

Atlantic Tropical Systems of 1977

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ABSTRACT

The 1977 hurricane season produced 105 "tropical systems", of which 19 acquired the closed circulation of a depression. Over half of these (69) originated over the African Continent. African seedlings initiated four of the six named Atlantic storms, and all but one of the eight east Pacific storms.

1. Introduction

This is the tenth consecutive year a seasonal tropical disturbance summary has been completed. The general philosophy of the counting method was outlined in previous articles by Simpson *et al.* (1968, 1969).

Lawrence (1978) describes the 1977 hurricane season as being "inactive". Thus, the current lull in hurricane activity being enjoyed by interests in the Atlantic continues. During the last six years the cause of the inactivity has generally been related to cool ocean temperatures and strong upper westerlies over the hurricane breeding grounds. In 1976 Hebert (1976) noted a trend toward normalcy for these two parameters, and this year Lawrence (1978) observed near-normal sea temperatures and upper winds over most of the tropical Atlantic. This would suggest an increase in storm activity. So what happened? Where were the storms?

It is interesting to note that tropical storm activity was also well below normal in the Pacific. This can be seen in Table 1 which compares the storm activity for both the Atlantic and Pacific in 1977 with longer period annual averages. The number of tropical storms in the Northern Hemisphere was around 30% below

TABLE 1. Storm activity in 1977 compared with long-term averages.

| | Named storms | | Hurricanes | |
|--------------|--------------|----------------|------------|----------------|
| | 1977 | Annual average | 1977 | Annual average |
| Atlantic | 6 | 8 (1900-76) | 5 | 5 |
| East Pacific | 8 | 15 (1966-76) | 4 | 7 |
| West Pacific | 19 | 28 (1959-76) | 11 | 19 |

normal in 1977. This is a very interesting observation and suggests global circulation influences. Lawrence (1978) related the inactivity in the Atlantic to a weaker than normal subtropical ridge. This produced a weak north-south shear of the horizontal winds—another term found by many authors to be important in storm development. Data are not available at our Center to see if similar conditions were also true in the Pacific.

2. Census of 1977 tropical systems

The systems observed during the 1977 hurricane season are given in Table 2, and results for several categories are summarized in Table 3 and Fig. 1.

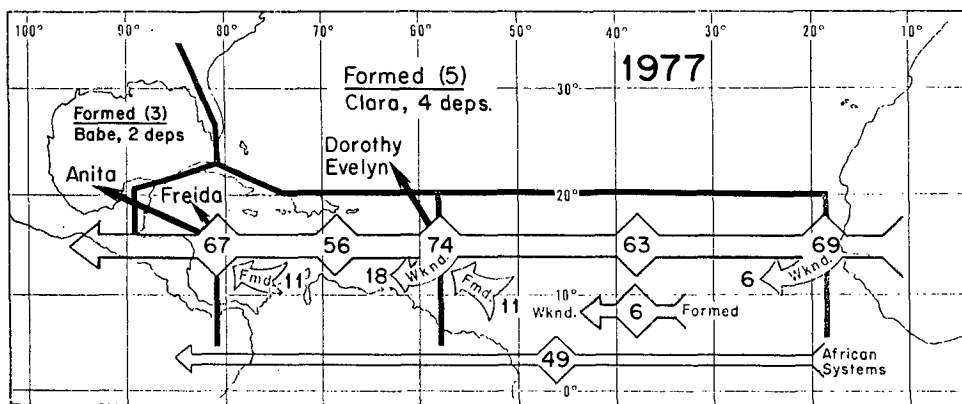


FIG. 1. Summary of tropical disturbances that passed three key stations (Dakar, Barbados, San Andres) in 1977 and those maintaining their identity while crossing the Atlantic and Caribbean.

TABLE 2. Summary of the tropical systems of 1977.

| Dakar passage | Nature | Formed in Atlantic | Date weakened Atlantic | Date Barbados passage | Nature | Weakened Caribbean | Formed Caribbean | San Andres passage | Nature | Formed Gulf of Mexico | Formed North Atlantic | Atlantic storm | Pacific depression | Pacific storm |
|---------------|--------|--------------------|------------------------|-----------------------|--------|--------------------|------------------|--------------------|--------|-----------------------|-----------------------|----------------|--------------------|---------------|
| May 3 | Wave | | | May 8 | Wave | | | May 12 | | | | | # 1 | Ava |
| May 4 | Wave | | | May 11 | Wave | | | May 15 | | | | | # 2 | |
| May 8 | Wave | 5/13 | 5/15 | May 14 | Wave | | | May 18 | | | | | # 3 | |
| May 11 | Wave | | | May 20 | Wave | | | May 25 | | | | | # 4 | |
| May 16 | Wave | 5/25 | | May 25 | Wave | 5/29 | | May 29 | Wave | | 6/3 | # 1 | | |
| May 21 | Wave | | | May 29 | Wave | | | June 2 | Wave | | | | | |
| May 26 | Wave | | | June 1 | Wave | | | June 4 | Wave | | | | | |
| May 28 | Wave | | | June 4 | Wave | | | June 8 | Wave | 6/13 | | | # 2 | |
| May 30 | Wave | | | June 7 | Wave | 6/7 | | June 11 | Wave | | | | | |
| June 2 | Wave | | | June 8 | Wave | | | June 14 | Wave | | | | | |
| June 3 | Wave | | | June 10 | Wave | | | June 16 | Wave | | | | | |
| June 5 | ITCZ | | | June 13 | ITCZ | | | June 18 | ITCZ | | | | # 5 | Bernice |
| June 8 | Wave | | | June 15 | Wave | | | June 20 | Wave | | | | | |
| June 10 | Wave | | | June 16 | Wave | 6/16 | | June 23 | Wave | | | | # 6 | |
| June 13 | Wave | | | June 17 | Wave | | | June 25 | ITCZ | | 6/17 | # 3 | | |
| June 15 | Wave | | | June 20 | Wave | | | June 26 | Wave | | | | # 7 | Claudia |
| June 18 | Wave | | | June 23 | Wave | | | June 28 | Wave | 6/24 | | | # 8 | |
| June 21 | Wave | | | June 26 | Wave | | | June 30 | Wave | | | | # 9 | |
| June 23 | Wave | | | June 27 | Wave | | | July 2 | Wave | | | | | |
| June 25 | Wave | | | June 29 | Wave | | | July 4 | Wave | | | | | |
| June 27 | Wave | | | July 1 | Wave | | | July 5 | ITCZ | | | | # 10 | |
| June 30 | Wave | | | July 5 | Wave | | | July 8 | Wave | | | | | |
| July 3 | Wave | | | July 10 | Wave | | | July 12 | Wave | | | | | |
| July 6 | Wave | 7/3 | | July 8 | Wave | 7/11 | | July 16 | Wave | 7/18 | | | | |
| July 8 | Wave | | | July 12 | Wave | 7/15 | | July 19 | ITCZ | | | | # 4 | |
| July 12 | Wave | | | July 14 | Wave | | | July 21 | Wave | | | | | |
| July 15 | Wave | | | July 16 | Wave | | | July 23 | Wave | | | | # 5 | |
| July 17 | Wave | | | July 19 | Wave | | | July 25 | Wave | | 7/21 | # 5 | | |
| July 20 | Wave | | | July 22 | Wave | | | July 28 | Wave | | | | # 6 | |
| July 22 | Wave | | | July 24 | Wave | 7/25 | | August 2 | Wave | | | | | |
| July 25 | Wave | | | August 1 | Wave | | | August 5 | Wave | 7/25 | | | | |
| July 28 | Wave | | | August 4 | Wave | | | August 7 | Wave | | | | # 12 | Doreen |
| | | | | | | | | August 9 | ITCZ | | | | | |

TABLE 2 (continued)

| Dakar passage | Nature | Formed in Atlantic | Date weakened | Date Barbados passage | Nature Caribbean | Weakened Caribbean | Formed Caribbean | San Andres passage | Nature | Formed Gulf of Mexico | Formed North Atlantic | Formed Atlantic depression | Atlantic storm | Pacific depression | Pacific storm |
|---------------|--------|--------------------|---------------|-----------------------|------------------|--------------------|------------------|--------------------|--------|-----------------------|-----------------------|----------------------------|----------------|--------------------|---------------|
| August 1 | Wave | | | August 7 | Wave | | 8/12 | August 12 | Wave | | | # 7 | | | |
| August 6 | Wave | | | August 12 | Wave | | | August 13 | ITCZ | | | | | | |
| August 8 | Wave | | | August 13 | Wave | | | August 16 | Wave | | | | | | |
| August 9 | Wave | | | August 15 | Wave | 8/13 | | August 19 | Wave | | | | | | |
| August 12 | Wave | | | August 17 | Wave | | | August 21 | Wave | | | | | | |
| August 14 | Wave | | | August 20 | Wave | | | August 24 | Wave | | | | | | |
| August 17 | Wave | | | August 23 | Wave | | | August 27 | Wave | 8/29 | | # 8 | Anita | # 13 | |
| August 20 | Wave | 8/19 | 8/23 | August 27 | Wave | | | August 31 | Wave | | | | | | |
| August 24 | Wave | | | August 29 | Wave | | | September 1 | Wave | | | | | | |
| August 25 | Wave | | | August 30 | Wave | 8/31 | | September 6 | Wave | | | | | # 14 | Emily |
| August 28 | Wave | 8/29 | | September 2 | Wave | | | September 9 | Wave | | | | | | |
| | | 9/2 | 9/4 | September 5 | Wave | | | | | 9/3 | | # 9 | Babe | | |
| | | | | | | | | | | | 9/3 | # 10 | | | |
| September 1 | Wave | | | September 8 | Wave | | | September 11 | Wave | | | # 11 | Clara | # 16 | Florence |
| September 3 | Wave | | | September 10 | Wave | | | September 13 | Wave | | | | | # 15 | |
| September 5 | Wave | 9/9 | | September 12 | ITCZ | | | September 15 | Wave | | | | | | |
| September 9 | Wave | | | September 14 | Wave | | | September 17 | Wave | | | | | | |
| September 10 | Wave | | 9/10 | September 17 | Wave | | | September 20 | Wave | 9/22 | | # 13 | | # 17 | Glenda |
| | | 9/13 | | September 19 | Wave | | | September 22 | Wave | | | | | | |
| September 12 | Wave | | | September 21 | Wave | 9/24 | | September 24 | ITCZ | | | # 14 | Dorothy | | |
| September 19 | Wave | 9/21 | | September 23 | Wave | | | September 27 | Wave | | | | | | |
| September 23 | Wave | | | September 25 | Wave | | | September 28 | Wave | | | | | # 18 | Heather |
| September 24 | Wave | 9/25 | 9/27 | September 27 | Wave | | | September 30 | Wave | | | | | | |
| September 27 | Wave | | | September 29 | Wave | 10/6 | | October 2 | Wave | | | | | | |
| September 30 | Wave | | 10/3 | October 4 | Wave | | | October 8 | Wave | | | 10/1 | # 16 | | |
| | | | | | | | | October 11 | Wave | | | 10/2 | # 15 | | |
| October 2 | Wave | | | October 7 | Wave | | | October 16 | Wave | | | | | # 18 | Frieda Evelyn |
| October 3 | Wave | | | October 10 | Wave | | | October 13 | Wave | | | 10/16 | # 17 | # 19 | |
| October 6 | Wave | | | October 12 | Wave | 10/13 | | October 16 | Wave | | | | | | |
| October 9 | Wave | | | October 15 | Wave | 10/16 | | October 13 | Wave | | | | | | |
| October 10 | Wave | | | October 17 | Wave | 10/18 | | | | | | | | | |

TABLE 2 (continued)

| Dakar passage | Nature | Formed in Atlantic | Date weakened Atlantic | Date Barbados passage | Nature Caribbean | Weakened Caribbean | Formed Caribbean | San Andres passage | Nature | Formed Gulf of Mexico | Formed North Atlantic | Formed Atlantic depression | Atlantic storm | Pacific depression | Pacific storm |
|---------------|--------|--------------------|------------------------|-----------------------|------------------|--------------------|------------------|--------------------|--------|-----------------------|-----------------------|----------------------------|----------------|--------------------|---------------|
| October 12 | Wave | | | October 18 | Wave | | | October 22 | Wave | | | | | | |
| | | 10/15 | | October 22 | ITCZ | 10/21 | | | | | | | | | |
| October 17 | Wave | 10/20 | 10/23 | October 23 | ITCZ | 10/23 | | | | | | | | | |
| | | 10/20 | 10/23 | October 24 | Wave | 10/25 | | | | 10/24 | | # 19 | | | |
| October 20 | Wave | 10/29 | 10/31 | October 27 | Wave | | | October 30 | Wave | | | | | | |
| October 23 | Wave | | | October 29 | Wave | | | November 2 | Wave | | | | | | |
| October 25 | Wave | | | November 1 | Wave | 11/2 | | | | | | | | | |
| October 30 | Wave | | 10/31 | | | | | | | | | | | | |
| November 1 | Wave | 10/30 | 11/3 | November 4 | ITCZ | 11/6 | | | | | | | | | |
| | | | | | | | 11/4 | | | | | | | | |
| November 4 | Wave | 11/6 | | November 10 | Wave | | 11/5 | November 5 | ITCZ | | | | | | |
| November 10 | Wave | | 11/14 | November 14 | Wave | | 11/7 | November 7 | ITCZ | | | | | | |
| November 13 | Wave | | 11/17 | | | | | November 9 | ITCZ | | | | | | |
| | | | | | | | | November 13 | Wave | | | | | | |
| | | | | | | | | November 17 | Wave | | | | | | |

TABLE 3. Summary of 1977 tropical systems according to type and geographical area of formation. The numbers in parentheses indicate systems that were counted in a weaker stage.

| | Africa | Tropical Atlantic | Sub-tropical Atlantic | Caribbean | Gulf of Mexico | Total |
|--------------|--------|-------------------|-----------------------|-----------|----------------|----------|
| Waves | 68 | 7 | 0 | 0 | 0 | 75 |
| ITCZ | 1 | 10 | 0 | 11 | 0 | 22 |
| Depression | 0 | (3) | 5 (2) | (2) | 3 (4) | 8 (11) |
| Named storms | 0 | 7 | (3) | (1) | (2) | (6) |
| Total | 69 | 17 (3) | 5 (5) | 11 (3) | 3 (6) | 105 (17) |

Table 2 describes the history of the 105 systems, giving the dates when they passed three key stations: Dakar, Senegal, Barbados and San Andres Island. The table also lists the spawning date of seedlings that formed and weakened along the intertropical convergence zone (ITCZ) in the Atlantic, and the dates of formation of subtropical cyclones or depressions over the Gulf of Mexico and the Atlantic north of 20°N. The Atlantic and eastern Pacific storms that were initiated by Atlantic seedlings are listed in the last four columns.

Table 3 summarizes the systems according to type and geographical area of formation. The numbers in parentheses indicate systems that were counted in a weaker stage of development. For example, Evelyn and Dorothy formed in the tropical Atlantic north of 20°N and were initiated by African waves. Once again, we see that nearly half the systems were wave perturbations in the trades whose origin was over Africa. This observation has been true every year we have completed the survey, and stresses the importance of Africa as a seed-bed for Atlantic disturbances.

Fig. 1 tabulates the total number of systems passing Dakar, Barbados and San Andres Island as well as the number that maintained their identity while traversing the Atlantic and Caribbean. Statistics are also presented on the seedlings that developed within four geographical areas: the Gulf of Mexico, the Caribbean Sea, and the subtropical and tropical Atlantic, where latitude 20°N has been used as a dividing line. Of the 69 African systems, 63 were tracked to the Caribbean and 49 all the way to the Pacific. Over the tropical Atlantic, 17 disturbances formed with 11 eventually passing through the Antilles. Six of these were identified along the ITCZ and were followed for at least 48 h before dissipating. A total of 74 systems crossed the Antilles (63 from Africa plus 11 that formed

TABLE 4. Monthly distribution of depressions for 1977 compared with the 10 year averages.

| | Jun | Jul | Aug | Sep | Oct | Nov | Total |
|---------------------------|-----|-----|-----|-----|-----|-----|-------|
| 10-year average (1967-76) | 2.5 | 3.5 | 6.0 | 7.5 | 4.0 | 0.5 | 24 |
| 1977 | 3 | 3 | 2 | 6 | 5 | 0 | 19 |

TABLE 5. Results of 1977 compared with averages and ranges for the previous nine years (1968-1976).

| | 9-year average (1968-76) | Range | 1977 |
|---------------------------|--------------------------|--------|------|
| Total systems (all types) | 103 | 85-113 | 105 |
| Dakar systems | 58 | 52-68 | 69 |
| Barbados systems | 58 | 44-72 | 74 |
| San Andres systems | 52 | 40-64 | 67 |
| Depressions* | 25 | 22-34 | 19 |
| Named storms | 8 | 4-13 | 6 |
| Subtropical storms | — | — | 0 |

* This is the total number of depressions while Table 4 refers to depressions during the hurricane season only (June-November).

in the Atlantic) of which 56 maintained their identity while traversing the Caribbean. The 11 disturbances that formed over the Caribbean added to the number from the Antilles resulted in 67 seedlings entering Central America.

One unusual aspect of the 1977 season was the early appearance of several well-defined African waves. The first wave of the season moved by Dakar on 3 May. A third African system in early May was tracked all the way to the eastern Pacific where it spawned Ava, their first named storm of the year. African systems do not generally occur until mid or late May.

The depression tracks for the months June through October are shown in Fig. 2. The first depression of the season was initiated in early June by an African wave in the northwest Caribbean. The last depression of the

TABLE 6. Summary of the type of seedling that initiated Atlantic named storms and depressions during 1977 compared with annual averages from previous years.

| Year | Tropical African systems | | Baroclinic | | Totals |
|---------------------------|--------------------------|-------------------|-------------------|---|--------|
| | Disturbance | Upper troposphere | Lower troposphere | | |
| Named storms | | | | | |
| 1977 | 3 | 1 | 1 | 1 | 6 |
| 10-year average (1967-76) | 4 | 2 | 1 | 1 | 8 |
| Active period (1967-70) | 4 | 3 | 1 | 1 | 9 |
| Inactive period (1971-76) | 4 | 1 | 2 | 2 | 9 |
| Depressions* | | | | | |
| 1977 | 10 | 1 | 3 | 5 | 19 |
| 10-year average (1967-76) | 10 | 3 | 4 | 7 | 24 |
| Active period (1967-70) | 13 | 5 | 3 | 4 | 25 |
| Inactive period (1971-76) | 9 | 2 | 4 | 8 | 23 |

* Only the depressions that occurred from June through November.

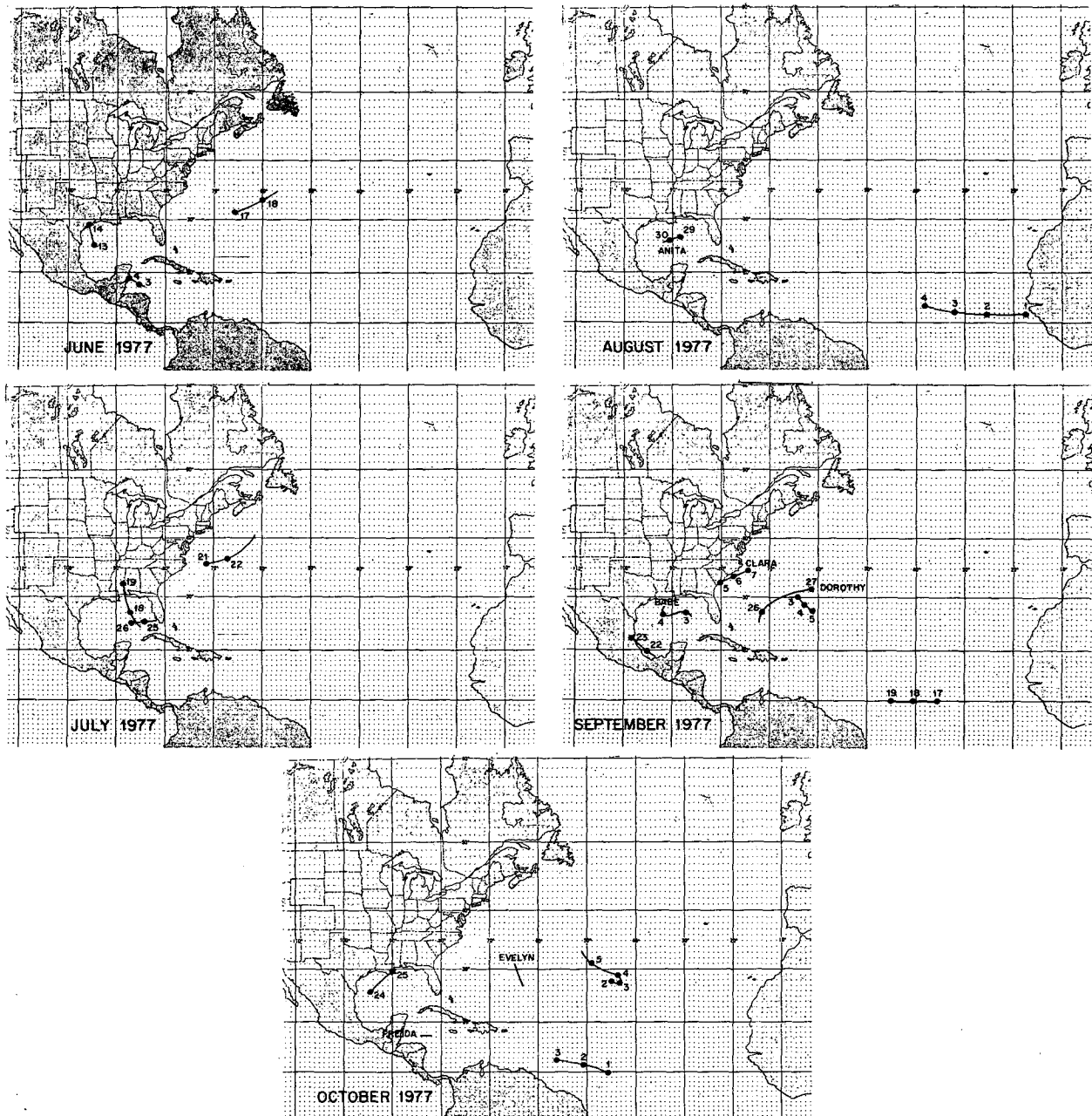


FIG. 2. Tracks of 1977 depressions.

year developed in October along an old baroclinic zone in the Gulf of Mexico.

This was the fewest number of depressions observed since 1967 when seasonal summaries were initiated. Two factors are related to this decrease in depression activity. First, there was a sharp drop in the number of depressions during the early peak of the hurricane season. This is seen in Table 4 which compares the monthly distributions of depressions for 1977 with the previous 10-year averages (1967-76). There were fewer depressions than normal in both August and September. The two depressions in August represent

only one-third of the expected number. The second factor is related to the geographical area of formation. Over two-thirds (14) of the depressions formed over the subtropical latitudes of the Gulf of Mexico and the North Atlantic. Only three depressions developed in the tropical Atlantic south of 20°N , where we normally expect between eight to ten.

Fig. 3 summarizes the source of eastern Pacific named storms. The eight storms in the eastern Pacific were the fewest in number since our counting system began in 1968, and represent only half of the expected number. All but one of the eight storms were initiated

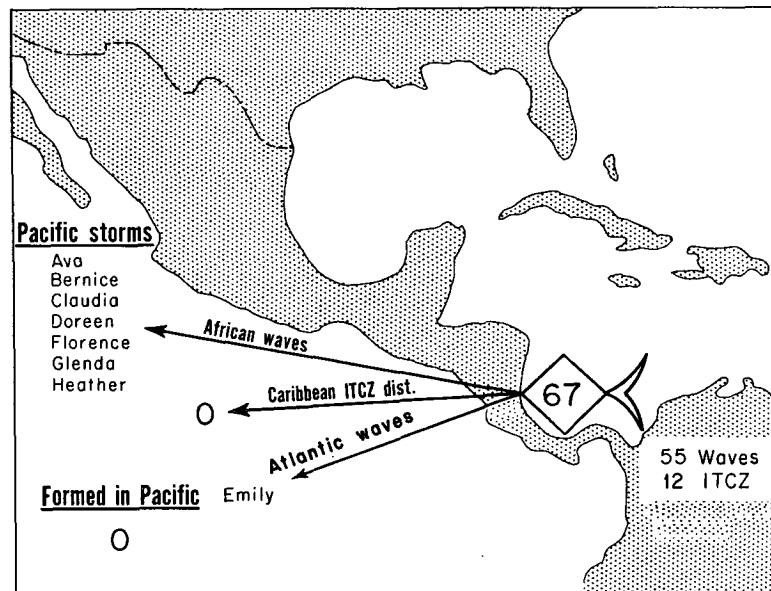


FIG. 3. Summary of the type of seedlings that initiated east Pacific storms in 1977.

by African disturbances. Again we see the dominant role played by African disturbances on the storm activity in the eastern Pacific.

3. Comparison with other years

Table 5 compares the tropical system in 1977 with averages and ranges determined over the previous nine years within several categories. The hurricane season in 1977 was a very interesting paradox. We have already seen that the named storms in eastern Pacific and Atlantic depressions were well below normal. The same is true of named storms in the Atlantic. Yet, the total number of systems was near normal, and the number of disturbances passing our three key locations was the highest in our 10-year history.

Table 6 summarizes the source of Atlantic depressions and named storms in 1977 compared with previous years. In the tables, the 1977 results are compared to averages for the past 10 years and to an "active" versus "inactive" period. The past 10 years can be divided into two periods. The years from 1967 to 1970 were characterized by normal storm activity, and the past six years have been relatively quiet. While the number of depressions and named storms initiated by "tropical-type" disturbances in 1977 was below normal

and typical of what we have observed during the inactive period of the past six years, the activity spawned by "baroclinic-type" disturbances was more typical of the "active periods". This combination produced a 25% reduction from normal in the number of depressions and named storms.

In conclusion, the 1977 hurricane season can be characterized by many disturbances, but few storms. This interesting paradox emphasizes the controlling influence of environmental conditions in tropical storm development. It appears that a large-scale hemispheric circulation pattern produced a weaker than normal subtropical high over the oceans. The resulting north-south shear of the lower tropospheric wind was reduced and lessened the threat of tropical storm development.

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