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ATLANTIC TROPICAL SYSTEMS OF 1970

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ABSTRACT

The history of all tropical systems that formed over the Atlantic, Caribbean, and Gulf of Mexico during the 1970 hurricane season has been documented. There were a total of 87 systems from which 26 depressions and seven named storms evolved.

1. INTRODUCTION

This is the fourth in a series of annual articles in which the purpose is to document the history of all synoptic scale disturbances that occurred over the tropical Atlantic, the Caribbean Sea, and the Gulf of Mexico during the hurricane season. Attention in this article is focused on less intense systems with strength below that of a tropical storm or hurricane. Details on named storms in 1970 may be found in a companion article by Simpson and Pelissier (1971).

Definitions were established in two previous papers by Simpson et al. (1968, 1969) and will not be repeated. The basic philosophy of this effort is to identify and follow the course of all synoptic scale disturbances in the wind and pressure fields. By synoptic scale, we imply a time scale of several days and a horizontal scale of hundreds of miles. Where possible, inferences have been based entirely on wind and pressure data. For example, the tracks of systems in the Caribbean were determined almost exclusively by upper air data from the network of island stations. Over the tropical Atlantic where conventional data are nonexistent, satellite pictures provide the only useful information; fortunately, moving disturbances have been found to be frequently associated with a recognizable cloud pattern that can be easily followed. By definition, we have decided to call systems "waves" if the stratocumulus field north of the equatorial trough zone is organized into an "inverted V" pattern, even though the main convective activity is in the intertropical convergence zone (ITCZ). By this, we are suggesting that a relative vorticity center is located within the belt of trade winds. If an enhanced area of convection persists along the equatorial trough for more than 48 hr and if the stratocumulus field is not influenced, the system is labeled as an ITCZ disturbance, implying a relative vorticity center within the equatorial trough. It is recognized that these definitions may have to be altered or refined when disturbances in the tropical Atlantic are monitored by meteorological platforms carrying pressure and wind instruments. Cold Lows in the upper troposphere have not been treated explicitly. The stronger ones with an influence extending downward to the lower troposphere have been counted indirectly as tropical waves.

2. CENSUS OF 1970 TROPICAL SYSTEMS

The results of 1970 are presented in tables 1 and 2 and figure 1 (p. 283). Table 1 gives selected information describing the history of each system including the dates when the systems passed three key stations, Dakar, Barbados, and San Andrés Island. This information is summarized in table 2 and shown graphically in figure 1.

There were a total of 87 independent systems in 1970, from which 26 depressions and seven named storms evolved. The numbers in parentheses in table 2 indicate systems that were counted in a weaker stage (e.g., in the Caribbean, a total of five depressions formed; but four of these were spawned by tropical waves with origins in Africa). As in previous years, over half the systems originated in Africa, and over half are wave-type by our definition.

Of the 54 systems that moved off Africa, 42 maintained their identity to the Antilles; whereas 12 weakened in the tropical Atlantic. Eleven systems formed over the Atlantic, combining with the 42 from Africa, producing 53 systems in the Antilles. Of the Antilles systems, 14 weakened and 36 crossed the Caribbean. Nine systems formed in the Caribbean, giving 45 disturbances moving into Central America. In addition, five ITCZ disturbances were tracked for several days in the tropical Atlantic before dissipating.

The depression tracks are shown in figure 2. Of the 26 depressions, two occurred in May; thus, during the hurricane season which officially extends from June 1 through November 30, there were 24 depressions and 85 tropical systems. Ten depressions and one storm (Greta) formed in the subtropical Atlantic (north of latitude 20°N); five depressions and one storm (Alma), in the Caribbean; one depression and four storms (Becky, Celia, Ella, and Felice) in the Gulf of Mexico; and four depressions and one storm (Dorothy), in the tropical Atlantic. Six of the African systems were depressions when they moved off the African coast.

Table 3 summarizes the type of systems that were responsible for the depressions and named storms in 1970. The initiating systems have been divided into two major categories according to their energy source: (1) those drawing primarily on latent heat and (2) those feeding mainly on baroclinic energy. Systems relying

TABLE 1.—*Pertinent information summarizing the history of tropical waves and disturbances in 1970*

Dakar passage	Nature	Weakened in Atlantic	Formed in Atlantic	Barbados passage	Nature	Weakened in Caribbean	Formed in Caribbean	San Andrés passage	Nature	Atlantic storm	Pacific storm
May 31	Wave	–	–	June 6	Wave	–	–	June 10	Wave	–	Connie
–	–	–	–	–	–	–	X	June 7	Wave	–	–
June 4	Wave	–	–	June 10	Wave	X	–	–	–	–	–
June 7	Wave	–	–	June 14	Wave	–	–	June 18	Wave	–	–
June 10	Wave	–	–	June 15	Wave	–	–	June 19	Wave	Dep.	–
June 13	Wave	–	–	June 20	Wave	X	–	–	–	–	–
June 15	Wave	–	–	June 21	Wave	–	–	June 23	Wave	–	Eileen
June 20	Wave	–	–	June 26	Wave	–	–	June 30	Wave	Dep.	Francesca
June 25	Wave	X	–	–	–	–	–	–	–	–	–
–	ITCZ	Mid-Atlantic	–	–	–	–	–	–	–	–	–
June 28	Wave	–	–	July 2	Wave	–	–	July 5	Wave	–	–
–	–	–	X	June 29	Wave	X	–	–	–	–	–
June 30	Wave	X	–	–	–	–	–	–	–	–	–
July 2	Wave	–	–	July 7	Wave	–	–	July 9	Wave	–	Gretchen
July 5	ITCZ	X	–	–	–	–	–	–	–	–	–
–	–	–	X	July 10	Wave	–	–	July 13	Wave	–	–
–	–	–	–	–	–	–	X	July 11	Wave	–	Helga
July 9	Wave	–	–	July 15	Wave	–	–	July 19	Storm	Becky	–
–	–	–	X	July 13	ITCZ	–	–	July 16	ITCZ	–	–
July 14	Wave	–	–	July 20	Wave	–	–	July 24	Wave	–	Joyce
July 16	Wave	–	–	July 22	Wave	–	–	July 26	Wave	–	–
–	ITCZ	Mid-Atlantic	–	–	–	–	–	–	–	–	–
July 19	Wave	–	–	July 26	Wave	–	–	July 29	Wave	–	–
July 23	Wave	–	–	July 28	Wave	–	–	July 31	Storm	Celia	–
July 26	ITCZ	–	–	July 30	Wave	–	–	Aug. 2	Wave	–	Kristen
–	ITCZ	Mid-Atlantic	–	–	–	–	–	–	–	–	–
July 27	Wave	–	–	Aug. 2	Wave	–	–	Aug. 6	Wave	–	–
July 29	ITCZ	–	–	Aug. 4	ITCZ	X	–	–	–	–	–
July 30	Wave	–	–	Aug. 7	Wave	–	–	Aug. 10	Wave	–	–
Aug. 2	Dep.	–	–	Aug. 9	Wave	X	–	–	–	Dep.	–
Aug. 5	ITCZ	–	–	Aug. 11	ITCZ	–	–	Aug. 13	ITCZ	–	Lorraine
Aug. 7	Dep.	–	–	Aug. 13	Wave	–	–	Aug. 16	Wave	Dep.	–
Aug. 10	Dep.	–	–	Aug. 16	Wave	X	–	–	–	Dep.	–
Aug. 13	ITCZ	–	–	Aug. 20	Storm	–	–	Aug. 24	Wave	Dorothy	–
Aug. 17	Wave	–	–	Aug. 24	Wave	X	–	–	–	–	–
Aug. 19	ITCZ	X	–	–	–	–	–	–	–	–	–
Aug. 20	Wave	–	–	Aug. 25	Wave	–	–	Aug. 28	Wave	–	Norma
Aug. 21	ITCZ	–	–	Aug. 27	Wave	–	–	Aug. 30	Wave	Dep.	–
–	–	–	X	Aug. 29	Wave	X	–	–	–	–	–
–	–	–	X	Aug. 31	ITCZ	–	–	Sept. 3	Wave	–	–
Aug. 26	Wave	–	–	Sept. 1	Wave	–	–	Sept. 4	Wave	–	Orlene
Aug. 30	Wave	–	–	Sept. 10	Dep.	–	–	Sept. 14	Wave	Dep.	–
Sept. 1	ITCZ	–	–	Sept. 7	Wave	–	–	Sept. 10	Wave	–	–
Sept. 3	Wave	X	–	–	–	–	–	–	–	–	–
Sept. 5	Dep.	X	–	–	–	–	–	–	–	Dep.	–
–	–	–	–	–	–	–	X	Sept. 7	Wave	Ella	–
–	ITCZ	Mid-Atlantic	–	–	–	–	–	–	–	–	–
Sept. 8	ITCZ	–	–	Sept. 14	ITCZ	–	–	Sept. 17	ITCZ	–	–
–	–	–	–	–	–	–	X	Sept. 16	Wave	–	–
Sept. 11	Wave	–	–	Sept. 19	Wave	X	–	–	–	Dep.	–
Sept. 14	ITCZ	X	–	–	–	–	–	–	–	–	–
Sept. 15	Wave	–	–	Sept. 24	Wave	–	–	Sept. 27	Wave	Greta	–
–	–	–	X	Sept. 16	Wave	–	–	Sept. 21	Wave	–	Dep.
–	–	–	X	Sept. 22	Wave	–	–	Sept. 25	Wave	–	–
Sept. 18	Wave	X	–	–	–	–	–	–	–	–	–
Sept. 19	ITCZ	X	–	–	–	–	–	–	–	–	–
Sept. 21	Wave	–	–	Sept. 27	Dep.	–	–	Oct. 1	Dep.	–	Patricia
Sept. 22	Dep.	X	–	–	–	–	–	–	–	Dep.	–
Sept. 24	Dep.	–	–	Oct. 1	Dep.	X	–	–	–	Dep.	–
Sept. 27	ITCZ	–	–	Oct. 4	ITCZ	X	–	–	–	–	–
Oct. 3	Wave	–	–	Oct. 10	Wave	X	–	–	–	–	–
–	–	–	–	–	–	–	X	Oct. 8	Wave	–	–
–	–	–	–	–	–	–	X	Oct. 11	Wave	–	–
–	–	–	–	–	–	–	X	Oct. 14	Wave	–	Rosalie
–	–	–	X	Oct. 15	Wave	–	–	Oct. 19	Wave	–	–
–	ITCZ	Mid-Atlantic	–	–	–	–	–	–	–	–	–
Oct. 6	Wave	–	–	Oct. 12	Wave	–	–	Oct. 17	–	–	–
Oct. 9	Wave	–	–	Oct. 18	Wave	X	–	–	–	–	–
–	–	–	–	–	–	–	X	Oct. 23	Wave	–	–
Oct. 15	Wave	–	–	Oct. 23	Wave	–	–	Oct. 26	Wave	–	Selma
–	–	–	X	Oct. 25	Wave	X	–	–	–	–	–
–	–	–	X	Oct. 27	ITCZ	X	–	–	–	–	–
Oct. 23	Wave	X	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	X	Nov. 3	ITCZ	–	–
Oct. 28	ITCZ	–	–	Nov. 4	ITCZ	–	–	Nov. 8	ITCZ	–	–
Oct. 31	Wave	–	–	Nov. 7	Wave	–	–	Nov. 11	Wave	–	–
Nov. 6	Wave	X	–	–	–	–	–	–	–	–	–
–	–	–	X	Nov. 12	Wave	X	–	–	–	–	–

TABLE 2.—*Number of tropical systems that formed in various geographical areas in 1970; the numbers in parentheses indicate systems that were counted in a weaker stage.*

Systems	Africa	Tropical Atlantic	Subtropical Atlantic	Caribbean	Gulf	Total independent systems
Waves	35	8	-	8	-	51
ITCZ disturbances	13	8	-	1	-	22
Depressions	6	- (3)	7 (4)	1 (4)	- (1)	14 (12)
Storms (named)	0	- (1)	- (1)	- (2)	- (3)	- (7)
Totals	54	16 (4)	7 (5)	10 (6)	- (4)	87 (19)

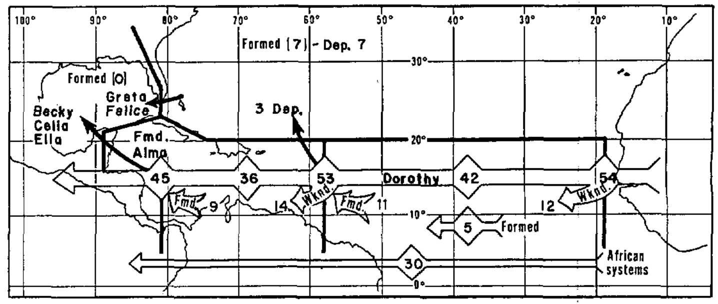

FIGURE 1.—Summary of the synoptic scale tropical systems observed from western Africa to the eastern Pacific during 1970. The large numerals indicate the number of systems passing five areas, the west coast of Africa, the mid-Atlantic, the Lesser Antilles, the Caribbean, and Central America.

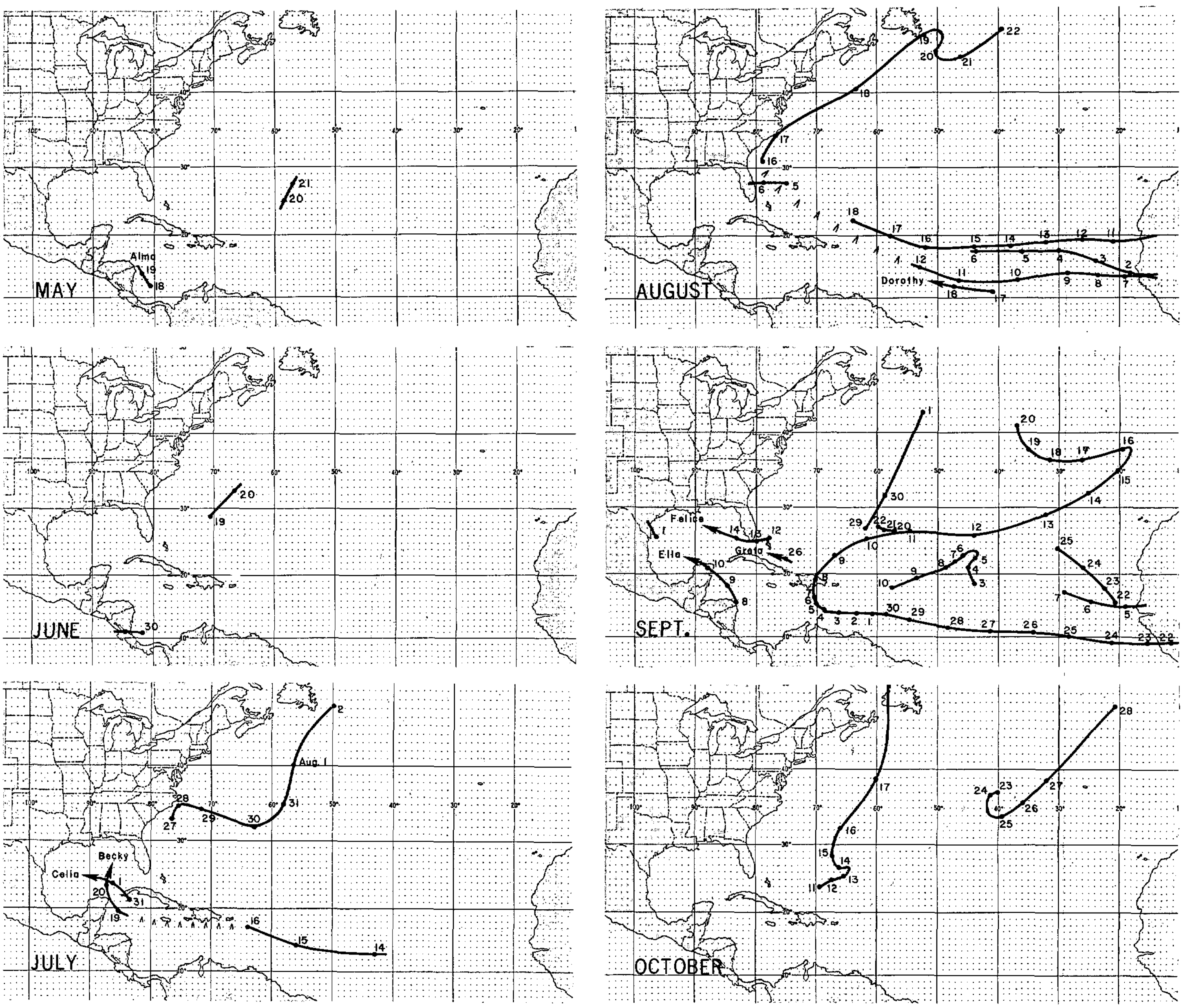

FIGURE 2.—Tracks of tropical depressions in 1970.

TABLE 3.—*Type of systems that initiated Atlantic named storms and depressions in 1970; the systems have been divided into two categories, tropical and baroclinic, depending on their source of energy.*

Type	Tropical		Baroclinic		Totals
	African Systems	Disturbances	Upper	Lower	
Named storms	4	2	1	0	7
Depressions	17	2	3	4	26

mainly on latent heat include:

1. ITCZ disturbances in both the Atlantic and Caribbean.
2. Non-ITCZ disturbances resulting from enhanced regions of convection. These are typical in the western Caribbean during late spring and early fall.
3. Tropical waves (although the driving mechanism is not clearly understood).

Baroclinic systems include:

1. Upper cold Lows.
2. Lower Lows that form on weak baroclinic zones originally associated with cold fronts.

Six of the named storms were initiated by tropical systems of which four were of African origin. Felice was the only storm not associated with a moisture-rich tropical system, and this storm was spawned by an upper cold Low. African systems were responsible for nearly two-thirds of the depressions (17). It is interesting to note that approximately a third of the depressions initiated by tropical systems strengthened and became named storms (6 of 19), while only one out of seven of the baroclinic originated depressions managed to intensify. The relatively cool air in a baroclinic system inhibits the development of concentrated convection required in the tropical storm/hurricane process.

Four of the depressions were noteworthy and deserve special comment. From the standpoint of damage, by far the most significant was the depression that brought record-breaking floods to Puerto Rico and adjacent islands in October. During the 6 days when this depression wandered aimlessly over the eastern Caribbean, a deluge of more than 30 in. of rain wrought havoc in Puerto Rico, accounting for 18 deaths, 34 missing, and property damage estimated at $65 million (in the U.S. Virgin Islands, one person was killed). The highest rainfall total for the 6 days was 38.4 in. in the Jayuya area, with some 24-hr totals ranging up to 17 in. The rainfall for the event exceeded any known previous record including the 1899 and 1928 hurricanes.

The depression formed over Africa and passed off the coast about 300 n.mi. south of Dakar on September 23. As the system approached the Antilles Islands, residents were alerted of the possibility of tropical storm formation, even though the presence of an upper troposphere trough in the eastern Caribbean did not favor significant intensification. The depression moved through the Antilles with winds and pressure hovering near the required values for a tropical storm. The center passed over St. Lucia

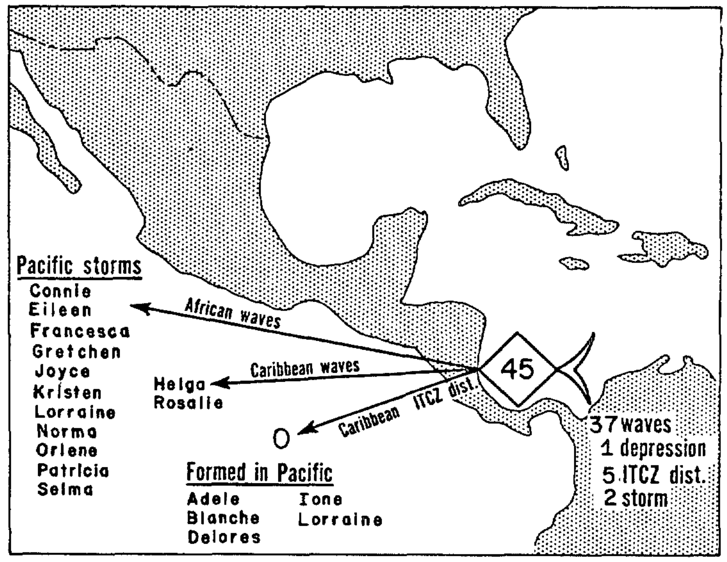

FIGURE 3.—Origin of tropical systems that initiated east Pacific storms in 1970.

Island where a minimum pressure of 1004 mb was recorded. Under the influence of the upper trough, the depression slowed down, and a rain shield spread northeastward over the Leeward Islands, the Virgin Islands, and Puerto Rico, with heaviest amounts concentrated in the vicinity of Puerto Rico.

The depression finally responded to the influence of upper westerlies on October 8 and accelerated toward the northeast. Ship reports were not sufficient to confirm the track indicated on the 12th, but satellite pictures suggest the remains of this system continued toward the northeast and experienced a second phase of intensification southeast of the Azores. Trapped by a blocking High, the depression turned westward and passed through the Azores with a central pressure of 994 mb before finally being absorbed into the westerlies.

The other three noteworthy depressions were associated with winds that approached hurricane force and have been described by Simpson and Pelissier (1971). Each year, two or three hybrid storms form that are neither pure tropical nor pure baroclinic in character but feed upon both latent heat and baroclinic sources of energy. Simpson and Pelissier (1971) call this type of system "neuter cyclones." Two of the three stronger depressions fall into this category. One formed north of Hispaniola on October 11 and moved slowly toward the northeast, passing very near Bermuda on the 16th. A second neuter cyclone formed off the South Carolina coast on August 16 and intensified while moving toward the northeast, with the center passing over ship *Hotel* (4YH).

The third, stronger depression has been called a "mini-cyclone" by Simpson and Pelissier (1971). This term is reserved for a storm that has true hurricane characteristics but is very small and concentrated, with maximum winds occurring at extremely small radii. The system that formed west of the Azores on October 23 appears to have been of this type.

Systems that originated on the Atlantic side of Central America played a very prominent part in producing a bumper crop of east Pacific storms and hurricanes where 18 storms formed. Eleven of these were initiated by systems of African origin (fig. 3). Two were spawned by waves that formed over the Caribbean, and five storms emerged from the ITCZ in the Pacific. Again in 1970, we see the vital role played by African systems in the development of both Atlantic and east Pacific storms, accounting for 15 of the 25 storms experienced in both oceans.

3. COMPARISON WITH OTHER YEARS

This is the fourth year that Atlantic tropical systems have been documented; however, some procedural changes between 1967 and 1968 limit direct comparison, for the most part, to the last 3 yr. Table 4 compares the totals in several categories for the years 1968, 1969, and 1970. One of the more significant points to be noted in this table is the nearly 20-percent reduction in the number of systems in 1970. This observation may not be entirely real. Over the tropical Atlantic, satellite pictures are the sole source of information. When a system is strong and the cloud patterns are well organized, the trans-Atlantic crossing can be established with reliability. This is not true for the weaker systems where the cloud organization is poorly defined. It has been our policy to assume that a system weakened over the Atlantic if the wind data at Dakar confirmed the passage of a system but cloud organization was not sufficient to verify an ocean crossing. When wind data in the Antilles revealed the passage of a wave that could not be traced back to Africa, we assumed that the system developed over the Atlantic. It is possible that some of the weaker systems may have been counted twice if, in fact, they actually transversed the Atlantic. This implies that years characterized by more intense perturbations would have fewer systems by our counting scheme.

The possibility of this being a plausible explanation for at least part of the reduction noted in 1970 is suggested by comparing the number of systems that could be tracked across the Atlantic during the last 3 yr. In 1968, 40 of the 57 African systems maintained their identity as far west as the Lesser Antilles. Similar statistics in 1969 show 33 of 58; and in 1970, 42 of 54. If we look at the proportion of African systems that could be followed across the Atlantic and Caribbean into the Pacific, we find approximately 30 percent in 1969 (21 of 58) and over 50 percent (30 of 54) in 1970. In both cases, 20 to 30 percent more of the African systems could be tracked westward to the Caribbean and Pacific in 1970 than in either 1968 or 1969. The African systems in 1970 were stronger and maintained their intensity longer than in the previous 2 yr.

Regardless, a notable feature of the 1970 season was the general lack of tropical storm activity in the middle and eastern Atlantic. This apparently was not due to a lack of depressions. Figure 2 shows that eight depressions formed over the tropical Atlantic or moved off the African coast in August and September; yet, only one was able to strengthen and become a named storm (Dorothy). Simpson and Pelissier (1971) noted that, during the middle of the hurricane season, the 700-mb subtropical ridge was displaced southward from its normal position. Thus, the broad zone of deep easterlies, which usually overlies the Tropics and provides a favorable setting for African disturbances to deepen, was weaker than normal. A similar situation also occurred in 1968 (Andrews 1968) when there were only seven named storms with a marked absence of Atlantic storms. In contrast, easterlies were normal or stronger than normal in both 1967 and 1969 (Posey 1967, Dickson 1969); and in both years, Atlantic storms were plentiful. The last 4 yr offer strong evidence that the main inhibiting factor for tropical cyclogenesis is related more to the prevailing environmental circulation features rather than to a lack of potential hurricane seedlings.

TABLE 4.—*Comparison of the tropical systems that occurred during the hurricane seasons of 1968, 1969, and 1970*

Explanation	1968	1969	1970
Total systems, all types	107	105	85
Dakar systems	57	58	54
Barbados systems	59	44	53
San Andrés systems	28	43	45
Depressions	19	28	24
Named storms	7	13	7

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