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THE "INVERTED V" CLOUD PATTERN—AN EASTERLY WAVE?

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ABSTRACT

"Easterly waves" in the tropical Atlantic have been found to be associated with a characteristic cloud pattern which has the appearance of an "Inverted V." Cloud bands are aligned approximately parallel to the lower tropospheric winds and change orientation along the wave axis.

One of the most interesting tropical cloud patterns observed by weather satellites during the 1967 Hurricane Season has been referred to as an "Inverted V." The first of these appeared near the West African coast in early June and was tracked westward across the Atlantic. During the next 3 mo this cycle was repeated a number of times. Simpson et al. (1968) noted the "Inverted V" but did not elaborate. It is the purpose of this paper to give a comprehensive description and to present evidence that this pattern is associated with wave perturbations in the lower tropospheric trade winds.

The term "Inverted V" was coined by operational personnel at both the National Hurricane Center and the National Environmental Satellite Center. These two units collaborated in daily map discussions during the 1967 Hurricane Season. In the briefings, it became convenient to label this pattern because of its recurring nature. Several names were suggested. In time, the term "Inverted V" became the most commonly used expression.

Four of the Inverted V's tracked in 1967 are presented in figures 1 through 4. Care must be exercised in generalizing the main cloud characteristics associated with any weather system because exceptions can usually be found. For example, Malkus et al. (1961) emphasized the individual nature of hurricanes suggesting that each possessed its own fingerprint; yet, there are features such as the eye wall which are common to all storms. It is these recurring features that one attempts to find. This is particularly true when associating circulation systems with satellite-observed cloud patterns. If cloudiness produced by a synoptic disturbance is not repetitive in character, one has little hope of ever being able to identify it from satellite photographs alone. In the Tropics, significant advancement has been made in understanding and interpreting satellite pictures of tropical storms and hurricanes, i.e. Sadler (1964), Fett (1964), Erickson (1967), and Fritz, Hubert, and Timchalk (1966). This has not been true with weaker disturbances where cloud organization is more variable and poorly defined; attempts to generalize these cloud patterns have not been very successful. Operationally, the stratification schemes of Fett (1966), Merritt (1964), and Arnold (1966) are of limited value. Partially this is because of the limitations inherent in the TIROS product on which these studies were based. In most cases, regular and complete views of patterns like the Inverted V were not possible. Arnold's work illustrates this point. One can see evidence of the Inverted V pattern in several of the pictures presented in his report. Yet, at the time of his study, distortion and gaps resulting from the narrow swath viewed by the TIROS satellite prohibited the identification of this pattern. The digitized cloud mosaics provide an exciting new tool for synoptic-scale investigations in the Tropics. Even though the digitizing procedure smoothes finer cloud elements, the advantages of having a daily cloud display on a standard map projection far overshadow other shortcomings.

Figure 5 is an attempt to show schematically several features of the Inverted V. In general, clouds assume a banded appearance. The bands are arranged in a pattern somewhat resembling a series of V's placed upside down; thus, the term Inverted V. Frequently the V's are considerably flattened or rounded. The number of bands or V's vary from case to case. Occasionally only part or half of the V's are present. When the pattern is well marked, one can find an axis that marks the apex of the V's and indicates the place where cloud bands change orientation. East of this axis, denoted by the heavy dashed line in figures 1 through 4, bands are orientated from northwest to southeast; whereas to the west of the axis, the bands are southwest to northeast. The pattern has reasonably good day-to-day continuity.

Other points that can be observed in figures 1 through 4 include:

1) The cloud organization is on a synoptic scale covering an area of nearly 1,000 sq mi extending at times from 5°–25°N and persisting for several days. Some Inverted V's were tracked for nearly a week as they crossed the Atlantic from Africa to the Caribbean Sea.

2) The systems moved westward at a speed nearly equal to the mean speed of the trade winds. The average speed for the Inverted V's that crossed the Atlantic was 15.6 kt and ranged from 12 to 19 kt.

3) The Inverted V is best defined in the eastern and central Atlantic and becomes less distinct as the pattern moves westward. In almost every case during 1967, the pattern disappeared either near or before reaching the Antilles Islands. Even though the Inverted V is gen-

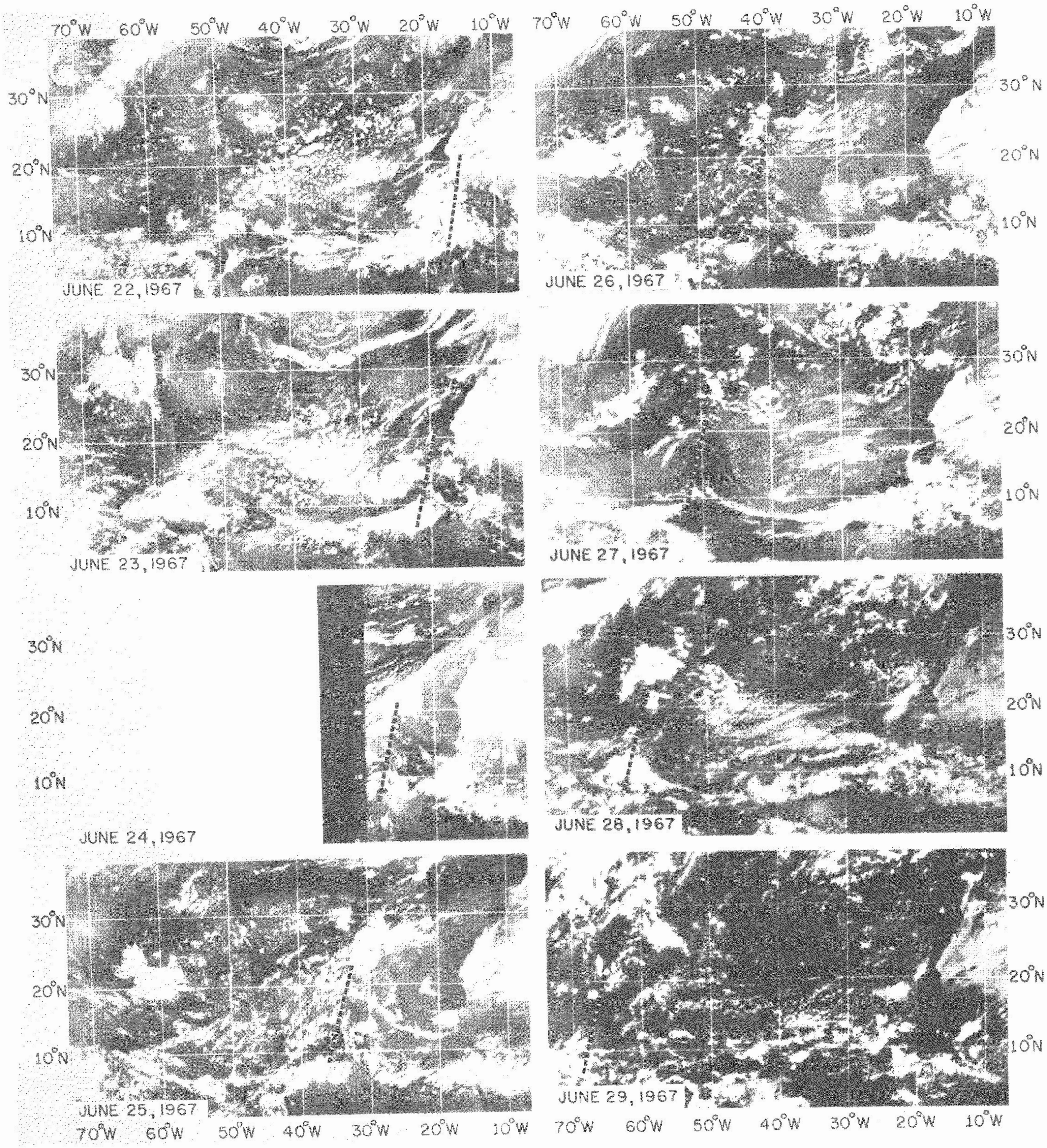

FIGURE 1.—A series of eight digitized cloud mosaics showing the history of an Inverted V cloud pattern that moved across the Atlantic The dashed line indicates the apex of the Inverted V.

erally better organized in the eastern Atlantic, the pattern usually does not become prominent until arriving at 25°–30°W.

4) The Intertropical Convergence cloud zone may or may not be a part of the pattern. In figures 1 and 2 the ITC cloud band is part of the Inverted V; whereas in figure 3 this zone of cloudiness is nearly undisturbed.

Considering the scale of cloud organization, it seems logical to conclude that a synoptic-scale circulation system must be responsible. The next step was to identify this feature by analyzing the flow pattern at various levels. The surface map was examined first because of data considerations. Surprisingly, neither the pressure nor wind varied significantly across the Inverted V patterns.

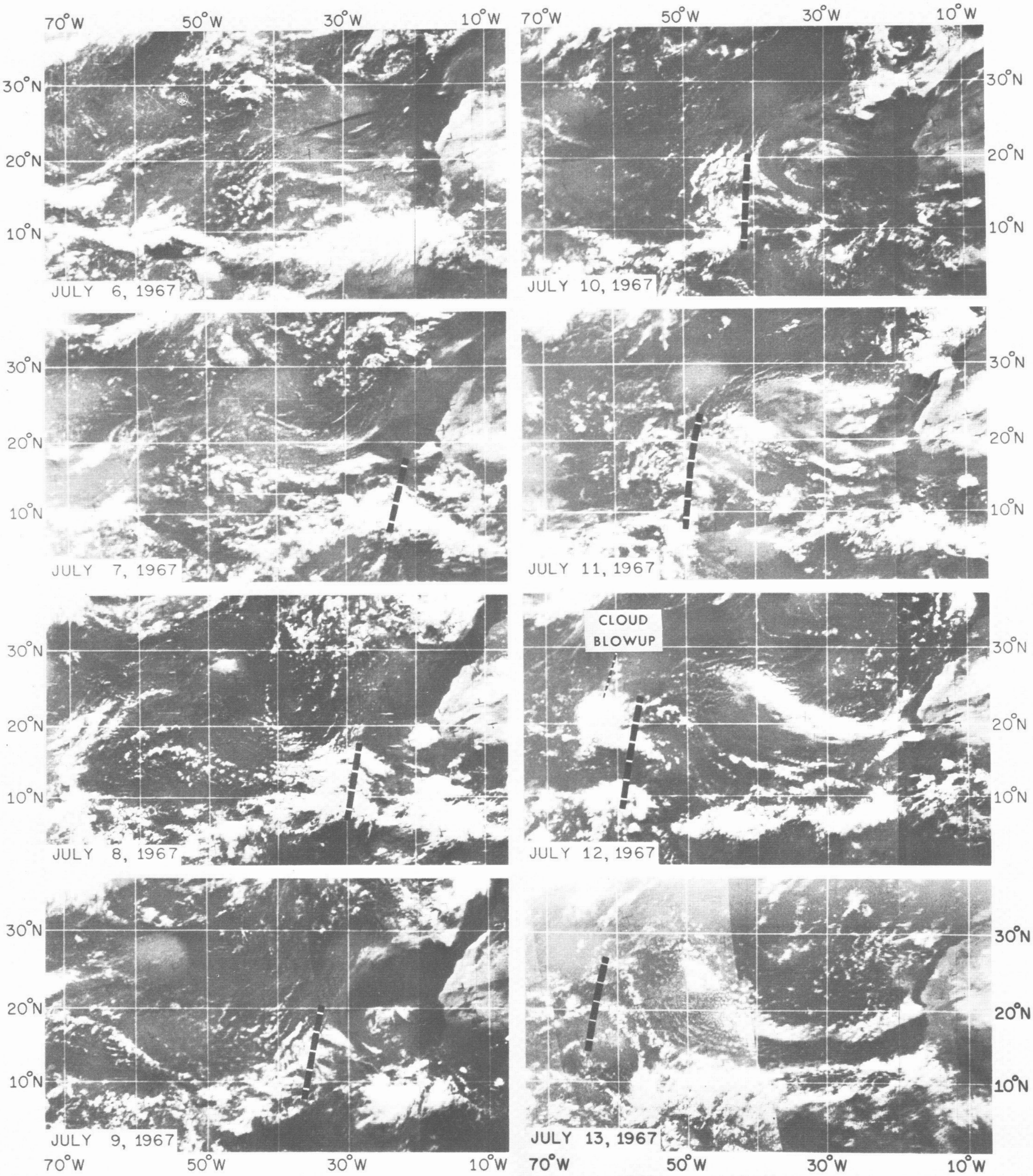

FIGURE 2.—Same as figure 1.

Next, the upper troposphere was investigated. Sparse jet aircraft reports provide some knowledge about the circulation patterns between 30,000 and 40,000 ft. Again, nothing was found that would shed light on the Inverted V patterns.

Finally, attention was focused on the middle troposphere where unfortunately data are very sparse. Insight into the circulation features at this level over the mid-Atlantic must be deduced indirectly utilizing time continuity from known conditions at the boundaries, i.e., Africa and the Caribbean Sea. Time sections proved to be the most useful analysis tool.

Figure 6 is a time section for Dakar (upper half) and for the Antilles Islands (bottom) for the period June 1

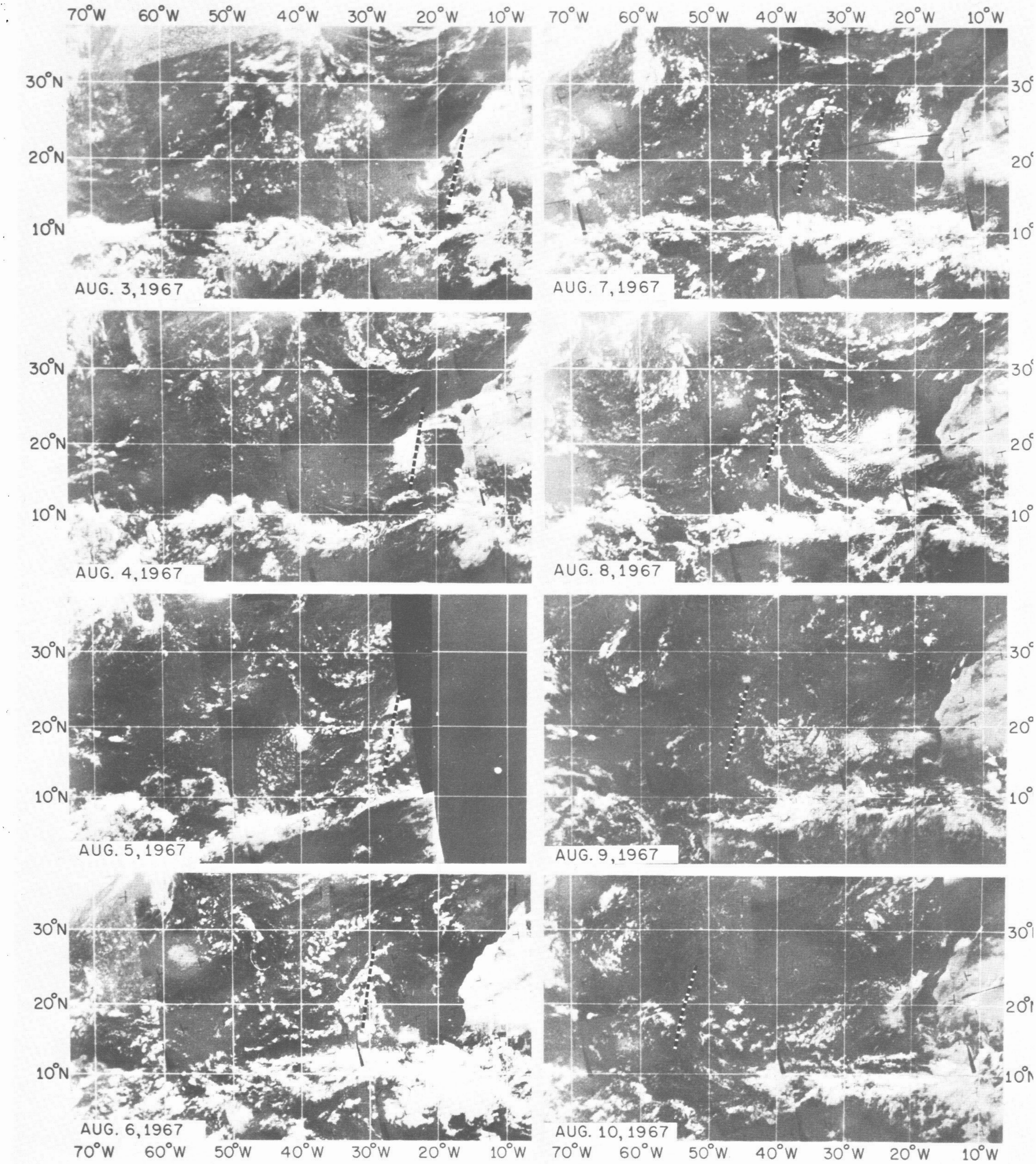

FIGURE 3.—Same as figure 1.

to August 20. Beginning in late August a series of stronger depressions moved off the African coast. Most of these were associated with a vortex or vortical cloud structure and the Inverted V pattern was not nearly so common in September and October. Therefore, this study was confined to the earlier part of the summer. Wave perturbations that passed these stations have been indicated by a heavy dashed line. Selected RAWIN's have been plotted to show the wind shift associated with these waves. The length of the dashed line reveals the vertical extent of the layer affected. Simpson et al. (1968) adopted a set of definitions that are to be used in the World Meteorological Organization (WMO) Regional Center for Tropical Meteorology in Miami, Fla. The term "tropical wave"

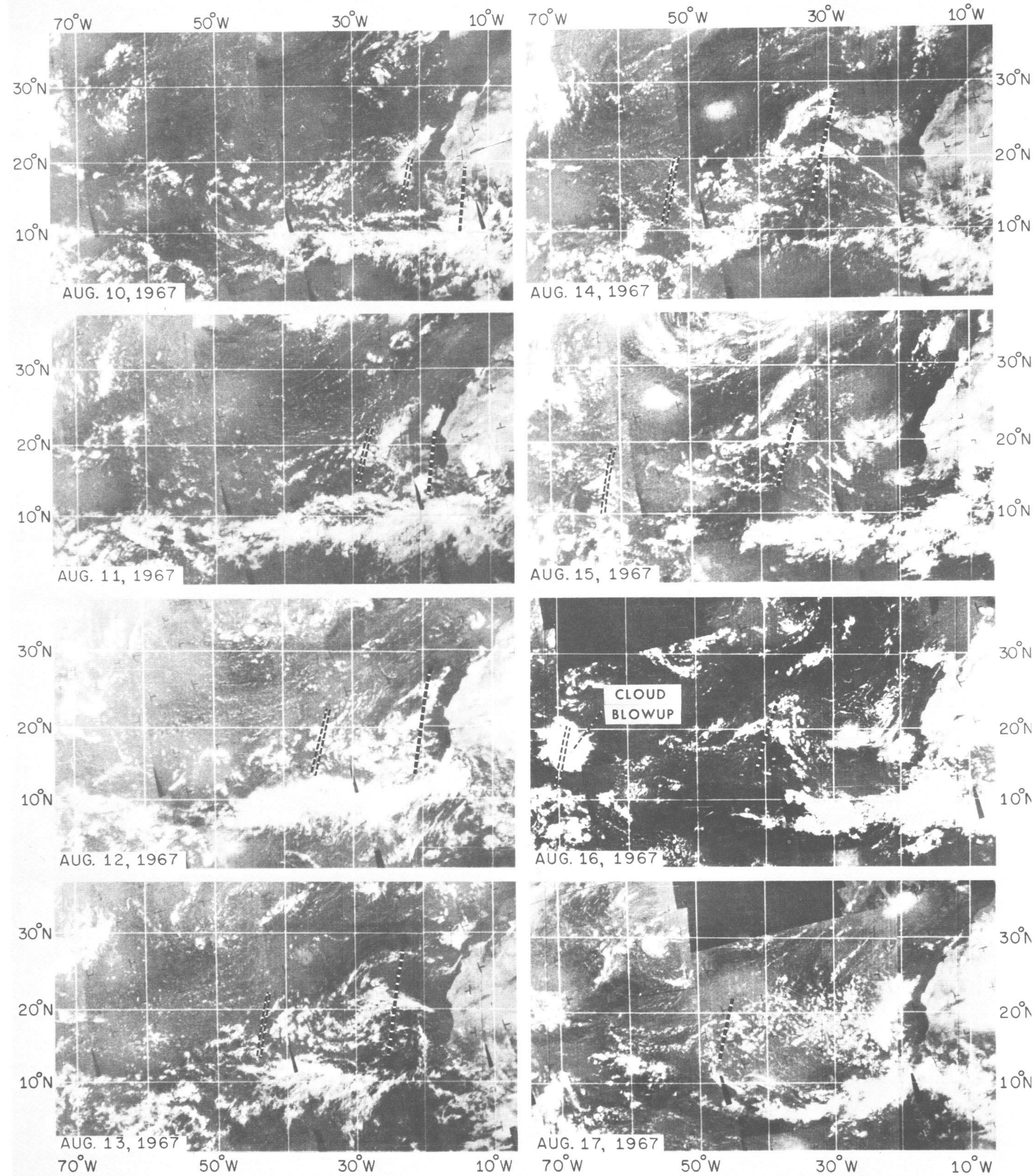

FIGURE 4.—Same as figure 1. A second wave axis is indicated by a double dashed line.

refers to any circulation feature that produces a trough, or cyclonic curvature maximum, in the trade wind easterlies. Subcategories of the tropical wave include: 1) downward reflections of upper cold Lows, 2) equatorial extensions of midlatitude troughs, and 3) the classical easterly wave, which has maximum amplitude in the lower or middle troposphere. In this note, primary emphasis will be on the easterly wave type unless otherwise specified.

It became apparent that these tropical waves were directly associated with the Inverted V cloud patterns. During the 2½-mo period of this study, 19 perturbations passed Dakar and each was accompanied by a cloud pattern that could be followed. Fourteen were of the Inverted V type, two were connected directly with the ITC, and three appeared similar to the "Inverted V" but lacked the banded character. In the latter three cases, an area of enhanced cloudiness could be tracked westward in conjunction with a moving cloud protrusion on the ITC. The ITC cloud zone was part of the cloud pattern in eight of the 14 Inverted V cases. In the remaining six cases, the ITC cloud band was essentially undisturbed. This latter observation gives strong support to the idea that the "Inverted V" pattern is caused by trade wind wave perturbations rather than ITC systems. If ITC disturbances were the responsible mechanism, then their presence should be reflected in the ITC cloud band. Since this was not always true, the easterly wave hypothesis appears to be more acceptable.

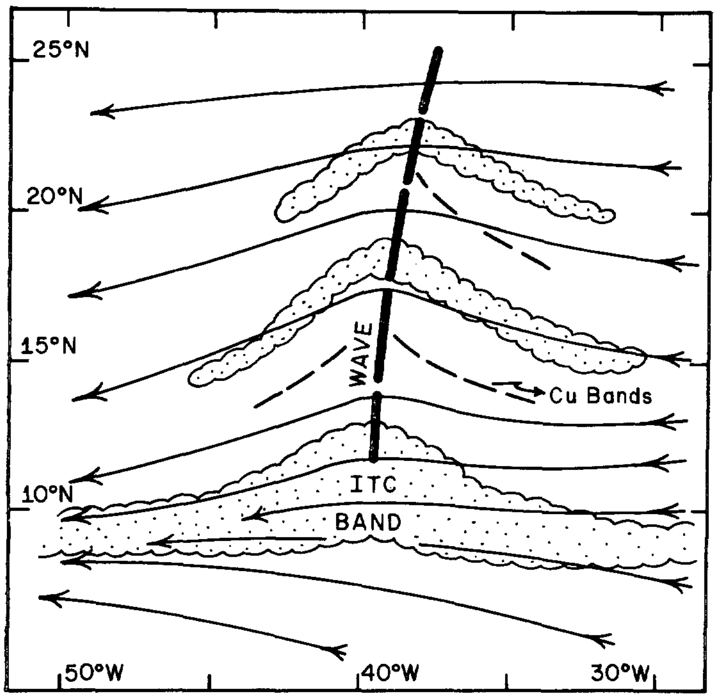

FIGURE 5.—A schematic showing the relationship between the lower tropospheric flow and the Inverted V cloud pattern.

The history of tropical waves, as determined by satellite pictures, is shown along the central portion of figure 6. When a wave passed Dakar and could be tracked as an Inverted V on the satellite pictures to the Lesser Antilles, the troughs were connected on the two time sections. If the cloud organization was so poor that satellite photographs could not be used to verify the ocean crossing, it was assumed that the system weakened somewhere between Africa and the Caribbean. Likewise, trough formation in the mid-Atlantic was assumed for those systems that passed the Antilles but could not be tracked back to Africa on the satellite photographs. It is possible that several of the perturbations which have been shown as forming over the Atlantic may have, in actuality, originated over Africa. For example, the troughs that moved by Dakar on July 3 and July 31 may be the perturbations that passed the Antilles on July 9 and August 7.

Thirteen of the 19 perturbations that passed Dakar could be tracked across the ocean and into the Caribbean. Six are shown to have weakened before reaching the Antilles. During the same period, 20 tropical waves passed the Antilles of which one was a downward reflection of an upper cold Low and six are indicated to have formed over the ocean. In this summary, the only cold Lows

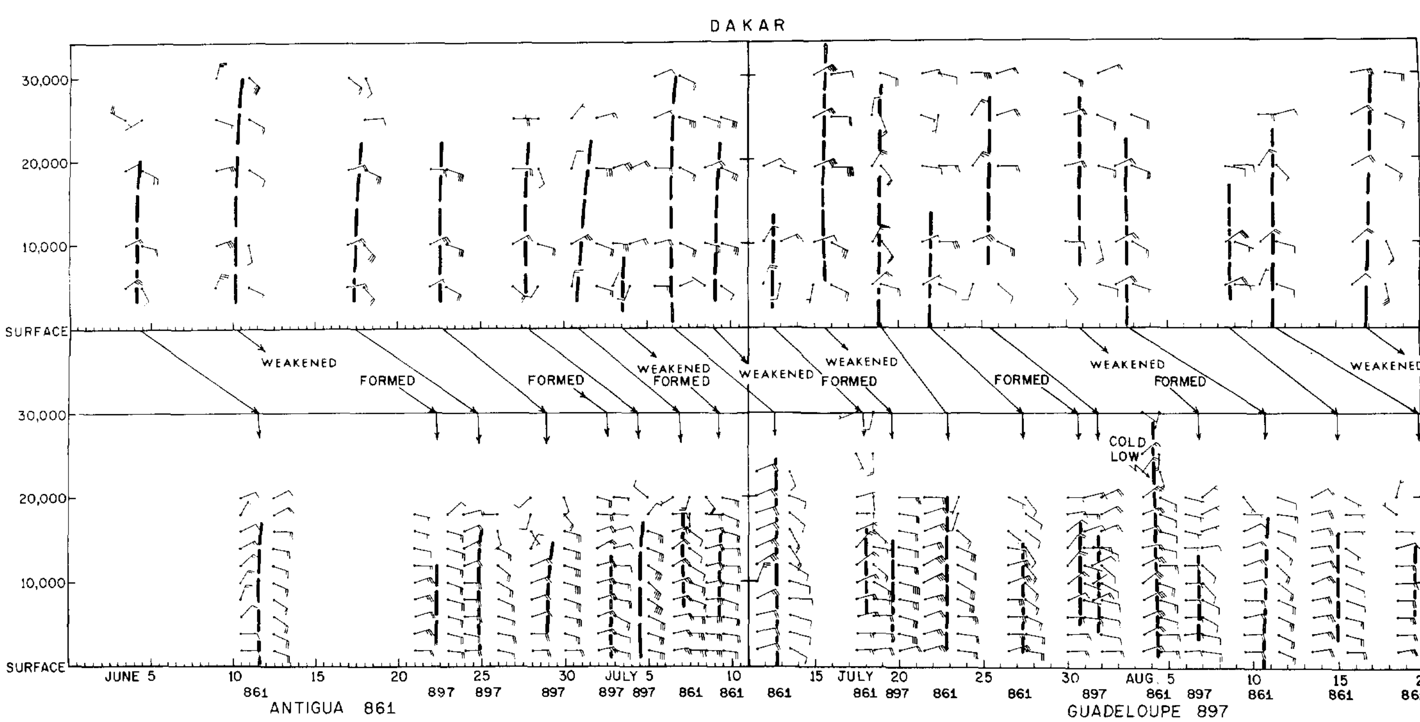

FIGURE 6.—Selected portions of the time sections for Dakar and various stations in the Antilles Islands showing the vertical wind structure of easterly waves that passed each location. The layer influenced by the wave is shown by the heavy dashed line. Lines between the two time sections indicate the history or continuity of the waves.

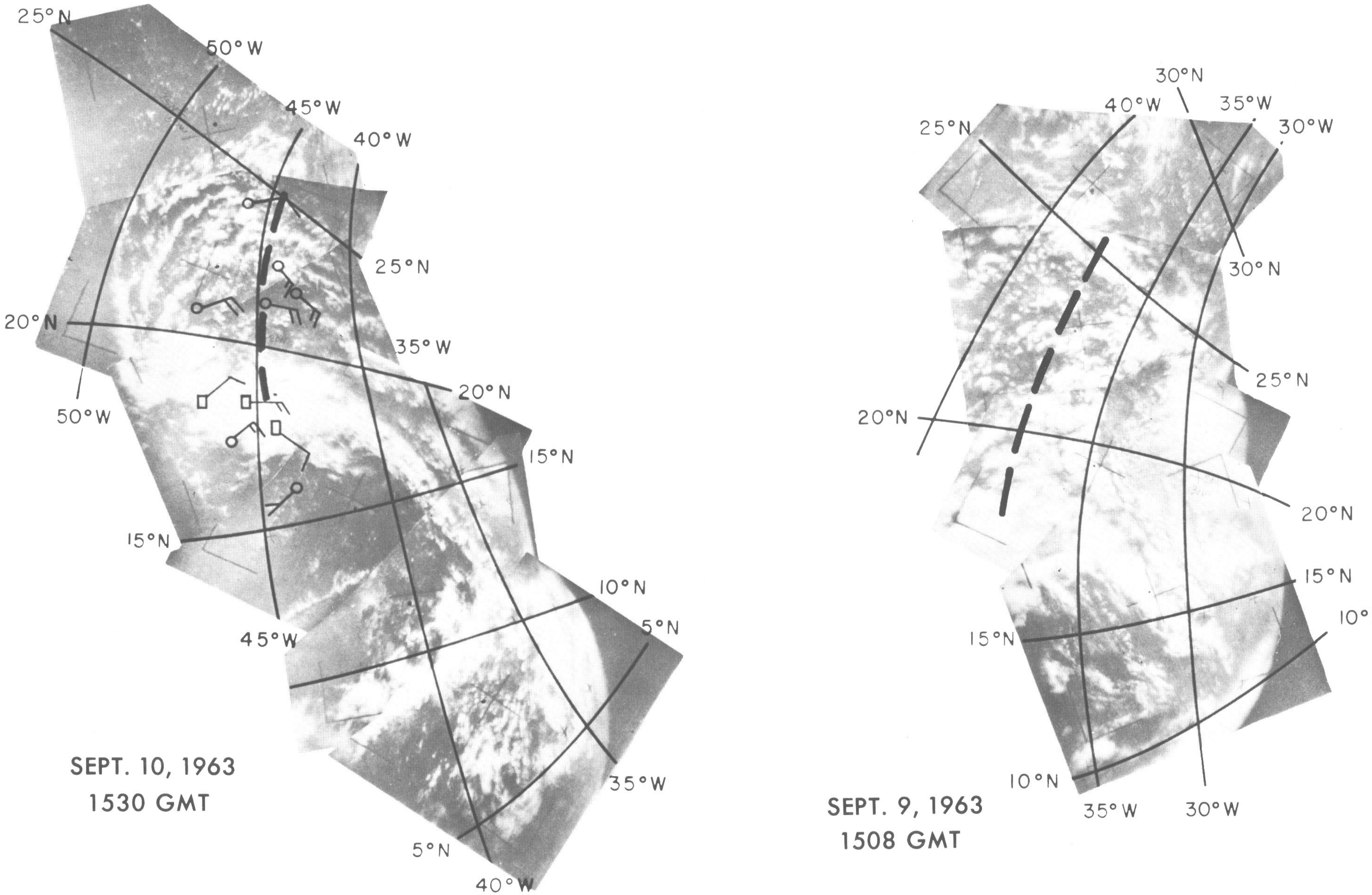

FIGURE 7.—An Inverted V cloud pattern observed by the TIROS satellite in 1963. Superimposed on the September 10 mosiac is a 36-hr composite of ship reports (open circles) and one low-level reconnaissance flight (open squares) showing a surface trough (dashed line) extending northward from a Low near 17°N, 45°W.

considered were those reflecting downward below the 700-mb level.

Two interesting facts may be noted on figure 6. Waves that passed Dakar were generally more intense and affected a much deeper layer of the atmosphere than those which moved by the Antilles. Fifteen of the 19 Dakar perturbations exerted their influence above 500 mb while only three of the 20 reached this level in the Antilles. This excludes the wave which was a downward reflection of an upper cold Low. Restricting attention to the 13 waves that crossed the Atlantic, 12 extended above 500 mb as they passed Dakar while only three affected this level on the Antilles. From this we can conclude that wave perturbations weaken and lose amplitude on their transoceanic journey. In general, this trend continues as systems move westward across the Caribbean. It is not uncommon to observe a rather strong perturbation in the Lesser Antilles that loses intensity and becomes almost indiscernible by the time it reaches the western Caribbean. The observed tendency for weakening is not altogether unexpected. It is generally agreed that easterly waves are cold-core systems. This implies an indirect circulation. Unless the relative cold air is replenished, gradual warming occurs and the circulation loses strength. In the rare case, convective processes become concentrated and produce the local heating required for tropical storm development. The far more common sequence is for waves to lose intensity as they move westward.

A second observation concerns the base of the perturbations. Only three of the 20 Antilles waves could be seen in the surface wind pattern. This suggests that the surface streamline map is a poor chart for tracking weaker wave perturbations and may explain why Aspliden et al. (1965) found no evidence of easterly waves in their surface analysis. This statement is not intended to imply that surface data are not important. Dunn's (1940) isallobaric centers are most useful. The cyclones followed by Aspliden et al. were mainly connected with the ITC. Their origin may have been associated with frictional convergence in the boundary layer, in accordance with the general ideas of Charney (1958) and Charney and Eliassen (1964*a*, 1964*b*). This process was recently reemphasized by Gray (1967).

Figure 6 reveals that maximum wave amplitude is usually between 5,000 and 15,000 ft, in full agreement with Riehl's (1945) classical easterly wave model.

The wave axis in the wind field appears to be located along the apex of the Inverted V cloud pattern. This relationship could not accurately be determined in 1967 because so few of the perturbations influenced the surface pressure pattern where data were available; however, an excellent documentation of this correlation occurred in 1963. The TIROS satellite viewed a well-organized Inverted V on September 9 and 10, which was associated with a strong pressure trough on the surface map, figure 7. There was even evidence of a weak circulation center near 17°N, 45°W. A 36-hr composite of ship reports has been superimposed on the September 10 TIROS mosaic. These data reveal the wave axis and low pressure center.

The schematic in figure 5 shows the proposed relationship between clouds and circulation. Cloud bands are aligned nearly parallel either to the lower tropospheric winds or to the shear, changing orientation at the wave axis. The sharp change in band orientation seen on July 10 and 13 and August 7, 8, and 16 suggests that bands are probably more closely aligned to the lower level wind shear than to the flow at any one level. This has been indicated in figure 5 where the cloud bands are shown to have a cross-flow orientation. This weather distribution is at variance with Riehl's (1945) classical model, although he did suggest that weather may be concentrated along convergence asymptotes. It also disagrees with a conclusion made by Fett (1966) who states "the classical easterly wave model which can include embedded vortices is extremely well related to observations obtained by satellites." However, the Inverted V does resemble closely the cloud distribution associated with a wave investigated by Malkus and Riehl (1967) in the Pacific. They found cloud bands aligned parallel to the wind and changing orientation at the wave axis.

The easterly wave model has provoked considerable controversy since its conception in the midforties. This, in part, is because some meteorologists have tried to interpret every disturbed weather area within the framework of this model. Simpson et al. (1968) have correctly implied that "the model" has been grossly overworked. As might be expected, this error in logic has led to unwarranted conclusions and unjust criticism. However, there have been numerous occasions when the circulation features appeared to agree with the classical model and still the weather pattern had little or no resemblance to it. There also appear to be significant geographical differences in both the nature and frequency of easterly waves. Thompson (1965) states emphatically that they "play no part in weather of the continent of Africa." Sadler (1966) questions their reality in the Pacific and implies the same may be true for other parts of the world. This conclusion is readily refuted by a number of studies, particularly in the Atlantic, of which two of the most recent are by Lateef and Smith (1967) and Krishnamurti and Baumhefner (1966). Even in the Pacific, Yanai (1961) recently described a typhoon formation from such a feature. Regardless of the viewpoint, the fact remains that the weather distribution described by the classical model is not always observed and this has destroyed confidence in the concept.

Satellite pictures in 1967 reveal two factors that may shed light on discrepancies between classical ideas and observations. First, it has already been noted that wave perturbations decrease in amplitude and intensity as they move westward across the Atlantic. This trend is also observed in the cloud structure, which frequently becomes unrecognizable by the time disturbances reach the Antilles. All four of the examples shown in figures 1 through 4 displayed this tendency; thus, the easterly wave cloud patterns over the Caribbean may not be typical.

A second and perhaps more serious complication concerns the extreme day-to-day variability of cloudiness associated with perturbations in the eastern Caribbean.

In spite of the fact that cloudiness generally decreases as disturbances move westward, a temporary blowup in cloudiness often occurred over the eastern Caribbean. Figure 4 shows an excellent example of this phenomena. Aside from the Inverted V identified in figure 4 by the heavier dashed line, a second wave perturbation is indicated by a double dashed line. Figure 6 shows that the latter disturbance was weak and cloudiness associated with it did not display any banded character. However, close examination reveals that an area of enhanced cloudiness can be followed across the Atlantic. The dramatic increase in cloudiness on August 16 is readily seen near 17°N, 68°W. This appears to be directly related to the flow pattern in the high troposphere. Simpson, Garstang, et al. (1967) recently documented a similar occurrence and concluded that the changes in cloudiness "are related to relatively small and subtle changes in the wind field at or above 500 mb." In the mean, an upper tropospheric trough, oriented east-northeast-west-southwest, is located across the Carribbean islands in the vicinity of Hispaniola or Puerto Rico during the summer months. This trough is similar to the summer mid-Pacific upper trough shown on the maps of Wiederanders (1961). Wave perturbations in the trades normally come under the influence of the Atlantic trough in the eastern Caribbean. Interaction between features in the upper and lower troposphere apparently produce a temporary enhancement of cloudiness. This correlation is illustrated in figure 8, which shows the 200-mb streamline pattern for the cloud blowup on August 16. The large overcast area is seen just east of the upper trough axis. A second example of cloud blowup is seen on July 12 near 21°N, 62°W, figure 2.

Ten of the 19 perturbations that crossed the Antilles exhibited a temporary cloud blowup over the eastern Caribbean which usually lasted only 1 day. The 200-mb pattern was examined for all 19 cases. Table 1 summarizes the results. The prevailing 200-mb flow over the eastern Caribbean was divided into three categories. Southeast to west flow indicates a trough or Low to the west or

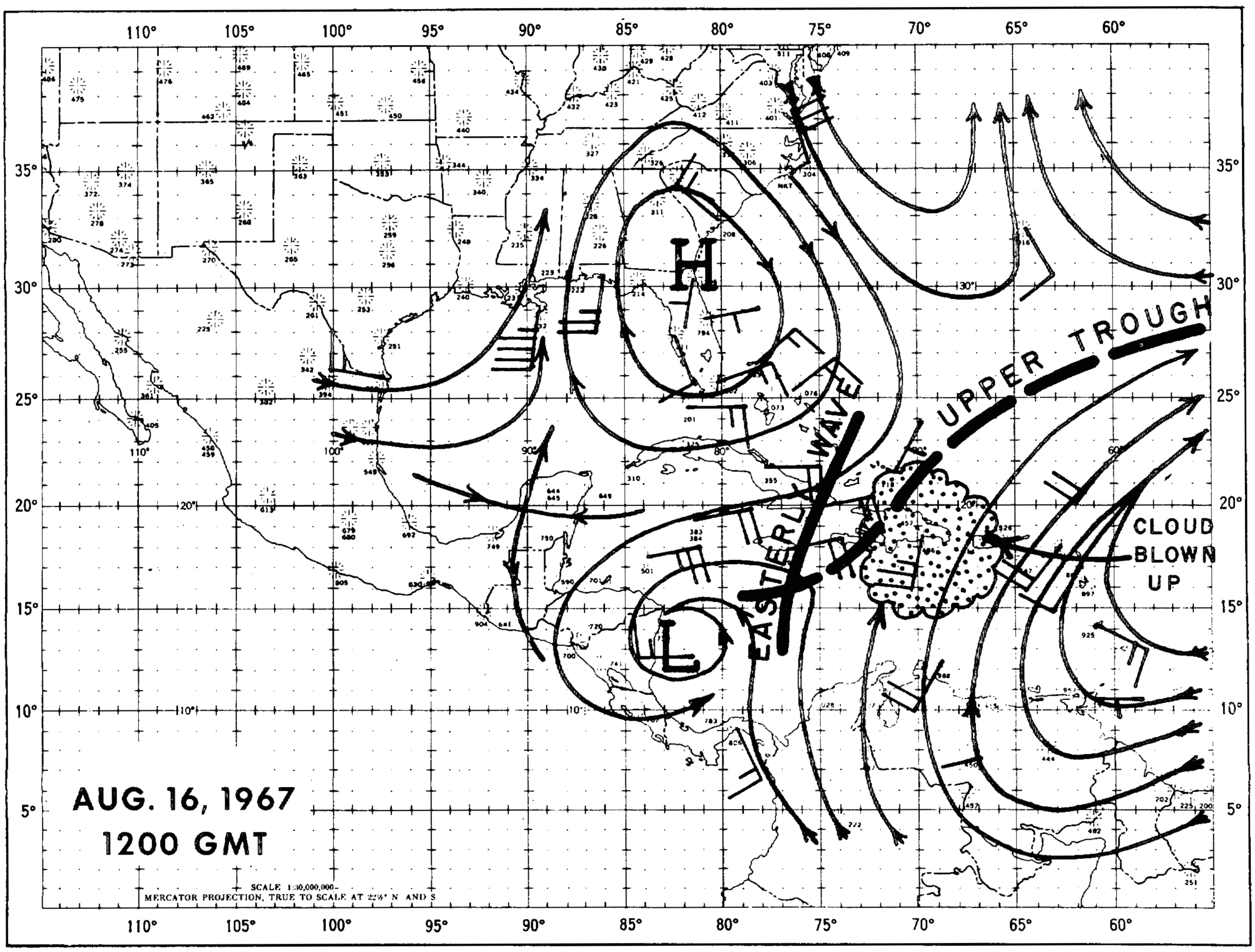

FIGURE 8.—A 200-mb streamline map on which the position of an easterly wave has been superimposed.

northwest in the vicinity of Puerto Rico or the lower Bahama Islands. The other two classes would generally be associated with ridging over the northeast or mid-Caribbean. Weaker waves may not be strong enough to reveal the interaction in the form of visible cloudiness because of small vertical motions. In order to include this effect the waves were divided into two groups, weak and strong. Arbitrarily, a strong wave is defined as one influencing a layer greater than 12,000-ft thickness. Seven of the waves were strong according to this definition.

TABLE 1.—*Summary of the relationship between the 200-mb flow and cloudiness associated with easterly waves over the eastern Caribbean Sea. The term "blowup" is used to indicate a temporary increase in cloudiness.*

Wave nature		Prevailing 200-mb flow over the eastern Caribbean			
		SE to W	W to NE	NE to SE	
No blowup cases	Strong	0	0	2	9
	Weak	2	2	3	
Blowup cases	Strong	5	0	0	10
	Weak	5	0	0	
		12	2	5	19

Table 1 reveals that all the blowups occurred as waves moved under the southeast quadrant of an upper trough or Low. This result is clearly seen on figure 9, which shows the position of enhanced cloudiness relative to the upper trough. During the months of June and July 1967, a trough persisted near Puerto Rico in the high troposphere; therefore, the daily maps closely resembled the mean 200-mb pattern presented in figure 9. On this figure, the geometric center of the cloudiness is indicated for each of the ten blowup cases. The cluster southeast of the trough is easily seen. When the upper flow was predom-

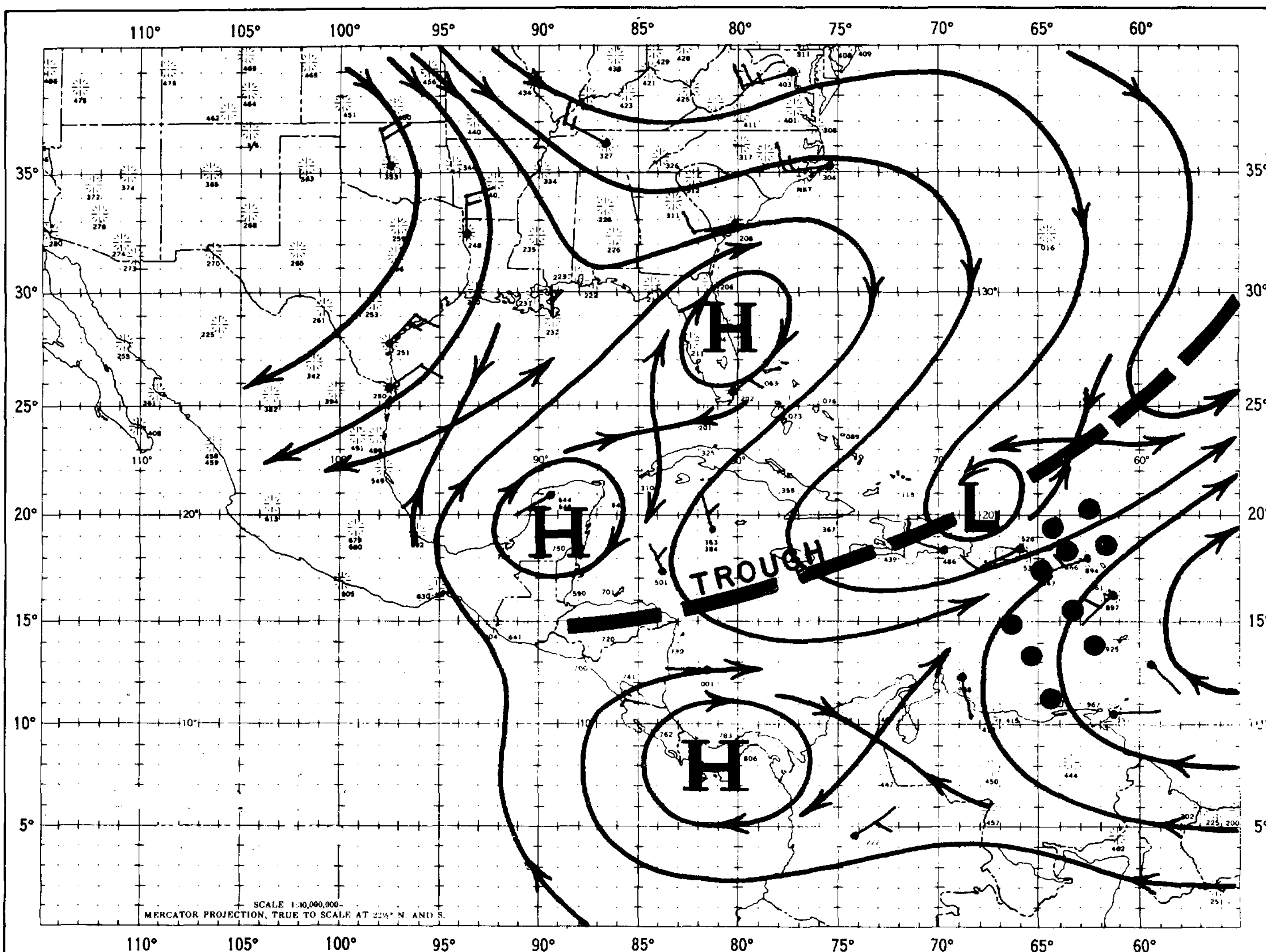

FIGURE 9.—The mean 200-mb streamline map for July 1967. The cloudiness associated with easterly waves was frequently enhanced over the eastern Caribbean Sea. The geometric center of the enhanced cloudy area relative to the upper trough is shown by the closed circles.

inantly ridging, enhancement did not occur. Only two of the waves did not show an increase in cloudiness when the upper flow appeared favorable and in both cases they were weak.

The tendency for disturbances to weaken as they move downstream combined with the complicating influence of the upper troposphere suggests that the Caribbean may be a poor area to study *pure* easterly waves. The weather distribution in Riehl's model was undoubtedly contaminated by these two effects because it was derived from observations taken primarily in the vicinity of Puerto Rico at a time when the upper tropospheric flow pattern was not well known. The concepts of his model may have limited application in other parts of the Tropics. It is hoped that in the near future, aircraft may be used to investigate Inverted V disturbances over the mid-Atlantic, away from the complicating factors of the Caribbean.

CONCLUSIONS

Tropical waves of the easterly wave type have been found to be associated with a cloud pattern that can be recognized on satellite pictures. The main feature of this pattern consists of cloud bands aligned generally parallel to the lower tropospheric flow or shear. The bands change orientation at the wave axis; therefore, they have the appearance of an Inverted V. This is in contrast to the weather distribution presented in Riehl's (1945) classical easterly wave model. Riehl hypothesized preferred weather sectors depending on the relationship between the wind speed of the basic current and the speed of motion of the wave.

Complicated interaction between easterly waves and the high troposphere cold trough was observed over the Caribbean Sea resulting in a temporary enhancement or blowup of cloudiness.

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REFERENCES

Arnold, J. E., "Easterly Wave Acitvity Over Africa and in the Atlantic With a Note on the Intertropical Convergence Zone During Early July 1961," *Satellite and Mesometeorology Research Project Paper* No. 65, Department of Geophysical Sciences, University of Chicago, **1966,** 33 pp.

Aspliden, C. I., Dean, G. A., and Landers, H., "Satellite Study, Tropical North Atlantic, 1963: I. Surface Wind Analyses, July 26—August 31," *Final Report,* Grant WBG 32, Department of Meteorology, Florida State University, Tallahassee, Sept. **1965,** 18 pp. and numerous charts.

Charney, J. G., "On the Formation of Tropical Depressions," paper presented at the First Technical Conference on Hurricanes and Tropical Meteorology, Miami, Fla., Nov. 19–22, **1958.**

Charney, J. G., and Eliassen, A., "On the Growth of the Hurricane Depression," *Journal of the Atmospheric Sciences,* Vol. 21, No. 1, Jan. **1964*a*,** pp. 68–75.

Charney, J. G., and Eliassen, A., "On the Growth of the Hurricane Depression, a Summary," *Geofisica Internacional,* Vol. 4, No. 4, Oct. **1964*b*,** pp. 223–230.

Dunn, G. E., "Cyclogenesis in the Tropical Atlantic," *Bulletin of the American Meteorological Society,* Vol. 21, No. 6, June **1940,** pp. 215–229.

Erickson, C. O., "Some Aspects of the Development of Hurricane Dorothy," *Monthly Weather Review,* Vol. 95, No. 3, Mar. **1967,** pp. 121–130.

Fett, R. W., "Aspects of Hurricane Structure: New Model Considerations Suggested by TIROS and Project Mercury Observations," *Monthly Weather Review,* Vol. 92, No. 2, Feb. **1964,** pp. 43–60.

Fett, R. W., "Upper-Level Structure of the Formative Tropical Cyclone," *Monthly Weather Review,* Vol. 94, No. 1, Jan. **1966,** pp. 9–18.

Fritz, S., Hubert, L. F., and Timchalk, A., "Some Inferences From Satellite Pictures of Tropical Disturbances," *Monthly Weather Review,* Vol. 94, No. 4, Apr. **1966,** pp. 231–236.

Gray, W. M., "Global View of the Origin of Tropical Disturbances and Storms," *Atmospheric Science Papers* No. 114, Department of Atmospheric Science, Colorado State University, Fort Collins, Oct. **1967,** 105 pp.

Krishnamurti, T. N., and Baumhefner, D., "Structure of a Tropical Disturbance Based on Solutions of a Multilevel Baroclinic Model," *Journal of Applied Meteorology,* Vol. 5, No. 4, Aug. **1966,** pp. 396–406.

Lateef, M. A., and Smith, C. L., "A Synoptic Study of Two Tropical Disturbances in the Caribbean," *ESSA Technical Memorandum* IERTM-NHRL 78, U.S. Department of Commerce, National Hurricane Research Laboratory, Miami, Fla., Apr. **1967,** 33 pp.

Malkus, J. S., Ronne, C., and Chaffee, M., "Cloud Patterns in Hurricane Daisy, 1958," *Tellus,* Vol. 13, No. 1, Feb. **1961,** pp. 8–30.

Malkus, J. S., and Riehl, H., "Cloud Structure and Distribution Over the Tropical Pacific Ocean," University of California Press, Berkeley, **1967,** 229 pp.

Merritt, E. S., "Easterly Waves and Perturbations, a Reappraisal," *Journal of Applied Meteorology,* Vol. 3, No. 4, Aug. **1964,** pp. 367–382.

Riehl, H., "Waves in the Easterlies," *University of Chicago Miscellaneous Report* No. 17, University of Chicago Press, **1945,** 79 pp.

Sadler, J. C., "Tropical Cyclones of the Eastern North Pacific as Revealed by TIROS Observations," *Journal of Applied Meteorology,* Vol. 3, No. 4, Aug. **1964,** pp. 347–366.

Sadler, J. C., "The Easterly Wave—The Biggest Hoax in Tropical Meteorology," paper presented at the seminar at the National Center for Atmospheric Research, Boulder, Colo., Aug. 8–12, **1966.**

Simpson, J., Garstang, M., Zipser, E., and Dean, G. A., "A Study of a Non-Deepening Tropical Disturbance," *Journal of Applied Meteorology,* Vol. 6, No. 2, Apr. **1967,** pp. 237–254.

Simpson, R. H., Frank, N., Shideler, D., and Johnson, H. M., "Atlantic Tropical Disturbances, 1967," *Monthly Weather Review,* Vol. 96, No. 4, Apr. **1968,** pp. 251–259.

Thompson, B. W., *The Climate of Africa,* Oxford University Press, New York, **1965,** 132 pp.

Wiederanders, C. J., "Analyses of Monthly Mean Resultant Winds for Standard Pressure Levels Over the Pacific," *Scientific Report* No. 3, Meteorology Division, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Mar. **1961,** 83 pp.

Yanai, M., "A Detailed Analysis of Typhoon Formation," *Journal of the Meteorological Society of Japan,* Ser. 2, Vol. 39, No. 4, Aug. **1961,** pp. 187–214.

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