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THE DEADLIEST, COSTLIEST, AND MOST INTENSE UNITED STATES TROPICAL CYCLONES FROM 1851 TO 2010 (AND OTHER FREQUENTLY REQUESTED HURRICANE FACTS)

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PREFACE

This version of the Deadliest, Costliest, and Most Intense United States Tropical Cyclones extends the work of Blake et al. (2007) to include 2007-2010 and revised hurricane best track data from the period 1915-1930. In addition, estimates from several storms are updated to correct errors as well as to include a more standardized methodology. In most storms since 1995, estimates of flood damage from the National Flood Insurance Program are included in the total damage estimates for a more realistic total. The technical memorandum also continues the methodology of Pielke et al. (2008) to produce an estimate of the monetary loss that historical hurricanes could exact on the current property-at-risk in the same location.

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ABSTRACT

This technical memorandum lists the deadliest tropical cyclones in the United States during 1851-2010 and the costliest tropical cyclones in the United States during 1900-2010. The compilation ranks damage, as expressed by monetary losses, in three ways: 1) contemporaneous estimates; 2) contemporaneous estimates adjusted by inflation to 2010 dollars; and 3) contemporaneous estimates adjusted for inflation and the growth of population and personal wealth (Pielke et al. 2008) to 2010 dollars. In addition, the most intense (i.e., major[1]) hurricanes to make landfall in the United States during the 160-year period are listed. Also presented are some additional statistics on United States hurricanes and tropical cyclones in general.

1. INTRODUCTION

The National Hurricane Center (NHC) receives numerous requests for statistical information on deaths and damage incurred during tropical cyclones (including tropical depression, tropical storms, subtropical storms and hurricanes) affecting the United States. Information about tropical cyclone intensity (i.e., maximum 1-min surface wind) is also frequently of interest. Estimates of these measures vary in the literature and our goal is to present the best compilation of currently available estimates. In some instances, data in our lists represent revised estimates based on more complete information received since earlier publications including previous versions of this technical memorandum. There are also other frequently asked questions about hurricanes, and these questions are answered in Section 3.

[1] A major hurricane is a category 3, 4, or 5 hurricane on the Saffir/Simpson Hurricane Wind Scale (see Table 1).

Table 1. The Saffir/Simpson Hurricane Wind Scale, modifed from Simpson (1974).

Scale Number (Category)	Winds Maximum 1-min (mph)
1	74-95
2	96-110
3	111-130
4	131-155
5	> 155

2. BACKGROUND AND DEFINITIONS

The Saffir/Simpson Hurricane Wind Scale (SSHWS, Table 1) provides specific wind values for each hurricane category. It is important to note that the original Saffir/Simpson hurricane scale category assignment of U.S. hurricanes was based on a combination of wind, central pressure and storm surge values (Hebert and Taylor 1975). Since about 1990, however, the NHC has assigned the SSHWS category on the basis of the maximum one-minute sustained wind speed only. Thus, there is an inconsistency in the Atlantic hurricane database (HURDAT) that will be rectified as the Atlantic best-track reanalysis project is completed (Landsea et al. 2004). Currently, the SSHWS category assignment is based on wind speed from 1851-1930 and 1990-2010 and on a combination of wind, pressure and storm surge from 1931-1989. Heavy rainfall associated with a hurricane was not one of the criteria used in the categorization.

The process of assigning a SSHWS category number to a hurricane in any location is subjective, and it is made on a county-by-county basis. In this study, we use criteria for direct hit as described in the work by Jarrell et al. (1992).

> Direct Hit - Using "R" as the radius of maximum winds in a hurricane (the distance in miles from the storm's center to the circle of maximum winds around the center), all or parts of coastal counties falling within approximately 2R to the right and R to the left of a storm's track were considered to have received a direct hit. (This assumes an observer at sea looking toward the shore. If there was no landfall, the closest point of approach was used in place of the landfall point). On average, this direct hit zone extended about 50 miles along the coastline (corresponding to an average value of R of 15 miles). Of course, some hurricanes were smaller than this and some, particularly at higher latitudes, were much larger. Cases were judged individually, and many borderline situations had to be resolved.

In this document, the term strike is designated to mean one of two things:

1) During the years 1851-1930 and 1990 to 2010, a hurricane strike is defined to be the occurrence of sustained hurricane force winds on the coastline or inland. This does not require the center to make landfall in the area of hurricane-force winds. Such an event occurred with Hurricane Ophelia in 2005, which remained offshore of the North Carolina coast but still brought sustained hurricane-force winds to the coastline.
2) During the years 1931 to 1989, a hurricane strike is defined as one whose center passes within the direct hit definition area provided above. The best-track reanalysis project is working to change the definition to be strictly determined by the winds, but for now the regional effects catalogued by HURDAT are in a transition period that could last several more years.

Statistics on tropical storm and hurricane activity in the North Atlantic Ocean (which includes the Gulf of Mexico and the Caribbean Sea) can also be found in McAdie et al. (2009). A stratification of hurricanes by SSHWS category which have affected coastal counties of the Gulf of Mexico and North Atlantic Ocean can be found in Jarrell et al. (1992) and also at the NOAA Coastal Services Center (http://csc.noaa.gov/hurricanes/) updated through 2010. Additional information about the

impact of hurricanes can be found in annual hurricane season summary articles in Monthly Weather Review, Storm Data and Mariner's Weather Log.

A continuing feature for this update is the inclusion of estimated inland wind impacts of some hurricanes. These cyclones are indicated with an "I" before the state abbreviation in the HURDAT database and this symbol is exclusively used for hurricane wind impacts that are felt in a state, but not at the coastal areas (see Appendix A). One example of this occurrence is Hurricane Dennis (2005). After landfall, Dennis produced category one hurricane winds over inland areas of Alabama, but these effects were not felt along the coast of Alabama. Thus an "I" is added in front of the state designation, to be IAL 1. If a hurricane primarily impacts the coastal areas of a state, inland effects are not listed separately. The goal of this listing is to indicate only the most significant impact to that state. Because of the geography of Florida, any effects in the state are considered coastal.

It is important to note the changing derivation of damage estimates at NHC. Death and damage totals for the period 1915-1965 were taken from Gentry (1966), which gave figures adjusted to 1957-59 costs as a base for the period 1915-1965. From 1966-1994, damages were obtained from Monthly Weather Review. However, the Monthly Weather Review estimates represented a highly variable and subjective combination of losses from the American Red Cross, the U.S. Office of Emergency Preparedness, insurance companies and press reports. After 1994, except for a few cases involving significant flooding, most of the Monthly Weather Review damage estimates were determined by doubling the private insurance losses reported by the Property Claim Service or the American Insurance Institute. These insurance loss figures do not include flood losses from the National Flood Insurance Program (NFIP), which have only been included since Hurricane Ike of 2008.

A standardized methodology for calculating total losses, including NFIP figures, has been developed and utilized for each storm that made landfall after 1994 in the mainland United States. In this document, for almost all storms that occurred beginning in the 1995 season, the final NHC damage estimate is the sum of double the insured loss estimate, plus an adjusted estimate of flood losses from NFIP. Because of the highly variable rates of flood insurance along the coast, it is improper to simply double the flood losses for an estimate of total flood damage. Instead, the county NFIP losses are multiplied by the estimated county penetration rates for the highest flood risk area using the Federal Emergency Management Agency (FEMA) special flood hazard area (SFHA, e.g. the 100-year base flood plain) for a more accurate measure. This estimate should still be conservative for total flood damages because most homeowner's policies are capped at $250,000 and areas outside of the SFHA can be affecting in a significant flood. Note that this calculation adds a significant amount of damage to previous estimates after 1994 (e.g. Allison 2001 rises from $5 billion to $9 billion). See Appendix B for other significant changes to several U.S. tropical cyclones private insurance damages estimates.

3. FAQ
Part I

The remainder of this memorandum provides answers to some of the most frequently asked questions about the characteristics and effects of the tropical cyclones in the United States from 1851-2010. Part I deals with the deadliest, costliest and most intense United States tropical cyclones.

(1) **What have been the deadliest tropical cyclones in the United States?** Table 2 lists the tropical cyclones that have caused at least 25 deaths on the U.S. mainland during the period 1851-2010. There have been no additions to this list since 2005. The Galveston Hurricane of 1900 was responsible for at least 8000 deaths and remains first on the list. A revision was made to Hurricane Katrina of 2005 to remove confirmed indirect deaths from the original total of 1500 based on recent research (Brunkard et al. 2008, Jonkman et al. 2009). The latest NHC estimate is that Katrina was directly responsible for about 1200 deaths and it remains the third deadliest hurricane to strike the United States. Figure 1 shows the paths of these deadly cyclones. Although these systems are spread out over most of the coast, there is a clustering of tracks on the coasts of Texas, southeastern Louisiana, south Florida, North Carolina and New England.

(2) **What have been the costliest tropical cyclones in the United States?** Table 3a lists the 30 costliest tropical cyclones to strike the U.S. mainland from 1900-2010. No monetary estimates are available before 1900. Amounts in the tables are not adjusted for inflation and include adjusted NFIP flood damage amounts beginning in 1995. Hurricane Ike of 2008 was the second-costliest hurricane on record and was the most significant addition to the list. Hurricane Katrina of 2005 was responsible for at least $108 billion of property damage and is by far the costliest hurricane to ever strike the United States. It is of note that the last ten hurricane seasons have produced 14 out of the 30 costliest systems to affect the United States. Figure 2 displays the near- landfall portion of these tropical cyclone tracks and shows concentrations of costly hurricanes along the central Gulf Coast, south Florida and the Carolinas. Table 3b re-orders Table 3a and the historical database after adjusting to 2010 dollars[2], which adds several other hurricanes. Since 2000, even after accounting for inflation, the United States has experienced 11 out of the 30 costliest tropical cyclones. Hawaiian, Puerto Rican and Virgin Island tropical cyclones since 1900 are listed as addenda to Tables 3a and 3b. Table 3b also lists the 30 costliest hurricanes (see also Figure 3) assuming that a hurricane having the same track, size and intensity as noted in the historical record would strike the area with today's population and property-at-risk. After this normalization to today's societal vulnerability, the last decade still accounts for eight of the top 30 tropical cyclones.

(3) **What have been the most intense hurricanes to strike the United States?** Table 4 lists the most intense major hurricanes to strike the U.S. mainland during the period 1851-2010. In this study, the major hurricanes have been ranked by estimating central pressure at time of landfall. We have used central pressure as a proxy for intensity due to the uncertainties in maximum wind speed estimates for many historical hurricanes. Hurricane Katrina had the third lowest pressure ever noted at landfall, behind the 1935 Florida Keys hurricane and Hurricane Camille in 1969.

[2] Adjusted to 2010 dollars on the basis of U.S. Department of Commerce Implicit Price Deflator for Construction. Available index numbers are rounded to the nearest tenth. This rounding can result in slight changes in the adjusted damage of one hurricane relative to another.

Although Hurricane Ike had a landfall pressure of 950 mb, it was not a major hurricane at landfall. Moreover, no major hurricanes hit the United States during the past 5 years. Figure 4 shows where these major hurricanes struck the coast. Puerto Rican and Virgin Island hurricanes are listed as addenda to Table 4.

A look at the lists of deadliest and costliest hurricanes reveals several striking facts: (1) Fourteen out of the fifteen deadliest hurricanes were of category 3 or higher intensity. (2) Large death totals were primarily a result of the 10 feet or greater rise of the ocean (storm surge) associated with many of these major hurricanes. Katrina of 2005 typifies this point. (3) A large portion of the damage in some of costliest tropical cyclones (Table 3a) resulted from inland floods caused by torrential rain (e.g. Agnes of 1972). (4) One-third of the 30 deadliest hurricanes were category 4 or higher. (5) Only seven of the deadliest hurricanes occurred during the past 25 years, while over two-thirds of the costliest hurricanes occurred during the same period.

Katrina provided a grim reminder of what can happen in a hurricane landfall. Sociologists estimate, however, that people only remember the worst effects of a hurricane for about seven years (B. Morrow, personal communication). One of the greatest concerns of the National Weather Service's (NWS) hurricane preparedness officials is that people will think that no more large loss of life will occur in a hurricane because of our advanced technology and improved hurricane forecasts. Bill Read, current Director of NHC, as well as former NHC Directors, have 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, maintained and executed.

The study by Jarrell et al. (1992) used 1990 census data to show that 85% of U.S. coastal residents from Texas to Maine had never experienced a direct hit by a major hurricane. This risk is higher today as an estimated 50 million residents have moved to coastal sections during the past twenty-five years. The experience gained through the landfall of 7 major hurricanes during the past 7 years has not lessened an ever-growing concern brought by the continued increase in coastal populations.

Continued coastal growth and inflation will almost certainly result in every future major landfalling hurricane (and even weaker hurricanes and tropical storms) replacing one of the current costliest hurricanes. For example, all three of the U.S. hurricane landfalls of 2008 made the top 30 list, despite none of them being major hurricanes at landfall. If warnings are heeded and preparedness plans developed, the death toll can be minimized. However, large property losses are inevitable in the absence of a significant change of attitude, policy, or laws governing building practices (codes and location) near the ocean.

Table 2. Mainland U.S. tropical cyclones causing 25 or greater deaths 1851-2010.

RANK	HURRICANE	YEAR	CATEGORY	DEATHS
1	TX (Galveston)	1900	4	8000 [a]
2	FL (SE/Lake Okeechobee)	1928	4	2500 [b]
3	*KATRINA* (SE LA/MS)	2005	3	1200
4	LA (Cheniere Caminanda)	1893	4	1100-1400 [c]
5	SC/GA (Sea Islands)	1893	3	1000-2000 [d]
6	GA/SC	1881	2	700
7	*AUDREY* (SW LA/N TX)	1957	4	416 [h]
8	FL (Keys)	1935	5	408
9	LA (Last Island)	1856	4	400
10	FL (Miami)/MS/AL/Pensacola	1926	4	372
11	LA (Grand Isle)	1909	3	350
12	FL (Keys)/S TX	1919	4	287 [e]
13	LA (New Orleans)	1915	3	275 [j]
13	TX (Galveston)	1915	4	275
15	New England	1938	3	256 [e]
15	*CAMILLE* (MS/SE LA/VA)	1969	5	256
17	*DIANE* (NE U.S.)	1955	1	184
18	GA, SC, NC	1898	4	179
19	TX	1875	3	176
20	SE FL	1906	3	164
21	TX (Indianola)	1886	4	150
22	MS/AL/Pensacola	1906	2	134
23	FL, GA, SC	1896	3	130
24	*AGNES* (FL/NE U.S.)	1972	1	122 [f]
25	*HAZEL* (SC/NC)	1954	4	95
26	*BETSY* (SE FL/SE LA)	1965	3	75
27	Northeast U.S.	1944	3	64 [g]
28	*CAROL* (NE U.S.)	1954	3	60
29	*FLOYD* (Mid Atlantic & NE U.S.)	1999	2	56
30	NC	1883	2	53
31	SE FL/SE LA/MS	1947	4	51
32	NC, SC	1899	3	50 [h,i]
32	GA/SC/NC	1940	2	50
32	*DONNA* (FL/Eastern U.S.)	1960	4	50
35	LA	1860	2	47 [h]
36	NC, VA	1879	3	46 [h,j]
36	*CARLA* (N & Central TX)	1961	4	46
38	TX (Velasco)	1909	3	41
38	*ALLISON* (SE TX)	2001	TS [k]	41
40	Mid-Atlantic	1889	TS [l]	40 [h,j]
40	TX (Freeport)	1932	4	40
40	S TX	1933	3	40
43	*HILDA* (LA)	1964	3	38
44	SW LA/Upper TX	1918	3	34
45	SW FL	1910	3	30
45	*ALBERTO* (NW FL, GA, AL)	1994	TS [k]	30
47	SC, FL	1893	3	28 [m]
48	New England	1878	2	27 [h,n]
48	Texas	1886	2	27 [h]
50	*ANDREW* (S FL, LA)	1992	5	26
50	*FRAN* (NC)	1996	3	26
52	LA	1926	3	25
52	*CONNIE* (NC)	1955	3	25
52	*IVAN* (NW FL, AL)	2004	3	25

ADDENDUM (Not Atlantic/Gulf Coast)

2	Puerto Rico (San Ciriaco)	1899	3	3369 [i]
6	P.R., USVI (San Narcico)	1867	3	811 [f,j]
6	Puerto Rico (San Lorenzo)	1852	1	800 [f,o]
12	Puerto Rico (San Felipe)	1928	5	312
17	USVI, P.R. (San Ciprian)	1932	2	225
25	*DONNA* (St. Thomas, VI)	1960	4	107
25	Puerto Rico (San Gil)	1888	1	100 [h]
38	Southern California	1939	TS [k]	45
38	*ELOISE* (Puerto Rico)	1975	TS [k]	44
48	USVI (Santa Juana")	1871	3	27 [h]
52	Puerto Rico (San Liborio)	1926	2	25

Notes:

a	Could be as high as 12,000
b	Could be as high as 3000
c	Total including offshore losses near 2000
d	August
e	Total including offshore losses is 600
f	No more than
g	Total including offshore losses is 390
h	At least
i	Puerto Rico 1899 and NC, SC 1899 are the same storm
j	Could include some offshore losses
k	Only of Tropical Storm intensity.
l	Remained offshore
m	Mid-October
n	Four deaths at shoreline or just offshore
o	Possibly a total from two hurricanes

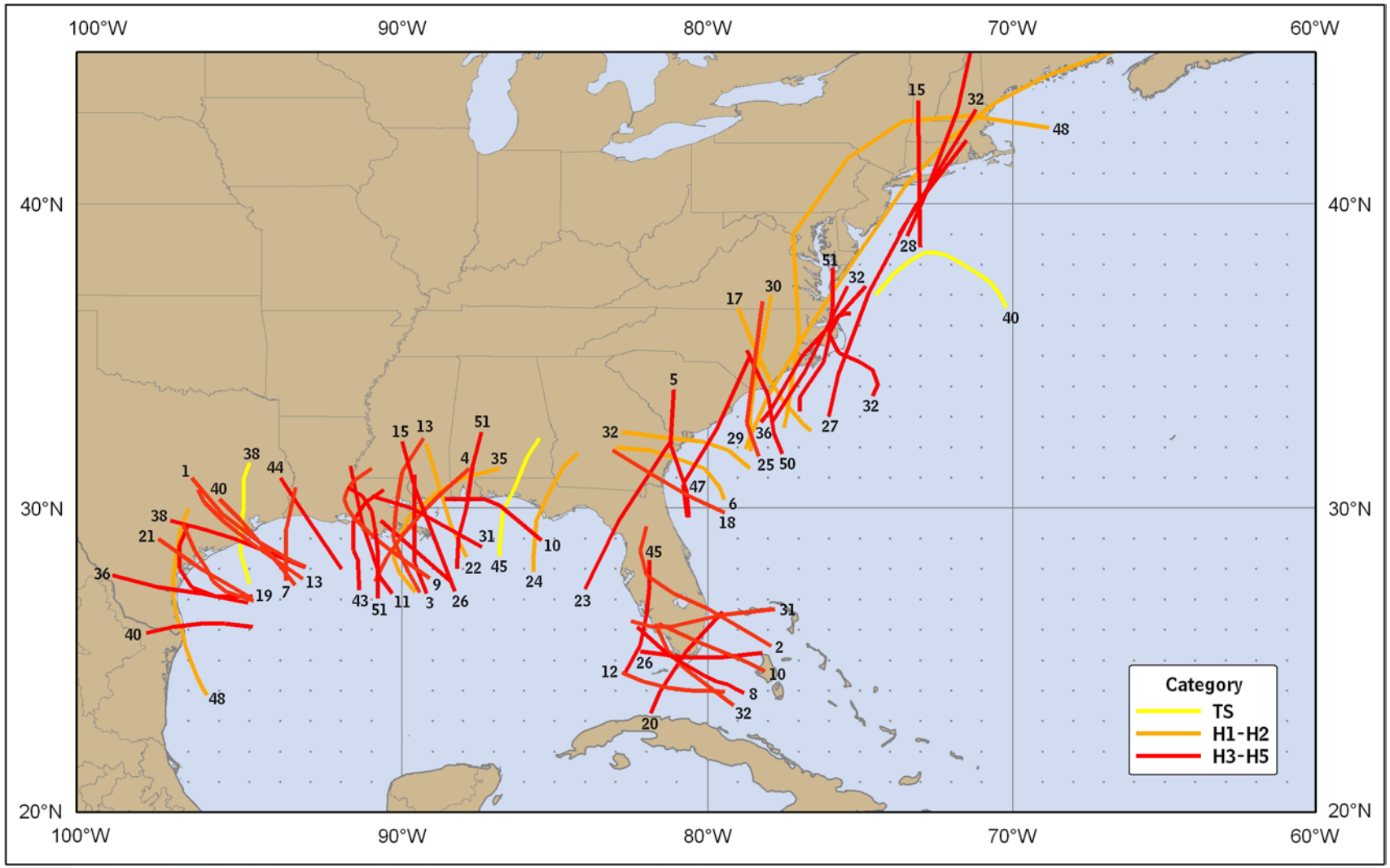

Figure 1. Mainland United States tropical cyclones causing 25 or more deaths, 1851-2010. The black numbers are the ranks of a given storm on Table 2 (e.g. 1 is the deadliest all-time). The colors are the intensity of the tropical cyclone at its maximum impact on the United States.

Table 3a. The 30 costliest mainland United States tropical cyclones, 1900-2010, (not adjusted for inflation).

RANK	TROPICAL CYCLONE	YEAR	CATEGORY	DAMAGE (U.S.)
1	*KATRINA* (SE FL, LA, MS)	2005	3	$108,000,000,000
2	*IKE (TX, LA)*	2008	2	29,520,000,000
3	*ANDREW* (SE FL/LA)	1992	5	26,500,000,000
4	*WILMA* (S FL)	2005	3	21,007,000,000
5	*IVAN* (AL/NW FL)	2004	3	18,820,000,000
6	*CHARLEY* (SW FL)	2004	4	15,113,000,000
7	*RITA* (SW LA, N TX)	2005	3	12,037,000,000
8	*FRANCES* (FL)	2004	2	9,507,000,000
9	*ALLISON* (N TX)	2001	TS	9,000,000,000
10	*JEANNE* (FL)	2004	3	7,660,000,000
11	*HUGO* (SC)	1989	4	7,000,000,000
12	*FLOYD* (Mid-Atlantic & NE U.S.)	1999	2	6,900,000,000
13	*ISABEL* (Mid-Atlantic)	2003	2	5,370,000,000
14	*OPAL* (NW FL/AL)	1995	3	5,142,000,000
15	*GUSTAV* (LA)	2008	2	4,618,000,000
16	*FRAN* (NC)	1996	3	4,160,000,000
17	*GEORGES* (FL Keys, MS, AL)	1998	2	2,765,000,000
18	*DENNIS (NW FL)*	2005	3	2,545,000,000
19	*FREDERIC (AL/MS)*	1979	3	2,300,000,000
20	*AGNES (FL/NE U.S.)*	1972	1	2,100,000,000
21	*ALICIA (N TX)*	1983	3	2,000,000,000
22	*BOB (NC, NE U.S)*	1991	2	1,500,000,000
22	*JUAN (LA)*	1985	1	1,500,000,000
24	*CAMILLE (MS/SE LA/VA)*	1969	5	1,420,700,000
25	*BETSY (SE FL/SE LA)*	1965	3	1,420,500,000
26	*ELENA (MS/AL/NW FL)*	1985	3	1,250,000,000
27	*DOLLY* (S TX)	2008	1	1,050,000,000
28	*CELIA (S TX)*	1970	3	930,000,000
29	*LILI* (SC LA)	2002	1	925,000,000
30	*GLORIA* (Eastern U.S.)	1985	3	900,000,000
ADDENDUM (Rank is independent of other events in group)				
17	*GEORGES* (USVI,PR)	1998	3	3,600,000,000
22	*INIKI* (Kauai, HI)	1992	3	1,800,000,000
22	*MARILYN* (USVI, PR)	1995	2	1,500,000,000
28	*HUGO* (USVI, PR)	1989	4	1,000,000,000

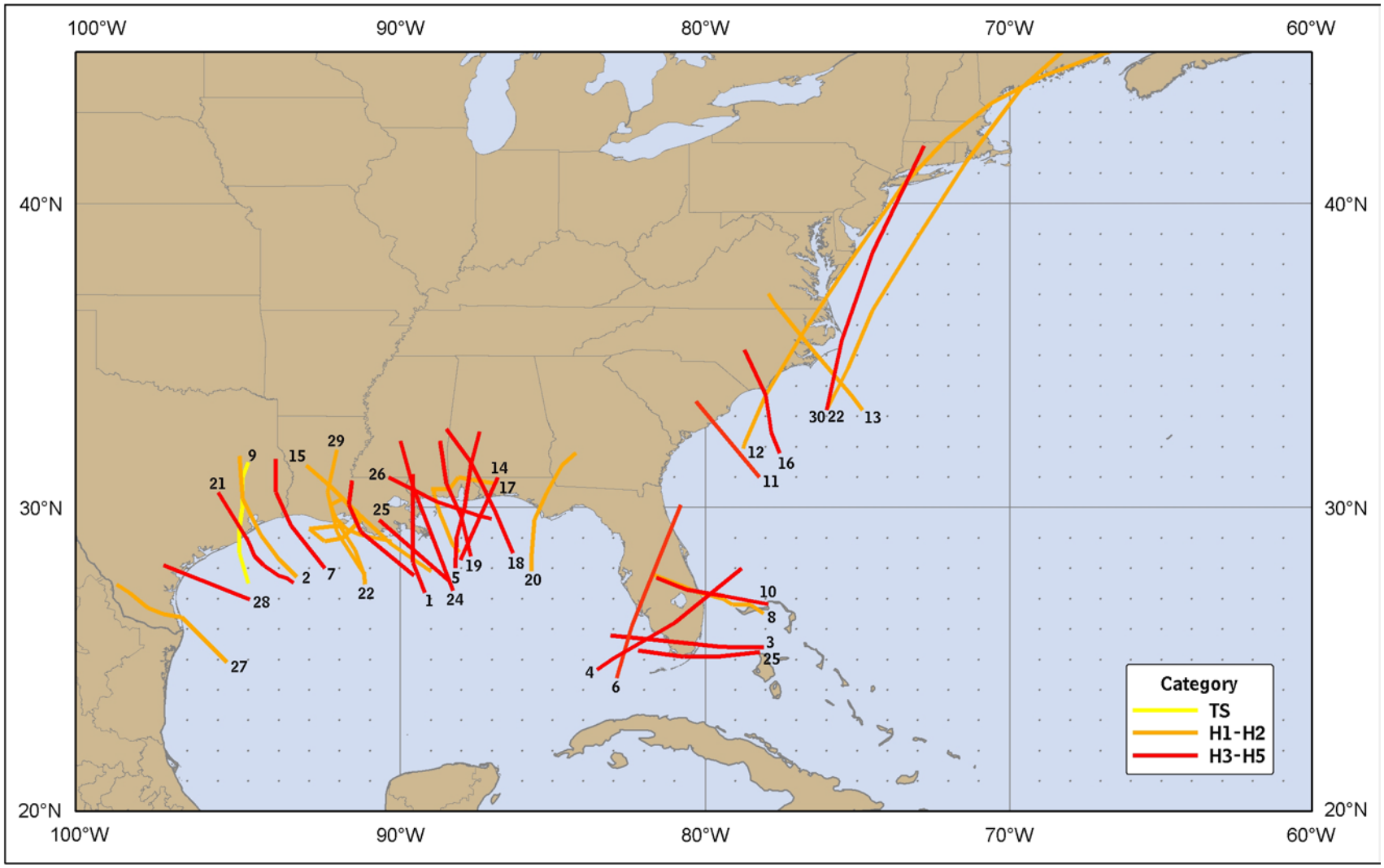

Figure 2. The 30 costliest tropical cyclones to strike the United States, 1900-2010. The black numbers are the ranks of a given storm on Table 3a (e.g. 1 is the costliest all-time). The colors are the intensity of the tropical cyclone at its maximum impact on the United States.

Table 3b. The 30 costliest mainland United States tropical cyclones, 1900-2010.

Ranked Using 2010 Deflator*					Ranked Using 2010 Inflation, Population and Wealth Normalization[L]				
RANK	TROPICAL CYCLONE	YEAR	Category	Damage (Millions)*	RANK	TROPICAL CYCLONE	YEAR	Category	Damage (Millions)[L]
1	*KATRINA* (LA/MS/FL)	2005	3	$105,840	1	SE Florida/Alabama	1926	4	$164,839
2	*ANDREW* (SE FL/SE LA)	1992	5	45,561	2	KATRINA (SE LA, MS, AL)	2005	3	113,400
3	*IKE (Upper TX/SW LA)*	2008	2	27,790	3	N Texas (Galveston)	1900	4	104,330
4	*WILMA* (SW/SE FL)	2005	3	20,587	4	N Texas (Galveston)	1915	4	71,397 [1]
5	*IVAN* (NW FL/AL)	2004	3	19,832	5	ANDREW (SE FL/LA)	1992	5	58,555
6	*CHARLEY* (SW FL)	2004	4	15,820	6	New England	1938	3	41,122
7	*HUGO* (SC)	1989	4	12,775	7	SW Florida	1944	3	40,621
8	*RITA* (LA/TX/FL)	2005	3	11,797	8	SE Florida/Lake Okeechobee	1928	4	35,298
9	*AGNES* (FL/NE U.S.)	1972	1	11,760	9	IKE (N TX/SW LA)	2008	2	29,520
10	*BETSY* (SE FL/SE LA)	1965	3	11,227	10	DONNA (FL/Eastern U.S.)	1960	4	28,159
11	*ALLISON* (N TX)	2001	TS	10,998	11	CAMILLE (MS/LA/VA)	1969	5	22,286
12	*FRANCES* (SE FL)	2004	2	10,018	12	WILMA (S FL)	2005	3	22,057
13	*CAMILLE* (MS/SE LA/VA)	1969	5	9,282	13	IVAN (NW FL, AL)	2004	3	21,575
14	*FLOYD* (Mid Atlc & NE U.S.)	1999	2	9,225	14	BETSY (SE FL/LA)	1965	3	18,749
15	*JEANNE* (SE FL)	2004	3	8,072	15	DIANE (NE U.S.)	1955	1	18,073
16	*OPAL* (NW FL/AL)	1995	3	7,729	16	AGNES (NW FL, NE U.S.)	1972	1	18,052
17	*DIANE* (NE U.S.)	1955	1	7,408	17	HAZEL (SC/NC)	1954	4	17,339
18	*FREDERIC* (AL/MS)	1979	3	6,571	18	CHARLEY (SW FL)	2004	4	17,210
19	New England	1938	3	6,325	19	CAROL (NE U.S.)	1954	3	16,940
20	*FRAN* (NC)	1996	3	6,140	20	HUGO (SC)	1989	4	16,088
21	*ISABEL* (NC/VA)	2003	2	6,112	21	SE Florida	1949	3	15,398
22	CELIA (S TX)	1970	3	5,918	22	CARLA (N & Central TX)	1961	4	14,920
23	NE U.S.	1944	3	5,706	23	SE Florida/Louisiana/Alabama	1947	4	14,406
24	*ALICIA* (N TX)	1983	3	4,569	24	NE U.S.	1944	3	13,881
25	*GUSTAV (LA)*	2008	2	4,347	25	SE FL/S TX	1919	4	13,847
26	*CAROL* (NE U.S.)	1954	3	4,175	26	SE Florida	1945	3	12,956
27	*GEORGES (FL, LA, MS)*	1998	2	3,860	27	RITA (SW LA/N TX)	2005	3	12,639
28	*JUAN* (LA)	1985	1	3,238	28	ALLISON (N TX)	2001	TS	12,523
29	*DONNA* (FL/Eastern U.S.)	1960	4	3,215	29	CELIA (S TX)	1970	3	12,104
30	*BOB* (NC, NE U.S)	1991	2	2,703	30	FRANCES (SE FL)	2004	2	10,899
ADDENDUM					notes				
30	*INIKI* (Kauai, HI)	1992	4	3,095	*	based on U.S. Census Bureau Price Deflator (Fisher) for Construction.			
30+	*GEORGES* (USVI,PR)	1998	3	2,513	[1]	Damage estimate in 1915 reference is considered too high			
30+	*MARILYN* (USVI,E. PR)	1995	2	2,255	[L]	'Normalization reflects inflation, changes in personal wealth and coastal			
30+	*HUGO* (USVI, PR)	1989	4	1,825		county population to 2005, (Pielke et al. 2007) then including an			
30+	San Felipe (PR)	1928	5	1,757		estimate to 2010 dollars.			

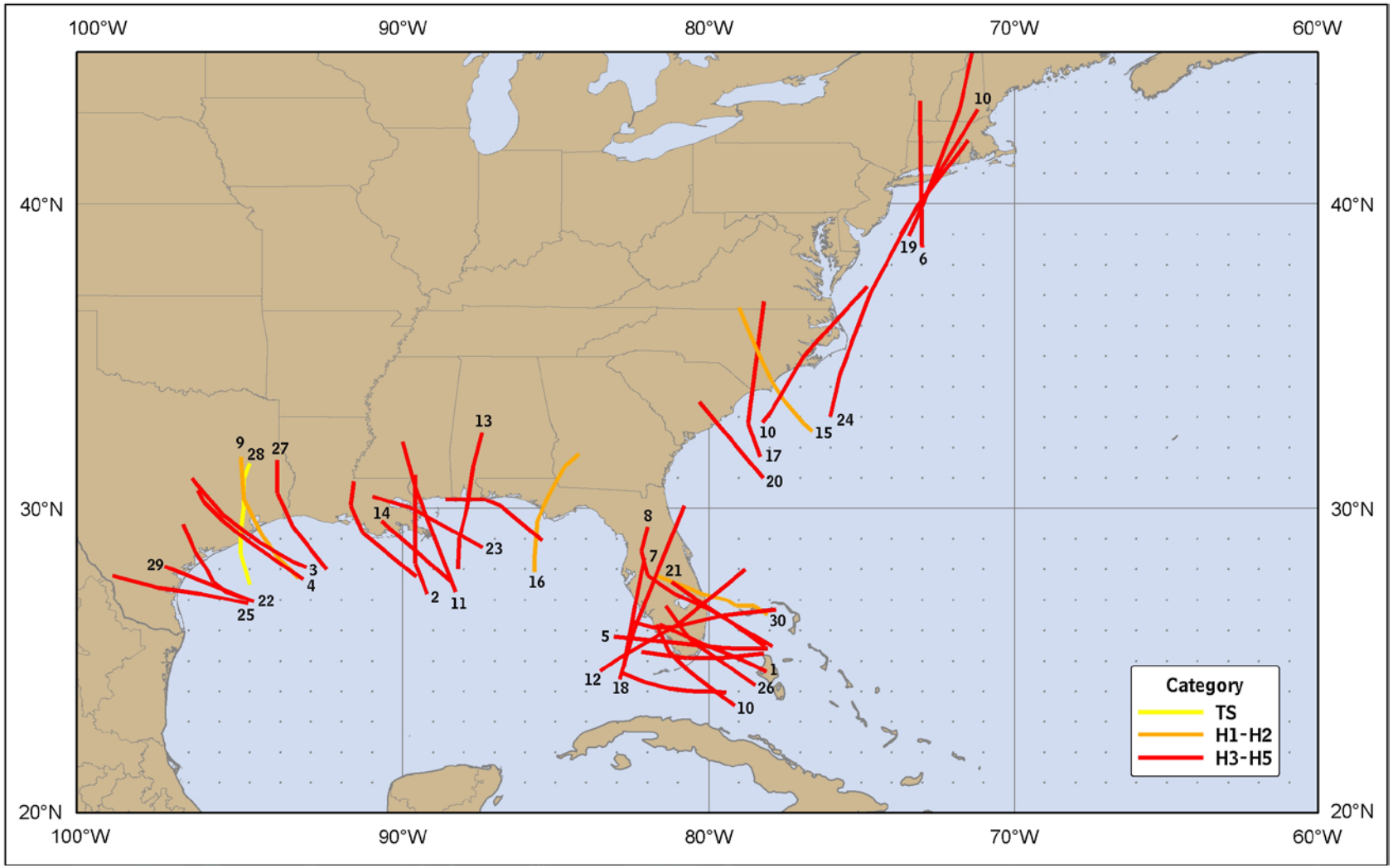

Figure 3. The 30 costliest United States tropical cyclones, ranked by normalization for inflation, population and wealth, 1900-2010. The black numbers are the ranks of a given storm on the right side of Table 3b.The colors are the intensity of the cyclone at its impact on the U.S. Coast.

Table 4. The most intense mainland United States hurricanes ranked by pressure, 1851-2010 (includes only major hurricanes at their most intense landfall).

RANK	HURRICANE	YEAR	CATEGORY (at landfall)	MINIMUM PRESSURE Millibars	Inches
1	FL (Keys)	1935	5	892	26.35
2	*CAMILLE (MS/SE LA/VA)*	1969	5	909	26.84
3	*KATRINA (SE LA, MS)*	2005	3	920	27.17
4	*ANDREW (SE FL/SE LA)*	1992	5	922	27.23
5	*TX (Indianola)*	1886	4	925	27.31
6	FL (Keys)/S TX	1919	4	927	27.37
7	FL (Lake Okeechobee)	1928	4	929	27.43
8	*DONNA (FL/Eastern U.S.)*	1960	4	930	27.46
8	FL (Miami)/MS/AL/Pensacola	1926	4	930	27.46
10	*CARLA (N & Central TX)*	1961	4	931	27.49
11	S TX	1916	4	932	27.52
12	LA (Last Island)	1856	4	934	27.58
12	*HUGO (SC)*	1989	4	934	27.58
14	TX (Galveston)	1900	4	936	27.64
15	*RITA (SW LA/N TX)*	2005	3	937	27.67
16	GA/FL (Brunswick)	1898	4	938	27.70
16	*HAZEL (SC/NC)*	1954	4	938	27.70
18	SE FL/SE LA/MS	1947	4	940	27.76
18	TX (Galveston)	1915	4	940	27.76
20	N TX	1932	4	941	27.79
20	*CHARLEY (SW FL)*	2004	4	941	27.79
22	*GLORIA (Eastern U.S.)*	1985	3	942	27.82
22	*OPAL (NW FL/AL)*	1995	3	942	27.82
24	LA (New Orleans)	1915	3	944	27.88
25	FL (Central)	1888	3	945	27.91
25	E NC	1899	3	945	27.91
25	*AUDREY (SW LA/N TX)*	1957	4	945	27.91
25	*CELIA (S TX)*	1970	3	945	27.91
25	*ALLEN (S TX)*	1980	3	945	27.91
30	New England	1938	3	946	27.94
30	*FREDERIC (AL/MS)*	1979	3	946	27.94
30	*IVAN (AL, NW FL)*	2004	3	946	27.94
30	*DENNIS (NW FL)*	2005	3	946	27.94
34	NE U.S.	1944	3	947	27.97
35	LA (Chenier Caminanda)	1893	4	948	27.99
35	*BETSY (SE FL/SE LA)*	1965	3	948	27.99
	ADDENDUM				
5	*DAVID* (S of PR)	1979	4	924	27.29
10	San Felipe (PR)	1928	5	931	27.49
18	*HUGO* (USVI & PR)	1989	4	940	27.76
43	*INIKI* (KAUAI, HI)	1992	3	950	27.91
65	*DOT* (KAUAI, HI)	1959	3	955	28.11

RANK	HURRICANE	YEAR	CATEGORY (at landfall)	MINIMUM PRESSURE Millibars	Inches
35	SE FL/NW FL	1929	3	948	27.99
35	SE FL	1933	3	948	27.99
39	NW FL	1917	3	949	28.02
39	NW FL	1882	3	949	28.02
39	*DIANA (NC)*	1984	3	949	28.02
39	S TX	1933	3	949	28.02
43	MS/AL	1916	3	950	28.05
43	GA/SC	1854	3	950	28.05
43	LA/MS	1855	3	950	28.05
43	LA/MS/AL	1860	3	950	28.05
43	LA	1879	3	950	28.05
43	*BEULAH (S TX)*	1967	3	950	28.05
43	*HILDA (Central LA)*	1964	3	950	28.05
43	*GRACIE (SC)*	1959	3	950	28.05
43	TX (Central)	1942	3	950	28.05
43	*JEANNE (FL)*	2004	3	950	28.05
43	*WILMA (S FL)*	2005	3	950	28.05
54	SE FL	1945	3	951	28.08
54	*BRET (S TX)*	1999	3	951	28.08
56	LA (Grand Isle)	1909	3	952	28.11
56	FL (Tampa Bay)	1921	3	952	28.11
56	*CARMEN (Central LA)*	1974	3	952	28.11
59	SC/NC	1885	3	953	28.14
59	S FL	1906	3	953	28.14
61	GA/SC	1893	3	954	28.17
61	*EDNA (New England)*	1954	3	954	28.17
61	SE FL	1949	3	954	28.17
61	*FRAN (NC)*	1996	3	954	28.17
65	SE FL	1871	3	955	28.20
65	LA/TX	1886	3	955	28.20
65	SC/NC	1893	3	955	28.20
65	NW FL	1894	3	955	28.20
65	*ELOISE (NW FL)*	1975	3	955	28.20
65	*KING (SE FL)*	1950	3	955	28.20
65	Central LA	1926	3	955	28.20
65	SW LA	1918	3	955	28.20

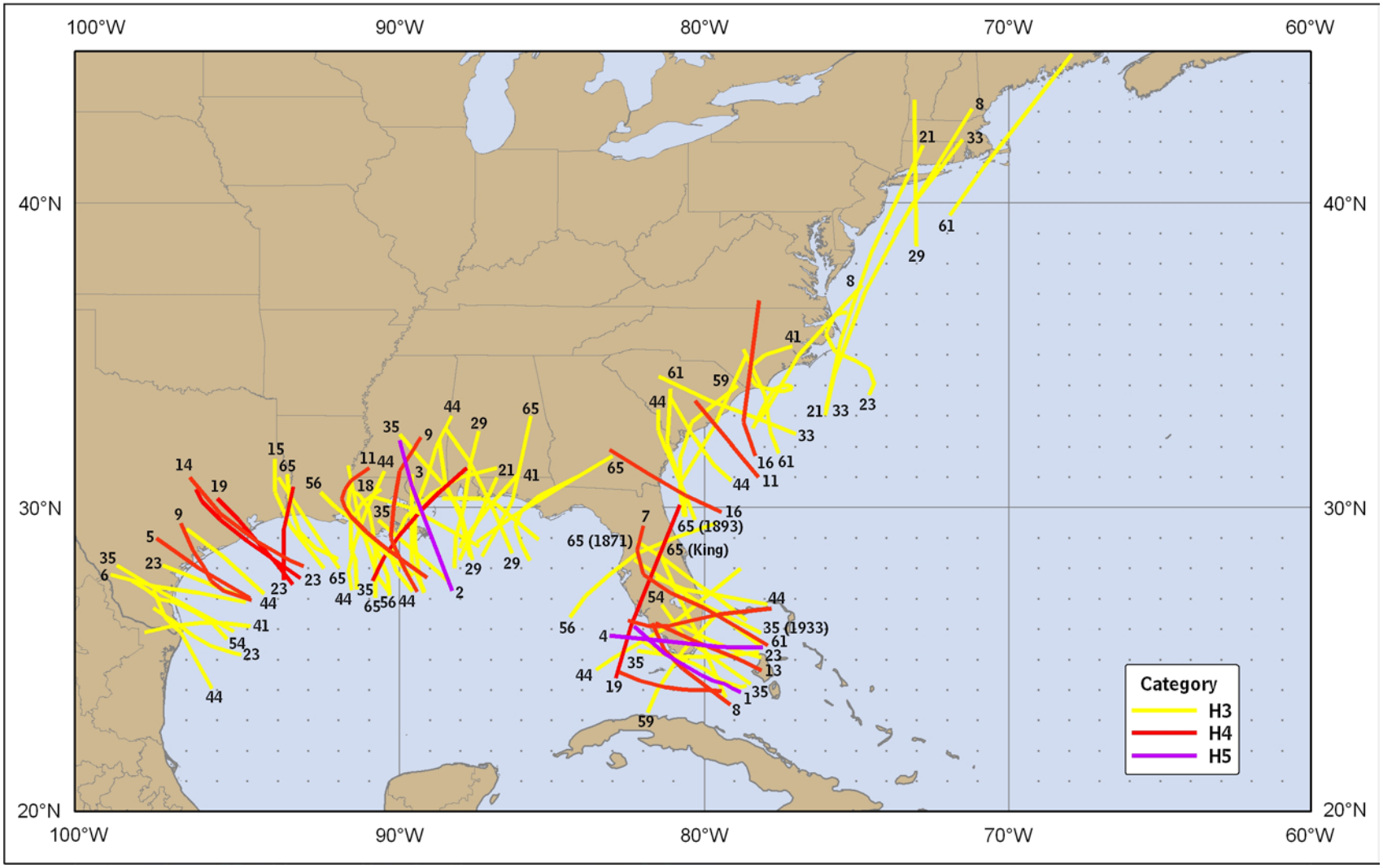

Figure 4. The most intense United States major hurricanes, ranked by pressure at landfall, 1851-2010. The black numbers are the ranks of a given storm on Table 4 (e.g. 1 has the lowest pressure all-time). The colors are the intensity of the tropical cyclone at its maximum impact on the United States.

Table 5 summarizes the hurricane strikes on the U. S. mainland since 1851. About two major hurricanes every three years made landfall somewhere along the Gulf or Atlantic coast. (All categories combined average about five hurricanes every three years.) Note that not all areas of the U.S. were settled before 1900 and there could be substantial gaps in landfall data coverage, especially in south Florida (Landsea et al. 2004).

Table 5. Hurricane strikes on the mainland United States (1851-2010).

Category	Strikes
5	3
4	18
3	75
2	75
1	113
TOTAL	284
MAJOR	96

Major hurricanes are categories 3,4 & 5.

Table 6, which lists hurricanes by decades since 1851, shows that during the 40-year period 1961-2000 both the number and intensity of landfalling U.S. hurricanes decreased sharply. Based on 1901-1960 statistics, the expected number of hurricanes and major hurricanes during the period 1961-2000 would have been 77 and 30, respectively. However, only 55 (or 71%) of the expected number of hurricanes struck the U.S. with only 19 major hurricanes (or 63% of that expected number). However, landfall activity during the 2000's has picked up significantly, and is now near the frequency seen in the very active 1950's. These increased landfalls are very different than the late 1990's, which showed average landfall frequencies despite having generally active seasons.

Despite the increase in overall activity, the United States hasn't seen a significant resurgence of exceptionally strong hurricane landfalls. During the past 40 years, the United States has experienced three Category 4 or stronger hurricanes: Charley in 2004, Andrew of 1992 and Hugo of 1989. However, on average, a category 4 or stronger hurricane strikes the United States about once every 8 years. We have seen fewer exceptionally strong hurricanes than an expected 40-year average of about 5. Fewer hurricanes, however, do not necessarily mean a lesser threat of disaster. The most intense U.S. hurricane in 1935, and the second costliest, Andrew in 1992, occurred in years which had much below-average hurricane activity.

Table 6. Number of hurricanes by category to strike the mainland U.S. each decade. (Updated from Blake et al., 2007)

	Category					ALL	Major
DECADE	1	2	3	4	5	1,2,3,4,5	3,4,5
1851-1860	7	5	5	1	0	18	6
1861-1870	8	6	1	0	0	15	1
1871-1880	7	6	7	0	0	20	7
1881-1890	8	9	4	1	0	22	5
1891-1900	8	5	5	3	0	21	8
1901-1910	10	4	4	0	0	18	4
1911-1920	8	5	4	3	0	20	7
1921-1930	8	2	3	2	0	15	5
1931-1940	4	7	6	1	1	19	8
1941-1950	8	6	9	1	0	24	10
1951-1960	8	1	6	3	0	18	9
1961-1970	3	5	4	1	1	14	6
1971-1980	6	2	4	0	0	12	4
1981-1990	9	2	3	1	0	15	4
1991-2000	3	6	4	0	1	14	5
2001-2010	8	4	6	1	0	19	7
1851-2010	113	75	75	18	3	284	96
Average per decade	7.1	4.7	4.7	1.1	0.2	17.8	6.0

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

Part II

This section answers other frequently asked questions about tropical storm and hurricane activity.

(1) What is the average number of tropical cyclones per year? Table 7 gives the average number of tropical cyclones which reached tropical storm, hurricane and major hurricane strength for selected time periods. The 30-year period from 1981-2010 is believed to provide the best current climatology because it samples equally the active and inactive phases of a multi-decadal cycle in Atlantic tropical cyclone frequency using modern increased monitoring capabilities. Using this period, the climatological mean numbers of tropical storms, hurricanes and major hurricanes are twelve, six, and three, respectively.

Table 7. Average number of tropical cyclones* which reached storm, hurricane and major hurricane status. Updated from Blake et al. (2007).

PERIOD	Number of Years	Average number of Tropical Storms	Average number of Hurricanes	Average number of Major Hurricanes
1851 - 2010	160	9.0	5.4	1.9
1944# - 2010	67	10.8	6.2	2.7
1966$ - 2010	45	11.4	6.3	2.4
1981 - 2010	30	12.1	6.4	2.7
1995^ - 2010	16	14.8	7.9	3.8

*Includes subtropical storms after 1967
#Start of aircraft reconnaissance
$Start of polar orbiting satellite coverage
^Start of the most recent warm Atlantic era (Goldenberg et al. 2001)

(2) What year(s) have had the most/least hurricanes and landfalls?
Table 8a shows the years of maximum and minimum tropical storm, hurricane, and major hurricane activity for the Atlantic hurricane basin. Tropical cyclone activity prior to the satellite surveillance era is uncertain and likely to be an underestimate of actual activity. The 2005 season set many records far above the previous records for the most number of tropical storms and hurricanes, but 1950 still holds the record for the maximum number of major hurricanes. 2010 had the third-most number of tropical storms and the second-most number of hurricanes. The two-year period of 2004-2005 was the most active ever seen in the Atlantic basin, setting records for the largest number of tropical storms and hurricanes in a two-year period and tying the record (13) for the largest number of major hurricanes set in 1950-1951. It is also of note that 10 out of the last 16 years have experienced 14 or more tropical storms.

Table 8a. Years of maximum and minimum tropical storm, hurricane, and major hurricane activity in the Atlantic basin 1851-2010. Updated from McAdie et al. (2009).

MAXIMUM ACTIVITY					
TROPICAL STORMS[1]		HURRICANES		MAJOR HURRICANES	
Number	Years	Number	Years	Number	Years
28	2005	15	2005	8	1950
21	1933	12	1969,2010	7	1961, 2005
19	1887,1995,2010	11	1887,1950,1995	6	1926,1955,1964,
18	1969	10	1870,1878,1886,		1996,2004
16	1936,2003,2008		1893,1916,1933,	5	1893,1916,1933,
15	1916,2000,2001		1998		1951,1958,1969,
	2004, 2007	9	1880,1955,1980,		1995,1999,2008,
14	1953,1990,1998		1996,2001,2004		2010
MINIMUM ACTIVITY*					
TROPICAL STORMS[1]		HURRICANES		MAJOR HURRICANES	
Number	Years	Number	Years	Number	Years
1	1914	0	1907,1914	0	In 31 years
3	1930	1	1905,1925		last in 1994
4	1857,1868,1883,	2	1890,1895,1917,	1	In 48 years
	1884,1890,1917,		1919,1930		last in 1997
	1925,1983		1931,1982		
5	In 18 years	3	In 30 years		
	last in 1962		last in 2009		

Notes

[1] Includes subtropical storms after 1967.

*likely underestimated before satellite imagery in 1966

Table 8b lists the years of maximum U.S. hurricane and major hurricane strikes. The 2005 season set the record for the most U.S. major hurricane strikes since 1851 and tied the record for second-most hurricane strikes. 2004-2005 produced 12 U.S. hurricane strikes, eclipsing the previous record of 11 hurricane strikes in consecutive years, set in 1886-1887. The 2009 and 2010 seasons did not see a hurricane strike, and the only other times that the United States has gone as long as two years without a hurricane strike are 1862-64, 1930-31, 1981-82 and 2000-01. Note that there is considerable uncertainty before about 1900 because significant areas of the Gulf and southeast Atlantic coasts were unpopulated. Multiple U.S. major hurricane strikes in one year are somewhat rare, occurring on average about once every decade.

Table 8b. Years of maximum United States hurricane and major hurricane strikes 1851-2010.

MAXIMUM U.S. ACTIVITY			
HURRICANE STRIKES		MAJOR HURRICANE STRIKES	
Number	Years	Number	Years
7	1886	4	2005
6	1985,2004,2005	3	1893,1909,1933,
5	1893,1909,1933		1954,2004
4	1869,1880,1887,	2	1879,1886,1915,
	1888,1906,1915,		1916,1926,1944,
	1916,1926,1964		1950,1955,1985

(3) When were the earliest and latest hurricane formations? The Atlantic hurricane season is defined as June 1 through November 30. The earliest observed hurricane formation occurred on March 7, 1908, while the latest observed formation was on December 31, 1954 (the second "Alice" of that year which persisted as a hurricane until January 5, 1955). Zeta of 2005 was the second latest tropical cyclone to form, just six hours ahead of Alice in 1954. The earliest hurricane to strike the United States was Alma which struck northwest Florida on June 9, 1966. Hurricane Kate was the latest hurricane to strike the United States on November 21, 1985. Note that a previously analyzed hurricane landfall on December 1, 1925 near Tampa, Florida has been recently re-analyzed to be a tropical storm landfall.

(4) What were the longest-lived and shortest-lived hurricanes? The third tropical cyclone of 1899 holds the record for most days as a tropical storm (28) and as major hurricane (11.5), while Ginger in 1971 holds the record for the most days as a hurricane (20). There have been many tropical cyclones that remained at hurricane intensity for 12 hours or less, the most recent of which was Karen of 2007.

(5) What was the hurricane with the lowest central pressure in the Atlantic basin? Wilma in 2005 had an estimated pressure of 882 millibars in the northwestern Caribbean Sea, breaking the previous record of 888 millibars held by Gilbert of 1988. The 1935 Labor Day hurricane in the Florida Keys had the lowest central pressure in any hurricane to strike the United States since 1851, with a pressure of 892 millibars.

(6) What were the strongest and weakest hurricanes in terms of maximum sustained winds? Different methodologies have been used to arrive at wind estimates in HURDAT during different time periods. The Atlantic re-analysis project is undergoing an extensive overhaul of the best track database at this time to standardize the methodology. Right now, this reanalysis of wind estimates is only available for the years 1851-1930. Substantial changes to the wind record are expected during the period 1931-1989. After this project is complete, NHC will publish a list of the strongest hurricanes in terms of winds. Numerous hurricanes have made landfall in the United States with minimal (75 mph) hurricane force winds, most recently Cindy of 2005.

(7) What was the most number of hurricanes occurring in the Atlantic basin at the same time? Four hurricanes occurred simultaneously on two occasions. The first occasion was August 22, 1893, and one of these hurricanes eventually killed 1,000-2,000 people in Georgia and South Carolina. The second occurrence was from September 25-27, 1998, when Georges, Ivan, Jeanne and Karl all existed at hurricane strength. In 1971 from September 10 to 12, there were five tropical cyclones at the same time; however, while most of these ultimately achieved hurricane intensity, there were never more than two hurricanes at any one time.

(8) How many hurricanes have there been in each month? Table 9a, updated from Blake et al. (2007), shows the total and average number of tropical storms, hurricanes and major hurricanes by month for the period 1851-2010. This table also has the monthly total and average number of hurricanes to strike the United States since 1851. Table 9b displays the same statistics from 1981-2010 corresponding to the 30-year climatological averages. Table 9c shows the record activity in the basin by month of formation.

Table 9a. Tropical storms, hurricanes and major hurricanes in the Atlantic basin by month of formation, 1851-2010, and for hurricanes striking the U.S. mainland 1851-2010.

	TROPICAL STORMS[1]		HURRICANES		MAJOR HURRICANES		U.S. HURRICANES	
MONTH	Total	Average	Total	Average	Total	Average	Total	Average
JANUARY-APRIL	5	*	1	*	0	0.00	0	0.00
MAY	21	0.1	4	*	1	*	0	0.00
JUNE	83	0.5	32	0.2	3	*	19	0.12
JULY	110	0.6	52	0.3	9	0.06	25	0.16
AUGUST	363	2.3	223	1.4	85	0.53	77	0.48
SEPTEMBER	492	3.1	335	2.1	145	0.91	107	0.67
OCTOBER	292	1.8	165	1.0	55	0.34	53	0.33
NOVEMBER	66	0.4	40	0.3	7	*	3	*
DECEMBER	10	0.1	4	*	0	0.00	0	0.00
YEAR	1442	9.0	856	5.4	305	1.91	284	1.78

[1] Includes subtropical storms after 1967. See McAdie et al. (2009) for details.
* Less than 0.05.

Table 9b. Tropical storms, hurricanes and major hurricanes in the Atlantic basin by month of formation, 1981-2010.

	TROPICAL STORMS[1]		HURRICANES		MAJOR HURRICANES	
MONTH	Total	Average	Total	Average	Total	Average
JANUARY-APRIL	2	0.1	0	*	0	*
MAY	3	0.1	0	*	0	*
JUNE	18	0.6	4	0.1	0	*
JULY	34	1.1	13	0.4	4	0.13
AUGUST	99	3.3	47	1.6	21	0.70
SEPTEMBER	119	4.0	78	2.6	40	1.33
OCTOBER	61	2.0	33	1.1	12	0.40
NOVEMBER	21	0.7	16	0.5	4	0.13
DECEMBER	5	0.2	2	0.1	0	*
YEAR	362	12.1	193	6.4	81	2.7

[1] Includes subtropical storms after 1967. See McAdie et al. (2009) for details.
* Less than 0.05.

Table 9c. Monthly records for the numbers of tropical storms, hurricanes and major hurricanes observed in the Atlantic basin by month of formation.

	TROPICAL STORMS[1]		HURRICANES		MAJOR HURRICANES	
MONTH	Record	Year	Record	Year	Record	Year
MAY	2	1887*	1	1970*	1	1951
JUNE	3	1968*	3	1886	1	1966*
JULY	5	2005	3	2005*	2	2005*
AUGUST	8	2004	5	2004*	3	2004*
SEPTEMBER	8	2010*	5	2005*	4	1961*
OCTOBER	7	2005	6	1870	2	2005*
NOVEMBER	3	2005*	3	2001	1	2008*
DECEMBER	2	2003*	1	2005*	0	-

[1] Includes subtropical storms after 1967. See McAdie et al. (2009) for details.

* occurred in other years, latest occurrence shown.

(9) How many hurricane strikes of various categories have affected each state? Table 10, updated from Blake et al. (2007), shows the hurricane strikes affecting the United States and individual states. Note the inland designation is only used for those hurricanes that exclusively struck inland portions of a state (not at the coast). The table shows that, on average, close to seven hurricanes every four years (~1.8 per year) strike the United States, while about two major hurricanes strike the U.S. coast every three years. Other noteworthy facts, updated from Blake et al. (2007), are: 1.) Forty percent of all U.S. hurricanes and major hurricanes were in Florida; 2.) Sixty percent of category 4 or higher hurricane strikes have occurred in either Florida or Texas; 3.) Sixty percent of all hurricanes affecting Georgia actually come from the south or southwest across northwestern Florida, though these hurricanes from the Gulf of Mexico are much weaker by the time they reach Georgia than those that come from the Atlantic Ocean. It should be noted that both Florida and Texas have extensive coastlines, which one reason for the high number of occurrences.

Table 10. Hurricane strikes 1851-2010 on the mainland U.S. coastline, and for individual states, including inland areas if effects were only inland portions of the state, by Saffir Simpson category. Updated from Blake et al. (2007).

	CATEGORY NUMBER					ALL	MAJOR HURRICANES
AREA	1	2	3	4	5		
U.S. (Texas to Maine)	113	75	75	18	3	284	96
Texas	27	18	12	7	0	64	19
(North)	14	8	3	4	0	29	7
(Central)	9	4	3	2	0	18	5
(South)	9	7	7	1	0	24	8
Louisiana	21	16	16	3	1	57	20
Mississippi	4	6	8	0	1	19	9
Alabama	17	5	5	0	0	27	5
(Inland only)	6	0	0	0	0	6	0
Florida	43	34	29	6	2	114	37
(Northwest)	27	18	14	0	0	59	14
(Northeast)	15	6	1	0	0	22	1
(Southwest)	17	10	10	4	1	42	15
(Southeast)	16	14	11	3	1	45	15
Georgia	15	5	2	1	0	23	3
(Inland only)	9	0	0	0	0	9	0
South Carolina	17	7	4	2	0	30	6
North Carolina	25	14	11	1	0	51	12
(Inland only)	3	0	0	0	0	3	0
Virginia	7	2	1	0	0	10	1
(Inland only)	2	0	0	0	0	2	0
Maryland	1	1	0	0	0	2	0
Delaware	2	0	0	0	0	2	0
New Jersey	2	0	0	0	0	2	0
Pennsylvania (Inland)	1	0	0	0	0	1	0
New York	6	1	5	0	0	12	5
Connecticut	5	3	3	0	0	11	3
Rhode Island	3	2	4	0	0	9	4
Massachusetts	6	2	3	0	0	11	3
New Hampshire	1	1	0	0	0	2	0
Maine	5	1	0	0	0	6	0

Notes:

*State totals will not equal U.S. totals, and Texas or Florida totals will not necessarily equal sum of sectional totals. Regional definitions are found in Appendix A
*Gulf Coast state totals will likely be underestimated because of lack of coastal population before 1900

(10) When are major hurricanes likely to strike a given area? Table 11 shows the incidence of major hurricanes by month for the U.S. mainland and for individual states. September has about as many major hurricane landfalls as October and August combined. The northern Gulf Coast from Texas to northwest Florida is the prime target for pre-August major hurricanes. The threat of major hurricanes increases from west to east as the season progresses, with major hurricanes favoring the U.S. East Coast by late September. Most major October hurricanes in the United States affect southern Florida.

Table 11. Incidence of major hurricane direct hits on the U.S. mainland and individual states, 1851-2010, by month. Updated from Blake et al. (2007).

AREA	JUNE	JULY	AUG.	SEPT.	OCT.	ALL
U.S. (Texas to Maine)	2	4	30	44	16	96
Texas	1	1	10	7		19
c (North)	1	1	3	2		7
b (Central)			2	2		4
a (South)			5	3		8
Louisiana	2		7	8	3	20
Mississippi		1	4	4		9
Alabama			1	4		5
Florida		2	6	19	10	37
a (Northwest)		2	1	7	3	13
d (Northeast)				1		1
b (Southwest)			2	7	6	15
c (Southeast)			4	8	3	15
Georgia			1	1	1	3
South Carolina			2	2	2	6
North Carolina			4	8	1	13
Virginia				1		1
Maryland						0
Delaware						0
New Jersey						0
Pennsylvania						0
New York			1	4		5
Connecticut			1	2		3
Rhode Island			1	3		4
Massachusetts				3		3
New Hampshire						0
Maine						0

Notes: *State totals do not equal U.S. totals and Texas or Florida totals do not necessarily equal the sum of sectional entries.
*Regional definitions are found in Appendix A.
*Gulf Coast states will likely be underrepresented because of a lack of coastal population before 1900.

(11) What's the farthest north that a major hurricane has ever hit the United States and what's the latest U.S. major hurricane landfall? Three major hurricanes have struck as far north as Massachusetts—Edna (1954), The 1938 Long Island Express, and Storm 6 in 1869. The latest in the season that a major hurricane has ever hit the United States was October 25, 1921 (the "Great Tampa Hurricane") with Wilma on October 24, 2005 being the second-latest.

(12) How long has it been since a hurricane or a major hurricane struck a given community? A chronological list of all known hurricanes to strike the United States from 1851-2010 can be found in Appendix A. Table 12 summarizes the occurrence of the last hurricane and major hurricane to strike the counties or parishes where most populated coastal communities are located from Brownsville, Texas to Eastport, Maine. An estimated return period of these hurricanes is also listed, which is computed from HURISK (Neumann 1987). These return periods are generally larger than reported in previous versions of the document because a search radius of 50 n mi is used instead of 75 n mi previously. The smaller radius employed here is more appropriate given the average maximum extent of hurricane force winds of about 50 n mi. Figures 5 and 6 show these return periods for hurricanes and major hurricanes for points along the coast. In order to obtain the same type of information listed in Table 12 for the remaining coastal communities, the reader is referred to the NOAA Coastal Services Center (http://csc.noaa.gov/hurricanes/). Even with these return period estimates, it should be noted that there is high uncertainty of when a hurricane might strike a given locality. After nearly 70 years without a direct hit, Pensacola, Florida was struck in a period of 11 years by Hurricane Erin and major Hurricane Opal in 1995, major Hurricane Ivan in 2004 and major Hurricane Dennis in 2005. Tampa has not experienced a major hurricane for 90 years. Many locations along the Gulf and Atlantic coasts have not experienced a major hurricane since records began in 1851 (see Table 12).

(13) What is the total United States damage (before and after adjustment for inflation) and death toll for each year since 1900? Table 13a summarizes this information. Table 13b ranks the top 30 years by deaths, unadjusted damage, adjusted damage and normalized damage. In most years the death and damage totals are 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 from 1966-1994 damage totals were used from Monthly Weather Review. From 1995-present, for almost every storm, the final NHC damage estimate is now the sum of double the insured loss estimate, plus an adjusted estimate of flood losses from NFIP. Adjusted damage were converted to 2010 dollars by the factors used in Table 3a. Note the addition of NFIP damages have significantly elevated some years post 1994 since the last edition of this publication.

(14) What are the deadliest and costliest hurricanes to affect Hawaii, Puerto Rico and the U.S. Virgin Islands since 1900? Table 14, provided by Hans Rosendal and Raphael Mojica of the National Weather Service Forecast Offices in Honolulu and San Juan, respectively, summarizes this information. Iniki in 1992 is the deadliest and costliest hurricane to affect Hawaii while Georges of 1998 is the costliest hurricane to affect Puerto Rico. The notorious San Felipe hurricane of 1928 was the deadliest hurricane in Puerto Rico since 1900.

Table 12. Last strike and mean return period (Neumann 1987) of a major hurricane or hurricane by county/parish within 50 n mi for certain populated coastal communities. Category in parenthesis.

		MAJOR HURRICANE		HURRICANE	
State	City (County/Parish)	Return Period	Last Strike By County	Return Period	Last Strike By County
Texas	Brownsville (Cameron)	30 yrs	1980(3) Allen	13 yrs	2008(1) Dolly
	Corpus Christi (Nueces)	36	1970(3) Celia	16	1971(1) Fern
	Port Aransas (Aransas)	33	1970(3) Celia	16	1971(1) Fern
	Matagorda (Matagorda)	40	1961(4) Carla	19	2003(1) Claudette
	Freeport (Brazoria)	26	1983(3) Alicia	11	2008(2) Ike
	Galveston (Galveston)	25	1983(3) Alicia	9	2008(2) Ike
	Houston (Harris)	31	1941(3)	16	2008(2) Ike
	Beaumont (Jefferson)	35	2005(3) Rita	16	2008(2) Ike
Louisiana	Cameron (Cameron)	33	2005(3) Rita	14	2008(1) Ike
	Morgan City (St. Mary)	25	1992(3) Andrew	8	2008(2) Gustav
	Houma (Terrebonne)	20	1992(3) Andrew	8	2008(2) Gustav
	New Orleans (Orleans)	23	2005(3) Katrina	10	2005(3) Katrina
Mississippi	Bay St. Louis (Hancock)	28	2005(3) Katrina	13	2005(3) Katrina
	Biloxi (Harrison)	26	2005(3) Katrina	11	2005(3) Katrina
	Pascagoula (Jackson)	22	2005(3) Katrina	11	2005(3) Katrina
Alabama	Mobile (Mobile)	28	2004(3) Ivan	10	2004(3) Ivan
	Gulf Shores (Baldwin)	25	2004(3) Ivan	9	2004(3) Ivan
Florida	Pensacola (Escambia)	22	2005(3) Dennis	9	2005(3) Dennis
	Destin (Okaloosa)	23	1995(3) Opal	9	1995(3) Opal
	Panama City (Bay)	26	1995(3) Opal	9	1995(3) Opal
	Apalachicola (Franklin)	31	1985(3) Elena	10	1998(2) Earl
	Homosassa (Citrus)	37	1950(3) Easy	11	1968(2) Gladys
	St. Petersburg (Pinellas)	33	1921(3)	10	1946(1)
	Tampa (Hillsboro)	36	1921(3)	11	1946(1)
	Sarasota (Sarasota)	30	1944(3)	10	1946(1)
	Fort Myers (Lee)	27	2004(4) Charley	10	2004(4) Charley
	Naples (Collier)	18	2005(3) Wilma	8	2005(3) Wilma
	Key West (Monroe)	18	2005(3) Wilma	8	2005(3) Wilma
	Miami (Miami-Dade)	14	1992(5) Andrew	6	2005(2) Wilma
	Fort Lauderdale (Broward)	16	1950(3) King	7	2005(2) Wilma
	W. Palm Beach (Palm Beach	18	2004(3) Jeanne	8	2005(2) Wilma
	Stuart (Martin)	19	2004(3) Jeanne	8	2005(2) Wilma
	Fort Pierce (St. Lucie)	19	2004(3) Jeanne	8	2004(3) Jeanne
Florida	Vero Beach (Indian River)	20 yrs	2004(3) Jeanne	9 yrs	2004(3) Jeanne
	Cocoa Beach (Brevard)	34	2004(3) Jeanne	12	2004(3) Jeanne
	Daytona Beach (Volusia)	37	<1880	12	1960(2) Donna
	St. Augustine (St. Johns)	40	<1880	13	1964(2) Dora
	Jacksonville (Duval)	39	<1880	13	1964(2) Dora
	Fernandina Beach (Nassau)	33	<1880	11	1928(2)
Georgia	Brunswick (Camden)	34	1898(4)	11	1928(1)
	Savannah (Chatham)	36	1893(3)	10	1979(2) David
S. Carolina	Hilton Head (Beaufort)	34	1959(3) Gracie	9	1979(2) David
	Charleston (Charleston)	22	1989(4) Hugo	8	2004(1) Gaston
	Myrtle Beach (Horry)	23	1954(4) Hazel	8	2004(1) Charley
N. Carolina	Wilmington (New Hanover)	18	1996(3) Fran	7	2005(1) Ophelia
	Morehead City (Carteret)	18	1996(3) Fran	6	2005(1) Ophelia
	Cape Hatteras (Dare)	16	1993(3) Emily	5	2003(2) Isabel
Virginia	Virginia Beach (Virginia Beach)	58	1944(3)	13	2003(1) Isabel
	Norfolk (Norfolk)	65	<1851	15	2003(1) Isabel
Maryland	Ocean City (Worcester)	44	<1851	15	1878(1)
	Baltimore (Baltimore)	>200	<1851	75	1878(1)
Delaware	Rehoboth Beach (Sussex)	50	<1851	17	1903(1)
	Wilmington (New Castle)	>200	<1851	45	1878(1)
New Jersey	Cape May (Cape May)	68	<1851	20	1903(1)
	Atlantic City (Atlantic)	76	<1851	18	1903(1)
New York	New York City (New York)	175	<1851	25	1903(1)
	Westhampton (Suffolk)	70	1985(3) Gloria	18	1985(3) Gloria
Connecticut	New London (New London)	74	1938(3)	20	1991(2) Bob
	New Haven (New Haven)	105	1938(3)	25	1985(2) Gloria
	Bridgeport (Fairfield)	110	1954(3) Carol	26	1985(2) Gloria
Rhode Island	Providence (Providence)	94	1954(3) Carol	24	1991(2) Bob
Mass.	Cape Cod (Barnstable)	58	1954(3) Edna	16	1991(2) Bob
	Boston (Suffolk)	>200	1869(3)	30	1960(1) Donna
N. Hampshire	Portsmouth (Rockingham)	>200	<1851	35	1985(2) Gloria
Maine	Portland (Cumberland)	180	<1851	43	1985(1) Gloria
	Eastport (Washington)	180	<1851	29	1969(1) Gerda

Notes: <1900 means before 1900 etc.

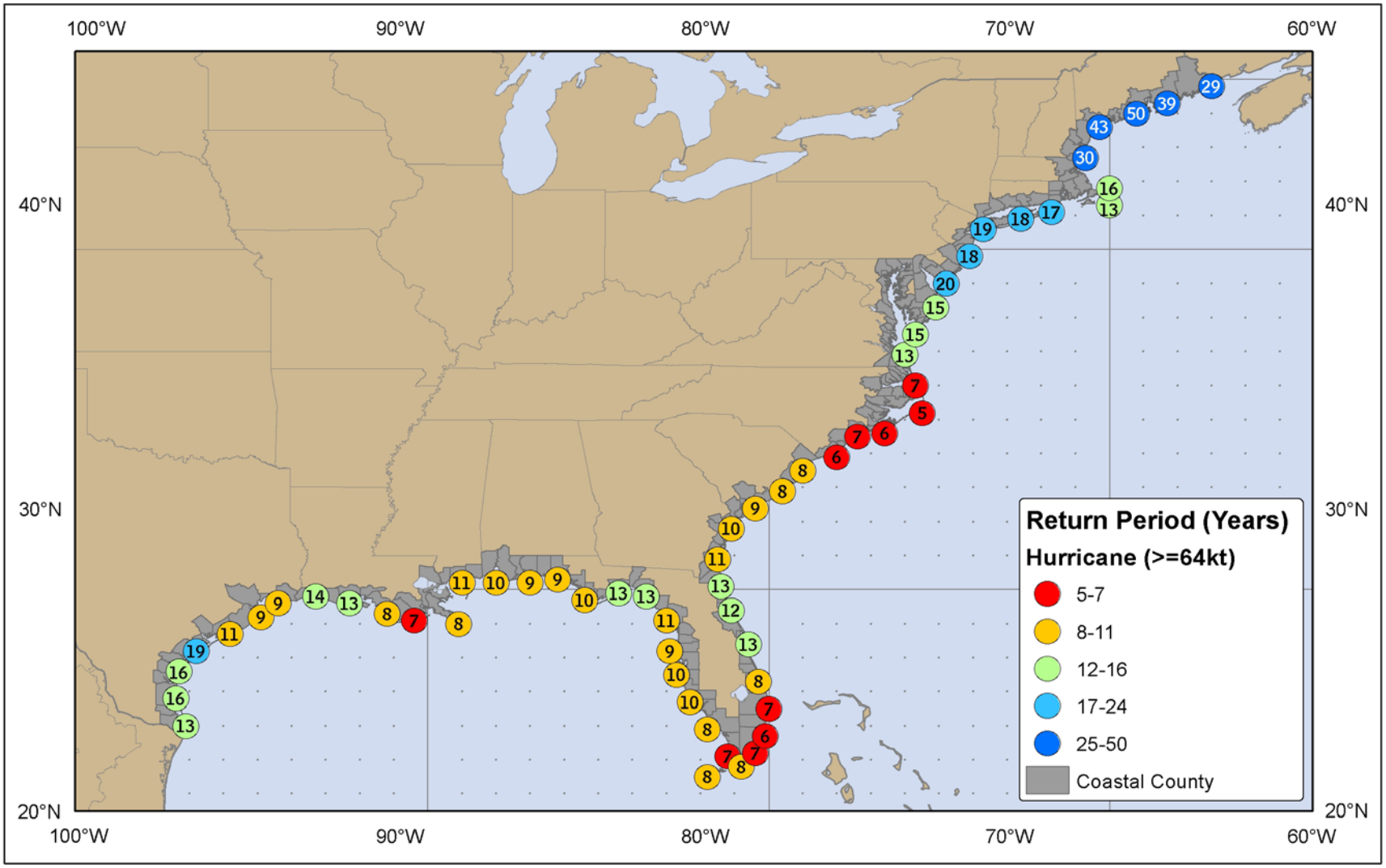

Figure 5. Estimated return period in years for hurricanes passing with 50 n mi of various locations on the U.S. Coast.

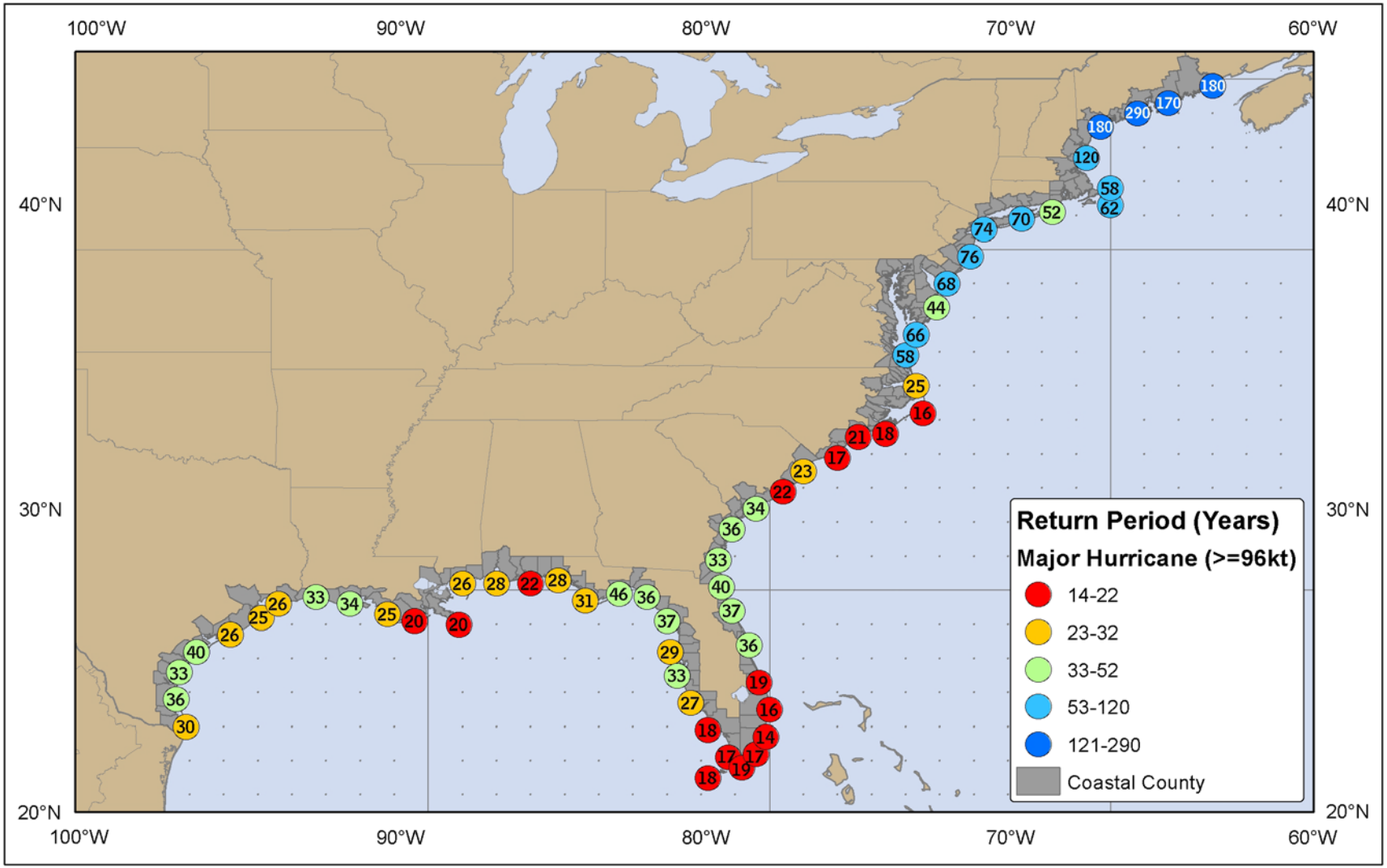

Figure 6. Estimated return period in years for major hurricanes passing with 50 n mi of various locations on the U.S. Coast.

Table 13a. Estimated annual deaths and damage (unadjusted and adjusted for inflation[1] and normalized[L] for inflation, growth in personal wealth and population) in the mainland United States from landfalling Atlantic or Gulf tropical cyclones 1900-2010.

		DAMAGE ($Millions)					DAMAGE ($Millions)		
Year	Deaths	Unadjusted	Adjusted[1]	Normalized[L]	Year	Deaths	Unadjusted	Adjusted[1]	Normalized[L]
1900	8,000 [+]	30	1,296 [2]	104,330	1956	19	27	227	606
1901	10	1	43 [2]	213	1957	426	152	1,244	4,034
1902	0	Minor	Minor	-	1958	2	11	90	535
1903	15	1	43 [2]	6,803	1959	24	23	190	902
1904	5	2	86 [2]	1,139	1960	65	396	3,290	31,469
1905	0	Minor	Minor	-	1961	46	414	3,446	15,192
1906	298	3 [+]	130 [2]	4,080	1962	3	2	16	97
1907	0	Minor	Minor	-	1963	10	12	97	259
1908	0	Minor	Minor	-	1964	49	515	4,206	16,478
1909	406	8	346 [2]	3,081	1965	75	1,445	11,420	22,324
1910	30	1	43 [2]	876	1966	54	15	113	353
1911	17	1 [+]	43 [2]	235	1967	18	200	1,463	4,217
1912	1	Minor	Minor	-	1968	9	10	70	690
1913	5	3	130 [2]	724	1969	256	1,421	9,284	22,286
1914	0	Minor	Minor	-	1970	11	931	5,924	12,117
1915	550	63	2,722 [3]	74,262	1971	8	213	1,281	2,188
1916	107	33	1,188	7,919	1972	122	2,100	11,760	18,458
1917	5	Minor	Minor	-	1973	5	18	92	153
1918	34	5	116	886	1974	1	150	697	1,127
1919	287 [4]	22	457	14,392	1975	21	490	2,097	2,931
1920	2	3	49	367	1976	9	100	402	511
1921	6	3	62	3,348	1977	0	10	36	56
1922	0	Minor	Minor	-	1978	36	20	64	153
1923	0	Minor	Minor	-	1979	22	3,045	8,700	14,801
1924	2	Minor	Minor	-	1980	2	300	776	1,682
1925	6	Minor	Minor	-	1981	0	25	60	180
1926	408	112	2,315	169,398	1982	0	Minor	Minor	45
1927	0	Minor	Minor	-	1983	22	2,000	4,569	7,843
1928	2,500	25	517	35,298	1984	4	66	145	304
1929	3	1	19	390	1985	30	4,000	8,634	11,622
1930	0	Minor	Minor	-	1986	9	57	118	178
1931	0	Minor	Minor	-	1987	0	8	16	20
1932	40	8	175	6,210	1988	6	106	201	327
1933	63	47	1,147	14,006	1989	56	7,670	13,997	17,609
1934	17	5	111	932	1990	13	57	101	133
1935	414	12	269	9,150	1991	16	1,500	2,630	3,196
1936	9	2	46	838	1992	24	26,500	45,561	60,547
1937	0	Minor	Minor	-	1993	4	57	93	133
1938	600	306	6,325	41,140	1994	38	973	1,526	2,036
1939	3	Minor	Minor	-	1995	29	5,921	8,899	12,527
1940	51	5	107	1,224	1996	36	4,816	7,108	9,233
1941	10	8	161	2,530	1997	4	120	172	206
1942	8	27	468	2,475	1998	23	4,285	5,982	6,237
1943	16	17	277	3,746	1999	62	7,572	10,124	11,897
1944	64	165	2,690	54,760	2000	6	27	34	38
1945	7	80	1,266	14,676	2001	45	9,310	11,376	12,954
1946	0	5	67	4,953	2002	9	1,551	1,851	1,991
1947	53	136	1,534	20,071	2003	24	5,600	6,374	6,880
1948	3	18	185	4,249	2004	60	51,135	53,884	58,620
1949	4	59	607	16,147	2005	1225	143,979	141,100	151,178
1950	19	36	363	5,806	2006	0	500	461	500
1951	0	2	18	376	2007	10	50	46	50
1952	3	3	26	120	2008	41	35,908	33,804	35,908
1953	2	6	55	59	2009	4	Minor	Minor	-
1954	193	756	6,847	37,455	2010	13	268	268	268
1955	218	985	8,774	24,438					

[+] 1900 could have been as high as 12,000, other years means "more than".

[1] Adjusted to 2010 dollars based on U.S. Census Bureau Price Deflator (Fisher) Index for Construction

[2] Using 1915 cost adjustment - none available prior to 1915.

[3] Considered too high in 1915 reference.

[4] Could include some offshore losses.

[L] Normalization reflects inflation, changes in personal wealth and coastal county population to 2010 dollars

Table 13b. As in Table 13a, but for the 30 deadliest years from 1851-2010 and costliest years from 1900 to 2010.

	Ranked on Deaths			Ranked on Unadjusted Damage			Ranked on Adjusted[1] Damage			Ranked by Normalized[L] Damage	
	Year	Deaths		Year	($ Millions)		Year	($ Millions)		Year	($ Millions)
1	1900	8,000 [+]		2005	143,979		2005	141,100		1926	169,398
2	1893	~ 3,000 [s]		2004	51,135		2004	53,884		2005	151,178
3	1928	2,500		2008	35,908		1992	45,561		1900	104,330
4	2005	1,225		1992	26,500		2008	33,804		1915	74,262
5	1881	700		2001	9,310		1989	13,997		1992	60,547
6	1915	550		1989	7,670		1972	11,760		2004	58,620
7	1957	426		1999	7,572		1965	11,420		1944	54,760
8	1935	414		1995	5,921		2001	11,376		1938	41,140
9	1926	408		2003	5,600		1999	10,124		1954	37,455
10	1909	406		1996	4,816		1969	9,284		2008	35,908
11	1906	298		1998	4,285		1995	8,899		1928	35,298
12	1919	287 [s]		1985	4,000		1955	8,774		1960	31,469
13	1969	256		1979	3,045		1979	8,700		1955	24,438
14	1938	256		1972	2,100		1985	8,634		1965	22,324
15	1955	218		1983	2,000		1996	7,108		1969	22,286
16	1954	193		2002	1,551		1954	6,847		1947	20,071
17	1972	122		1991	1,500		2003	6,374		1972	18,458
18	1916	107		1965	1,445		1938	6,325		1989	17,609
19	1965	75		1969	1,421		1998	5,982		1964	16,478
20	1960	65		1955	985		1970	5,924		1949	16,147
21	1944	64		1994	973		1983	4,569		1961	15,192
22	1933	63		1970	931		1964	4,206		1979	14,801
23	1999	62		1954	756		1961	3,446		1945	14,676
24	2004	60		1964	515		1960	3,290		1919	14,392
25	1989	56		2006	500		1915	2,722 [2]		1933	14,006
26	1966	54		1975	490		1944	2,690		2001	12,954
27	1947	53		1961	414		1991	2,630		1995	12,527
28	1940	51		1960	396		1926	2,315		1970	12,117
29	1964	49		1938	306		1975	2,097		1999	11,897
30	1961	46		1980	300		2002	1,851		1985	11,622

[+] Could have been as high as 12,000.

[1] Adjusted to 2010 dollars based on U.S. Census Bureau Price Deflator (Fisher) Index for Construction

[2] Considered too high in 1915 reference.

[3] Using 1915 cost adjustment - none available prior to 1915.

[s] Could include offshore losses

[L] Normalization reflects inflation, changes in personal wealth and coastal county population to 2006, (Pielke et al. 2008), then including an estimate to 2010 dollars.

Table 14. Deadliest & Costliest Tropical Cyclones (1900-2010) for Hawaii, Puerto Rico and the U.S. Virgin Islands.

Name	Date	Island or CPA	Unadjusted Damage ($000)	Adjusted for Inflation [3]	Deaths
Mokapu Cyclone	Aug 19,1938	25 mi NE Oahu	Unk	Unk	Unk
Hiki	Aug 15,1950	100 mi NE Hawaii	Unk	Unk	Unk
Nina	Dec 02,1957	100 mi SW Kauai	200	1,636	4
Dot	Aug 06,1959	Kauai	6,000	49,657	0
Iwa	Nov 23,1982	25 mi NW Kauai	312,000	733,237	1
Iniki	Sep 11,1992	Kauai	1,800,000	3,094,737	4
San Hipolito	Aug 22,1916	Puerto Rico	1,000	36,000	1
San Liborio	Jul 23,1926 [1]	SW Puerto Rico	5,000	103,353	25
San Felipe	Sep 13,1928	Puerto Rico	85,000	1,757,006	312
San Nicolas	Sep 10,1931 [1]	Puerto Rico	200	4,386	2
San Ciprian	Sep 26,1932 [1]	USVI, PR	30,000	657,893	225
San Mateo	Sep 21,1949	St. Croix	Unk	-	Unk
Santa Clara (Betsy)	Aug 12,1956	Puerto Rico	40,000	336,855	16
Donna	Sep 05,1960 [1]	PR & St. Thomas	Unk	-	107
Eloise (T.S.)	Sep 15,1975 [1]	Puerto Rico	Unk	-	44
David	Aug 30,1979 [2]	S. of Puerto Rico	Unk	-	Unk
Frederic (T.S.)	Sep 04,1979 [2]	Puerto Rico	125,000	357,143	7
Hugo	Sep 18,1989	USVI, PR	1,000,000	1,824,953	5
Marilyn	Sep 16,1995	USVI, E. PR	1,500,000	2,254,601	8
Hortense	Sep 10,1996	SW Puerto Rico	500,000	737,952	18
Georges	Sep 21,1998	USVI & PR	1,800,000	2,512,821	0
Lenny	Nov 17,1999	USVI & PR	330,000	441,201	0

[1] Effects continued into the following day. [2] Damage and Casualties from David and Frederic are combined.
[3] Adjusted to 2010 dollars based on U.S. Census Bureau Price Deflator (Fisher) Index for Construction

(15) Are there hurricane landfall cycles? Figures 7 through 22 show the landfalling portion of the tracks of major hurricanes that have struck the United States between 1851-2010. Figure 23 shows all major hurricane strikes on the U.S. coast. The reader might note the tendency for the major hurricane landfalls to cluster in certain areas during certain decades. A comparison of 20-year periods beginning in 1851 indicates that the major hurricanes tended to be in Gulf Coast states before 1891, then favored Florida and the western Gulf until 1911, shifting to the eastern Gulf Coast states and Florida during the next 20 years, then to Florida and the Atlantic Coast states during the 1940s-1950s, and back to the western Gulf Coast states in the following 20-year period. Most major hurricanes have recently favored Florida and the central Gulf Coast states, though the source of this hurricane landfall variability is unknown.

CONCLUSIONS

In virtually every coastal city from Texas to Maine, the present National Hurricane Center Director (Bill Read) and former directors have stated that the United States is vulnerable to another hurricane disaster. Hurricanes Katrina and Ike are sad reminders of the exposure of the United States to hurricanes. The areas along the United States Gulf and Atlantic coasts where most of this country's hurricane-related fatalities have occurred are also experiencing the most significant growth in population. The lack of coastal readiness for a hurricane, as suggested by Hebert et al. (1975), Jarrell et al. (1992) and Table 12, is a serious problem and could lead to future disasters. This situation, in combination with continued building along the coast, will lead to dangerous problems for many areas in hurricanes.

The message to coastal residents is this: Become familiar with what hurricanes can do, develop a hurricane plan, and when a hurricane threatens your area, increase your chances of survival by executing your plan. The largest loss of life can occur in the storm surge, so coastal residents should prepare to move 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 disastrous loss of life is inevitable.

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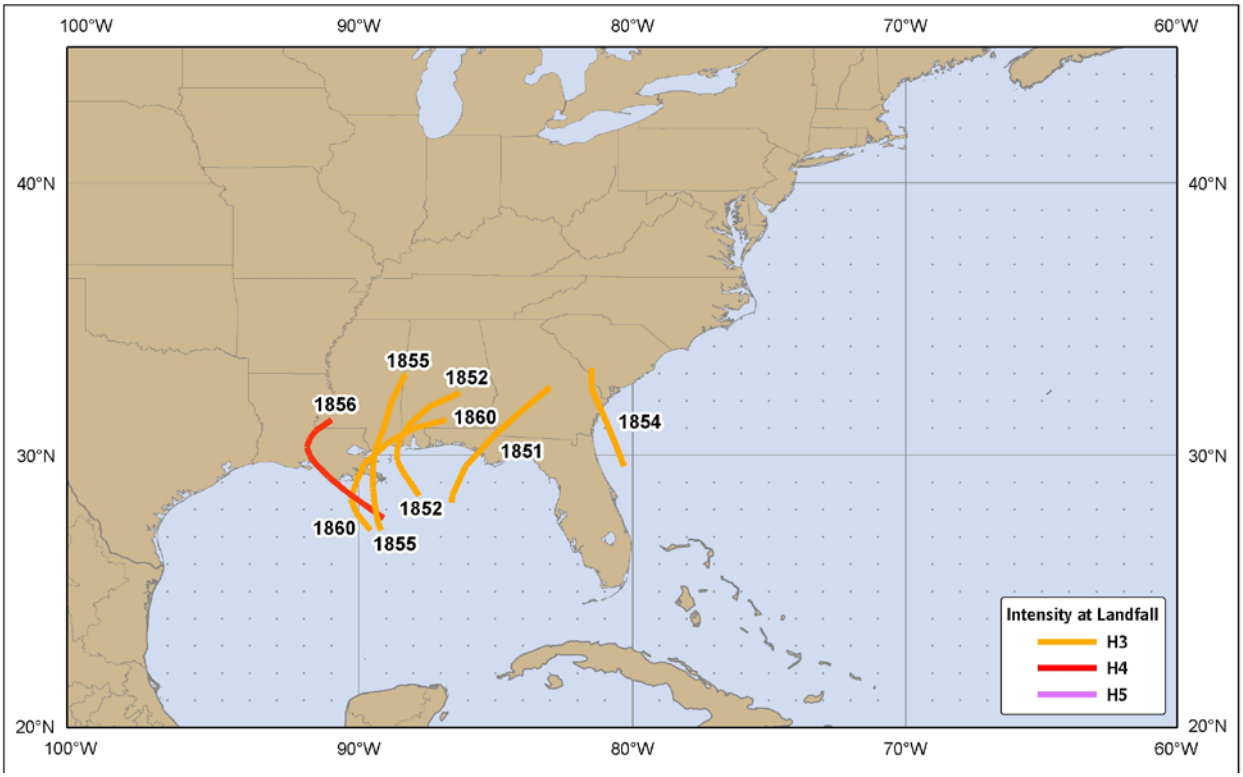

Figure 7. United States major hurricane strikes (category 3 or higher), 1851-1860. Line color indicates intensity at landfall for Figures 7-22.

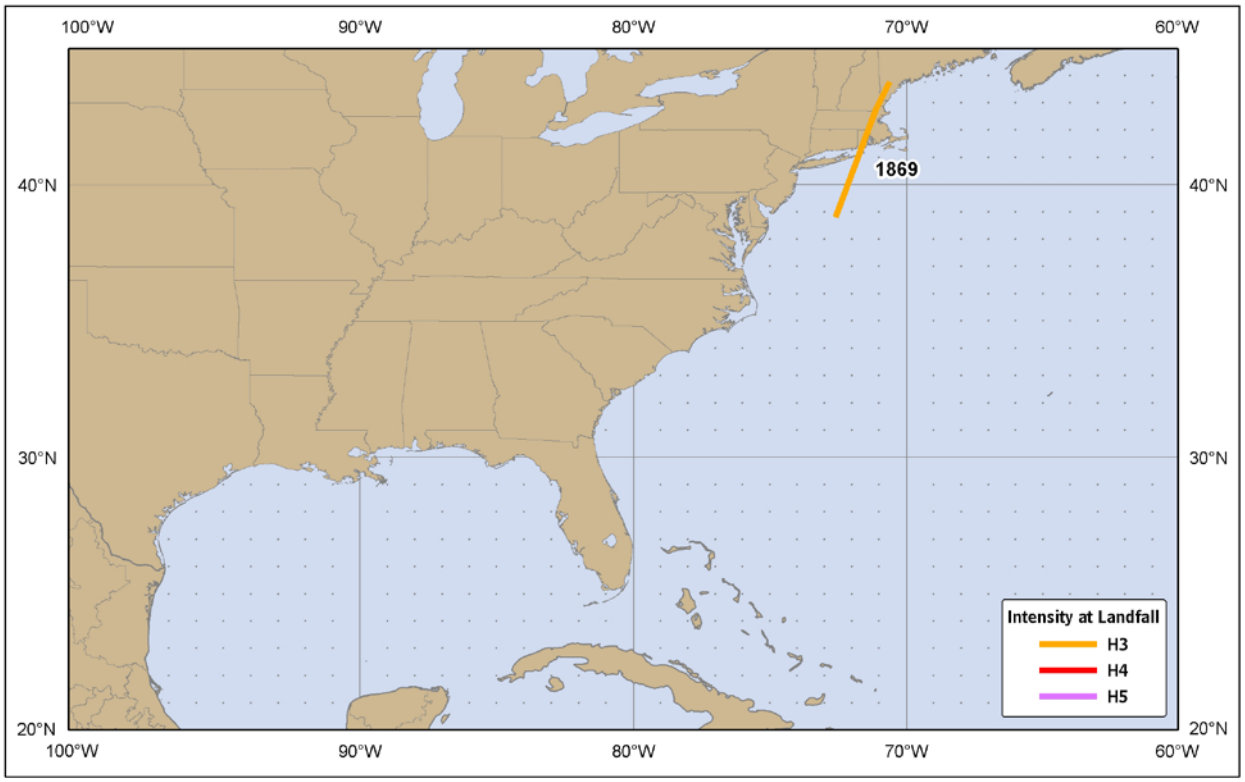

Figure 8. United States major hurricane strikes (category 3 or higher), 1861-1870.

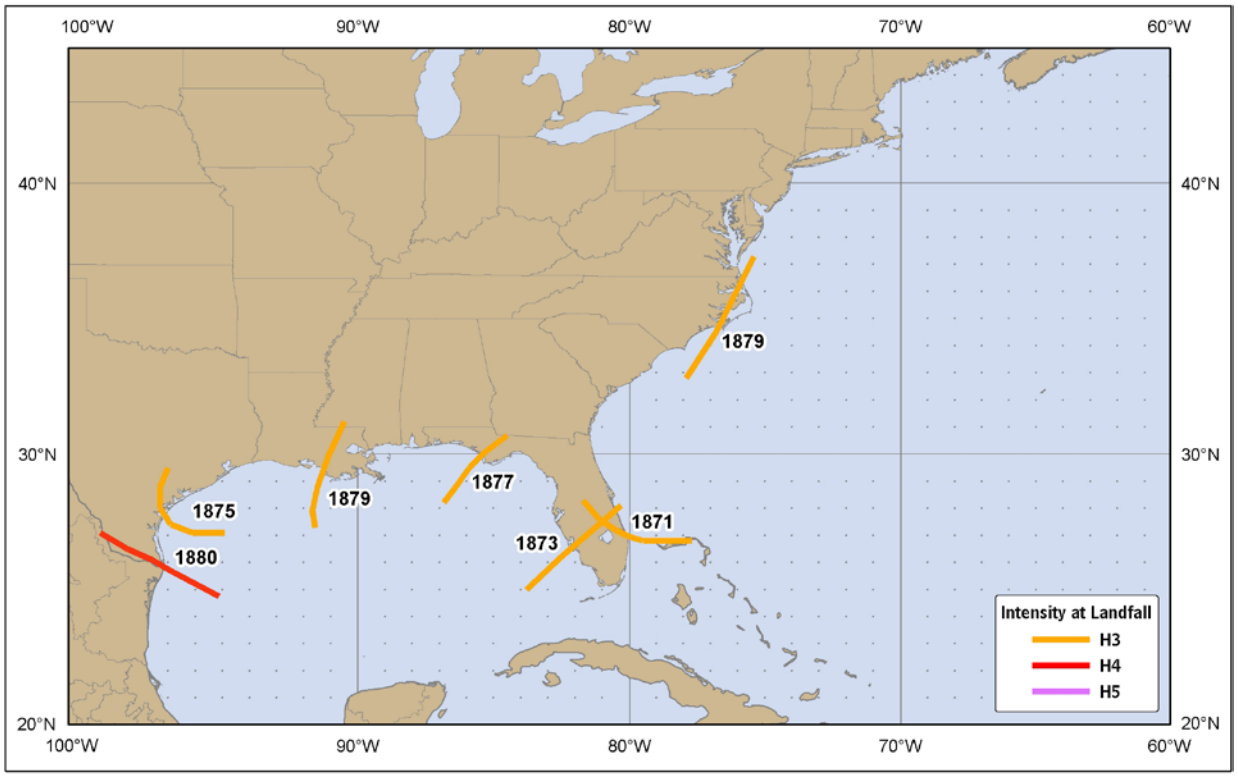

Figure 9. United States major hurricane strikes (category 3 or higher), 1871-1880.

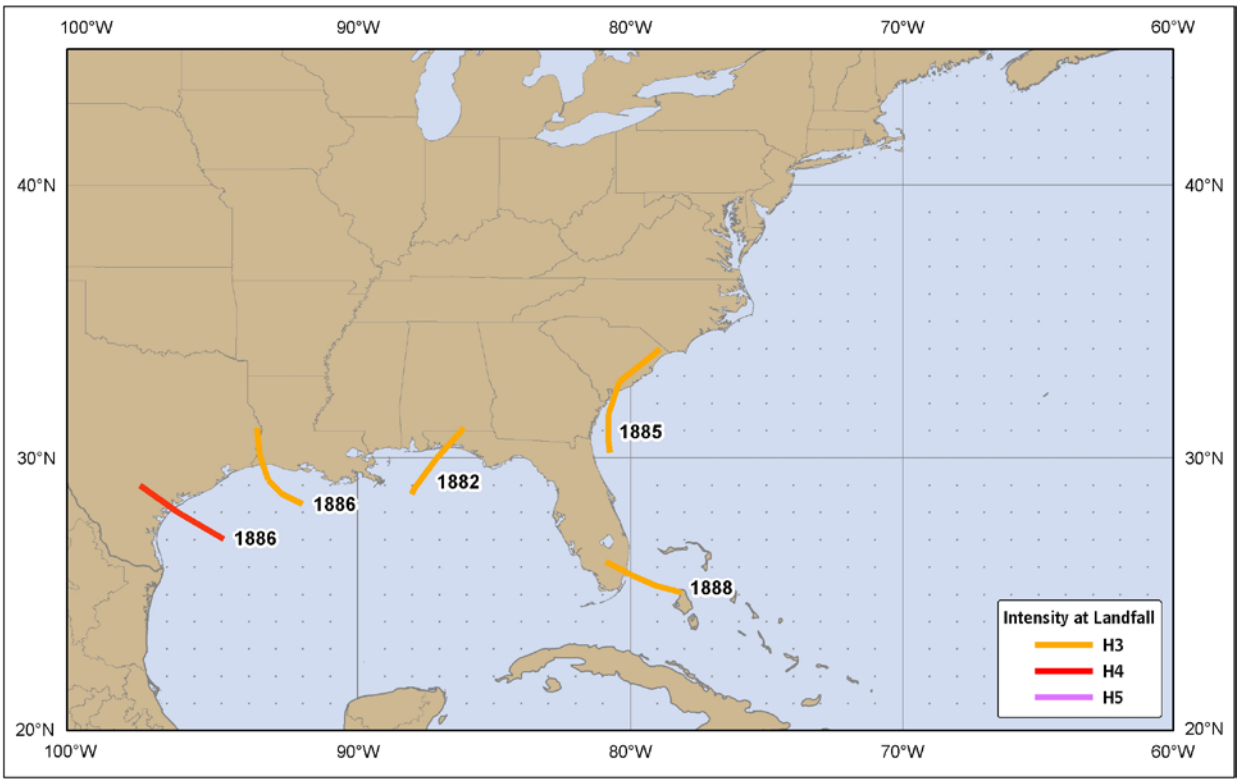

Figure 10. United States major hurricane strikes (category 3 or higher), 1881-1890.

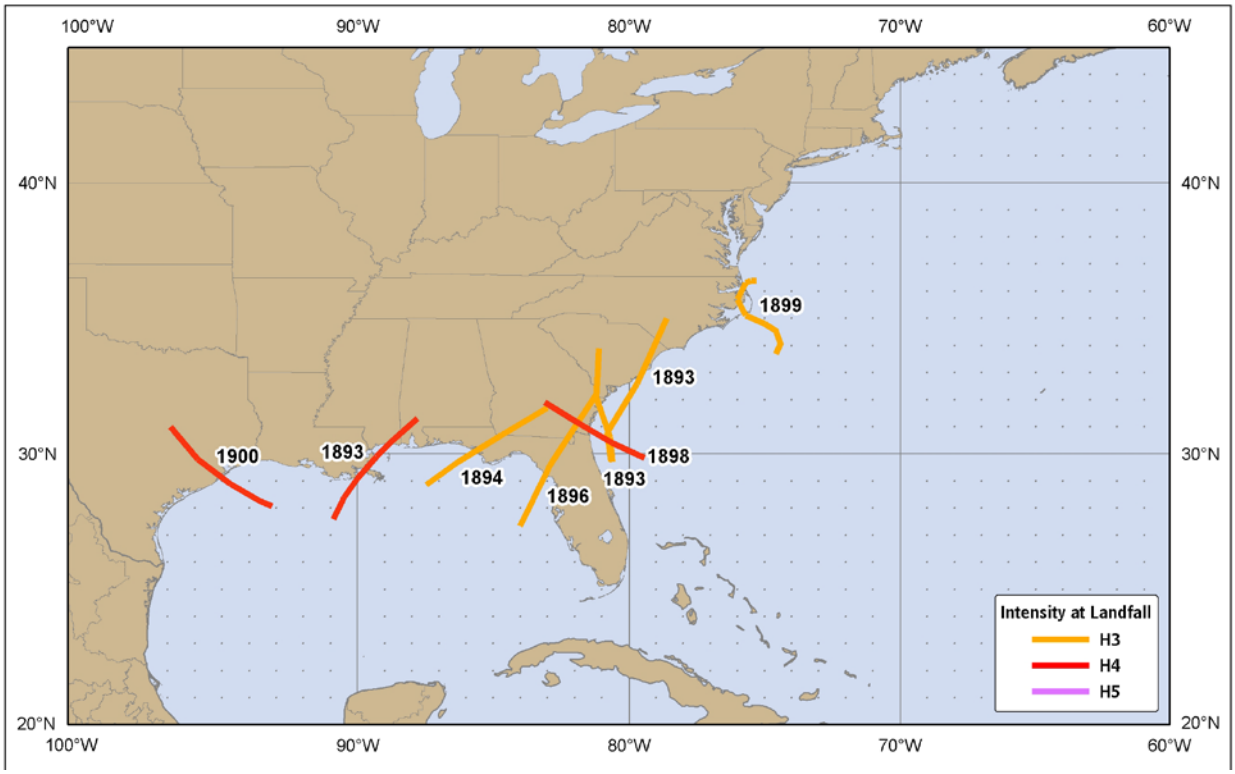

Figure 11. United States major hurricane strikes (category 3 or higher), 1891-1900.

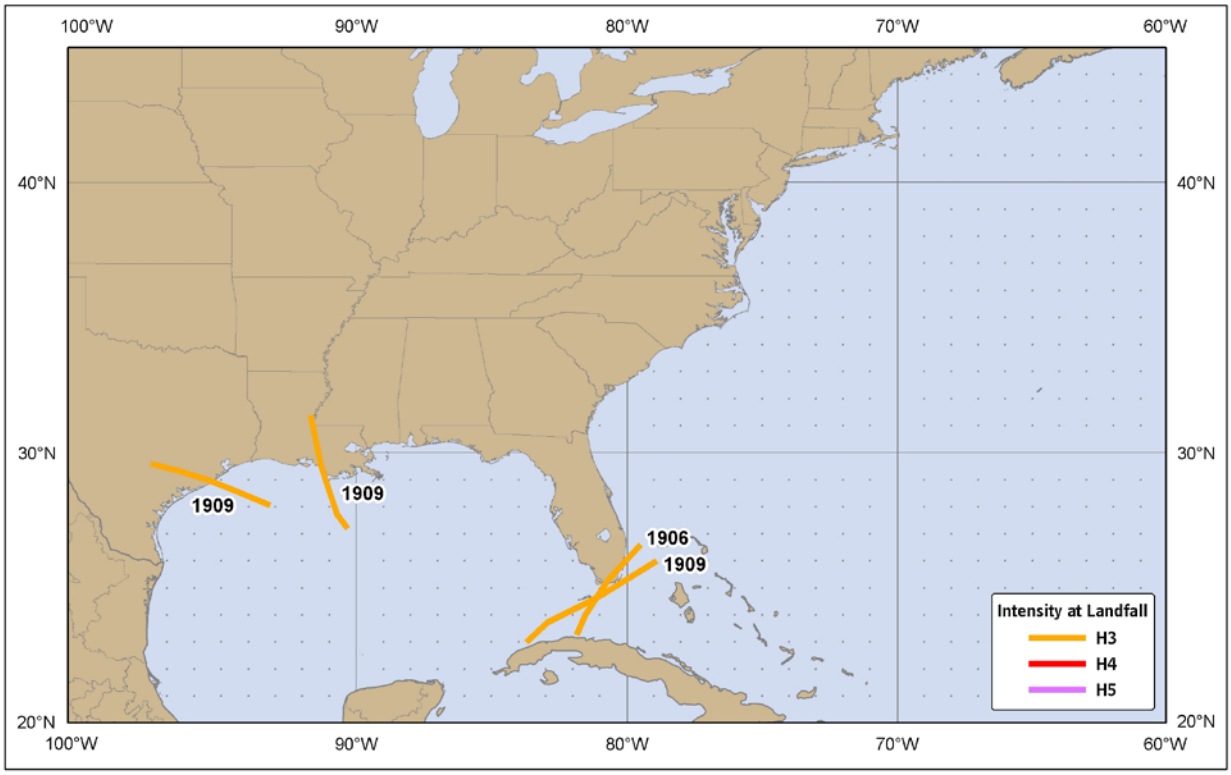

Figure 12. United States major hurricane strikes (category 3 or higher), 1901-1910.

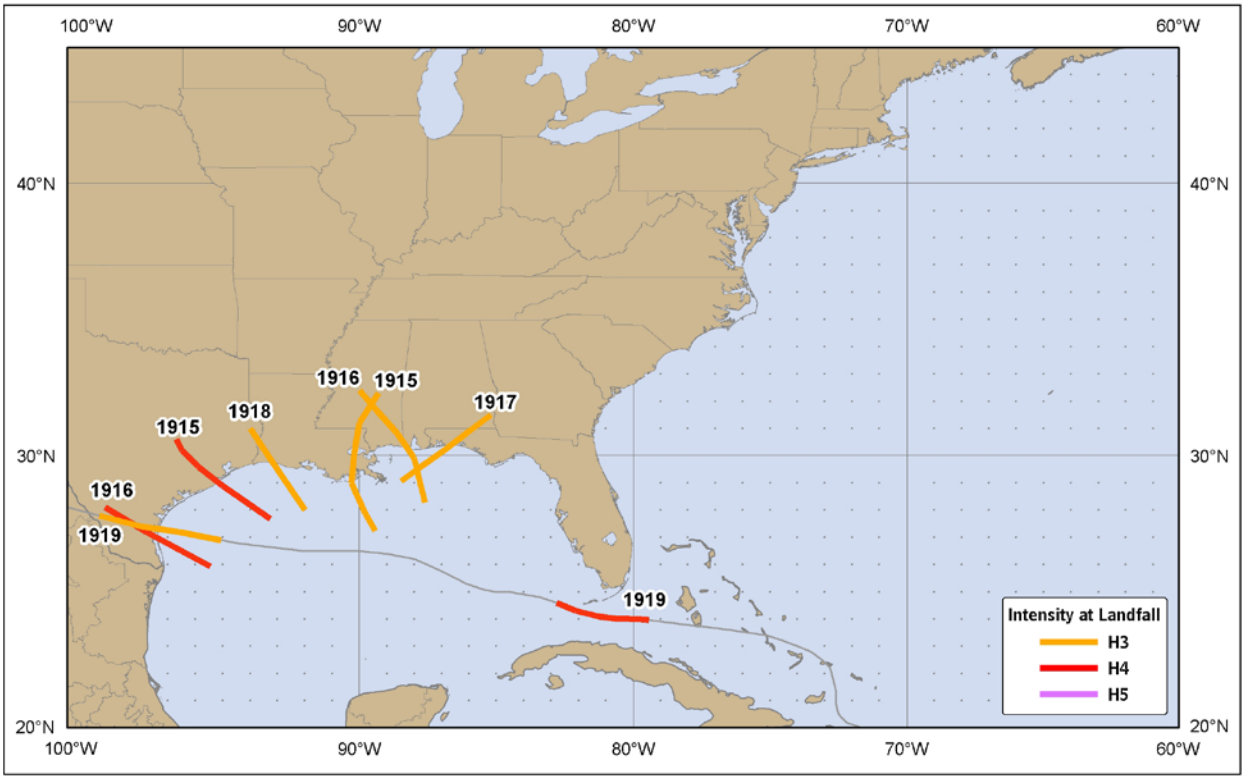

Figure 13. United States major hurricane strikes (category 3 or higher), 1911-1920.

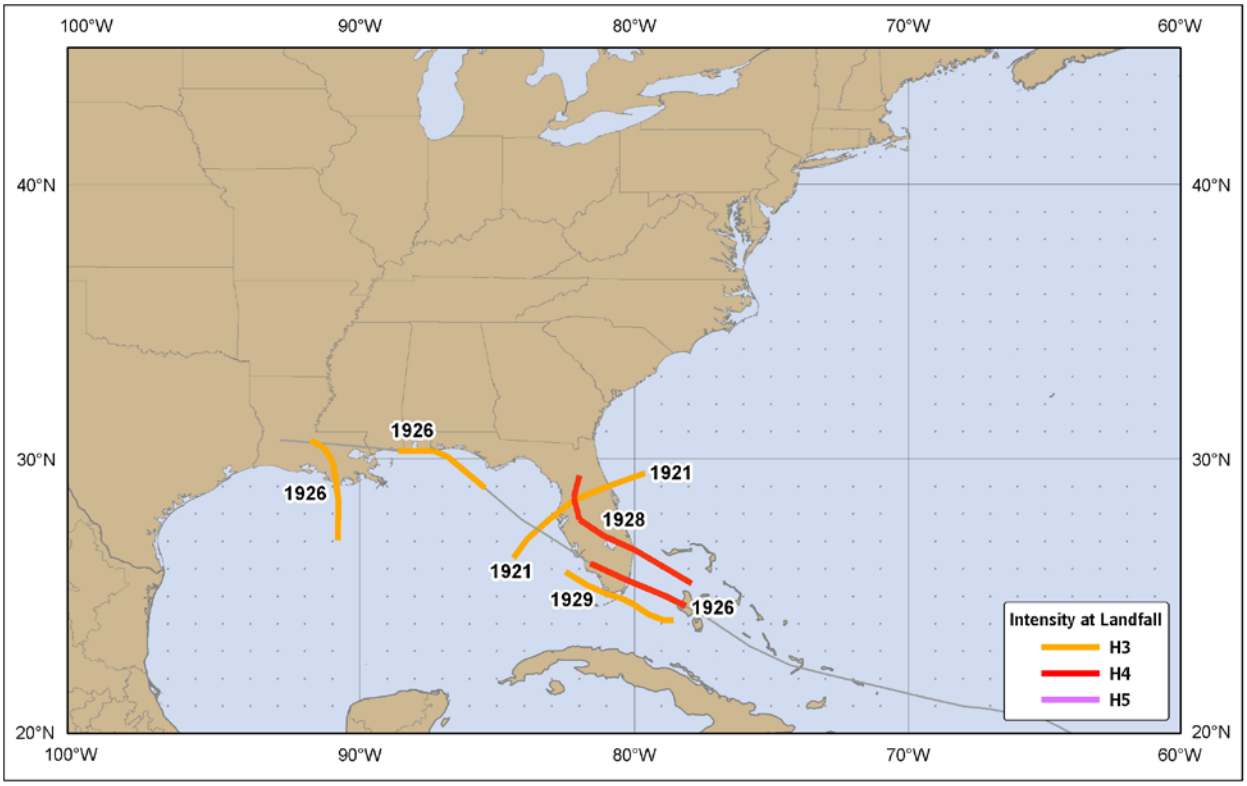

Figure 14. United States major hurricane strikes (category 3 or higher), 1921-1930.

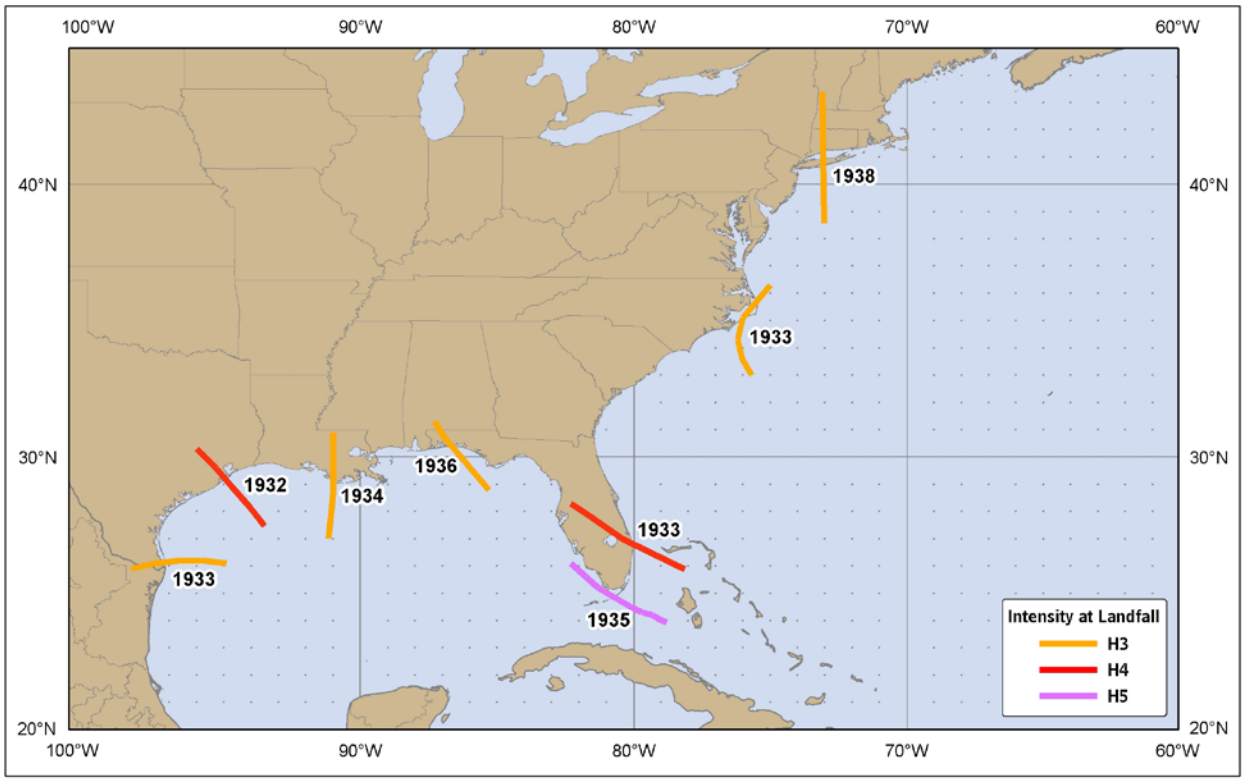

Figure 15. United States major hurricane strikes (category 3 or higher), 1931-1940.

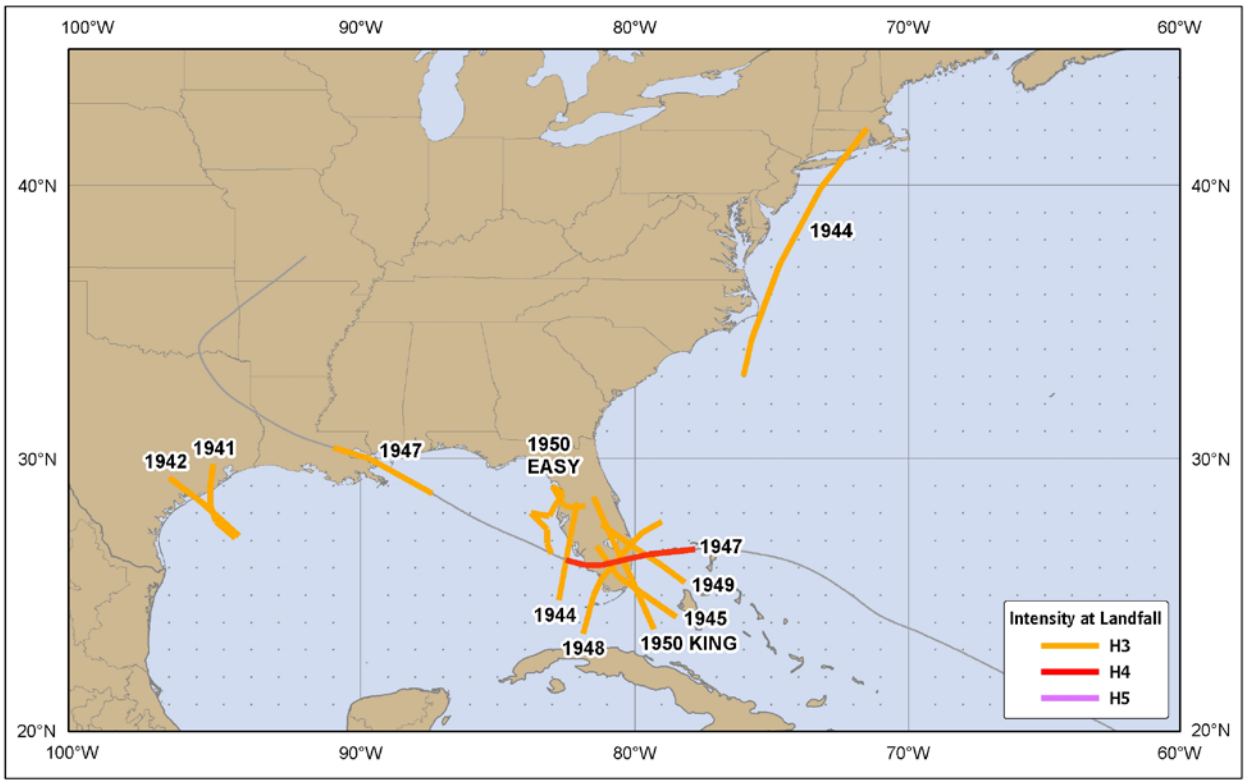

Figure 16. United States major hurricane strikes (category 3 or higher), 1941-1950.

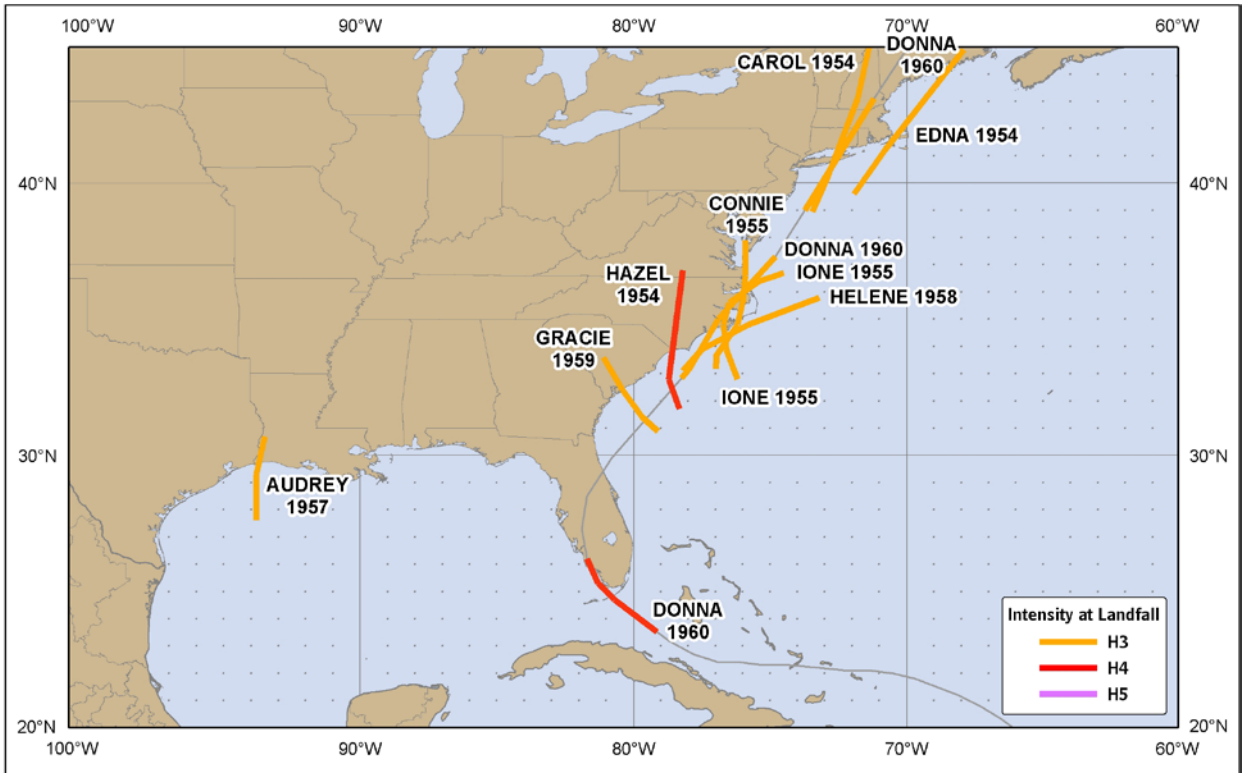

Figure 17. United States major hurricane strikes (category 3 or higher), 1951-1960.

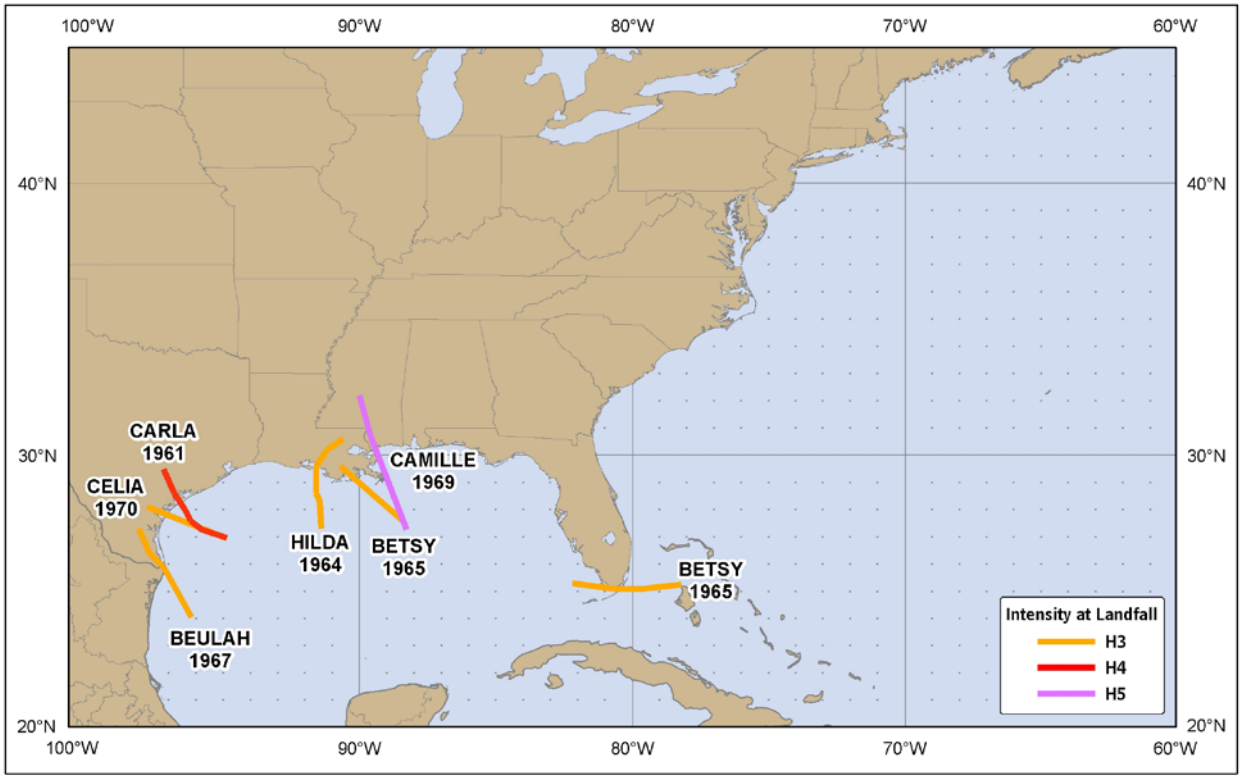

Figure 18. United States major hurricane strikes (category 3 or higher), 1961-1970.

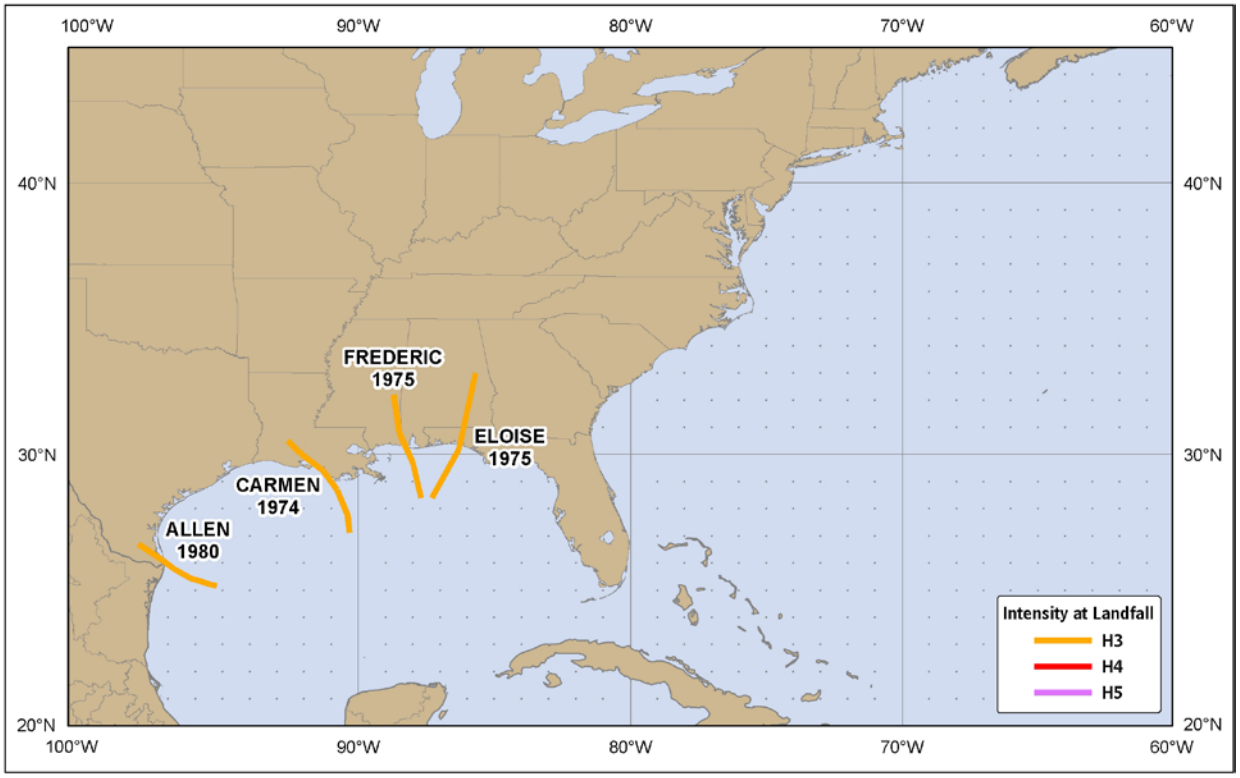

Figure 19. United States major hurricane strikes (category 3 or higher), 1971-1980.

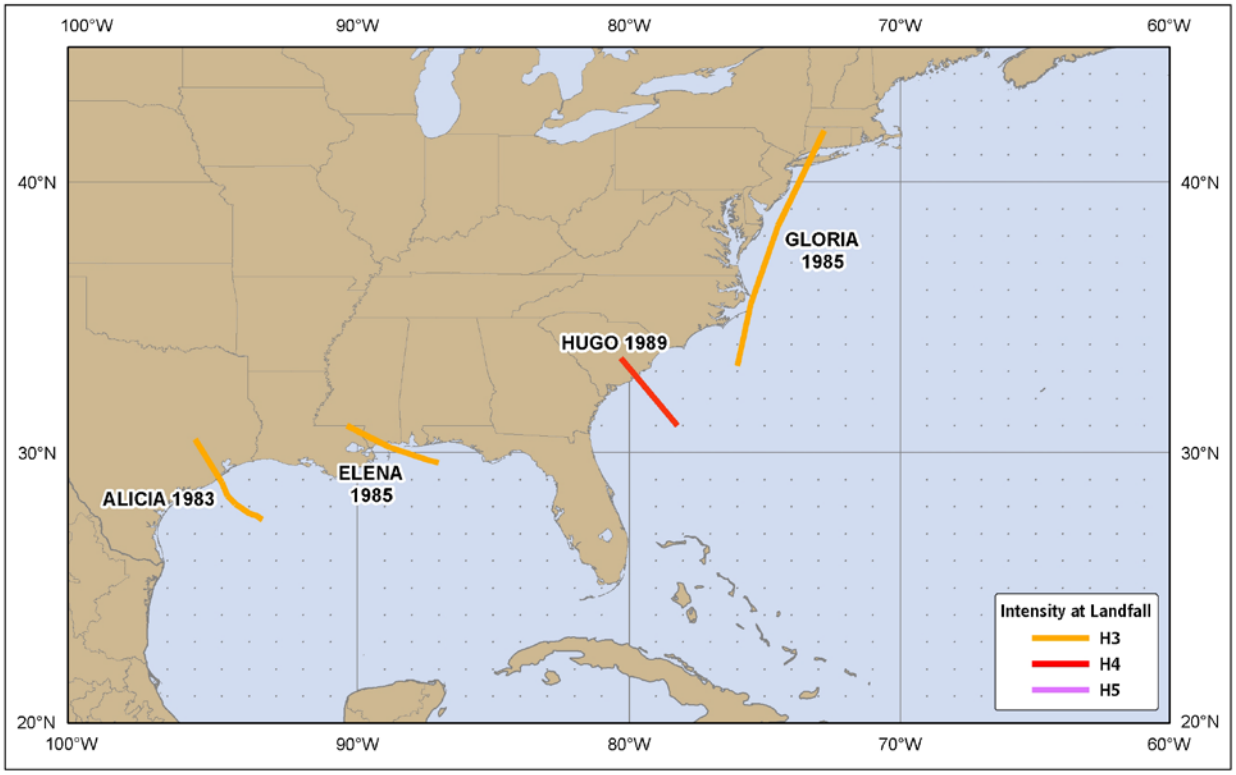

Figure 20. United States major hurricane strikes (category 3 or higher), 1981-1990.

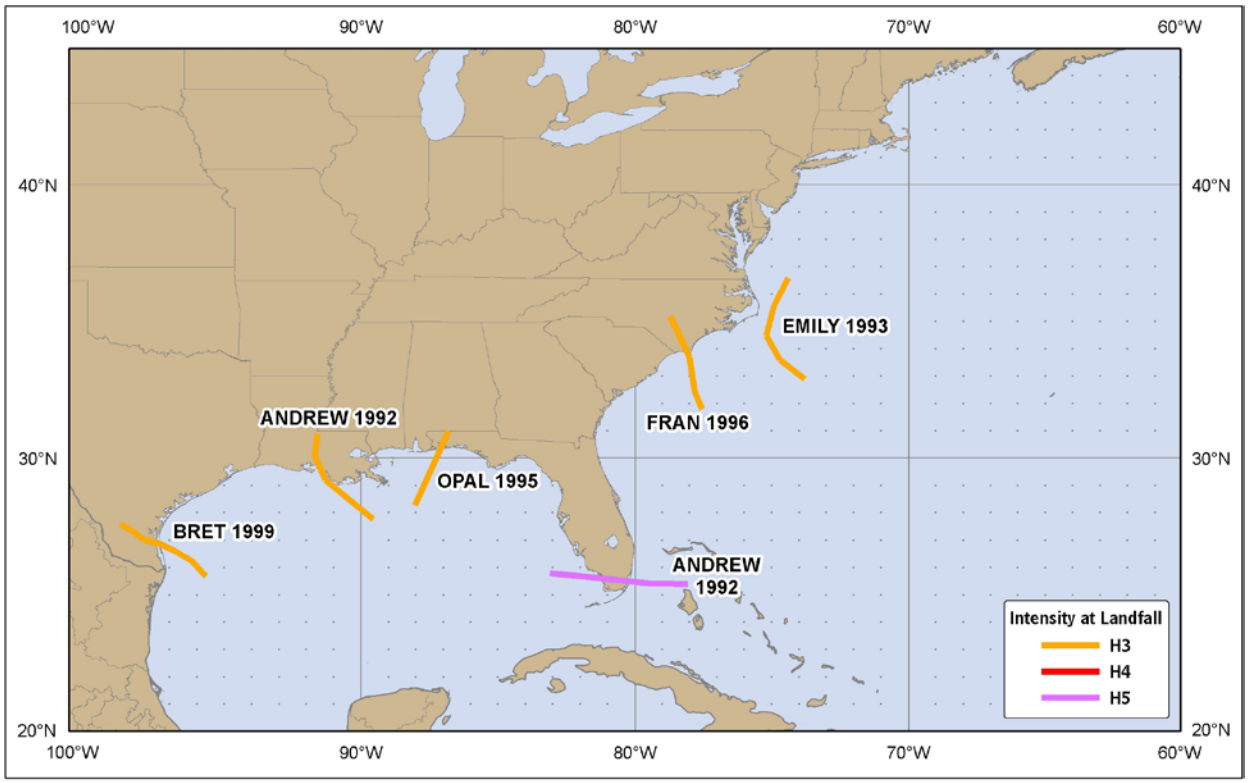

Figure 21. United States major hurricane strikes (category 3 or higher), 1991-2000.

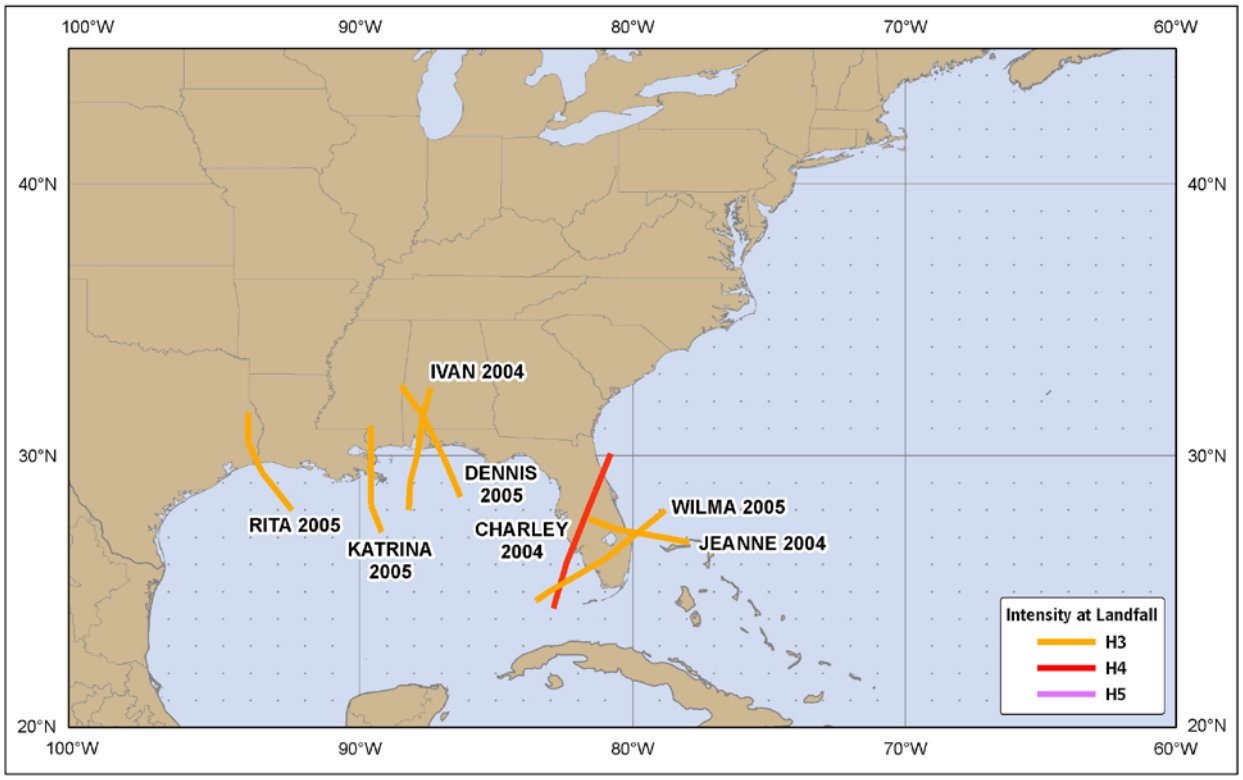

Figure 22. United States major hurricane strikes (category 3 or higher), 2001-2010.

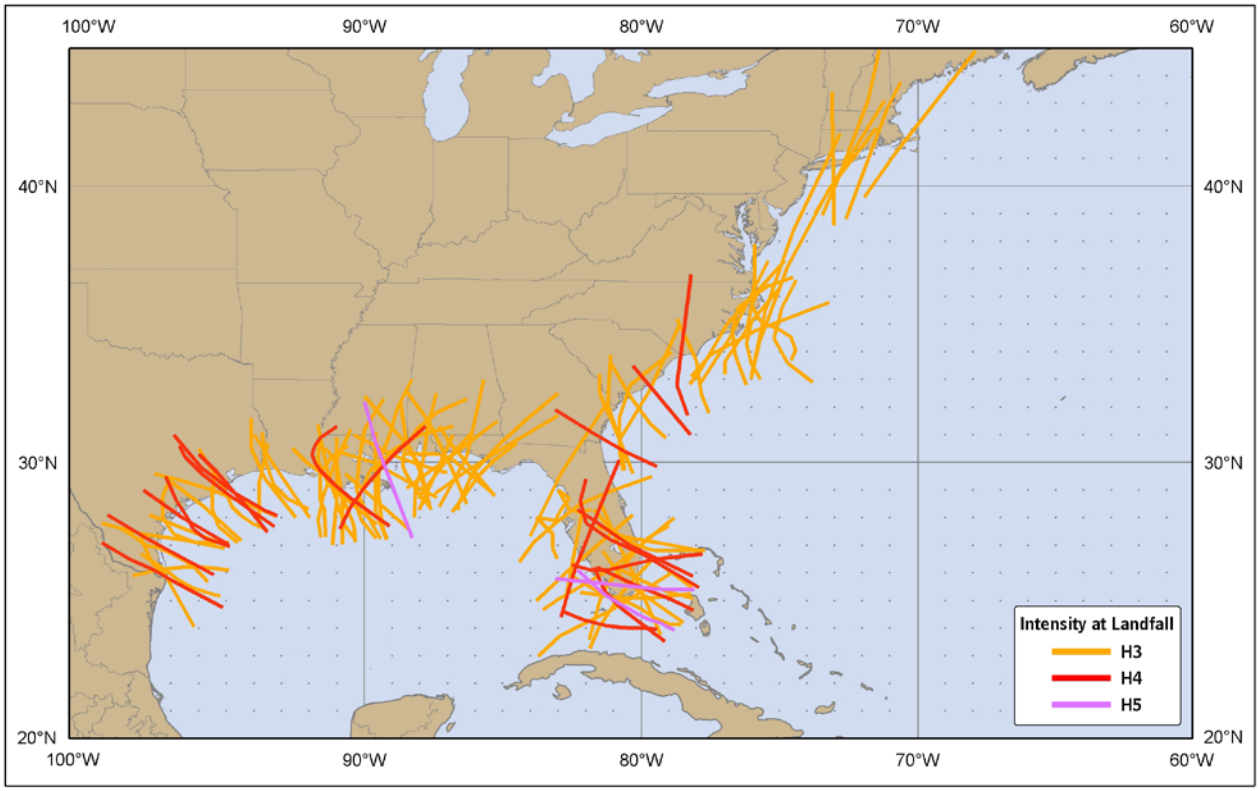

Figure 23. United States major hurricane strikes (category 3 or higher), 1851-2010.

Appendix A: Chronological list of all hurricanes that struck the continental United States, 1851-2010.(Updated from Blake et al. 2007 and reflecting official HURDAT reanalysis changes through 1930).

Year	Month		States Affected and Category by States	Highest Saffir-Simpson U.S. Category	Central Pressure	Max. Winds	Name
1851	Jun		TX, C1	1	977 mb	80 kt	-----
1851	Aug		FL, NW3; I-GA, 1	3	960	100	"Great Middle Florida"
1852	Aug		AL, 3; MS, 3; LA, 2; FL, SW2, NW1	3	961	100	"Great Mobile"
''	''						
1852	Sep		FL, SW1	1	985	70	-----
1852	Oct		FL, NW2; I-GA, 1	2	969	90	"Middle Florida"
1853	Oct	*	GA, 1	1	965	70	-----
1854	Jun		TX, S1	1	985	70	-----
1854	Sep		GA, 3; SC, 2; FL, NE1	3	950	100	"Great Carolina"
1854	Sep		TX, C2	2	969	90	"Matagorda"
1855	Sep		LA, 3; MS, 3	3	950	110	"Middle Gulf Shore"
1856	Aug		LA, 4	4	934	130	"Last Island"
1856	Aug		FL, NW2; I-AL, 1; I-GA, 1	2	969	90	"Southeastern States"
1857	Sep	&	NC, 1	1	961	80	-----
1858	Sep		NY, 1; CT, 1; RI, 1; MA, 1	1	976	80	"New England"
1859	Sep		AL, 1; FL, NW1	1	985	70	-----
1860	Aug		LA, 3; MS, 3; AL, 2	3	950	110	-----
1860	Sep		LA, 2; MS, 2; AL, 1	2	969	90	-----
1860	Oct		LA, 2	2	969	90	-----
1861	Aug	*	FL, SW1	1	970	70	"Key West"
1861	Sep		NC, 1	1	985	70	"Equinoctial"
1861	Nov		NC, 1	1	985	70	"Expedition"
1865	Sep		LA, 2; TX, N1	2	969	90	"Sabine River-Lake Calcasieu"
1865	Oct		FL, SW2; FL, SE1	2	969	90	-----
1866	Jul		TX, C2	2	969	90	-----
1867	Jun		SC, 1	1	985	70	-----
1867	Oct		LA, 2; TX, S1, N1; FL, NW1	2	969	90	"Galveston"
1869	Aug		TX, C2	2	969	90	"Lower Texas Coast"
1869	Sep		LA, 1	1	985	70	-----
1869	Sep		RI, 3; MA, 3; NY, 1; CT, 1	3	963	100	"Eastern New England"
1869	Oct	&	ME, 2; MA, 1	2	965	90	"Saxby's Gale"
1870	Jul		AL, 1	1	985	70	"Mobile"
1870	Oct	*	FL, SW1, SE1	1	970	70	"Twin Key West (I)"
1870	Oct		FL, SW1	1	977	80	"Twin Key West (II)"
1871	Aug		FL, SE3, NE1, NW1	3	955	100	-----
1871	Aug		FL, SE2, NE1	2	965	90	-----
1871	Sep		FL, NW1, SW1	1	985	70	-----
1873	Sep		FL, NW1	1	985	70	-----
1873	Oct		FL, SW3, SE2, NE1	3	959	100	-----
1874	Sep		FL, NW1; SC, 1; NC, 1	1	985	70	-----
1875	Sep		TX, C3, S2	3	960	100	-----
1876	Sep		NC, 1; VA, 1	1	980	80	-----
1876	Oct		FL, SW2, SE1	2	973	90	-----
1877	Sep		LA, 1; FL, NW1	1	985	70	-----
1877	Oct		FL, NW3; I-GA, 1	3	960	100	-----
1878	Sep		FL, NW2,SW2, NE1; SC,1; GA,1	2	970	90	-----
1878	Oct		NC, 2; VA, 1; MD, 1; DE, 1; NJ, 1; I-PA, 1	2	963	90	-----
1879	Aug		NC, 3; VA, 2; MA, 1	3	971	100	-----
1879	Aug		TX, N2; LA, 2	2	964	90	-----
1879	Sep		LA, 3	3	950	110	-----
1880	Aug	#	TX, S3	3	931	110	-----
1880	Aug		FL, SE2, NE1, NW1	2	972	90	-----
1880	Sep		NC, 1	1	987	70	-----
1880	Oct		FL, NW1	1	985	70	-----
1881	Aug		GA, 2; SC, 1	2	970	90	-----
1881	Sep		NC, 2	2	975	90	-----
1882	Sep		FL, NW3; I-AL, 1	3	949	100	-----
1882	Sep		LA, 2; TX, N1	2	969	90	-----
1882	Oct		FL, NW1	1	985	70	-----
1883	Sep		NC, 2; SC, 1	2	965	90	-----
1885	Aug		SC, 3; NC, 2; GA, 1; FL, NE1	3	953	100	-----
1886	Jun		TX, N2; LA, 2	2	973	85	-----
1886	Jun		FL, NW2; I-GA, 1	2	973	85	-----

1886	Jun		FL, NW2; I-GA, 1	2	973	85	-----
1886	Jul		FL, NW1	1	985	70	-----
1886	Aug		TX, C4	4	925	135	"Indianola"
1886	Sep	#	TX, S1, C1	1	973	80	-----
1886	Oct		LA, 3; TX, N2	3	955	105	-----
1887	Jul		FL, NW1; I-AL, 1	1	981	75	-----
1887	Aug	*	NC, 1	1	946	65	-----
1887	Sep		TX, S2	2	973	85	-----
1887	Oct		LA, 1	1	981	75	-----
1888	Jun		TX, C1	1	985	70	-----
1888	Aug		FL, SE3, SW1; LA2; I-MS, 1	3	945	110	-----
1888	Oct		FL, NW2, NE1	2	970	95	-----
1889	Sep		LA, 1	1	985	70	-----
1891	Jul		TX, C1, N1	1	977	80	-----
1891	Aug		FL, SE1	1	985	70	-----
1893	Aug		NY, 1; CT, 1	1	986	75	"Midnight Storm"
1893	Aug		GA, 3; SC, 3; I-NC, 1; FL,NE1	3	954	100	"Sea Islands"
1893	Sep		LA, 2	2	973	85	-----
1893	Oct		LA, 4; MS, 2; AL, 2	4	948	115	"Chenier Caminanda"
1893	Oct		SC, 3; NC, 2; I-VA, 1	3	955	105	-----
1894	Sep		FL, SW2, NE1; SC, 1; VA, 1	2	975	90	-----
1894	Oct		FL, NW3; I-GA, 1; NY, 1; RI, 1; CT, 1	3	955	105	-----
1895	Aug	#	TX, S1	1	973	65	-----
1896	Jul		FL, NW2	2	973	85	-----
1896	Sep		RI, 1; MA, 1	1	985	70	-----
1896	Sep		FL, NW3, NE3; GA, 2; SC, 1; I-NC, 1; I-VA, 1	3	960	110	-----
1897	Sep		LA, 1; TX, N1	1	981	75	-----
1898	Aug		FL, NW1	1	985	70	-----
1898	Aug		GA, 1; SC, 1	1	980	75	-----
1898	Oct		GA, 4; FL, NE2	4	938	115	-----
1899	Aug		FL, NW2	2	979	85	-----
1899	Aug		NC, 3	3	945	105	-----
1899	Oct		NC, 2; SC, 2	2	955	95	-----
1900	Sep		TX, N4	4	936	125	"Galveston"
1901	Jul		NC, 1	1	983	70	-----
1901	Aug		LA, 1; MS, 1; AL, 1	1	973	80	-----
1903	Sep		FL, SE1, NW1	1	976	80	-----
1903	Sep		NJ, 1; DE, 1	1	990	70	-----
1904	Sep		SC, 1	1	985	70	-----
1904	Oct		FL, SE1	1	985	70	-----
1906	Jun		FL, SW1, SE1	1	979	75	-----
1906	Sep		SC, 1; NC, 1	1	977	80	-----
1906	Sep		MS, 2; AL, 2; FL, NW2; LA, 1	2	958	95	-----
1906	Oct		FL, SW3, SE3	3	953	105	-----
1908	Jul		NC, 1	1	985	70	-----
1909	Jun		TX, S2	2	972	85	-----
1909	Jul		TX, N3	3	959	100	"Velasco"
1909	Aug	#	TX, S1	1	955	65	-----
1909	Sep		LA, 3; MS, 2	3	952	105	"Grand Isle"
1909	Oct		FL, SW3, SE3	3	957	100	-----
1910	Sep		TX, S2	2	965	95	-----
1910	Oct		FL, SW2	2	955	95	-----
1911	Aug		FL, NW1; AL,1	1	985	70	-----
1911	Aug		SC, 2; GA, 1	2	972	85	-----
1912	Sep		AL, 1; FL, NW1	1	988	65	-----
1912	Oct		TX, S2	2	973	85	-----
1913	Jun		TX, S1	1	988	65	-----
1913	Sep		NC, 1	1	976	75	-----
1913	Oct		SC, 1	1	989	65	-----
1915	Aug		FL, NE1	1	990	65	-----
1915	Aug		TX, N4, C1; LA, 1	4	940	115	"Galveston"
1915	Sep		FL, NW1	1	982	80	-----
1915	Sep		LA, 3; MS, 2	3	944	110	"New Orleans"
1916	Jul		MS, 3; AL, 2; FL, NW2	3	950	105	-----
1916	Jul		SC, 2	2	960	95	-----
1916	Aug		TX, S4	4	932	115	-----
1916	Oct		AL, 2; FL, NW2	2	970	95	-----
1917	Sep		FL, NW3; LA, 2; AL, 1	3	949	100	-----
1918	Aug		LA, 3; TX, N1	3	955	105	-----
1918	Aug		NC, 1	1	988	65	-----
1919	Sep		FL, SW4, SE2; TX, S3, C3	4	927	130	-----

1920	Sep	LA, 2	2	975	85	-----
1921	Jun	TX, C1, N1	1	980	80	-----
1921	Oct	FL, SW3, NW2, NE1	3	952	105	"Tampa Bay"
1923	Oct	LA, 1; MS, 1	1	983	70	-----
1924	Aug	* NC, 1; MA, 1	1	963	65	-----
1924	Sep	FL, NW1	1	980	75	-----
1924	Oct	FL, SW1, SE1	1	975	80	-----
1925	Dec	FL, SW1	1	985	65	-----
1926	Jul	FL, NE2; SE1	2	967	90	-----
1926	Aug	LA, 3	3	955	100	-----
1926	Sep	FL, SE4, SW3,NW3; AL, 3; MS,1	4	930	125	"Great Miami"
1926	Oct	* FL, Sw1, SE1	1	949	75	-----
1928	Aug	FL, SE2	2	977	85	-----
1928	Sep	FL, SE4, SW3,NE1, NW1; GA,1;	4	929	125	"Lake Okeechobee"
''	''	SC, 1				
1929	Jun	TX, C1	1	982	80	-----
1929	Sp-Oc	FL, SE3, SW2, NW1	3	948	100	-----
1932	Aug	TX, N4	4	941	-----	"Freeport"
1932	Sep	AL, 1	1	979	-----	-----
1933	Jl-Au #	TX, S2; FL, SE1	2	975	-----	-----
1933	Aug	NC, 2; VA, 2	2	971	-----	-----
1933	Sep	TX, S3	3	949	-----	-----
1933	Sep	FL, SE3	3	948	-----	-----
1933	Sep	NC, 3	3	957	-----	-----
1934	Jun	LA, 3	3	962	-----	-----
1934	Jul	TX, S2	2	975	-----	-----
1935	Sep	FL, SW5, NW2	5	892	-----	"Labor Day"
1935	Nov	FL, SE2	2	973	-----	-----
1936	Jun	TX, S1	1	987	-----	-----
1936	Jul	FL, NW3	3	964	-----	-----
1936	Sep	NC, 2	2	-----	-----	-----
1938	Aug	LA, 1	1	985	-----	-----
1938	Sep	NY, 3; CT, 3; RI, 3; MA, 3	3	946	-----	"Great New England"
1939	Aug	FL, SE1, NW1	1	985	-----	-----
1940	Aug	TX, N2; LA, 2	2	972	-----	-----
1940	Aug	GA, 2; SC, 2	2	970	-----	-----
1941	Sep	TX, N3	3	958	-----	-----
1941	Oct	FL, SE2, SW2, NW2	2	975	-----	-----
1942	Aug	TX, N1	1	992	-----	-----
1942	Aug	TX, C3	3	950	-----	-----
1943	Jul	TX, N2	2	969	-----	-----
1944	Aug	NC, 1	1	990	-----	-----
1944	Sep	NC, 3; VA, 3; NY, 3; CT, 3;	3	947	-----	-----
''	''	RI, 3; MA, 2				
1944	Oct	FL, SW3, NE2	3	962	-----	-----
1945	Jun	FL, NW1	1	985	-----	-----
1945	Aug	TX, C2	2	967	-----	-----
1945	Sep	FL, SE3	3	951	-----	-----
1946	Oct	FL, SW1	1	980	-----	-----
1947	Aug	TX, N1	1	992	-----	-----
1947	Sep	FL, SE4, SW2; MS, 3; LA, 3	4	940	-----	-----
1947	Oct	GA, 2; SC, 2; FL, SE1	2	974	-----	-----
1948	Sep	LA, 1	1	987	-----	-----
1948	Sep	FL, SW3, SE2	3	963	-----	-----
1948	Oct	FL, SE2	2	975	-----	-----
1949	Aug	* NC, 1	1	980	-----	-----
1949	Aug	FL, SE3	3	954	-----	-----
1949	Oct	TX, N2	2	972	-----	-----
1950	Aug	AL, 1	1	980	-----	Baker
1950	Sep	FL, NW3	3	958	-----	Easy
1950	Oct	FL, SE3	3	955	-----	King
1952	Aug	SC, 1	1	985	-----	Able
1953	Aug	NC, 1	1	987	-----	Barbara
1953	Sep	ME, 1	1	-----	-----	Carol
1953	Sep	FL, NW1	1	985	-----	Florence
1954	Aug	NY, 3; CT, 3; RI, 3; NC, 2	3	960	-----	Carol
1954	Sep	MA, 3; ME, 1	3	954	-----	Edna
1954	Oct	SC, 4; NC, 4; MD, 2	4	938	-----	Hazel
1955	Aug	NC, 3; VA, 1	3	962	-----	Connie
1955	Aug	NC, 1	1	987	-----	Diane
1955	Sep	NC, 3	3	960	-----	Ione
1956	Sep	LA, 2; FL, NW1	2	975	-----	Flossy
1957	Jun	TX, N4; LA, 4	4	945	-----	Audrey
1958	Sep	* NC, 3	3	946	-----	Helene

1959	Jul	SC, 1	1	993	-----	Cindy
1959	Jul	TX, N1	1	984	-----	Debra
1959	Sep	SC, 3	3	950	-----	Gracie
1960	Sep	FL, SW4; NC, 3; NY, 3;	4	930	-----	Donna
''	''	FL, NE2; CT, 2; RI, 2; MA, 1;				
''	''	NH, 1; ME, 1				
1960	Sep	MS, 1	1	981	-----	Ethel
1961	Sep	TX, C4	4	931	-----	Carla
1963	Sep	TX, N1	1	996	-----	Cindy
1964	Aug	FL, SE2	2	968	-----	Cleo
1964	Sep	FL, NE2	2	966	-----	Dora
1964	Oct	LA, 3	3	950	-----	Hilda
1964	Oct	FL, SW2, SE2	2	974	-----	Isbell
1965	Sep	FL, SE3; LA, 3	3	948	-----	Betsy
1966	Jun	FL, NW2	2	982	-----	Alma
1966	Oct	FL, SW1	1	983	-----	Inez
1967	Sep	TX, S3	3	950	-----	Beulah
1968	Oct	FL, NW2, NE1	2	977	-----	Gladys
1969	Aug	LA, 5; MS, 5	5	909	-----	Camille
1969	Sep	ME, 1	1	980	-----	Gerda
1970	Aug	TX, S3	3	945	-----	Celia
1971	Sep	LA, 2	2	978	-----	Edith
1971	Sep	TX, C1	1	979	-----	Fern
1971	Sep	NC, 1	1	995	-----	Ginger
1972	Jun	FL, NW1; NY, 1; CT, 1	1	980	-----	Agnes
1974	Sep	LA, 3	3	952	-----	Carmen
1975	Sep	FL, NW3; I-AL1	3	955	-----	Eloise
1976	Aug	NY, 1	1	980	-----	Belle
1977	Sep	LA, 1	1	995	-----	Babe
1979	Jul	LA, 1	1	986	-----	Bob
1979	Sep	FL, SE2, NE2; GA, 2; SC, 2	2	970	-----	David
1979	Sep	AL, 3; MS, 3	3	946	-----	Frederic
1980	Aug	TX, S3	3	945	100	Allen
1983	Aug	TX, N3	3	962	100	Alicia
1984	Sep	* NC, 2	2	949	95	Diana
1985	Jul	SC, 1	1	1002	65	Bob
1985	Aug	LA, 1	1	987	80	Danny
1985	Sep	AL, 3; MS, 3; FL, NW3	3	959	100	Elena
1985	Sep	NC, 3; NY,3; CT,2; NH,2; ME,1	3	942	90	Gloria
1985	Oct	LA, 1	1	971	75	Juan
1985	Nov	FL, NW2; I-GA 1	2	967	85	Kate
1986	Jun	TX, N1	1	990	75	Bonnie
1986	Aug	NC, 1	1	990	65	Charley
1987	Oct	FL, SW1	1	993	65	Floyd
1988	Sep	LA, 1	1	984	70	Florence
1989	Aug	TX, N1	1	986	70	Chantal
1989	Sep	SC, 4; I-NC 1	4	934	120	Hugo
1989	Oct	TX, N1	1	983	75	Jerry
1991	Aug	RI, 2; MA, 2; NY, 2; CT, 2	2	962	90	Bob
1992	Aug	FL, SE5, SW4; LA, 3	5	922	145	Andrew
1993	Aug	* NC, 3	3	960	100	Emily
1995	Aug	FL, NW2, SE1	2	973	85	Erin
1995	Oct	FL, NW3, I-AL 1	3	942	100	Opal
1996	Jul	NC, 2	2	974	90	Bertha
1996	Sep	NC, 3	3	954	100	Fran
1997	Jul	LA, 1; AL, 1	1	984	70	Danny
1998	Aug	NC, 2	2	964	95	Bonnie
1998	Sep	FL, NW1	1	987	70	Earl
1998	Sep	FL, SW2; MS, 2	2	964	90	Georges
1999	Aug	TX, S3	3	951	100	Bret
1999	Sep	NC, 2	2	956	90	Floyd
1999	Oct	FL, SW1	1	987	70	Irene
2002	Oct	LA, 1	1	963	80	Lili
2003	Jul	TX, C1	1	979	80	Claudette
2003	Sep	NC, 2; VA, 1	2	957	90	Isabel
2004	Aug	* NC, 1	1	972	70	Alex
2004	Aug	FL, SW4, SE1, NE1; SC,1; NC,1	4	941	130	Charley
2004	Aug	SC, 1	1	985	65	Gaston
2004	Sep	FL, SE2, SW1	2	960	90	Frances
2004	Sep	AL, 3; FL, NW3	3	946	105	Ivan
2004	Sep	FL, SE3, SW1, NW1	3	950	105	Jeanne
2005	Jul	LA, 1	1	991	65	Cindy

2005	Jul	FL, NW3; I-AL 1	3	946	105	Dennis
2005	Aug	FL, SE1, SW1; LA, 3; MS, 3;	3	920	110	Katrina
''	''	AL, 1				
2005	Sep	* NC, 1	1	982	65	Ophelia
2005	Sep	FL, SW1; LA, 3; TX, N2	3	937	100	Rita
2005	Oct	FL, SW3; FL, SE2	3	950	105	Wilma
2007	Sep	TX, N1; LA, 1	1	985	80	Humberto
2008	Jul	TX, S1	1	967	75	Dolly
2008	Sep	LA, 2	2	954	90	Gustav
2008	Sep	TX, N2; LA, 1	2	950	95	Ike

Notes:

States Affected and Category by States Affected: The impact of the hurricane on individual U.S. states based upon the Saffir-Simpson Hurricane Wind Scale (through the estimate of the maximum sustained surface winds at each state). (TX S-South Texas, TX C-Central Texas, TX N-North Texas, LA-Louisiana, MS-Mississippi, AL-Alabama, FL NW-Northwest Florida, FL SW-Southwest Florida, FL SE-Southeast Florida, FL NE-Northeast Florida, GA-Georgia, SC-South Carolina, NC-North Carolina, VA-Virginia, MD-Maryland, DE-Delaware, NJ-New Jersey, NY-New York, PA-Pennsylvania, CT-Connecticut, RI-Rhode Island, MA-Massachusetts, NH-New Hampshire, ME-Maine. In Texas, south refers to the area from the Mexican border to Corpus Christi; central spans from north of Corpus Christi to Matagorda Bay; and north refers to the region from north of Matagorda Bay to the Louisiana border. In Florida, the north-south dividing line is from Cape Canaveral [28.45N] to Tarpon Springs [28.17N]. The dividing line between west and east Florida goes from 82.69W at the north Florida border with Georgia, to Lake Okeechobee and due south along longitude 80.85W.) Occasionally, a hurricane will cause a hurricane impact (estimated maximum sustained surface winds) in an inland state. To differentiate these cases versus coastal hurricane impacts, these inland hurricane strikes are denoted with an "I" prefix before the state abbreviation. States that have been so impacted at least once during this time period include Alabama (IAL), Georgia (IGA), North Carolina (INC), Virginia (IVA), and Pennsylvania (IPA). The entire Florida peninsula, by the nature of its relatively small landmass, is considered as coastal in this database.

Highest U.S. Saffir-Simpson Category: The highest Saffir-Simpson Hurricane Wind Scale impact in the United States based upon estimated maximum sustained surface winds produced at the coast.

Central Pressure: The observed (or analyzed from peripheral pressure measurements) central pressure of the hurricane at landfall.

Maximum Winds: Estimated maximum sustained (1-min) surface (10-m) winds occurring along the U. S. coast. Winds are estimated to the nearest 10 kt for the period of 1851 to 1885 and to the nearest 5 kt since 1886. (1 kt = 1.15 mph.)

* - Indicates that the hurricane center did not make a U.S. landfall (or substantially weakened before making landfall), but did produce the indicated hurricane force winds over land. In this case, central pressure is given for the hurricane's point of closest approach.

& - Indicates that the hurricane center did make a direct landfall, but that the strongest winds likely remained offshore. Thus the winds indicated here are lower than in HURDAT.

- Indicates that the hurricane made landfall over Mexico, but also caused sustained hurricane force surface winds in Texas. The strongest winds at landfall impacted Mexico, while the weaker maximum sustained winds indicated here were conditions estimated to occur in Texas. Indicated central pressure given is that at Mexican landfall.

Additional Note: Because of the sparseness of towns and cities before 1900 in some coastal locations along the United States, the above list is not complete for all states. Before the Gulf of Mexico and Atlantic coasts became settled, hurricanes may have been underestimated in their intensity or missed completely for small-sized systems (e.g., 2004's Hurricane Charley). The following list provides estimated dates when more complete tropical cyclone records began for specified regions of the United States based upon U.S Census reports and other historical analyses. Years in parenthesis indicate possible starting dates for more complete records and if that year is before the 1850s then data may be available with additional research:
Texas-south > 1880, Texas-central > 1851, Texas-north > 1860, Louisiana > 1880, Mississippi > 1851, Alabama < 1851 (1830), Florida-northwest > 1880, Florida-southwest > 1900, Florida-southeast > 1900, Florida-northeast > 1880, Georgia < 1851 (1800), South Carolina < 1851 (1760), North Carolina < 1851 (1760), Virginia < 1851 (1700), Maryland < 1851 (1760), Delaware < 1851 (1700), New Jersey < 1851 (1760), New York < 1851 (1700), Connecticut < 1851 (1660), Rhode Island < 1851 (1760), Massachusetts < 1851 (1660), New Hampshire < 1851 (1660), and Maine < 1851 (1790).

Appendix B—

Other major changes since the last edition (excluding the inclusion of NFIP flood numbers for 1995-present):

Celia (1970)—The original estimate of $434 million has been replaced by an estimate of $930 million. The insured losses for Celia according to PCS were about $310 million. In storms of that era (1965-1974), insurance rates of coverage for property were lower than today. In addition, most final estimates of damages were between 2.6 and 20 times the insured losses reported by PCS. Given the low coverage rates, the severe wind intensity and the historical average, the previous estimate of $434 million appears to be a gross underestimate. The new damage estimate is a tripling of the insured losses, which were about $310 million, leaving a new total of $930 million.

Georges (1998)—The previous version of this document erroneously contained only the insured loss estimate, not the standard doubled estimate—this only corrects an error from the last edition—the NHC estimate is unchanged.

Bonnie (1986)—The NHC official estimate was $2 million, which is far below the PCS estimate of $21 million and likely based on preliminary estimates. A standard doubling of the insured loss leads to an estimate of $42 million for Bonnie. This also changes the total damage for 1986 from $17 million to $57 million.

Florence (1988)—The NHC official estimate was $2.5 million, which is below the PCS estimate of $10 million and was likely based on preliminary estimates. A standard doubling of the insured loss leads to an estimate of $20 million for Florence.

Gilbert (1988)—The NHC official estimate was $50 million, but PCS has $40 million in insured losses. For consistency, doubling the insured loss totals for that storm leads to a final NHC estimate of $80 million dollars for Gilbert. This also increases the 1988 yearly estimate (with Florence) by an additional $47 million.

Edouard (1996)—The NHC estimate was for minor unspecified damage, but PCS has $10 million for estimated insured property losses. A standard doubling yields $20 million in total damages. This also caused a small upward increase in yearly losses for 1996.

Updated PCS insurance numbers were available for several 2004 hurricanes.