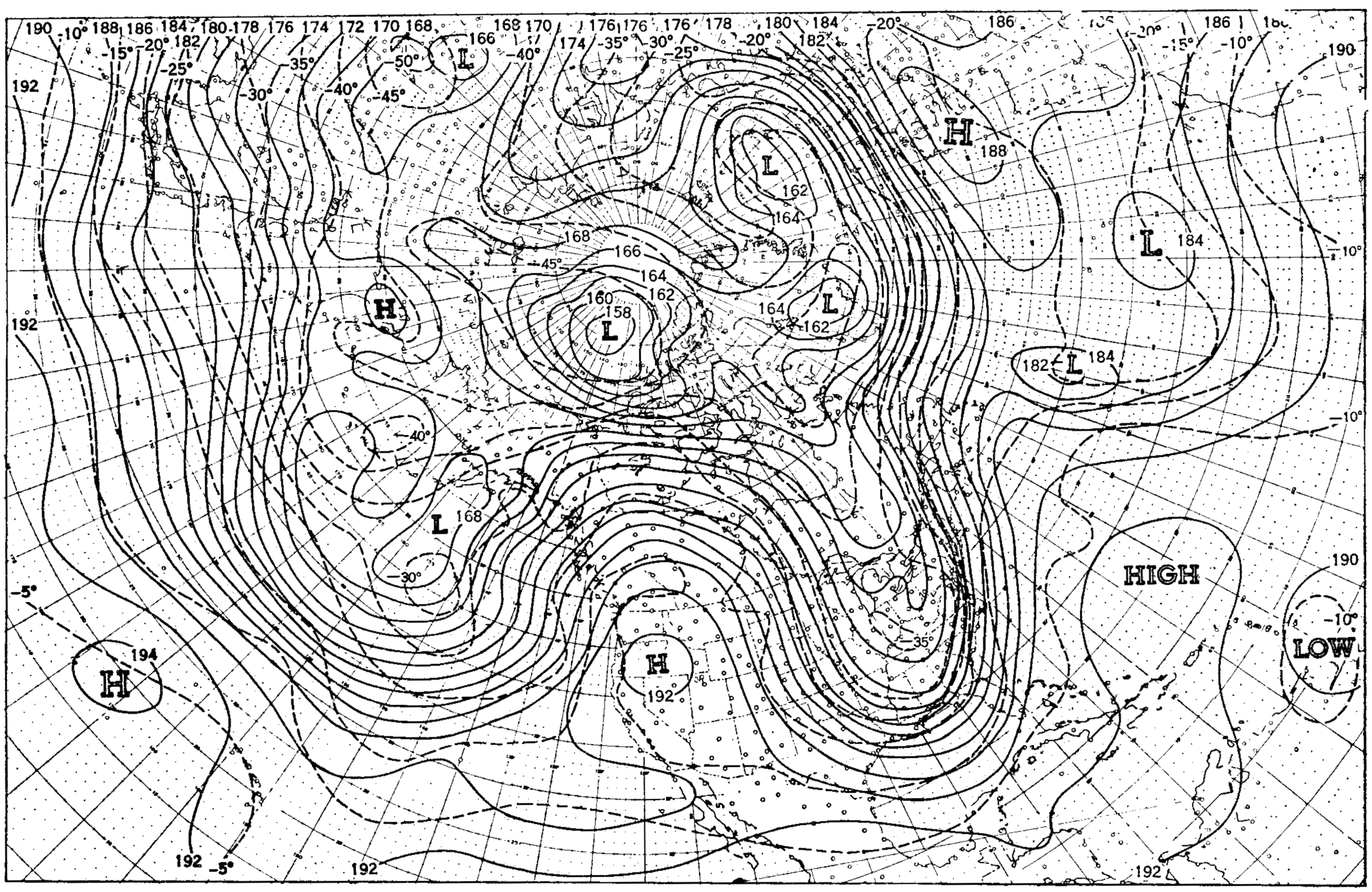

FIGURE 6.—500-mb. chart for 0300 GMT, December 19, 1954. The greatest amplitude in the wave pattern was observed at this time.

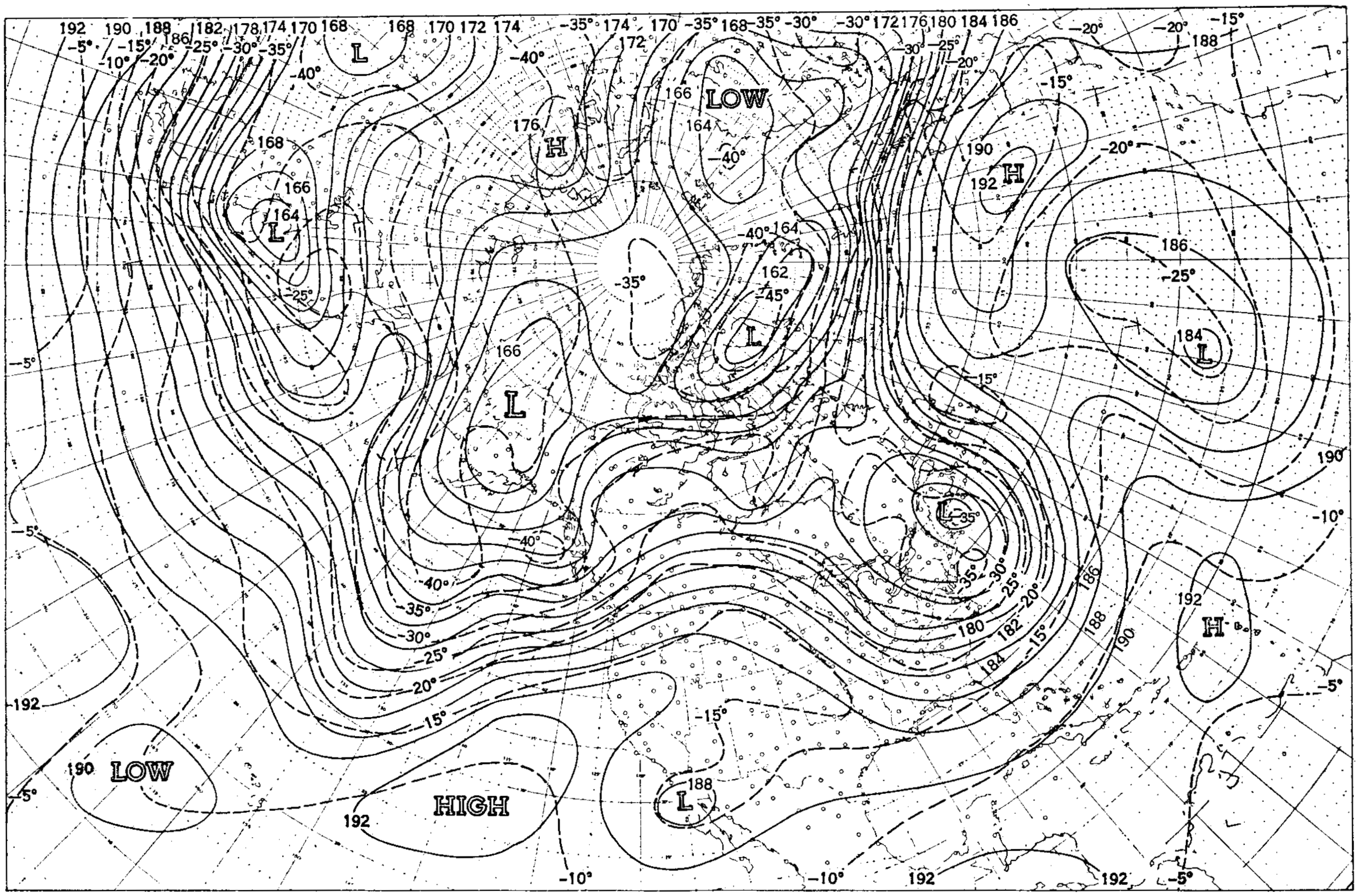

FIGURE 7.—500-mb. chart for 0300 GMT, December 22, 1954.

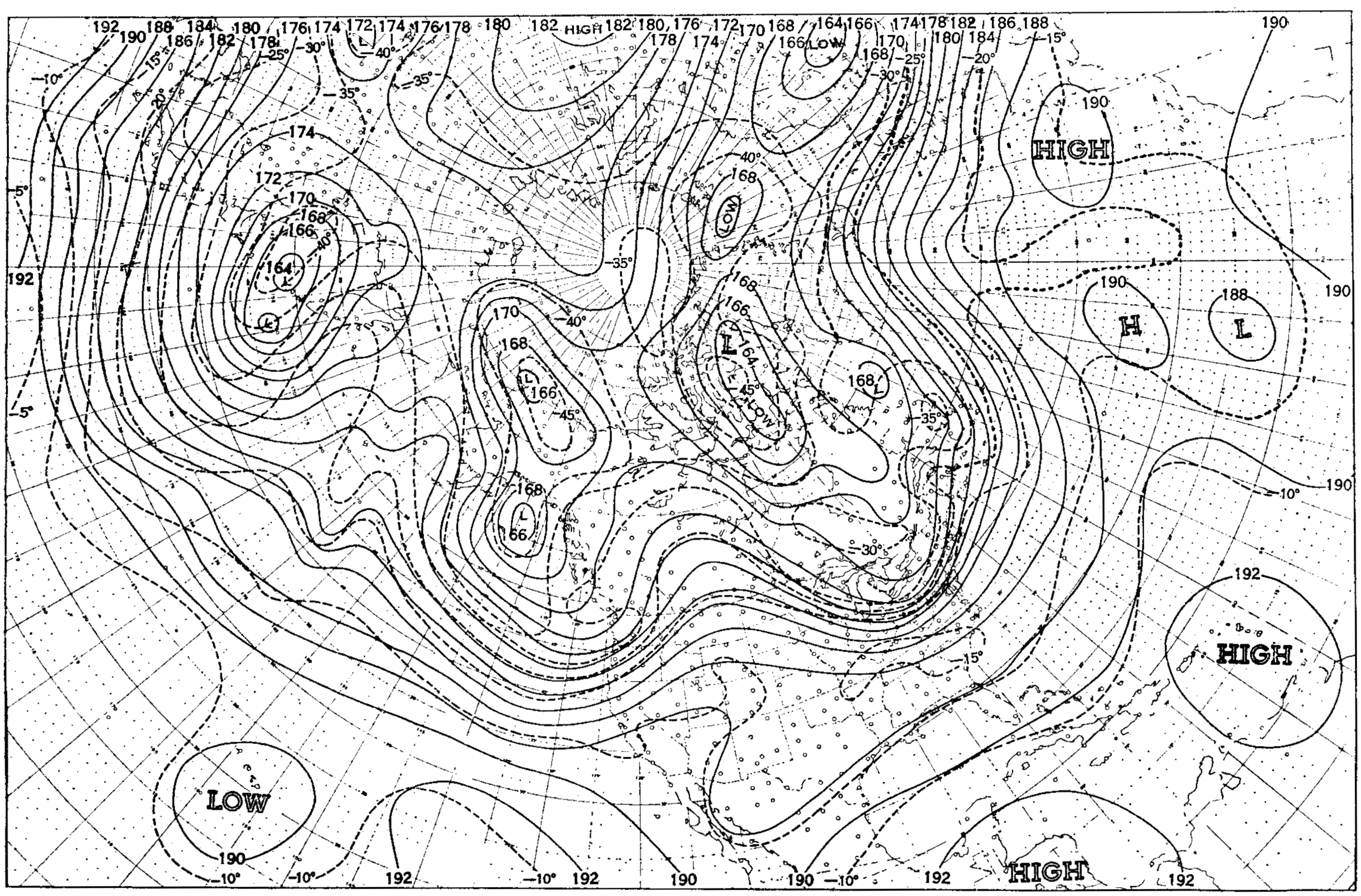

FIGURE 8.—500-mb. chart for 0300 GMT, December 24, 1954.

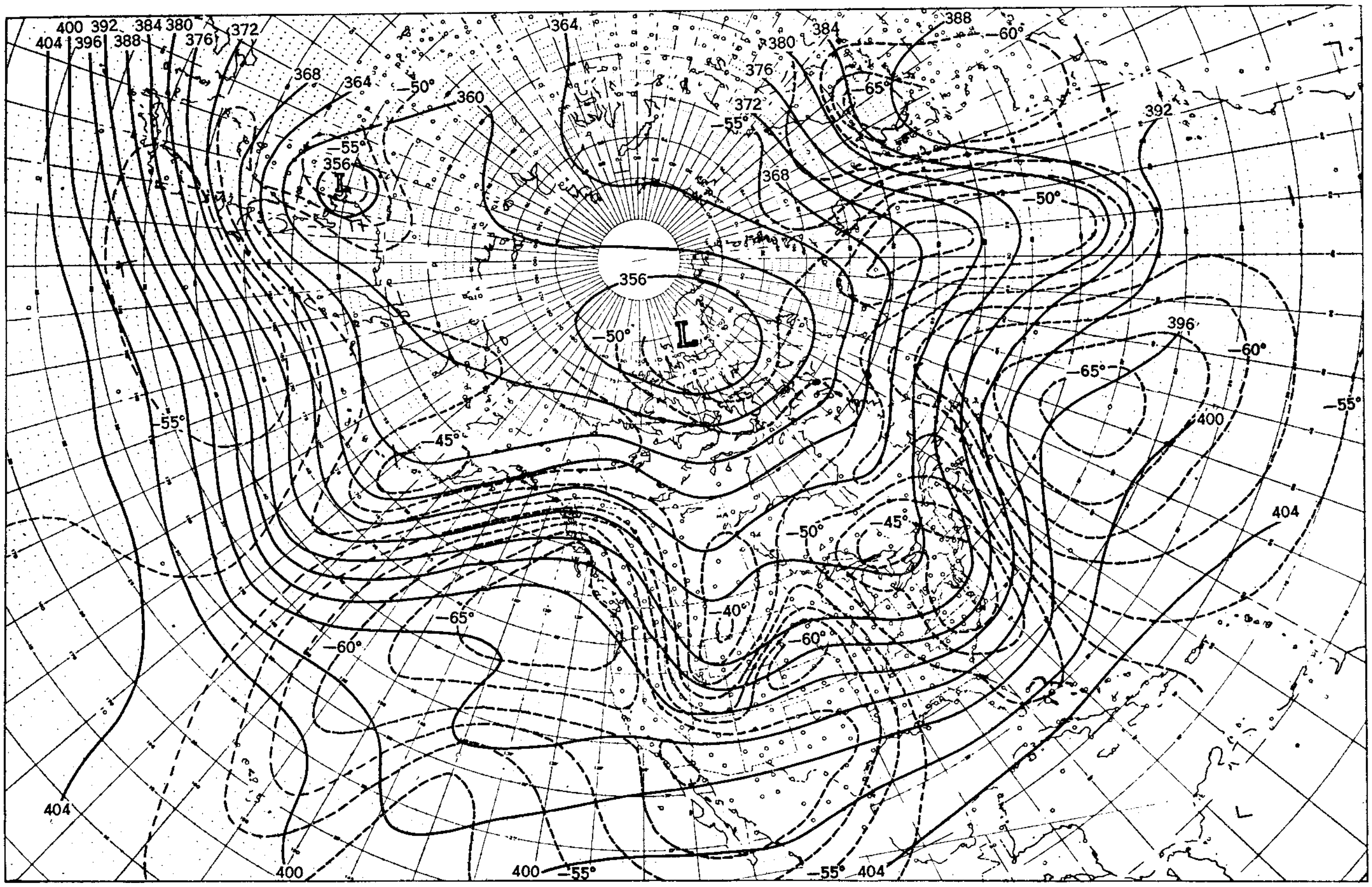

FIGURE 9.—200-mb. chart for 0300 GMT, December 16, 1954. Contours (solid lines) are in hundreds of geopotential feet; isotherms (dashed lines), in ° C at 2.5° intervals.

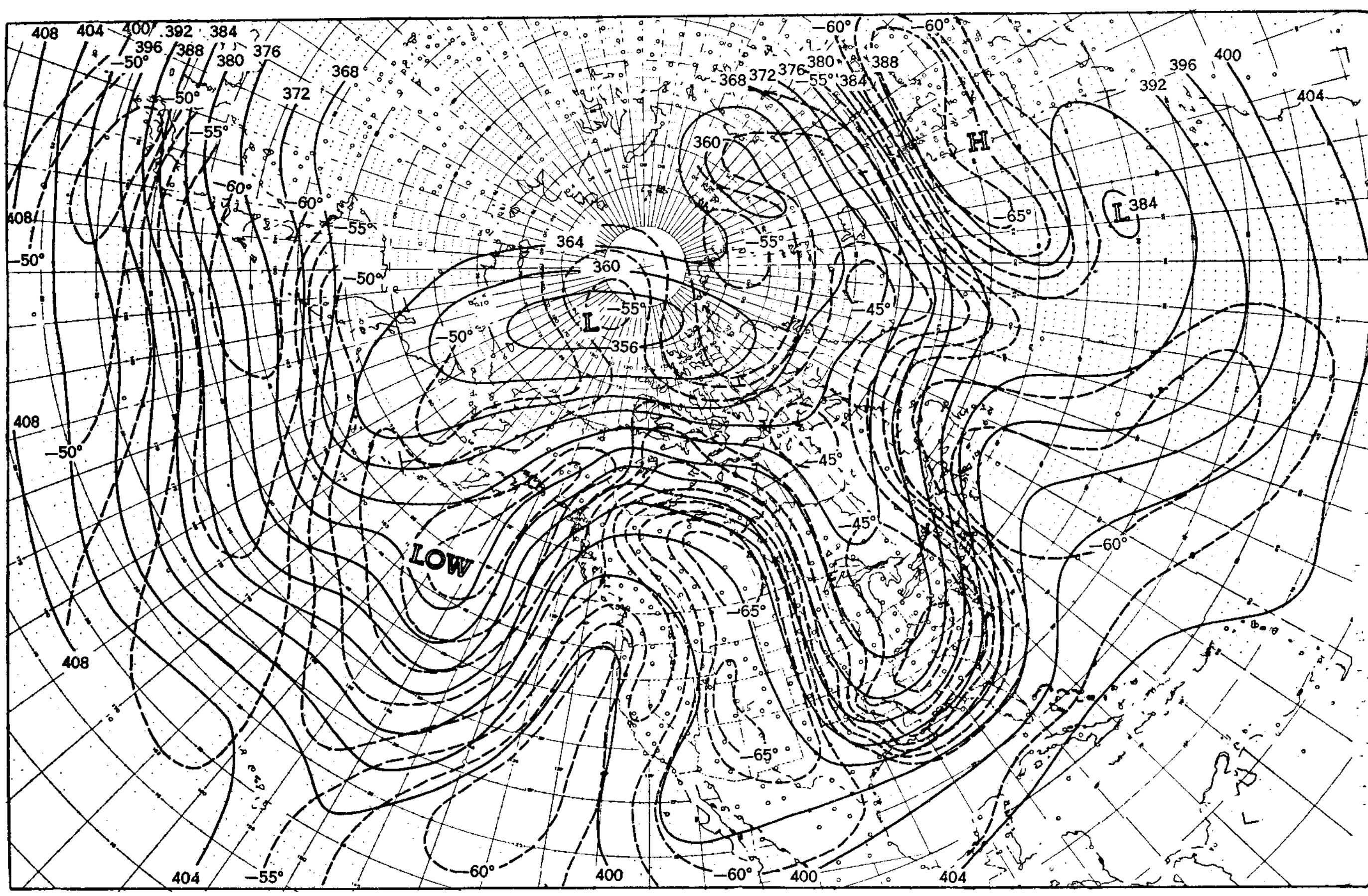

FIGURE 10.—200-mb. chart for 0300 GMT, December 19, 1954. Maximum amplitude stage.

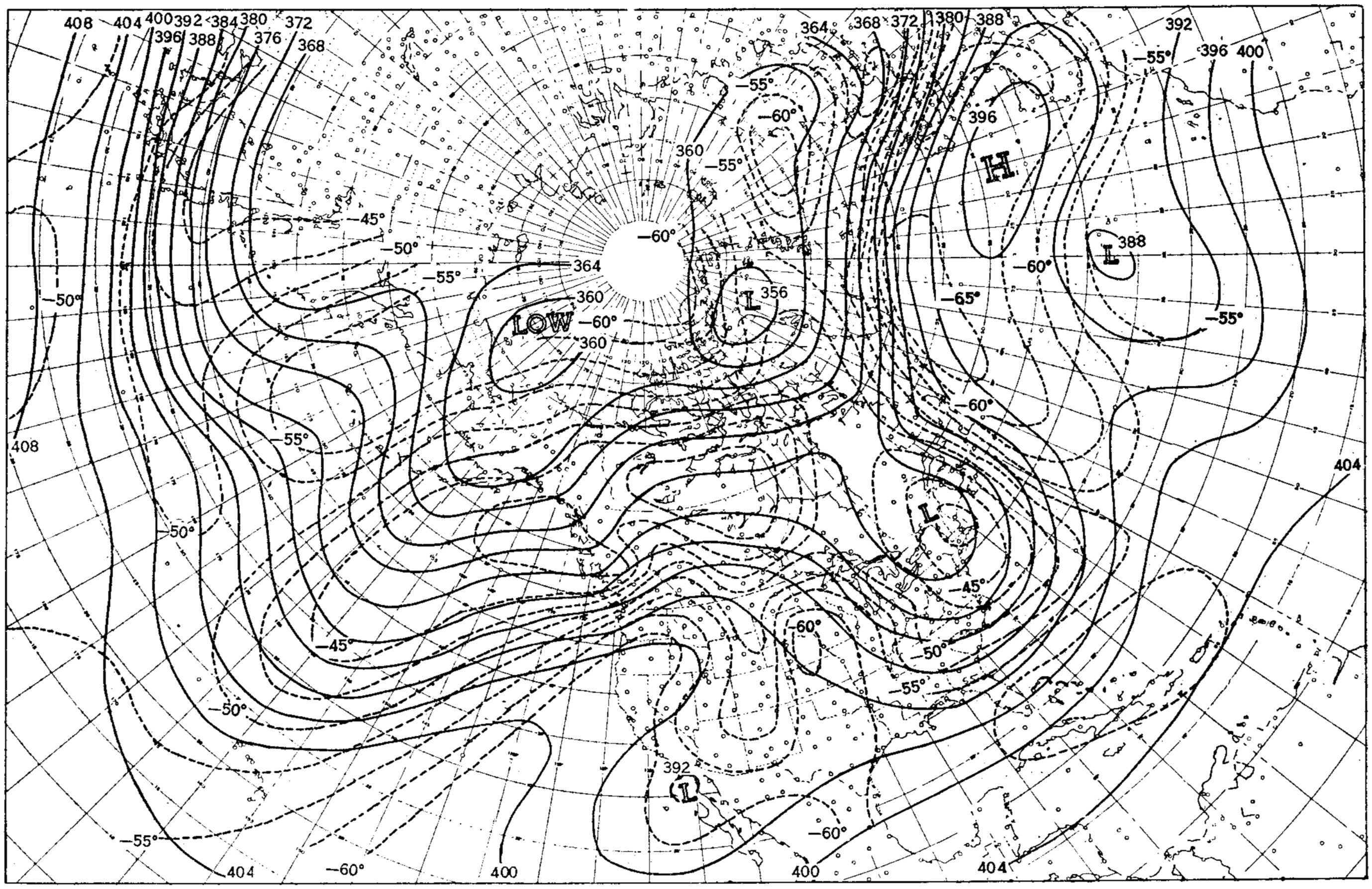

FIGURE 11.—200-mb. chart for 0300 GMT, December 22, 1954.

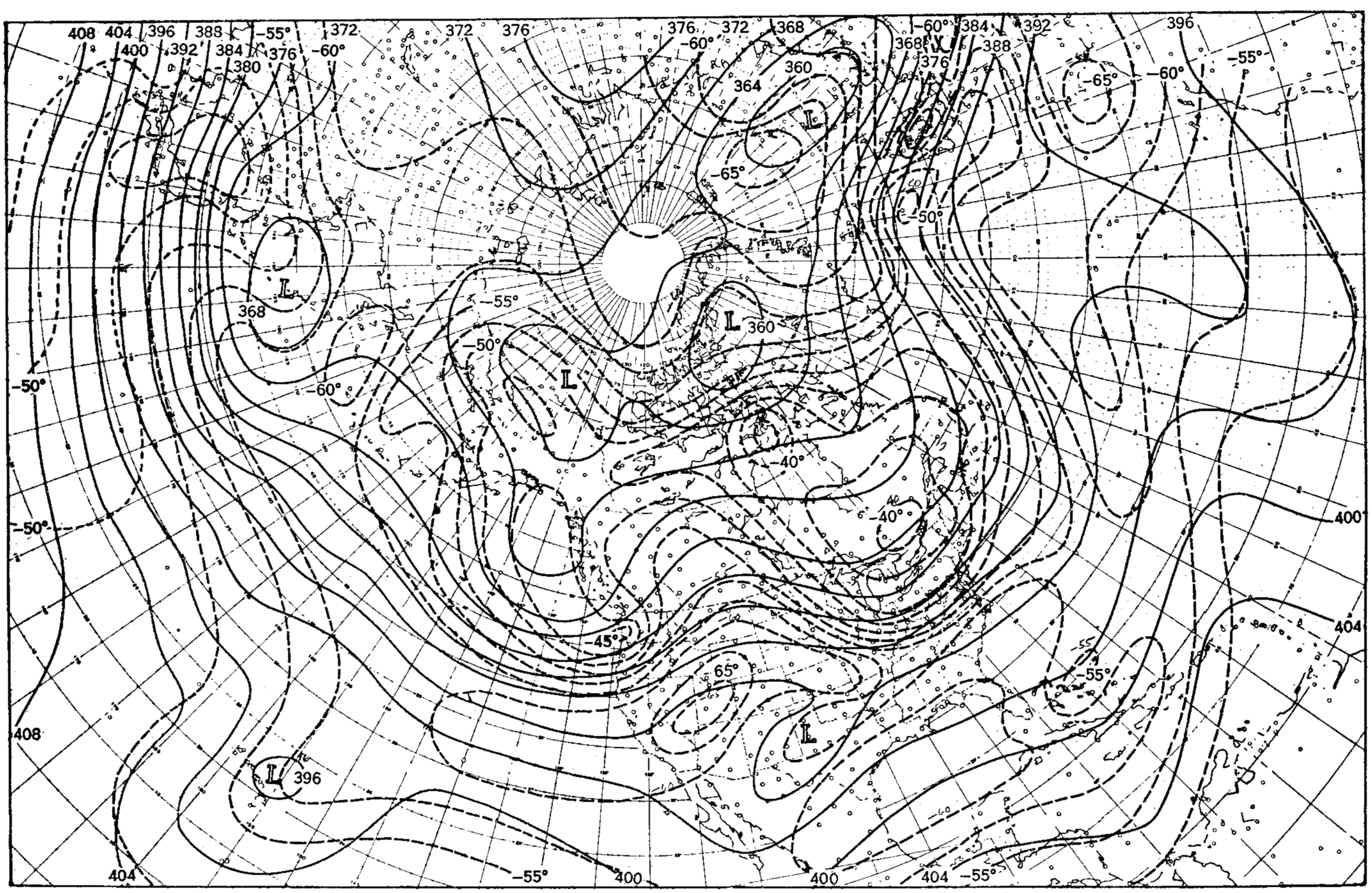

FIGURE 12.—200-mb. chart for 0300 GMT, December 24, 1954.

By 0300 GMT December 19 (fig. 6) well-defined Highs had developed in the western United States and in the southern British Isles. In the Pacific a strong westerly flow persisted to the longitude of the stationary trough near 160° W.; then it was deflected northward over the top of the North American ridge. The difluent trough of the 16th had deepened and moved into eastern United States. The trough along the east coast on the 16th had filled completely in its northern portion, but a remnant of its southern portion was responsible for the cut-off Low in the Atlantic near 40° N., 45° W. on the 19th. The deepening of the eastern United States trough fits in with the results of Austin [9] who found that when a ridge intensifies over North America the next downstream trough intensifies 75 percent of the time. The synoptic situation, with two pronounced blocks, had become remarkably stable. The fields of strong temperature advection of the 16th had been eliminated by the 19th. The result was that for the next 3 days changes in the circulation were very small. The North American block, of which the Great Basin High was a part, was similar to one of Elliott, Kerr, and Burke's [10] blocking types which according to them has an average life of about 5 days with individual blocking sieges frequently lasting from 2 to 8 days.

The anomalous nature of the flow pattern may be seen from the following: Heights at 500 mb. over Georgia and Louisiana were about 1,000 feet below the December normal and the same applied to an area in the Pacific near 45° N., 155° W. But heights in the States of Washington and Oregon were 1,000 feet above normal and over the southern portion of the British Isles about 700 feet above normal. Similar anomalies were observed in the temperature field. Aklavik, Canada, just north of the Arctic circle, had a 500-mb. temperature of −22° C. at 0030 GMT December 19 which was 11° C. warmer than the 500-mb. temperature at Atlanta, Ga. (latitude 34° N.).

Turning now to the 500-mb. chart for 0300 GMT December 22 (fig. 7) and looking first at the Atlantic, notice that the block in the eastern part of that ocean had changed very little in the preceding 3 days. The trough in eastern North America on the 19th had moved to the east coast, and the flow to the rear of this trough was from northwest as compared to flow from the north on the 19th. The tendency was to weaken the meridional flow. While the 500-mb. heights were still about 600 feet greater than the December normal, the flow between the trough near 155° W. and the northern portion of the North American coast was from the southwest; on the 19th the flow in this area had been chiefly from the south. Again there was a trend toward zonal flow. The trough near 155° W. had moved very little in the past 3 days and had filled somewhat. But in Japan a change of great significance for the destruction of the flow pattern had taken place. In northern Japan intense cyclogenesis accompanied height falls of 1,500 feet from the 19th to the 22d. On the 19th the U. S. Air Force "Buzzard" flight along the east coast of Japan reported 500-mb. wind speeds of 60 knots or lower but on the 22d winds as strong as 170 knots were reported. While data are scarce over large areas of the Pacific, it seems reasonable to conclude that the effect of the deepening Japanese Low and the increase in wind speed was to shorten the wavelength between the troughs in the Pacific so that stationary conditions could no longer exist. Eastward progression of the troughs then took place.

By 0300 GMT December 24 (fig. 8) the flow pattern at 500 mb. was chiefly zonal again and the cycle was completed. The collapse of the meridional flow was reflected in (1) the weakened low-latitude Low in the Atlantic, the southward displacement (to near the coast of Portugal) and weakening of the blocking High, (2) the eastward movement and filling of the trough along the east coast of the United States, (3) the eastward movement of a weak Low from Baja California to northern Texas, (4) the weakening High in western North America associated with the movement of the east Pacific trough to near the west coast of North America, and (5) the movement of the Japanese trough to the mid-Pacific. The temperature field also had become more nearly normal with the warm air in southerly latitudes and the cold air to the north.

CIRCULATION NEAR THE BASE OF THE STRATOSPHERE (THE 200-MB. LEVEL)

The 200-mb. level is, practically speaking, the highest elevation for which the flow pattern aloft can be drawn routinely and fairly objectively from a large number of upper air observations over a large part of the hemisphere. At higher elevations data rapidly become scarcer and less reliable. In addition the 200-mb. level is usually near or slightly above the subtropical tropopause and so roughly represents the conditions at the base of the stratosphere. In many cases the jet stream lies near the 200-mb. level.

The 200-mb. chart for 0300 GMT December 16 (fig. 9) showed many of the same features as the 500-mb. chart for the same time. The troughs and ridges sloped very little from the 500- to the 200-mb. level. The westerly jet moving across the Pacific split as it approached the west coast of North America, one branch continuing across British Columbia, the other going across southern California. Whether the split in the jet caused the block to be set up or vice versa is difficult to say. At 200 mb., troughs are usually warm and ridges cold, so one finds that areas of warm advection at 500 mb. are areas of cold advection at 200 mb. For example, the areas of marked cold advection in British Columbia and in the western Atlantic correspond to areas of warm advection at 500 mb.

Note that to the south of the jet stream the coldest air occurred and that still farther to the south the air was warmer. Similarly, to the north of the jet there were areas of warm air with colder air farther north. This would seem to indicate that the temperature distribution is not entirely due to advection but is at least partly controlled by the dynamics of the jet stream. Riehl [11] has shown that this type of temperature distribution may be accounted for by rising motion to the right of the jet (looking downstream) and sinking motion to the left.

By 0300 GMT December 19 (fig. 10) the jet stream had been distorted into waves of large amplitude. When the flow is mainly westerly it is frequently possible to pick out a polar jet stream and a subtropical jet stream at 200 mb. However, in this case the southern portion of the polar jet was so far south that it was not possible to distinguish between the two jet streams.

The temperature gradients had diminished considerably over the High and the advection was very weak. The indicated advection was quite strong in mid-Pacific and in northeast United States. At 200 mb. it is almost always observed that the temperature fields move much more slowly than the winds, that is, the temperatures do not rise or fall as much as the advection indicates. This means that where cold air advection is indicated the air is sinking and where warm advection is indicated the air is rising. The peculiarly shaped warm tongue over Washington and Oregon seems to be due to sinking motion for, judging from the trajectory, the air coming into that region should have been colder.

Figure 11 is the 200-mb. chart for 0300 GMT December 22. The chief features of interest are the tendency for the jet flow to become less meridional, the weaker fields of advection, and the single, well defined jet over both oceans and the North American continent. The only reflection at 200 mb. of the surface High was the sharp ridge in the western United States. Winds from the Pacific flowing into this ridge were about 90 knots, too strong to make the sharp anticyclonic bend. These strong winds could be expected to overshoot the ridge then curve back into the Southwest and form a trough.

In figure 12, 0300 GMT December 24, the Low seen in New Mexico may be due to this overshooting of the ridge, but it may also be thought of as the Low over Baja California on the 22d which had moved eastward as the westerly flow increased at southerly latitudes. Probably both influences were active.

The jet stream flow at this time was chiefly westerly with winds as strong as 180 knots reported in northern Japan. The subtropical jet became more clearly defined in southern Texas and along the Gulf of Mexico coast. Here again the coldest air is found near the jet with the suggestion of rising motion.

VERTICAL CROSS-SECTIONS THROUGH THE ANTICYCLONE

In order to throw additional light on the structure of the atmosphere over the High, a series of vertical cross-sections was prepared to show the temperature and wind fields and the changes in the location and intensity of the fronts and tropopauses. Since many of the soundings extended to 50 mb. it was possible to examine 95 percent by weight of the atmosphere above the High. The cross-sections run approximately from north to south from Aklavik, Canada, to Tucson, Ariz. The isotachs are drawn for the total wind speed—not for the west wind component as is frequently done.

At 0300 GMT December 16 (fig. 13) a front from the Pacific had brought a deep cold air mass over Spokane and Boise with temperatures near −25° C. at 550 mb. The subtropical tropopause seems to have been pulled down to about 270 mb. over this cold air. A shallow Arctic front was observed over the northernmost stations. As is usual, a lower polar tropopause (near 400 mb.) existed over the Arctic air at Aklavik.

A northerly jet existed over Spokane with wind speeds of 115 knots. Even though the isotherms in the cross-section were nearly horizontal over the High, which was centered near Spokane, the atmosphere was not barotropic. An east-west cross-section would show a large temperature gradient along the isobaric surfaces over the High. This temperature field was associated with the increasing northerly wind with height. When the High first appeared over the continent the atmosphere above it was baroclinic but it soon became barotropic, as will be seen on the next chart.

The cross-section for 0300 GMT December 19 (fig. 14) shows that warm tropical air had invaded the troposphere to the south of Fort Nelson. Clear skies had led to pronounced radiation inversions near the ground in the warm air. The frontal boundaries between the Arctic, polar, and tropical air masses were well defined in the northern section of the chart. It is interesting to note the barotropic character of the warm airmass—the isotherms were very nearly horizontal in the troposphere all the way from Tucson (latitude 32° N.) to Fort Nelson (latitude 59° N.). The winds varied little with elevation in the warm air; at Boise, for example, the wind at 700 mb. was 7 knots from 50° and at 50 mb., 13 knots from 60°. The wind observations clearly show that the anticyclonic circulation existed up to at least 25 mb. (25 km.) for the wind at that level at a point about 250 miles northwest of Aklavik was 95 knots from 240°, while at Las Vegas it was 33 knots from 60°. The Great Basin High extended at least as far above the subtropical tropopause as it did below it; the anticyclonic whirl extended from the ground up through at least 98 percent (by weight) of the atmosphere.

The highest level for which it was possible to draw contours and isotherms based on a fairly large number of wind, temperature, and height observations (or extrapolated heights) for most of North America, was the 50-mb. level (21 km.). At this level (fig. 17) the anticyclonic circulation was quite prominent in the West with the center over the State of Washington, only slightly displaced from the surface center.

As shown in figure 14, a double tropopause existed over the tropical air. The lower one (between 200 and 250 mb.) may be identified with the tropopause at approximately the same height on the 16th. The lower, sub-

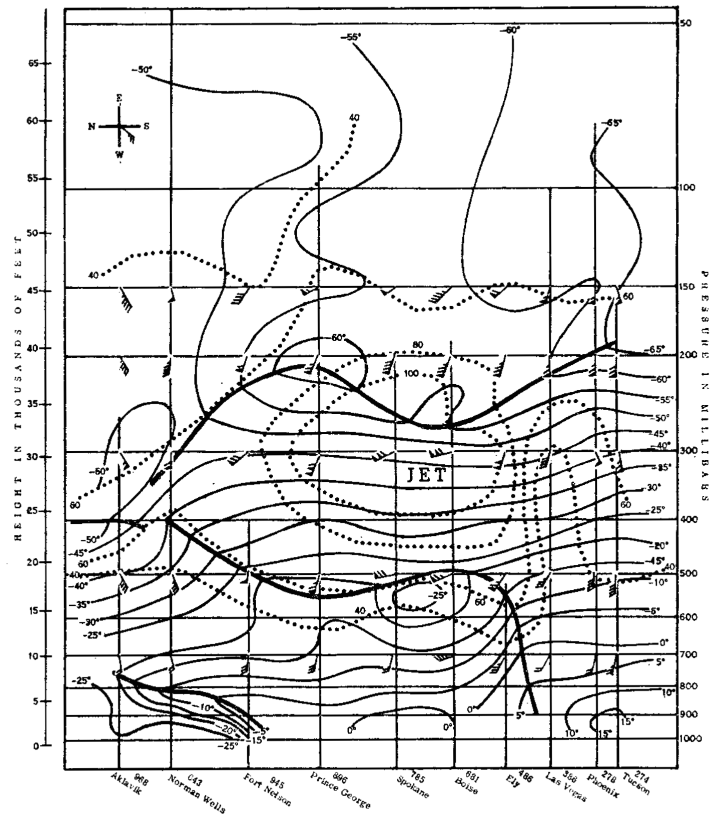

FIGURE 13.—Cross-section, roughly north-south, at 0300 GMT, December 16, 1954. Heavy lines indicate fronts and tropopauses. Isotherms in ° C are shown as solid lines. Isotachs are shown as dashed lines.

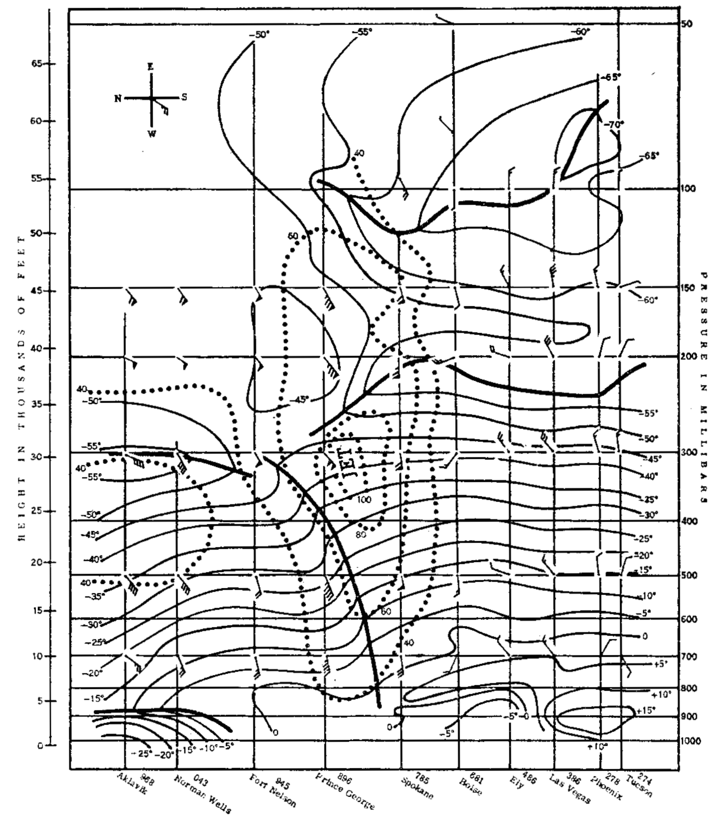

FIGURE 15.—Cross-section at 0300 GMT, December 22, 1954.

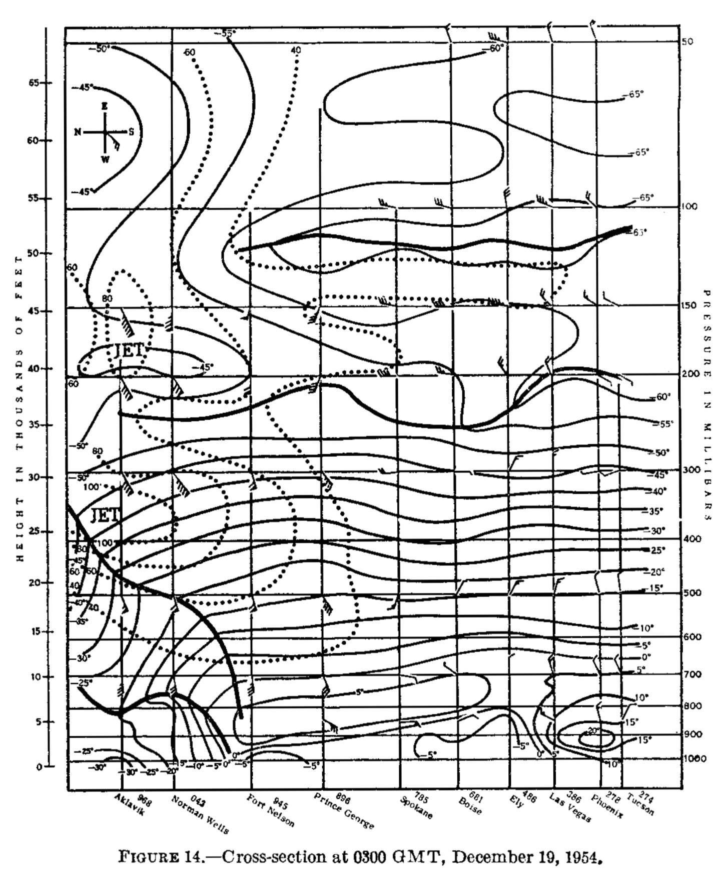

FIGURE 14.—Cross-section at 0300 GMT, December 19, 1954.

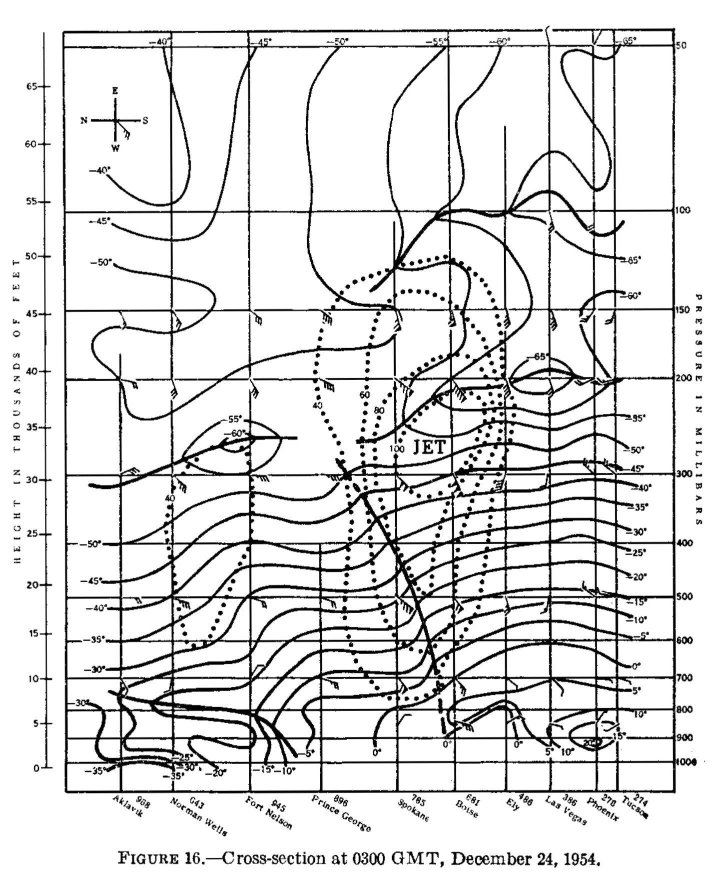

FIGURE 16.—Cross-section at 0300 GMT, December 24, 1954.

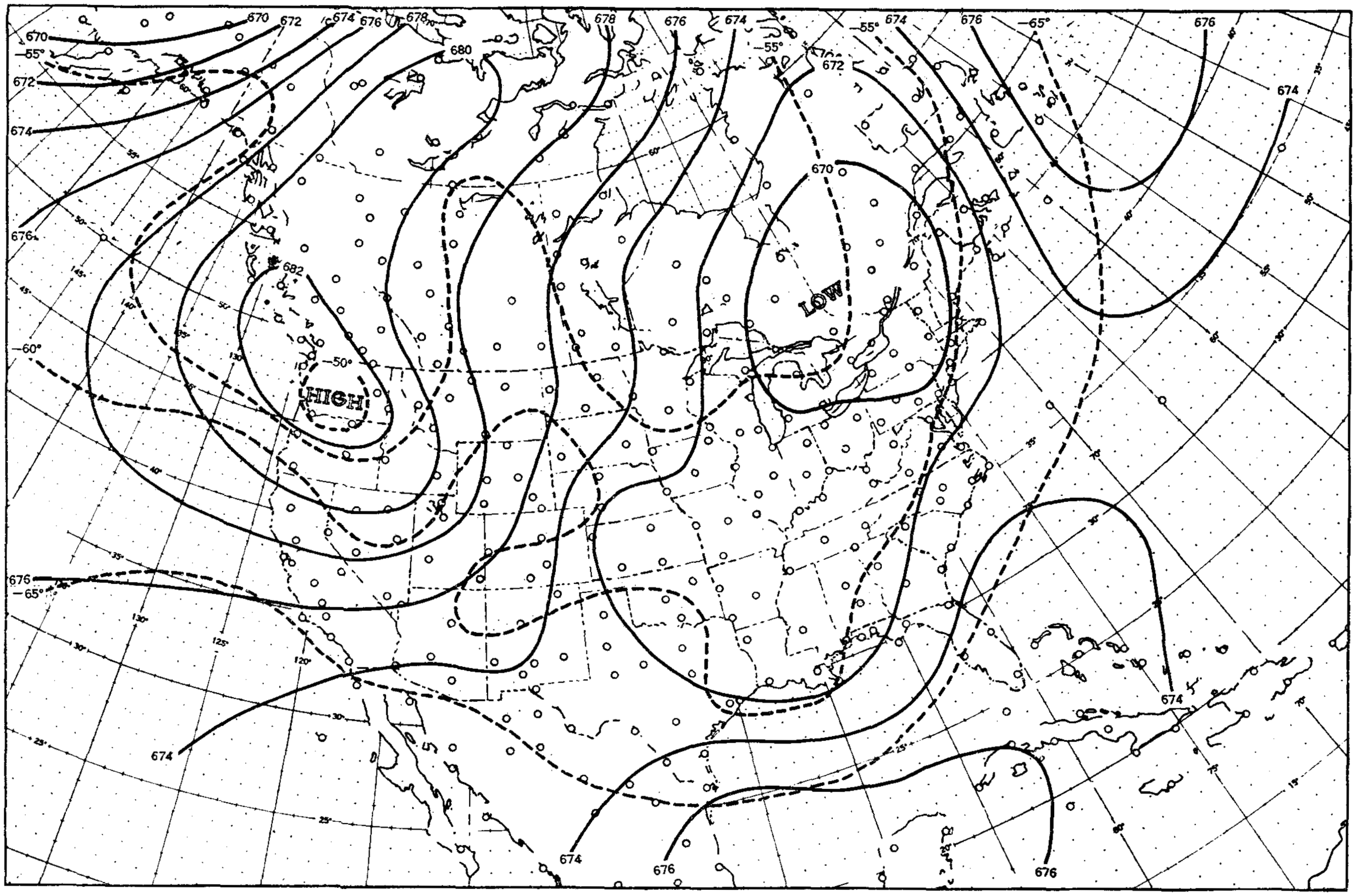

FIGURE 17.—50-mb. chart for 0300 GMT, December 19, 1954. Contours (solid lines) are in hundreds of geopotential feet; isotherms (dashed lines), in ° C.

tropical tropopause was more clearly defined and had a potential temperature near 335° A. The upper tropopause, which lay near 120 mb., had a potential temperature of about 385° A., and the characteristics of the typical tropical tropopause. It is not clear why a double tropopause should exist in the warm air, and one cannot even be sure that the second tropopause formed between the 16th and the 19th, for several soundings in the southern part of the cross-section for the former day did not reach high levels.

The wind maximum, about 100 knots from southwest, had moved a considerable distance northward and to a lower elevation, that is, to the northernmost stations, where the atmosphere was decidedly baroclinic.

On the cross-section for 0300 GMT December 22 (fig. 15) the shallow layer of Arctic air appeared in the lower layers of the Aklavik and Norman Wells soundings. But the maritime polar front had pushed southward to near Spokane in a deep layer. The jet stream with a wind maximum of 110 knots, also had advanced southward with the front. Both tropopauses were still clearly defined above the warm air and only slight changes in elevation had taken place. However, the subtropical tropopause had risen somewhat in advance of the ground position of the front and had lowered over the deepest cold tropospheric air. This seems to imply rising motion near the tropopause in the former region and sinking motion in the latter.

At this time the surface position of the High was near Boise. The barotropic structure of the High and almost vertical slope of its axis is shown by the nearly horizontal isotherms over the station, the slight variation in wind with height, and the very weak wind at almost all elevations. For example, the wind at 50 mb. at Boise was from 20° at 5 knots.

The cross-section for the 24th (fig. 16) contains much the same information as that for the 22d. The cold maritime air had continued to push southward as had the jet. However, the maritime polar cold front had become more diffuse and the height difference between the polar and subtropical tropopauses was less than on the 22d. The double tropopause structure still existed over the warm air.

It may be interesting to note that the temperature contrast, even as high as the 50-mb. level, was quite comparable to that at 700 mb.; for example, at 50 mb. Las Vegas was 24° C. colder than Norman Wells, while at 700 mb. Las Vegas was 27° C. warmer. However, at the lower elevations most of the temperature contrast was concentrated in a narrower band of latitude.

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REFERENCES

1. V. P. Starr, "On the Production of Kinetic Energy in the Atmosphere," *Journal of Meteorology*, vol. 5, No. 5, October 1948, pp. 193–196.
2. S. Petterssen, "Some Aspects of the General Circulation of the Atmosphere," *Centenary Proceedings of the Royal Meteorological Society*, 1950, pp. 120–155.
3. L. W. Sheridan, "A Study of Northern Hemisphere Pressure-Center Tracks," *Transactions, American Geophysical Union*, vol. 26, No. 1, February 1945, pp. 49–57.
4. U. S. Weather Bureau, "Weather of the Week," *Weekly Weather and Crop Bulletin, National Summary*, vol. XLI, Nos. 52 and 53, December 20 and 27, 1954.
5. S. E. Blewett and J. L. H. Paulhus, *Report on Six-Day Weather Types of North America*, California Institute of Technology, 1942, pp. 128–129.
6. E. B. Garriott, "Long-Range Weather Forecasts," Weather Bureau *Bulletin No. 35*, Washington, D. C., 1904, p. 61.
7. H. Wexler, "Anticyclones," *Compendium of Meteorology*, American Meteorological Society, Boston 1951, pp. 621–629.
8. R. Berggren, B. Bolin and C. -G. Rossby, "An Aerological Study of Zonal Motion, Its Perturbations and Break-Down," *Tellus*, vol. 1, No. 2, May 1949, pp. 14–37.
9. J. M. Austin and Collaborators, "Aspects of Intensification and Motion of Wintertime 500-mb. Patterns," *Bulletin of the American Meteorological Society*, vol. 34, No. 9, November 1953, pp. 383–392.
10. R. D. Elliott, R. E. Kerr, Jr., and W. G. Burke, "Handbook of Single-Station Analysis and Forecasting Techniques," U. S. Navy, Project AROWA, *Report 53-3*, Supplement No. 1, July 1953.
11. H. Riehl, "Jet Stream in Upper Troposphere and Cyclone Formation," *Transactions, American Geophysical Union*, vol. 29, No. 2, April 1948, pp. 175–186.

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