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North Atlantic Basin Tropical Cyclone Activity in Relation to Temperature and Decadal-Length Oscillation Patterns

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June 2009

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LIST OF ABBREVIATIONS AND ACRONYMS

2-mma	2-mo moving average
10-yma	10-yr moving average
<AT>	average Armagh Observatory temperature
B	before
cl	confidence level
Class.	classification
CSU	Colorado State University
Dur	duration
EA	East Atlantic
<EA>	average East Atlantic
EN	El Niño
ENSO	El Niño-Southern Oscillation
ERSST.v3b	extended reconstructed sea surface temperature, version 3b
fd	first difference
FSD	first storm day
GL	genesis location
H	hurricane
LAT	latitude
<LAT>	average latitude
LN	La Niña
LONG	longitude
<LONG>	average longitude
LP	lowest pressure
<LP>	average lowest pressure
M	moderate
max	maximum
MH	major hurricane
MSFC	Marshall Space Flight Center
NAO	North Atlantic Oscillation

LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

<NAO>	average North Atlantic Oscillation
NASA	National Aeronautics and Space Administration
NENM	number of El Niño months
NH	number of hurricanes
NLNM	number of La Niña months
NMH	number of major hurricanes
NNM	number of neutral months
NOAA	National Oceanic and Atmospheric Administration
NTC	number of tropical cyclones
NUSLFH	number of U.S. land-falling hurricanes
ONI	Oceanic Niño Index
<ONI>	average Oceanic Niño Index
P	proportion
PWS	peak wind speed
<PWS>	average peak wind speed
S	strong
SNBR	storm number (from best track data)
SOI	Southern Oscillation Index
<SOI>	average Southern Oscillation Index
SS	subtropical storm
TS	tropical storm
TSR	tropical storm risk
U.S.	United States
USLFH	U.S. land-falling hurricane
W	weak

NOMENCLATURE

d	first-difference deviation
f	frequency
m	mean
N	number
$P(r)$	probability of r events occurring using Poisson distribution
R	coefficient of correlation for bi-variate fit
$R \times R$	coefficient of determination for bi-variate fit
r	coefficient of linear correlation or number of events in Poisson distribution
$r \times r$	coefficient of determination
sd	standard deviation
SE	standard error of estimate for bi-variate fit
se	standard error of estimate

TECHNICAL PUBLICATION

NORTH ATLANTIC BASIN TROPICAL CYCLONE ACTIVITY IN RELATION TO TEMPERATURE AND DECADAL-LENGTH OSCILLATION PATTERNS

1. INTRODUCTION

Previously, an extended forecast of the frequencies of tropical cyclone activity for the 2009 North Atlantic basin hurricane season was given.[1] Three conclusions resulting from that study were (1) continued increased activity exceeding long-term averages should be expected during the 2009 hurricane season, (2) temperature now appears to be the principal driver of the increased activity and storm strength, especially during the current interval of high activity (1995–2008), and (3) near-record values are possible during the 2009 hurricane season, especially if warming continues unabated and El Niño (EN) does not recur. Based on the current high-activity interval, the central 50% frequencies for numbers of tropical cyclones, hurricanes, and major (or intense) hurricanes were found to be, respectively, about 12–18, 6–10, and 3–5, with only a 5% chance of exceeding 23, 13, or 7, respectively, during the 2009 hurricane season.

In the previous study, the role of decadal-length oscillation was examined using the Oceanic Niño Index (ONI), which is derived from the Extended Reconstructed Sea Surface Temperature, version 3 (ERSST.v3). The ONI is a 3-mo running mean of the sea-surface temperature anomalies of the Niño 3.4 region, located between 5° N. and 5° S. latitude and 120° W. and 170° W. longitude, and based on the 1971–2000 base period.[2] It is updated monthly and has become the de facto means for defining the occurrences of warm EN and cold La Niña (LN) events. Because the ERSST.v3 data set has recently (in December 2008) been superseded by ERSST.v3b and will no longer be updated, it seems prudent to repeat the analyses using the newer ONI values. Also, it seems prudent to examine other indices, like the Southern Oscillation Index (SOI), the North Atlantic Oscillation (NAO) index, and the East Atlantic (EA) index, as well, for determining possible effects of decadal-length oscillation on the expected frequencies of North Atlantic basin tropical cyclones, especially for the upcoming 2009 hurricane season.

Additionally, in the previous study, the 2008 frequencies of North Atlantic basin tropical cyclone activity were taken directly from the yearend National Hurricane Center's Tropical Cyclone Reports,[3] which are found to differ slightly from the recently published Atlantic tracks file 1851–2008.[4] For example, whereas tropical cyclone Laura was described as a tropical storm having peak wind speed (PWS) equal to 50 kt in the yearend report, according to the best track file, it now is classified as a hurricane having PWS = 70 kt. Other slight differences are also found for several of the other tropical cyclones as well. Because the best tracks data file was employed for the interval of 1950–2007, to be consistent, the analyses of the former study will be repeated here using the best tracks data including the year 2008.

In this NASA Technical Publication, the frequencies of North Atlantic basin tropical cyclones, hurricanes, major hurricanes, and U.S. land-falling hurricanes for the interval 1950–2008 are examined, hopefully, leading to a more refined prediction for the 2009 hurricane season. Also examined are PWS, average PWS (<PWS>), lowest pressure (LP), average LP (<LP>), and the genesis location (average latitude <LAT> and longitude <LONG>; i.e., the average latitudinal and longitudinal position of the yearly tropical cyclones when first attaining sustained winds of 34 kt or greater) of the tropical cyclones, as well as the first differences of their 10-year moving average (10-yma) values. Linear regression analyses between the 10-yma values of the aforementioned parameters against 10-yma values of surface-air temperature as measured at the Armagh Observatory in Northern Ireland (<AT>) and against 10-yma values of ONI, SOI, NAO, and EA are also investigated, as well as bi-variate regression analyses using combinations of temperature and pressure indices. This study is a continuation of climate-related investigations that have been performed at Marshall Space Flight Center (MSFC) over the past decade concerning North Atlantic basin tropical cyclones, El Niño-Southern Oscillation (ENSO), and other climate-related topics.[1,5–18]

2. RESULTS AND DISCUSSION

2.1 Tropical Cyclone Frequencies (1950–2008)

Figure 1 displays the yearly frequencies of North Atlantic basin tropical cyclones for the interval 1950–2008: (a) The number of tropical cyclones (NTC), (b) the number of hurricanes (NH), (c) the number of major hurricanes (NMH), (d) the number of U.S. land-falling hurricanes (NUSLFH), and (e) the number of El Niño and La Niña months (NENM and NLNM, respectively) based on the ONI values using ERSST.v3b. In figure 1(a)–(d), the thin, jagged line represents the actual yearly counts and the thick, smoothed line represents the 10-yma (or trend line). The total number of events is displayed for each grouping in the left portion of each subpanel. It should be noted that NH now numbers 371, as compared to 369 in the previous publication.[1] The higher number reflects the change in status for Laura in 2008 (from tropical storm to hurricane) and for Keith in 1988 listed in the best tracks file as a tropical storm, yet having PWS = 65 kt, thus making it a hurricane by the standard used in this study. (Namely, if the PWS during the best tracks window of observations meets or exceeds 64 kt, it will be counted as a hurricane, and if the PWS meets or exceeds 96 kt, it will be counted as a major hurricane.) Also displayed is a thin, horizontal line that represents the mean for the entire interval, and the standard deviation (*sd*), whose values appear to the right in each subpanel (a)–(d). Thus, for the interval 1950–2008, on average, there have been 10.8 tropical cyclones, 6.3 hurricanes, 2.7 major hurricanes, and 1.6 U.S. land-falling hurricanes occurring in any given year (season).

To the extreme right of subpanels (a)–(d) are the frequency distributions. Hence, the primary modes are 8 and 11 for NTC, 4 for NH, 2 for NMH, and 1 for NUSLFH. Noticeable in each subpanel is that the parametric trend line (i.e., the 10-yma values) is now above the long-term average, beginning in the 1990s. The highest NTC (28) occurred in 2005, while the lowest (4) occurred in 1983. Similarly, the highest NH (15) occurred in 2005, while the lowest (2) occurred in 1983. The highest NMH (8) occurred in 1950, while no major hurricanes occurred in 1968, 1972, 1986, and 1994. The highest NUSLFH (6) occurred in 1985, 2004, and 2005, while no U.S. land-falling hurricanes occurred in 1951, 1962, 1973, 1978, 1981, 1982, 1990, 1994, 2000, 2001, and 2006. All distributions are rightward (or positively) skewed.

On the basis of the behavior of NMH, it can be argued that the overall interval of 1950–2008 can be subdivided into two high-activity intervals (1950–1965 and 1995–2008) separated by one low-activity interval (1966–1994). During the current high-activity interval, 12 of 14 years have had NTC above its long-term mean (10.8), averaging instead ≈14.9 per year ($sd = 4.7$; range 8 to 28). Similarly, 11 of 14 years have had NH above its long-term mean (6.3), averaging ≈8.1 per year ($sd = 3$; range 3 to 15), and 10 of 14 years have had NMH above its long-term mean (2.7), averaging ≈3.9 per year ($sd = 1.8$; range 1 to 7). Eight of 14 years have had NUSLFH above its long-term mean (1.6), averaging 2.1 per year ($sd = 2$; range zero to 6). Thus, the current high-activity interval has averaged ≈5.3 additional tropical cyclones, ≈2.7 additional hurricanes, ≈2.3 additional major hurricanes, and ≈0.8 additional U.S. land-falling hurricanes, as compared to the preceding low-activity interval.

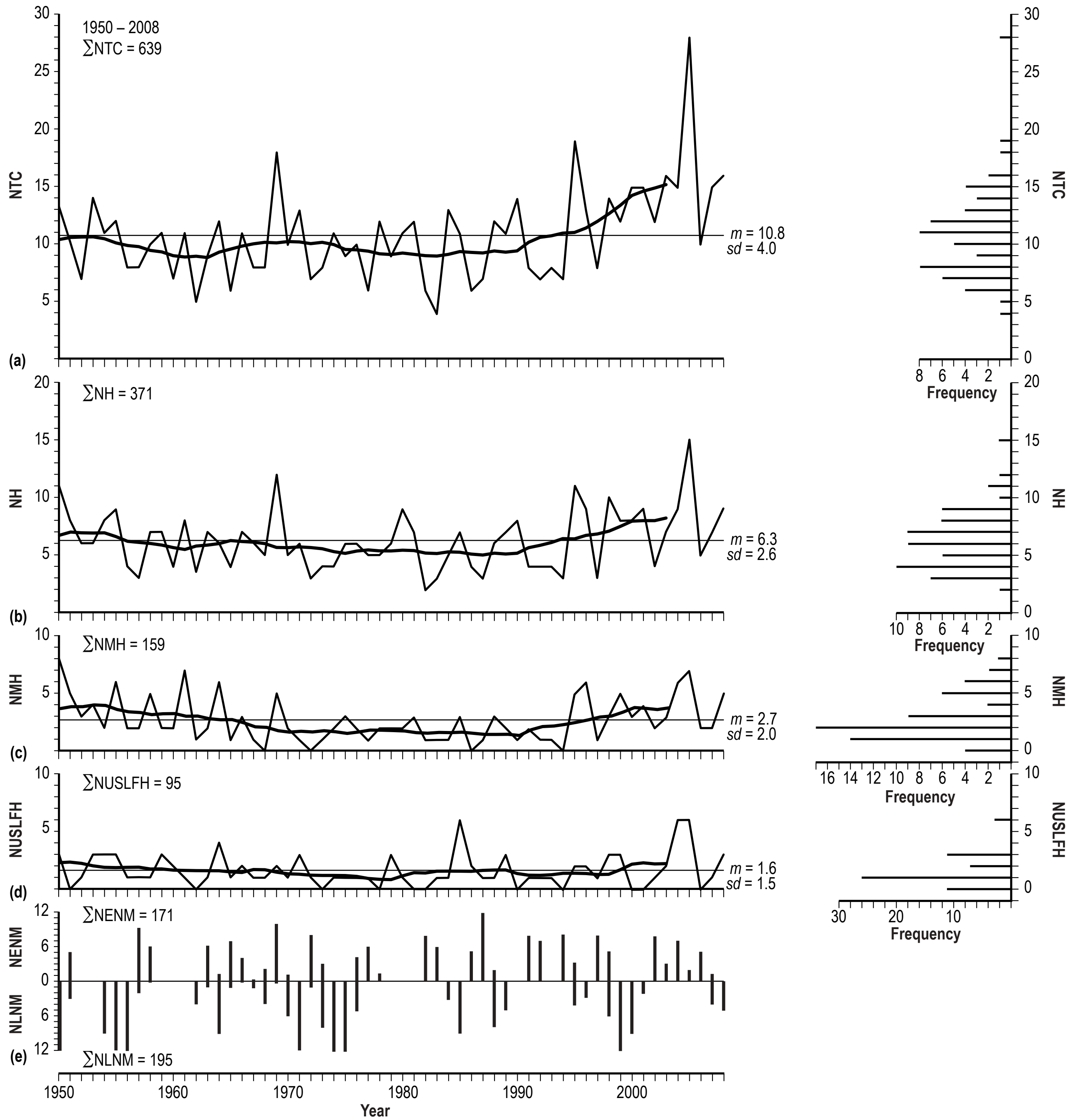

Figure 1. Yearly variation of (a) NTC, (b) NH, (c) NMH, (d) NUSLFH, and (e) NENM and NLNM for the interval 1950–2008. Also given is the frequency distribution for (a)–(d).

Concerning the occurrences of EN and LN (fig. 1(e)), overall, there have been 171 NENM and 195 NLNM, implying 342 ENSO-neutral months. Thus, about half the time, ENSO-neutral conditions have prevailed, while about one-quarter of the time each, an extreme in the ENSO cycle has occurred. During the current high-activity interval (1995–2008), there have been 81 ENSO-neutral months, 45 NLNM, and 42 NENM. During the first high-activity interval (1950–1965; actually the beginning of this supposed high-activity interval occurs before 1950), there were 94 ENSO-neutral months, 64 NLNM, and 34 NENM, while during the low-activity interval (1966–1994), there were 167 ENSO-neutral months, 86 NLNM, and 95 NENM. Thus, during the combined high-activity intervals (of about the same length as the low-activity interval), there have been 175 ENSO-neutral months, 109 NLNM, and 76 NENM. It appears then that during high-activity intervals, there seems to be somewhat greater likelihood of having more LN months and fewer EN months, while during low-activity intervals, the reverse seems true. More will be said of EN and LN events in a later section.

Table 13 provides the basic information utilized in this study, spanning the interval 1945–2008, so that 10-yma values can be constructed for interpretation (1950–2003). Because of its length, it is placed in the appendix to avoid interruption of the flow in the presentation of the results of this study. The table is arranged by year and storm number (SNBR) adapted from the aforementioned best tracks data.[4] Given is the name of the tropical cyclone (otherwise, coded “unnamed”); its classification, where TS means tropical storm (i.e., 34 kt ≤ PWS < 64 kt), H means hurricane (i.e. 64 kt ≤ PWS < 96 kt), and MH means major hurricane (i.e., PWS ≥96 kt); the first storm day (FSD, meaning the first calendar month/day in the best tracks data when the sustained wind speed equaled or exceeded 34 kt); the genesis location (GL) in terms of N. latitude and W. longitude (meaning the latitude and longitude of the tropical cyclone on FSD, expressed in degrees north and west, respectively); the group location (meaning the general area of the North Atlantic basin where the GL is located, where 1 refers to the Gulf of Mexico area, 2 refers to the Caribbean Sea area, 3 refers loosely to the east coastal area—north of Hispaniola and westward from just east of Bermuda, 4 refers to the lower North Atlantic basin-Cape Verdi area, and 5 is the open North Atlantic basin area); the PWS (meaning the peak wind speed in knots during the window of observations contained in the best tracks data); the LP (meaning the lowest pressure in millibars during the window of observations contained in the best track data); and the USLFH (meaning the state or states where the U.S. land-falling hurricane struck and the strength of the U.S. land-falling hurricane based on the Saffir-Simpson hurricane scale.[19] Occasionally, the term SS (for subtropical storm) is used in the classification column. However, based upon the reported PWS during the window of observations in the best track file, the term TS or H appears beside SS to show how the tropical cyclone was counted in this study. Concerning the USLFH column, it is important to remember that tropical cyclones classified as category 3 or higher strike the U.S. coast as major hurricanes (peak sustained winds in excess of 95 kt). Only Camille in 1969 and Andrew in 1992 struck the U.S. coastline as category 5 tropical cyclones. The devastation of Katrina in 2005 (a category 3 storm at landfall) took the lives of about 1,500 people and is the costliest hurricane to date, costing more than $84 billion in 2006 dollars; see http://www.nhc.noaa.gov/Deadliest_Costliest.shtml.[20] The second costliest hurricane is Andrew in 1992, costing more than $48 billion in 2006 dollars. For each year, a summary is provided, giving NTC, NH, NMH, NUSLFH, PWS, <PWS>, LP, <LP>, and the average GL of all tropical cyclones in the year, in terms of N. latitude and W. longitude.

Table 1 provides the record of yearly counts of NTC, NH, NMH, and NUSLFH that are plotted as the thin, jagged line in figure 1, and NLNM, NNM (i.e., the number of ENSO-neutral months), and NENM. It also provides yearly values of PWS and LP and yearly averages of <LAT>, <LONG>, <PWS>, <LP>, <ONI>, <AT>, <SOI>, <NAO>, and <EA> that will be plotted in later figures, and it provides the names of those tropical cyclones having PWS ≥140 kt during the interval of 1945–2008. Similarly, table 2 provides the record of yearly 10-yma values for each of the parameters that are plotted as the thick, smoothed lines in the appropriate figures (1950–2003).

Table 2 and figure 1 clearly show that the trend lines for NTC, NH, NMH, and NUSLFH are now above their long-term averages. In fact, for NTC, the value for 2003 (15.3) is more than 40% higher than the largest value seen in the 1950s (10.6 in 1952 and 1953) and ≈70% higher than the lowest value seen in the low-activity interval. For NH, its 2003 value (8.2) is ≈17% higher than its peak value in the 1950s (7 in 1951) and more than 60% higher than the lowest value seen in the low-activity interval. For NMH, its 2003 value (3.8) is comparable to the highest value seen in the 1950s (4 in 1953 and 1954), which is also true for NUSLFH (2003, having a value of 2.2, and 1950 and 1951, having a value of 2.3), both being more than 140% higher than the lowest values seen in the low-activity interval. Comparisons for the other parameters will be discussed in later sections.

Table 3 shows the Poisson distributions[1,21] for NTC, NH, NMH, and NUSLFH. The central 50% intervals are about 8–12 for NTC (actually 55.4%), 4–7 for NH (actually 57.5%), 1–3 for NMH (actually 64.7%), and 1–2 for NUSLFH (actually 58.1%). Concerning NUSLFH, while there is about a 20.2% probability of having no U.S. land-falling hurricanes during any given season, there is about a 21.5% probability of having 3 or more U.S. land-falling hurricanes.

Table 4 gives the frequency of U.S. land strikes by state for the three time intervals, 1950–1965, 1966–1994, and 1995–2008, and for the entire interval 1950–2008. Clearly, the state of Florida has the highest number of land strikes, accounting for more than 28% of all land strikes. This is not unexpected owing to Florida's long coastline and being a peninsula between the Gulf of Mexico and the North Atlantic Ocean. The number of strikes on Florida has actually increased with the passage of time, from 11 in the first interval to 21, so far, in the current interval. North Carolina, Louisiana, and Texas round out the top double-digit, land-struck states that together with Florida, account for two-thirds of all land strikes by hurricanes in the United States during the interval 1950–2008.

Although there were 95 U.S. land-falling hurricanes during 1950–2008, they accounted for 159 separate land strikes. Many of the U.S. land-falling hurricanes obviously had multiple land strikes. For example, Donna in 1960 had eight land strikes as it went up the eastern seaboard. Table 5 provides a convenient listing of U.S. land-falling hurricanes for 1945–2008. In 2008, there were three U.S. land-falling hurricanes, including Dolly, Gustav, and Ike.

2.2 Latitudinal and Longitudinal Variation of Tropical Cyclones

Figure 2 displays the yearly average latitudinal (fig. 2(a)) and longitudinal (fig. 2(b)) position of the combined tropical cyclones as determined from their GL values. Essentially, it maps the yearly variation of their centroid positions. The construction of the plots follows that of figure 1, with the thin, jagged lines representing the yearly averages and the thick, smoothed lines

Table 1. Summary of yearly values for North Atlantic basin tropical cyclones.

Year	NTC	NH	NMH	NUSLFH	GL		PWS	<PWS>	LP	<LP>	<ONI>	NLNM	NNM	NENM	<AT>	<SOI>	<NAO>	<EA>	Comment
					<Lat>	<Long>													
1945	11	5	3	3	17.5	75.2	120	72.7	951	974.8	–	–	–	–	10.29	4.59	–	–	
1946	6	3	1	1	23.1	82.6	115	63.3	975	977.0	–	–	–	–	9.23	–6.71	–	–	
1947	9	5	2	3	19.2	72.4	140	73.3	947	969.7	–	–	–	–	9.15	2.31	–	–	Unnamed
1948	9	6	4	3	19.1	68.4	115	78.9	963	983.5	–	–	–	–	9.71	–1.17	–	–	
1949	13	7	3	3	19.2	66.2	130	74.6	954	979.7	–	–	–	–	10.32	–1.11	–	–	
1950	13	11	8	3	19.7	62.1	160	100.4	955	964.0	–1.06	12	0	0	9.17	15.38	–0.12	0.14	Dog
1951	10	8	5	0	19.7	63.3	140	89.0	964	964.0	0.09	3	4	5	8.95	–0.69	–0.01	0.03	Easy
1952	7	6	3	1	16.4	63.9	130	92.9	934	976.7	–0.03	0	12	0	8.81	–2.28	–0.43	–0.25	
1953	14	6	4	3	18.8	66.2	130	74.6	929	979.3	0.42	0	12	0	9.87	–6.80	–0.02	–0.27	
1954	11	8	2	3	21.8	69.7	120	75.5	937	973.3	–0.63	9	3	0	9.15	4.08	0.00	–0.42	
1955	12	9	6	3	18.6	60.0	150	92.1	914	951.4	–1.24	12	0	0	9.49	10.58	–0.40	–0.44	Janet
1956	8	4	2	1	22.0	79.4	120	73.8	954	986.9	–0.80	12	0	0	9.37	10.73	–0.04	–0.84	
1957	8	3	2	1	23.6	75.7	135	72.5	945	979.0	0.69	1	2	9	9.83	–3.89	–0.20	–0.53	
1958	10	7	5	1	17.8	59.8	140	89.5	934	977.0	0.61	0	6	6	9.45	–3.20	–0.59	0.20	Cleo
1959	11	7	2	3	24.5	75.9	120	71.4	950	987.4	–0.06	0	12	0	10.20	–0.04	0.35	0.11	
1960	7	4	2	2	21.4	71.2	140	82.1	932	971.7	–0.19	0	12	0	9.44	3.83	–0.41	0.06	Donna; Ethel
1961	11	8	7	1	19.5	61.5	150	97.7	920	957.0	–0.23	0	12	0	9.58	0.80	0.04	0.45	Carla; Hattie
1962	5	3	1	0	22.7	57.4	100	75.0	968	974.8	–0.47	4	8	0	8.76	5.40	–0.34	–0.54	
1963	9	7	2	1	19.7	60.1	125	81.1	944	979.1	0.40	1	5	6	8.57	–1.95	–0.42	–0.27	
1964	12	6	6	4	19.8	62.9	135	82.1	941	972.0	–0.62	9	2	1	9.49	6.28	–0.04	–0.05	
1965	6	4	1	1	22.8	63.5	135	76.7	941	973.3	0.64	1	4	7	8.82	–8.43	–0.13	–0.60	
1966	11	7	3	2	20.9	57.4	130	74.1	929	983.6	0.26	0	8	4	9.38	–4.24	–0.33	–0.11	
1967	8	6	1	1	20.1	56.3	140	79.4	923	976.0	–0.35	1	11	0	9.40	3.20	0.37	–0.33	Beulah
1968	8	5	0	1	27.1	72.9	75	63.8	965	986.1	–0.03	4	6	2	9.32	3.02	–0.94	–0.09	
1969	18	12	5	2	24.0	65.5	165	80.0	905	979.4	0.69	0	2	10	8.93	–5.38	–0.06	–0.11	Camille
1970	10	5	2	1	24.4	74.1	110	72.5	945	986.0	–0.36	6	5	1	9.28	3.93	–0.25	0.27	
1971	13	6	1	3	25.1	69.3	140	70.4	943	984.9	–0.95	12	0	0	9.72	10.95	0.01	–0.68	
1972	7	3	0	1	32.2	67.5	90	65.0	944	982.6	0.84	1	3	8	8.74	–7.35	0.51	–0.41	Edith
1973	8	4	1	0	22.8	63.8	100	68.8	962	982.3	–0.64	8	1	3	9.33	7.28	–0.09	0.11	
1974	11	4	2	1	24.7	69.5	130	67.7	928	990.1	–0.97	12	0	0	8.94	9.90	0.18	–0.33	
1975	9	6	3	1	27.7	61.8	120	83.9	939	971.9	–1.14	12	0	0	9.69	13.60	–0.07	–0.46	
1976	10	6	2	1	25.0	65.2	105	70.5	957	982.1	–0.15	5	3	4	9.33	1.11	0.19	–1.04	

Table 1. Summary of yearly values for North Atlantic basin tropical cyclones (Continued).

Year	NTC	NH	NMH	NUSLFH	GL <Lat>	GL <Long>	PWS	<PWS>	LP	<LP>	<ONI>	NLNM	NNM	NENM	<AT>	<SOI>	<NAO>	<EA>	Comment
1977	6	5	1	1	28.1	77.4	150	79.2	926	982.2	0.45	0	6	6	8.92	–9.90	–0.34	0.37	Anita
1978	12	5	2	0	23.6	64.8	120	66.3	947	987.9	–0.15	0	11	1	9.21	–1.65	0.32	0.10	
1979	9	6	2	3	20.5	63.2	150	76.1	924	977.4	0.16	0	12	0	8.35	–1.91	0.14	0.38	David
1980	11	9	2	1	23.8	54.1	165	83.2	899	976.1	0.14	0	12	0	9.11	–3.08	–0.41	0.05	Allen
1981	12	7	3	0	23.2	61.3	115	75.0	946	981.8	–0.32	0	12	0	9.09	1.80	–0.15	0.26	
1982	6	2	1	0	23.8	70.7	115	71.3	950	983.2	0.95	0	4	8	9.43	–13.05	0.43	0.46	
1983	4	3	1	1	28.6	75.9	100	72.5	963	985.5	0.47	0	6	6	9.77	–8.33	0.31	0.38	
1984	13	5	1	1	25.3	63.0	115	61.9	949	988.8	–0.45	3	9	0	9.29	–0.11	0.25	–0.18	
1985	11	7	3	6	25.2	71.6	125	78.2	920	977.4	–0.58	9	3	0	8.70	0.86	–0.18	0.36	
1986	6	4	0	2	24.3	69.3	90	67.5	979	991.7	0.28	0	7	5	8.57	–2.38	0.50	0.51	
1987	7	3	1	1	19.2	56.8	110	59.3	958	992.1	–1.29	0	0	12	9.07	–13.08	–0.12	0.28	
1988	12	6	3	1	21.6	64.6	160	73.3	888	972.8	–0.83	8	2	2	9.65	7.82	–0.01	0.27	Gilbert
1989	11	7	2	3	18.1	56.8	135	78.6	923	976.5	–0.63	5	7	0	10.07	6.77	0.70	0.19	
1990	14	8	1	0	19.7	52.2	105	65.4	956	986.9	0.25	0	12	0	9.93	–2.19	0.59	0.33	
1991	8	4	2	1	27.4	62.2	115	68.1	946	980.6	0.80	0	4	8	9.42	–8.78	0.27	–0.11	
1992	7	4	1	1	27.4	58.6	150	81.4	922	974.4	0.76	0	5	7	9.45	–10.38	0.58	0.25	Andrew
1993	8	4	1	1	20.4	63.1	100	61.3	960	986.9	0.47	0	12	0	9.27	–9.47	0.18	–0.27	
1994	7	3	0	0	18.3	62.1	95	65.0	972	989.6	0.62	0	4	8	9.32	–11.93	0.58	0.79	
1995	19	11	5	2	18.8	61.7	130	76.3	919	973.4	0.08	4	5	3	10.22	–2.27	–0.08	–0.31	
1996	13	9	6	2	16.2	62.3	125	80.4	933	971.1	–0.29	3	9	0	9.22	5.69	–0.21	0.10	
1997	8	3	1	1	27.0	70.5	110	56.3	946	990.8	1.26	0	4	8	10.32	–11.67	–0.16	0.30	
1998	14	10	3	3	19.2	57.5	155	83.2	905	971.4	0.09	6	1	5	10.09	–1.08	–0.48	0.93	Mitch
1999	12	8	5	3	17.5	64.1	135	91.3	921	964.7	–1.06	12	0	0	10.18	7.95	0.39	0.25	
2000	15	8	3	0	20.8	62.2	120	71.3	941	979.5	–0.74	9	3	0	9.93	7.80	0.21	0.59	
2001	15	9	4	0	22.2	63.4	125	75.6	934	979.5	–0.12	2	10	0	9.57	0.53	–0.18	0.75	
2002	12	4	2	1	26.2	69.9	125	65.0	934	984.6	0.78	0	4	8	10.20	–6.10	0.04	0.85	
2003	16	7	3	2	22.0	64.0	145	70.3	915	981.8	0.48	0	9	3	10.02	–3.14	0.10	0.84	Isabel
2004	15	9	6	6	19.7	57.4	145	82.3	912	971.7	0.56	0	5	7	10.21	–4.82	0.24	0.15	Ivan
2005	28	15	7	6	22.5	66.8	160	76.8	882	974.4	0.21	0	10	2	10.24	–3.63	–0.27	0.45	Emily; Katrina; Rita; Wilma
2006	10	5	2	0	21.9	56.6	105	68.5	955	981.2	0.25	0	7	5	10.43	–1.93	–0.21	0.84	
2007	15	7	2	1	22.1	64.7	150	68.3	907	981.9	–0.30	4	7	1	10.59	1.45	0.17	0.45	Dean
2008	16	9	5	3	19.9	63.0	125	78.4	935	976.9	–0.56	5	7	0	9.78	10.17	–0.38	0.37	

Table 2. Summary of 10-yma values for North Atlantic basin tropical cyclones.

Year	NTC	NH	NMH	NUSLFH	GL		PWS	<PWS>	LP	<LP>	<AT>	<ONI>	<SOI>	<NAO>	<EA>
					<LAT>	<LONG>									
1950	10.4	6.7	3.7	2.3	19.5	68.2	131.5	80.5	949.1	973.0	9.43	–	1.06	–	–
1951	10.5	7.0	3.9	2.3	19.5	67.3	133.3	82.0	946.2	972.4	9.39	–	2.23	–	–
1952	10.6	6.9	3.9	2.2	19.7	67.3	133.3	82.5	945.0	973.3	9.43	–	2.79	–	–
1953	10.6	6.9	4.0	2.0	19.8	67.1	134.3	83.0	943.5	973.5	9.45	–	2.38	–	–
1954	10.5	6.9	4.0	1.9	20.0	67.1	135.0	83.3	941.8	973.5	9.44	–	2.33	–	–
1955	10.1	6.6	3.6	1.9	20.4	68.1	133.5	82.3	940.5	974.3	9.44	–0.16	1.81	–0.16	–0.23
1956	9.9	6.2	3.4	1.9	20.5	68.4	133.0	81.8	937.1	974.3	9.49	–0.13	1.31	–0.17	–0.21
1957	9.8	6.1	3.4	1.9	20.8	68.0	132.0	81.3	936.6	973.9	9.52	–0.17	1.77	–0.17	–0.21
1958	9.5	6.0	3.2	1.7	21.1	67.4	130.3	80.7	939.1	973.8	9.45	–0.19	2.39	–0.18	–0.22
1959	9.3	5.9	3.3	1.7	21.1	66.7	130.8	81.4	940.0	973.7	9.40	–0.19	2.74	–0.20	–0.20
1960	9.0	5.6	3.3	1.6	21.2	66.6	130.8	81.0	941.6	974.7	9.38	–0.10	1.90	–0.19	–0.19
1961	8.9	5.5	3.1	1.6	21.3	65.6	130.5	80.2	941.7	975.7	9.35	0.05	0.20	–0.19	–0.16
1962	9.0	5.8	3.1	1.6	21.1	63.6	131.3	80.6	939.3	975.3	9.33	0.05	–0.19	–0.18	–0.12
1963	8.9	5.9	2.8	1.6	21.4	63.3	128.3	79.6	939.8	975.6	9.30	–0.03	0.48	–0.17	–0.12
1964	9.2	6.0	2.7	1.6	21.8	63.4	127.3	78.8	939.1	975.7	9.23	–0.03	0.52	–0.21	–0.15
1965	9.7	6.3	2.8	1.5	22.0	63.0	128.0	78.7	937.5	976.0	9.16	0.00	0.26	–0.22	–0.15
1966	9.9	6.2	2.5	1.5	22.4	63.6	126.0	76.9	939.3	978.1	9.16	–0.04	0.77	–0.21	–0.19
1967	10.1	6.1	2.2	1.7	23.1	64.4	125.0	75.0	939.2	979.9	9.17	–0.01	0.64	–0.17	–0.24
1968	10.2	6.0	2.1	1.7	23.8	65.1	123.3	73.9	938.9	980.5	9.20	0.00	0.46	–0.11	–0.22
1969	10.1	5.7	1.8	1.5	24.2	65.7	121.8	72.6	939.2	981.5	9.21	–0.07	1.11	–0.08	–0.21
1970	10.2	5.7	1.7	1.3	24.7	65.8	120.8	72.2	938.4	982.4	9.23	–0.18	2.39	–0.07	–0.22
1971	10.3	5.8	1.8	1.3	25.1	66.2	118.8	72.4	939.7	982.2	9.27	–0.29	3.76	–0.04	–0.26
1972	10.1	5.7	1.7	1.2	25.7	67.6	118.0	72.2	941.3	982.5	9.24	–0.27	3.37	–0.05	–0.27
1973	10.2	5.6	1.8	1.2	25.9	68.3	120.8	72.3	940.5	982.9	9.21	–0.23	2.48	–0.02	–0.23
1974	10.0	5.3	1.8	1.2	25.6	67.8	122.3	72.2	940.6	982.8	9.18	–0.26	2.42	0.05	–0.19
1975	9.6	5.2	1.6	1.2	25.4	66.7	124.3	72.6	939.2	982.2	9.14	–0.27	2.25	0.05	–0.18
1976	9.6	5.5	1.7	1.1	25.3	65.3	125.8	73.3	937.1	981.6	9.10	–0.21	1.44	0.04	–0.14
1977	9.5	5.5	1.9	0.9	24.7	65.0	125.8	73.9	937.5	981.5	9.11	–0.17	0.70	0.02	–0.05
1978	9.2	5.4	1.9	0.9	24.6	65.8	127.0	74.4	937.9	981.7	9.16	–0.11	–0.37	0.04	0.00
1979	9.1	5.4	1.9	0.9	24.9	66.1	126.3	74.3	939.0	981.8	9.20	–0.03	–1.65	0.06	0.02
1980	9.3	5.5	1.8	1.2	24.8	66.2	125.8	73.7	939.1	982.0	9.17	0.02	–2.79	0.06	0.07
1981	9.2	5.4	1.7	1.5	24.7	66.9	125.3	73.3	939.2	982.7	9.08	0.07	–3.60	0.07	0.19

Table 2. Summary of 10-yma values for North Atlantic basin tropical cyclones (Continued).

Year	NTC	NH	NMH	NUSLFH	GL		PWS	<PWS>	LP	<LP>	<AT>	<ONI>	<SOI>	<NAO>	<EA>
					<LAT>	<LONG>									
1982	9.1	5.2	1.6	1.5	24.2	66.1	122.5	72.1	941.9	983.7	9.05	0.14	–3.93	0.10	0.26
1983	9.1	5.2	1.7	1.6	23.7	65.1	122.5	71.5	940.6	983.4	9.08	0.15	–3.62	0.09	0.27
1984	9.2	5.3	1.7	1.6	23.4	64.7	124.0	72.0	937.6	982.6	9.19	0.07	–2.71	0.10	0.27
1985	9.5	5.3	1.7	1.6	23.1	64.3	120.5	71.2	940.4	983.1	9.32	0.04	–2.23	0.18	0.27
1986	9.4	5.1	1.6	1.6	23.1	64.3	117.5	70.0	943.2	983.6	9.37	0.10	–2.72	0.25	0.27
1987	9.3	5.0	1.5	1.7	23.5	63.7	119.3	70.1	941.8	983.1	9.39	0.15	–3.11	0.28	0.24
1988	9.5	5.2	1.5	1.7	23.3	62.5	121.0	70.1	940.3	982.7	9.37	0.14	–3.04	0.28	0.20
1989	9.4	5.1	1.5	1.7	22.5	61.8	120.0	69.6	941.3	982.9	9.34	0.19	–3.69	0.29	0.21
1990	9.5	5.2	1.5	1.4	21.8	61.2	119.3	69.7	942.4	982.7	9.42	0.28	–4.43	0.31	0.23
1991	10.3	5.7	1.9	1.2	21.1	60.4	121.3	70.3	940.0	981.5	9.53	0.28	–4.19	0.28	0.17
1992	10.7	5.9	2.2	1.2	21.1	60.7	123.0	70.8	937.1	980.4	9.62	0.25	–3.71	0.25	0.15
1993	10.8	6.1	2.2	1.3	21.4	61.1	122.8	71.1	937.4	980.2	9.71	0.30	–4.09	0.22	0.19
1994	11.0	6.4	2.4	1.4	21.2	61.1	122.3	72.2	938.1	979.6	9.74	0.32	–4.47	0.18	0.22
1995	11.1	6.4	2.6	1.4	21.2	61.9	122.8	73.2	937.3	978.6	9.74	0.25	–3.91	0.15	0.24
1996	11.5	6.7	2.8	1.4	21.0	62.5	124.0	73.8	935.9	978.2	9.75	0.15	–2.95	0.11	0.30
1997	12.1	6.9	3.0	1.3	20.7	63.1	123.3	73.4	935.9	978.6	9.79	0.11	–2.27	0.06	0.37
1998	12.7	7.1	3.1	1.4	20.7	63.7	124.3	73.0	934.3	978.9	9.87	0.11	–1.74	0.03	0.45
1999	13.5	7.5	3.5	1.7	20.9	63.5	129.0	74.3	929.0	977.7	9.95	0.11	–1.07	0.00	0.48
2000	14.4	8.0	3.9	2.2	21.1	63.6	133.0	75.2	924.2	976.9	10.00	0.11	–0.78	–0.02	0.48
2001	14.7	8.0	3.8	2.3	21.6	63.5	133.5	74.7	923.4	977.5	10.06	0.14	–1.23	–0.03	0.56
2002	14.9	8.0	3.7	2.2	21.7	63.0	134.5	74.7	922.6	977.5	10.13	0.09	–0.95	–0.02	0.60
2003	15.3	8.2	3.8	2.2	21.4	62.9	135.0	75.0	922.1	977.3	10.13	–0.02	0.27	0.01	0.58

Table 3. Poisson distributions for NTC, NH, NMH, and NUSLFH based on 1950–2008 statistics.

Events	NTC	(m=10.8)	NH	(m=6.3)	NMH	(m=2.7)	NUSLFH	(m=1.6)
r	*f*	*P*(*r*)	*f*	*P*(*r*)	*f*	*P*(*r*)	*f*	*P*(*r*)
0	0	0.00002	0	0.00184	4	0.06721	11	0.20190
1	0	0.00022	0	0.01157	14	0.18145	26	0.32303
2	0	0.00119	1	0.03644	17	0.24496	7	0.25843
3	0	0.00428	7	0.07653	9	0.22047	11	0.13783
4	1	0.01156	10	0.12053	2	0.14882	1	0.05513
5	1	0.02498	6	0.15187	6	0.08036	0	0.01764
6	4	0.04496	9	0.15946	4	0.03616	3	0.00470
7	6	0.06937	9	0.14352	2	0.01395		
8	8	0.09365	6	0.11302	1	0.00471		
9	3	0.11238	6	0.07911	0	0.00141		
10	5	0.12137	1	0.04984	0	0.00038		
11	8	0.11916	2	0.02855	0	0.00009		
12	7	0.10724	1	0.01499	0	0.00002		
13	4	0.08909	0	0.00726	0	0.00000		
14	3	0.06873	0	0.00327				
15	4	0.04949	1	0.00137				
16	2	0.03340	0	0.00054				
17	0	0.02122	0	0.00020				
18	1	0.01273	0	0.00007				
19	1	0.00724	0	0.00002				
20	0	0.00391	0	0.00001				
21	0	0.00201	0	0.00000				
22	0	0.00099						
23	0	0.00046						
24	0	0.00021						
25	0	0.00009						
26	0	0.00004						
27	0	0.00001						
28	1	0.00001						
29	0	0.00000						

Note: m is the mean and $P(r)$ is the probability of r events occurring.

Table 4. Frequency of U.S. land strikes by state.

State	Interval			Total	Percent
	1950–1965	1966–1994	1995–2008		
AL	1	3	5	9	5.7
CT	2	3	0	5	3.1
FL	11	13	21	45	28.3
GA	0	2	0	2	1.3
LA	4	9	8	21	13.2
MA	2	1	0	3	1.9
MD	1	0	0	1	0.6
ME	3	2	0	5	3.1
MS	1	3	2	6	3.8
NC	8	6	8	22	13.8
NH	1	1	0	2	1.3
NY	2	4	0	6	3.8
RI	2	1	0	3	1.9
SC	4	3	2	9	5.7
TX	4	8	6	18	11.3
VA	1	0	1	2	1.3
Total	47	59	53	159	100.1*

*Total percent exceeds 100% because of roundoff error.

Table 5. Listing of U.S. land-falling hurricanes.

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	USLFH
					N. Lat	W. Long.			
1945	715	Unnamed	MH	06/20	17.5	85.7	100	–	FL1
	719	Unnamed	MH	08/24	19.4	94.0	120	966	TX2
	723	Unnamed	MH	09/12	19.0	56.6	120	951	FL3
1946	730	Unnamed	MH	10/05	18.0	87.2	115	979	FL1
1947	734	Unnamed	H	08/18	24.0	80.0	70	–	TX1
	735	Unnamed	MH	09/04	14.5	20.1	140	947	FL4, LA3, MS3, FL2
	739	Unnamed	H	10/09	15.4	82.0	75	973	GA2, SC2, FL1
1948	745	Unnamed	H	09/01	23.8	94.7	70	989	LA1
	747	Unnamed	MH	09/18	18.2	78.8	105	963	FL3, FL2
	748	Unnamed	MH	10/03	15.3	81.8	115	975	FL2
1949	750	Unnamed	H	08/21	21.3	62.6	95	977	NC1
	751	Unnamed	MH	08/23	18.2	60.0	130	954	FL3
	759	Unnamed	MH	09/27	13.3	90.1	115	–	TX2
1950	764	Baker	MH	08/20	16.3	55.0	105	979	AL1
	767	Easy	MH	09/01	19.1	84.1	110	958	FL3
	773	King	MH	10/13	16.0	84.2	105	955	FL3
1952	787	Able	H	08/24	16.4	51.2	90	998	SC1

Table 5. Listing of U.S. land-falling hurricanes (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	USLFH
					N. Lat	W. Long.			
1953	794	Barbara	H	08/11	22.8	73.9	95	987	NC1
	796	Carol	MH	08/31	10.6	37.7	130	929	ME1
	800	Florence	MH	09/23	16.9	75.8	110	968	FL1
1954	809	Carol	H	08/25	25.1	75.5	85	976	NY3, CT3, RI3, NC2
	811	Edna	MH	09/04	19.3	62.8	105	–	MA3, ME1
	815	Hazel	MH	10/05	12.4	59.2	120	937	SC4, NC4, MD2
1955	819	Connie	MH	08/03	15.7	39.2	125	936	NC3, VA1
	820	Diane	MH	08/09	18.9	54.3	105	969	NC1
	826	Ione	MH	09/10	15.4	44.2	105	938	NC3
1956	836	Flossy	H	09/22	22.2	89.8	80	980	LA2, FL1
1957	839	Audrey	MH	06/25	21.6	93.3	125	946	TX4, LA4
1958	853	Helene	MH	09/23	22.5	64.8	115	934	NC3
1959	859	Cindy	H	07/07	31.5	77.1	65	–	SC1
	860	Debra	H	07/23	27.5	93.1	75	984	TX1
	863	Gracie	MH	09/22	21.8	74.1	120	950	SC3
1960	871	Donna	MH	08/30	10.3	26.9	140	932	FL4, NC3, NY3, FL2, CT2, RI2, MA1, NH1, ME1
	872	Ethel	MH	09/14	23.9	90.6	140	981	MS1
1961	876	Carla	MH	09/05	16.3	82.7	150	931	TX4
1963	893	Cindy	H	09/16	26.7	93.7	70	996	TX1
1964	903	Cleo	MH	08/21	13.7	49.1	135	950	FL2
	904	Dora	MH	09/01	11.7	47.0	115	942	FL2
	908	Hilda	MH	09/29	22.0	84.2	130	941	LA3
	909	Isbell	MH	10/13	20.0	85.0	110	964	FL2, FL2
1965	913	Betsy	MH	08/29	19.2	63.4	135	941	FL3, LA3
1966	917	Alma	MH	06/06	18.1	84.2	110	970	FL2
	925	Inez	MH	09/24	14.8	48.7	130	929	FL1
1967	929	Beulah	MH	09/07	13.9	60.8	140	923	TX3
1968	943	Gladys	H	10/15	19.4	83.3	75	965	FL2, FL1
1969	946	Camille	MH	08/14	19.4	82.0	165	905	LA5, MS5
	950	Gerda	MH	09/08	29.7	79.7	110	979	ME1
1970	964	Celia	MH	08/01	23.3	85.8	110	945	TX3
1971	977	Edith	MH	09/07	12.7	69.1	140	943	LA2
	978	Fern	H	09/08	26.9	92.6	80	978	TX1
	979	Ginger	H	09/10	27.7	66.1	95	959	NC1
1972	986	Agnes	H	06/16	20.0	86.2	75	978	FL1, NY1, CT1
1974	1005	Carmen	MH	08/30	17.0	67.4	130	928	LA3
1975	1015	Eloise	MH	09/16	19.0	65.6	110	955	FL3, AL1
1976	1022	Belle	MH	08/07	25.6	73.2	105	957	NY1
1977	1031	Babe	H	09/03	27.6	88.5	65	995	LA1
1979	1049	Bob	H	07/10	23.5	93.8	65	986	LA1
	1051	David	MH	08/26	11.6	42.2	150	924	FL2, FL2, GA2, SC2
	1053	Frederic	MH	08/30	11.5	36.0	115	943	AL3, MS3
1980	1057	Allen	MH	08/02	11.0	42.8	165	899	TX3

Table 5. Listing of U.S. land-falling hurricanes (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	USLFH
					N. Lat	W. Long.			
1983	1086	Alicia	MH	08/15	27.2	91.0	100	963	TX3
1984	1094	Diana	MH	09/08	28.5	77.4	115	949	NC2
1985	1104	Bob	H	07/22	26.2	83.8	65	1002	SC1
	1106	Danny	H	08/14	23.7	87.8	80	988	LA1
	1107	Elena	MH	08/28	22.6	80.0	110	953	AL3, MS3, FL3
	1109	Gloria	MH	09/17	14.6	28.3	125	920	NC3, NY3, CT2, NH2, ME1
	1112	Juan	H	10/26	23.8	92.5	75	971	LA1
	1113	Kate	MH	11/15	21.1	63.8	105	954	FL2, GA1
1986	1115	Bonnie	H	06/24	26.6	89.5	75	992	TX1
	1116	Charley	H	08/15	32.2	78.5	70	980	NC1
1987	1126	Floyd	H	10/10	16.0	82.2	65	993	FL1
1988	1133	Florence	H	09/07	22.7	90.2	70	983	LA1
1989	1141	Chantal	H	07/31	25.4	91.0	70	984	TX1
	1146	Hugo	MH	09/11	12.5	29.2	135	923	SC4, NC1
	1148	Jerry	H	10/13	20.4	93.0	75	983	TX1
1991	1165	Bob	MH	08/16	26.4	75.8	100	950	NY2, CT2, RI2, MA2
1992	1173	Andrew	MH	08/17	12.3	42.0	150	922	FL5, FL4, LA3
1993	1183	Emily	MH	08/25	28.0	60.4	100	960	NC3
1995	1198	Erin	H	07/31	22.3	73.2	80	974	FL1, FL2
	1208	Opal	MH	09/30	21.1	88.5	130	919	FL3, AL1
1996	1214	Bertha	MH	07/05	11.0	39.0	100	960	NC2
	1218	Fran	MH	08/27	14.6	44.9	105	946	NC3
1997	1230	Danny	H	07/17	28.3	91.4	70	984	LA1, AL1
1998	1235	Bonnie	MH	08/20	17.3	57.3	100	954	NC2
	1238	Earl	H	08/31	22.4	93.8	85	964	FL1
	1240	Georges	MH	09/16	10.6	31.3	135	937	FL2, MS2
1999	1249	Bret	MH	08/19	19.8	94.7	125	944	TX3
	1253	Floyd	MH	09/08	15.3	48.2	135	921	NC2
	1256	Irene	H	10/13	18.5	83.4	95	960	FL1
2002	1301	Lili	MH	09/23	12.1	54.6	125	940	LA1
2003	1304	Claudette	H	07/07	13.2	59.8	75	982	TX1
	1310	Isabel	MH	09/06	13.9	32.7	145	915	NC2, VA1
2004	1318	Alex	MH	08/01	31.6	79.2	105	957	NC1
	1320	Charley	MH	08/10	12.9	65.3	125	947	FL4, FL1, FL1, SC1, NC1
	1323	Frances	MH	08/25	11.5	39.8	125	937	FL2, FL1
	1324	Gaston	H	08/28	31.3	78.2	65	986	SC1
	1326	Ivan	MH	09/03	9.7	30.3	145	912	AL3, FL3
	1327	Jeanne	MH	09/14	16.4	62.6	105	951	FL3, FL1, FL1

Table 5. Listing of U.S. land-falling hurricanes (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	USLFH
					N. Lat	W. Long.			
2005	1335	Cindy	H	07/05	25.1	90.2	65	992	LA1
	1336	Dennis	MH	07/05	13.0	65.9	130	930	FL3, AL1
	1343	Katrina	MH	08/24	24.5	76.5	150	902	FL1, FL1, LA3, MS3, AL1
	1347	Ophelia	H	09/07	27.9	78.8	75	976	NC1
	1349	Rita	MH	09/18	22.2	72.3	155	897	FL1, LA3, TX2
	1354	Wilma	MH	10/17	16.9	79.6	160	882	FL3, FL2
2007	1378	Humberto	H	09/12	27.8	95.1	80	985	TX1, LA1
2008	1389	Dolly	H	07/20	17.8	83.6	85	964	TX1
	1392	Gustav	MH	08/25	15.1	69.6	125	943	LA2
	1394	Ike	MH	09/01	17.3	38.4	125	935	TX2, LA1

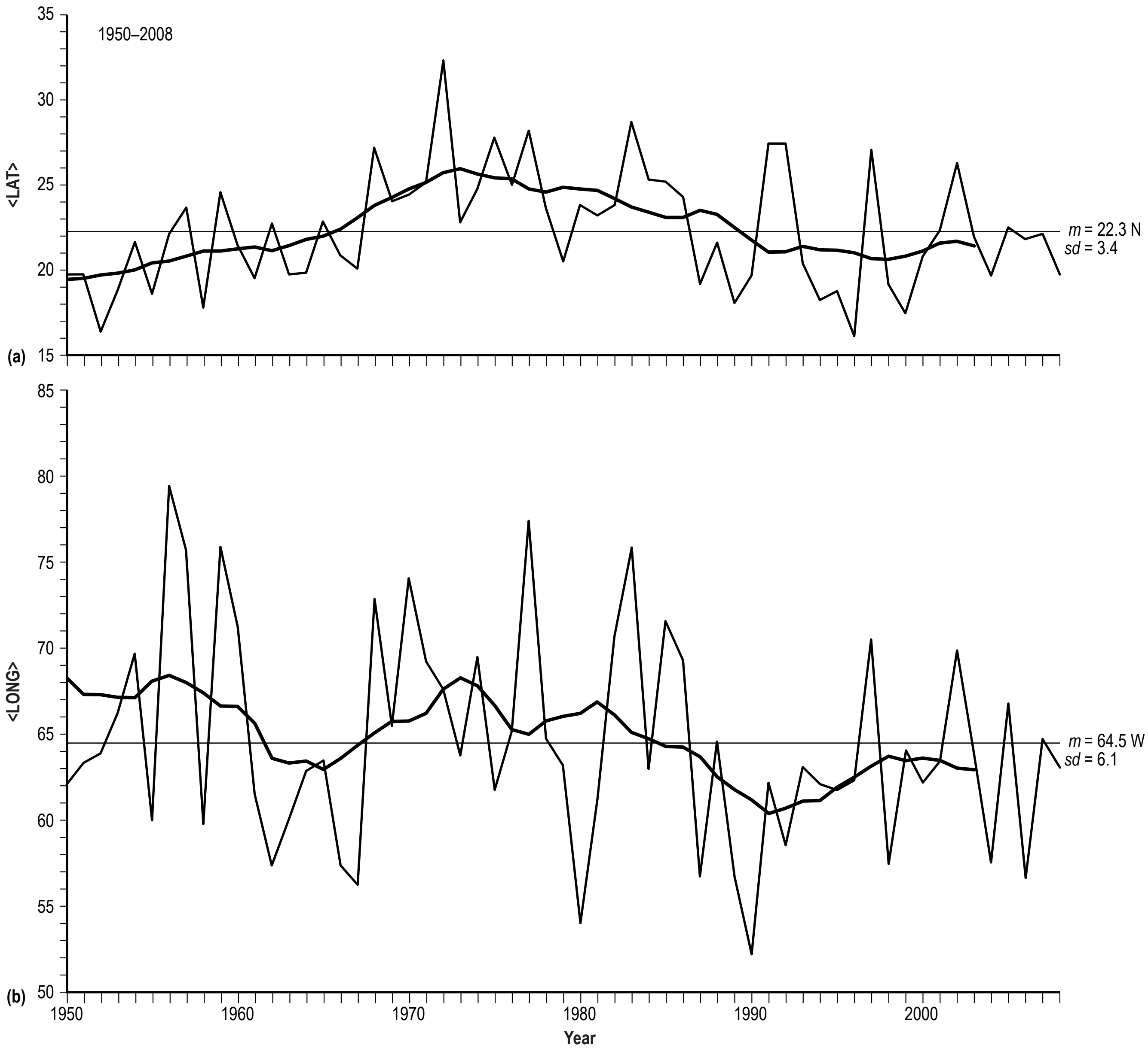

Figure 2. Yearly variation of (a) <LAT> and (b) <LONG> for the interval 1950–2008.

representing their 10-yma values. For 1950–2008, <LAT> and <LONG> measures, respectively, about 22.3° N. and about 64.5° W. Values lying above the means suggest more tropical cyclones originating at higher northerly latitudes and more westerly longitudes (i.e., closer to the United States) than values lying below the means. It appears that the 1950s saw more tropical cyclones, on average, forming in the deeper tropics and closer to the United States than other times. Also, the 1970s apparently saw more tropical cyclones forming at higher northern latitudes and closer to the United States than other times. Since the 1990s, however, although there has been a return to deeper tropical latitudes, on average, the tropical cyclones appear to be forming farther away from the United States, based on <LONG>.

Figure 3 combines the two plots into a single plot of the centroid variation using the 10-yma values. The vertical and horizontal thin lines are the parametric means. The years 1950, 1960, 1970, 1980, 1990, and 2000 are marked by filled circles. The year 2003 (the last 10-yma parametric value available year) is marked by a filled square. Time moves along the dotted line. Thus, the 1950s can be characterized as always being in the lower-left quadrant (meaning lower northerly latitude and more westerly longitude). The 1960s are seen to transition from the lower-left quadrant, first to the lower-right quadrant, then to the upper-left quadrant (meaning a lower northerly latitude and more westerly longitude, first transitioning to lower northerly latitude and less westerly longitude, then to more northerly latitude and less westerly longitude, and finally to more northerly latitude and more westerly longitude). The 1970s can be characterized as always being in the upper-left quadrant (meaning more northerly latitude and more westerly longitude). The 1980s are seen to transition from the upper-left quadrant to the lower-right quadrant (meaning a transition from more northerly latitude and more westerly longitude to lower northerly latitude and less westerly longitude). The 1990s through 2003 can be characterized as always being in the lower-right quadrant (meaning lower northerly latitude and less westerly longitude). It may be that the eastward drift in longitude associated with North Atlantic basin tropical cyclones might simply be related to better observations because of the use of satellites beginning in the 1970s. Certainly, the current high-activity interval, while reflecting a deeper tropics origin for tropical cyclones, which was also seen in the 1950s, remains several degrees farther eastward than was seen in the 1950s.

Table 6 gives the proportion of NUSLFH to NH based on GL, divided into 5° latitudinal and longitudinal bins. For convenience, across the bottom of the table, the proportions have been crudely grouped according to geographic areas. (See table 13 in the appendix.) For example, group 1, which covers the Gulf of Mexico area, marks the GL for 51 tropical cyclones that became hurricanes at some point in their development (in total, 132 tropical cyclones formed in the group 1 area, or about 20.7% of the total). Of these 51 hurricanes, 27 struck the United States as a hurricane. Thus, 27/51, or 52.9% of the tropical cyclones that originated in the Gulf of Mexico area and that became hurricanes, struck the United States as hurricanes. The 27 U.S. land-falling hurricanes represent 28.4% of all NUSLFH (27/95), and the 51 tropical cyclones of group 1 that became hurricanes represent 13.7% of all hurricanes (51/371).

Group 2 represents the Caribbean Sea area. Some 63 tropical cyclones originated in the Caribbean that later became hurricanes (in total, 86 tropical cyclones formed in the group 2 area, or ≈13.5% of the total). Of the 63, 21 struck the United States (33.3%) as hurricanes. Of the 95 U.S. land-falling hurricanes, group 2 accounts for 22.1%, and of the 371 hurricanes, group 2 accounts for 17%.

Group 3 represents the eastern seaboard area. Some 83 tropical cyclones originated in this area that later became hurricanes (in total, 157 tropical cyclones formed in the group 3 area, or about 24.6% of the total). Of the 83, 19 struck the United States (22.9%) as hurricanes. Of the 95 U.S. land-falling hurricanes, group 3 accounts for 20%, and of the 371 hurricanes, group 3 accounts for 22.4%.

Group 4 represents the lower North Atlantic-Cape Verde area. Some 125 tropical cyclones originated in this area that later became hurricanes (in total, 176 tropical cyclones formed in the group 4 area, about 27.5% of the total). Of the 125, 28 struck the United States (22.4%)

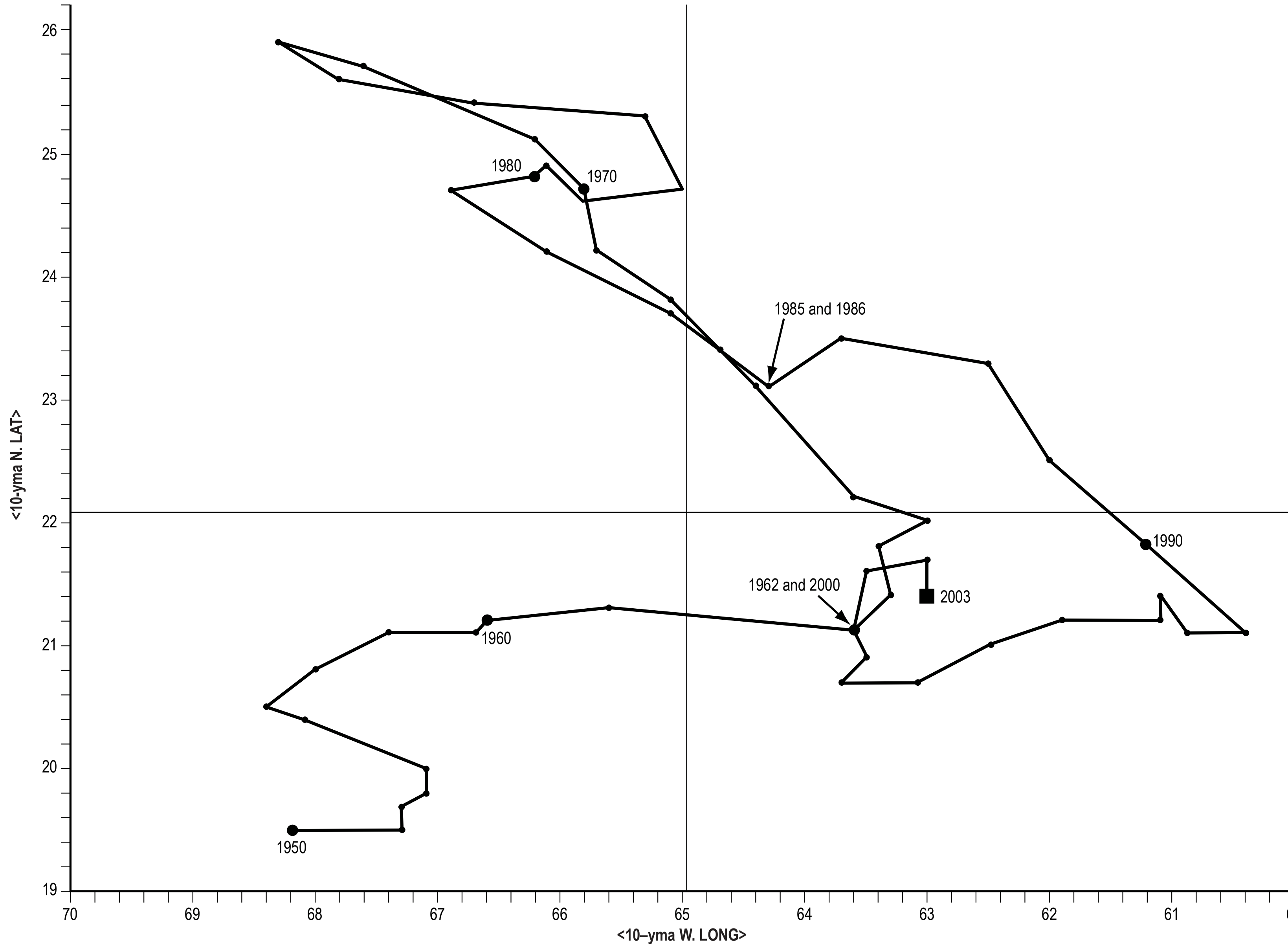

Figure 3. Yearly variation of the centroid location of North Atlantic basin tropical cyclones.

Table 6. Proportion: NUSLFH/NH for 1950–2008 (based on GL).

W. Longitude	N. Latitude								Total
	44.9–40.0	**39.9–35.0**	**34.9–30.0**	**29.9–25.0**	**24.9–20.0**	**19.9–15.0**	**14.9–10.0**	**9.9–5.0**	
99.9–95.0				1/1	0/2				1/3
94.9–90.0				7/7	7/15	1/1			15/23
89.9–85.0				2/5	6/13	0/2			8/20
84.9–80.0				1/3	2/4	9/20	0/7		12/34
79.9–75.0			4/8	5/10	1/2	2/5	0/2		12/27
74.9–70.0		0/3	0/8	1/7	4/8	0/1	0/2		5/29
69.9–65.0			0/7	1/9	0/3	3/5	3/7		7/31
64.9–60.0		0/1	0/5	1/5	2/7	3/7	1/5		7/30
59.9–55.0	0/3	0/2	0/3	0/4	0/4	2/9	2/7		4/32
54.9–50.0			0/3	0/3	0/4	2/8	1/9		3/27
49.9–45.0		0/1	0/4	0/1	0/5	1/6	4/15		5/32
44.9–40.0		0/1	0/1		0/2	1/3	3/11		4/18
39.9–35.0		0/1			0/2	2/5	4/13		6/21
34.9–30.0			0/1		0/1	0/4	2/12	1/1	3/19
29.9–25.0	0/1					0/1	3/11		3/13
24.9–20.0		0/1	0/1			0/2	0/7		0/11
19.9–15.0							0/1		0/1
Total	0/3	0/10	4/41	19/56	22/72	26/79	23/109	1/1	95/371

Group 1 (Gulf of Mexico area):*	27/51	(27/51=52.9%, 27/95=28.4%, 51/371=13.7%)
Group 2 (Caribbean Sea area):**	21/63	(21/63=33.3%, 21/95=22.1%, 63/371=17.0%)
Group 3 (East coast area):***	19/83	(19/83=22.9%, 19/95=20.0%, 83/371=22.4%)
Group 4 (Lower N. Atlantic–Cape Verde area):†	28/125	(28/125=22.4%, 28/95=29.5%, 125/371=33.7%)
Group 5 (Open N. Atlantic area):‡	0/49	(0/49=0.0%, 0/95=0.0%, 49/371=13.2%)
Total:	95/371	

Notes:
*18.0N–30.0N, 80.0W–99.9W and 15.0–19.9N, 90.0–94.9W
**10.0N–19.9N, 60.0W–89.9W
***20.0N–39.9N, 60.0W–79.9W
†5.0N–19.9N, 15.0W–59.9W
‡20.0N–44.9N, 15.0W–59.9W

as hurricanes. Of the 95 USLFH, group 4 accounts for 29.5%, and of the 371 hurricanes, group 4 accounts for 33.7%.

Group 5 represents the open North Atlantic area. Some 49 tropical cyclones originated in this area that later became hurricanes (in total, 88 tropical cyclones formed in the group 5 area). Of the 49, none struck the United States as hurricanes, and of the 371 hurricanes, group 5 accounts for 13.2%.

Obviously, tropical cyclones that initially form in the Gulf of Mexico, Caribbean Sea, and along the eastern seaboard, and that become hurricanes, are the most worrisome, since as a single group, they account for more than 70% of the U.S. land-falling hurricanes. Katrina, although it formed in the group 3 area, moved westward across Florida and into the Gulf of Mexico before striking Louisiana, Mississippi, and Alabama. Andrew, the second costliest hurricane to strike the U.S. mainland, originated in the group 4 area, which contains the largest single grouping of tropical cyclones.

The importance of table 6 is that during the 2009 hurricane season (or any future season), should a tropical cyclone that later becomes a hurricane form in a particular latitudinal-longitudinal bin, an estimate can easily be made regarding the likelihood of it striking the United States. As an example, should a tropical cyclone that later becomes a hurricane form in the group 1 area, specifically, in the latitudinal-longitudinal bin of 25° N.–29.9° N., 90° W.–94.9° W. (an area just off the Texas-Louisiana coast), past experience has shown that this has previously occurred seven times and, in every case, the tropical cyclone struck the U.S. coastline as a hurricane.

Figure 4 is a map of the North Atlantic basin, included to assist the reader in more clearly visualizing the construction of table 6. Tracking charts are available online at <http://www.nhc.noaa.gov/tracking_charts.shtml>.[22]

During the first high-activity interval 1950–1965, the variation by group, respectively, from 1 to 5 was 38-19-29-49-19. For the low-activity interval 1966–1994, the variation in numbers was 56-29-86-68-38. For the current high-activity interval 1995–2008, it has been 38-38-42-59-51. For the combined high-activity intervals, it has been 76-57-71-108-50. It appears then that during the high-activity intervals, there is a general increase in tropical cyclone frequency throughout the North Atlantic basin, as compared to the low-activity interval. Only for the group 3 area are there more tropical cyclones forming during the low-activity interval than in the combined high-activity intervals. Perhaps, this is somehow related to the occurrences of EN, since the low-activity interval has more EN months than the combined high-activity intervals (95 versus 76), and the effect of EN would be to hinder formation of tropical cyclones in the lower tropics (i.e., in groups 2 and 4), thereby, allowing only higher latitudinal tropical cyclones to form.

Figure 5 displays the yearly variation in the number of tropical cyclone formations by group for the interval 1950–2008. The thin, horizontal lines represent the long-term means for each group. Figure 5(a) shows the yearly variation for group 1 (the Gulf of Mexico area). Some 132 tropical cyclones formed in this region between 1950 and 2008, with no formations occurring only twice, 1962 and 1992. The peak number of group 1 area formations measures 5 and has occurred twice, in 1957 and 2003. In 2008, only two tropical cyclones formed in the group 1 area, Edouard (August 4) and Marco (October 6), both only of tropical storm strength.

Figure 5(b) shows the yearly variation for group 2 (Caribbean Sea area). Some 86 tropical cyclones formed in this region during the interval 1950–2008, with no formations occurring during 13 years, 9 of which occurred during the low-activity interval. The last no-formation year for the group 2 area was 1997, an EN year. The number during the current high-activity interval appears to have increased (true for all groups, not just group 2, even when compared to the first high-activity interval). The highest yearly number to date is 7 in 2005. In 2008, 6 tropical cyclones formed in the group 2 area, Arthur (May 31), Dolly (July 20), Fay (August 15), Gustav (August 25), Omar (October 14), and Paloma (November 6).

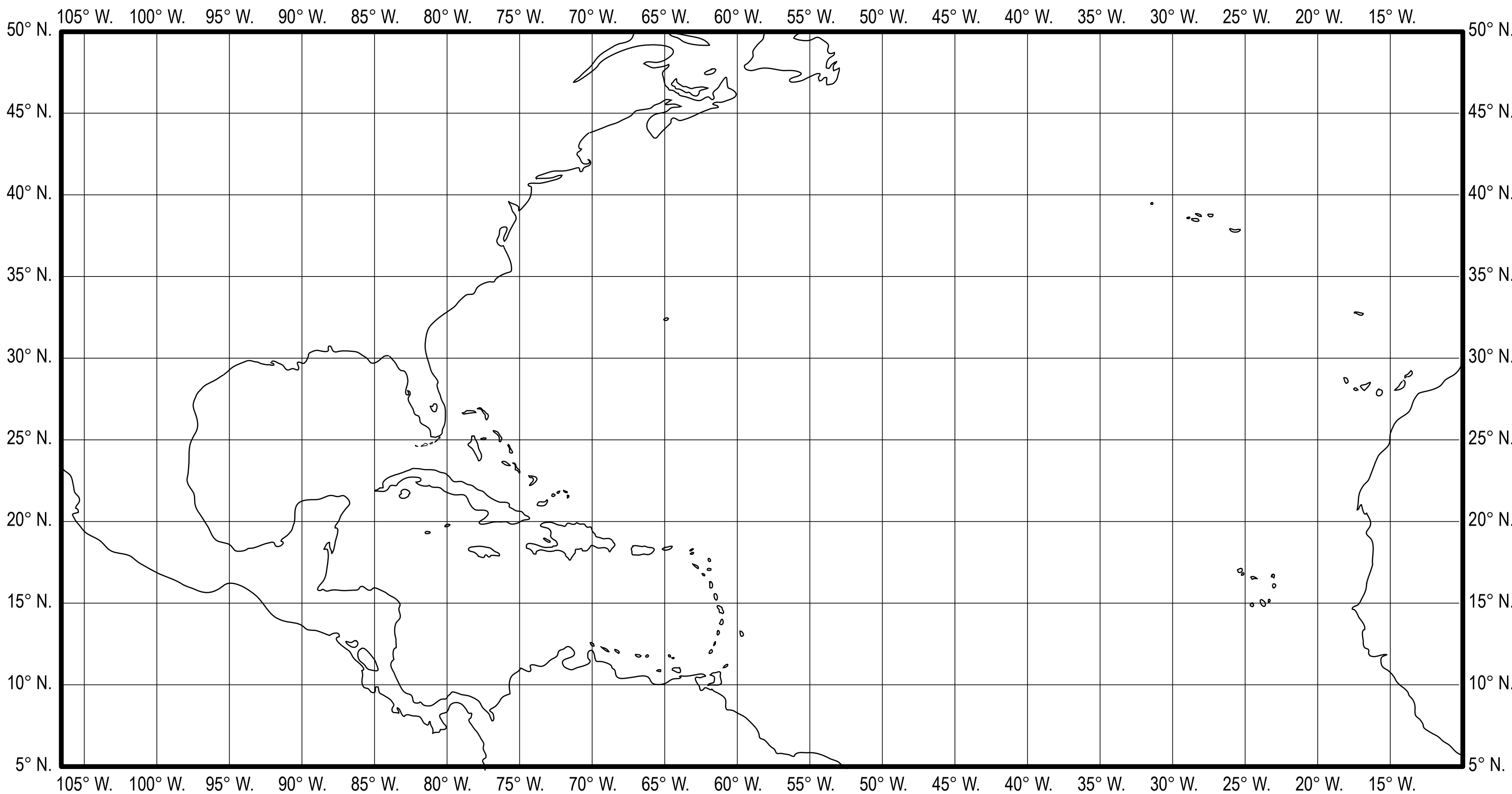

Figure 4. Map of the North Atlantic basin hurricane tracking chart, National Hurricane Center, Miami, FL.

Figure 5(c) shows the yearly variation for group 3 (the east coast area). Some 157 tropical cyclones formed in this area, with no formations only occurring 5 times: 1950, 1955, 1965, 1989, and 1994. The peak highest yearly number to date is 7 in 2005. In 2008, 2 tropical cyclones formed in the group 3 area: Cristobal (July 19) and Kyle (September 25).

Figure 5(d) shows the yearly variation for group 4 (the lower North Atlantic-Cape Verdi area). Some 176 tropical cyclones formed in this area, with no formations occurring only 3 times: 1972, 1977, and 1983, these years associated with the occurrence of EN. The highest yearly number to date is 9 in 1995, the start of the current high-activity interval. In 2008, 3 tropical cyclones formed in the group 4 area: Bertha (July 3), Ike (September 1), and Josephine (September 2).

Figure 5(e) shows the yearly variation for group 5 (the open North Atlantic area). Some 88 tropical cyclones formed in this area, with no formations occurring 14 times, 5 times during the first high-activity interval, 7 during the low-activity interval, and only twice during the current high-activity interval. The highest yearly number is 8 in 2005, well above its long-term average. In 2008, 3 tropical cyclones formed in the group 5 area: Hanna (August 28), Laura (September 26), and Nana (October 12).

2.3 Peak Wind Speed and Lowest Pressure Variation

Figure 6 displays the yearly variation of PWS (fig. 6(a)) and <PWS> (fig. 6(b)). Its construction follows that of figures 1 and 2. Based on the 10-yma trend line, PWS is found to be higher than its long-term average (127.3 kt) in the 1950s, lower in the 1960s–1980s, and higher once again in the 1990s and 2000s. In fact, the 10-yma value for 2003 (135 kt) is found to equal the previous high 10-yma value in 1954. Between 1998 and 2003, the 10-yma value for PWS has been higher every year than the preceding yearly value, increasing from 123.3 kt in 1997 to 135 kt in 2003, an increase of ≈9.5%. Seven of 14 years in the span of 1995–2008 had yearly PWS in excess of its long-term average, with the lowest yearly PWS being 105 kt in 2006, a year in which EN occurred during the months of August–December.

The trend line for <PWS> follows closely that of PWS, although values have not yet risen above the long-term average (75.4 kt) in the current epoch, with current values (75 kt in 2003) paling in comparison to those seen in the 1950s (83.3 kt in 1954). As with yearly PWS, only 7 of the past 14 years have had yearly <PWS> in excess of the long-term average, with the lowest yearly <PWS> being 56.3 kt in 1997, also a year dominated by EN (May–December).

Figure 7 shows the yearly variation of LP (fig. 7(a)) and <LP> (fig. 7(b)). Its construction follows that of figures 1, 2, and 6. The trend line for LP has consistently been above the long-term average (931.7 mb) until the 1990s, hovering at ≈940 mb. Since 1997, however, the trend line has fallen from 935.9 to 922.1 mb (in 2003), indicating a strengthening. As with PWS and <PWS>, 7 of the past 14 years have had LP below the long-term average (remember, LP varies inversely with PWS, so strengthening is indicated by lower LP and higher PWS, and weakening is indicated by higher LP and lower PWS), with 8 tropical cyclones having LP ≤ 920 mb during the current epoch, the lowest being Wilma in 2005, holding the record at 882 mb. The names of the strongest tropical cyclones (those having LP ≤ 925 mb) appear on the chart. The year 2005 is the only year to have more than a single tropical cyclone having LP ≤ 925 mb (Katrina, Rita, and Wilma).

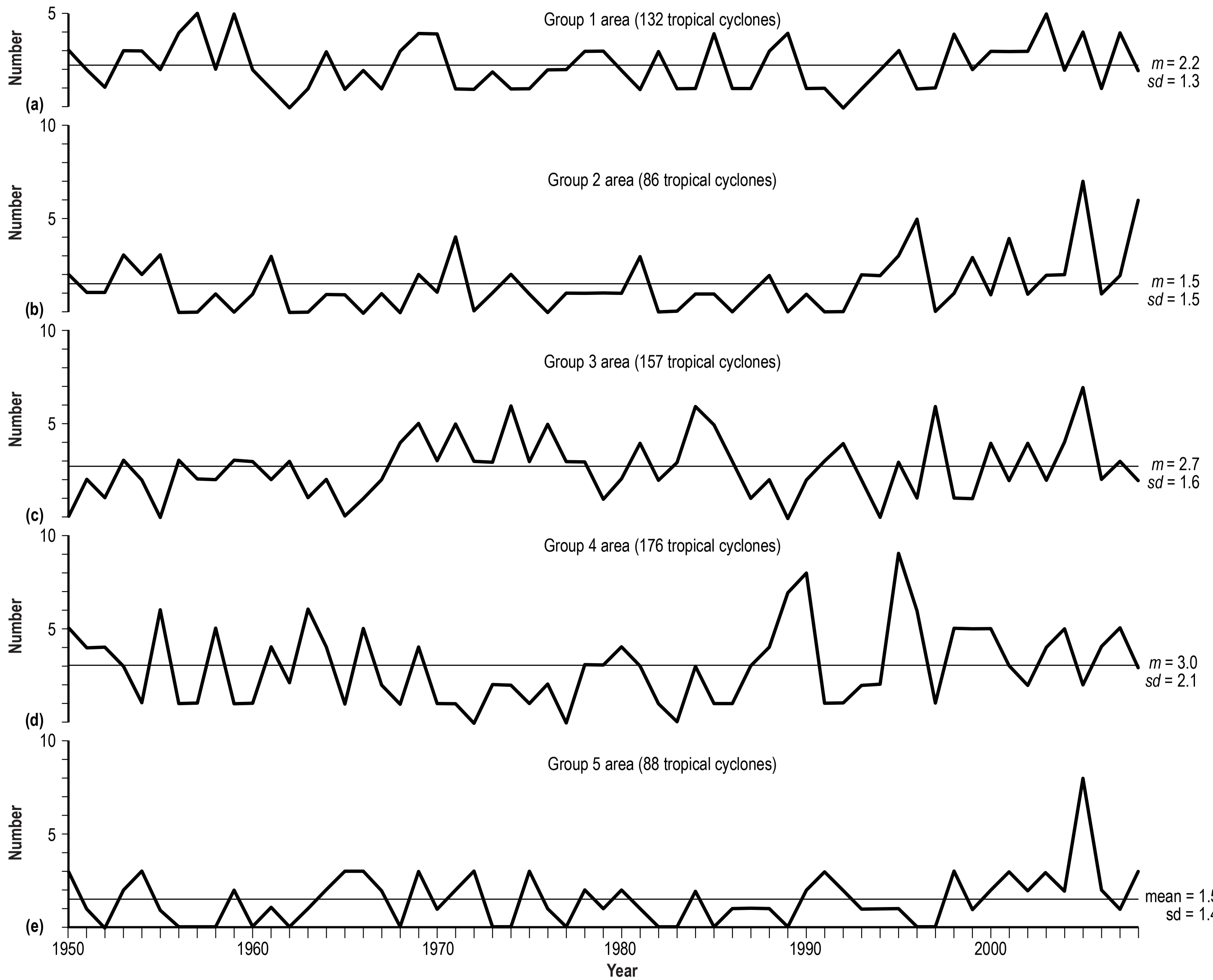

Figure 5. Yearly variation of the number of tropical cyclones in selected geographical areas: (a) Group 1 (Gulf of Mexico), (b) group 2 (Caribbean Sea), (c) group 3 (east coast), (d) group 4 (lower North Atlantic-Cape Verdi), and (e) group 5 (open North Atlantic).

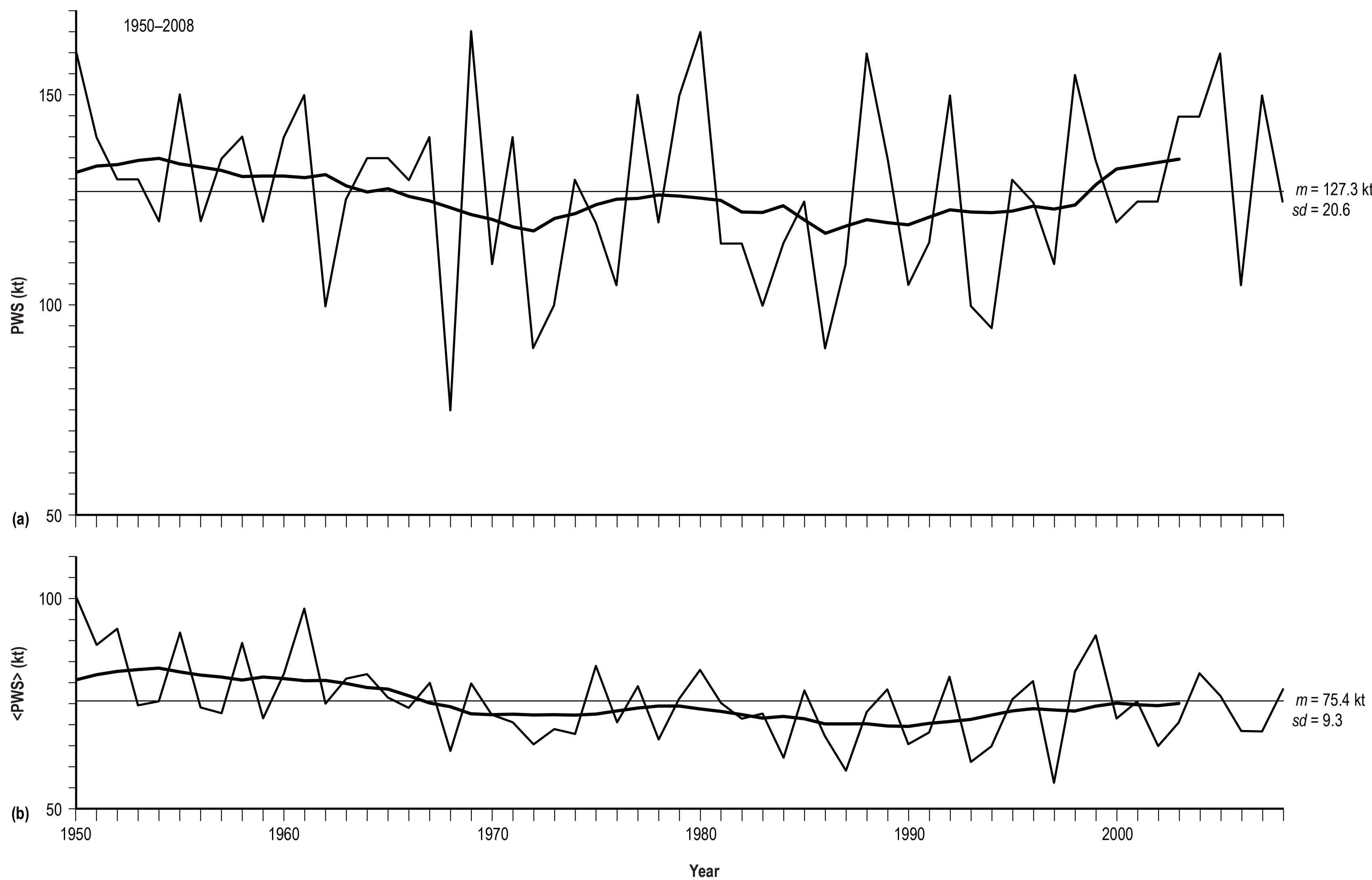

Figure 6. Yearly variation of (a) PWS and (b) <PWS> for the interval 1950–2008.

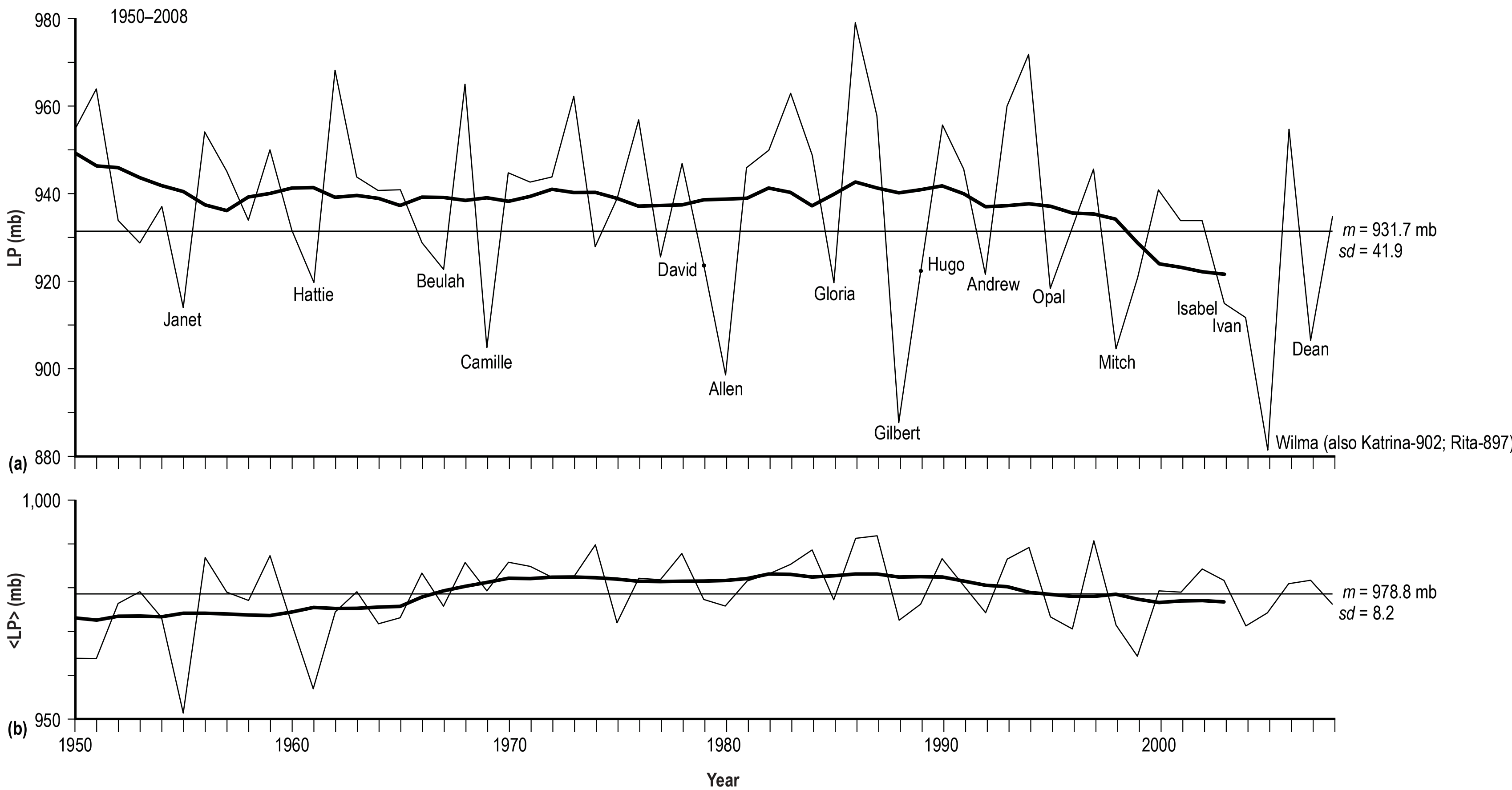

Figure 7. Yearly variation of (a) LP and (b) <LP> for the interval 1950–2008. Also given are the names of the most powerful tropical cyclones (LP ≤ 925 mb).

The trend line for <LP> appears to follow the inverse of <PWS>, as is to be expected. Lower <LP> is seen in the 1950s, higher <LP> in the 1960s–1980s, and lower <LP> again in the 1990s and 2000s, although the <LP> during the current epoch (977.3 mb in 2003) remains higher than was seen in the 1950s (972.4 mb in 1951). Seven of the past 14 years have had yearly <LP> below the long-term average (978.8 mb), of similar behavior to PWS, <PWS>, and LP.

It should be noted that yearly pressures (LP and <LP>) are not as reliably determined as PWS and <PWS>, especially for years prior to the 1970s. During the early record, many of the tropical cyclones in the best tracks file, while having measurements of wind speed, more often than not, have no pressure determinations. So, figure 6 should be viewed with some caution, especially for the early years.

2.4 Effects of El Niño and La Niña

The warm EN phase of the ENSO phenomenon has long been recognized as having a dampening effect on the frequency of North Atlantic basin tropical cyclones.[23] While apparently true, determination of a generally accepted, consistent listing of EN (and LN) events has often been lacking, because of the different methodologies used in the past to define them.

The ONI, based on the ERSST.v3b (replacing the ERSST.v3 in December 2008),[24] has now become the de facto means whereby ENSO conditions are described. As noted in the Introduction, the ONI is updated monthly and is available online.[2] When the ONI has at least a 5-mo continuous value of 5 °C or warmer, an EN is said to be occurring, while when the ONI has at least a 5-mo continuous value of –5 °C or cooler, a LN is said to be occurring. All other times are said to be representative of ENSO-neutral conditions.

Table 7 is a listing of EN and LN events based on the ONI using ERSST.v3b. Although having the same number of events as was listed in the previous publication[1] (17 EN and 13 LN events), the listing has subtly changed. Some events have different start and/or end dates and some events have different maximum ONI values (thereby affecting their strength classification—W=weak, M=moderate, and S=strong).

Table 8 summarizes specific characteristics of the 17 EN and 13 LN events. For example, using the ERSST.v3b data set, on average, the duration of an EN from beginning to end is ≈10 mo, having an *sd* of ≈4 mo, and a range of 5 to 19 mo. The recurrence rate (from the end of an old EN event to the start of a new EN event) averages ≈32 mo, having an *sd* of ≈18 mo, and a range of 3 to 64 mo. The last EN event ended in January 2007, more than 2 yr ago, so based on the average recurrence rate, one might expect another EN to occur soon. During an EN event, on average, 8 tropical cyclones form in the North Atlantic basin during the event, having an *sd* of ≈3.5 and a range of zero to 15 in number; ≈4 hurricanes form, having an *sd* of ≈2, and a range of zero to 9; ≈1.5 major hurricanes form, having an *sd* of ≈2 and a range of zero to 6; and ≈1 hurricane strikes the U.S. coastline, having an *sd* of ≈1 and a range of zero to 6.

Likewise, on average, the duration of a LN event from beginning to end is ≈15 mo, having an *sd* of ≈11 mo and a range of 5 to 37 mo. The recurrence rate (from the end of an old LN event to

Table 7. Listing of EN and LN events based on ONI (ERSST.v3b).

Start	End	Dur (mo)	max ONI	<ONI>	Event Type	Strength	Sums NTC	NH	NMH	NUSLFH
B01–1950	03–1951	>15	–1.7	–1.06	LN	S	13	11	8	3
08–1951	12–1951	5	0.8	0.70	EN	W	9	7	4	0
04–1954	01–1957	34	–2.0	–0.98	LN	S	31	21	10	9
04–1957	06–1958	15	1.7	0.99	EN	S	9	3	2	1
09–1962	01–1963	5	–0.7	–0.62	LN	W	3	2	1	0
07–1963	01–1964	7	1.0	0.86	EN	M	9	7	2	1
04–1964	01–1965	10	–1.2	–0.93	LN	M	12	6	6	4
06–1965	04–1966	11	1.6	1.12	EN	S	6	4	1	1
12–1967	04–1968	5	–0.9	–0.72	LN	W	0	0	0	0
11–1968	06–1969	8	1.0	0.79	EN	M	0	0	0	0
09–1969	01–1970	5	0.8	0.66	EN	W	12	8	2	1
07–1970	01–1972	19	–1.3	–0.91	LN	M	22	10	3	4
05–1972	03–1973	11	2.1	1.32	EN	S	7	3	0	1
05–1973	05–1976	37	–2.1	–1.11	LN	S	29	14	6	2
09–1976	02–1977	6	0.8	0.63	EN	W	3	2	0	0
09–1977	01–1978	5	0.7	0.64	EN	W	6	4	0	1
05–1982	06–1983	14	2.3	1.39	EN	S	6	2	1	0
10–1984	09–1985	12	–1.1	–0.71	LN	M	11	8	2	4
08–1986	02–1988	19	1.6	1.11	EN	S	11	6	1	2
05–1988	05–1989	13	–1.9	–1.29	LN	S	12	6	3	1
05–1991	07–1992	15	1.8	1.13	EN	S	9	4	2	1
05–1994	03–1995	11	1.3	0.83	EN	M	7	3	0	0
09–1995	03–1996	7	–0.7	–0.63	LN	W	7	5	3	1
05–1997	05–1998	13	2.5	1.74	EN	S	8	3	1	1
07–1998	06–2000	24	–1.6	–1.03	LN	S	26	18	8	6
10–2000	02–2001	5	–0.7	–0.58	LN	W	4	1	0	0
05–2002	03–2003	11	1.5	1.03	EN	S	12	4	2	1
06–2004	02–2005	9	0.9	0.72	EN	W	15	9	6	6
08–2006	01–2007	6	1.1	0.83	EN	M	7	5	2	0
09–2007	05–2008	9	–1.4	–1.04	LN	M	13	6	2	1

Table 8. Statistical aspects of EN and LN events based on ONI (ERSST.v3b).

Event Type	Number	Duration	Recurrence Rate*	NTC	NH	NMH	NUSLFH
EN	17	10.1 (4.2/5–19)	31.9 (18.3/3–64)	8.0 (3.5/0–15)	4.4 (2.4/0–9)	1.5 (1.6/0–6)	1.0 (1.4/0–6)
LN	13	15.0 (10.7/5–37)	43.2 (30.3/4–101)	14.1 (10.0/0–31)	8.3 (6.4/0–21)	4.0 (3.3/0–10)	2.7 (2.7/0–9)

*Means from the end of one event to the start of the next event of the same type.

the start of a new LN event) averages ≈43 mo, having an *sd* of ≈30 mo and a range of 4 to 101 mo. The last LN event ended in May 2008, so based on the average recurrence rate, one might not expect another LN to occur anytime soon. While true, the latest forecast is for ENSO-neutral to LN-like conditions to prevail during 2009.[25] During a LN event, on average, 14 tropical cyclones form in the North Atlantic basin during the event, having an *sd* of ≈10 and a range of zero to 31; about 8 hurricanes form, having an *sd* of ≈6 and a range of zero to 21; ≈4 major hurricanes form, having an *sd* of ≈3 and a range of zero to 10; and ≈3 hurricanes strike the U.S. coastline, having an *sd* of ≈3 and a range of zero to 9. It is apparent then that while numbers of tropical cyclones, hurricanes, major hurricanes, and U.S. land-falling hurricanes tend to be depressed during an EN event, the opposite seems true for a LN event, usually having considerably higher frequencies in comparison.

Figure 8 displays the yearly number of tropical cyclone formations for the low-latitudinal groups 2 + 4 (fig. 8(a)) and high-latitudinal groups 1 + 3 + 5 (fig. 8(b)) (recall groups 1–5 previously mentioned in sec. 2.2) in relation to the yearly variation of NENM (fig. 8(c)). The thin, jagged line is the yearly mean; the thick, smoothed line is the 10-yma trend line; and the thin, horizontal line is the long-term average. While it appears true that most (10 of 15) EN peak years, including 1957, 1965, 1972, 1977, 1982, 1987, 1991, 1994, 1997, and 2002, associate with reduced tropical cyclone formation in the lower latitudinal regions of the North Atlantic basin (using the long-term mean as the discriminator), some do not, including 1951, 1963, 1969, 2004, and 2006. Also, there is no apparent corresponding increase in the number of high-latitudinal tropical cyclones during most EN peak years (only 5 of 10 had increased numbers above the long-term average, including 1957, 1969, 1972, 2002, and 2004). The trend lines for both the low- and high-latitudinal groups now exceed the long-term averages, the low-latitudinal group beginning after about 1990 and the high-latitudinal group after about 1998. Since 1995, 12 of 14 years have had numbers of tropical cyclones in the low-latitudinal groups greater than its long-term mean and 10 of 14 years have had numbers of tropical cyclones in the high-latitudinal groups greater than its long-term mean. The average number of tropical cyclones since 1995 measures 6.9 for the low-latitudinal group ($sd = 2.9$ and range of 1 to 12) and 7.6 for the high-latitudinal group ($sd = 4.1$ and range of 2 to 19).

2.5 First Differences in 10-yma Values of Tropical Cyclone Frequencies

Previously, it was shown that the first differences in the 10-yma values of the tropical cyclone frequencies can be used to estimate the seasonal frequencies for the following season.[1] The first difference is simply the difference between the following year's 10-yma value and the current year's 10-yma value (recall that 10-yma values always lag real time by 5 yr, so the last available 10-yma is for the year 2003).

Figure 9 displays the first differences (fd) of the 10-yma values for (a) NTC, (b) NH, (c) NMH, and (d) NUSLFH. To the right is the frequency distribution for each first difference. Clearly, the largest grouping of first difference values closely bounds the innermost values (typically, values between ±0.1 and ±0.2). For example, 26 of 53 fd values (49.1%) of fd (NTC) lie within the range ±0.1 and 36 of 53 values (67.9%) lie within the range ±0.2. Because the seasonal value[1] for 2009 (i.e., NTC (2009)) is equal to $20(X_{10\text{-yma}}(-1) \pm d) - X(-5) - 2\Sigma X(i)$, where $X_{10\text{-yma}}(-1)$ is the 10-yma value for NTC (2003), which equals 15.3; $X(-5)$ is the value of NTC (1999), which equals 12;

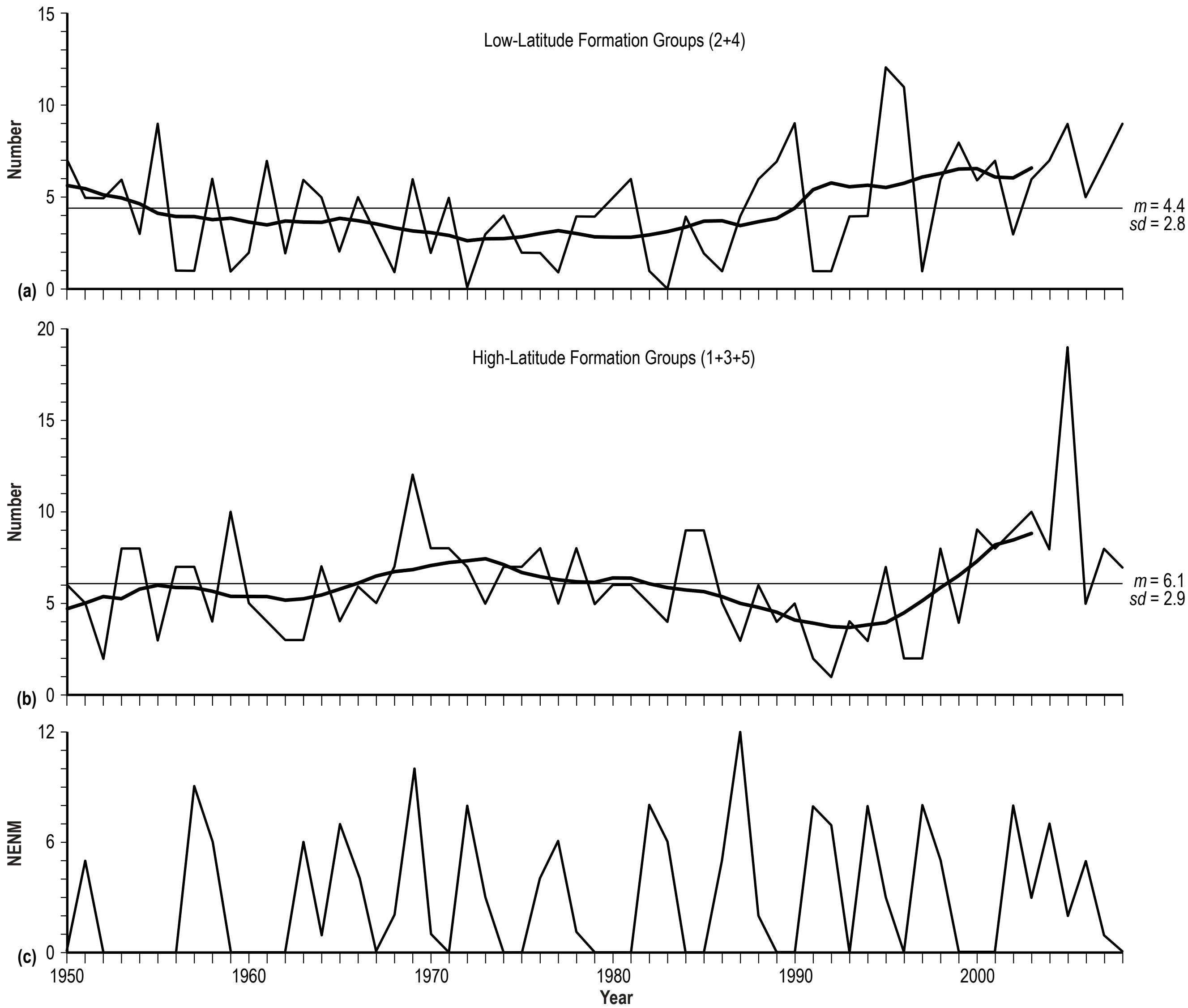

Figure 8. Yearly variation of the (a) low-latitude formation groups (2 + 4), (b) high-latitude formation groups (1 + 3 + 5), and (c) NENM for the interval 1950–2008.

and $2\Sigma X(i)$ is twice the sum of NTC between the years 2000 and 2008, which equals 284, NTC (2009) is found to equal $10 \pm 20d$. Presuming $d = \pm 0.1$, NTC (2009) is computed to be 10 ± 2, while presuming $d = \pm 0.2$, NTC (2009) is computed to be 10 ± 4. Because there is a 90.6% probability that $d \geq -0.2$, a lower limit of ≈6 can be established for NTC (2009) (i.e., there is only about a 10% probability that NTC (2009) <6). There is a 22.6% probability that $d > 0.2$. Hence, there is about a 1 in 4 or 5 chance that NTC (2009) will exceed 14. The average d during the interval 1990–2002 is 0.45 (having $sd = 0.27$ and range = 0.1 to 0.9). Presuming $d = 0.45$, NTC (2009) is computed to be 19, well below the record number of 28 in 2005, yet equal in number to that seen in 1995, which marked the beginning of the current high-activity interval and is the second most prolific number of tropical cyclones in a season.

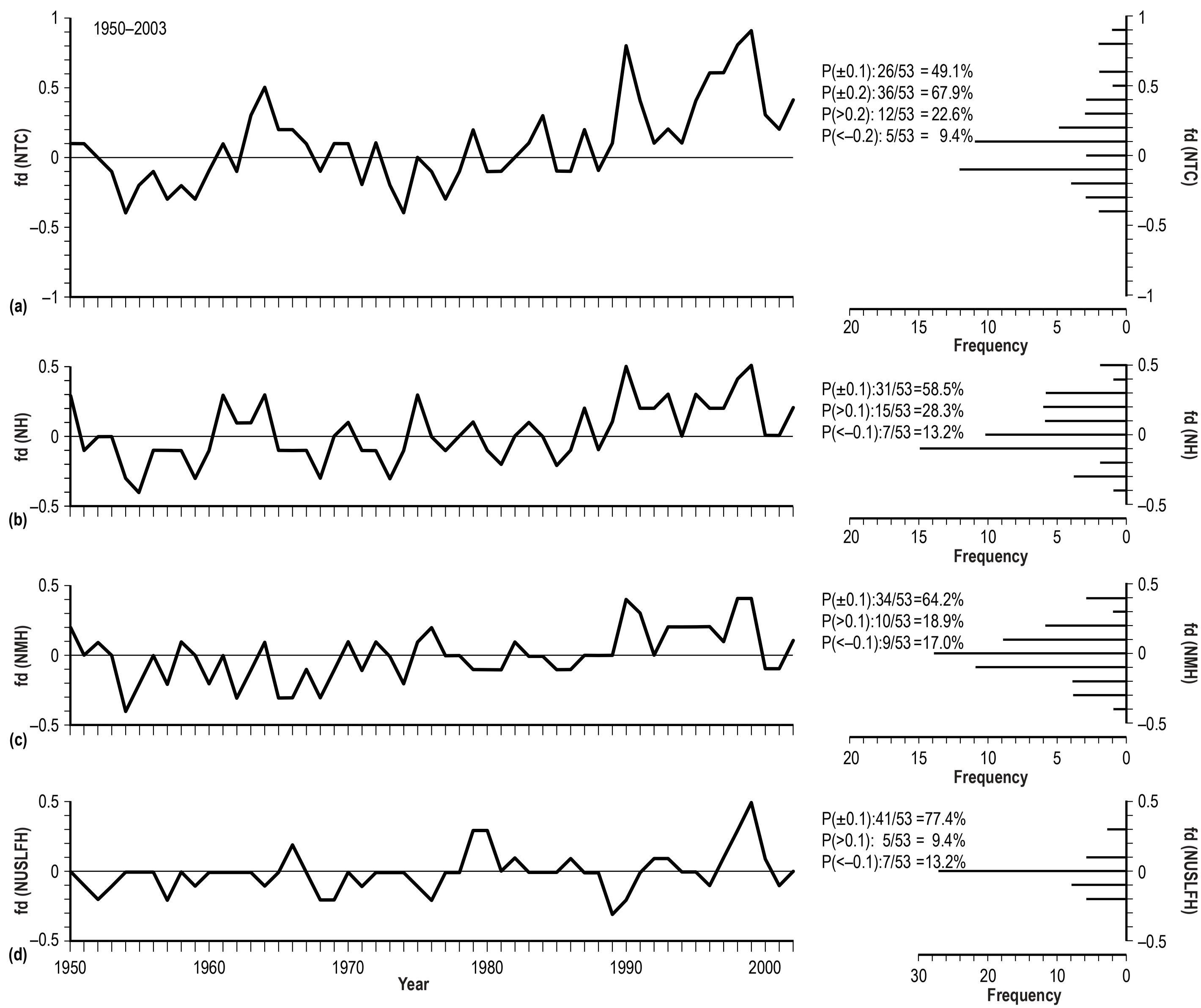

Figure 9. Yearly variation of the first differences of the 10-yma values of (a) NTC, (b) NH, (c) NMH, and (d) NUSLFH for the interval 1950–2002. Also given is the frequency distribution for (a)–(d).

For fd (NH), 31 of 53 fd values (58.5%) of fd (NH) lie within the range ±0.1, with a 28.3% probability of $d > 0.1$ and a 13.2% probability of $d < -0.1$. Because NH (2009) = $10 \pm 20d$, NH (2009) can be estimated to be ≈10 ± 2 (using $d = \pm 0.1$), inferring about an 87% probability that NH (2009) ≥8. The average d during the interval 1990–2002 is 0.23 (having $sd = 0.17$ and range of zero to 0.5). Presuming $d = 0.23$, NH (2009) = 14–15, which would be near the record number of 15 that was seen in 2005.

For fd (NMH), 34 of 53 fd values (64.2%) lie within the range ±0.1, with an 18.9% probability of $d > 0.1$ and a 17% probability of $d < -0.1$. Because NMH (2009) = $3 \pm 20d$, NMH (2009) can be estimated to be about 3 ± 2 (using $d = \pm 0.1$), inferring about an 83% probability that NMH (2009) ≥1. The average d during the interval 1990–2002 is 0.18 (having $sd = 0.17$ and range of –0.1 to 0.4). Presuming $d = 0.18$, NMH (2009) = 6–7, which also is near the record number of 8 that was seen in 1950.

For fd (NUSLFH), 41 of 53 fd values (77.4%) lie within the range ±0.1, with a 9.4% probability of $d > 0.1$ and a 13.2% probability of $d < -0.1$. Because NUSLFH (2009) = $3 \pm 20d$, NUSLFH (2009) can be estimated to be about 3 ± 2 (using $d = \pm 0.1$), inferring about a 90.6% probability that NUSLFH ≤5. The average d during the interval 1990–2002 is 0.06 (having $sd = 0.18$ and range of –0.3 to 0.5). Presuming $d = 0.06$, NUSLFH (2009) = 4, which is below the record number of 6 that was seen in 1985, 2004, and 2005.

2.6 First Differences in 10-yma Values of Latitudinal and Longitudinal Genesis Locations

Figure 10 shows the fd values for (a) <LAT> and (b) <LONG>. As before, for the first difference of the frequencies of tropical cyclones, fd (LAT) and fd (LONG) tend to be centrally located, with fd (LAT) having values that typically lie within ±0.5° about 86.8% of the time (46 of 53 seasons) and with fd (LONG) having values that typically lie within ±1° about 90.6% of the time (48 of 53 seasons). For latitude and longitude, this implies that the 10-yma values for 2004 very probably will remain in the lower right quadrant of figure 3. For latitude, there is a 94.3% probability that the 10-yma of latitude for 2004 will be southward of 21.9° N. For longitude, there is a 98.1% probability that the 10-yma for 2004 will be eastward of 63.9° W. Together, this suggests, perhaps, that a greater number of tropical cyclones might originate in the lower tropics and farther from the U.S. coastline (group 4).

For <LAT> (2009), its value is computed to be about $15.9 \pm 20d$, or about 15.9 ± 10° N., using $d = \pm 0.5°$. Since yearly values of <LAT> have never fallen below 16.2° N. (1996) or above 32.2° N. (1972), this seems to suggest that <LAT> for 2009 will lie somewhere between 16.2° and 25.9° N. Based on the 1950–2008 yearly values, individual tropical cyclones have always originated between 9° N. (Fran in 1990) and 43° N. (an unnamed storm in 1991).

Similarly, for <LONG> (2009), its value is computed to be about $57.9 \pm 20d$, or about 57.9° ± 2° W., using $d = \pm 1°$. Since yearly values of <LONG> have never been eastward of 52.2° W. (1990) or more westward than 79.4° W. (1956), this seems to suggest that <LONG> for 2009 will lie between 55.9° and 59.9° W., inferring that the yearly average will lie eastward of the mean longitude (64.5° W.). Based on the 1950–2008 yearly values, individual tropical cyclones have always originated between 18.5° W. (an unnamed storm in 1988) and 97.4° W. (Amelia in 1978).

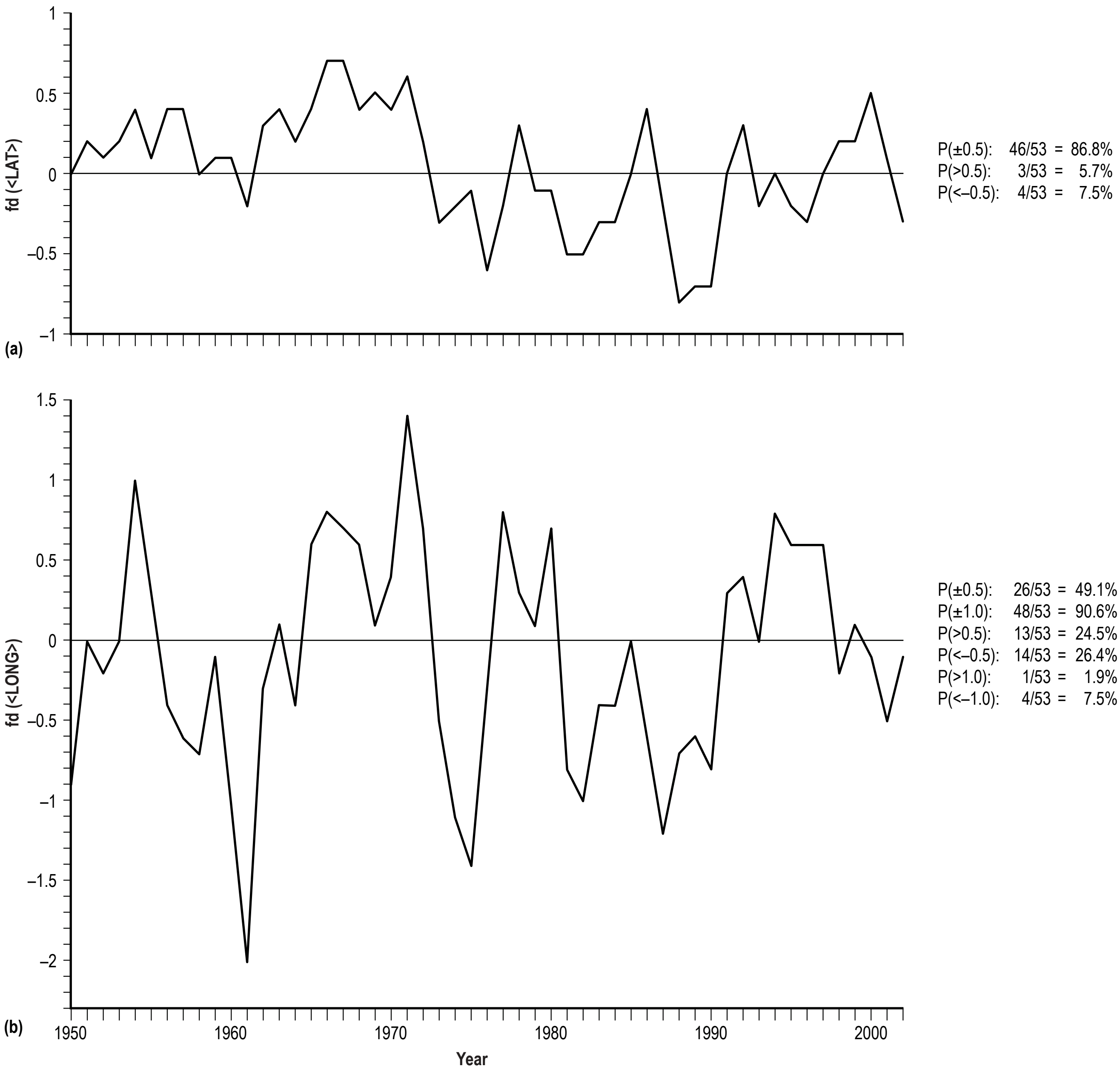

Figure 10. Yearly variation of the first differences of the 10-yma values of (a) <LAT> and (b) <LONG> for the interval 1950–2002.

2.7 First Differences in 10-yma Values of Peak Wind Speeds and Pressures

Figure 11 displays the fd values for (a) PWS, (b) <PWS>, (c) LP, and (d) <LP>. As before, the distribution of fd values tends to be concentrated centrally. For fd (PWS), 29 of 53 seasons (54.7%) have values that lie within ±1 kt and 46 of 53 seasons (86.8%) have values that lie within ±2 kt. For fd (<PWS>), 44 of 53 seasons (83%) have values that lie within ±1 kt. For fd (LP), 24 of 53 seasons (45.3%) have values that lie within ±1 mb and 40 of 53 seasons (75.5%) have values that lie within ±2 mb. For fd (<LP>), 48 of 53 seasons (90.6%) have values that lie within ±1 mb.

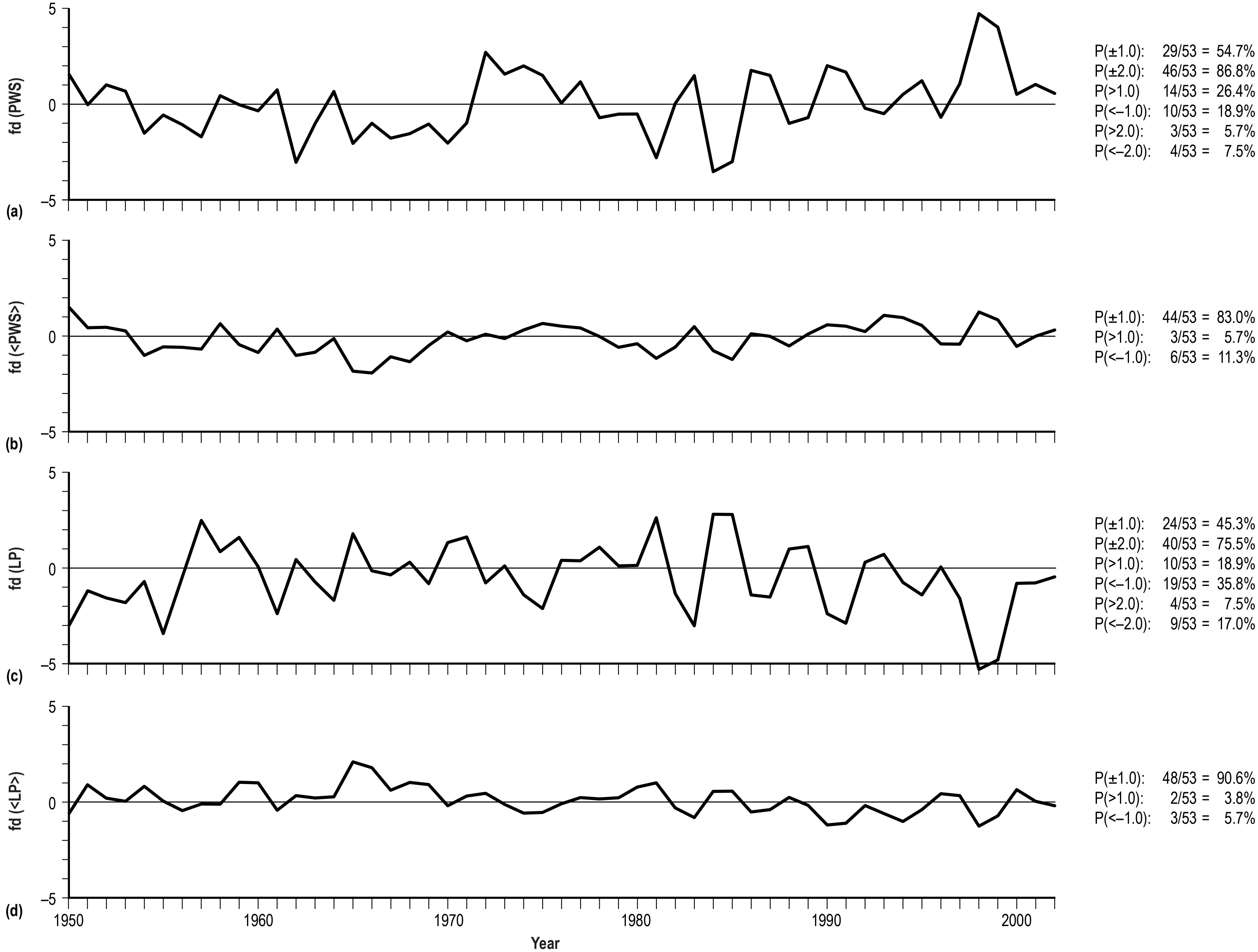

Figure 11. Yearly variation of the first differences of the 10-yma values of (a) PWS, (b) <PWS>, (c) LP, and (d) <LP> for the interval 1950–2002.

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For PWS (2009), its computed value is 165 ± 20*d*, suggesting a 92.5% probability that PWS during 2009 will exceed 125 kt (using *d* = ±2). The average *d* during the interval 1990–2002 is 1.2 (*sd* = 1.6 and range of –0.7 to 4.7), meaning that if *d* = 1.2 for 2003, then PWS (2009) would be 189 kt. The highest yearly PWS is 165 kt (Camille in 1969 and Allen in 1980) and the lowest yearly PWS is 75 kt (Gladys in 1968). Therefore, it seems more plausible that PWS (2009) ≤165 kt, probably somewhere in the range of 125 to 165 kt.

For <PWS> (2009), its computed value is 95.7 ± 20*d*, suggesting an 88.7% probability that <PWS> for 2009 will exceed 75.7 kt (using *d* = ±1). The average *d* during the interval 1990–2002 is 0.4 (*sd* = 0.6 and range of –0.5 to 1.3), meaning that if *d* = 0.4 for 2003, then <PWS> (2009) would be 103.7 kt. The highest yearly <PWS> is 100.4 kt in 1950 and the lowest yearly <PWS> is 56.3 kt in 1997. Therefore, it seems more plausible that <PWS> (2009) ≤100.4 kt, probably, somewhere in the range of 75.7 to 100.4 kt.

For LP (2009), its computed value is 891 ± 20*d*, suggesting a 92.5% probability that LP during 2009 will fall below 931 mb (using *d* = ±2). The average *d* during the interval 1990–2002 is –1.6 (*sd* = 1.8 and range of –5.3 to 0.7), meaning that if *d* = –1.6, then LP (2009) would be 899 mb. The lowest yearly LP is 882 mb (Wilma in 2005) and the highest yearly LP is 978 mb (Earl in 1986). Therefore, it seems more plausible that LP (2009) ≥899 mb, probably, somewhere in the range of 899 to 931 mb. Only four tropical cyclones have had LP ≤902 mb. These include Gilbert – 888 mb in 1988 and Katrina – 902 mb, Rita – 897 mb, and Wilma – 882 mb in 2005.

For <LP> (2009), its computed value is 958.3 ± 20*d*, suggesting a 96.3% probability that <LP> for 2009 will fall below 978.3 mb (using *d* = ±1). The average *d* during the interval 1990–2002 is –0.4 (*sd* = 0.6 and range of –1.2 to 0.6), meaning that if *d* = –0.4, then <LP> (2009) would be 950.3 mb. The lowest yearly <LP> is 951.4 mb in 1955 and the highest yearly <LP> is 992.1 mb in 1987. Therefore, it seems more plausible that <LP> (2009) ≥951.4 mb, probably, somewhere in the range of 951.4 to 978.3 mb.

2.8 Temperature and Decadal-Length Oscillations

Figure 12 shows the yearly variation of (a) the mean surface-air temperature as measured at the Armagh Observatory (Northern Ireland) (<AT>) and (b) the <ONI> based on ERSST.v3b for the interval 1950–2008, both measured in degrees Celsius and following the same construction used in previous figures. Concerning <AT> (fig. 12(a)), the trend line (i.e., 10-yma values, the thick, smoothed line) is relatively flat in the 1950s, having a value of about 9.4–9.5 °C (essentially, the mean value, 9.47 °C). Cooling occurs in the 1960s and 1970s, followed by a warming from the 1980s through the present. The trend line exceeds the mean beginning in 1991 and measures 10.13 °C in 2002 and 2003, which is the highest 10-yma value ever seen in the Armagh Observatory surface-air temperature data (extending back to 1844). Since 1995, 10 of 14 years have had yearly <AT> exceeding 10 °C, and since 1990, 13 of 19 years have been warmer than the mean temperature. For 2008, <AT> fell below 10 °C, measuring 9.78 °C, which is the first time this has happened since 2001. Monthly values of Armagh surface-air temperatures can be found online at <http://climate.arm.ac.uk/scan.html>[26] and monthly and yearly values can be found online at <http://climate.arm.ac.uk.calibrated/airtemp/index.html>.[27]

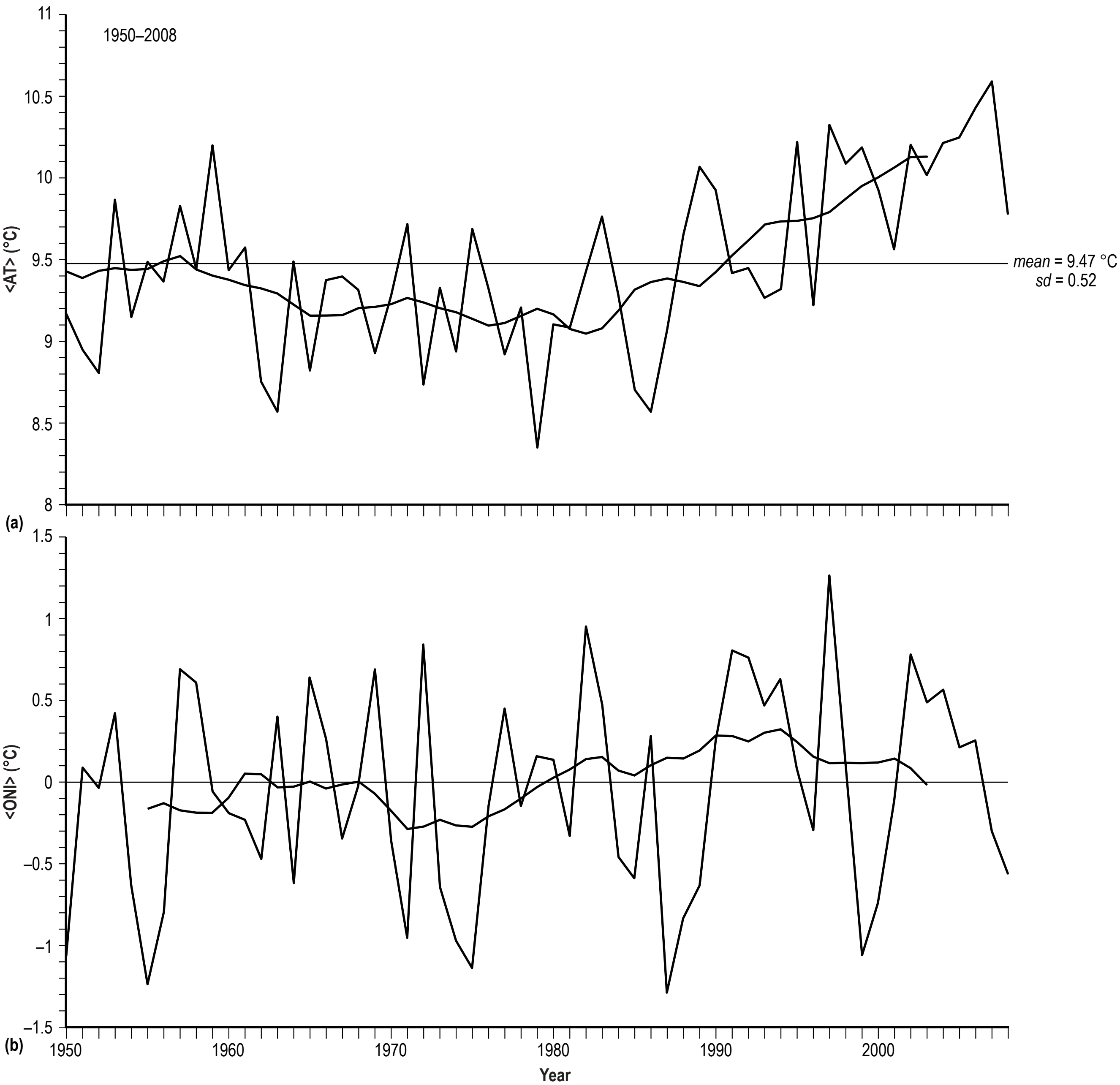

Figure 12. Yearly variation of the (a) <AT> and (b) <ONI> for the interval 1950–2008.

Concerning <ONI> (fig. 12(b), its trend line typically was of negative value during the 1950s, near zero during the 1960s, of negative value again in the 1970s, and of positive value in the 1980s and 1990s. The trend line appears to have turned negative again in 2003. Since 1995, 8 of 14 years have had yearly <ONI> positive values, and since 1990, 13 of 19 years have had yearly <ONI> positive values. For 2007 and 2008, <ONI> values are –0.30 and –0.56, respectively. (<ONI>, as used here, is simply the average of the monthly ONI values for the year. As noted in the Introduction, monthly ONI values can be found online.[2])

Figure 13 displays the yearly variation of three other possibly important indices: (a) <SOI>, (b) <NAO>, and (c) <EA>. The SOI is calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti (French Polynesia) and Darwin (Australia). Sustained negative values of the SOI often indicate the occurrences of EN events, while sustained positive values often indicate the occurrences of LN events. The SOI monthly values can be found online at <http://www.bom.gov.au/climate/glossary/soi.shtml>.[28]

The NAO is a prominent teleconnection pattern, one that consists of a north-south dipole of anomalies, with one center located over Greenland and the other of opposite sign spanning central latitudes of the North Atlantic Ocean between 35° N. and 40° N. The positive phase of the NAO reflects below-normal heights and pressure across the high latitudes of the North Atlantic Ocean and above-normal heights and pressure over the central Atlantic Ocean, the eastern United States and Western Europe, while the negative phase reflects an opposite pattern of heights and pressure over these regions. Both the positive and negative phases are associated with basin-wide changes in the intensity and location of the North Atlantic jet stream and storm track, and in large-scale modulations of the normal patterns of zonal and meridional heat and moisture transport.[29] The NAO exhibits considerable interseasonal and interannual variability, and prolonged periods (of several months length) of both positive and negative phases of the pattern are common.

The EA is another prominent teleconnection pattern over the North Atlantic Ocean. It consists of a north-south dipole of anomaly centers spanning the North Atlantic Ocean from east to west. The positive phase of the EA pattern is associated with above-average surface temperatures in Europe in all months and below-average temperatures over the southern United States during January–May and the north-central United States during July–October. The EA pattern exhibits very strong multidecadal variability, with the negative phase prevailing during much of 1950–1976 and the positive phase occurring during much of 1977–2008.[30] Monthly values of the NAO and EA indices are available online at <ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh>.[31]

Concerning <SOI> (fig. 13(a)), the trend line generally was of positive value between 1950 and 1977, turning negative in value in 1978 and remaining so until 2003 when its value became positive. The highest yearly positive value occurred in 1950 (15.38) and the most negative yearly value occurred in 1987 (–13.08). The value in 2008 was 10.17. Since 1995, 8 of 14 years have had yearly <SOI> negative values, and since 1990, 13 of 19 years have had yearly <SOI> negative values.

Concerning <NAO> (fig. 13(b)), the trend line was of negative value prior to 1974 and generally of positive value since 1974, although it appears highly likely to be on the precipice of turning negative once again. The highest yearly positive value occurred in 1989 (0.70) and the most negative yearly value occurred in 1968 (–0.94). The value in 2008 was –0.38. Since 1995, 8 of 14 years have had yearly <NAO> negative values, and since 1990, 8 of 19 years have had <NAO> negative values.

Concerning <EA> (fig. 13(c)), the trend line was of negative value prior to 1978 and has been of positive value since 1978. The highest yearly positive value occurred in 1998 (0.93) and the most negative yearly value occurred in 1976 (–1.04). The value in 2008 was 0.37. Since 1995, 13 of 14 years have had positive yearly <EA> values, and since 1990, 16 of 19 years have had positive yearly <EA> values.

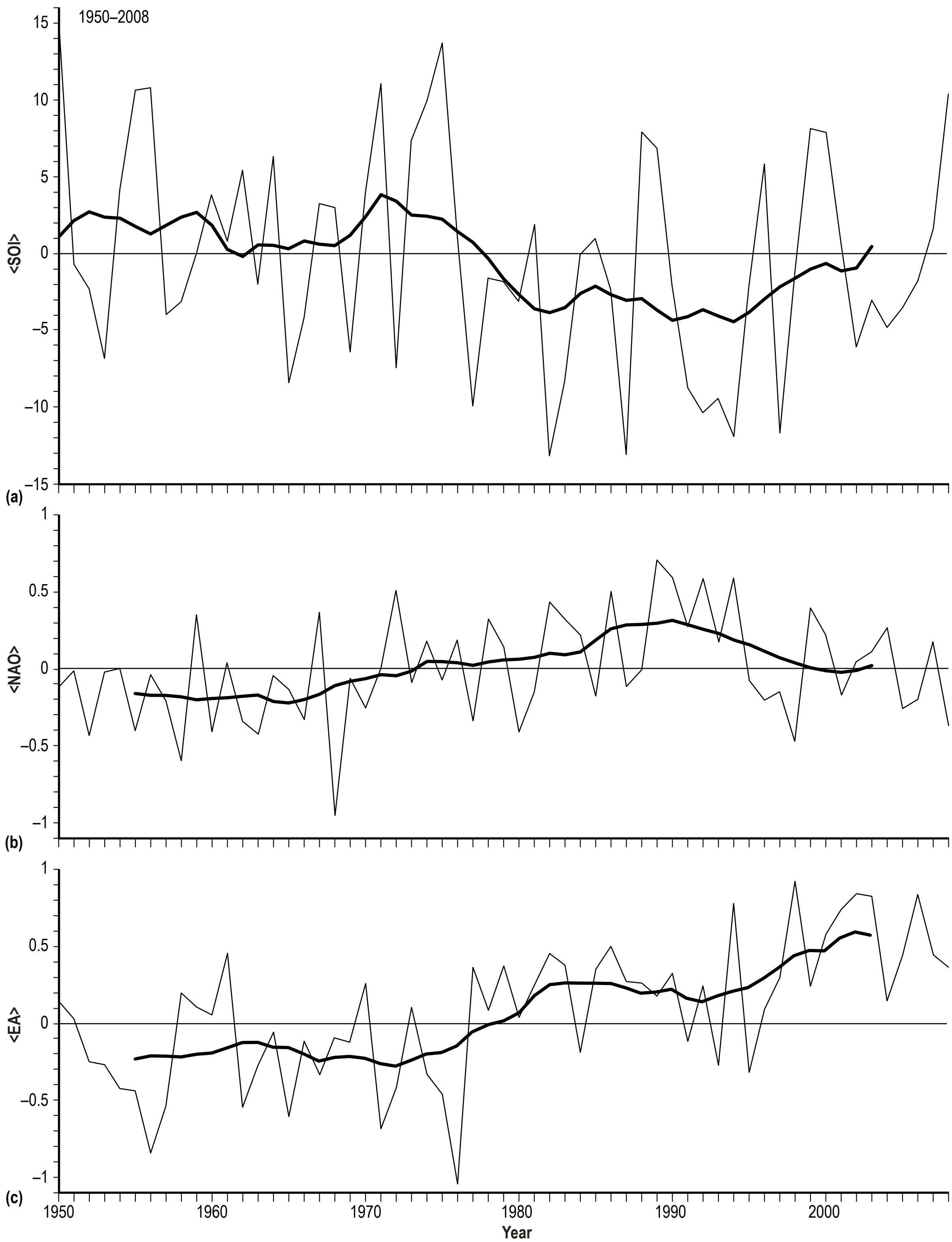

Figure 13. Yearly variation of the (a) <SOI>, (b) <NAO>, and (c) <EA> for the interval 1950–2008.

2.9 First Differences in 10-yma Values of <AT>, <ONI>, <SOI>, <NAO>, and <EA>

Figure 14 shows the fd values for (a) <AT>, (b) <ONI>, (c) <SOI>, (d) <NAO>, and (e) <EA>. For fd (<AT>), 39 of 53 fd values (73.6%) lie within the range ±0.05, with 18.9% probability of *d* > 0.05 and a 7.5% probability of *d* < –0.05. Because <AT> (2009) = 10.48 ± 20*d*, <AT> (2009) can be estimated to be 10.48 ± 1 °C (using *d* = ±0.05), inferring about 92.5% probability that <AT> (2009) ≥9.48 °C. The average *d* during the interval 1990–2002 is 0.05 (*sd* = 0.03 and range of zero to 0.09). Presuming *d* = 0.05, <AT> (2009) = 11.48 °C, which if true, would be a new record high at Armagh (the present record high is 10.59 °C in 2007, which is the highest yearly mean temperature at Armagh going back to 1844).

For fd (<ONI>), 32 of 48 fd values (66.7%) lie within the range ±0.05, with an equal number of fd values lying both above or below the central range (16.7% each). Because <ONI> (2009) = –0.46 ± 20*d*, <ONI> (2009) can be estimated to be –0.46 ± 1 °C (using *d* = ±0.05), inferring about an 83.4% probability of <ONI> (2009) being either ≥ –1.46 °C or ≤0.54 °C. The average *d* during the interval 1990–2002 is –0.02 (*sd* = 0.05 and range = –0.11 to 0.05). Presuming *d* = –0.02, <ONI> (2009) = –0.86 °C.

For fd (<SOI>), 26 of 53 fd values (49.1%) lie within the range ±0.5, with a 28.3% probability of *d* >0.5 and a 22.6% probability of *d* < –0.5. Because <SOI> (2009) = –3.21 ± 20*d*, <SOI> (2009) can be estimated to be –3.21 ± 10 (using *d* = ±0.5), inferring about a 77.4% probability of <SOI> (2009) being ≥ –13.21. The average *d* during the interval 1990–2002 is 0.36 (*sd* = 0.51 and range = –0.45 to 1.22). Presuming *d* = 0.36, <SOI> (2009) = 3.99.

For fd (<NAO>), 44 of 48 fd values (91.7%) lie within the range ±0.05, with an 8.3% probability of *d* >0.05 and 0% probability of *d* < –0.05. Because <NAO> (2009) = 0.37 ± 20*d*, <NAO> (2009) can be estimated to be 0.37 ± 1 (using *d* = ±0.05), inferring about a 100% probability of <NAO> (2009) being ≥–0.63. The average *d* during the interval 1990–2002 is –0.02 (*sd* = 0.02 and range = –0.05 to 0.03). Presuming *d* = –0.02, <NAO> (2009) = –0.03.

For fd (<EA>), 40 of 48 fd values (83.3%) lie within the range ±0.05, with a 14.6% probability of *d* > 0.05 and a 2.1% probability of *d* < –0.05. Because <EA> (2009) = 0.77 ± 20*d*, <EA> (2009) can be estimated to be 0.77 ± 1 (using *d* = ±0.05), inferring about a 97.9% probability of <EA> (2009) being ≥–0.23. The average *d* during the interval 1990–2002 is 0.03 (*sd* = 0.04 and range = –0.06 to 0.08). Presuming *d* = 0.03, <EA> (2009) = 1.37, which is higher than 0.93 in 1998, the previous high.

2.10 Single- and Bi-Variate Fits

Visual comparison of figures 1, 2, 6, and 7 against figures 12 and 13 and of figures 9–11 against figure 14 suggests possibly strong associations to exist between 10-yma values of the tropical cyclone parameters and, in particular, Armagh temperature, and perhaps some of the decadal-length oscillation parameters as well. Table 9 gives the results of linear regression analysis comparing 10-yma values of the parameters, grouped by the determining parameter (i.e., <AT>, <ONI>, <SOI>, <NAO>, and <EA>), arranged in decreasing order of the inferred coefficient of correlation (*r*), and limited to confidence levels (*cl*) >95% for the common interval 1955–2003. Some 26 correlations are identified. Interestingly, 9 of the 10 tropical cyclone parameters associate strongly with Armagh

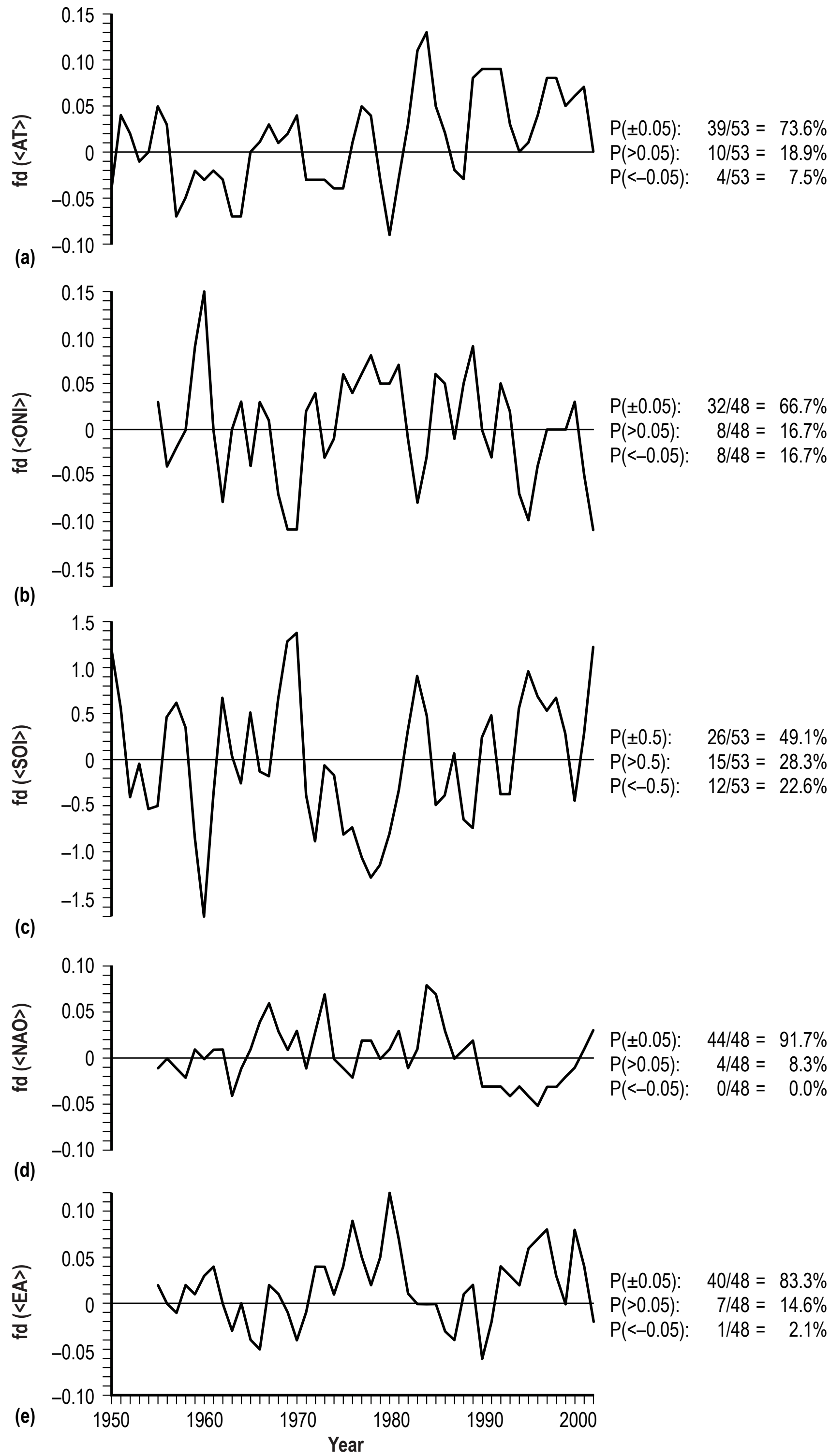

Figure 14. Yearly variation of the first differences of the 10-yma values of (a) <AT>, (b) <ONI>, (c) <SOI>, (d) <NAO>, and (e) <EA> for the interval 1950–2002.

Table 9. Inferred statistically important linear regressions (*cl* > 95%).

Regression Equation	*r*	*r*×*r*	*se*	*cl*
NTC = –35.460 + 4.864<AT>	0.880	0.775	0.792	>99.9
NH = –16.127 + 2.348<AT>	0.851	0.725	0.464	>99.9
LP = 1,060.636 – 13.059<AT>	–0.785	0.616	3.124	>99.9
NMH = –14.519 + 1.797<AT>	0.693	0.480	0.564	>99.9
<LAT> = 59.192 – 3.877<AT>	–0.673	0.452	1.288	>99.9
NUSLFH = –3.973 + 0.583<AT>	0.537	0.288	0.277	>99.9
<LONG> = 96.090 – 3.344<AT>	–0.460	0.212	1.918	>99.9
PWS = 63.986 + 6.530<AT>	0.409	0.167	4.358	>99.5
<LP> = 1,020.133 – 4.305<AT>	–0.401	0.161	2.966	>99.5
<LONG> = 64.707 – 10.696<ONI>	–0.824	0.679	1.247	>99.9
<LAT> = 22.730 – 4.830<ONI>	–0.470	0.220	1.537	>99.9
<PWS> = 74.576 – 9.055<ONI>	–0.410	0.168	3.406	>99.5
<LONG> = 65.027 + 0.618<SOI>	0.691	0.478	1.581	>99.9
<PWS> = 75.057 + 0.829<SOI>	0.545	0.297	3.129	>99.9
<PWS> = 74.765 – 19.852<NAO>	–0.855	0.731	1.938	>99.9
<LP> = 979.389 + 14.173<NAO>	0.703	0.495	2.305	>99.9
PWS = 125.743 – 18.746<NAO>	–0.625	0.390	3.773	>99.9
NMH = 2.443 – 2.719<NAO>	–0.559	0.312	0.649	>99.9
<LONG> = 64.700 – 7.165<NAO>	–0.525	0.276	1.874	>99.9
NTC = 10.100 + 4.093<EA>	0.659	0.435	1.255	>99.9
LP = 938.338 – 11.378<EA>	–0.609	0.370	3.989	>99.9
<LONG> = 64.885 – 4.803<EA>	–0.588	0.346	1.778	>99.9
NH = 5.897 + 1.512<EA>	0.488	0.238	0.729	>99.9
<PWS> = 74.850 – 6.162<EA>	–0.444	0.197	3.348	>99.8
NUSLFH = 1.495 + 0.422<EA>	0.345	0.119	0.308	>98
<LAT> = 22.803 – 2.058<EA>	–0.318	0.101	1.648	>95

surface air temperature. Only <PWS> fails to strongly associate with <AT>, although it is strongly associated with <NAO>.

Table 10 rearranges the 26 inferred correlations given in table 9 by tropical cyclone parameter in descending order of *r*. For NTC, two correlations are highly statistically important (*cl* > 99.9%), the strongest being the one against the 10-yma of <AT>. Its *r* equals 0.880, inferring that the regression can explain about 77.5% of the variance in the 10-yma of NTC. <AT> also provides the strongest correlations for NH (*r* = 0.851), NMH (*r* = 0.693), NUSLFH (*r* = 0.537), <LAT> (*r* = –0.673), and LP (*r* = –0.785). <ONI> provides the strongest correlation for <LONG> (*r* = –0.824), and <NAO> provides the strongest correlations for PWS (*r* = –0.625), <PWS> (*r* = –0.855), and <LP> (*r* = 0.703).

Table 11 gives the results of bi-variate analysis for the interval 1955–2003 for the tropical cyclone parameters, using <AT> in combination with each of the other determining parameters (i.e., <ONI>, <SOI>, <NAO>, and <EA>), arranged by tropical cyclone parameter and in

Table 10. Inferred statistically important linear regressions (*cl* > 95%), grouped by tropical cyclone parameter in descending order of *r*.

Regression Equation	*r*	*r*×*r*	*se*	*cl*
NTC = –35.460 + 4.864<AT>	0.880	0.775	0.792	>99.9
NTC = 10.100 + 4.093<EA>	0.659	0.435	1.255	>99.9
(NTC: *m* = 10.345, *sd* = 1.652)				
NH = –16.127 + 2.348<AT>	0.851	0.725	0.464	>99.9
NH = 5.897 + 1.512<EA>	0.488	0.238	0.729	>99.9
(NH: *m* = 5.988, *sd* = 0.825)				
NMH = –14.519 + 1.797<AT>	0.693	0.480	0.564	>99.9
NMH = 2.443 – 2.719<NAO>	–0.559	0.312	0.649	>99.9
(NMH: *m* = 2.404, *sd* = 0.775)				
NUSLFH = –3.973 + 0.583<AT>	0.537	0.288	0.277	>99.9
NUSLFH = 1.495 + 0.422<EA>	0.345	0.119	0.308	>98
(NUSLFH: *m* = 1.520, *sd* =0.325)				
<LAT> = 59.192 – 3.877<AT>	–0.673	0.452	1.288	>99.9
<LAT> = 22.730 – 4.830<ONI>	–0.470	0.220	1.537	>99.9
<LAT> = 22.803 – 2.058<EA>	–0.318	0.101	1.648	>95
(<LAT>: *m* = 22.680, *sd* = 1.723)				
<LONG> = 64.707 – 10.696<ONI>	–0.824	0.679	1.247	>99.9
<LONG> = 65.027 + 0.618<SOI>	0.691	0.478	1.581	>99.9
<LONG> = 64.885 – 4.803<EA>	–0.588	0.346	1.778	>99.9
<LONG> = 64.700 – 7.165<NAO>	–0.525	0.276	1.874	>99.9
<LONG> = 96.090 – 3.344<AT>	–0.460	0.212	1.918	>99.9
(<LONG>: *m* = 64.598, *sd* = 2.172)				
PWS = 125.743 – 18.746<NAO>	–0.625	0.390	3.773	>99.9
PWS = 63.986 + 6.530<AT>	0.409	0.167	4.358	>99.5
(PWS: *m* = 125.476, *sd* = 4.775)				
<PWS> = 74.765 – 19.852<NAO>	–0.855	0.731	1.938	>99.9
<PWS> = 75.057 + 0.829<SOI>	0.545	0.297	3.129	>99.9
<PWS> = 74.850 – 6.162<EA>	–0.444	0.197	3.348	>99.8
<PWS> = 74.576 – 9.055<ONI>	–0.410	0.168	3.406	>99.5
(<PWS>: *m* = 74.482, *sd* = 3.696)				
LP = 1,060.636 – 13.059<AT>	–0.785	0.616	3.124	>99.9
LP = 938.338 – 11.378<EA>	–0.609	0.370	3.989	>99.9
(LP: *m* = 937.657, *sd* = 4.974)				
<LP> = 979.389 + 14.173<NAO>	0.703	0.495	2.305	>99.9
<LP> = 1,020.133 – 4.305<AT>	–0.401	0.161	2.966	>99.5
(<LP>: *m* = 979.592, *sd* = 3.207)				

Table 11. Statistically important bi-variate correlations, grouped by tropical cyclone parameter in descending order of *R*.

Bi-variate Fit	*R*	*R*×*R*	*SE*
NTC = –37.133 + 5.049<AT> + 0.098<SOI>	0.904	0.818	0.720
NTC = –39.378 + 5.282<AT> – 1.741<ONI>	0.893	0.797	0.761
NTC = –36.003 + 4.923<AT> – 0.857<NAO>	0.883	0.779	0.793
NTC = –31.797 + 4.471<AT> + 0.640<EA>	0.882	0.779	0.794
(NTC: *m* = 10.345, *sd* = 1.652)			
NH = –17.432 + 2.490<AT> – 2.003<NAO>	0.933	0.870	0.304
NH = –17.735 + 2.526<AT> + 0.094<SOI>	0.888	0.789	0.387
NH = –19.048 + 2.660<AT> – 1.291<ONI>	0.883	0.779	0.396
NH = –19.357 + 2.695<AT> – 0.568<EA>	0.861	0.742	0.428
(NH: *m* = 5.988, *sd* = 0.825)			
NMH = –16.620 + 2.025<AT> – 3.231<NAO>	0.953	0.908	0.240
NMH = –16.880 + 2.058<AT> + 0.138<SOI>	0.811	0.658	0.463
NMH = –23.567 + 2.768<AT> – 1.590<EA>	0.798	0.637	0.477
NMH = –18.503 + 2.222<AT> – 1.765<ONI>	0.770	0.593	0.505
(NMH: *m* = 2.404, *sd* = 0.775)			
NUSLFH = –4.422 + 0.632<AT> – 0.685<NAO>	0.626	0.391	0.259
NUSLFH = –4.310 + 0.624<AT> + 0.066<SOI>	0.569	0.324	0.273
NUSLFH = –4.296 + 0.618<AT> – 0.055<EA>	0.537	0.289	0.280
NUSLFH = –4.345 + 0.623<AT> – 0.163<ONI>	0.537	0.289	0.280
(NUSLFH: *m* = 1.520, *sd* = 0.325)			
<LAT> = 60.886 – 4.061<AT> + 2.587<NAO>	0.720	0.518	1.222
<LAT> = 69.282 – 4.960<AT> + 1.771<EA>	0.703	0.495	1.251
<LAT> = 54.061 – 3.330<AT> – 2.274<ONI>	0.698	0.488	1.260
<LAT> = 58.204 – 3.768<AT> + 0.058<SOI>	0.684	0.468	1.284
(<LAT>: *m* = 22.680, *sd* = 1.723)			
<LONG> = 73.446 – 0.929<AT> – 9.998<ONI>	0.796	0.633	1.344
<LONG> = 86.564 – 2.292<AT> + 0.551<SOI>	0.757	0.572	1.451
<LONG> = 91.856 – 2.885<AT> – 6.450<NAO>	0.635	0.403	1.714
<LONG> = 72.111 – 0.771<AT> – 4.206<EA>	0.605	0.366	1.766
(<LONG>: *m* = 64.598, *sd* = 2.172)			
PWS = 50.420 + 8.001<AT> – 20.771<NAO>	0.772	0.596	3.100
PWS = 49.444 + 8.136<AT> + 0.843<SOI>	0.583	0.340	3.963
PWS = 36.081 + 9.506<AT> – 12.328<ONI>	0.537	0.288	4.116
PWS = 19.223 + 11.331<AT> – 7.524<EA>	0.523	0.274	4.156
(PWS: *m* = 125.476, *sd* = 4.775)			
<PWS> = 57.976 + 1.783<AT> – 20.321<NAO>	0.849	0.721	1.993
<PWS> = 1.798 + 7.796<AT> – 12.190<EA>	0.646	0.417	2.882
<PWS> = 55.943 + 2.034<AT> + 0.887<SOI>	0.568	0.322	3.108
<PWS> = 159.981 – 9.067<AT> – 11.485<ONI>	0.417	0.174	3.432
(<PWS>: *m* = 74.482, *sd* = 3.696)			
LP = 1,076.797 – 14.783<AT> + 7.145<ONI>	0.896	0.802	2.260

Table 11. Statistically important bi-variate correlations, grouped by tropical cyclone parameter in descending order of R (Continued).

Bi-variate Fit							R	$R \times R$	SE
LP	=	1,064.874	–	13.519<AT>	+	6.510<NAO>	0.864	0.746	2.562
LP	=	1,067.178	–	13.782<AT>	–	0.380<SOI>	0.812	0.659	2.967
LP	=	1,046.571	–	11.550<AT>	–	2.468<EA>	0.806	0.650	3.008
(LP: *m* = 937.657, *sd* = 4.974)									
<LP>	=	1,031.198	–	5.504<AT>	+	15.525<NAO>	0.861	0.741	1.669
<LP>	=	1,036.661	–	6.068<AT>	+	7.324<ONI>	0.781	0.610	2.045
<LP>	=	1,031.102	–	5.517<AT>	–	0.639<SOI>	0.642	0.412	2.513
<LP>	=	1,077.638	–	10.476<AT>	+	10.103<EA>	0.615	0.379	2.582
(<LP>: *m* = 979.592, *sd* = 3.207)									

descending order of the bi-variate coefficient of correlation (R). Slight improvements in the inferred fits are seen, as compared to the single-variate linear correlations (tables 9 and 10), except for <LONG>. For example, the best bi-variate fit for NTC is the one using both <AT> and <SOI>. It has an $r = 0.904$ and $se = 0.720$, as compared to the single-variate fit using <AT> alone, which has $R = 0.880$ and $SE = 0.792$. Similarly, the best bi-variate fits for NH and NMH use the combination of <AT> and <NAO>, and appear to greatly improve their estimates, as compared to the single-variate fits using <AT> alone (from 0.851 to 0.933 and from 0.693 to 0.953, respectively). This suggests that the bi-variate fits might provide a means for improved forecasting of the frequencies of North Atlantic basin tropical cyclone activity during a season, provided good estimates for <AT>, <ONI>, <SOI>, <NAO>, and <EA> can be made. The combination of <AT> and <NAO> also provides improved correlation for NUSLFH, <LAT>, PWS, and <LP>; the combination of <AT> and <ONI> provides improved correlation for LP; and the single-variate fit using <ONI> alone seems to be the best for estimating <LONG>.

Previously, it was shown[1] that the current high-activity interval has even stronger correlations when limited to just the last several years or so. The analysis is repeated here using a slightly longer interval (1990–2003) and using all the parameters (<AT>, <ONI>, <SOI>, <NAO>, and <EA>), not just <AT> and <ONI>. Table 12 gives the results of single-variate linear correlation analysis arranged like table 10. Plainly, limiting the analysis to just the last several years (i.e., the current high-activity interval) greatly strengthens all of the inferred correlations. Because the linear correlation analyses typically resulted in correlations having $r > 0.9$, bi-variate analysis was eschewed.

Using the more limited interval 1990–2003, one finds that the correlation between NTC and <AT> is even more highly statistically important, having $r = 0.977$ and $se = 0.488$, than that found for the longer interval 1955–2003 (table 10), having $r = 0.880$ and $se = 0.792$, or than that derived using the best bi-variate correlation (table 11), having $R = 0.904$ and $SE = 0.720$. Presuming the validity of the inferred limited interval correlations for the 2004 10-yma estimated values, one might be able to better guess, in particular, the frequencies for the 2009 North Atlantic basin hurricane season, and possibly even for the values of the other tropical cyclone parameters (<LAT>, <LONG>, PWS, <PWS>, LP, and <LP>) as well.

Table 12. Results of single-variate linear correlation analysis using the limited time interval 1990–2003 ($n = 14$), grouped by tropical cyclone parameter in descending order of r.

Regression Equation	*r*	*r*×*r*	*se*	*cl*
NTC = –72.326 + 8.622<AT>	0.977	0.955	0.488	>99.9
NTC = 15.214 + 1.140<SOI>	0.959	0.920	0.564	>99.9
NTC = 8.283 + 11.263<EA>	0.957	0.916	0.577	>99.9
NTC = 13.936 – 14.772<NAO>	–0.933	0.870	0.717	>99.9
NTC = 15.217 – 16.343<ONI>	–0.863	0.745	1.005	>99.9
(NTC: *m* = 12.321, *sd* = 1.921)				
NH = –36.186 + 4.385<AT>	0.985	0.970	0.217	>99.9
NH = 7.709 – 7.725<NAO>	–0.967	0.935	0.248	>99.9
NH = 8.296 + 0.564<SOI>	0.941	0.885	0.333	>99.9
NH = 4.869 + 5.564<EA>	0.937	0.878	0.354	>99.9
NH = 8.310 – 8.159<ONI>	–0.854	0.729	0.521	>99.9
(NH: *m* = 6.864, *sd* = 0.969)				
NMH = 3.576 – 6.314<NAO>	–0.980	0.960	0.161	>99.9
NMH = –31.290 + 3.481<AT>	0.969	0.939	0.220	>99.9
NMH = 4.039 + 0.454<SOI>	0.939	0.882	0.273	>99.9
NMH = 1.302 + 4.417<EA>	0.922	0.850	0.315	>99.9
NMH = 4.053 – 6.592<ONI>	–0.855	0.731	0.424	>99.9
(NMH: *m* = 2.886, *sd* = 0.782)				
NUSLFH = 0.807 + 2.251<EA>	0.878	0.771	0.209	>99.9
NUSLFH = –14.563 + 1.648<AT>	0.857	0.734	0.218	>99.9
NUSLFH = 2.155 + 0.213<SOI>	0.822	0.676	0.247	>99.9
NUSLFH = 1.907 – 2.678<NAO>	–0.777	0.604	0.274	>99.8
NUSLFH = 2.111 – 2.804<ONI>	–0.680	0.462	0.319	>99
(NUSLFH: *m* = 1.614, *sd* = 0.419)				
<LAT> = 21.114 + 0.525<ONI>	0.156	0.024	0.355	<90
<LAT> = 21.161 + 0.423<NAO>	0.151	0.023	0.348	<90
<LAT> = 21.118 + 0.249<EA>	0.119	0.014	0.347	<90
<LAT> = 21.181 – 0.010<SOI>	–0.049	0.002	0.380	<90
<LAT> = 20.454 + 0.077<AT>	0.0.49	0.002	0.238	<90
(<LAT>: *m* = 21.207, *sd* = 0.341)				
<LONG> = 63.311 – 9.248<NAO>	–0.941	0.886	0.389	>99.9
<LONG> = 60.001 + 6.411<EA>	0.878	0.771	0.606	>99.9
<LONG> = 63.906 + 0.633<SOI>	0.858	0.736	0.633	>99.9
<LONG> = 64.044 – 9.844<ONI>	–0.838	0.702	0.666	>99.9
<LONG> = 19.545 + 4.355<AT>	0.795	0.633	0.815	>99.8
(<LONG>: *m* = 62.300, *sd* = 1.192)				
PWS = –105.796 + 23.641<AT>	0.939	0.882	2.028	>99.9
PWS = 134.102 + 3.078<SOI>	0.907	0.823	2.404	>99.9
PWS = 115.423 + 30.314<EA>	0.903	0.815	2.456	>99.9
PWS = 130.470 – 38.221<NAO>	–0.846	0.716	3.037	>99.9

Table 12. Results of single-variate linear correlation analysis using the limited time interval 1990–2003 (*n* = 14), grouped by tropical cyclone parameter in descending order of *r* (Continued).

Regression Equation	*r*	*r*×*r*	*se*	*cl*
PWS = 133.783 – 42.284<ONI>	–0.783	0.613	3.554	>99.9
(PWS: *m* = 126.293, *sd* = 5.482)				
<PWS> = 74.551 – 14.582<NAO>	–0.958	0.918	0.534	>99.9
<PWS> = –4.306 + 7.870<AT>	0.927	0.895	0.842	>99.9
<PWS> = 75.468 + 0.990<SOI>	0.865	0.748	1.003	>99.9
<PWS> = 69.462 + 9.747<EA>	0.861	0.741	0.984	>99.9
<PWS> = 75.603 – 14.936<ONI>	–0.820	0.672	1.098	>99.9
(<PWS>: *m* = 72.957, *sd* = 1.848)				
LP = 1,236.908 – 30.974<AT>	–0.955	0.912	3.005	>99.9
LP = 922.587 – 4.040<SOI>	–0.924	0.854	2.536	>99.9
LP = 947.085 – 39.739<EA>	–0.918	0.843	2.905	>99.9
LP = 927.256 + 51.053<NAO>	0.877	0.769	3.585	>99.9
LP = 922.941 + 55.857<ONI>	0.802	0.643	4.393	>99.9
(LP: *m* = 932.836, *sd* = 7.064)				
<LP> = 977.523 + 13.252<NAO>	0.939	0.882	0.759	>99.9
<LP> = 1,050.179 – 7.253<AT>	–0.922	0.850	0.962	>99.9
<LP> = 976.743 – 0.878<SOI>	–0.829	0.687	1.389	>99.5
<LP> = 981.969 – 8.361<EA>	–0.797	0.635	1.291	>99.5
<LP> = 976.956 + 11.758<ONI>	0.669	0.448	1.328	>99
(<LP>: *m* = 978.971, *sd* = 1.713)				

For NH, the best linear correlation is based on <AT>, having *r* = 0.985 and *se* = 0.217. For NMH, the best linear correlation is based on <NAO>, having *r* = –0.980 and *se* = 0.161. For NUSLFH, the best linear correlation is based on <EA>, having *r* = 0.878 and *se* = 0.209. For <LONG>, the best linear correlation is based on <NAO>, having *r* = –0.941 and *se* = 0.389. For PWS, the best linear correlation is based on <AT>, having *r* = 0.939 and *se* = 2.028. For <PWS>, the best linear correlation is based on <NAO>, having *r* = –0.958 and *se* = 0.534. For LP, the best linear correlation is based on <AT>, having *r* = –0.955 and *se* = 3.005. For <LP>, the best linear correlation is based on <NAO>, having *r* = 0.939 and *se* = 0.759. None of the inferred correlations are statistically important for <LAT> during the limited interval 1990–2003.

3. SUMMARY

As noted in the previous study,[1] two groups provide extended forecasts in the month of December prior to the start of hurricane season, while the National Oceanic and Atmospheric Administration (NOAA) gives its official forecast in the month of May just before the start of hurricane season. The two groups giving the early estimates include the Colorado State University (CSU) team, given by P.J. Klotzbach and W.M. Gray, and the Tropical Storm Risk (TSR) team in the United Kingdom, given by M. Saunders and A. Lea. For the 2009 hurricane season, both teams have given initial estimates that call for increased activity exceeding long-term averages for NTC, NH, and NMH. In particular, the CSU team predicts that the 2009 hurricane season will see 14 tropical cyclones, 7 hurricanes, and 3 major hurricanes,[32] and the TSR team predicts that the 2009 hurricane season will see 10–19 tropical cyclones, 5–11 hurricanes, and 2–5 major hurricanes,[33] essentially the $\pm 1\sigma$ spread about the mean for the current high-activity interval 1995–2008. (Note added in proof: In April 2009, the CSU team reduced its December 2008 estimates for the 2009 hurricane season, from 14 to 12 tropical cyclones, from 7 to 6 hurricanes, and from 3 to 2 major hurricanes. Also, the TSR team slightly altered its estimates from 10 to 19 to about 11 to 19 tropical cyclones and from 5 to 11 to 5 to 10 hurricanes, while keeping the same estimate of 2 to 5 major hurricanes.)

For the interval 1950–2008, on average, there have been about 11 tropical cyclones, 6 hurricanes, 2–3 major hurricanes, and 1–2 U.S. land-falling hurricanes. Based on Poisson statistics, the central 50% intervals correspond approximately to 8–12 for NTC, 4–7 for NH, 1–3 for NMH, and 1–2 for NUSLFH using the entire interval 1950–2008, with a strong rightward (or positive) skew towards higher numbers. Instead, presuming a normal distribution and limiting oneself to the current high-activity interval 1995–2008, one projects the 90% prediction intervals to be about 7–23 for NTC, 3–13 for NH, 1–7 for NMH, and zero to 6 for NUSLFH, inferring only a 5% chance of having 24 or more tropical cyclones, 14 or more hurricanes, 8 or more major hurricanes, and 7 or more U.S. land-falling hurricanes.

On the basis of the behavior of NMH, it can be argued that the overall interval 1950–2008 can be subdivided into two high-activity intervals (1950–1965 and 1995–2008) separated by one low-activity interval (1966–1994). During the current high-activity interval, 12 of 14 years have had NTC above its long-term mean (10.8), averaging ≈14.9 per year (range 8 to 28); 11 of 14 years have had NH above its long-term mean (6.3), averaging ≈8.1 per year (range 3 to 15); 10 of 14 years have had NMH above its long-term mean (2.7), averaging ≈3.9 per year (range 1 to 7); and 8 of 14 years have had NUSLFH above its long-term mean (1.6), averaging ≈2.1 per year (range zero to 6).

During the interval 1950–2008, there have been 171 NENM, 195 NLNM, and 342 NNM. During the current high-activity interval, there have been 42 NENM, 45 NLNM, and 81 NNM, where EN and LN events are determined using the ONI, based on the ERSST.v3b. During the interval 1950–2008, there have been 17 EN and 13 LN events. Since May 1994, there have been 5 EN and 4 LN events, including two strong EN events (May 1997–May 1998 and May 2002–March 2003) and one strong LN event (July 1998–June 2000). Since May 1994, the 5 EN events have averaged ≈10 mo in duration (range 6 to 13 mo), while the 4 LN events have averaged ≈11 mo in duration (range 5 to 24 mo). During the interval 1950–2008, the recurrence rate for EN (from the end of one to the start of the next), on average, is ≈32 mo (range 3 to 64 mo) and the recurrence rate for LN is ≈43 mo (range 4 to 101 mo). The last EN event ended in January 2007 and the last LN event ended in May 2008. Presently, NOAA forecasts continuing LN-like to ENSO-neutral conditions to prevail in 2009. If the prediction is true, then the frequency of tropical cyclones in the North Atlantic basin should be average to above average in number during the 2009 hurricane season. If, however, another EN should suddenly appear, then the frequency of tropical cyclones in the North Atlantic basin should be average to below average in number during the 2009 hurricane season. Of the 17 EN events determined by ONI during the interval 1950–2008, all have onsets between April and November, with the month of May having the most onsets of EN events. Interestingly, 5 of the 6 onsets for EN events occurring in May were associated with strong events, and 6 of 8 strong EN events had onsets in April and/or May (8 of 8 had onsets in April–August). On average, strong EN events persist ≈13.6 mo in duration, peaking ≈6.8 mo after onset. So, if a strong EN event should happen to appear beginning in mid-2009, frequencies of tropical cyclones would be expected to be reduced in numbers, as compared to the averages of the current high-activity interval.

During any given season, the state of Florida stands better than a 28% chance of being struck somewhere along its coastline. Together, the states of Florida, North Carolina, Louisiana, and Texas have experienced about two-thirds of all previous land strikes by hurricanes in the United States during the interval 1950–2008. During 2008, three land-falling hurricanes struck the U.S. coastline, including Dolly (Texas), Gustav (Louisiana), and Ike (Texas and Louisiana).

By season's end, the location of the 10-yma values for <LAT> and <LONG> for 2004 is expected to remain in the lower-right quadrant of figure 3, below about 22.1° N. and eastward of 64.9° W. This suggests, perhaps, that greater production may occur from the group 4 area (lower North Atlantic-Cape Verdi area), an area that between 1950 and 2008 has accounted for about one-third of all tropical cyclones that became hurricanes and ≈30% of all U.S. land-falling hurricanes. Certainly, figure 8(a) suggests that tropical cyclones forming in the lower tropics are on the increase and will be a main contributor to this season's NTC, provided EN is not a factor in the 2009 North Atlantic basin hurricane season.

The 10-yma of PWS has been higher than its long-term average (127.3 kt) every year between 1998 and 2003 (the last available 10-yma year). In 2003, it measured 135 kt, a value equal to the previous high in 1954. The 10-yma of <PWS> for 2003 measures 75 kt, a value near its long-term average, but well below the peak <PWS> of 83.3 kt in 1954. If the current high-activity interval continues, it might be that 10-yma values of PWS and <PWS> will plateau or possibly continue to increase to even higher values.

Similarly, since 1997, the 10-yma of LP has fallen from 935.9 mb to 922.1 mb, well below its long-term average of 931.7 mb. During the current high-activity interval, there have been 8 tropical cyclones having LP ≤920 mb, the lowest (and record holder) being 882 mb by Wilma in 2005. The year 2005 is the only year to have more than a single tropical cyclone having LP ≤920 mb (Katrina, Rita, and Wilma). The 10-yma of <LP> in 2003 (977.3 mb), while lower than its long-term average

(978.8 mb), remains higher than was seen in the 1950s (972.4 mb in 1951). Again, presuming the continuation of the current high-activity interval, values of LP and <LP> might possibly bottom out or continue to decline to even lower (stronger) values.

First differences of the 10-yma frequencies of tropical cyclones allows for the crude prediction of the next season's frequencies, provided the year is not a statistical outlier. Of the 53 fd values for NTC, about 50% fall within $d = \pm 0.1$ and about 68% fall within $d = \pm 0.2$. For the year 2009, presuming it will not be a statistical outlier year, $NTC = 10 \pm 2d$, inferring about a 2 out of 3 chance that it will measure about 6–14. Because there is better than a 1 in 5 chance that $d > 0.2$, NTC in 2009 could be higher than 14. The average d during the interval 1990–2002 is 0.45, inferring that NTC could be as high as 19, if d for 2003 is 0.45. For the other tropical cyclone parameters, the year 2009 should see about ≥8 NH, possibly as many as 15 if d for 2003 measures 0.23, the average d for 1990–2002; ≥1 NMH, possibly as many as 7 if d for 2003 measures 0.18, the average d for 1990–2002; ≤5 NUSLFH (there is only about a 10% chance of NUSLFH ≥6); 16.2° N. ≤ <LAT> ≤ 25.9° N.; 55.9° W. ≤ <LONG> ≤ 59.9° W.; 125 kt ≤ PWS ≤ 165 kt; 75.7 kt ≤ <PWS> ≤ 100.4 kt; 899 mb ≤ LP ≤ 931 mb; and 951.4 mb ≤ <LP> ≤ 978.3 mb.

Because <AT> and some of the decadal-length oscillation parameters bear strong resemblance to the variations of the tropical cyclone parameters, close correlation is expected and was, indeed, found, especially between the tropical cyclone parameters and <AT>. For example, the decreasing frequencies and weakening strengths of the tropical cyclones during the mid-1960s through the mid-1990s associates strongly with a cooling as described using <AT>, while the higher frequencies and stronger cyclones of the 1950s and now the mid-1990s through the present strongly associate with warmer temperatures. In particular, the 10-yma of <AT> exceeds its long-term average (9.47 °C) beginning in 1991 and now measures 10.13 °C in 2002 and 2003, the highest 10-yma values ever recorded at Armagh Observatory (Northern Ireland) going back more than 150 yr. Since 1995, 10 of 14 years have had yearly averages of <AT> exceeding 10 °C, and since 1990, 13 of 19 years have been warmer than the mean temperature. For 2008, Armagh surface air temperature fell below 10 °C (to 9.78 °C), the first such instance since 2001.

Like the tropical cyclone parameters, first difference values of the 10-yma values of <AT> lie close to the central value of zero. For <AT>, 39 of 53 fd values (nearly 75%) lie within the range ±0.05, with nearly a 1 in 5 chance of being >0.05. <AT> for 2009 is expected to be about 10.48 ± 1 °C, with better than a 90% probability that it will measure ≥9.48 °C. The average d during the interval 1990–2002 is 0.05, inferring <AT> = 11.48 °C, if d for 2003 is 0.05. Any yearly <AT> value above 10.59 °C (the highest yearly temperature in 2007) represents a new record high.

For the decadal-length oscillation parameters, values for 2009 are expected to be about –0.86 °C for ONI (presuming $d = -0.02$, the average d for the interval 1990–2002); 3.99 for <SOI> (presuming $d = 0.36$, the average d for the interval 1990–2002); –0.03 for <NAO> (presuming $d = -0.02$, the average d for the interval 1990–2002); and 1.37 for <EA>, which is higher than its record high of 0.93 in 1998 (presuming $d = 0.03$, the average d for the interval 1990–2002). For the 2009 parameters, there is >80% probability that ONI will be either ≥–1.46 °C or ≤0.54 °C; >75% probability that <SOI> ≥–13.21; essentially a 100% probability that <NAO> ≥–0.63; and nearly 98% probability that <EA> ≥–0.23.

Presuming $d = \pm 0.05$ °C for <AT>, the 10-yma of <AT> for 2004 equals 10.13 ± 0.05 °C. Using this value in the inferred statistically important linear regression best-fits for the limited time interval 1990–2003 (table 12) allows for the estimate of the frequencies of tropical cyclones, yielding 10-yma expected values for 2004 of NTC, NH, NMH, and NUSLFH, respectively, equal to 15 ± 0.4, 8.2 ± 0.3, 4 ± 0.1, and 2.1 ± 0.1. The 10-yma value of NTC = 15, however, appears too low to be statistically meaningful, for it suggests a yearly value of ≈4 for NTC in 2009, which has only occurred once in the past 59 hurricane seasons (in 1983) and has a probability of occurrence based on Poisson statistics of only 1.7%; the value of 15.4, on the other hand, suggests NTC = 12 in 2009, which is much more reasonable. This may indicate that the 10-yma value of <AT> for 2004 will be ≥10.18 °C, inferring a yearly <AT> ≥10.48 °C in 2009. The expected value of 8.2 ± 0.3 for the 10-yma of NH for 2004 suggests a yearly value in 2009 of 10 ± 6 for NH. Presuming the 10-yma of <AT> for 2004 to be ≥10.18 °C, the 10-yma of NH ≥ 8.2 ± 0.3 in 2004 and the expected yearly value of NH in 2009 would be ≥ 10 ± 6. The expected value of 4 ± 0.1 for the 10-yma value of NMH for 2004 suggests a yearly value in 2009 of 7 ± 2 for NMH. Again, presuming the 10-yma of <AT> for 2004 to be ≥10.18 °C, the 10-yma of NMH ≥ 4 ± 0.1 in 2004 and the expected yearly NMH for 2009 ≥ 7 ± 2. The expected value of 2.1 ± 0.1 for the 10-yma value of NUSLFH for 2004 suggests a yearly value in 2009 of 1 ± 3 for NUSLFH, inferring fewer than 4 U.S. land-falling hurricanes, possibly none. A larger 10-yma value for <AT> in 2004 would increase the likelihood of a greater number of U.S. land-falling hurricanes.

In conclusion, although difficult to reduce the uncertainties, it seems that 2009, more probably than not, will have seasonal frequencies of NTC, NH, NMH, and NUSLFH that will equal or exceed long-term averages, a conclusion supported by both temperature and decadal-length oscillation patterns. The biggest unknown is whether or not another EN event should make an unexpected appearance. Although NOAA's current forecast is for continued LN-like to ENSO-neutral conditions to prevail in 2009, based on its recurrence rate, another EN event might soon appear, perhaps, either later this year or sometime next year. Also, presuming that EN does not recur in 2009, at least one tropical cyclone is expected to have PWS ≥ 140 ± 20 kt and LP possibly below 920 mb, especially, if yearly <AT> exceeds 10.48 °C in 2009.

APPENDIX

Table 13 is a listing of North Atlantic basin tropical cyclones for the interval 1945–2008.

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008.

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
1945	715	Unnamed	MH	06/20	17.5	85.7	2	100	–	FL1
	716	Unnamed	TS	07/19	25.5	92.4	1	45	–	
	717	Unnamed	TS	08/01	12.1	56.3	4	50	–	
	718	Unnamed	TS	08/17	17.4	55.3	4	60	–	
	719	Unnamed	MH	08/24	19.4	94.0	1	120	966	TX2
	720	Unnamed	TS	08/29	13.0	82.6	2	50	993	
	721	Unnamed	TS	09/03	20.0	84.0	1	35	–	
	722	Unnamed	TS	09/10	18.3	60.3	2	50	–	
	723	Unnamed	MH	09/12	19.0	56.6	4	120	951	FL3
	724	Unnamed	H	10/02	15.3	80.3	2	85	982	
	725	Unnamed	H	10/11	15.5	79.5	2	85	982	
Summary: NTC = 11, NH = 5, NMH = 3, NUSLFH = 3 PWS = 120, <PWS> = 72.7, LP = 951, <LP> = 974.8 <N. Lat.> = 17.5, <W. Long.> = 75.2										
1946	726	Unnamed	TS	06/13	27.0	85.5	1	35	–	
	727	Unnamed	H	07/05	29.0	79.0	2	70	–	
	728	Unnamed	TS	08/25	20.5	93.2	1	35	–	
	729	Unnamed	H	09/12	23.8	79.6	2	85	975	
	730	Unnamed	MH	10/05	18.0	87.2	2	115	979	FL1
	731	Unnamed	TS	10/31	20.0	71.0	3	40	–	
Summary: NTC = 6, NH = 3, NMH = 1, NUSLFH = 1 PWS = 115, <PWS> = 63.3, LP = 975, <LP> = 977.0 <N. Lat.> = 23.1, <W. Long.> = 82.6										
1947	732	Unnamed	TS	07/31	19.5	92.0	1	40	–	
	733	Unnamed	H	08/09	13.7	74.6	2	95	–	
	734	Unnamed	H	08/18	24.0	80.0	1	70	–	TX1
	735	Unnamed	MH	09/04	14.5	20.1	4	140	947	FL4, LA3, MS3, FL2
	736	Unnamed	TS	09/07	27.9	85.0	1	40	–	
	737	Unnamed	TS	09/20	18.6	78.1	2	50	989	
	738	Unnamed	TS	10/06	22.0	77.0	3	45	–	
	739	Unnamed	H	10/09	15.4	82.0	2	75	973	GA2, SC2, FL1
	740	Unnamed	MH	10/16	17.4	62.4	2	105	–	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
Summary: NTC = 9, NH = 5, NMH = 2, NUSLFH = 3 PWS = 140, <PWS> = 73.3, LP = 947, <LP> = 969.7 <N. Lat.> = 19.2, <W. Long.> = 72.4										
1948	741	Unnamed	TS	05/22	16.0	75.0	2	45	–	
	742	Unnamed	TS	07/07	26.3	90.6	1	35	–	
	743	Unnamed	MH	08/26	19.5	58.9	4	105	–	
	744	Unnamed	TS	08/31	13.5	53.0	4	50	1,007	
	745	Unnamed	H	09/01	23.8	94.7	1	70	989	LA1
	746	Unnamed	MH	09/04	14.3	19.7	4	115	–	
	747	Unnamed	MH	09/18	18.2	78.8	2	105	963	FL3, FL2
	748	Unnamed	MH	10/03	15.3	81.8	2	115	975	FL2
	749	Unnamed	H	11/08	24.6	63.3	3	70	–	
Summary: NTC = 9, NH = 6, NMH = 3, NUSLFH = 3 PWS = 115, <PWS> = 78.9, LP = 963, <LP> = 983.5 <N. Lat.> = 19.1, <W. Long.> = 68.4										
1949	750	Unnamed	H	08/21	21.3	62.6	3	95	977	NC1
	751	Unnamed	MH	08/23	18.2	60.0	2	130	954	FL3
	752	Unnamed	TS	08/30	11.9	55.8	4	45	–	
	753	Unnamed	MH	09/03	18.4	65.0	2	110	–	
	754	Unnamed	TS	09/03	23.7	89.0	1	40	1,008	
	755	Unnamed	TS	09/05	27.3	40.4	5	40	–	
	756	Unnamed	TS	09/13	15.5	33.7	4	50	–	
	757	Unnamed	H	09/20	26.0	92.0	1	85	–	
	758	Unnamed	H	09/21	16.2	62.5	2	70	–	
	759	Unnamed	MH	09/27	13.3	90.1	P/1	115	–	TX2
	760	Unnamed	H	10/12	18.1	78.6	2	90	–	
	761	Unnamed	TS	10/13	21.8	49.2	5	50	–	
	762	Unnamed	TS	11/03	17.8	82.0	2	50	–	
Summary: NTC = 13, NH = 7, NMH = 3, NUSLFH = 3 PWS = 130, <PWS> = 74.6, LP = 954, <LP> = 979.7 <N. Lat.> = 19.2, <W. Long.> = 66.2										
1950	763	Able	MH	08/12	16.5	54.5	4	120	–	
	764	Baker	MH	08/20	16.3	55.0	4	105	979	AL1
	765	Charlie	MH	08/21	13.1	24.0	4	100	–	
	766	Dog	MH	08/30	15.2	55.3	4	160	–	
	767	Easy	MH	09/01	19.1	84.1	2	110	958	FL3
	768	Fox	MH	09/08	15.6	40.1	4	120	–	
	769	George	H	09/27	24.4	52.7	5	95	–	
	770	How	TS	10/01	25.8	88.6	1	50	–	
	771	Item	H	10/08	20.8	90.6	1	95	–	
	772	Jig	MH	10/11	24.3	47.2	5	105	–	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
	773	King	MH	10/13	16.0	84.2	2	105	955	FL3
	774	Unnamed	TS	10/17	22.0	42.0	5	60	–	
	775	Love	H	10/18	27.5	89.2	1	80	–	
Summary: NTC = 13, NH = 11, NMH = 8, NUSLFH = 3 PWS = 160, <PWS> = 100.4, LP = 955, <LP> = 964.0 <N. Lat.> = 19.7, <W. Long.> = 62.1										
1951	776	Able	MH	05/16	31.0	75.3	3	100	–	
	777	Baker	TS	08/02	22.0	54.3	5	50	–	
	778	Charlie	MH	08/15	14.3	55.3	4	115	964	
	779	Dog	MH	08/31	13.4	46.5	4	100	–	
	780	Easy	MH	09/02	14.0	37.0	4	140	–	
	781	Fox	MH	09/04	11.8	29.0	4	100	–	
	782	George	TS	09/20	19.8	93.0	1	50	–	
	783	How	H	10/01	26.1	86.8	1	95	–	
	784	Item	H	10/13	16.2	80.2	2	70	–	
	785	Jig	H	10/15	28.1	75.6	3	70	–	
Summary: NTC = 10, NH = 8, NMH = 5, NUSLFH = 0 PWS = 140, <PWS> = 89.0, LP = 964, <LP> = 964.0 <N. Lat.> = 19.7, <W. Long.> = 63.3										
1952	786	Unnamed	TS	02/02	20.2	87.4	1	50	–	
	787	Able	H	08/24	16.4	51.2	4	90	998	SC1
	788	Baker	MH	08/31	16.7	58.4	4	105	969	
	789	Charlie	MH	09/23	16.8	67.6	3	105	993	
	790	Dog	H	09/25	14.0	51.0	4	75	998	
	791	Easy	H	10/07	15.5	51.0	4	95	968	
	792	Fox	MH	10/21	15.0	80.7	2	130	934	
Summary: NTC = 7, NH = 6, NMH = 3, NUSLFH = 1 PWS = 130, <PWS> = 92.9, LP = 934, <LP> = 976.7 <N. Lat.> = 16.4, <W. Long.> = 63.9										
1953	793	Alice	TS	05/25	14.4	81.8	2	60	997	
	794	Barbara	H	08/11	22.8	73.9	3	95	987	NC1
	795	Unnamed	TS	08/28	21.7	82.6	1	50	985	
	796	Carol	MH	08/31	10.6	37.7	4	130	929	ME1
	797	Dolly	MH	09/08	20.3	65.9	3	100	995	
	798	Edna	MH	09/14	17.0	62.4	2	110	–	
	799	Unnamed	TS	09/14	23.1	94.2	1	60	–	
	800	Florence	MH	09/23	16.9	75.8	2	110	968	FL1
	801	Gail	H	10/02	13.5	37.0	4	70	–	
	802	Unnamed	TS	10/03	20.3	79.0	3	60	–	
	803	Unnamed	TS	10/05	18.7	40.2	4	60	–	
	804	Hazel	TS	10/07	20.5	86.4	1	60	994	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

					Genesis Location					
Year	SNBR	Name	Class.	FSD	N. Lat	W. Long.	PWS	LP	LP	USLFH
	805	Unnamed	TS	11/23	22.0	56.5	5	45	–	
	806	Unnamed	TS	12/08	20.8	53.1	5	35	–	
Summary: NTC = 14, NH = 6, NMH = 4, NUSLFH = 3 PWS = 130, <PWS> = 74.6, LP = 929, <LP> = 979.3 <N. Lat.> = 18.8, <W. Long.> = 66.2										
1954	807	Alice	H	06/24	22.0	94.0	1	70	–	
	808	Barbara	TS	07/28	28.0	90.5	1	40	–	
	809	Carol	H	08/25	25.1	75.5	3	85	976	NY3, CT3, RI3, NC2
	810	Dolly	H	08/31	20.9	68.4	3	85	–	
	811	Edna	MH	09/04	19.3	62.8	2	105	–	MA3,
	812	Florence	H	09/11	20.9	94.7	1	65	–	
	813	Gilda	TS	09/24	14.1	76.8	2	60	–	
	814	Unnamed	H	09/29	31.6	48.4	5	85	–	
	815	Hazel	MH	10/05	12.4	59.2	4	120	937	SC4, NC4, MD2
	816	Unnamed	TS	11/17	23.8	44.5	5	45	–	
	817	Alice	H	12/30	22.0	51.6	5	70	1,007	
Summary: NTC = 11, NH = 8, NMH = 2, NUSLFH = 3 PWS = 120, <PWS> = 75.5, LP = 937, <LP> = 973.3 <N. Lat.> = 21.8, <W. Long.> = 69.7										
1955	818	Brenda	TS	07/31	27.5	88.4	1	60	–	
	819	Connie	MH	08/03	15.7	39.2	4	125	936	NC3, VA1
	820	Diane	MH	08/09	18.9	54.3	4	105	969	NC1
	821	Edith	H	08/23	15.3	51.0	4	85	–	
	822	Unnamed	TS	08/23	17.7	80.0	2	40	–	
	823	Flora	H	09/02	19.0	31.1	4	90	967	
	824	Gladys	H	09/04	21.5	94.6	1	80	–	
	825	Hilda	MH	09/11	18.6	62.9	2	110	952	
	826	Ione	MH	09/10	15.4	44.2	4	105	938	NC3
	827	Janet	MH	09/21	13.2	54.3	4	150	914	
	828	Unnamed	TS	10/10	28.4	42.0	5	55	–	
	829	Katie	MH	10/15	12.1	77.7	2	100	984	
Summary: NTC = 12, NH = 9, NMH = 6, NUSLFH = 3 PWS = 150, <PWS> = 92.1, LP = 914, <LP> = 951.4 <N. Lat.> = 18.6, <W. Long.> = 60.0										
1956	830	Unnamed	TS	06/12	24.0	91.0	1	50	1,004	
	831	Anna	H	07/26	20.8	93.5	1	70	991	
	833	Betsy	MH	08/09	13.5	47.2	4	105	954	
	833	Carla	TS	09/05	21.5	74.9	3	45	996	
	834	Dora	TS	09/10	20.5	91.1	1	60	1,001	
	835	Ethel	TS	09/12	25.4	74.3	3	60	999	
	836	Flossy	H	09/22	22.2	89.8	1	80	980	LA2, FL1

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location N. Lat	Genesis Location W. Long.	PWS	LP	LP	USLFH
	837	Greta	MH	11/02	28.1	73.5	3	120	970	
Summary: NTC = 8, NH = 4, NMH = 2, NUSLFH = 1 PWS = 120, <PWS> = 73.8, LP = 954, <LP> = 986.9 <N. Lat.> = 22.0, <W. Long.> = 79.4										
1957	838	Unnamed	TS	06/08	26.2	87.8	1	60	–	
	839	Audrey	MH	06/25	21.6	93.3	1	125	946	TX4, LA4
	840	Bertha	TS	08/08	27.0	88.9	1	60	998	
	841	Carrie	MH	09/03	13.7	25.9	4	135	945	
	842	Debbie	TS	09/07	23.9	89.8	1	35	–	
	843	Esther	TS	09/17	23.7	92.8	1	45	1,000	
	844	Frieda	H	09/22	27.8	66.5	3	70	992	
	845	Unnamed	TS	10/23	24.7	60.7	3	50	993	
Summary: NTC = 8, NH = 3, NMH = 2, NUSLFH = 1 PWS = 135, <PWS> = 72.5, LP = 945, <LP> = 979.0 <N. Lat.> = 23.6, <W. Long.> = 75.7										
1958	846	Alma	TS	06/14	21.7	95.0	1	45	997	
	847	Becky	TS	08/11	17.0	35.5	4	50	–	
	848	Cleo	MH	08/11	10.8	21.6	4	140	948	
	849	Daisy	MH	08/24	25.2	73.6	3	110	935	
	850	Ella	MH	08/30	14.0	59.6	4	100	1,009	
	851	Fifi	H	09/05	12.2	49.8	4	80	1,000	
	852	Gerda	TS	09/13	15.9	64.2	2	60	1,004	
	853	Helene	MH	09/23	22.5	64.8	3	115	934	NC3
	854	Ilsa	MH	09/24	17.7	52.1	4	115	998	
	855	Janice	H	10/05	20.9	81.5	1	80	968	
Summary: NTC = 10, NH = 7, NMH = 5, NUSLFH = 1 PWS = 140, <PWS> = 89.5, LP = 934, <LP> = 977.0 <N. Lat.> = 17.8, <W. Long.> = 59.8										
1959	856	Arlene	TS	05/29	25.3	87.7	1	50	1,000	
	857	Beulah	TS	06/16	22.0	95.6	1	60	987	
	858	Unnamed	H	06/18	30.4	77.7	3	70	993	
	859	Cindy	H	07/07	31.5	77.1	3	65	–	SC1
	860	Debra	H	07/23	27.5	93.1	1	75	984	TX1
	861	Edith	TS	08/18	14.3	57.9	4	50	1,007	
	862	Flora	H	09/10	22.0	46.0	5	65	994	
	863	Gracie	MH	09/22	21.8	74.1	3	120	950	SC3
	864	Hannah	MH	09/28	26.9	51.2	5	110	959	
	865	Irene	TS	10/07	27.1	88.9	1	50	1,001	
	866	Judith	H	10/17	21.2	85.1	1	70	999	
Summary: NTC = 11, NH = 7, NMH = 2, NUSLFH = 3 PWS = 120, <PWS> = 71.4, LP = 950, <LP> = 987.4 <N. Lat.> = 24.5, <W. Long.> = 75.9										

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

					Genesis Location					
Year	SNBR	Name	Class.	FSD	N. Lat	W. Long.	PWS	LP	LP	USLFH
1960	867	Unnamed	TS	06/23	24.7	96.3	1	40	1,002	
	868	Abby	H	07/10	13.8	61.0	2	85	–	
	869	Brenda	TS	07/29	31.5	81.5	3	50	–	
	870	Cleo	H	08/17	24.4	75.5	3	80	–	
	871	Donna	MH	08/30	10.3	26.9	4	140	932	FL4, NC3, NY3, FL2, CT2, RI2, MA1, NH1, ME1
	872	Ethel	MH	09/14	23.9	90.6	1	140	981	MS1
	873	Florence	TS	09/18	21.2	66.8	3	40	–	
Summary: NTC = 7, NH = 4, NMH = 2, NUSLFH = 2 PWS = 140, <PWS> = 82.1, LP = 932, <LP> = 971.7 <N. Lat.> = 21.4, <W. Long.> = 71.2										
1961	874	Anna	MH	07/20	11.5	60.2	2	100	976	
	875	Betsy	MH	09/02	13.3	41.7	4	120	945	
	876	Carla	MH	09/05	16.3	82.7	2	150	931	TX4
	877	Debbie	MH	09/06	15.1	24.1	4	105	970	
	878	Esther	MH	09/11	14.4	36.7	4	125	927	
	879	Unnamed	TS	09/14	34.7	77.9	3	35	–	
	880	Frances	MH	09/30	16.1	58.7	4	110	948	
	881	Gerda	TS	10/19	31.5	71.5	3	60	987	
	882	Hattie	MH	10/27	11.6	81.5	2	140	920	
	883	Jenny	H	11/06	28.8	47.0	5	70	974	
	884	Inga	TS	11/05	20.8	94.7	1	60	992	
Summary: NTC = 11, NH = 8, NMH = 7, NUSLFH = 1 PWS = 150, <PWS> = 97.7, LP = 920, <LP> = 957.0 <N. Lat.> = 19.5, <W. Long.> = 61.5										
1962	885	Alma	H	08/27	30.6	79.7	3	85	986	
	886	Becky	TS	08/28	19.5	23.3	4	35	–	
	887	Celia	TS	09/12	16.4	48.7	4	60	995	
	888	Daisy	H	10/02	21.8	63.2	3	95	968	
	889	Ella	MH	10/15	25.0	72.1	3	100	950	
Summary: NTC = 5, NH = 3, NMH = 1, NUSLFH = 0 PWS = 100, <PWS> = 75.0, LP = 968, <LP> = 974.8 <N. Lat.> = 22.7, <W. Long.> = 57.4										
1963	890	Arlene	H	08/02	11.5	46.0	4	90	969	
	891	Beulah	MH	08/21	15.5	52.8	4	105	958	
	892	Unnamed	TS	09/11	34.8	59.7	5	50	992	
	893	Cindy	H	09/16	26.7	93.7	1	70	996	TX1
	894	Debra	H	09/21	19.9	47.9	4	65	999	
	895	Edith	H	09/24	12.9	56.5	4	85	990	
	896	Flora	MH	09/29	10.0	52.8	4	125	940	
	897	Ginny	H	10/19	30.8	71.8	3	95	958	
	898	Helena	TS	10/25	15.3	59.4	4	45	1,001	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
Summary: NTC = 9, NH = 7, NMH = 2, NUSLFH = 1 PWS = 125, <PWS> = 81.1, LP = 944, <LP> = 978.1 <N. Lat.> = 19.7, <W. Long.> = 60.1										
1964	899	Unnamed	TS	06/07	32.5	78.6	3	50	–	
	900	Unnamed	TS	07/31	33.7	57.2	5	45	1,006	
	901	Abby	TS	08/07	28.5	94.4	1	55	1,000	
	902	Brenda	TS	08/08	32.4	64.9	3	45	1,006	
	903	Cleo	MH	08/21	13.7	49.1	4	135	950	FL2
	904	Dora	MH	09/01	11.7	47.0	4	115	942	FL2
	905	Ethel	MH	09/04	18.0	37.0	4	100	969	
	906	Florence	TS	09/08	21.4	29.4	5	40	–	
	907	Glayds	MH	09/13	15.4	46.0	4	125	945	
	908	Hilda	MH	09/29	22.0	84.2	1	130	941	LA3
	909	Isbell	MH	10/13	20.0	85.0	1	110	964	FL2, FL2
	910	Unnamed	TS	11/06	13.9	81.4	2	35	997	
Summary: NTC = 12, NH = 6, NMH = 6, NUSLFH = 4 PWS = 135, <PWS> = 82.1, LP = 941, <LP> = 972.0 <N. Lat.> = 19.8, <W. Long.> = 62.9										
1965	911	Unnamed	TS	06/14	24.1	91.1	1	45	–	
	912	Anna	H	08/21	32.4	51.8	5	80	–	
	913	Betsy	MH	08/29	19.2	63.4	2	135	941	FL3, LA3
	914	Carol	H	09/17	12.4	30.7	4	85	974	
	915	Debbie	TS	09/28	26.5	89.7	5	45	1,001	
	916	Elena	H	10/14	22.0	54.1	5	70	977	
Summary: NTC = 6, NH = 4, NMH = 1, NUSLFH = 1 PWS = 135, <PWS> = 76.7, LP = 941, <LP> = 973.3 <N. Lat.> = 22.8, <W. Long.> = 63.5										
1966	917	Alma	MH	06/06	18.1	84.2	1	110	970	FL2
	918	Becky	H	07/02	35.8	55.3	5	65	985	
	919	Celia	H	07/14	21.3	61.8	3	70	995	
	920	Dorothy	H	07/23	31.8	41.9	5	75	989	
	921	Ella	TS	07/24	16.8	52.2	4	45	1,008	
	922	Faith	MH	08/22	14.3	28.0	4	110	950	
	923	Greta	TS	09/04	19.8	59.0	4	50	1,004	
	924	Hallie	TS	09/21	21.5	95.4	1	45	997	
	925	Inez	MH	09/24	14.8	48.7	4	130	929	FL1
	926	Judith	TS	09/28	12.2	51.2	4	45	1,007	
	927	Lois	H	11/06	23.9	53.5	5	70	986	
Summary: NTC = 11, NH = 7, NMH = 3, NUSLFH = 2 PWS = 130, <PWS> = 74.1, LP = 929, <LP> = 983.6 <N. Lat.> = 20.9, <W. Long.> = 57.4										
1967	928	Arlene	H	08/30	20.9	44.8	5	75	982	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

					Genesis Location					
Year	SNBR	Name	Class.	FSD	N. Lat	W. Long.	PWS	LP	LP	USLFH
	929	Beulah	MH	09/07	13.9	60.8	2	140	923	TX3
	930	Chloe	H	09/08	22.7	38.0	5	95	958	
	931	Doria	H	09/09	27.8	79.2	3	75	973	
	932	Edith	TS	09/28	14.4	55.1	4	50	1,002	
	933	Fern	H	10/02	21.5	93.0	1	75	987	
	934	Ginger	TS	10/06	18.0	18.1	4	45	1,002	
	935	Heidi	H	10/20	21.4	61.5	3	80	981	
Summary: NTC = 8, NH = 6, NMH = 1, NUSLFH = 1 PWS = 140, <PWS> = 79.4, LP = 923, <LP> = 976.0 <N. Lat.> = 20.1, <W. Long.> = 56.3										
1968	936	Abby	H	06/02	21.4	84.8	1	65	965	
	937	Brenda	H	06/21	30.9	76.3	3	65	990	
	938	Candy	TS	06/23	26.4	96.6	1	60	999	
	939	Dolly	H	08/12	35.0	71.3	3	70	985	
	940	Edna	TS	09/15	15.8	34.9	4	55	1,005	
	941	ST1	SS(H)	09/16	34.8	67.6	3	70	979	
	942	Frances	TS	09/26	33.2	68.2	3	50	1,001	
	943	Gladys	H	10/15	19.4	83.3	1	75	965	FL2, FL1
Summary: NTC = 8, NH = 5, NMH = 0, NUSLFH = 1 PWS = 75, <PWS> = 63.8, LP = 965, <LP> = 986.1 <N. Lat.> = 27.1, <W. Long.> = 72.9										
1969	944	Anna	TS	07/27	11.2	36.0	4	60	1,002	
	945	Blanche	H	08/11	32.5	71.1	3	75	997	
	946	Camille	MH	08/14	19.4	82.0	1	165	905	LA5, MS5
	947	Debbie	MH	08/15	14.0	41.5	4	105	951	
	948	Eve	TS	08/25	29.8	76.0	3	50	996	
	949	Francelia	MH	08/30	14.3	72.2	2	100	973	
	950	Gerda	MH	09/08	29.7	79.7	3	110	979	ME1
	951	Holly	H	09/15	12.7	48.5	4	75	984	
	952	Inga	MH	09/21	16.7	50.2	4	100	964	
	953	Unnamed	H	09/21	34.1	70.5	3	65	985	
	954	Unnamed	TS	09/25	35.0	38.5	5	60	990	
	955	ST1	SS(TS)	09/29	24.0	85.7	1	50	996	
	956	Jenny	TS	10/02	25.5	82.1	1	40	1,000	
	957	Kara	H	10/09	27.2	73.3	3	90	978	
	958	Laurie	H	10/19	21.5	89.5	1	90	973	
	959	Unnamed	TS	10/29	32.0	44.5	5	60	990	
	960	Unnamed	H	10/30	42.5	57.0	5	65	988	
	961	Martha	H	11/21	10.3	81.0	2	80	979	
Summary: NTC = 18, NH = 12, NMH = 5, NUSLFH = 2 PWS = 165, <PWS> = 80.0, LP = 905, <LP> = 979.4 <N. Lat.> = 24.0, <W. Long.> = 65.5										

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
1970	962	Alma	H	05/20	15.5	82.5	2	70	993	
	963	Becky	TS	07/20	23.3	86.4	1	55	1,003	
	964	Celia	MH	08/01	23.3	85.8	1	110	945	TX3
	965	Unnamed	TS	08/18	37.0	72.5	3	60	992	
	966	Dorothy	TS	08/19	12.8	50.7	4	60	996	
	967	Ella	MH	09/10	22.0	89.0	1	110	967	
	968	Felice	TS	09/15	26.5	86.5	1	60	997	
	969	Greta	TS	09/26	22.7	76.2	3	45	1,005	
	970	Unnamed	H	10/13	25.9	65.5	3	90	974	
	971	Unnamed	H	10/21	34.8	45.8	5	65	988	
Summary: NTC = 10, NH = 5, NMH = 2, NUSLFH = 1 PWS = 110, <PWS> = 72.5, LP = 945, <LP> = 986.0 <N. Lat.> = 24.4, <W. Long.> = 74.1										
1971	972	Arlene	TS	07/05	36.7	72.9	3	55	1,000	
	973	Unnamed	H	08/05	40.5	58.5	5	75	974	
	974	Beth	H	08/14	34.4	72.3	3	75	977	
	975	Chloe	TS	08/20	14.3	63.5	2	55	1,004	
	976	Doria	TS	08/27	29.2	77.2	3	55	993	
	977	Edith	MH	09/07	12.7	69.1	2	140	943	LA2
	978	Fern	H	09/08	26.9	92.6	1	80	978	TX1
	979	Ginger	H	09/10	27.7	66.1	3	95	959	NC1
	980	Heidi	TS	09/12	29.2	74.0	3	55	996	
	981	Irene	H	09/17	12.5	73.0	2	70	989	
	982	Janice	TS	09/22	12.0	45.8	4	55	1,005	
	983	Kristy	TS	10/20	33.5	52.8	5	45	992	
	984	Laura	TS	11/14	16.6	82.5	2	60	994	
Summary: NTC = 13, NH = 6, NMH = 1, NUSLFH = 3 PWS = 140, <PWS> = 70.4, LP = 943, <LP> = 984.9 <N. Lat.> = 25.1, <W. Long.> = 69.3										
1972	985	Alpha	SS(TS)	05/26	34.0	73.5	3	60	991	
	986	Agnes	H	06/16	20.0	86.2	1	75	977	FL1, NY1, CT1
	987	Betty	H	08/24	37.2	56.2	5	90	976	
	988	Carrie	TS	08/31	32.5	72.0	3	60	992	
	989	Dawn	H	09/06	27.3	77.9	3	70	997	
	990	Charlie	SS(TS)	09/20	39.5	59.0	5	60	944	
	991	Delta	SS(TS)	11/02	34.7	48.0	5	40	1,001	
Summary: NTC = 7, NH = 3, NMH = 0, NUSLFH = 1 PWS = 90, <PWS> = 65.0, LP = 944, <LP> = 982.6 <N. Lat.> = 32.2, <W. Long.> = 67.5										
1973	992	Alice	H	07/03	27.8	66.0	3	80	986	
	993	Alfa	SS(TS)	07/31	35.0	72.5	3	40	1,005	
	994	Brenda	H	08/18	21.2	86.0	1	80	977	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
	995	Christine	TS	08/28	10.5	30.0	4	60	996	
	996	Delia	TS	09/03	24.0	88.0	1	60	986	
	997	Ellen	MH	09/15	14.0	25.7	4	100	962	
	998	Fran	H	10/09	30.7	62.3	3	70	978	
	999	Gilda	TS	10/18	19.5	79.9	2	60	968	
Summary: NTC = 8, NH = 4, NMH = 1, NUSLFH = 0 PWS = 100, <PWS> = 68.8, LP = 962, <LP> = 982.3 <N. Lat.> = 22.8, <W. Long.> = 63.8										
1974	1000	ST1	SS(TS)	06/25	25.4	86.2	1	55	1,000	
	1001	ST2	SS(TS)	07/17	35.0	68.8	3	45	1,006	
	1002	ST3	SS(TS)	08/10	38.0	70.0	3	50	992	
	1003	Alma	TS	08/13	10.1	52.0	4	55	1,007	
	1004	Becky	MH	08/28	32.1	69.0	3	100	977	
	1005	Carmen	MH	08/30	17.0	67.4	2	130	928	LA3
	1006	Dolly	TS	09/03	30.2	72.0	3	45	1,004	
	1007	Elaine	TS	09/09	32.3	72.1	3	60	1,001	
	1008	Fifi	H	09/16	17.0	77.8	2	95	971	
	1009	Gertrude	H	09/28	10.8	51.8	4	65	999	
	1010	ST4	SS(TS)	10/06	23.8	77.0	3	45	1,006	
Summary: NTC = 11, NH = 4, NMH = 2, NUSLFH = 1 PWS = 130, <PWS> = 67.7, LP = 928, <LP> = 990.1 <N. Lat.> = 24.7, <W. Long.> = 69.5										
1975	1011	Amy	TS	06/29	34.4	75.8	3	60	981	
	1012	Blanche	H	07/26	32.2	74.6	3	75	980	
	1013	Caroline	MH	08/29	23.1	92.6	1	100	963	
	1014	Doris	H	08/28	33.3	46.3	5	95	965	
	1015	Eloise	MH	09/16	19.0	65.6	2	110	955	FL3, AL1
	1016	Faye	H	09/19	20.0	39.0	5	90	977	
	1017	Gladys	MH	09/24	13.5	40.4	4	120	939	
	1018	Hallie	TS	10/26	32.5	78.7	3	45	1,002	
	1019	ST2	SS(TS)	12/09	41.6	42.9	5	60	985	
Summary: NTC = 9, NH = 6, NMH = 3, NUSLFH = 1 PWS = 120, <PWS> = 83.9, LP = 939, <LP> = 971.9 <N. Lat.> = 27.7, <W. Long.> = 61.8										
1976	1020	ST1	SS(TS)	05/23	26.3	89.0	1	45	994	
	1021	Anna	TS	07/30	29.8	42.0	5	45	999	
	1022	Belle	MH	08/07	25.6	73.2	3	105	957	NY1
	1023	Candice	H	08/18	33.4	67.5	3	80	964	
	1024	Dottie	TS	08/19	25.0	81.7	1	45	999	
	1025	Emmy	H	08/22	16.2	56.0	4	90	974	
	1026	Frances	MH	08/28	14.7	45.3	4	100	963	
	1027	ST3	SS(TS)	09/14	31.0	81.2	3*	40	1,011	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

					Genesis Location					
Year	SNBR	Name	Class.	FSD	N. Lat	W. Long.	PWS	LP	LP	USLFH
	1028	Gloria	H	09/27	25.7	58.0	3	90	970	
	1029	Holly	H	10/23	22.5	58.0	3	65	990	
Summary: NTC = 10, NH = 6, NMH = 2, NUSLFH = 1 PWS = 105, <PWS> = 70.5, LP = 957, <LP> = 982.1 <N. Lat.> = 25.0, <W. Long.> = 65.2										
1977	1030	Anita	MH	08/30	26.8	89.8	1	150	926	
	1031	Babe	H	09/03	27.6	88.5	1	65	995	LA1
	1032	Clara	H	09/08	35.1	71.7	3	65	993	
	1033	Dorothy	H	09/27	30.9	65.8	3	75	980	
	1034	Evelyn	H	10/14	30.9	64.9	3	70	994	
	1035	Frieda	TS	10/17	17.2	83.9	2	50	1005	
Summary: NTC = 6, NH = 5, NMH = 1, NUSLFH = 1 PWS = 150, <PWS> = 79.2, LP = 926, <LP> = 982.2 <N. Lat.> = 28.1, <W. Long.> = 77.4										
1978	1036	ST1	SS(TS)	01/19	23.5	47.6	5	40	1,002	
	1037	Amelia	TS	07/31	26.4	97.4	1	45	1,005	
	1038	Bess	TS	08/06	23.9	94.0	1	45	1,005	
	1039	Cora	H	08/08	14.0	43.2	4	80	980	
	1040	Debra	TS	08/28	28.7	94.1	1	50	1,000	
	1041	Ella	MH	08/30	27.3	63.1	3	120	956	
	1042	Flossie	H	09/04	15.5	42.9	4	85	976	
	1043	Greta	MH	09/14	12.5	67.5	2	115	947	
	1044	Hope	TS	09/15	32.9	64.8	3	55	987	
	1045	Irma	TS	10/04	35.1	31.5	5	45	1,001	
	1046	Juliet	TS	10/08	18.8	58.7	4	45	1,006	
	1047	Kendra	H	10/29	24.2	73.2	3	70	990	
Summary: NTC = 12, NH = 5, NMH = 2, NUSLFH = 0 PWS = 120, <PWS> = 66.3, LP = 947, <LP> = 987.9 <N. Lat.> = 23.6, <W. Long.> = 64.8										
1979	1048	Ana	TS	06/22	14.2	54.7	4	50	1,005	
	1049	Bob	H	07/10	23.5	93.8	1	65	986	LA1
	1050	Claudette	TS	07/17	17.8	60.3	2	45	997	
	1051	David	MH	08/26	11.6	42.2	4	150	924	FL2, FL2, GA2, SC2
	1052	Elena	TS	08/30	26.8	91.8	1	35	1,004	
	1053	Frederic	MH	08/30	11.5	36.0	4	115	943	AL3, MS3
	1054	Gloria	H	09/06	22.0	33.8	5	85	975	
	1055	Henri	H	09/16	22.1	92.2	1	75	983	
	1056	ST1	SS(H)	10/24	35.0	64.0	3	65	980	
Summary: NTC = 9, NH = 6, NMH = 2, NUSLFH = 3 PWS = 150, <PWS> = 76.1, LP = 924, <LP> = 977.4 <N. Lat.> = 20.5, <W. Long.> = 63.2										
1980	1057	Allen	MH	08/02	11.0	42.8	4	165	899	TX3

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
	1058	Bonnie	H	08/14	14.7	37.3	4	85	975	
	1059	Charley	H	08/21	34.0	68.0	3	70	989	
	1060	Danielle	TS	09/05	29.4	93.4	1	50	1,004	
	1061	Earl	H	09/05	17.8	26.7	4	65	985	
	1062	Frances	MH	09/06	12.7	21.8	4	100	958	
	1063	Georges	H	09/07	34.4	67.9	3	70	993	
	1064	Hermine	TS	09/21	15.1	81.6	2	60	993	
	1065	Ivan	H	10/04	35.6	24.6	5	90	970	
	1066	Jeanne	H	11/09	20.8	85.1	1	85	986	
	1067	Karl	H	11/25	36.0	46.0	5	75	985	
Summary: NTC = 11, NH = 9, NMH = 2, NUSLFH = 1 PWS = 165, <PWS> = 83.2, LP = 899, <LP> = 976.1 <N. Lat.> = 23.8, <W. Long.> = 54.1										
1981	1068	Arlene	TS	05/07	19.0	80.6	2	50	999	
	1069	Bret	TS	06/29	36.0	65.0	3	60	996	
	1070	Cindy	TS	08/03	38.7	64.9	3	50	1,002	
	1071	Dennis	H	08/08	11.3	31.3	4	70	995	
	1072	Emily	H	09/01	29.9	69.7	3	80	966	
	1073	Floyd	MH	09/04	19.0	64.0	2	100	975	
	1074	Gert	H	09/08	15.6	60.6	2	90	988	
	1075	Harvey	MH	09/12	19.4	56.3	4	115	946	
	1076	Irene	MH	09/23	12.5	40.8	4	105	959	
	1077	Jose	TS	10/30	27.7	46.6	5	45	998	
	1078	Katrina	H	11/04	18.3	81.4	1	75	980	
	1079	ST3	SS(TS)	11/12	31.0	74.0	3	60	978	
Summary: NTC = 12, NH = 7, NMH = 3, NUSLFH = 0 PWS = 115, <PWS> = 75.0, LP = 946, <LP> = 981.8 <N. Lat.> = 23.2, <W. Long.> = 61.3										
1982	1080	Alberto	H	06/03	22.8	85.0	1	75	985	
	1081	ST1	SS(TS)	06/18	28.7	82.8	1	60	984	
	1082	Beryl	TS	08/28	13.9	22.7	4	63	989	
	1083	Chris	TS	09/10	27.3	94.2	1	55	994	
	1084	Debby	MH	09/14	23.5	71.9	3	115	950	
	1085	Ernesto	TS	10/01	26.5	67.8	3	60	997	
Summary: NTC = 6, NH = 2, NMH = 1, NUSLFH = 0 PWS = 115, <PWS> = 71.3, LP = 950, <LP> = 983.2 <N. Lat.> = 23.8, <W. Long.> = 70.7										
1983	1086	Alicia	MH	08/15	27.2	91.0	1	100	963	TX3
	1087	Barry	H	08/24	27.4	76.3	3	70	986	
	1088	Chantal	H	09/11	31.6	63.3	3	65	994	
	1089	Dean	TS	09/26	28.0	73.0	3	55	999	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location N. Lat	Genesis Location W. Long.	PWS	LP	LP	USLFH
Summary: NTC = 4, NH = 3, NMH = 1, NUSLFH = 1 PWS = 100, <PWS> = 72.5, LP = 963, <LP> = 985.5 <N. Lat.> = 28.6, <W. Long.> = 75.9										
1984	1090	ST1	SS(TS)	08/19	38.0	56.4	5	50	1,000	
	1091	Arthur	TS	08/29	11.2	55.0	4	45	1,004	
	1092	Bertha	TS	08/31	14.9	45.3	4	35	1,007	
	1093	Cesar	TS	08/31	38.9	65.0	3	50	989	
	1094	Diana	MH	09/08	28.5	77.4	3	115	949	NC2
	1095	Edouard	TS	09/14	20.5	96.2	1	55	998	
	1096	Fran	TS	09/16	14.8	24.8	4	55	994	
	1097	Gustav	TS	09/18	32.1	64.7	3	45	1,006	
	1098	Hortense	H	09/23	29.2	59.1	5	65	993	
	1099	Isidore	TS	09/26	24.7	77.0	3	50	999	
	1100	Josephine	H	10/08	24.1	71.4	3	90	965	
	1101	Klaus	H	11/06	17.0	66.7	2	80	971	
	1102	Lili	H	12/12	34.5	60.5	3	70	980	
Summary: NTC = 13, NH = 5, NMH = 1, NUSLFH = 1 PWS = 115, <PWS> = 61.9, LP = 949, <LP> = 988.8 <N. Lat.> = 25.3, <W. Long.> = 63.0										
1985	1103	Ana	TS	07/16	31.3	66.6	3	60	996	
	1104	Bob	H	07/22	26.2	83.8	1	65	1,002	SC1
	1105	Claudette	H	08/11	34.0	74.0	3	75	980	
	1106	Danny	H	08/14	23.7	87.8	1	80	988	LA1
	1107	Elena	MH	08/28	22.6	80.0	1*	110	953	AL3, MS3, FL3
	1108	Fabian	TS	09/16	26.0	66.5	3	55	994	
	1109	Gloria	MH	09/17	14.6	28.3	4	125	920	NC3, NY3, CT2, NH2, ME1
	1110	Henri	TS	09/23	35.3	74.3	3	50	996	
	1111	Isabel	TS	10/07	18.5	70.5	2	60	997	
	1112	Juan	H	10/26	23.8	92.5	1	75	971	LA1
	1113	Kate	MH	11/15	21.1	63.8	3	105	954	FL2, GA1
Summary: NTC = 11, NH = 7, NMH = 3, NUSLFH = 6 PWS = 125, <PWS> = 78.2, LP = 920, <LP> = 977.4 <N. Lat.> = 25.2, <W. Long.> = 71.6										
1986	1114	Andrew	TS	06/06	29.7	77.5	3	45	999	
	1115	Bonnie	H	06/24	26.6	89.5	1	75	992	TX1
	1116	Charley	H	08/15	32.2	78.5	3	70	980	NC1
	1117	Danielle	TS	09/07	11.2	55.8	4	50	1,000	
	1118	Earl	H	09/11	22.4	51.6	5	90	979	
	1119	Frances	H	11/19	23.9	62.9	3	75	1,000	
Summary: NTC = 6, NH = 4, NMH = 0, NUSLFH = 2 PWS = 90, <PWS> = 67.5, LP = 979, <LP> = 991.7 <N. Lat.> = 24.3, <W. Long.> = 69.3										

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location N. Lat	Genesis Location W. Long.	PWS	LP	LP	USLFH
1987	1120	Unnamed	TS	08/09	27.3	94.0	1	40	1,007	
	1121	Arlene	H	08/11	29.4	74.4	3	65	987	
	1122	Bret	TS	08/18	15.1	26.0	4	45	1,000	
	1123	Cindy	TS	09/07	24.6	39.3	5	45	1,000	
	1124	Dennis	TS	09/10	10.8	25.0	4	45	1,000	
	1125	Emily	MH	09/20	11.4	56.4	4	110	958	
	1126	Floyd	H	10/10	16.0	82.2	2	65	993	FL1
Summary: NTC = 7, NH = 3, NMH = 1, NUSLFH = 1 PWS = 110, <PWS> = 59.3, LP = 958, <LP> = 992.1 <N. Lat.> = 19.2, <W. Long.> = 56.8										
1988	1127	Alberto	TS	08/07	41.5	69.0	3*	35	1,002	
	1128	Beryl	TS	08/08	29.7	89.4	1	45	1,001	
	1129	Chris	TS	08/28	28.2	80.0	3*	45	1,005	
	1130	Debby	H	09/02	20.7	95.2	1	65	987	
	1131	Ernesto	TS	09/03	35.2	53.1	5	55	994	
	1132	Unnamed	TS	09/07	13.8	18.5	4	50	994	
	1133	Florence	H	09/07	22.7	90.2	1	70	983	LA1
	1134	Gilbert	MH	09/09	14.5	60.1	2	160	888	
	1135	Helene	MH	09/20	13.2	33.8	4	125	938	
	1136	Isaac	TS	09/30	11.4	56.0	4	40	1,005	
	1137	Joan	MH	10/11	10.1	45.0	4	125	932	
	1138	Keith	TS(H)	11/20	17.8	84.5	2	65	945	
Summary: NTC = 12, NH = 6, NMH = 3, NUSLFH = 1 PWS = 160, <PWS> = 73.3, LP = 888, <LP> = 972.8 <N. Lat.> = 21.6, <W. Long.> = 64.6										
1989	1139	Allison	TS	06/26	27.8	95.8	1	45	999	
	1140	Barry	TS	07/11	17.7	48.2	4	45	1,005	
	1141	Chantal	H	07/31	25.4	91.0	1	70	984	TX1
	1142	Dean	H	08/01	15.8	49.3	4	90	968	
	1143	Erin	H	08/19	18.5	32.7	4	90	968	
	1144	Felix	H	08/26	17.2	22.9	4	75	979	
	1145	Gabrielle	MH	08/31	11.3	24.8	4	125	937	
	1146	Hugo	MH	09/11	12.5	29.2	4	140	918	SC4, NC1
	1147	Iris	TS	09/18	11.9	53.2	4	60	1,001	
	1148	Jerry	H	10/13	20.4	93.0	1	75	983	TX1
	1149	Karen	TS	11/30	20.8	84.2	1	50	1,000	
Summary: NTC = 11, NH = 7, NMH = 2, NUSLFH = 3 PWS = 135, <PWS> = 78.6, LP = 923, <LP> = 976.5 <N. Lat.> = 18.1, <W. Long.> = 56.8										
1990	1150	Arthur	TS	07/24	10.5	56.8	4	60	995	
	1151	Bertha	H	07/28	28.6	75.8	3	70	973	
	1152	Cesar	TS	08/02	15.4	32.3	4	45	1,000	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location N. Lat	Genesis Location W. Long.	PWS	LP	LP	USLFH
	1153	Diana	H	08/05	16.6	83.6	2	85	980	
	1154	Edouard	TS	08/03	39.2	23.3	5	40	1,003	
	1155	Fran	TS	08/13	9.0	53.6	4	35	1,008	
	1156	Gustav	MH	08/25	13.3	49.0	4	105	956	
	1157	Hortense	TS	08/26	14.4	40.0	4	55	993	
	1158	Isidore	H	09/05	10.4	33.8	4	80	979	
	1159	Josephine	H	09/24	19.4	34.4	4	75	980	
	1160	Klaus	H	10/03	16.2	59.6	4	70	985	
	1161	Lili	H	10/06	36.0	44.0	5	65	987	
	1162	Marco	TS	10/10	24.1	82.0	1	55	989	
	1163	Nana	H	10/16	22.1	62.1	3	75	989	
Summary: NTC = 14, NH = 8, NMH = 1, NUSLFH = 0 PWS = 105, <PWS> = 65.4, LP = 956, <LP> = 986.9 <N. Lat.> = 19.7, <W. Long.> = 52.2										
1991	1164	Ana	TS	07/04	36.2	70.7	3	45	1,000	
	1165	Bob	MH	08/16	26.4	75.8	3	100	950	NY2, CT2, RI2, MA2
	1166	Claudette	MH	09/05	26.2	56.0	5	115	946	
	1167	Danny	TS	09/08	10.3	35.0	4	45	998	
	1168	Erika	TS	09/09	29.3	53.1	5	50	997	
	1169	Fabian	TS	10/15	20.3	84.1	1	40	1,002	
	1170	Grace	H	10/26	27.2	65.5	3	85	980	
	1171	Unnamed	H	10/29	43.0	57.5	5	65	972	
Summary: NTC = 8, NH = 4, NMH = 2, NUSLFH = 1 PWS = 115, <PWS> = 68.1, LP = 946, <LP> = 980.6 <N. Lat.> = 27.4, <W. Long.> = 62.2										
1992	1172	ST1	SS(TS)	04/22	24.9	61.5	3	45	1,002	
	1173	Andrew	MH	08/17	12.3	42.0	4	150	922	FL5, FL4, LA3
	1174	Bonnie	H	09/18	33.7	58.0	5	95	965	
	1175	Charley	H	09/22	31.6	34.0	5	95	965	
	1176	Danielle	TS	09/22	32.8	74.2	3	55	1,001	
	1177	Earl	TS	09/29	29.7	79.3	3	55	990	
	1178	Frances	H	10/22	26.6	61.2	3	75	976	
Summary: NTC = 7, NH = 4, NMH = 1, NUSLFH = 1 PWS = 150, <PWS> = 81.4, LP = 922, <LP> = 974.4 <N. Lat.> = 27.4, <W. Long.> = 58.6										
1993	1179	Arlene	TS	06/19	25.9	95.9	1	35	1,000	
	1180	Bret	TS	08/05	10.4	43.4	4	50	1,002	
	1181	Cindy	TS	08/14	14.5	60.9	2	40	1,007	
	1182	Dennis	TS	08/24	15.4	34.0	4	45	1,000	
	1183	Emily	MH	08/25	28.0	60.4	3	100	960	NC3
	1184	Floyd	H	09/07	26.2	68.2	3	70	966	
	1185	Gert	H	09/15	11.3	83.0	2	85	970	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location N. Lat	Genesis Location W. Long.	PWS	LP	LP	USLFH
	1186	Harvey	H	09/20	31.5	59.0	5	65	990	
Summary: NTC = 8, NH = 4, NMH = 1, NUSLFH = 1 PWS = 100, <PWS> = 61.3, LP = 960, <LP> = 986.9 <N. Lat.> = 20.4, <W. Long.> = 63.1										
1994	1187	Alberto	TS	07/02	23.7	87.1	1	55	993	
	1188	Beryl	TS	08/15	29.7	85.6	1	50	1,000	
	1189	Chris	H	08/17	11.7	41.2	4	70	979	
	1190	Debby	TS	09/10	13.7	60.2	2	60	1,006	
	1191	Ernesto	TS	09/22	11.8	30.3	4	50	997	
	1192	Florence	H	11/02	23.2	47.7	5	95	972	
	1193	Gordon	H	11/10	14.6	82.7	2	75	980	
Summary: NTC = 7, NH = 3, NMH = 0, NUSLFH = 0 PWS = 95, <PWS> = 65.0, LP = 972, <LP> = 989.6 <N. Lat.> = 18.3, <W. Long.> = 62.1										
1995	1194	Allison	H	06/03	19.3	85.7	2	65	982	
	1195	Barry	TS	07/07	31.6	71.0	3	60	989	
	1196	Chantal	TS	07/14	21.1	64.4	3	60	991	
	1197	Dean	TS	07/30	28.6	94.0	1	40	999	
	1198	Erin	H	07/31	22.3	73.2	3	80	974	FL1, FL2
	1199	Felix	MH	08/08	15.5	36.4	4	120	929	
	1200	Gabrielle	TS	08/10	23.5	96.5	1	60	990	
	1201	Humberto	H	08/22	13.7	34.3	4	95	968	
	1202	Iris	H	08/22	13.3	50.6	4	95	957	
	1203	Jerry	TS	08/23	26.4	79.7	2	35	1,002	
	1204	Karen	TS	08/28	16.6	41.5	4	45	1,000	
	1205	Luis	MH	08/29	11.6	29.0	4	120	935	
	1206	Marilyn	MH	09/13	11.8	52.7	4	100	950	
	1207	Noel	H	09/27	12.1	40.6	4	65	987	
	1208	Opal	MH	09/30	21.1	88.5	1	130	919	FL3, AL1
	1209	Pablo	TS	10/05	10.2	37.5	4	50	994	
	1210	Roxanne	MH	10/09	16.5	83.1	2	100	958	
	1211	Sebastien	TS	10/21	16.0	55.1	4	55	1,001	
	1212	Tanya	H	10/27	26.2	57.9	5	75	970	
Summary: NTC = 19, NH = 11, NMH = 5, NUSLFH = 2 PWS = 130, <PWS> = 76.3, LP = 919, <LP> = 973.4 <N. Lat.> = 18.8, <W. Long.> = 61.7										
1996	1213	Arthur	TS	06/19	31.5	78.7	3	45	992	
	1214	Bertha	MH	07/05	11.0	39.0	4	100	960	NC2
	1215	Cesar	H	07/25	12.1	68.1	2	70	990	
	1216	Dolly	H	08/19	18.2	83.0	2	70	989	
	1217	Edouard	MH	08/22	13.2	31.6	4	125	933	
	1218	Fran	MH	08/27	14.6	44.9	4	105	946	NC3

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
	1219	Gustav	TS	08/28	11.0	33.6	4	40	1,005	
	1220	Hortense	MH	09/07	15.4	58.3	4	120	935	
	1221	Isidore	MH	09/25	10.3	28.5	4	100	960	
	1222	Josephine	TS	10/06	25.1	91.8	1	60	970	
	1223	Kyle	TS	10/11	16.9	87.1	2	45	1,001	
	1224	Lili	MH	10/16	17.5	83.8	2	100	960	
	1225	Marco	H	11/19	13.8	80.9	2	65	983	
Summary: NTC = 13, NH = 9, NMH = 6, NUSLFH = 2 PWS = 125, <PWS> = 80.4, LP = 933, <LP> = 971.1 <N. Lat.> = 16.2, <W. Long.> = 62.3										
1997	1226	ST	SS(TS)	06/01	33.2	75.3	3	45	1,003	
	1227	Ana	TS	07/01	31.8	75.4	3	40	1,000	
	1228	Bill	H	07/11	31.8	68.9	3	65	987	
	1229	Claudette	TS	07/13	31.9	73.0	3	40	1,003	
	1230	Danny	H	07/17	28.3	91.4	1	70	984	LA1, AL1
	1231	Erika	MH	09/03	12.3	47.1	4	110	946	
	1232	Fabian	TS	10/05	26.3	63.1	3	40	1,004	
	1233	Grace	TS	10/15	20.3	69.6	3	40	999	
Summary: NTC = 8, NH = 3, NMH = 1, NUSLFH = 1 PWS = 110, <PWS> = 56.3, LP = 946, <LP> = 990.8 <N. Lat.> = 27.0, <W. Long.> = 70.5										
1998	1234	Alex	TS	07/29	13.3	36.8	4	45	1,002	
	1235	Bonnie	MH	08/20	17.3	57.3	4	100	954	NC2
	1236	Charley	TS	08/21	26.0	94.5	1	60	1,001	
	1237	Danielle	H	08/24	14.2	37.9	5	90	960	
	1238	Earl	H	08/31	22.4	93.8	1	85	964	FL1
	1239	Frances	TS	09/09	24.2	95.5	1	55	990	
	1240	Georges	MH	09/16	10.6	31.3	4	135	937	FL2, MS2
	1241	Hermine	TS	09/19	27.5	91.3	1	40	999	
	1242	Ivan	H	09/20	16.0	32.6	5	80	975	
	1243	Jeanne	H	09/21	11.0	19.4	4	90	969	
	1244	Karl	H	09/24	33.2	60.7	3	90	970	
	1245	Lisa	H	10/05	14.2	47.1	4	65	995	
	1246	Mitch	MH	10/22	11.6	77.9	2	155	905	
	1247	Nicole	H	11/24	27.9	29.1	5	75	979	
Summary: NTC = 14, NH = 10, NMH = 3, NUSLFH = 3 PWS = 155, <PWS> = 83.2, LP = 905, <LP> = 971.4 <N. Lat.> = 19.2, <W. Long.> = 57.5										
1999	1248	Arlene	TS	06/12	28.3	57.5	5	50	1,006	
	1249	Bret	MH	08/19	19.8	94.7	1	125	944	TX3
	1250	Cindy	MH	08/20	13.6	26.6	4	120	942	
	1251	Dennis	H	08/24	22.4	70.0	3	90	962	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
	1252	Emily	TS	08/24	11.5	53.8	4	45	1,005	
	1253	Floyd	MH	09/08	15.3	48.2	4	135	921	NC2
	1254	Gert	MH	09/12	14.2	31.9	4	130	930	
	1255	Harvey	TS	09/20	26.3	87.4	1	50	995	
	1256	Irene	H	10/13	18.5	83.4	2	95	960	FL1
	1257	Jose	H	10/18	10.9	52.8	4	85	979	
	1258	Katrina	TS	10/29	13.2	82.9	2	35	999	
	1259	Lenny	MH	11/14	16.4	79.9	2	135	933	
Summary: NTC = 12, NH = 8, NMH = 5, NUSLFH = 3 PWS = 135, <PWS> = 91.3, LP = 921, <LP> = 964.7 <N. Lat.> = 17.5, <W. Long.> = 64.1										
2000	1260	Alberto	MH	08/04	12.0	22.3	4	110	950	
	1261	Beryl	TS	08/14	23.1	94.6	1	45	1,007	
	1262	Chris	TS	08/18	16.2	55.4	5	35	1,009	
	1263	Debby	H	08/20	13.3	46.8	4	75	993	
	1264	Ernesto	TS	09/02	16.2	49.5	4	35	1,008	
	1265	Florence	H	09/11	30.4	72.2	3	70	985	
	1266	Gordon	H	09/16	22.5	86.7	1	70	981	
	1267	Helene	TS	09/21	24.9	86.6	1	60	986	
	1268	Isaac	MH	09/22	12.3	25.9	4	120	943	
	1269	Joyce	H	09/26	11.5	31.9	4	80	975	
	1270	Keith	MH	09/29	17.4	84.8	2	120	941	
	1271	Leslie	TS	10/05	29.9	77.3	3	60	973	
	1272	Michael	H	10/16	29.9	71.8	3	85	965	
	1273	Nadine	TS	10/20	30.4	57.2	5	50	999	
	1274	ST	SS(TS)	10/25	22.5	70.0	3	55	978	
Summary: NTC = 15, NH = 8, NMH = 3, NUSLFH = 0 PWS = 120, <PWS> = 71.3, LP = 941, <LP> = 979.5 <N. Lat.> = 20.8, <W. Long.> = 62.2										
2001	1275	Allison	TS	06/05	27.5	95.0	1	50	1,002	
	1276	Barry	TS	08/02	26.2	84.9	1	60	991	
	1277	Chantal	TS	08/17	13.1	60.6	2	60	997	
	1278	Dean	TS	08/22	17.9	64.3	2	60	994	
	1279	Erin	MH	09/02	13.2	37.5	4	105	968	
	1280	Felix	MH	09/11	18.6	47.7	4	100	962	
	1281	Gabrielle	H	09/13	25.3	84.9	1	70	975	
	1282	Humberto	H	09/22	27.9	66.3	3	90	970	
	1283	Iris	MH	10/05	14.8	64.5	2	125	948	
	1284	Jerry	TS	10/07	11.0	53.8	4	45	1,004	
	1285	Karen	H	10/11	29.8	62.5	3	70	982	
	1286	Lorenzo	TS	10/30	28.5	44.6	5	35	1,007	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
	1287	Michelle	MH	11/01	15.8	83.1	2	120	934	
	1288	Noel	H	11/04	33.9	50.4	5	65	986	
	1289	Olga	H	11/24	29.3	50.3	5	80	973	
Summary: NTC = 15, NH = 9, NMH = 4, NUSLFH = 0 PWS = 125, <PWS> = 75.6, LP = 934, <LP> = 979.5 <N. Lat.> = 22.2, <W. Long.> = 63.4										
2002	1290	Arthur	TS	07/15	35.5	73.3	3	50	992	
	1291	Bertha	TS	08/05	29.3	89.2	1	35	1,008	
	1292	Cristobal	TS	08/06	30.4	76.4	3	45	999	
	1293	Dolly	TS	08/29	9.7	32.2	4	50	997	
	1294	Edouard	TS	09/02	30.1	79.7	3	55	1,002	
	1295	Fay	TS	09/06	27.8	93.9	1	50	998	
	1296	Gustav	H	09/08	30.2	71.1	3	85	960	
	1297	Hanna	TS	09/12	26.7	86.4	1	50	1,001	
	1298	Isidore	MH	09/18	17.1	78.1	2	110	934	
	1299	Josephine	TS	09/18	34.7	52.7	5	50	1,004	
	1300	Kyle	H	09/21	30.4	51.6	5	75	980	
	1301	Lili	MH	09/23	12.1	54.6	4	125	940	LA1
Summary: NTC = 12, NH = 4, NMH = 2, NUSLFH = 1 PWS = 125, <PWS> = 65.0, LP = 934, <LP> = 984.6 <N. Lat.> = 26.2, <W. Long.> = 69.9										
2003	1302	Ana	TS	04/19	33.8	67.6	3	50	994	
	1303	Bill	TS	06/29	23.4	90.5	1	50	997	
	1304	Claudette	H	07/07	13.2	59.8	4	75	982	TX1
	1305	Danny	H	07/17	32.5	55.2	5	65	1,001	
	1306	Erika	H	08/14	26.4	83.3	1	60	988	
	1307	Fabian	MH	08/28	15.0	36.2	4	125	939	
	1308	Grace	TS	08/30	24.9	93.3	1	35	1,007	
	1309	Henri	TS	09/05	27.7	85.1	1	50	997	
	1310	Isabel	MH	09/06	13.9	32.7	4	145	915	NC2, VA1
	1311	Juan	H	09/25	28.4	62.0	3	90	969	
	1312	Kate	MH	09/27	21.0	44.2	5	110	952	
	1313	Larry	TS	09/30	21.2	92.5	1	55	993	
	1314	Mindy	TS	10/10	19.1	68.8	2	40	1,002	
	1315	Nicholas	TS	10/14	10.9	41.9	4	60	990	
	1316	Odette	TS	12/04	13.3	75.7	2	55	993	
	1317	Peter	TS	12/07	27.5	34.5	5	60	990	
Summary: NTC = 16, NH = 7, NMH = 3, NUSLFH = 2 PWS = 145, <PWS> = 70.3, LP = 915, <LP> = 981.8 <N. Lat.> = 22.0, <W. Long.> = 64.0										
2004	1318	Alex	MH	08/01	31.6	79.2	3	105	957	NC1
	1319	Bonnie	TS	08/09	22.5	87.6	1	55	1,001	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location N. Lat	Genesis Location W. Long.	PWS	LP	LP	USLFH
	1320	Charley	MH	08/10	12.9	65.3	2	125	947	FL4, FL1, FL1, SC1, NC1
	1321	Danielle	H	08/14	12.6	24.2	4	95	964	
	1322	Earl	TS	08/14	10.5	53.5	4	45	1,009	
	1323	Frances	MH	08/25	11.5	39.8	4	125	937	FL2, FL1
	1324	Gaston	H	08/28	31.3	78.2	3	65	986	SC1
	1325	Hermine	TS	08/29	31.1	69.8	3	50	1,002	
	1326	Ivan	MH	09/03	9.7	30.3	4	145	910	AL3, FL3
	1327	Jeanne	MH	09/14	16.4	62.6	2	105	951	FL3, FL1, FL1
	1328	Karl	MH	09/16	11.2	32.1	4	125	943	
	1329	Lisa	H	09/20	13.5	35.4	5	65	990	
	1330	Matthew	TS	10/08	24.1	94.2	1	40	997	
	1331	Nichole	SS(TS)	10/10	30.0	65.2	3	45	986	
	1332	Otto	TS	11/26	27.3	41.0	5	45	995	
Summary: NTC = 15, NH = 9, NMH = 5, NUSLFH = 6 PWS = 145, <PWS> = 82.3, LP = 912, <LP> = 971.7 <N. Lat.> = 19.7, <W. Long.> = 57.4										
2005	1333	Arlene	TS	06/09	18.2	83.9	2	60	990	
	1334	Bret	TS	06/29	20.0	95.8	1	35	1,005	
	1335	Cindy	H	07/05	25.1	90.2	1	65	992	LA1
	1336	Dennis	MH	07/05	13.0	65.9	2	130	930	FL3, AL1
	1337	Emily	MH	07/12	11.0	46.8	4	140	929	
	1338	Franklin	TS	07/22	25.7	75.9	3	60	997	
	1339	Gert	TS	07/24	20.8	95.0	1	40	1,005	
	1340	Harvey	TS	08/03	29.5	68.6	3	55	994	
	1341	Irene	H	08/07	20.2	45.0	5	90	970	
	1342	Jose	TS	08/22	19.6	95.0	1	45	1,001	
	1343	Katrina	MH	08/24	24.5	76.5	3	150	902	FL1, FL1, LA3, MS3, AL1
	1344	Lee	TS	08/31	29.0	50.4	5	35	1,006	
	1345	Maria	MH	09/02	21.1	49.4	5	100	962	
	1346	Nate	H	09/06	28.4	66.6	3	80	979	
	1347	Ophelia	H	09/07	27.9	78.8	3	75	976	NC1
	1348	Philippe	H	09/17	13.5	54.9	4	70	985	
	1349	Rita	MH	09/18	22.2	72.3	3	155	897	FL1, LA3, TX2
	1350	Stan	H	10/02	19.5	87.2	2	70	977	
	1351	ST	SS(TS)	10/04	35.9	28.5	5	45	997	
	1352	Tammy	TS	10/05	27.3	79.7	3	45	1,001	
	1353	Vince	H	10/08	32.9	20.6	5	65	988	
	1354	Wilma	MH	10/17	16.9	79.6	2	160	882	FL3, FL2
	1355	Alpha	TS	10/22	16.5	68.5	2	45	998	
	1356	Beta	MH	10/27	11.0	81.3	2	100	962	
	1357	Gamma	TS	11/18	15.7	85.6	2	45	1,002	

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location		PWS	LP	LP	USLFH
					N. Lat	W. Long.				
	1358	Delta	TS	11/20	28.0	43.5	5	60	980	
	1359	Epsilon	H	11/29	31.5	49.2	5	75	981	
	1360	Zeta	TS	12/30	24.2	36.1	5	55	994	
Summary: NTC = 28, NH = 15, NMH = 7, NUSLFH = 6 PWS = 160, <PWS> = 76.8, LP = 882, <LP> = 974.4 <N. Lat.> = 22.5, <W. Long.> = 66.8										
2006	1361	Alberto	TS	06/11	22.5	86.3	1	60	969	
	1362	Unnamed	TS	07/17	40.0	65.1	3*	45	998	
	1363	Beryl	TS	07/18	33.0	73.3	3	50	1,000	
	1364	Chris	TS	08/01	16.8	58.9	4	55	1,001	
	1365	Debby	TS	08/23	14.9	28.1	4	45	999	
	1366	Ernesto	H	08/25	13.7	65.8	2	65	985	
	1367	Florence	H	09/05	16.8	46.1	4	80	965	
	1368	Gordon	MH	09/11	20.9	56.3	5	105	955	
	1369	Helene	MH	09/14	12.9	31.9	4	105	955	
	1370	Isaac	H	09/28	27.4	54.0	5	75	985	
Summary: NTC = 10, NH = 5, NMH = 2, NUSLFH = 0 PWS = 105, <PWS> = 68.5, LP = 955, <LP> = 981.2 <N. Lat.> = 21.9, <W. Long.> = 56.6										
2007	1371	Andrea	SS(H)	05/06	35.5	74.0	3	65	998	
	1372	Barry	TS	06/01	23.6	85.7	1	50	990	
	1373	Chantal	TS	07/31	35.5	66.5	3	60	964	
	1374	Dean	MH	08/14	11.8	38.3	4	150	907	
	1375	Erin	TS	08/15	25.8	94.0	1	50	995	
	1376	Felix	MH	09/01	12.1	59.4	4	150	930	
	1377	Gabrielle	TS	09/08	30.1	71.8	3	50	1,004	
	1378	Humberto	H	09/12	27.8	95.1	1	80	985	TX1, LA1
	1379	Ingrid	TS	09/13	13.7	46.7	4	40	1,002	
	1380	Jerry	TS	09/23	36.2	46.1	5	35	1,003	
	1381	Karen	H	09/25	10.3	37.0	4	65	988	
	1382	Lorenzo	H	09/27	20.6	95.1	1	70	990	
	1383	Melissa	TS	09/29	14.5	27.4	4	35	1,005	
	1384	Noel	H	10/28	16.3	71.6	2	75	965	
	1385	Olga	TS	12/10	18.3	61.8	2	50	1,003	
Summary: NTC = 15, NH = 7, NMH = 2, NUSLFH = 1 PWS = 150, <PWS> = 68.3, LP = 907, <LP> = 981.9 <N. Lat.> = 22.1, <W. Long.> = 64.7										
2008	1386	Arthur	TS	05/31	17.5	87.5	2	40	1,004	
	1387	Bertha	MH	07/03	13.1	24.0	4	105	955	
	1388	Cristobal	TS	07/19	32.4	78.8	3	55	998	
	1389	Dolly	H	07/20	17.8	83.6	2	85	963	TX1

Table 13. Listing of North Atlantic basin tropical cyclones for the interval 1945–2008 (Continued).

Year	SNBR	Name	Class.	FSD	Genesis Location N. Lat	Genesis Location W. Long.	PWS	LP	LP	USLFH
	1390	Edouard	TS	08/04	28.1	88.5	1	55	997	
	1391	Fay	TS	08/15	18.5	68.8	2	60	986	
	1392	Gustav	MH	08/25	15.1	69.6	2	125	943	LA2
	1393	Hanna	H	08/28	20.1	58.6	5	75	977	
	1394	Ike	MH	09/01	17.3	38.4	4	125	935	TX2, LA1
	1395	Josephine	TS	09/02	12.7	23.2	4	55	994	
	1396	Kyle	H	09/25	22.0	69.4	3	75	984	
	1397	Laura	H	09/26	39.0	35.0	5	70	991	
	1398	Marco	TS	10/06	18.9	93.7	1	55	998	
	1399	Nana	TS	10/12	16.0	37.1	5	35	1,004	
	1400	Omar	MH	10/14	14.5	69.6	2	115	958	
	1401	Paloma	MH	11/06	14.8	82.1	2	125	944	

Summary: NTC = 16, NH = 9, NMH = 5, NUSLFH = 3
PWS = 125, <PWS> = 78.4, LP = 935, <LP> = 976.9
<N. Lat.> = 19.9, <W. Long.> = 63.0

Note: Group 1 (Gulf of Mexico area): 18.0N–30.0N, 80.0W–99.9W and 15.0N–19.9N, 90.0W–94.9W
Group 2 (Caribbean Sea area): 10.0N–19.9N, 60.0W–89.9W
Group 3 (East coast area): 20.0N–39.9N, 60.0W–79.9W
Group 4 (Lower N. Atlantic-Cape Verdi area): 5.0N–19.9N, 15.0W–59.9W
Group 5 (Open N. Atlantic area): 20.0N–44.9N, 15.0W–59.9W
P/1 means the tropical cyclone formed in the Pacific Ocean, then moved into the Gulf of Mexico.
* means it belongs in the group, even though it does not fall within the areal bounds as given above.

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14. ABSTRACT
Yearly frequencies of North Atlantic basin tropical cyclones, their locations of origin, peak wind speeds, average peak wind speeds, lowest pressures, and average lowest pressures for the interval 1950–2008 are examined. The effects of El Niño and La Niña on the tropical cyclone parametric values are investigated. Yearly and 10-year moving average (10-yma) values of tropical cyclone parameters are compared against those of temperature and decadal-length oscillation, employing both linear and bi-variate analysis, and first differences in the 10-yma are determined. Discussion of the 2009 North Atlantic basin hurricane season, updating earlier results, is given.

15. SUBJECT TERMS
tropical cyclone activity, North Atlantic basin, forecasting, global warming, decadal-length oscillations, Oceanic Oscillation Index, El Niño, La Niña, North Atlantic Oscillations, East Atlantic Index, Southern Oscillation Index, 2009 hurricane season

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