Atlantic Tropical Systems of 1989

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ABSTRACT

The 1989 season produced 63 African waves, 15 tropical depressions and 11 tropical storms, 7 of which became hurricanes. All of the tropical storms developed from African waves. A comparison with the past 22 years is included.

1. Introduction

This is the second consecutive year that an annual summary of Atlantic tropical systems has been prepared since the gap between 1980 and 1988. The main purpose of this article is to tabulate and summarize all synoptic-scale Atlantic tropical systems that developed from May through November 1989. This will help to gain a better understanding of the climatology of tropical systems. The general philosophy used in the counting method was presented in a previous article by Avila and Clark (1989). Upper air data over west Africa as well as daily images from the European satellite (METEOSAT) were added to the 1989 tropical wave analysis.

2. Census of 1989 systems

The 1989 season was characterized as a Cape Verde hurricane year in which seven of the tropical cyclones were named near those islands and then tracked westward across the Atlantic. The season had 11 named storms, seven of which acquired hurricane intensity. This compares to the past 50-year average of 9.5 tropical storms, of which 5.5 became hurricanes. The season produced a category five (Hugo) and a category four (Gabrielle) hurricane according to the Saffir-Simpson scale (Simpson 1974). Hugo was not a category five at the time of landfall, but it left a path of devastation across the Leeward Islands, Virgin Islands, Puerto Rico and South and North Carolina. Gabrielle was a classic Cape Verde type hurricane, but it remained over the open water throughout its entire life. The annual summary by Case and Mayfield (1990) describes the systems that strengthened into name storms or hurricanes.

Figure 1 shows the total number of waves that emerged off Africa and traveled over the tropical Atlantic, the Caribbean Sea, the Gulf of Mexico and the eastern Pacific. The 63 African waves as indicated by the large arrow in Fig. 1 gives an average of one wave crossing a particular longitude every 3.2 days. The first wave passed Dakar on 15 May and the last one on 25 November. Figure 1 also highlights the approximate longitudes over which the depressions and storms formed. There was a preferred longitude band for formation just west of the Cape Verde Islands along 25°W. Except for Tropical Depression One, which developed along a frontal zone in the southwest Gulf of Mexico, all of the systems had their origin from African seedlings. Note that Tropical Depression One is not attached to the main stream of waves on Fig. 1. African waves were also a large contributor to the eastern Pacific tropical cyclones.

Most of the waves during 1989 were well organized and vigorous and indeed they began developing into tropical depressions during the early part of the season reaching a peak in August. This is illustrated in Fig. 2, which gives the distribution of tropical depressions per month. The large number of systems that developed along 25°W coincided with a persistent upper-level anomalous anticyclonic flow over the tropical belt between Africa and 55°W from June to September, see Climate Diagnostic Bulletin, 1989. It is very difficult to assert if the anomalous flow was produced by the waves themselves or caused by a large-scale atmospheric change. Another interesting aspect in 1989 was the above average rainfall experienced over Africa during the summer of 1989 (Gray 1989). One can speculate that this above normal rainfall, may have been related to the intensity of those waves. Furthermore, quantitative measurements of African dust transported through the Atlantic were not available, but an inspection of satellite images suggests that the amount of African dust associated with the tropical waves was relatively small during 1989. This could also be a consequence of the wet pattern over the western Sahel this past season.

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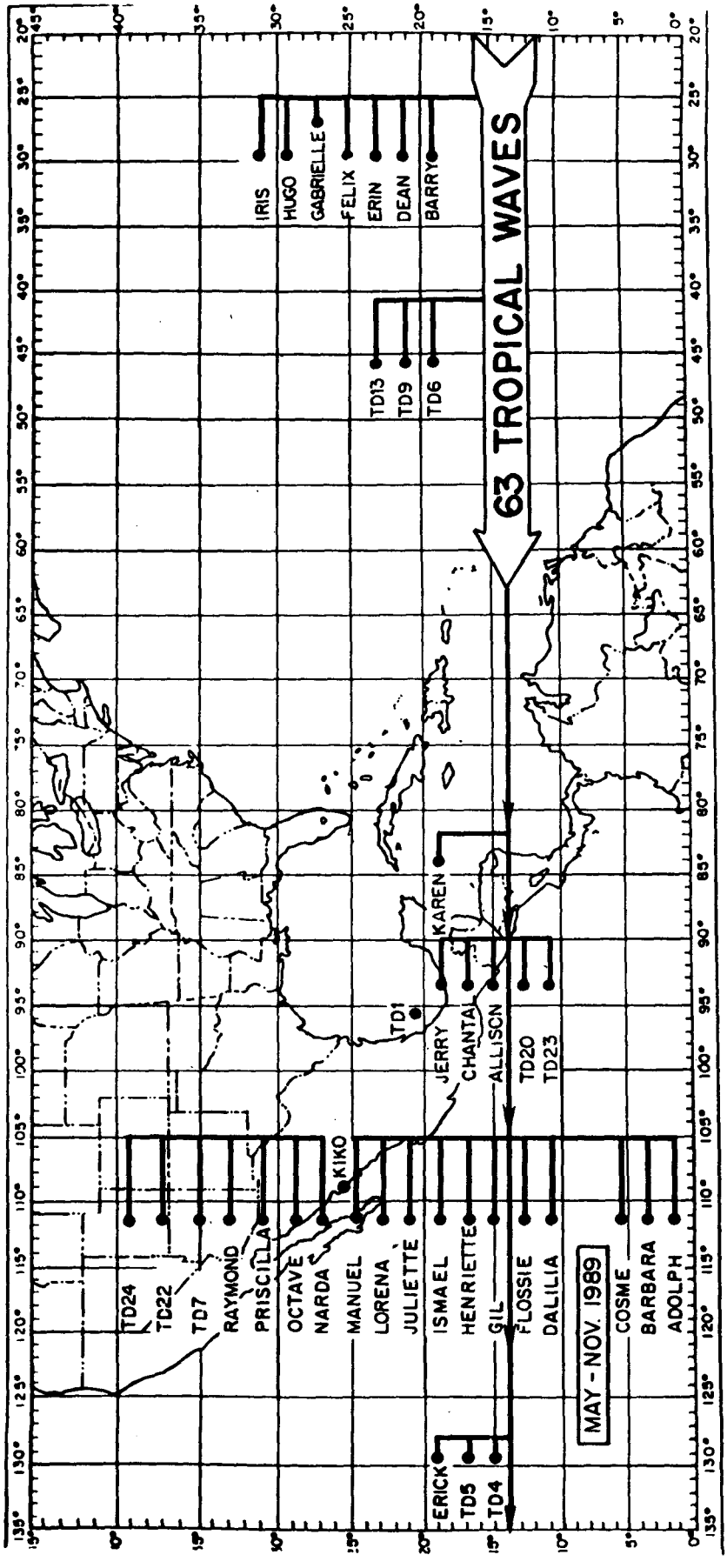

FIG. 1. Total number of waves that maintained their identities while traveling the Atlantic, Caribbean, the Gulf of Mexico and the eastern Pacific. The figure highlights the longitude bands in which tropical cyclones developed.

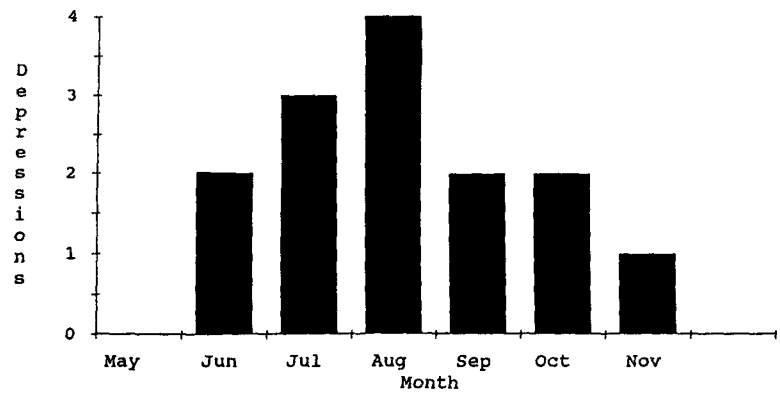

FIG. 2. Number of tropical depressions per month during 1989.

3. Description of tropical depressions that did not strengthen to named storms

The depression tracks for 1989 are shown is Fig. 3. The geostationary satellite images of tropical depressions are displayed on Figs. 4a–d. Only the depressions that did not reach tropical storm status are described. Tropical Depression One formed over the southwest Gulf of Mexico on 16 June and quickly dissipated on 17 June over the same area. This was the only system that developed along a frontal zone.

Depression Six formed on 16 August from a tropical wave 965 km east of the Lesser Antilles while moving westward near 10 m s^{-1}. Consequently, a tropical storm watch was issued for portions of the northeast Caribbean. The depression interacted with an upper level low just before reaching the islands and dissipated on 17 August.

Depression Nine formed on 27 August from a westward moving tropical wave 790 km east of Barbados. An Air Force plane was unable to find a circulation center on 28 August and the depression was downgraded to a wave. Strong upper level shear apparently removed the convection from the low-level center.

TABLE 1. Atlantic tropical system statistics for 1967–89.

		Total			African		Ratio	
Year	Waves	African depressions	Tropical storms	Tropical hurricanes	Depressions	Storms	African depressions / Total depressions	African storms / Total storms
1967	61	29	8	6	14	5	.48	.65
1968	57	19	7	4	8	4	.42	.57
1969	58	28	18	12	16	10	.57	.56
1970	54	26	10	4	16	7	.82	.70
1971	56	23	13	6	12	6	.52	.56
1972	57	24	4	3	6	1	.25	.25
1973	56	24	7	4	10	4	.42	.57
1974	52	25	7	4	12	5	.48	.71
1975	61	28	8	6	14	5	.50	.63
1976	68	23	8	6	10	5	.43	.63
1977	69	19	6	5	7	3	.37	.50
1978	63	31	11	5	18	6	.58	.55
1979	52	27	8	5	20	8	.74	1.00
1980	49	19	11	9	14	8	.78	.73
1981	62	22	11	7	17	6	.77	.55
1982	61	9	5	2	6	3	.67	.60
1983	57	6	4	3	3	1	.50	.25
1984	59	20	12	5	8	5	.40	.42
1985	53	14	11	7	9	8	.64	.73
1986	49	10	6	4	6	3	.60	.50
1987	57	14	7	3	11	5	.79	.71
1988	62	19	12	5	16	9	.84	.75
Average	57.8	20.8	8.8	5.2	11.5	5.3	.56	.60
1989	63	15	11	7	14	11	.93	1.00

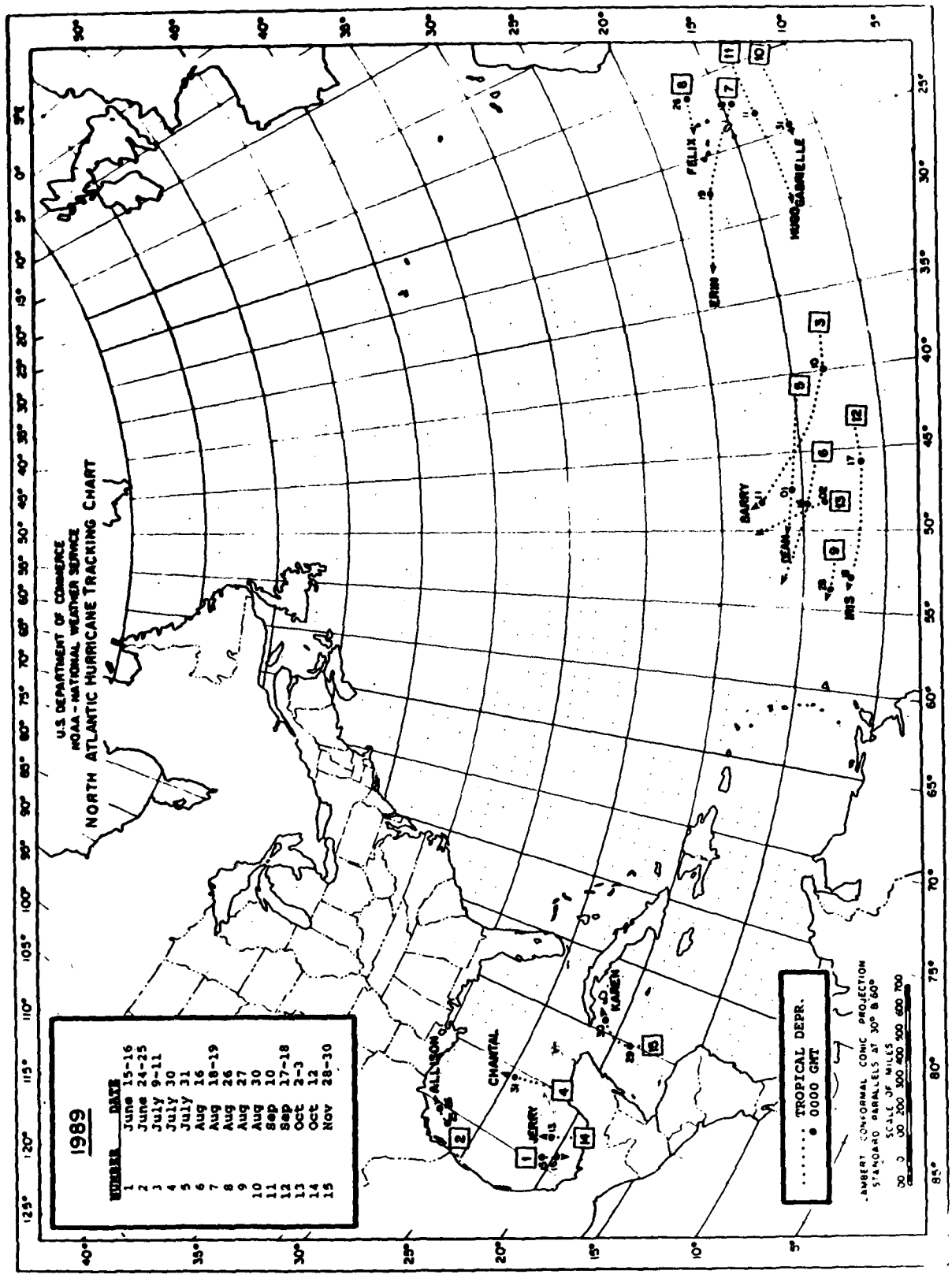

FIG. 3. Tropical depression tracks of 1989.

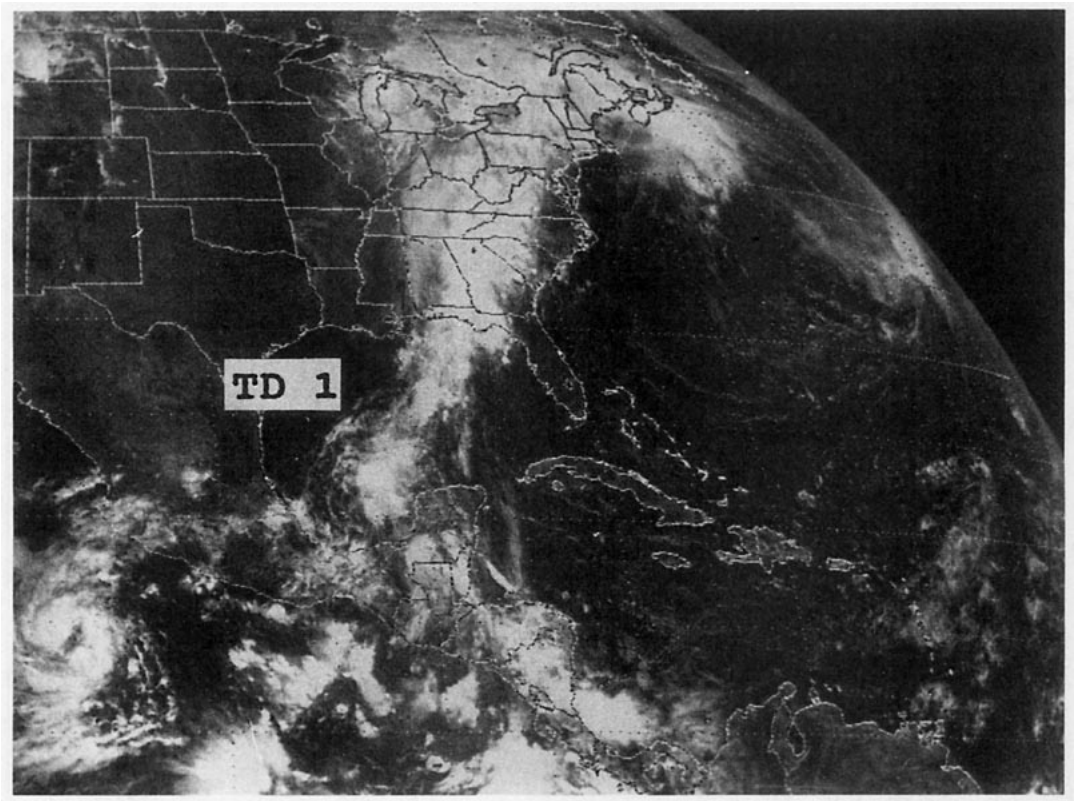

FIG. 4a. Geostationary, visible satellite picture of Tropical Depression One at 1601 UTC 16 June 1989 in the Bay of Campeche.

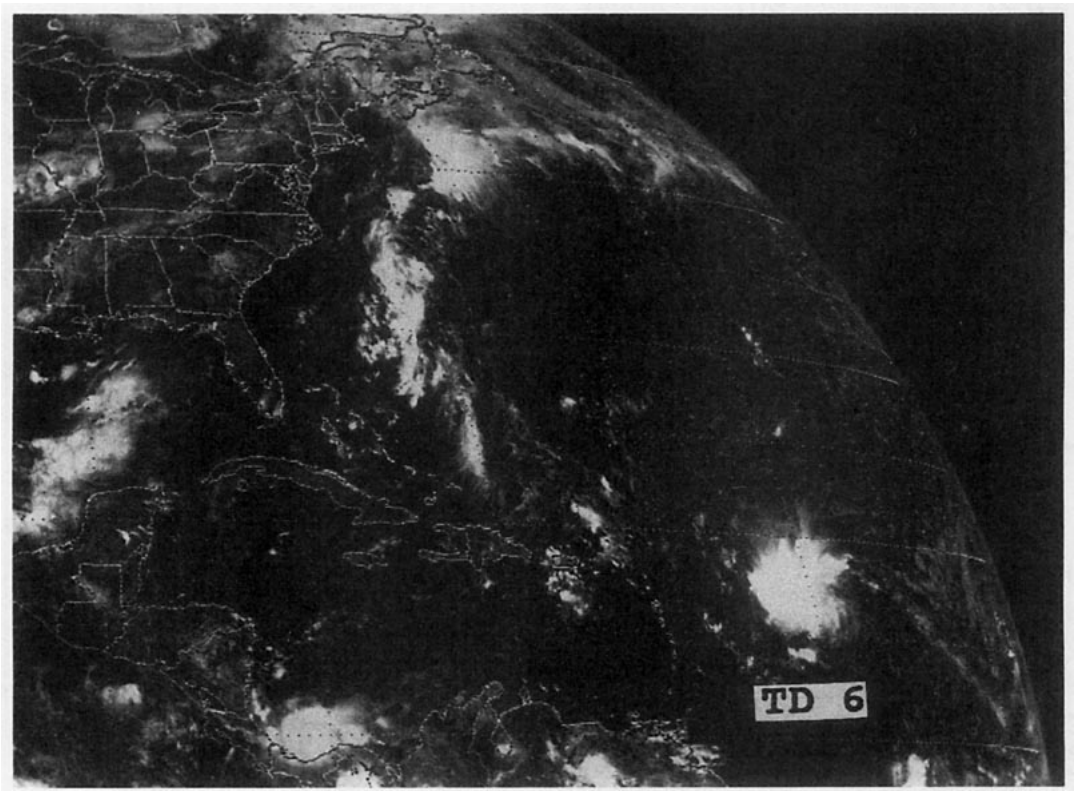

FIG. 4b. Geostationary, visible satellite picture of Tropical Depression Six at 1501 UTC 16 August 1989 east of the Lesser Antilles.

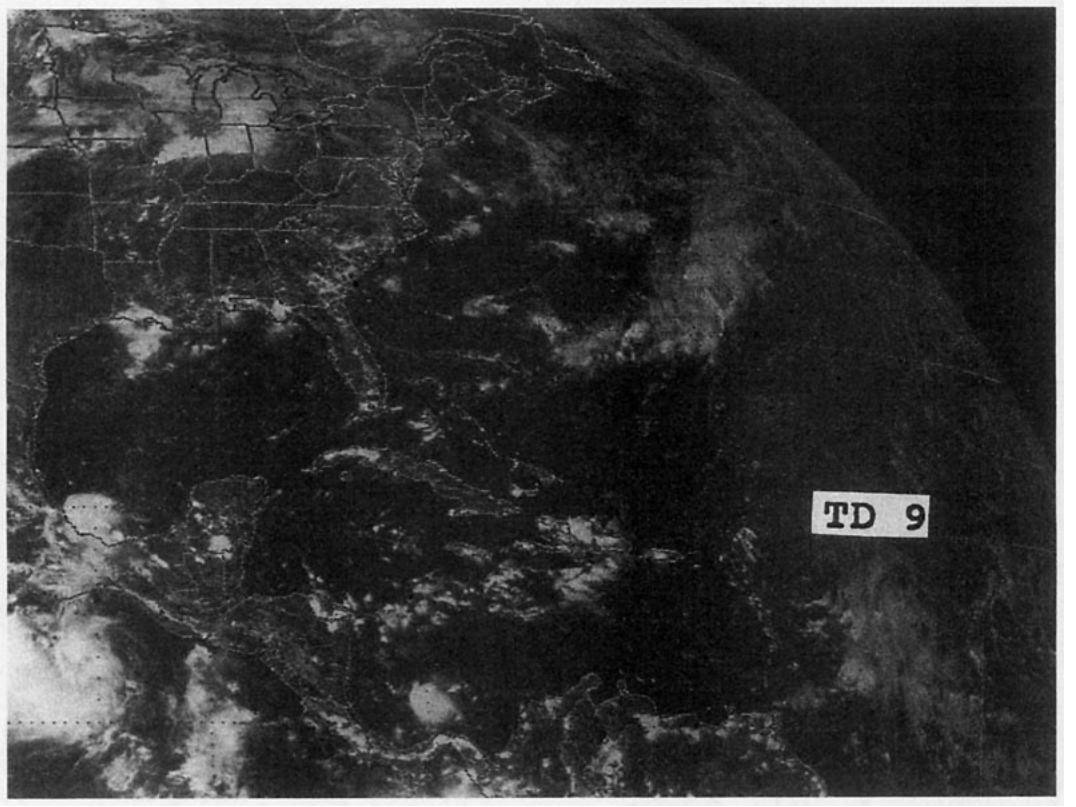

FIG. 4c. Geostationary, visible satellite picture of Tropical Depression Nine at 1901 UTC 28 August 1989 east of the Lesser Antilles.

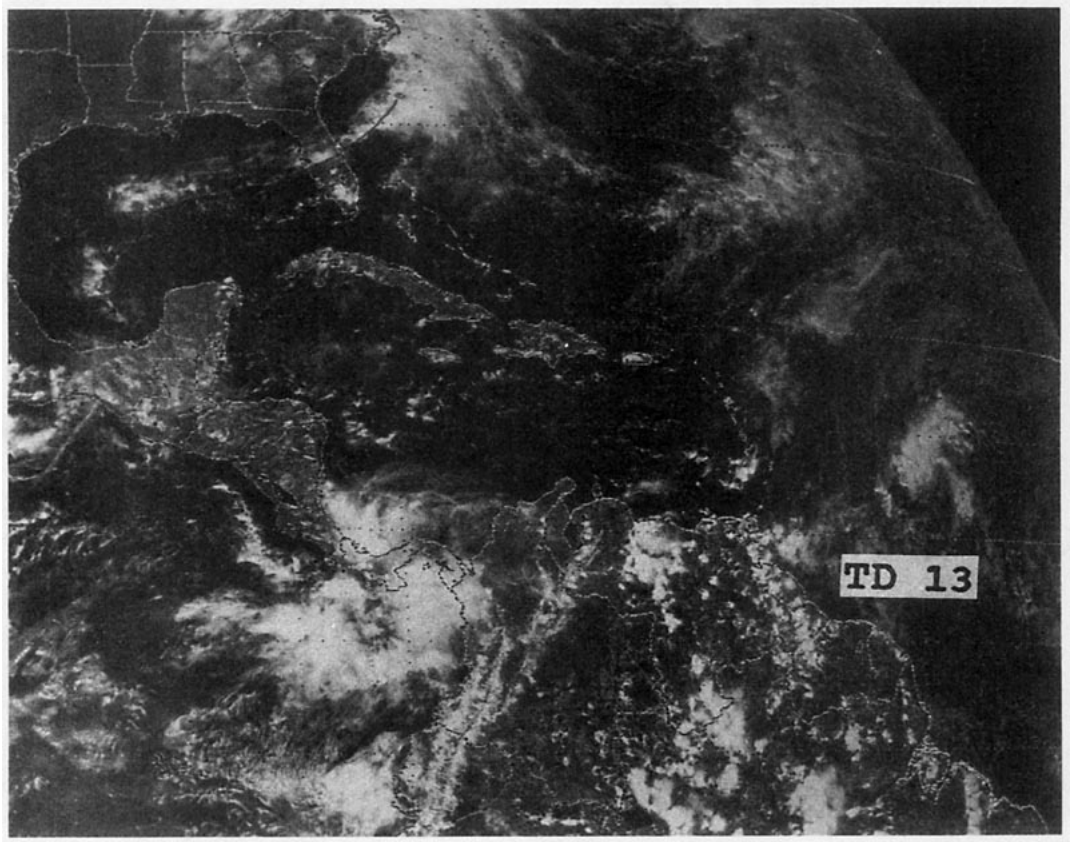

FIG. 4d. Geostationary, visible satellite picture of tropical Depression Thirteen at 1801 UTC 02 October 1989, east of the Lesser Antilles.

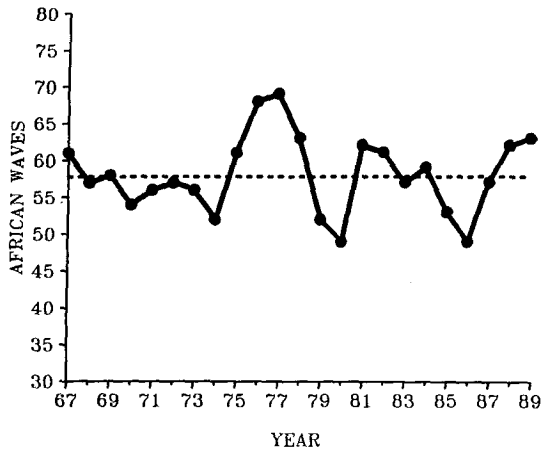

FIG. 5a. Total numbers of African waves from 1967 to 1989. Horizontal line represents the average for the 1967–88 period.

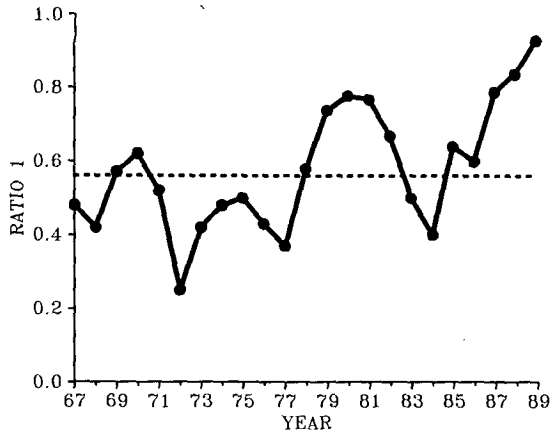

FIG. 6a. Ratio of the number of tropical depressions of African origin to the total number of depressions from 1967 to 1989. Horizontal line represents the average for the period 1967 to 1988.

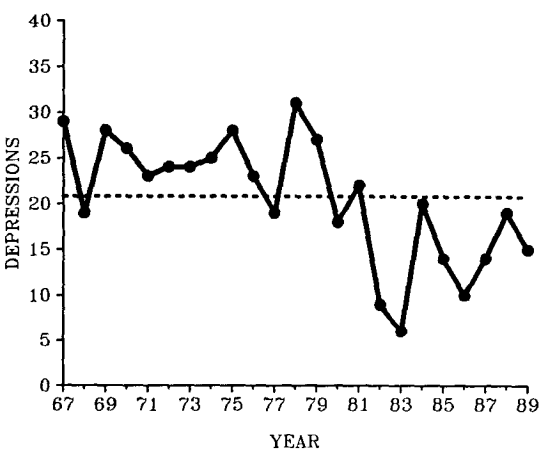

FIG. 5b. Total number of tropical depressions from 1967 to 1989. Horizontal line indicates the average for the 1967–88 period.

Depression Thirteen also developed from a well-organized tropical wave on 2 October 1400 km east of the Windward Islands. Conditions appeared favorable for the depression to become a tropical storm. However, on 3 October, a rather strong middle-latitude trough developed to the north which not only turned the depression northward, but also sheared the system completely.

4. Comparison with other years

Figure 5a and Table 1 show the number of waves from 1967 to 1989. There were 63 tropical waves during 1989, not significantly different from 1988. This number is slightly higher than the previous 22-year average, given in Table 1. However, these variations could be related to observational methods. It is extremely difficult to draw conclusions from such a short record.

Figures 5b,c and Table 1 show the number of tropical

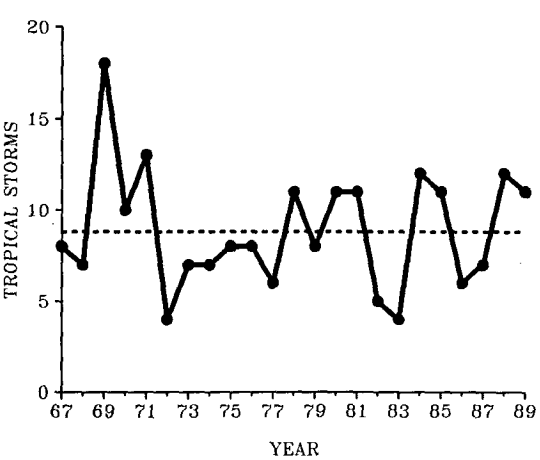

FIG. 5c. Total number of tropical storms from 1967 to 1989. Horizontal line indicates the average for the 1967–88 period.

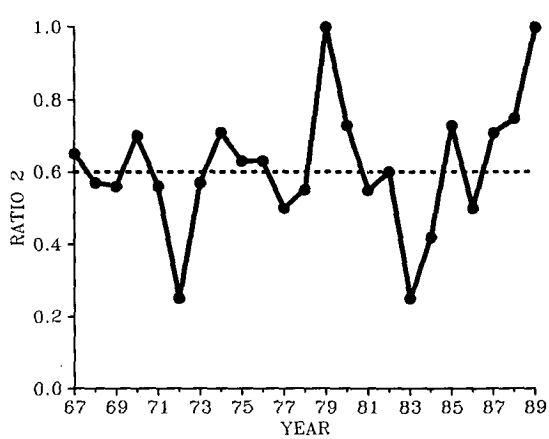

FIG. 6b. Ratio of the number of tropical storms of African origin to the total number of storms. Horizontal line represents the average for the 1967–88 period.

TABLE 2. Comparison of African, non-Arican and average years with season averaged Hurricane Destruction Potential (HDP). African years: Ratio of the number of tropical storms of African origin to the total number of storms is higher or equal to 0.70. Non-African years: Ratio of the number of tropical storms of African origin to the total number of storms is lower or equal 0.50. Average years: Ratio of number of tropical storms of African origin to the total number of tropical storms is less than 0.70 and higher than 0.50. HDP: Sum of the square of each hurricane's maximum wind for each 6-hour period of its existence (Gray, 1988).

										HDP
African years	1970	1974	1979	1980	1985	1987	1988	1989		66
Non-African years	1971	1972	1977	1983	1984	1986				28
Average years	1967	1968	1969	1973	1975	1976	1978	1981	1982	55

depressions and storms for the same period. There were 15 tropical depressions, 11 of which became tropical storms in 1989. The number of depressions continued to be slightly below normal if compared with an average of 21 depressions from 1967 to 1988. Figure 5b suggests a decrease of the number of depressions since 1980. The same is not true for tropical storms. This decrease in the number of depressions could be interpreted as a real trend; however, organized clusters of convection over the oceans or some mid-latitude frontal lows may have been classified as tropical depressions during the early years.

An inspection of Figs. 5a and 5b as well as the yearly totals in Table 1 indicates that the number of waves is unrelated to the number of depressions each year and that the nature of the wave and the large scale environment play the most important role for storm development. On the other hand, the environment apparently exerts very little influence on the number of waves.

Frank (1974) introduced a parameter that seemed to be useful in describing the overall character of the hurricane season. This is computed by forming the ratio of the number of depressions of African origin to the total number of depressions. Low numbers of this value suggest a high number of depressions had their origin from cold lows or frontal zones.

In 1989 the ratio was 0.93, a value even higher than the previous year record of 0.84 for the 1967–88 period shown in Fig. 6a. This indicates the strong "tropical character" of the past two seasons. However, due to the variability observed in the number of depressions shown in Fig. 5b, a ratio between the number of storms of African origin and the total number of storms appears to be more appropriate to describe the character of the season, see Avila and Clark (1989). Note there is no trend in the number of tropical storms during the past 22 years in Fig. 5c.

The ratio of the number of storms of African origin to the total number of storms is given in Fig. 6b. The 22-year average African contribution to the total number of storms was 60% compared to 56% for the number of depressions (Fig. 6a). Africa contributed 100% to the total number of storms during 1989, indicating the highly tropical characteristics of the 1989 hurricane season. This equals the value for 1979 when the Cape Verde-type hurricanes David and Frederic occurred.

Figure 6b shows that, typically, Africa is the main source of storms for the Atlantic basin. In 1972, 1977, 1983 and 1986, Africa produced small numbers of storms. Those years coincided with moderate to strong El Niño episodes (Gray 1988), and although the African impulses were present, the hostile environment induced by those episodes did not permit the waves to develop.

Avila and Clark (1989) arbitrarily separated "African years" and "non-African years" by considering the relative contribution to tropical storm development by African waves. Those years in which the ratio is greater or equal than 0.70 were considered African years and non-African years by those whose ratio is less or equal to 0.50. For other ratio values those years were defined as "average years."

Table 2 summarizes the African, non-African and average years. The table includes the Hurricane Destruction Potential (HDP) which is a measure of a hurricane's potential for wind and storm surge destruction. It is defined as the sum of the square of each hurricane's maximum winds for each six-hour period of its existence. The average HDP during African years of the 1967–89 period was larger than the average HDP of the non-African years. This continues to lend credence to the idea that usually the most intense hurricanes are spawned by African waves, thus the importance of monitoring such waves.

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