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THE DEADLIEST, COSTLIEST, AND MOST INTENSE UNITED STATES
HURRICANES OF THIS CENTURY (AND OTHER FREQUENTLY REQUESTED
HURRICANE FACTS)

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National Hurricane Center
Miami, Florida
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Atmospheric Administration
John V. Byrne, Administrator

National Weather
Service
Richard E. Hallgren, Director



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by

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ABSTRACT

Lists of United States Hurricanes which have caused 25 or more deaths and fifty million dollars or more in damages (unadjusted) during this century have been compiled from all data sources available at the National Hurricane Center (NHC). In addition, all major¹ hurricanes which have made landfall in the United States during this century are listed. Some additional statistics on United States hurricanes of this century and tropical cyclones in general are also presented.

1. INTRODUCTION

Numerous requests are received at the National Hurricane Center for statistical information on deaths, damages, and severity of hurricanes which have affected the United States. In the past this has required searching through various reference materials, depending on the nature of the individual request. Different sources gave different estimates of these statistics so that decisions had to be constantly made as to which information should be given out by NHC as "official" from the National Hurricane Information Center (another function of NHC). Requests to other Weather Service offices posed the same dilemma. These lists are being published in the hope of presenting a single source of the best currently available estimates of deaths, damages, and intensity of major U.S. hurricanes which have made landfall in this century. In some instances, data in these lists present revised estimates for individual hurricanes based on more complete information received after earlier published values including the previous version of this technical memorandum.

There are other frequently asked questions about hurricanes. What is the average number of hurricanes per year? What year(s) had the most and least hurricanes? What hurricane had the longest life? When did the earliest and latest hurricane occur? What was the most intense Atlantic hurricane? What was the largest number of hurricanes in existence on the same day? When was the last time a major hurricane or any hurricane hit a given community directly²? Answers to these and several other questions are provided in the next section.

¹A major hurricane is in category 3, 4, or 5 on the Saffir/Simpson Hurricane Scale (see references), and is comparable to a Great Hurricane in other publications. Table 1 gives the criteria used.

²A direct hit means experiencing the core of strong winds and high tides (approximately 50 miles along the coastline) of a hurricane.

Statistics on probabilities and the total number of storms and hurricanes to affect the U.S. coastline by fifty-mile segments, as well as only hurricanes, and major (or great) hurricanes can be found in Simpson and Lawrence (1971). Statistics on total storm/hurricane activity in the North Atlantic Ocean (which includes the Gulf of Mexico and the Caribbean Sea) can be found in Neumann, Cry, Caso, and Jarvinen (1981). A detailed breakdown of hurricanes by category which have affected coastal counties of the Gulf of Mexico and North Atlantic both directly and indirectly³ can be found in Hebert and Taylor (1975), which has been updated where necessary for this technical memorandum. The best source of how a hurricane affected individual localities or states can be found in the annual articles on the hurricane season in the Monthly Weather Review (1982) and the Storm Data tabulation (1982) for the United States, respectively.

2. DISCUSSION

Part I

What have been the deadliest hurricanes of this century in the U.S.? Table 2 lists the 31 deadliest hurricanes to strike the U.S. in this century. Three hurricanes prior to 1900 are listed as an addendum because of their large death tolls.

What have been the costliest hurricanes of this century in the U.S.? Table 3 lists the 29 costliest hurricanes to strike the U.S. in this century. Figures are unadjusted for inflation. Table 3a re-orders these plus several other hurricanes after adjusting to 1980 dollars.⁴

What have been the most intense hurricanes to strike the U.S. during this century?

Table 4 lists the 55 major hurricanes which have struck the U.S. during this century. Hurricanes are ordered by the lowest estimated central pressure at time of landfall and highest category to affect the United States

A look at the lists of deadliest and costliest hurricanes of this century reveals several striking facts: (1) The twelve deadliest hurricanes were all the equivalent of a category 4 or higher, if the excessive forward speed is considered as raising the category of a hurricane by one. (2) All of the thirty-one deadliest hurricanes were major hurricanes except for the inland flood-producing hurricanes Agnes and Diane. These large death totals are primarily a result of the 15- to 20-foot rise of the ocean (storm surge) associated with these major hurricanes. (3) A large portion of the damage in the six costliest hurricanes (Table 3) resulted from inland flooding caused by torrential rainfall in mountainous areas. (4) Nearly three fifths of the deadliest hurricanes were the equivalent of a category four or higher, but only one third of the costliest hurricanes (Table 3) met this criterion. (5) Very few of the deadliest hurricanes have occurred during the past twenty years in contrast to most of the costliest hurricanes.

³Indirectly means experiencing at least wind gusts of hurricane force and/or tides of 4 to 5 feet or more above normal from a nearby hurricane.

⁴See reference with Table 3a.

Table 2. The deadliest United States hurricanes of this century.

DEADLIEST HURRICANES, UNITED STATES 1900-1982
(25 or more deaths)

HURRICANE	YEAR	CATEGORY	DEATHS
1. Texas (Galveston)	1900	4	6000
2. Florida (Lake Okeechobee)	1928	4	1836
3. Florida (Keys/S. Texas)	1919	4	600-900#
4. New England	1938	3*	600
5. Florida (Keys)	1935	5	408
6. AUDREY (Louisiana/Texas)	1957	4	390
Northeast U.S.	1944	3*	390@
8. Louisiana (Grand Isle)	1909	4	350
9. Louisiana (New Orleans)	1915	4	275
10. Texas (Galveston)	1915	4	275
11. CAMILLE (Miss./La.)	1969	5	256
12. Florida (Miami)	1926	4	243
13. DIANE (Northeast U.S.)	1955	1	184
14. Florida (Southeast)	1906	2	164
15. Mississippi/Alabama/Pensacola	1906	3	134
16. AGNES (Northeast U.S.)	1972	1	122
17. HAZEL (South Carolina/N.C.)	1954	4*	95
18. BETSY (Fla./La.)	1965	3	75
19. CAROL (Northeast U.S.)	1954	3*	60
20. Southeast Florida/La.-Miss.	1947	4	51
21. DONNA (Fla./Eastern U.S.)	1960	4	50
22. Georgia/Carolinas	1940	2	50
23. CARLA (Texas)	1961	4	46
24. Texas (Velasco)	1909	3	41
25. Texas (Freeport)	1932	4	40
26. South Texas	1933	3	40
27. HILDA (Louisiana)	1964	3	38
28. Louisiana (Southwest)	1918	3	34
29. Florida (Southwest)	1910	3	30
30. CONNIE (North Carolina)	1955	3	25
31. Louisiana (Central)	1926	3	25

* Moving more than 30 miles per hour.

Over 500 of these lost on ships at sea.

@ Some 344 of these lost on ships at sea.

ADDENDUM

Louisiana	1893	2000
South Carolina/Georgia	1893	1000-2000
Georgia/South Carolina	1881	700

Table 3. The costliest United States hurricanes of this century.

COSTLIEST HURRICANES, UNITED STATES 1900-1982
(More than \$50,000,000 damage)

HURRICANE	YEAR	CATEGORY	DAMAGE (U.S.)
1. FREDERIC (Ala./Miss.)	1979	3	\$2,300,000,000
2. AGNES (Northeast U.S.)	1972	1	2,100,000,000
3. CAMILLE (Miss./La.)	1969	5	1,420,700,000
4. BETSY (Fla./La.)	1965	3	1,420,500,000
5. DIANE (Northeast U.S.)	1955	1	831,700,000
6. ELOISE (Northwest Fla.)	1975	3	550,000,000#
7. CAROL (Northeast U.S.)	1954	3*	461,000,000
8. CELIA (S. Texas)	1970	3	453,000,000
9. CARLA (Texas)	1961	4	408,000,000
10. CLAUDETTE (Texas)	1979	T.S.@	400,000,000
11. DONNA (Fla./Eastern U.S.)	1960	4	387,000,000
12. DAVID (Fla./Eastern U.S.)	1979	2	320,000,000
13. New England	1938	3*	306,000,000
14. ALLEN (S. Texas)	1980	3	300,000,000
15. HAZEL (S.C./N.C.)	1954	4*	281,000,000
16. DORA (Northeast Fla.)	1964	2	250,000,000
17. BEULAH (S. Texas)	1967	3	200,000,000
18. AUDREY (La./Tex.)	1957	4	150,000,000
19. CARMEN (Louisiana)	1974	3	150,000,000
20. CLEO (Southeast Fla.)	1964	2	128,500,000
21. HILDA (Louisiana)	1964	3	125,000,000
22. Florida (Miami)	1926	4	112,000,000
23. Southeast Fla./La.-Miss.	1947	4	110,000,000
24. Northeast U.S.	1944	3*	100,000,000+
25. BELLE (Northeast U.S.)	1976	1	100,000,000
26. IONE (N. Carolina)	1955	3	88,000,000
27. Southwest and Northeast Fla.	1944	3	63,000,000
28. Southeast Florida	1945	3	60,000,000
29. Southeast Florida	1949	3	52,000,000+

* Moving more than 30 miles per hour.

Includes \$60,000,000 in Puerto Rico.

@ Only of Tropical Storm intensity, but included because of high damage amount.

Table 3a. The costliest United States hurricanes of this century.
(Adjusted to 1980 dollars) **

COSTLIEST HURRICANES, UNITED STATES 1900-1982
(More than \$300,000,000 damage)

HURRICANE	YEAR	CATEGORY	DAMAGE (U.S.)
1. AGNES (Northeast U.S.)	1972	1	\$4,700,000,000
2. BETSY (Fla./La.)	1965	3	4,670,000,000
3. CAMILLE (Miss./La.)	1969	5	3,810,000,000
4. DIANE (Northeast U.S.)	1955	1	3,086,000,000
5. New England	1938	3*	2,632,000,000
6. FREDERIC (Ala./Miss.)	1979	3	2,550,000,000
7. CAROL (Northeast U.S.)	1954	3*	1,733,000,000
8. CARLA (Texas)	1961	4	1,412,000,000
9. DONNA (Fla./Eastern U.S.)	1960	4	1,335,000,000
10. CELIA (S. Texas)	1970	3	1,142,000,000
11. HAZEL (S.C./N.C.)	1954	4*	1,057,000,000
12. Florida (Miami)	1926	4	963,000,000
13. ELOISE (Northwest Fla.)	1975	3	880,000,000#
14. DORA (Northeast Fla.)	1964	3	850,000,000
15. Northeast U.S.	1944	3*	677,000,000
16. BEULAH (S. Texas)	1967	3	608,000,000
17. Southeast (Fla./La.-Miss.)	1947	4	516,000,000
18. AUDREY (La./Tex.)	1957	4	510,000,000
19. CLAUDETTE (Texas)	1979	T.S.@	444,000,000
20. CLEO (Southeast Florida)	1964	2	437,000,000
21. Southwest and Northeast Fla.	1944	3	427,000,000
22. HILDA (Louisiana)	1964	3	425,000,000
23. Southeast Florida	1945	3	395,000,000
24. DAVID (Fla./Eastern U.S.)	1979	2	355,000,000
25. IONE (N. Carolina)	1955	3	326,000,000
26. ALLEN (S. Texas)	1980	3	300,000,000
North Texas (Galveston)	1915	4	860,000,000 ¹
North Texas (Galveston)	1900	4	516,000,000 ²

1 Considered too high in 1915 reference.

2 Using 1915 cost adjustment- none available prior to 1915

* Moving more than 30 miles per hour.

Includes \$105,000,000 in Puerto Rico.

@ Only of Tropical Storm intensity, but included because of high damage amount.

** Adjusted to 1980 dollars on basis of U.S. Department of Commerce composite construction cost indexes.

Table 4. The most intense United States hurricanes of this century (at time of landfall).

MOST INTENSE HURRICANES, UNITED STATES 1900-1982
(At time of landfall)

HURRICANE	YEAR	CATEGORY	MILLIBARS	INCHES
1. Florida (Keys)	1935	5	892	26.35
2. CAMILLE (La./Miss.)	1969	5	909	26.84
3. Florida (Keys)/South Tex.	1919	4	927	27.37
4. Florida (Lake Okeechobee)	1928	4	929	27.43
5. DONNA (Fla./Eastern U.S.)	1960	4	930	27.46
6. Texas (Galveston)	1900	4	931	27.49
7. Louisiana (Grand Isle)	1909	4	931	27.49
8. Louisiana (New Orleans)	1915	4	931	27.49
9. CARLA (Texas)	1961	4	931	27.49
10. Florida (Miami)	1926	4	935	27.61
11. HAZEL (S.C./N.C.)	1954	4*	938	27.70
12. Southeast Fla./La.-Miss.	1947	4	940	27.76
13. North Texas	1932	4	941	27.79
14. AUDREY (La./Tex.)	1957	4#	945	27.91
15. Texas (Galveston)	1915	4#	945	27.91
16. CELIA (S. Texas)	1970	3	945	27.91
17. ALLEN (S. Texas)	1980	3@	945	27.91
18. New England	1938	3*	946	27.94
19. FREDERIC (Ala./Miss.)	1979	3	946	27.94
20. Northeast U.S.	1944	3*	947	27.97
21. S. Carolina/N. Carolina	1906	3	947	27.97
22. BETSY (Fla./La.)	1965	3	948	27.99
23. Southeast and Northwest Fla.	1929	3	948	27.99
24. Southeast Florida	1933	3	948	27.99
25. South Texas	1916	3	948	27.99
26. Miss./Ala.	1916	3	948	27.99
27. South Texas	1933	3	949	28.02
28. BEULAH (S. Texas)	1967	3	950	28.05
29. HILDA (Louisiana)	1964	3	950	28.05
30. GRACIE (S. Carolina)	1959	3	950	28.05
31. Texas (Central)	1942	3	950	28.05
32. Southeast Florida	1945	3	951	28.08
33. Florida (Tampa Bay)	1921	3	952	28.11
34. CARMEN (Louisiana)	1974	3	952	28.11
35. EDNA (New England)	1954	3*	954	28.17
36. Southeast Florida	1949	3	954	28.17
37. ELOISE (Northwest Fla.)	1975	3	955	28.20
38. KING (Southeast Fla.)	1950	3	955	28.20

* Moving more than 30 miles per hour.

Classified category 4 because of extreme tides.

@ Reached Cat. 5 intensity three times along its path through the Caribbean and Gulf of Mexico. The lowest pressure reported was 899 mb (26.55 in.) at 1742Z 8-7-80 off the northeastern tip of Yucatan Peninsula.

Table 4 continued.

HURRICANE	YEAR	CATEGORY	MILLIBARS	INCHES
39. Louisiana	1926	3	955	28.20
40. Louisiana	1918	3	955	28.20
41. Southwest Florida	1910	3	955	28.20
42. North Carolina	1933	3	957	28.26
43. Florida (Keys)	1909	3	957	28.26
44. EASY (Northwest Fla.)	1950	3	958	28.29
45. Texas (North)	1941	3	958	28.29
46. Northwest Florida	1917	3	958	28.29
47. Texas (North)	1909	3	958	28.29
48. Mississippi/Alabama	1906	3	958	28.29
49. CAROL (Northeast U.S.)	1954	3*	960	28.35
50. IONE (North Carolina)	1955	3	960	28.35
51. CONNIE (N.C./Va.)	1955	3	962	28.41
52. Southwest and Northeast Fla.	1944	3	962	28.41
53. Louisiana	1934	3	962	28.41
54. Southwest and Northeast Fla.	1948	3	963	28.44
55. Northwest Florida	1936	3	964	28.47

* Moving more than 30 miles per hour.

DIRECT HITS BY HURRICANES
U.S. GULF & ATLANTIC COASTS
1900-1982

Category 5:	2
4:	13
3:	40
2:	33
1:	48
TOTAL	<u>136</u>

Major hurricanes (Cat. 3, 4 & 5): 55

This means that during the period 1900-1982, an average of 2 major hurricanes every 3 years made landfall somewhere along the U. S. Gulf or Atlantic coast. (All categories combined average about 5 hurricanes every 3 years for the same period.)

One of the greatest concerns of the National Weather Service's (NWS) hurricane preparedness officials is that these statistics mislead people into thinking that no more large loss of life will occur in a hurricane because of our advanced technology. Dr. Neil Frank, spokesman for the NWS hurricane warning service and Director of NHC, has repeatedly emphasized the great danger of a catastrophic loss of life in a future hurricane if proper preparedness plans for vulnerable areas are not formulated.

The study by Hebert and Taylor (1975) has been updated to show that as of 1980 almost 80% of U.S. coastal residents from Texas to Maine have never experienced a direct hit by a major hurricane. Many of these 32 million residents have moved to coastal sections during the past twenty years. A look at Table 5 which lists hurricanes by decades in this century shows that during this twenty-year period both the number and intensity of landfalling U.S. hurricanes have decreased sharply! Based on 1900-1959 statistics from the same study, the expected number of hurricanes and major hurricanes during the period 1960-79 was 36 and 15, respectively. In fact, only 27 or 75% of the expected number of hurricanes struck the U.S. with only 10 major hurricanes or 67% of that expected number. It has been thirteen years since the last category 4 or 5 hurricane (Camille, 1969) struck the U.S., the only one in the last 21 years! On the average a category 4 or greater hurricane strikes the U.S. once every 5 years. Fewer hurricanes do not necessarily mean a lesser threat of disaster, however. The 1919 hurricane which was both the third deadliest and third most intense of this century to strike the U.S. occurred in a year which had a total of only three storms/hurricanes. The most intense hurricane of record in 1935 and the fourth costliest in 1965 (Betsy) occurred in years which had a total of only six storms/hurricanes.

The conclusions are obvious. A large death toll in a U.S. hurricane is still possible. The decreased death totals in recent years may be as much a result of lack of major hurricanes striking the most vulnerable areas as they are of any fail-proof forecasting, warning, and observing systems. Continued coastal growth and inflation will almost certainly result in every future major land-falling hurricane replacing one of the current costliest hurricanes. If warnings are heeded and preparedness plans developed, the death toll can be reduced, but large property losses are inevitable.

Part II

In addition to information about U.S. hurricanes, this section will also include some statistics on total tropical storm and hurricane activity.

- (1) What is the average number of hurricanes per year?

Table 6 gives the average number of tropical cyclones which reached storm strength and hurricane strength for various time periods. A total of ten tropical cyclones reaching storm strength with six of these becoming hurricanes appears to be the best averages to use for most recent time periods up to 30 years. The averages of eight tropical cyclones and five hurricanes for the longer 95-year period is a reflection of less detection and fewer actual storms prior to 1930.

Table 5. Number of hurricanes of various categories to strike the United States each decade. Updated from Hebert and Taylor (1975).

DECADE	CATEGORY					ALL 1,2,3,4,5	MAJOR 3,4,5
	1	2	3	4	5		
1900-1909	5	5	4	2		16	6
1910-1919	8	3	5	3		19	8
1920-1929	6	4	3	2		15	5
1930-1939	4	5	6	1	1	17	8
1940-1949	7	8	7	1		23	8
1950-1959	8	1	7	2		18	9
1960-1969	4	5	3	2	1	15	6
1970-1979	6	2	4			12	4
1900-1979	48	33	39	13	2	135	54

Note: Only the highest category to affect the U.S. has been used.

Table 6. Average number of tropical cyclones which reached storm strength and hurricane strength for various time periods. Adapted from Neumann, et al (1981)

PERIOD	NUMBER OF YEARS	AVERAGES (PER YEAR)	
		TROPICAL CYCLONES ¹	HURRICANES
1886-1980	95	8.3	4.9
1951-1980	30	9.6	5.9
1961-1980	20	9.6	5.7
1971-1980	10	9.6	5.3
1976-1980	5	9.6	6.0
1979-1980	2	10.0	7.0

¹Includes subtropical storms after 1967.

What year(s) have had the most and least hurricanes?

Table 7 shows the years of maximum and minimum tropical cyclone and hurricane activity for the entire Atlantic Ocean.

The only years when a hurricane failed to strike the U.S. coast were 1902, 1905, 1907, 1914, 1922, 1927, 1930, 1931, 1937, 1951, 1958, 1962, 1973, 1981, and 1982. Note that only twice has the U.S. gone as long as two years without a hurricane. The most hurricanes to strike the U.S. in one year were six in 1916. There were five in 1933, and four in 1906, 1909, and 1964. Three hurricanes have struck the U.S. in one year a total of fourteen times. Ten of these fourteen times occurred during the period 1944-1959! In this century three or more hurricanes have struck the U.S. an average of once every four years! See Table 13. A chronological list of all hurricanes to strike the U.S. during this century through 1974 including month, category by states affected, and minimum sea level pressure at landfall can be found in Hebert and Taylor (1975).

When did the earliest and latest hurricane occur?

The hurricane season is defined as June 1 through November 30. An early hurricane can be defined as occurring in the three months prior to the start of the season, and a late hurricane can be defined as occurring in the three months after the season. With these criteria the earliest observed hurricane in the Atlantic was on March 7, 1908, while the latest observed hurricane was on December 31, 1954. The earliest hurricane to strike the U.S. in this century was Alma which struck northwest Florida on June 9, 1966. The latest hurricane to strike the U.S. was late on November 30, 1925 near Tampa, Florida.

What were the longest-lived and shortest-lived hurricanes?

Ginger in 1971 holds the record for both the most number of days as a hurricane (20) and tropical cyclone (31). There have been many tropical cyclones which attained hurricane intensity for periods of 12 hours or less.

What were the strongest and weakest Atlantic hurricanes? To strike the U.S.?

In terms of central pressure (and probably winds), the strongest observed hurricane in the Atlantic was the 1935 Labor Day hurricane in the Florida Keys with a pressure of 892 millibars. Camille in 1969 with a pressure of 909 millibars at landfall was the strongest hurricane to strike the U.S. mainland. Numerous hurricanes have reached only the minimum wind speed of 74 miles per hour.

How many hurricanes have there been in each month?

Table 8 adapted from Neumann, et al (1981) shows the total and average number of tropical cyclones and those which became hurricanes by months for the period 1886-1980. In addition, the monthly total and average number of hurricanes to strike the U.S. in this century are given.

Table 7. Years of maximum and minimum tropical cyclone and hurricane activity in the North Atlantic Ocean, Caribbean Sea, and Gulf of Mexico during the period 1871-1982.

MAXIMUM ACTIVITY			
TROPICAL CYCLONES ¹		HURRICANES ²	
NUMBER	YEAR(S)	NUMBER	YEAR(S)
21	1933	12	1969
18	1969	11	1916, 1950
17	1887	10	1887, 1893, 1933
16	1936	9	1955, 1980

MINIMUM ACTIVITY			
TROPICAL CYCLONES		HURRICANES	
NUMBER	YEAR(S)	NUMBER	YEAR(S)
1	1890, 1914	0	1907, 1914
2	1925, 1930	1	1890, 1905, 1919, 1925
		2	1895, 1897, 1904, 1917, 1922, 1930, 1931, 1981, 1982

¹Includes subtropical storms after 1967. See Neumann, et al (1981) for details
²After 1885.

Table 8. Total and average number of tropical cyclones and hurricanes in the North Atlantic Ocean, Caribbean Sea, and Gulf of Mexico by month of origin for the period 1886-1980 (from Neumann, et al, 1981), and for hurricanes striking the U.S. coast in this century (updated from Hebert and Taylor, 1975).

MONTH	TROPICAL CYCLONES ¹		HURRICANES		U.S. HURRICANES ²	
	TOTAL	AVG.	TOTAL	AVG.	TOTAL	AVG.
JAN-APRIL	3	*	1	*	0	0.0
MAY	13	0.1	3	*	0	0.0
JUNE	50	0.5	21	0.2	10	0.1
JULY	61	0.6	32	0.3	14	0.2
AUGUST	186	2.0	135	1.4	33	0.4
SEPTEMBER	267	2.8	171	1.8	55	0.7
OCTOBER	173	1.8	86	0.9	20	0.2
NOVEMBER	35	0.4	17	0.2	3	*
DECEMBER	5	0.1	2	*	0	0.0
YEAR	793	8.3	468	4.9	135	1.6

¹Includes subtropical storms after 1967. See Neumann, et al (1981) for details.
²1900-1980

*Less than 0.05

What was the largest number of hurricanes in existence in the Atlantic Ocean at the same time?

According to information on the master data tape of Neumann, et al (1978), there have never been four hurricanes in existence in the North Atlantic at the same time in this century. On August 22, 1893 four hurricanes co-existed, one of them being the hurricane which killed an estimated 2,000 people in Georgia-South Carolina several days later.

On September 11, 1961 three hurricanes and possibly a fourth existed. The only other years in this century with three hurricanes on the map at the same time were 1950 and 1967.

- (8) How many direct hits by hurricanes of various categories have affected each state?

Table 9 adapted from Hebert and Taylor (1975) shows the number of hurricanes (direct hits) affecting the U.S. and individual states. The table shows that on the average close to two hurricanes per year strike the U.S., while two major hurricanes cross the U.S. coast somewhere every three years.

Other noteworthy facts cited in Hebert and Taylor (1975) are: 1. Thirty-eight percent of all U.S. hurricanes hit Florida; 2. Sixty-seven percent of category 4 or higher hurricanes have hit either Florida or Texas; 3. Approximately one out of every two hurricanes is a major one along the middle Gulf coast, southern Florida, and New York and southern New England.

When are the major hurricanes likely to strike given areas?

Table 10 shows the incidence of major hurricanes by months for the U.S. and individual states. For the United States as a whole, September has had more major hurricanes than all other months combined. Only in Texas and Louisiana are August major hurricanes almost an equal threat. Most major October hurricanes occur in southern Florida. However, three of the most devastating hurricanes did not occur in September--Audrey (1957) in June, Camille (1969) in August, and Hazel (1954) in October.

- (10) How long has it been since a major hurricane directly hit a given community? Any hurricane? Indirectly?

Table 11 summarizes the occurrence of the last major hurricane or of any hurricane to directly hit the more populated coastal communities from Brownsville, Texas to Eastport, Maine. In addition, if a hurricane indirectly affected a community after the last direct hit, it is listed in the last column of the table.

Table 9. Number of hurricanes (direct hits) affecting U.S. and individual states 1900-1982 according to Saffir/Simpson Hurricane Scale. Updated from Hebert and Taylor (1975).

AREA	CATEGORY NUMBER					ALL	MAJOR HURRICANES (≥3)
	1	2	3	4	5		
U.S. (Texas to Maine)	48	33	40	13	2	136	55
Texas	9	9	8	6	0	32	14
(North)	4	3	2	4	0	13	6
(Central)	2	2	1	1	0	6	2
(South)	3	4	5	1	0	13	6
Louisiana	5	5	7	3	1	21	11
Mississippi	1	1	4	0	1	7	5
Alabama	4	1	4	0	0	9	4
Florida	16	14	15	5	1	51	21
(Northwest)	9	6	5	0	0	20	5
(Northeast)	1	7	0	0	0	8	0
(Southwest)	5	3	5	2	1	16	8
(Southeast)	4	10	7	3	0	24	10
Georgia	1	4	0	0	0	5	0
South Carolina	5	4	2	1*	0	12	3
North Carolina	9	3	6	1*	0	19	7
Virginia	1	1	1*	0	0	3	1*
Maryland	0	1*	0	0	0	1*	0
Delaware	0	0	0	0	0	0	0
New Jersey	1*	0	0	0	0	1*	0
New York	3	0	4*	0	0	7	4*
Connecticut	2	1*	3*	0	0	6	3*
Rhode Island	0	1*	3*	0	0	4*	3*
Massachusetts	2	1*	2*	0	0	5	2*
New Hampshire	1*	0	0	0	0	1*	0
Maine	4	0	0	0	0	4	0

*Indicates all hurricanes in this category were moving greater than 30 mph.

Note: State totals will not equal U.S. totals and Texas and Florida sectional totals will not equal state totals.

Table 10. Incidence of major hurricanes (direct hits) by months to affect the United States and individual states according to the Saffir/Simpson Hurricane Scale.

AREA	MONTH					ALL
	JUNE	JULY	AUG.	SEPT.	OCT.	
U.S. (Texas to Maine)	2	3	12	31	7	55
Texas	1	1	6	6		14
(North)	1	1	2	2		6
(Central)			1	1		2
(South)			3	3		6
Louisiana	2		3	5	1	11
Mississippi		1	1	3		5
Alabama		1		3		4
Florida		1	1	14	5	21
(Northwest)		1		4		5
(Northeast)						0
(Southwest)				5	3	8
(Southeast)			1	7	2	10
Georgia						0
South Carolina				2	1	3
North Carolina			1	5	1	7
Virginia				1		1
Maryland						0
Delaware						0
New Jersey						0
New York			1	3		4
Connecticut			1	2		3
Rhode Island			1	2		3
Massachusetts				2		2
New Hampshire						0
Maine						0

Note: State totals will not equal U.S. totals and Texas and Florida sectional totals will not equal state totals.

Table 11. Last occurrence of a direct or indirect hit by any hurricane and/or by a major hurricane at the more populated coastal communities from Texas to Maine. Category is in parentheses.

STATE	CITY	DIRECT		INDIRECT	
		LAST MAJOR	LAST ANY	LAST ANY	
Texas	Brownsville	1980(3) Allen	1980(3) Allen		
	Corpus Christi	1970(3) Celia	1971(1) Fern	1980(3) Allen	
	Port Aransas	1970(3) Celia	1971(1) Fern	1980(3) Allen	
	Matagorda	1961(4) Carla	1971(1) Fern		
	Freeport	1961(4) Carla	1971(1) Fern		
	Galveston	1941(3)	1963(1) Cindy	1971(1) Fern	
	Houston	1941(3)	1959(1) Debra	1963(1) Cindy	
	Beaumont	<1900	1963(1) Cindy		
Louisiana	Lake Charles	1957(4) Audrey	1971(2) Edith		
	Morgan City	1974(3) Carmen	1979(1) Bob		
	Houma	1974(3) Carmen	1979(1) Bob		
	New Orleans	1965(3) Betsy	1965(3) Betsy	1969(5) Camille	
Mississippi	Bay St. Louis	1969(5) Camille	1969(5) Camille		
	Biloxi	1969(5) Camille	1969(5) Camille	1979(3) Frederic	
	Pascagoula	1979(3) Frederic	1979(3) Frederic		
Alabama	Mobile	1979(3) Frederic	1979(3) Frederic		
Florida	Pensacola	1926(3)	1926(3)	1979(3) Frederic	
	Panama City	1975(3) Eloise	1975(3) Eloise		
	Apalachicola	<1900	1972(1) Agnes	1975(3) Eloise	
	Homosassa	1950(3) Easy	1968(2) Gladys		
	St. Petersburg	1921(3)	1946(1)	1968(2) Gladys	
	Tampa	1921(3)	1946(1)	1968(2) Gladys	
	Sarasota	1944(3)	1946(1)	1966(2) Alma	
	Fort Myers	1960(3) Donna	1960(3) Donna	1966(2) Alma	
	Naples	1960(4) Donna	1964(2) Isbell	1965(3) Betsy	
	Key West	1948(3)	1966(1) Inez		
	Miami	1950(3) King	1964(2) Cleo	1965(3) Betsy	
	Fort Lauderdale	1950(3) King	1964(2) Cleo	1965(3) Betsy	
	West Palm Beach	1949(3)	1979(2) David		
	Stuart	1949(3)	1979(2) David		
	Fort Pierce	1933(3)	1979(2) David		
	Vero Beach	<1900	1979(2) David		
	Cocoa	<1900	1979(2) David		
	Daytona Beach	<1900	1960(2) Donna	1979(2) David	
	St. Augustine	<1900	1964(2) Dora		
	Jacksonville	<1900	1964(2) Dora		
	Fernandina Beach	<1900	1928(2)	1964(2) Dora	
Georgia	Brunswick	<1900	1928(1)		
	Savannah	<1900	1979(2) David		
South Carolina	Hilton Head	1959(3) Gracie	1979(2) David		
	Charleston	1959(3) Gracie	1959(3) Gracie		
	Myrtle Beach	1954(4*) Hazel	1954(4*) Hazel		
North Carolina	Wilmington	1960(3*) Donna	1960(3*) Donna		
	Morehead City	1960(3*) Donna	1960(3*) Donna		
	Cape Hatteras	1960(3*) Donna	1960(3*) Donna		

Table 11 continued.

STATE	CITY	DIRECT		INDIRECT
		LAST MAJOR	LAST ANY	LAST ANY
Virginia	Virginia Beach	1944(3*)	1955(1) Connie	1960(3*) Donna
	Norfolk	<1900	1955(1) Connie	
Maryland	Ocean City	<1900	<1900	1960(3*) Donna
	Baltimore	<1900	<1900	1954(2*) Hazel
Delaware	Rehoboth Beach	<1900	<1900	1960(3*) Donna
	Wilmington	<1900	<1900	<1900
New Jersey	Cape May	<1900	1903(1)	1960(3*) Donna
	Atlantic City	<1900	1903(1)	1960(3*) Donna
New York	New York City	<1900	1903(1)	1976(1) Belle
	Westhampton	1960(3*) Donna	1960(3*) Donna	
Connecticut	New London	1938(3*)	1972(1) Agnes	
	New Haven	1938(3*)	1938(3*)	1960(2*) Donna
	Bridgeport	1954(3*) Carol	1960(2*) Donna	
Rhode Island	Providence	1954(3*) Carol	1960(2*) Donna	
Massachusetts	Cape Cod	1954(3*) Edna	1954(3*) Edna	1960(2*) Donna
	Boston	<1900	1960(1*) Donna	
New Hampshire	Portsmouth	<1900	1960(1*) Donna	
Maine	Portland	<1900	1960(1*) Donna	
	Eastport	<1900	1969(1) Gerda	

*Moving more than 30 miles per hour

<1900 means before 1900

Perhaps the most illustrative example of the uncertainty of when a hurricane might strike a given locality is Pensacola, Florida. Although Dunn (1967) lists Pensacola as the city with the second highest frequency of hurricane force winds (1 in 10), it has been more than 50 years since any hurricane directly struck Pensacola!

In order to obtain the same type of information listed in Table 11 for the remaining coastal communities, the reader is referred to Hebert and Taylor (1975).

What is the total U.S. damage (unadjusted) and death toll for each year of this century?

Table 12 summarizes this information. In most years the death and damage totals are usually the result of a single, major hurricane. Gentry (1966) gives damages adjusted to 1957-59 costs as a base for the period 1915-1965. For the most part, death and damage totals for the period 1915-1965 were taken from Gentry's paper, and for the remaining years from the Monthly Weather Review.

Are there hurricane cycles?

Figures 1 through 8 show the landfalling portion of the tracks of major hurricanes which have struck the U.S. during this century.

Table 12. Estimated annual deaths and damages (unadjusted) in the United States for each year of this century.

YEAR	DEATHS	DAMAGE (\$ millions)	YEAR	DEATHS	DAMAGE (\$ millions)
1900	6000+	30	1942	8	27
1901	10	1	1943	16	17
1902	0	Minor	1944	64	165
1903	15	1	1945	7	80
1904	5	2	1946	0	5
1905	0	Minor	1947	53	136
1906	298	3+	1948	3	18
1907	0	0	1949	4	59
1908	0	0	1950	19	36
1909	406	8	1951	0	2
1910	30	1	1952	3	3
1911	17	1+	1953	2	6
1912	1	Minor	1954	193	756
1913	5	3	1955	218	985
1914	0	0	1956	19	27
1915	550	63	1957	400	152
1916	107	33	1958	2	11
1917	5	Minor	1959	24	23
1918	34	5	1960	65	396
1919	287	22	1961	46	331
1920	2	3	1962	3	2
1921	6	3	1963	10	12
1922	0	0	1964	49	515
1923	0	Minor	1965	75	1445
1924	2	Minor	1966	54	15
1925	6	Minor	1967	18	200
1926	269	107	1968	9	10
1927	0	0	1969	256	1421
1928	1836	25	1970	11	454
1929	3	1	1971	8	213
1930	0	Minor	1972	121	2100
1931	0	0	1973	5	18 ¹
1932	0	0	1974	1	150
1933	63	47	1975	21	550 ²
1934	17	5	1976	9	100
1935	414	12	1977	0	10
1936	9	2	1978	36	20
1937	0	Minor	1979	22	3045
1938	600	300	1980	2	300
1939	3	Minor	1981	0	25
1940	51	5	1982	0	Minor
1941	10	8			

¹\$15 million in crop damage caused by torrential rains with tropical depression five days after tropical storm Delia.

²Includes \$60 million in Puerto Rico.

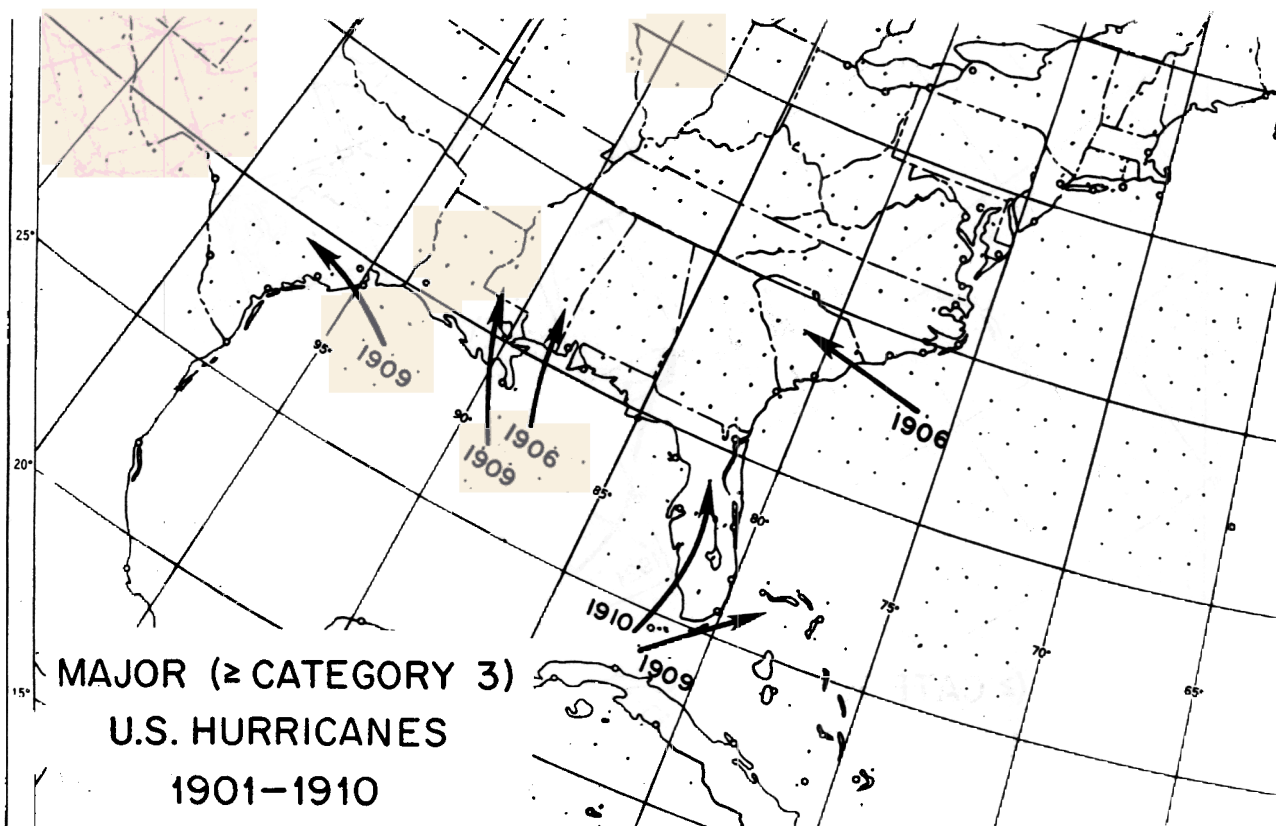


Figure 1. Major (greater than or equal to a category 3) landfalling United States hurricanes during the period 1901-1910.

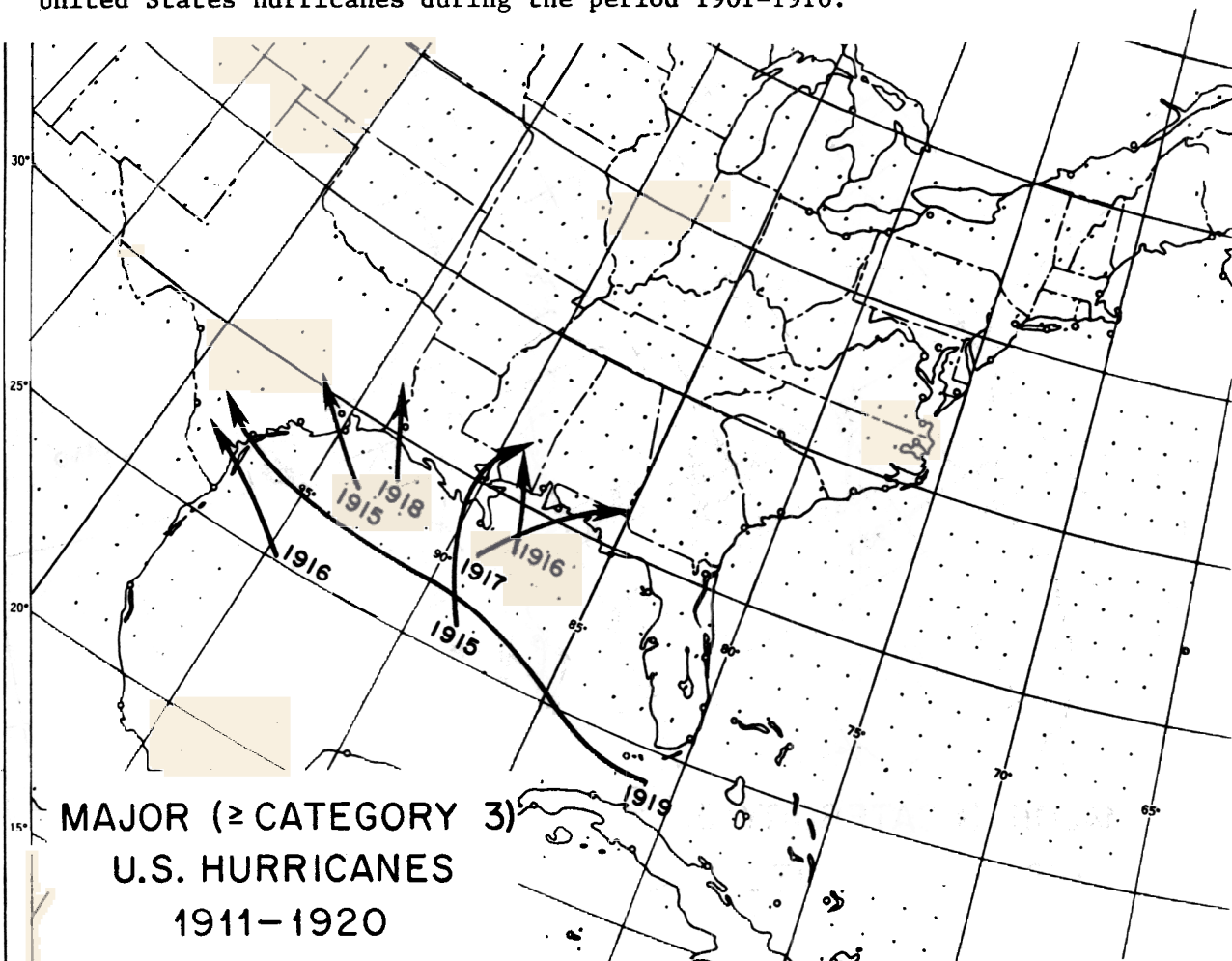


Figure 2. Major (greater than or equal to a category 3) landfalling United States hurricanes during the period 1911-1920.

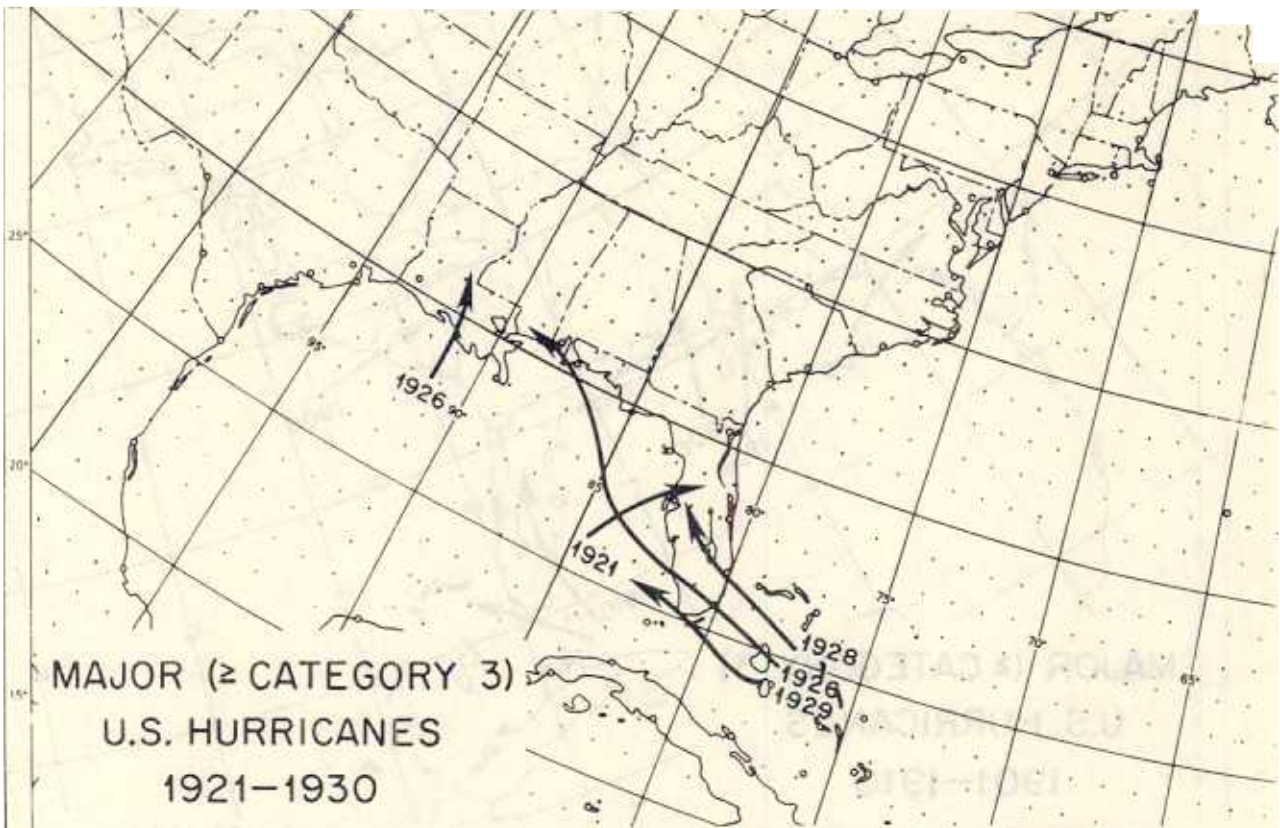


Figure 3. Major (greater than or equal to a category 3) landfalling United States hurricanes during the period 1921-1930.

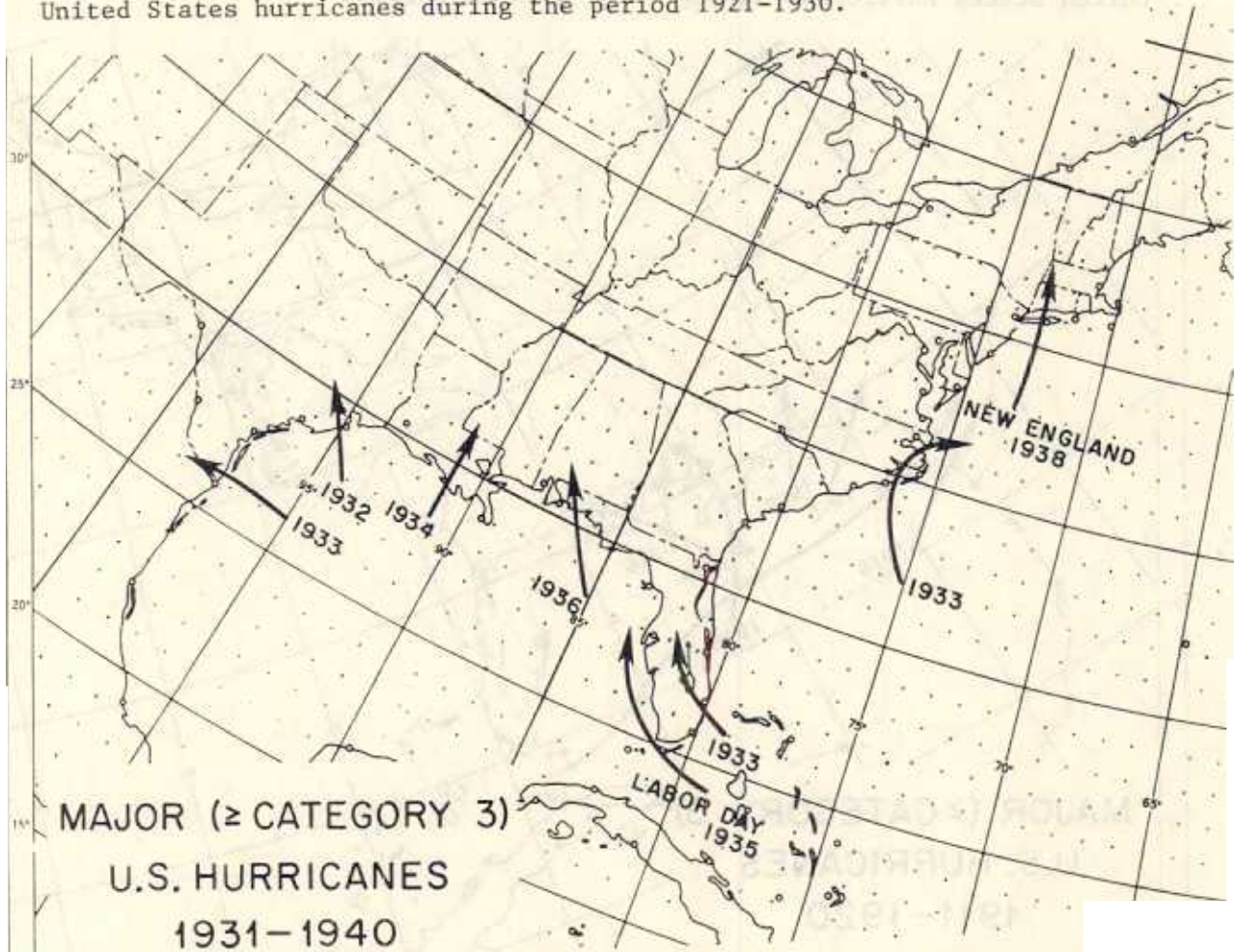


Figure 4. Major (greater than or equal to a category 3) landfalling United States hurricanes during the period 1931-1940.

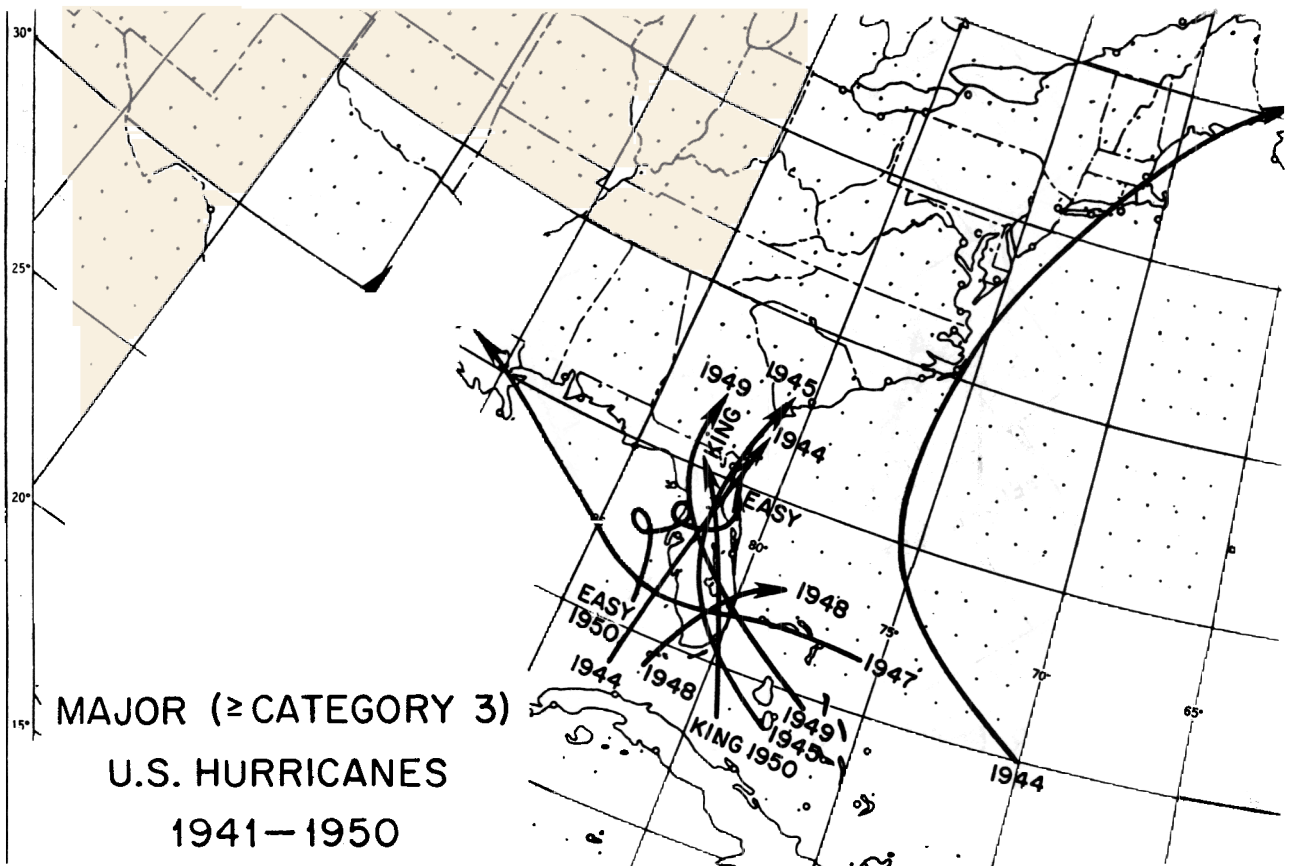


Figure 5. Major (greater than or equal to a category 3) landfalling United States hurricanes during the period 1941–1950.

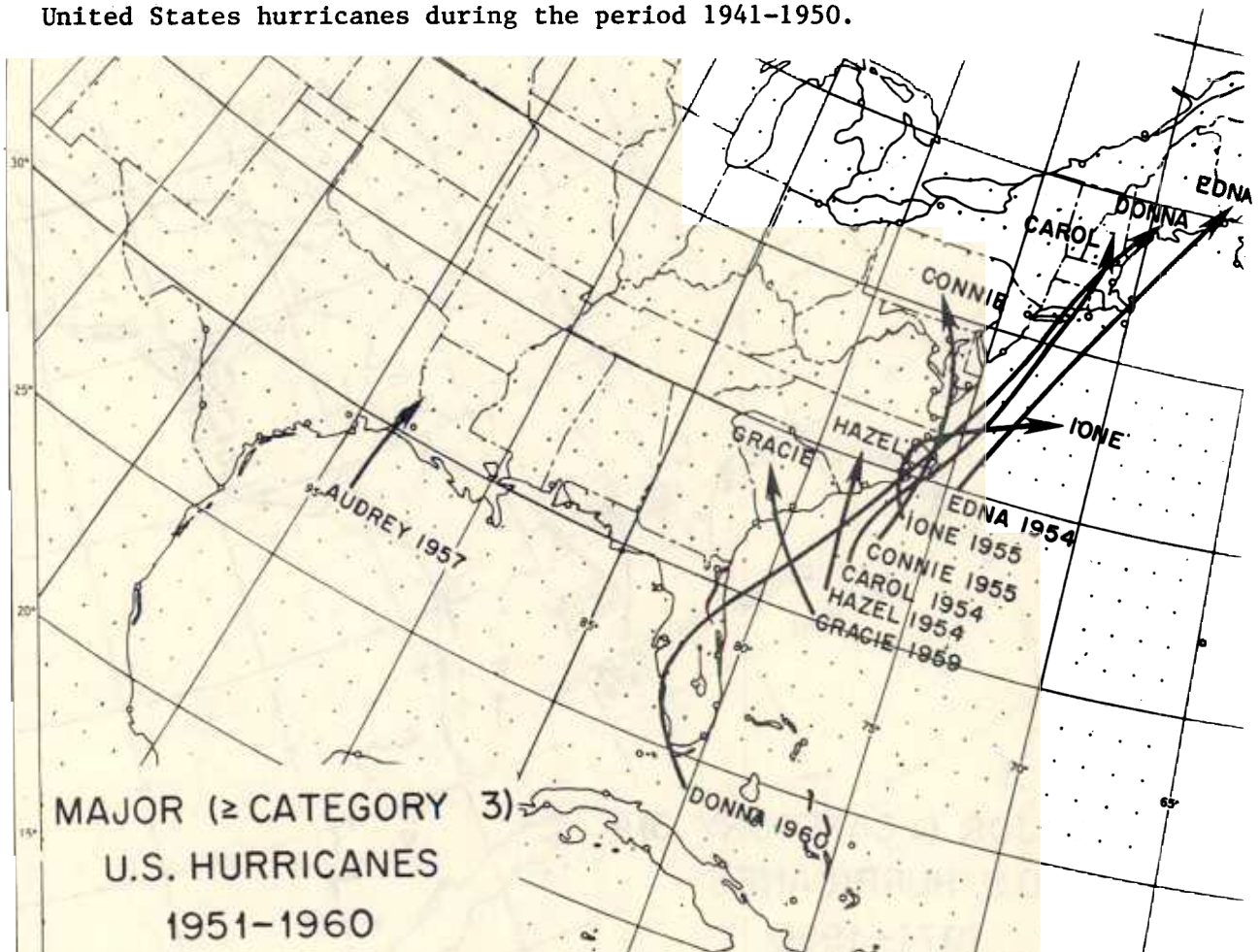


Figure 6. Major (greater than or equal to a category 3) landfalling United States hurricanes during the period 1951–1960.

**MAJOR ($\geq$ CATEGORY 3)
U.S. HURRICANES
1961-1970**

Figure 7. Major (greater than or equal to a category 3) landfalling United States hurricanes during the period 1961-1970.

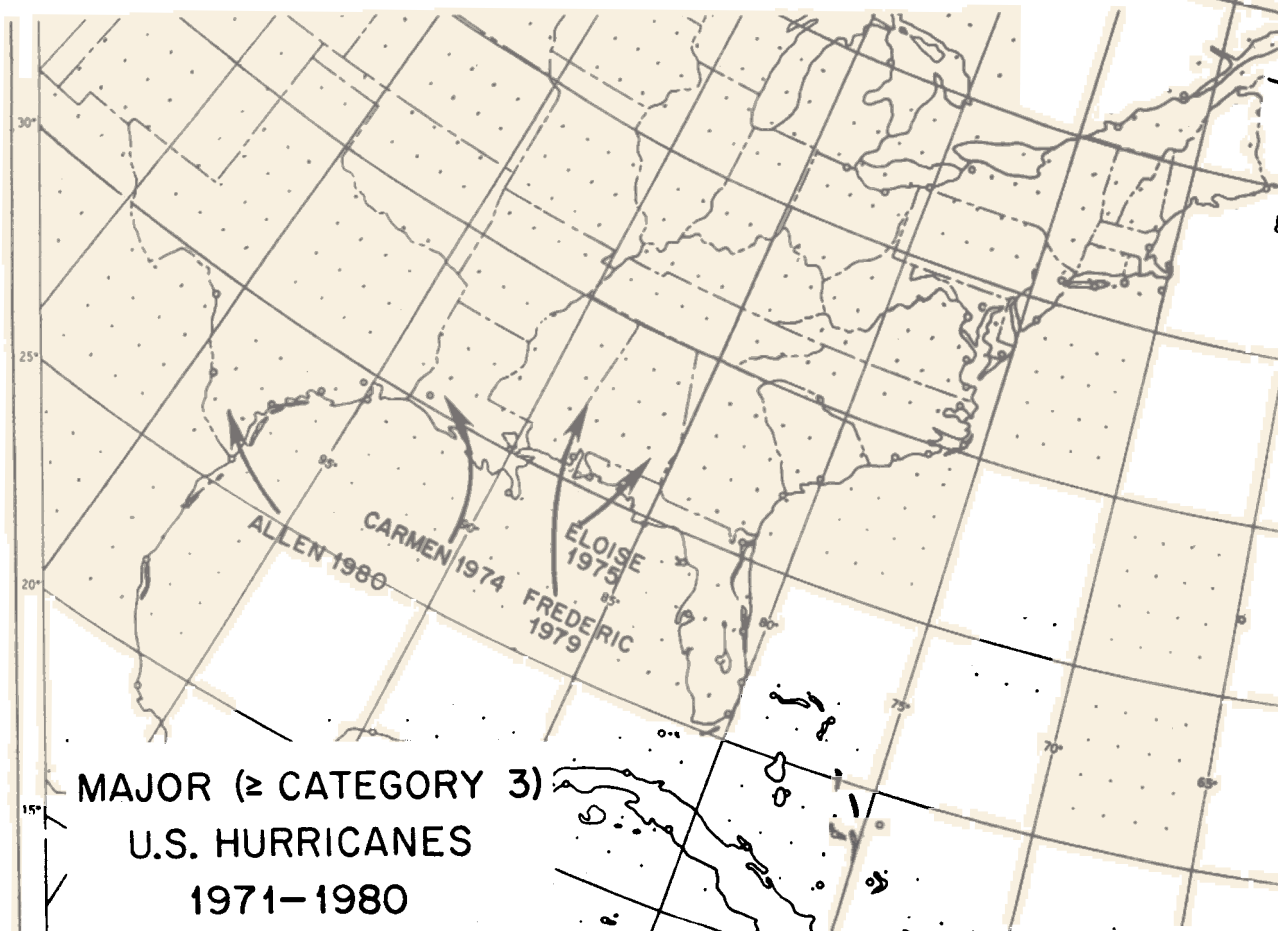


Figure 8. Major (greater than or equal to a category 3) landfalling United States hurricanes during the period 1971-1980.

The reader might note the tendency of the major hurricanes to cluster in certain areas during certain decades. Another interesting point is the general tendency for this clustering to occur in the latter half of individual decades in one area and in the first half of individual decades in another area. During the very active period of the thirties this clustering is not apparent.

A comparison of twenty-year periods beginning in 1900 indicates that the major hurricanes tended to be in the western Gulf Coast states at the beginning of the century, shifting to the eastern Gulf Coast states and Florida during the next twenty years, then to Florida and the Atlantic Coast states during the forties and fifties, and back to the western Gulf Coast states in the last two decades.

- (13) Are there hurricane cycles evident in certain years regardless of category or geographical area?

Table 13 gives a tabulation of hurricanes of all categories to affect the U.S. by individual years within each decade.

Table 13. Major and all category landfalling hurricanes in the United States by individual years.

	MAJOR										
	00	01	02	03	04	05	06	07	08	09	TOTAL
1900-09	1						2			3	6
1910-19	1					2	2	1	1	1	8
1920-29		1					2		1	1	5
1930-39			1	3	1	1	1		1		8
1940-49		1	1		2	1		1	1	1	8
1950-59	2				3	2		1		1	9
1960-69	1	1			1	1		1		1	6
1970-79	1				1	1				1	4
TOTAL	6	3	2	3	8	8	7	4	4	~	51
1980-	1	0	0								

	ALL										
	00	01	02	03	04	05	06	07	08	09	TOTAL
1900-09	1	2		2	1		4		1	4	15
1910-19	2	2	2	2		3	6	1	1	1	20
1920-29	2	2		1	2	1	3		2	2	15
1930-39			2	5	2	2	3		2	1	17
1940-49	2	2	2	1	3	3	1	3	3	3	23
1950-59	3		1	3	3	3	1	1		3	18
1960-69	2	1		1	4	1	2	1	1	2	15
1970-79	1	3	1		1	1	1	1		3	12
TOTAL	13	12	8	15	16	14	21	7	10	19	135
1980-	1	0	0								

Figures 1 through 8 certainly support the existence of a cyclical nature of major hurricanes affecting given regions. Table 13 is also suggestive of preferred periods. However, it is left to the reader to decide what weight should be given to these statistics.

3. SUMMARY

In virtually every coastal city of any size from Texas to Maine, Dr. Neil Frank, Director of the National Hurricane Center, has stated that the United States is building toward a hurricane disaster. The population growth versus low hurricane experience levels indicated in Hebert and Taylor (1975), together with updated statistics presented in the discussion section of this paper, form the basis for his statement. Stated simply, the areas of the United States where 9 out of 10 persons lose their lives by drowning from the storm surge during hurricanes (along the immediate Gulf of Mexico and Atlantic shorelines) are the very areas where the most dramatic increases in population have occurred in recent years. This situation, in combination with continued building on low coastal elevations, will lead to serious problems for many areas in future hurricanes. Since it is likely that people will always live along the immediate shoreline, a pleasant way of life, the solution to the problem lies in education and preparedness.

The message to coastal residents is this: Become familiar with what hurricanes can do, and when a hurricane threatens your area, increase your chances of survival by moving away from the water until the hurricane has passed! Unless this message is clearly understood by coastal residents through a thorough and continuing preparedness effort, a future disaster is inevitable.

Acknowledgement: Mary Watson drafted the figures

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