A COLD FRONT INVASION OF SOUTHERN VENEZUELA

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ABSTRACT

A cold front is found with the aid of IGY data to have penetrated from the Southern Hemisphere to 5° N. in southern Venezuela. The cold front is the most evident synoptic weather feature related to heavy rain in southern Venezuela at that time.

1. INTRODUCTION

Polar air from time to time penetrates deep into the Tropics. These polar outbreaks have a marked effect on the tropical weather.

Residual cold fronts from the North American continent are a well-known if occasional cause of heavy rains and floods in the Coast Ranges of northern Venezuela, at about 10° N. Such rains have been described by Gol [1] and occur at the height of the Northern Hemisphere winter.

This note presents evidence that residual cold fronts may also reach Venezuela from the Southern Hemisphere. A residual cold front crossed the equator in July 1957 in northern Brazil and appears to have been a factor in heavy rains in the Guayana Highlands of southern Venezuela at 5° N. At least one similar cold-front penetration to the Northern Hemisphere has been cited earlier in the literature.

The findings of this case study also have implications as to the character of the Intertropical Convergence Zone (ITCZ). No such zone was found as a definite weather entity during the period studied.

2. THE FRIAGEM

A cold outbreak into the upper Amazon Basin, called "friagem" in Brazil, is common enough in Southern Hemisphere winter. A synoptic description of this phenomenon has been given by Serra and Ratisbonna [2]. Their charts include one extreme outbreak when a cold front penetrated northward across the equator in July and August 1928. These charts are reproduced in figure 1.

3. BACKGROUND FOR STUDY AND DATA

This study began as an investigation of what was thought to be a purely tropical rain. The presence of the cold front was initially unsuspected by the author.

Heavy rain fell over the Guayana Range in southern Venezuela on July 21, 22, and 23, 1957. Gol [1] estimated from scanty data that more than 100 mm. of rain fell in the 24-hr. period ending on the morning of July 22 over much of the Guayana Highlands, with a 300-mm. center at the position shown in figure 8. He estimated that in the following 24 hr. a band of rainfall with several 100-mm. centers stretched along the sixth parallel in Venezuela slightly north of the rain area of the preceding day.

Daily weather maps published by the Venezuelan Meteorological Service [3] normally contain little or no Brazilian data and the daily maps of the Brazilian Meteorological Service [4] contain little or no Venezuelan data. Thus the equatorial region is on the fringes of both weather charts and can not normally be analyzed in a definitive way. However, since July 1957 was within the International Geophysical Year (IGY), the availability of special IGY collections of weather data facilitated the construction of weather charts for this heavy, supposedly equatorial rain.

Daily 1200 GMT surface weather charts for July 17 through July 22, 1957, are shown in figures 2 through 7. Most of the data to construct these charts were obtained from the IGY data depository at the National Weather Records Center of the U.S. Weather Bureau at Asheville, N.C. The published daily weather maps of Venezuela and Brazil and forecast center synoptic weather charts from the U.S. Weather Bureau Office at San Juan, Puerto Rico were also consulted for additional data. Data between 20° S. and 25° S. correspond to the IGY maps, Part III [5] [6]. The tropical sections of the IGY maps—to extend from 20° S. to 20° N.—were not yet published.

To supplement the 1200 GMT reports, a few 0600 GMT ship reports were added to the maps. The ships' pressures have been corrected for the normal diurnal variation from 0600 GMT to 1200 GMT and are enclosed in brackets on the charts. At a few continental stations the pressure was consistently high or low in comparison with adjacent stations; this deviation was taken into account in constructing the isobaric analysis. High-elevation continental stations that reduce pressure to standard levels other than sea level were omitted.

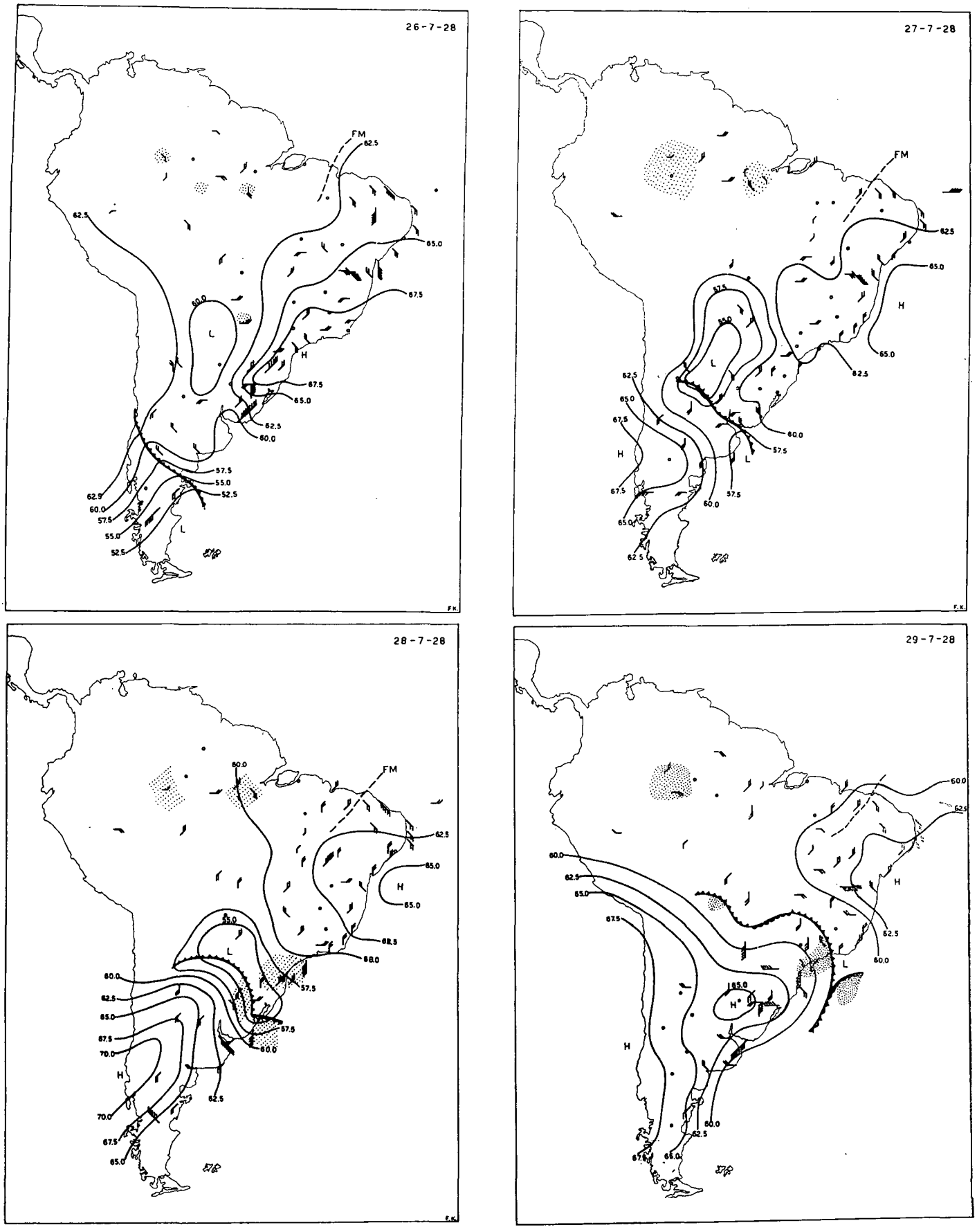

FIGURE 1.—(A). A *friagem* which reached the equator. Daily weather maps July 26–29, 1928. Sea level pressure in centimeters of mercury. (From [2].)

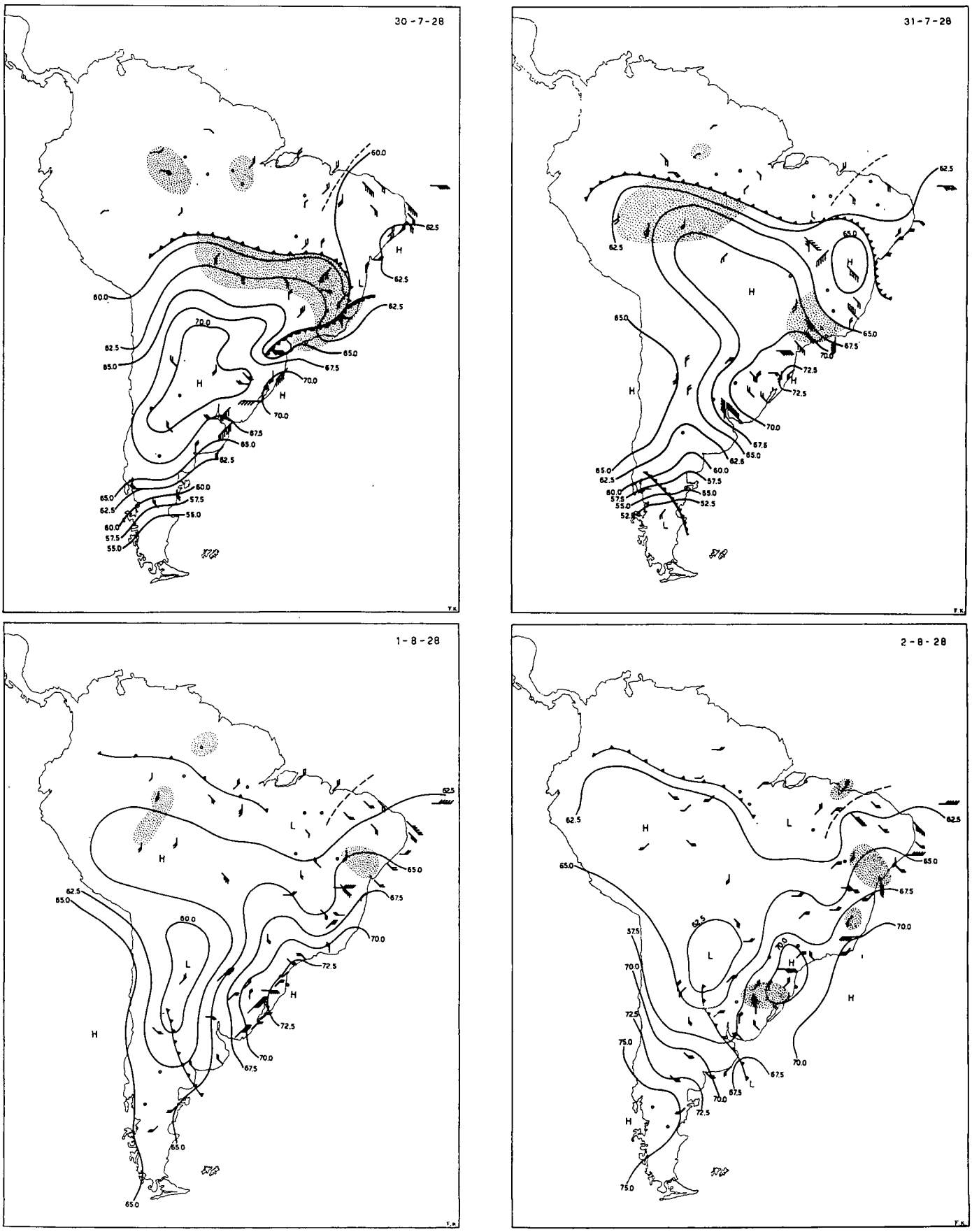

FIGURE 1.—(B). Daily weather maps for July 30–August 2, 1928. (From [2].)

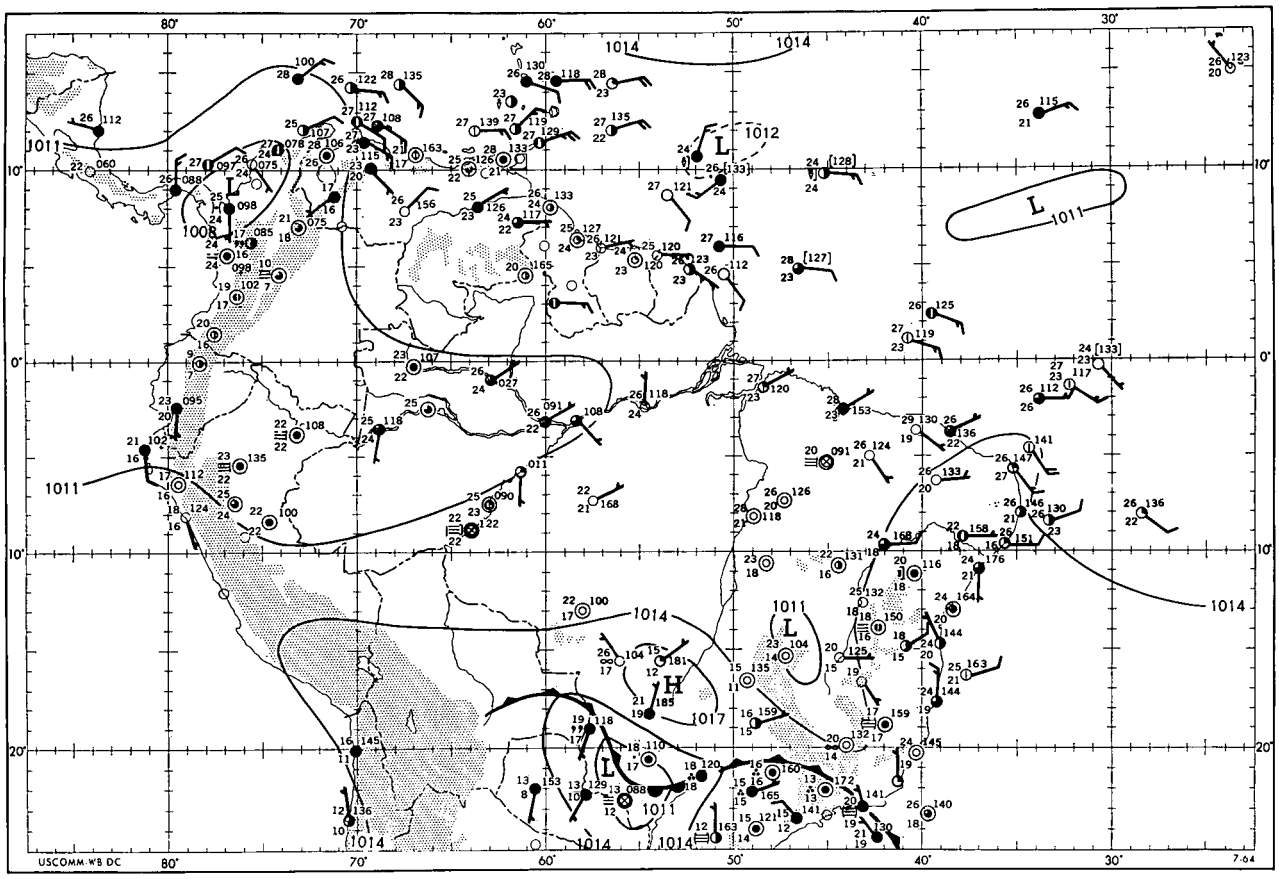

FIGURE 2. Surface weather chart 1200 GMT July 17, 1957.

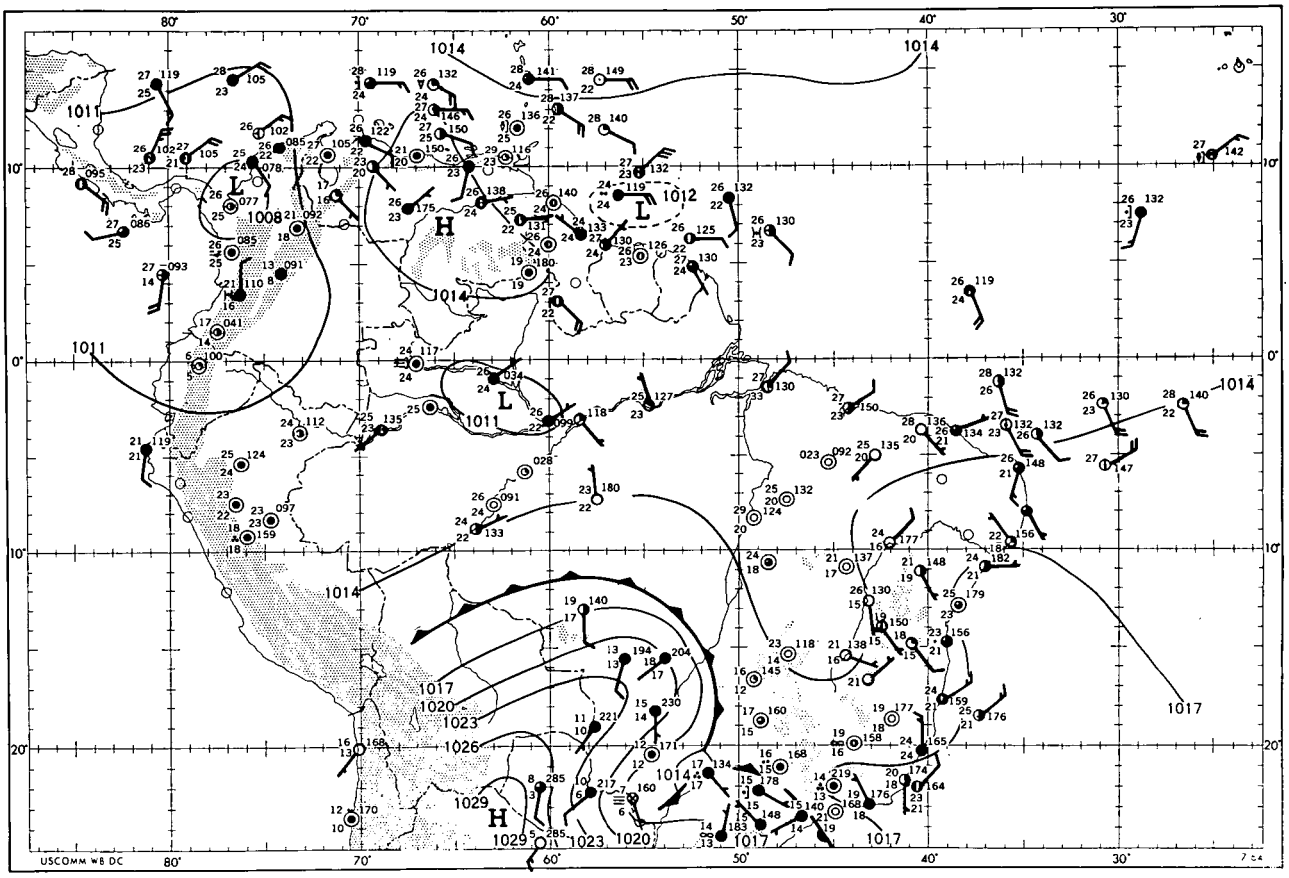

FIGURE 3.—Surface weather chart 1200 GMT July 18, 1957.

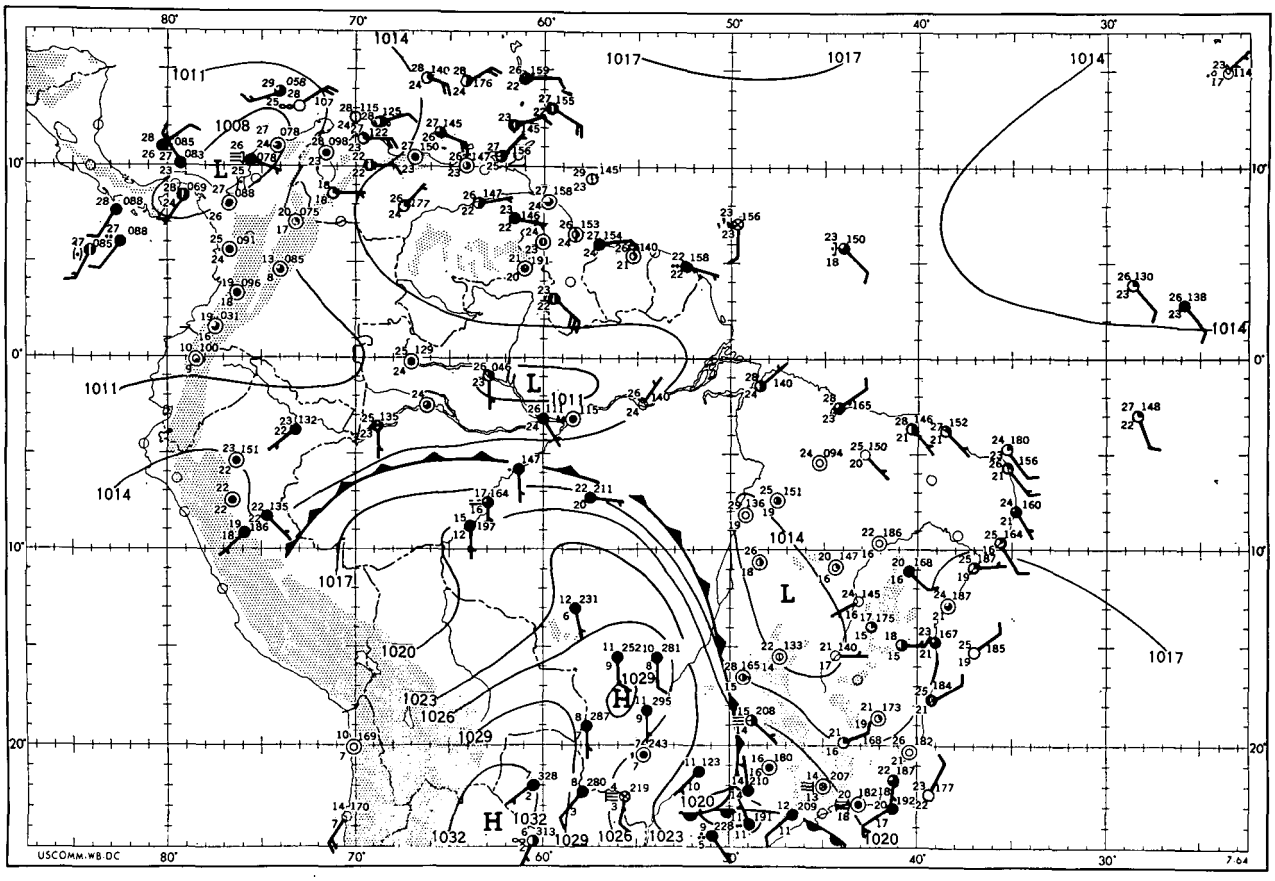

FIGURE 4.—Surface weather chart 1200 GMT July 19, 1957.

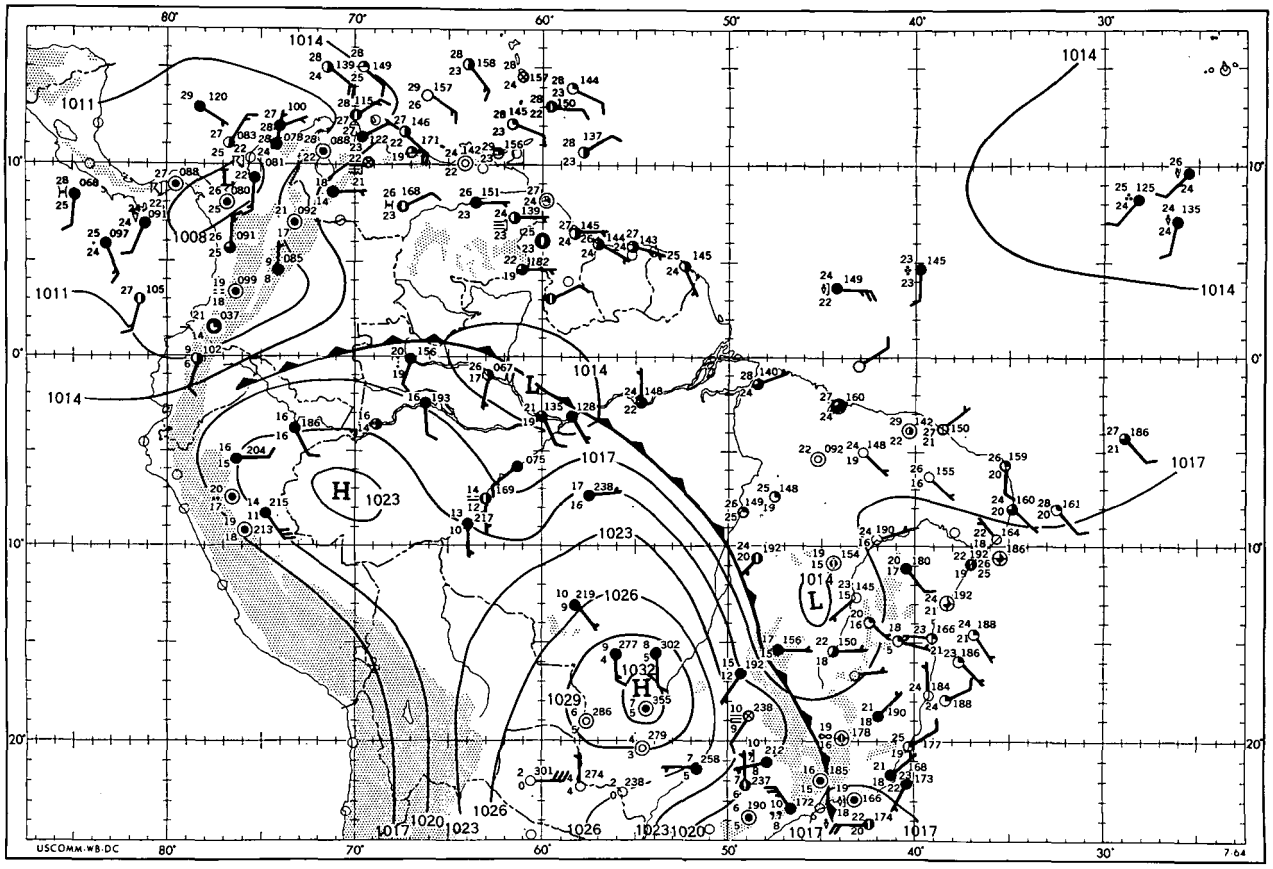

FIGURE 5.—Surface weather chart 1200 GMT July 20, 1957.

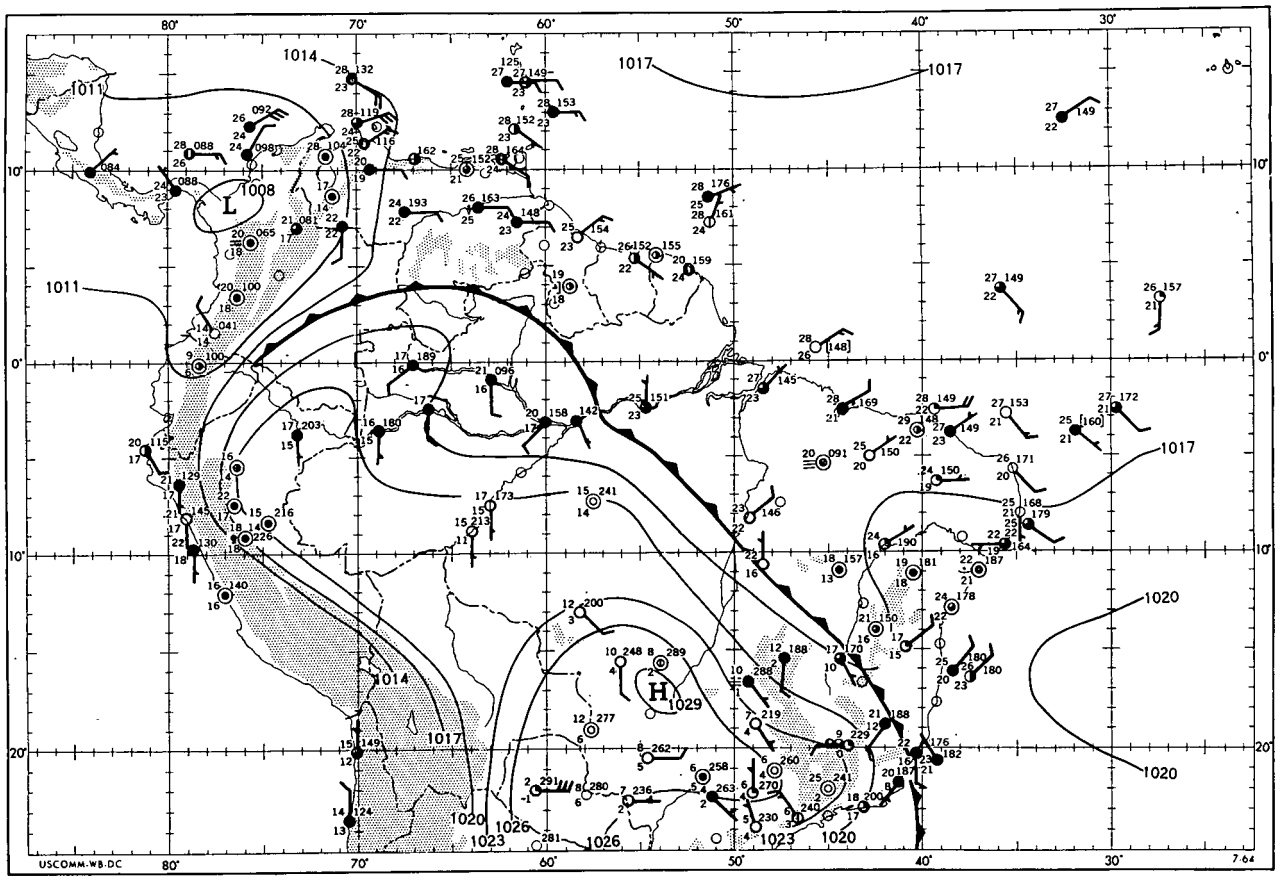

FIGURE 6.—Surface weather chart 1200 GMT July 21, 1957.

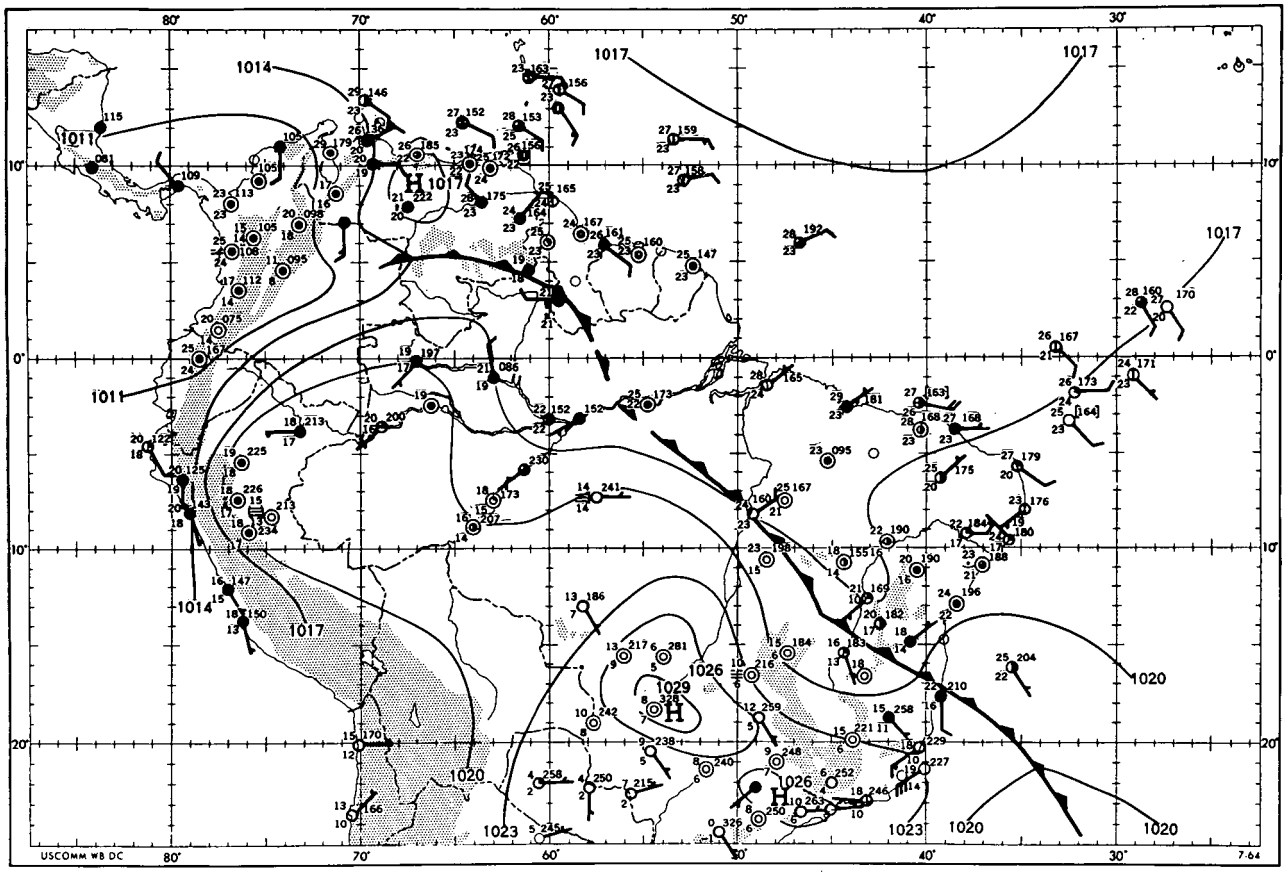

FIGURE 7.—Surface weather chart 1200 GMT July 22, 1957.

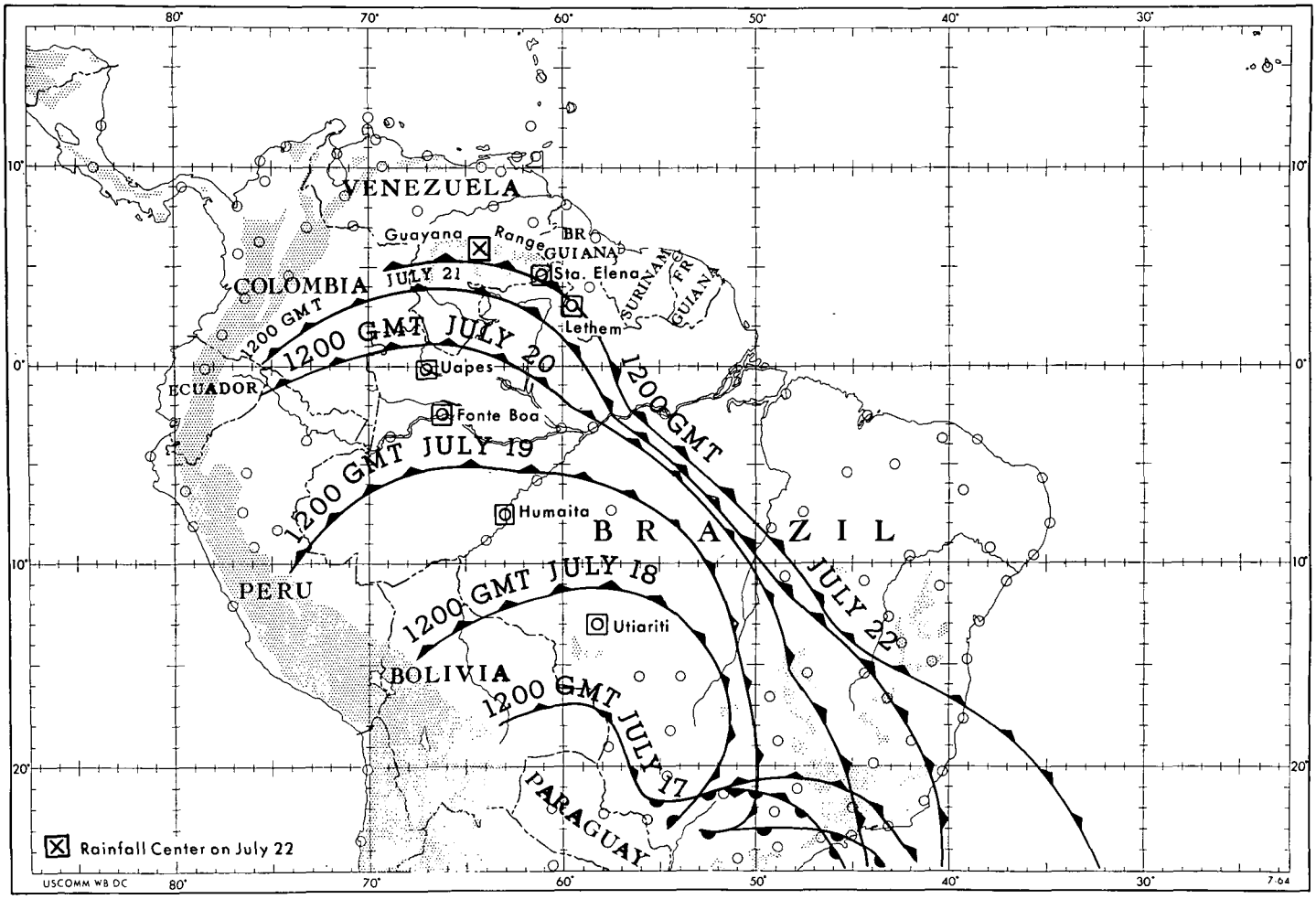

FIGURE 8.—Positions of cold front, July 17–22, 1957.

4. THE COLD FRONT

A cold front, found across southern Brazil and extending into Bolivia on July 17 (fig. 2), moved steadily northward during the next five days, after which it dissipated over equatorial regions. The successive frontal positions are shown in figure 8. The most telling evidence that a cold front did indeed pass is in the time sequence of the weather at selected stations shown in figure 9. The station locations are marked on figure 8. Changes in wind, temperature, dew point, weather, and pressure, though small, were quite definite at the four Brazilian stations and at Lethem, British Guiana. At Sta. Elena, Venezuela, the northernmost of the stations, it is conjectural whether or when a change in air mass was experienced.

It is judged that the cold air crossed the upper Amazon Basin by inertia from its previous motion and produced showers but no extraordinary rainfall amounts in the very light pre-existing flow. Upon reaching the mountains of Venezuela this cold air encountered a barrier to its further progress and tended to pile up to a greater depth. At the same time it encountered a more definite easterly flow of equatorial air from the Northern Hemisphere. The interaction of the two flows coupled with the orographic effects of the mountains and solar heating released heavy rain. The foregoing is surmised, as there is insufficient detail of weather data to identify specific rain-causing factors with certainty.

5. TROPICAL LOW

Higgs [7] has described a small tropical Low that developed at this time at an unusually low latitude and drifted toward the South American coast. This Low is shown on our charts at 10° N., 50° W. on figure 2 and southwest of this position the next day. There is no evidence from the surface maps that this disturbance in the Atlantic contributed to the Venezuelan rain. This does not entirely preclude the possibility that it still existed as a weak disturbance in the wind field aloft, or as a site of greater than usual moisture at intermediate levels, and had drifted to the region of the Guayana Highlands.

6. COMMENTS ON INTERTROPICAL CONVERGENCE ZONE

The map for July 17, 1957 (fig. 2) is probably a typical one for the season. The Intertropical Convergence Zone over the South American continent is weak. There is no

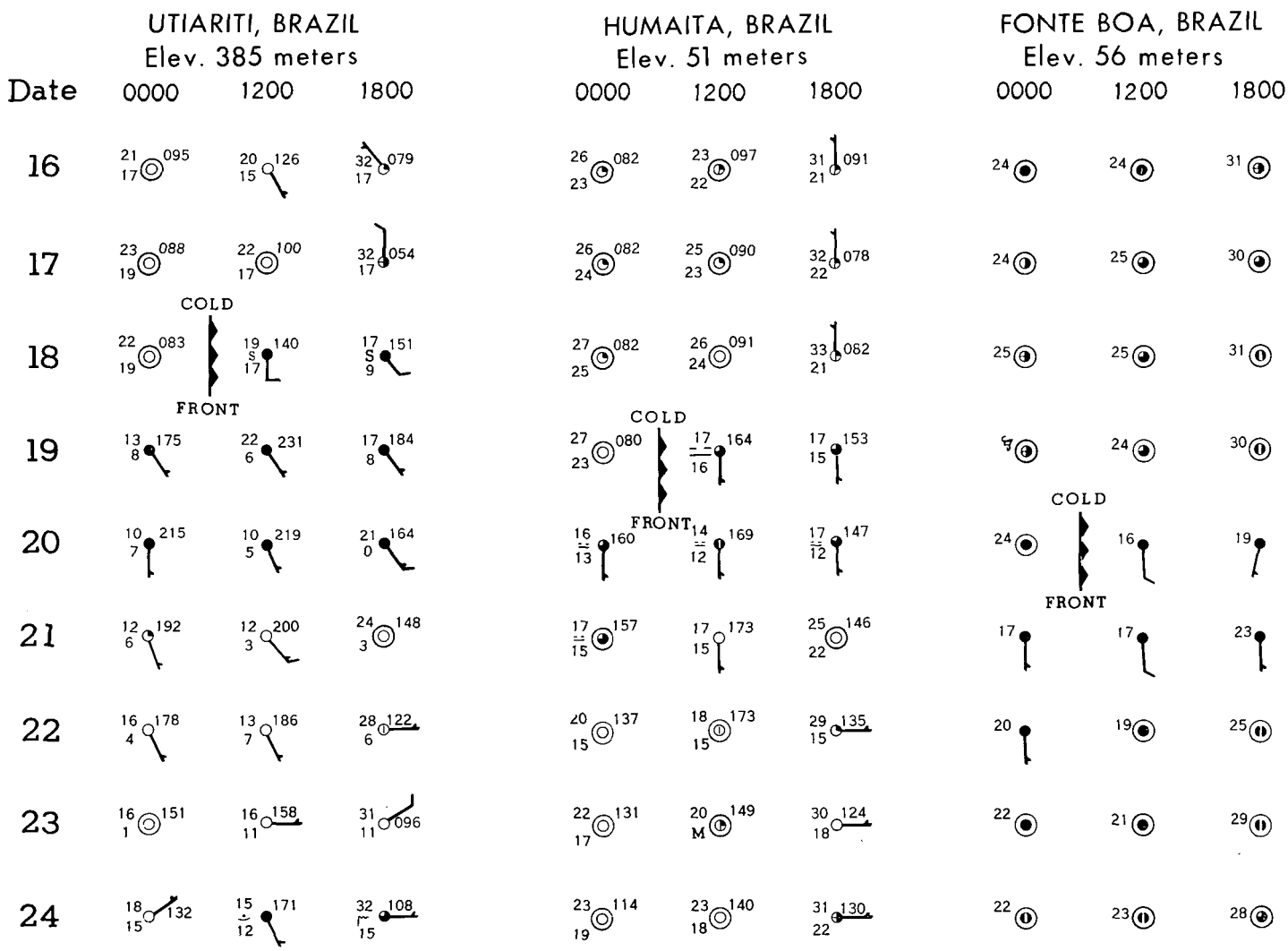

FIGURE 9.—Surface weather data, showing passage of cold front. Station locations are shown in figure 8. Time GMT.

marked confluence of air masses from the two hemispheres, nor are any extraordinary convective weather phenomena detected by the available stations. There is a weak trough of low pressure approximately along the Amazon River. Godske et al. [8] point out that the ITCZ in this region does not generally show marked convergence and that there is little predisposition to form a front. The ITCZ, lying on the fringes of almost all weather maps currently prepared for tropical America, is poorly understood and is frequently ascribed in a hazy fashion to be the cause of severe convective weather. Gol [1], lacking any definite evidence, was forced to assume that the July 1957 rains were the result of strong ITCZ action.

When improved communications facilitate the daily preparation by the respective Meteorological Services of weather maps that cover all of northern South America much of the mystery concerning the ITCZ should be rapidly dispelled. We suspect that if good enough data were available the synoptic practice of sketching an ITCZ for thousands of miles on weather maps day after day would diminish. The ITCZ could then represent restricted locations of true confluence of air streams. Satellite information also promises to sharpen understanding of the ITCZ [9].

7. CONCLUSIONS

1. It is found that a cold front moved northward across the equator in South America during a cold wave in July 1957. This adds to the evidence of unity instead of dichotomy between tropical and mid-latitude weather.

2. By implication, this phenomenon was associated with heavy rain in the Guayana Highlands of Venezuela at 5° N.

3. The Intertropical Convergence Zone, during the period depicted by the series of maps,was virtually nonexistent as an identifiable entity. Regional daily weather maps, dependent on improved communications facilities between National Meteorological Services, are needed in this region to show the real daily role of the ITCZ.

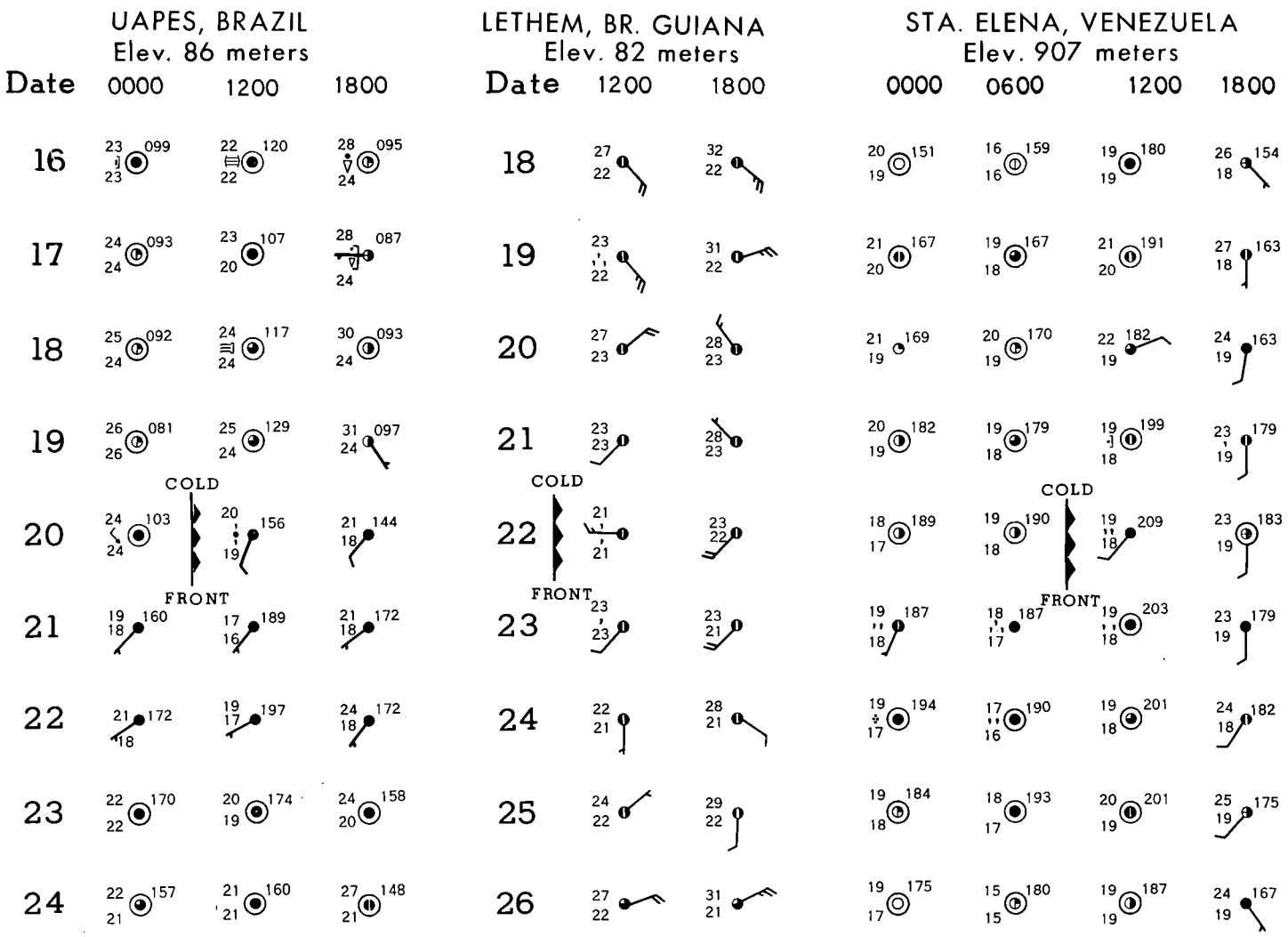

FIGURE 9.--Continued.

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