NASA/TP—2014–218200

On the Sizes of the North Atlantic Basin Tropical Cyclones Based on 34- and 64-kt Wind Radii Data, 2004–2013

Robert M. Wilson
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September 2014

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LIST OF ABBREVIATIONS, ACRONYMS, SYMBOLS, AND DESIGNATORS

A34WA	average 34-kt wind area for a tropical cyclone (nmi^2)
<A34WA>	mean yearly A34WA for all tropical cyclones in a season (nmi^2)
A64WA	average 64-kt wind area for a tropical cyclone (nmi^2)
<A64WA>	mean yearly A64WA for all tropical cyclones in a season (nmi^2)
ACE	accumulated cyclone energy ($10^4\ kt^2$)
AMO	Atlantic Multidecadal Oscillation (index)
<AMO>	mean yearly AMO
CO_2	carbon dioxide
DOY	day of year
FHD	first hurricane day
FMHD	first major hurricane day
FSD	first storm day
GLOTI	Global Land-Ocean Temperature Index (°C)
<GLOTI>	mean yearly GLOTI
H	hurricane
HISACE	highest individual storm ACE
HISPDI	highest individual storm PDI
HURDAT	hurricane database (original version)
HURDAT2	hurricane database (newer version)
L34WA	largest 34-kt wind area (nmi^2)

<L34WA>	mean yearly L34WA
L34WR	largest 34-kt wind radius (nmi)
<L34WR>	mean yearly L34WR
L64WA	largest 64-kt wind area (nmi^2)
<L64WA>	mean yearly L64WA
L64WR	largest 64-kt wind radius (nmi)
<L64WR>	mean yearly L64WR
LIS	largest individual storm
LIS(L34WA)	largest individual storm of L34WA
LIS(L34WR)	largest individual storm of L34WR
LIS(L64WA)	largest individual storm of L64WA
LIS(L64WR)	largest individual storm of L64WR
LISNSD	largest individual storm of NSD
LOS	length of season (days)
LP	lowest pressure (mb)
<LP>	mean yearly LP for all tropical cyclones in a season
LHD	last hurricane day
LMHD	last major hurricane day
LSD	last storm day
MH	major hurricane
MLCO2	Mauna Loa carbon dioxide (index)
<MLCO2>	mean yearly MLCO2
NH	number of hurricanes

NHD	number of hurricane days
<N. Lat.>	mean yearly north latitude for all tropical cyclones in a season (degrees)
NMH	number of major hurricanes
NMHD	number of major hurricane days
NSD	number of storm days
NTC	number of tropical cyclones
NTCA	net tropical cyclone activity (index)
NTS	number of tropical storms
NUSLFH	number of U.S. land-falling hurricanes
ONI	Oceanic Niño Index
<ONI>	mean yearly ONI
PDI	power dissipation index (10^6 kt^3)
PWS	peak wind speed (kt)
<PWS>	mean yearly PWS
SOI	Southern Oscillation Index
<SOI>	mean yearly SOI
SS	substorm
total 34WA	sum of the 34-kt wind areas for all tropical cyclones in a season
total 64WA	sum of the 64-kt wind areas for all tropical cyclones in a season
total ACE	sum of ACE for all tropical cyclones in a season
total NHD	sum of NHD for all tropical cyclones in a season
total NMHD	sum of NMHD for all tropical cyclones in a season
total NSD	sum of NSD for all tropical cyclones in a season

total PDI	sum of PDI for all tropical cyclones in a season
TS	tropical storm
U.S.	United States
USLFH	U.S. land-falling hurricane
UT	universal time
<W. Long.>	mean yearly west longitude for all tropical cyclones in a season (degrees)

NOMENCLATURE

a	y-intercept
b	slope
cl	confidence level
r	coefficient of correlation
r^2	coefficient of determination
sd	standard deviation
se	standard error of estimate
x	independent variable
y	dependent variable

TECHNICAL PUBLICATION

ON THE SIZES OF THE NORTH ATLANTIC BASIN TROPICAL CYCLONES BASED ON 34- AND 64-KT WIND RADII DATA, 2004–2013

1. INTRODUCTION

At the end of the 2012 North Atlantic basin hurricane season, the National Hurricane Center retired the older HURDAT dataset and initiated a newer version called HURDAT2. The newer version reformatted the original HURDAT data and included additional data, in particular, the 34-, 50-, and 64-kt wind radii (in nautical miles) by quadrant (northeast, southeast, southwest, and northwest). Presently, this tropical cyclone wind radii dataset is available only for the most recent interval 2004–2013.[1,2]

The purpose of this Technical Publication is (1) to examine the distributions of the 34- and 64-kt wind radii data to determine the sizes of the wind areas for individual tropical cyclones and for each year during the interval 2004–2013; (2) to determine if there are any discernible trends (i.e., statistically important) in the tropical cyclone wind radii and areal data during this very brief 10-year period; and (3) to determine the effects, if any, of specific climate-related factors[3] on the tropical cyclone wind radii and areal data (e.g., the Oceanic Niño Index (ONI), the Southern Oscillation Index (SOI), the Atlantic Multidecadal Oscillation (AMO) index, the Mauna Loa Carbon Dioxide (MLCO2) index, and the Global Land-Ocean Temperature Index (GLOTI)).

2. RESULTS AND DISCUSSION

Table 1 provides a listing of the tropical cyclones that occurred in the North Atlantic basin during the interval 2004–2013. Included in the listing are some 164 tropical cyclones, of which 77 became hurricanes (34 of the 77 hurricanes became major or intense hurricanes) and 17 struck the United States (U.S.) coastline with hurricane-force winds (≥64 kt). The table gives the name of each tropical cyclone; the class of the tropical cyclone at greatest strength, i.e., substorm (SS), tropical storm (TS), hurricane (H), and major hurricane (MH); the first storm day (FSD), i.e., the first day the tropical cyclone attained a 1-min sustained peak wind speed of at least 34 kt and the tropical cyclone was not classified as 'extratropical'; the last storm day (LSD), i.e., the last day the tropical cyclone had a 1-min sustained peak wind speed of at least 34 kt and the tropical cyclone was not classified as extratropical; the genesis location, i.e., the onset location of the tropical cyclone in terms of its N. latitudinal and W. longitudinal position on the FSD; the group descriptor, i.e., the general area where the storm had its onset, where group 1 is the region of the Gulf of Mexico; group 2, the Caribbean Sea; group 3, the east coast near the U.S.; group 4, the lower N. Atlantic basin/Cape Verdi area; and group 5, the open N. Atlantic basin farther away from the U.S.; the peak wind speed (PWS) in kt; the lowest pressure (LP) in mb; the power dissipation index (PDI) in units of 10^6 kt^3; the accumulated cyclone energy (ACE) in units of 10^4 kt^2; the largest 34-kt wind radius (L34WR) in nmi; the largest 34-kt wind area (L34WA) in nmi^2; the average 34-kt wind area (A34WA) in nmi^2, i.e., the average area of the tropical cyclone during its lifetime based on each of the 6-hr time measurements at 0000, 0600, 1200, and 1800 universal time (UT); the largest 64-kt wind radius (L64WR) in nmi; the largest 64-kt wind area (L34WA) in nmi^2; the average 64-kt wind area (A64WA) in nmi^2, i.e., the average area of the tropical cyclone during its lifetime based on each of the 6-hr time measurements at 0000, 0600, 1200, and 1800 UT; the number of storm days (NSD), i.e., the number of days that the tropical cyclone had a sustained 1-min PWS of at least 34 kt and the storm was not classified as extratropical; the number of hurricane days (NHD), i.e., the number of days that the tropical cyclone had a sustained 1-min PWS of at least 64 kt and the storm was not classified as extratropical; the number of major hurricane days (NMHD), i.e., the number of days that the tropical cyclone had a sustained 1-min PWS of at least 96 kt and the storm was not classified as extratropical; and the identification of those storms that were U.S. land-falling hurricanes (USLFH), i.e., those storms that struck the U.S. coastline with at least minimal hurricane-force winds, identifying the states that were struck and the class of the storm at landfall, where classes 1 and 2 mean the tropical cyclone struck the U.S. with minimal hurricane-force winds, 64–95 kt, and classes 3 through 5 mean the tropical cyclone struck the U.S. with major hurricane-force winds, ≥96 kt.

At the bottom of each yearly tabular listing are the yearly summaries identifying totals, peak parametric values, mean parametric values, and the net tropical cyclone activity (NTCA), described as a percentage relative to the 1950–2000 average. For the 34- and 64-kt wind radii and areas, the LIS value simply means the 'largest individual storm' value and the values within the symbols <> mean the average of the yearly 34- and 64-kt wind radii and areas. Also included is the length of season (LOS), i.e., the inclusive elapsed time in days between the day of year (DOY) associated with the FSD for the first tropical cyclone of the yearly season and the DOY associated with the LSD for the last tropical cyclone of the yearly season.

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34-and 64-kt wind radii (in nmi) and areal data.

2004&																				
				Genesis Location																
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Alex	MH	08/01	08/06	31.6	79.2	3	105	957	9.5	11.4	300	150,816	54,430	50	3,691	2,728	5.00	3.25	0.75	^NC1
Bonnie	TS	08/09	08/12	22.5	87.6	1	55	1,001	1.2	2.6	60	5,400	3,524	–	–	–	3.25	–	–	
Charley	MH	08/10	08/14	12.9	65.3	2	125 (130)	947 (941)	9.0	10.6	100	21,559	14,775	50	2,847	1,234	4.75	3.00	0.50	FLSW4, FLSE1, FLNE1, SC1, NC1
Danielle	H	08/14	08/20	12.6	24.2	4	95	964	9.5	12.1	120	31,455	15,611	25	1,787	1,318	6.75	3.50	–	
Earl	TS	08/14	08/15	10.5	53.5	4	45	1,009	0.3	0.8	90	10,780	9,614	–	–	–	1.25	–	–	
Frances	MH	08/25	09/07	11.5	39.8	4	125	937 (935)	48.0	45.9	175	76,537	48,968	85	14,883	7,484	12.50	10.00	6.75	FLSE2, FLSW1
Gaston	H	08/28	09/01	31.3	78.2	3	65	986 (985)	1.3	2.7	120	17,671	7,653	10	157	157	3.25	0.25	–	SC1
Hermine	TS	08/29	08/31	31.1	69.8	3	50	1,002	0.5	1.3	125	12,272	5,959	–	–	–	2.00	–	–	
Ivan	MH	09/03	09/23	9.7	30.3	4	145	910	83.5	70.4	250	130,572	50,556	100	21,795	9,262	14.75	11.50	10.00	AL3, FLNW3
Jeanne	MH	09/14	09/27	16.4	62.6	2	105	951 (950)	18.4	24.2	180	73,062	27,747	60	10,446	4,232	13.00	6.50	0.75	FLSE3, FLSW1, FLNW1
Karl	MH	09/16	09/24	11.2	32.1	4	125	938	28.5	28.4	350	324,468	107,362	90	14,844	8,823	8.25	7.00	3.50	
Lisa	H	09/20	10/03	13.5	35.4	5	65	987	6.3	12.2	200	88,357	18,655	20	628	628	11.75	0.50	–	
Matthew	TS	10/08	10/10	24.1	94.2	1	40	997	0.4	1.0	150	25,525	19,994	–	–	–	1.75	–	–	
Nicole	SS	10/10	10/11	31.0	66.3	3	45	986	0.5	1.2	300	204,204	85,973	–	–	–	1.75	–	–	
Otto	TS	11/29	12/02	29.6	47.9	5	45	996	0.8	1.9	275	130,082	51,701	–	–	–	3.00	–	–	
Summary: NTC = 15, NTS = 6, NH = 9, NMH = 6, NUSLFH = 5, PWS = 145, <PWS> = 82.3, LP = 910, <LP> = 971.2, <N. Lat.> = 20.0, <W. Long.> = 57.8, Total PDI = 217.7, Total ACE = 226.7, Total NSD = 93.00, Total NHD = 45.50, Total NMHD = 22.25, HISPDI = 83.5, HISACE = 70.4, LISNSD = 14.75, NTCA = 231.4%, FSD = 214, LSD = 337, LOS = 124, LIS(L34WR) = 350, <L34WR> = 186, LIS(L34WA) = 324,468, <L34WA> = 86,851, LIS(A34WA) = 107,362, <A34WA> = 34,835, LIS(L64WR) = 100, <L64WR> = 54, LIS(L64WA) = 21,795, <L64WA> = 7,898, LIS(A64WA) = 9,262, <A64WA> = 3,985																			

Notes:

Group 1 (Gulf of Mexico area): 18.0° N.–30.0° N., 80.0° W.–99.9° W., and 15.0° N.–19.9° N., 90.0° W.–94.9° W.
Group 2 (Caribbean Sea area): 10.0° N.–19.9° N., 60.0° W.–89.9° W.
Group 3 (East coast area): 20.0° N.–39.9° N., 60.0° W.–79.9° W.
Group 4 (Lower N. Atlantic–Cape Verdi area): 5.0° N.–19.9° N., 15.0° W.–59.9° W.
Group 5 (Open N. Atlantic area): 20.0° N.–46.0° N., 15.0° W.–59.9° W.
PDI = sum of wind speed cubed (in units of 10×10^6 kt^3).
ACE = sum of wind speed squared (in units of 10×10^4 kt^2).
& = the year is classified as an ENY (i.e., NENM >5 months).
^ = the Hurricane Center did not make USLF, but did produce hurricane force winds over land.

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34- and 64-kt wind radii (in nmi) and areal data (Continued).

2005																			
				Genesis Location															
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Arlene	TS	06/09	06/11	18.2	83.9	2	60	990 (989)	1.3	2.6	140	39,625	18,593	–	–	–	2.75	–	–	
Bret	TS	06/29	06/29	20.0 (19.9)	95.8 (95.7)	1	35	1,005 (1,002)	0.1	0.4	30	2,827	2,566	–	–	–	0.75	–	–	
Cindy	H	07/05	07/06	25.1	90.2	1	65	992 (991)	0.8	1.5	90	19,792	13,188	20	628	628	1.50	0.25	–	LA1
Dennis	MH	07/05	07/11	13.0	65.9	2	130	930	19.4	18.8	200	79,502	37,830	55	4,359	2,548	5.75	4.00	2.50	FLNW3, AL2
Emily	MH	07/12	07/21	11.0	46.8	4	140	929	35.7	32.9	140	40,762	24,089	60	6,244	2,764	9.25	7.00	4.25	
Franklin	TS	07/22	07/29	25.7	75.9	3	60	997	3.2	6.7	140	25,525	11,349	–	–	–	8.00	–	–	
Gert	TS	07/24	07/25	20.8	95.0	1	40	1,005	0.2	0.5	75	17,671	11,167	–	–	–	1.00	–	–	
Harvey	TS	08/03	08/08	29.5	68.6	3	55	994	2.6	5.4	120	26,704	13,589	–	–	–	5.75	–	–	
Irene	H	08/07	08/18	20.2	45.0	5	90	970	8.9	13.1	360	207,109	21,065	30	1,335	988	8.75	3.00	–	
Jose	TS	08/22	08/23	19.6	95.0	1	45 (50)	1,001 (998)	0.2	0.4	40	3,534	2,068	–	–	–	0.75	–	–	
Katrina	MH	08/24	08/30	24.5	76.5	3	150	902	22.1	20.0	200	105,950	37,211	90	21,049	8,814	6.00	4.00	2.25	FLSE1, LA3, MS3, AL2
Lee	TS	08/31	08/31	29.0	50.4	5	35	1,006	0.1	0.2	60	5,655	5,655	–	–	–	0.50	–	–	
Maria	MH	09/02	09/10	21.1	49.4	5	100	962	10.3	14.3	225	119,282	50,270	75	13,254	3,969	8.00	4.75	0.25	
Nate	H	09/06	09/10	28.4	66.6	3	80	979	4.7	7.2	240	89,064	39,448	60	7,069	1,944	4.75	2.25	–	
Ophelia	H	09/07	09/17	27.9	78.8	3	75	976	9.8	15.7	150	53,564	30,270	45	4,595	2,544	10.75	3.75	–	
Philippe	H	09/17	09/23	13.5	54.9	4	70	985	3.3	6.0	120	23,326	10,143	15	353	353	5.75	1.50	–	
Rita	MH	09/18	09/25	22.2	72.3	3	155	897 (895)	29.5	25.1	180	74,534	42,027	75	14,510	7,952	6.50	4.25	3.25	TXNE3, LA2
Stan	H	10/02	10/04	19.5	87.2	2	70	977	1.3	2.4	100	19,615	11,962	15	707	619	2.50	0.50	–	
Unnamed	SS/TS	10/04	10/05	35.9	28.5	5	45	997	0.2	0.5	90	12,723	11,427	–	–	–	0.75	–	–	
Tammy	TS	10/05	10/06	27.3	79.7	3	45	1,001	0.3	0.8	230	74,318	42,243	–	–	–	1.25	–	–	
Vince	H	10/08	10/10	32.9	20.6	5	65	988	1.4	2.7	70	15,394	9,768	15	707	707	2.75	0.25	–	
Wilma	MH	10/17	10/25	16.9	79.6	2	160	882	45.7	38.9	375	236,601	83,037	90	16,454	11,588	8.75	7.50	4.75	FLSW3, FLSE1
Alpha	TS	10/22	10/23	16.5	68.5	2	45	998	0.3	0.7	45	3,809	2,307	–	–	–	1.00	–	–	
Beta	MH	10/27	10/30	11.0	81.3	2	100	962	4.8	6.5	60	9,582	5,534	15	707	707	3.75	1.50	0.25	
Gamma	TS	11/15	11/20	14.3	66.0	2	45	1,002	0.4	1.1	90	12,723	9,036	–	–	–	2.25	–	–	
Delta	TS	11/22	11/28	30.7	40.5	5	60	980	3.1	6.0	275	188,986	77,132	–	–	–	5.75	–	–	

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34- and 64-kt wind radii (in nmi) and areal data (Continued).

2005																				
				Genesis Location																
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Epsilon	H	11/29	12/08	31.5	49.2	5	75	981	8.3	13.4	130	41,783	24,430	35	1,787	905	9.25	5.00	–	
Zeta	TS	12/30	01/06	24.2	36.1	5	55	994	3.1	6.3	175	52,524	24,547	–	–	–	7.00	–	–	
Summary: NTC =28, NTS = 13, NH = 15, NMH = 7, NUSLFH = 5, PWS = 160, <PWS> = 76.8, LP = 882, <LP> =974.4, <N. Lat.> = 22.5, <W. Long.> = 66.0, Total PDI = 221.1, Total ACE = 250.1, Total NSD = 131.50, Total NHD = 49.50, Total NMHD = 17.50, HISPDI = 45.7, HISACE = 38.9, LISNSD = 10.75, NTCA = 278.4%, FSD = 160, LSD = 371, LOS = 212, LIS(L34WR) = 375, <L34WR> = 148, LIS(L34WA) = 23,6601, <L34WA> = 57,219, LIS(A34WA) = 83,037, <A34WA> = 23,998, LIS(L64WR) = 90, <L64WR> = 46, LIS(L64WA) = 21,049, <L64WA> = 6,251, LIS(A64WA) = 11,588, <A64WA> = 3,135																			

Notes:

Group 1 (Gulf of Mexico area): 18.0° N.–30.0° N., 80.0° W.–99.9° W., and 15.0° N.–19.9° N., 90.0° W.–94.9° W.
Group 2 (Caribbean Sea area): 10.0° N.–19.9° N., 60.0° W.–89.9° W.
Group 3 (East coast area): 20.0° N.–39.9° N., 60.0° W.–79.9° W.
Group 4 (Lower N. Atlantic–Cape Verdi area): 5.0° N.–19.9° N., 15.0° W.–59.9° W.
Group 5 (Open N. Atlantic area): 20.0° N.–46.0° N., 15.0° W.–59.9° W.
PDI = sum of wind speed cubed (in units of 10×10^6 kt^3).
ACE = sum of wind speed squared (in units of 10×10^4 kt^2).

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34- and 64-kt wind radii (in nmi) and areal data (Continued).

2006																				
				Genesis Location																
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Alberto	TS	06/11	06/14	22.5	86.3	1	60	995	1.4	2.8	200	51,915	30,201	–	–	–	3.25	–	–	
Unnamed	TS	07/17	07/18	40.0	65.1	3*	45	998	0.3	0.6	60	2,827	2,827	–	–	–	1.00	–	–	
Beryl	TS	07/18	07/21	33.0	73.3	3	50	1,000	1.0	2.3	120	22,462	14,384	–	–	–	3.00	–	–	
Chris	TS	08/01	08/03	16.8	58.9	4	55	1,001	1.0	2.2	70	7,697	4,638	–	–	–	2.50	–	–	
Debby	TS	08/23	08/26	14.9	28.1	4	45	999	1.0	2.3	90	6,362	4,484	–	–	–	3.25	–	–	
Ernesto	H	08/25	09/01	13.7	65.8	2	65	985	2.8	5.7	125	24,544	8,898	10	79	79	7.00	0.25	–	
Florence	H	09/05	09/12	16.8	46.1	4	80	974	5.9	9.6	360	319,500	136,439	90	14,137	5,966	7.75	2.75	–	
Gordon	MH	09/11	09/20	20.9	56.3	5	105	955	18.3	22.2	200	56,784	25,585	70	3,848	1,794	9.50	8.00	1.25	
Helene	MH	09/14	09/24	12.9	31.9	4	105	955	19.4	24.3	350	320,541	93,303	100	20,577	6,584	10.75	8.25	0.75	
Isaac	H	09/28	10/02	27.4	54.0	5	75	985	4.0	6.5	225	80,012	33,817	35	2,376	1,495	4.75	2.00	–	
Summary: NTC = 10, NTS = 5, NH = 5, NMH = 2, NUSLFH = 0, PWS = 105, <PWS> = 68.5, LP = 955, <LP> = 984.7, <N. Lat.> = 21.9, <W. Long.> = 56.6, Total PDI = 55.1, Total ACE = 78.5, Total NSD = 52.75, Total NHD = 21.25, Total NMHD = 2.00, HISPDI = 19.4, HISACE = 24.3, LISNSD = 10.75, NTCA = 85.0%, FSD = 162, LSD = 275, LOS = 114, LIS(L34WR) = 360, <L34WR> = 180, LIS(L34WA) = 320,541, <L34WA> = 89,264, LIS(A34WA) = 136,439, <A34WA> = 35,458, LIS(L64WR) = 100, <L64WR> = 61, LIS(L64WA) = 20,577, <L64WA> = 8,203, LIS(A64WA) = 6,584, <A64WA> = 3,184																			

Notes:

Group 1 (Gulf of Mexico area): 18.0° N.–30.0° N., 80.0° W.–99.9° W., and 15.0° N.–19.9° N., 90.0° W.–94.9° W.
Group 2 (Caribbean Sea area): 10.0° N.–19.9° N., 60.0° W.–89.9° W.
Group 3 (East coast area): 20.0° N.–39.9° N., 60.0° W.–79.9° W.
Group 4 (Lower N. Atlantic–Cape Verdi area): 5.0° N.–19.9° N., 15.0° W.–59.9° W.
Group 5 (Open N. Atlantic area): 20.0° N.–46.0° N., 15.0° W.–59.9° W.
PDI = sum of wind speed cubed (in units of 10×10^6 kt^3).
ACE = sum of wind speed squared (in units of 10×10^4 kt^2).
* = means it belongs in the group, even though it does not fall within the areal bounds as given above.

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34- and 64-kt wind radii (in nmi) and areal data (Continued).

2007																				
				Genesis Location																
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Andrea	SS/TS	05/09	05/10	30.8	78.7	3	50	1,001	0.4	0.9	175	56,176	25,137	–	–	–	1.25	–	–	
Barry	TS	06/01	06/02	23.6	85.7	1	50	997	0.3	0.8	80	12,017	10,309	–	–-	–	1.00	–	–	
Chantal	TS	07/31	08/01	37.1	65.5	3	45	994	0.3	0.7	175	36,776	26,517	–	–	–	1.00	–	–	
Dean	MH	08/14	08/22	11.8	38.3	4	150	907 (905)	40.8	35.2	240	80,052	43,579	60	6,597	4,132	8.50	6.75	4.00	
Erin	TS	08/15	08/16	25.8	94.0	1	35	1,003	0.1	0.4	75	4,418	3,888	–	–	–	0.75	–	–	
Felix	MH	09/01	09/05	12.1	59.4	4	150	930 (929)	22.1	18.0	100	21,382	12,372	40	3,004	1,473	4.25	3.00	2.00	
Gabrielle	TS	09/08	09/10	30.1	71.8	3	50	1,004	0.6	1.5	125	24,544	10,267	–	–	–	2.25	–	–	
Humberto	H	09/12	09/13	27.8	95.1	1	80	985	1.1	1.8	50	4,909	3,001	15	177	177	1.50	0.50	–	CTX1, LA1
Ingrid	TS	09/13	09/15	13.7	46.7	4	40	1,002	0.5	1.3	45	4,771	3,788	–	–	–	2.50	–	–	
Jerry	TS	09/23	09/24	36.2	46.1	5	35	1,003	0.2	0.7	90	19,969	16,700	–	–	–	1.50	–	–	
Karen	H	09/25	09/29	10.3	37.0	4	65	988	1.9	3.6	180	62,380	27,743	50	3,220	2,680	4.00	0.50	–	
Lorenzo	H	09/27	09/28	20.6	95.1	1	70	990	0.9	1.5	60	4,948	3,770	20	785	785	1.00	0.50	–	
Melissa	TS	09/29	09/30	14.5	27.4	4	35	1,005	0.2	0.5	60	9,189	9,189	–	–	–	1.00	–	–	
Noel	H	10/28	11/02	16.3	71.6	2	70	980	3.1	5.6	300	151,975	46,403	60	7,069	3,701	5.50	1.00	–	
Olga	TS	12/11	12/12	18.4	64.7	2	50	1,003	0.6	1.3	300	94,739	64,686	–	–	–	1.75	–	–	
Sample: NTC = 15, NTS = 9, NH = 6, NMH = 2, NUSLFH = 1, PWS = 150, <PWS> = 65.0, LP = 907, <LP> = 986.1, <N. Lat.> = 21.9, <W. Long.> = 65.1, Total PDI = 73.1, Total ACE = 73.8, Total NSD = 37.75, Total NHD = 12.25, Total NMHD = 6.00, HISPDI = 40.8, HISACE = 35.2, LISNSD = 8.50, NTCA = 98.6%, FSD = 129, LSD = 346, LOS = 218, LIS(L34WR) = 300, <L34WR> = 130, LIS(L34WA) = 151,975, <L34WA> = 39,216, LIS(A34WA) = 64,686, <A34WA> = 20,490, LIS(L64WR) = 60, <L64WR> = 41, LIS(L64WA) = 7,069, <L64WA> = 3,475, LIS(A64WA) = 4,132, <A64WA> = 2,158																			

Notes:

Group 1 (Gulf of Mexico area): 18.0° N.–30.0° N., 80.0° W.–99.9° W., and 15.0° N.–19.9° N., 90.0° W.–94.9° W.
Group 2 (Caribbean Sea area): 10.0° N.–19.9° N., 60.0° W.–89.9° W.
Group 3 (East coast area): 20.0° N.–39.9° N., 60.0° W.–79.9° W.
Group 4 (Lower N. Atlantic–Cape Verdi area): 5.0° N.–19.9° N., 15.0° W.–59.9° W.
Group 5 (Open N. Atlantic area): 20.0° N.–46.0° N., 15.0° W.–59.9° W.
PDI = sum of wind speed cubed (in units of 10×10^6 kt^3).
ACE = sum of wind speed squared (in units of 10×10^4 kt^2).

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34- and 64-kt wind radii (in nmi) and areal data (Continued).

2008#																				
				Genesis Location																
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Arthur	TS	05/31	06/01	17.5	87.5	2	40	1,004	0.3	0.8	225	55,469	37,961	–	–	–	1.50	–	–	
Bertha	MH	07/03	07/20	13.1	24.0	4	105 (110)	955 (952)	20.1	28.4	200	78,461	31,110	45	4,064	1,340	17.00	7.50	0.75	
Cristobal	TS	07/19	07/23	32.4	78.8	3	55	998	1.8	3.7	110	15,158	10,490	–	–	–	4.00	–	–	
Dolly	H	07/20	07/24	17.8	83.6	2	85	967 (963)	3.3	5.4	150	53,014	35,445	30	1,649	1,099	4.50	1.25	–	ATX1
Edouard	TS	08/04	08/05	28.1	88.5	1	55	996	0.8	1.7	60	10,073	5,341	–	–	–	2.00	–	–	
Fay	TS	08/15	08/23	18.5	68.8	2	60	986	3.5	7.3	150	40,762	17,415	–	–	–	8.25	–	–	
Gustav	MH	08/25	09/02	15.1	69.6	2	125 (135)	943 (941)	16.0	18.2	220	104,929	31,511	70	8,639	4,685	8.00	3.25	1.25	LA2
Hanna	H	08/28	09/07	20.1	58.6	5	75	977	5.6	10.4	275	133,066	57,904	40	2,513	2,068	9.75	0.75	–	
Ike	MH	09/01	09/14	17.3	38.4	4	125	935	37.7	39.2	240	133,596	57,883	110	23,110	7,332	13.00	10.00	4.25	CTX2, LA1
Josephine	TS	09/02	09/05	12.7	23.2	4	55	994	1.4	3.1	150	25,525	15,741	–	–	–	3.75	–	–	
Kyle	H	09/25	09/29	22.0	69.4	3	75	984	3.4	5.4	210	83,193	42,283	75	9,759	5,366	4.00	1.75	–	
Laura	TS	09/29	10/01	37.0	47.0	5	50	994	1.1	2.2	270	168,546	118,320	–	–	–	2.25	–	–	
Marco	TS	10/06	10/07	18.9	93.7	1	55	998	0.7	1.3	15	707	436	–	–	–	1.25	–	–	
Nana	TS	10/12	10/13	16.0	37.1	5	35	1,004	0.2	0.5	100	12,272	8,929	–	–	–	1.00	–	–	
Omar	MH	10/14	10/18	14.5	69.6	2	115	958	7.2	9.3	135	29,158	20,546	40	1,865	1,139	4.50	3.00	0.25	
Paloma	MH	11/06	11/09	14.8	82.1	2	125	944	8.9	9.2	120	24,190	11,805	25	1,963	1,333	3.50	2.25	1.00	
Summary: NTC = 16, NTS = 8, NH = 8, NMH = 5, NUSLFH = 3, PWS = 125, <PWS> = 77.2, LP = 935, <LP> = 977.3, <N. Lat.> = 19.7, <W. Long.> = 63.7, Total PDI = 112.0, Total ACE = 146.1, Total NSD = 88.25, Total NHD = 29.75, Total NMHD = 7.50, HISPDI = 37.7, HISACE = 39.2, LISNSD = 17.00, NTCA = 161.8%, FSD = 152, LSD = 314, LOS = 163, LIS(L34WR) = 275, <L34WR> = 164, LIS(L34WA) = 168,546, <L34WA> = 60,507, LIS(A34WA) = 118,320, <A34WA> = 31,445, LIS(L64WR) = 110, <L64WR> = 54, LIS(L64WA) = 23,110, <L64WA> = 6,695, LIS(A64WA) = 7,332, <A64WA> = 3,045																			

Notes:

Group 1 (Gulf of Mexico area): 18.0° N.–30.0° N., 80.0° W.–99.9° W., and 15.0° N.–19.9° N., 90.0° W.–94.9° W.
Group 2 (Caribbean Sea area): 10.0° N.–19.9° N., 60.0° W.–89.9° W.
Group 3 (East coast area): 20.0° N.–39.9° N., 60.0° W.–79.9° W.
Group 4 (Lower N. Atlantic–Cape Verdi area): 5.0° N.–19.9° N., 15.0° W.–59.9° W.
Group 5 (Open N. Atlantic area): 20.0° N.–46.0° N., 15.0° W.–59.9° W.
PDI = sum of wind speed cubed (in units of 10×10^6 kt^3).
ACE = sum of wind speed squared (in units of 10×10^4 kt^2).
# = the year is classified as an LNY (i.e., NLNM > 5 months).

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34- and 64-kt wind radii (in nmi) and areal data (Continued).

2009&																				
				Genesis Location																
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Ana	TS	08/12	08/16	14.4	33.3	4	35	1,003	0.3	0.9	60	5,655	4,090	–	–	–	1.75	–	–	
Bill	MH	08/15	08/24	11.2	34.5	4	115	943	25.3	26.5	275	162,067	82,425	100	16,513	7,188	8.75	7.00	3.00	
Claudette	TS	08/16	08/17	28.2	84.2	1	50	1,005	0.3	0.7	80	6,538	5,002	–	–	–	1.00	–	–	
Danny	TS	08/26	08/29	24.6	70.1	3	50	1,006	0.9	2.0	180	57,432	40,203	–	–	–	2.75	–	–	
Erika	TS	09/01	09/03	16.7	57.3	4	45	1,004	0.5	1.3	200	49,087	28,765	–	–	–	2.00	–	–	
Fred	MH	09/08	09/12	11.7	25.4	4	105	958	8.1	9.9	105	22,266	14,556	25	1,649	1,242	4.75	2.75	0.50	
Grace	TS	10/04	10/06	38.5	29.5	5	55	986	1.0	2.0	45	4,771	4,374	–	–	–	2.00	–	–	
Henri	TS	10/06	10/08	16.1	50.5	4	45	1,005	0.5	1.2	90	9,189	4,396	–	–	–	2.00	–	–	
Ida	H	11/04	11/10	11.4	81.8	2	90	975	5.7	8.1	175	53,014	21,389	30	1,237	639	5.00	2.25	–	
Summary: NTC = 9, NTS = 6, NH = 3, NMH = 2, NUSLFH = 0, PWS = 115, <PWS> = 65.6, LP = 943, <LP> = 987.2, <N. Lat.> = 19.2, <W. Long.> = 51.8, Total PDI = 42.6, Total ACE = 52.6, Total NSD = 30.00, Total NHD = 12.00, Total NMHD = 3.50, HISPDI = 25.3, HISACE = 26.5, LISNSD = 8.75, NTCA = 68.6%, FSD = 224, LSD = 314, LOS = 91, LIS(L34WR) = 275, <L34WR> = 134, LIS(L34WA) = 162,067, <L34WA> = 41,113, LIS(A34WA) = 82,425, <A34WA> = 22,800, LIS(L64WR) = 100, <L64WR> = 52, LIS(L64WA) = 16,513, <L64WA> = 6,466, LIS(A64WA) = 7,188, <A64WA> = 3,023																			

Notes:

Group 1 (Gulf of Mexico area): 18.0° N.–30.0° N., 80.0° W.–99.9° W., and 15.0° N.–19.9° N., 90.0° W.–94.9° W.
Group 2 (Caribbean Sea area): 10.0° N.–19.9° N., 60.0° W.–89.9° W.
Group 3 (East coast area): 20.0° N.–39.9° N., 60.0° W.–79.9° W.
Group 4 (Lower N. Atlantic–Cape Verdi area): 5.0° N.–19.9° N., 15.0° W.–59.9° W.
Group 5 (Open N. Atlantic area): 20.0° N.–46.0° N., 15.0° W.–59.9° W.
PDI = sum of wind speed cubed (in units of 10×10^6 kt^3).
ACE = sum of wind speed squared (in units of 10×10^4 kt^2).
& = the year is classified as an ENY (i.e., NENM > 5 months).

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34- and 64-kt wind radii (in nmi) and areal data (Continued).

2010#																			
				Genesis Location															
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Alex	H	06/26	07/01	16.7	84.9	2	90 (95)	948 (946)	4.9	7.7	180	75,477	28,108	50	3,024	1,859	5.75	1.50	–	
Bonnie	TS	07/23	07/23	23.1 (23.0)	75.9 (75.7)	3	40	1,005	0.1	0.4	75	7,599	4,955	–	–	–	0.75	–	–	
Colin	TS	08/03	08/07	13.7	46.6	4	50	1,006 (1,005)	1.1	2.8	120	19,262	10,398	–	–	–	4.75	–	–	
Danielle	MH	08/22	08/30	11.8	33.1	4	115	942	18.0	21.1	270	182,369	61,160	75	10,073	4,936	8.75	7.00	1.00	
Earl	MH	08/25	09/04	14.3	29.7	4	125	927	26.7	27.7	220	112,783	55,927	80	12,959	8,342	10.50	6.00	3.50	
Fiona	TS	08/30	09/03	14.9	47.7	4	55	998	1.4	3.1	120	20,499	12,620	–	–	–	4.25	–	–	
Gaston	TS	09/01	09/01	12.7	35.0	4	35	1,005	0.1	0.2	35	962	962	–	–	–	0.50	–	–	
Hermine	TS	09/06	09/07	21.8	95.1	1	55 (60)	990 (989)	0.8	1.6	90	13,744	10,516	–	–	–	1.75	–	–	
Igor	MH	09/08	09/21	13.8	23.3	4	135	924	44.5	41.9	400	414,298	124,817	90	16,081	9,488	12.25	9.75	5.00	
Julia	MH	09/12	09/20	13.1	22.1	4	120	948	13.0	15.5	210	72,276	32,565	30	2,042	1,728	8.00	3.50	1.25	
Karl	MH	09/14	09/18	18.1	83.6	1	110	956	4.9	6.3	90	20,420	7,903	20	982	652	3.50	1.25	0.25	
Lisa	H	09/21	09/26	16.8	31.9	4	75	982	2.1	4.1	50	5,184	4,336	10	236	236	4.75	0.50	–	
Matthew	TS	09/23	09/25	13.9	76.2	2	50	998	0.7	1.5	150	33,399	16,859	–	–	–	2.00	–	–	
Nicole	TS	09/28	09/29	20.4	83.0	1	40	995	0.3	0.7	300	141,372	98,960	–	–	–	1.25	–	–	
Otto	H	10/06	10/10	22.6	67.8	3	75	976	3.4	5.4	190	48,066	35,039	30	1,374	1,178	3.75	1.50	–	
Paula	H	10/11	10/15	14.4	82.5	2	90	981	5.6	7.5	50	7,108	5,518	20	844	436	4.00	2.50	–	
Richard	H	10/21	10/25	16.7	80.6	2	85	977	3.1	5.0	90	15,001	8,699	15	511	358	4.25	1.25	–	
Shary	H	10/29	10/30	26.8	63.0	3	65	989	1.2	2.1	90	16,454	14,297	10	79	79	1.75	0.75	–	
Tomas	H	10/29	11/07	9.8	55.3	4	85	982	7.6	11.9	150	40,252	19,017	30	1,414	762	8.75	3.00	–	
Summary: NTC = 19, NTS = 7, NH = 12, NMH = 5, NUSLFH = 0, PWS = 135, <PWS> = 78.7, LP = 924, <LP> = 975.2, <N. Lat.> = 16.6, <W. Long.> = 58.8, Total PDI = 139.5, Total ACE = 166.5, Total NSD = 191.25, Total NHD = 38.50, Total NMHD = 11.00, HISPDI = 44.5, HISACE = 41.9, LISNSD = 12.25, NTCA = 230.9%, FSD = 177, LSD = 311, LOS = 135, LIS(L34WR) = 400, <L34WR> = 152, LIS(L34WA) = 414,298, <L34WA> = 66,659, LIS(A34WA) = 124,817, <A34WA> = 29,087, LIS(L64WR) = 90, <L64WR> = 38, LIS(L64WA) = 16,081, <L64WA> = 4,135, LIS(A64WA) = 9,488, <A64WA> = 2,505																			

Notes:

Group 1 (Gulf of Mexico area): 18.0° N.–30.0° N., 80.0° W.–99.9° W., and 15.0° N.–19.9° N., 90.0° W.–94.9° W.
Group 2 (Caribbean Sea area): 10.0° N.–19.9° N., 60.0° W.–89.9° W.
Group 3 (East coast area): 20.0° N.–39.9° N., 60.0° W.–79.9° W.
Group 4 (Lower N. Atlantic–Cape Verdi area): 5.0° N.–19.9° N., 15.0° W.–59.9° W.
Group 5 (Open N. Atlantic area): 20.0° N.–46.0° N., 15.0° W.–59.9° W.
PDI = sum of wind speed cubed (in units of 10×10^6 kt^3).
ACE = sum of wind speed squared (in units of 10×10^4 kt^2).
# = the year is classified as an LNY (i.e., NLNM > 5 months).

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34- and 64-kt wind radii (in nmi) and areal data (Continued).

2011#																				
				Genesis Location																
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Arlene	TS	06/28	06/30	20.7	93.5	1	55	993	0.9	1.9	120	25,211	16,973	–	–	–	2.25	–		
Bret	TS	07/18	07/21	27.5	78.1	3	60	995	1.5	3.3	60	8,207	5,994	–	–	–	4.00	–	–	
Cindy	TS	07/20	07/22	33.4	57.0	5	60	994	1.2	2.3	90	13,607	11,430	–	–	–	2.50	–	–	
Don	TS	07/27	07/30	22.0	86.7	1	45	997	0.7	1.6	60	4,084	3,644	–	–	–	2.50	–	–	
Emily	TS	08/02	08/07	14.9	61.4	2	45	1,003	1.0	2.1	100	15,099	10,061	–	–	–	3.25	–		
Franklin	TS	08/13	08/13	37.6	61.1	3	40	1,004	0.1	0.3	60	4,084	4,084	–	–	–	0.50	–	–	
Gert	TS	08/14	08/16	27.7	62.3	3	55	1,000	0.9	1.9	60	7,952	5,675	–	–	–	2.25	–	–	
Harvey	TS	08/19	08/22	15.9	83.4	2	55	994	0.7	1.5	70	3,848	2,341	–	–	–	2.00	–	–	
Irene	MH	08/21	08/28	15.0	59.0	4	105	942	15.4	18.8	280	132,732	76,721	80	13,980	7,168	8.00	6.25	0.50	NC1
Jose	TS	08/27	08/28	27.9	63.4	3	40	1,006	0.3	0.8	45	3,181	2,163	–	–	–	1.50	–	–	
Katia	MH	08/30	09/10	11.0	29.6	4	120	942	22.5	27.0	250	149,697	56,515	80	12,959	5,597	11.50	9.50	1.25	
Unnamed	TS	09/01	09/02	37.4	63.7	3	40	1,002	0.3	0.8	60	5,655	5,367	–	–	–	1.50	–	–	
Lee	TS	09/02	09/05	27.2	91.4	1	50	986	0.7	1.8	250	95,622	67,860	–	–	–	2.75	–	–	
Maria	H	09/07	09/16	11.9	37.5	4	70	983	4.8	9.2	300	133,596	38,149	60	2,827	2,278	9.00	1.00	–	
Nate	H	09/07	09/11	20.3	92.9	1	65	994	2.3	4.4	120	28,451	18,212	40	1,257	1,257	4.25	0.50	–	
Ophelia	MH	09/21	10/03	12.5	39.7	4	120	940	15.9	18.7	220	71,079	49,913	40	3,142	1,907	9.75	3.50	2.00	
Philippe	H	09/24	10/08	11.1	26.1	4	80	976	9.3	15.9	90	19,969	12,150	30	2,042	1,066	13.75	2.50	–	
Rina	MH	10/24	10/28	16.0	81.9	2	100	966	8.2	10.1	100	22,934	14,591	25	1,433	853	4.75	2.75	0.75	
Sean	TS	11/08	11/11	27.7	69.8	3	55	982	1.9	3.7	330	185,197	92,686	–	–	–	3.75	–	–	
Summary: NTC = 19, NTS = 12, NH = 7, NMH = 4, NUSLFH = 1, PWS = 120, <PWS> = 66.3, LP = 940, <LP> =9,842, <N. Lat.> = 22.0, <W. Long.> = 65.2, Total PDI = 88.6, Total ACE = 126.1, Total NSD = 89.75, Total NHD = 26.00, Total NMHD = 4.50, HISPDI = 22.5, HISACE = 27.0, LISNSD = 13.75, NTCA = 144.9%, FSD = 179, LSD = 315, LOS = 137, LIS(L34WR) = 330, <L34WR> = 140, LIS(L34WA) = 185,197, <L34WA> = 48,958, LIS(A34WA) = 92,686, <A34WA> = 26,028, LIS(L64WR) = 80, <L64WR> = 51, LIS(L64WA) = 13,980, <L64WA> = 5,377, LIS(A64WA) = 7,168, <A64WA> = 2,875																			

Notes:

Group 1 (Gulf of Mexico area): 18.0° N.–30.0° N., 80.0° W.–99.9° W., and 15.0° N.–19.9° N., 90.0° W.–94.9° W.
Group 2 (Caribbean Sea area): 10.0° N.–19.9° N., 60.0° W.–89.9° W.
Group 3 (East coast area): 20.0° N.–39.9° N., 60.0° W.–79.9° W.
Group 4 (Lower N. Atlantic–Cape Verdi area): 5.0° N.–19.9° N., 15.0° W.–59.9° W.
Group 5 (Open N. Atlantic area): 20.0° N.–46.0° N., 15.0° W.–59.9° W.
PDI = sum of wind speed cubed (in units of 10×10^6 kt^3).
ACE = sum of wind speed squared (in units of 10×10^4 kt^2).
# = the year is classified as an LNY (i.e., NLNM > 5 months).

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34- and 64-kt wind radii (in nmi) and areal data (Continued).

2012																				
				Genesis Location																
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Alberto	TS	05/19	05/22	32.5	77.3	3	50	995	0.8	1.9	60	5,105	3,560	–	–	–	3.00	–	–	
Beryl	TS	05/26	05/30	32.3	75.0	3	60	992	1.2	2.5	120	23,562	17,335	–	–	–	3.00	–	–	
Chris	H	06/18	06/22	38.0	61.3	3	75	974	2.3	4.1	80	12,488	10,011	20	785	602	3.75	0.75	–	
Debby	TS	06/23	06/26	25.5	87.6	1	55	990	1.3	2.9	220	72,021	46,272	–	–	–	3.75	–	–	
Ernesto	H	08/02	08/10	13.0	53.6	4	85	973	5.4	9.2	140	35,893	17,872	30	1,100	904	7.75	1.00	–	
Florence	TS	08/04	08/06	14.1	28.6	4	50	1,002	0.7	1.5	70	8,954	5,370	–	–	–	2.00	–	–	
Gordon	H	08/16	08/20	30.5	55.4	5	95	965	6.4	8.6	110	29,060	17,709	30	2,042	1,737	4.75	2.25	–	
Helene	TS	08/07	08/18	20.3	95.9	1	40	1,004	0.1	0.3	30	707	668	–	–	–	0.50	–	–	
Isaac	H	08/21	08/30	15.2	53.1	4	70	965	6.1	10.8	200	83,331	50,571	60	5,655	4,668	9.25	1.75	–	LA1
Joyce	TS	08/23	08/23	14.8	41.1	4	35	1,006	0.1	0.2	180	50,894	36,757	–	–	–	0.50	–	–	
Kirk	H	08/29	09/02	24.0	44.5	5	90	970	5.3	7.7	120	17,122	8,215	15	609	454	5.00	2.00	–	
Leslie	H	08/30	09/11	13.8	42.6	4	70	968	7.8	16.3	270	157,629	56,940	30	2,121	1,033	12.00	3.25	–	
Michael	MH	09/04	09/11	26.2	43.0	5	100	964	13.5	16.7	70	13,352	7,765	20	1,119	792	7.50	5.25	0.25	
Nadine	H	09/12	10/03	17.5	44.8	4	80	978	15.6	26.3	350	170,746	58,199	40	2,278	1,283	20.75	5.25	–	
Oscar	TS	10/03	10/05	18.2	41.8	4	45	994	0.6	1.5	180	40,841	35,863	–	–	–	2.00	–	–	
Patty	TS	10/11	10/13	25.4	72.2	3	40	1,005	0.4	1.1	60	5,498	3,475	–	–	–	2.00	–	–	
Rafael	H	10/12	10/17	14.7	62.7	2	80	969	5.0	7.4	270	137,837	52,143	60	6,205	3,283	5.00	2.50	–	
Sandy	H	10/22	10/29	12.7	78.7	2	100	940	12.8	16.1	480	541,296	209,563	180	43,118	15,908	7.50	5.75	–	^NY1
Tony	TS	10/24	10/25	26.5	49.6	5	45	1,000	0.5	1.2	90	12,174	7,674	–	–	–	1.75	–	–	
Summary: NTC = 19, NTS = 9, NH = 10, NMH = 1, NUSLFH = 2^, PWS = 100, <PWS> = 66.6, LP = 940, <LP> = 981.8, <N. Lat.> = 21.9, <W. Long.> = 58.4, Total PDI = 85.9, Total ACE = 136.3, Total NSD = 101.75, Total NHD = 29.75, Total NMHD = 0.25, HISPDI = 15.6, HISACE = 26.3, LISNSD = 20.75, NTCA = 124.1%, FSD = 140, LSD = 303, LOS = 164, LIS(L34WR) = 480, <L34WR> = 163, LIS(L34WA) = 541,296, <L34WA> = 74,658, LIS(A34WA) = 209,563, <A34WA> = 33,998, LIS(L64WR) = 180, <L64WR> = 49, LIS(L64WA) = 43,118, <L64WA> = 6,503, LIS(A64WA) = 15,908, <A64WA> = 3,066																			

Notes:

Group 1 (Gulf of Mexico area): 18.0° N.–30.0° N., 80.0° W.–99.9° W., and 15.0° N.–19.9° N., 90.0° W.–94.9° W.
Group 2 (Caribbean Sea area): 10.0° N.–19.9° N., 60.0° W.–89.9° W.
Group 3 (East coast area): 20.0° N.–39.9° N., 60.0° W.–79.9° W.
Group 4 (Lower N. Atlantic–Cape Verdi area): 5.0° N.–19.9° N., 15.0° W.–59.9° W.
Group 5 (Open N. Atlantic area): 20.0° N.–46.0° N., 15.0° W.–59.9° W.
PDI = sum of wind speed cubed (in units of 10×10^6 kt^3).
ACE = sum of wind speed squared (in units of 10×10^4 kt^2).
^ = the Hurricane Center did not make USLF, but did produce hurricane-force winds over land.

Table 1. Listing of North Atlantic basin tropical cyclones (2004–2013) including 34- and 64-kt wind radii (in nmi) and areal data (Continued).

2013																			
				Genesis Location															
Name	Class	FSD	LSD	N. Lat.	W. Long.	Group	PWS	LP	PDI	ACE	L34WR	L34WA	A34WA	L64WR	L64WA	A64WA	NSD	NHD	NMHD	USLFH
Andrea	TS	06/05	06/07	25.1	86.6	1	55	992	0.9	1.9	120	33,301	19,978	–	–	–	2.00	–	–	
Barry	TS	06/19	06/20	19.5	94.0	1	40	1,003	0.4	0.9	70	7,226	5,388	–	–	–	1.25	–	–	
Chantal	TS	07/07	07/10	9.3	41.4	4	55	1,003	1.1	2.5	80	12,881	7,751	–	–	–	3.25	–	–	
Dorian	TS	07/24	07/27	13.5	27.1	4	50	1,002	1.1	2.6	60	9,582	3,787	–	–	–	3.50	–	–	
Erin	TS	08/15	08/18	14.1	24.6	4	40	1,006	0.6	1.5	60	7,618	3,273	–	–	–	3.00	–	–	
Fernand	TS	08/25	08/26	18.9	95.1	1	50	1,001	0.4	0.9	30	2,827	2,251	–	–	–	0.75	–	–	
Gabrielle	TS	09/10	09/13	29.0	65.0	3	55	1,003	0.8	1.7	100	17,750	11,318	–	–	–	2.50	–	–	
Humberto	H	09/09	09/18	13.3	22.4	4	80	979	5.3	8.9	200	81,132	33,353	40	2,985	2,469	8.00	1.75	–	
Ingrid	H	09/13	09/16	19.3	95.1	1	75	983	3.2	5.2	90	13,430	9,615	30	1,021	609	3.50	1.50	–	
Jerry	TS	09/30	10/03	27.2	46.8	3	45	1,005	0.7	1.9	60	6,440	4,168	–	–	–	3.50	–	–	
Karen	TS	10/03	10/05	21.5	86.8	1	55	998	1.2	2.6	120	24,347	14,751	–	–	–	2.75	–	–	
Lorenzo	TS	10/21	10/23	28.2	55.6	5	45	1,000	0.7	1.6	60	8,168	7,163	–	–	–	2.50	–	–	
Melissa	TS	11/18	11/21	29.1	53.4	5	55	980	1.7	3.5	270	153,388	96,245	–	–	–	3.50	–	–	
Unnamed	SS	12/05	12/07	32.4	27.5	5	45	997	0.6	1.5	300	134,225	55,842	–	–	–	2.25	–	–	
Summary: NTC = 14, NTS = 12, NH = 2, NMH = 0, NUSLFH = 0, PWS = 80, <PWS> = 53.2, LP = 979, <LP> = 996.6, <N. Lat.> = 21.5, <W. Long.> = 58.7, Total PDI = 18.7, Total ACE = 37.2, Total NSD = 42.25, Total NHD = 3.25, Total NMHD = 0.0, HISPDI = 5.3, HISACE = 8.9, LISNSD = 8.00, NTCA = 46.5%, FSD = 156, LSD = 341, LOS = 186, , LIS(L34WR) = 300, <L34WR> = 116, LIS(L34WA) = 153,388, <L34WA> = 36,594, LIS(A34WA) = 96,245, <A34WA> = 1,963, LIS(L64WR) = 40, <L64WR> = 35, LIS(L64WA) = 2,985, <L64WA> = 2,003, LIS(A64WA) = 2,469, <A64WA> = 1,509																			

Notes:

Group 1 (Gulf of Mexico area): 18.0° N.–30.0° N., 80.0° W.–99.9° W., and 15.0° N.–19.9° N., 90.0° W.–94.9° W.
Group 2 (Caribbean Sea area): 10.0° N.–19.9° N., 60.0° W.–89.9° W.
Group 3 (East coast area): 20.0° N.–39.9° N., 60.0° W.–79.9° W.
Group 4 (Lower N. Atlantic–Cape Verdi area): 5.0° N.–19.9° N., 15.0° W.–59.9° W.
Group 5 (Open N. Atlantic area): 20.0° N.–46.0° N., 15.0° W.–59.9° W.
PDI = sum of wind speed cubed (in units of 10×10^6 kt^3).
ACE = sum of wind speed squared (in units of 10×10^4 kt^2).

As an example, the HURDAT2 dataset shows that the first tropical cyclone for the 2004 hurricane season (Alex) had its onset at 1800 UT on August 1, marking its FSD and also the FSD for the 2004 hurricane season (DOY 214). The onset location at FSD was 31.6° N. and 79.2° W., occurring in the general region classified as group 3, the east coast near the U.S. The PWS = 105 kt and LP = 957 mb occurred on August 5 at 0000 and 0600 UT, classifying it as an MH. The LSD for Alex occurred on August 6 at 1200 UT (DOY 219). Hence, its lifetime as a tropical cyclone spanned 20 time measurements or 5 days (NSD; 4 time measurements equals 1 day). During its lifetime, Alex had at least minimal hurricane-force winds for 13 time measurements or 3.25 days (NHD), and it had major hurricane-force winds (PWS ≥96 kt) for 3 time measurements or 0.75 days (NMHD). Although the hurricane's center did not actually make a direct U.S. landfall, Alex did produce minimal hurricane-force winds over North Carolina; hence, it is classified as an USLFH and marked with the symbol ^. Its PDI (i.e., the sum of the peak 1-min sustained wind speeds cubed over its lifetime) measured 9.5 ($\times 10^6$ kt^3) and its ACE (i.e., the sum of the peak 1-min sustained wind speeds squared over its lifetime) measured 11.4 ($\times 10^4$ kt^2). The L34WR for Alex measured 300 nmi (from August 5 at 1200 UT through August 6 at 1200 UT) and the L34WA during its lifetime measured 150,816 nmi^2 (on August 5 at 1200 UT). The A34WA (based on the 20 time measurements) measured 54,430 nmi^2. The L64WR for Alex measured 50 nmi (from August 4 at 0600 UT through August 6 at 0600 UT), the L64WA measured 3,691 nmi^2 (from August 5 at 0000 UT through August 5 at 1200 UT) and the A64WA measured 2,728 nmi^2. (The appendix describes the methodology employed here for determining the areal values, using Alex as an example.)

Continuing the example, the 2004 hurricane season had NTC = 15, NTS = 6, NH = 9, NMH = 6, and NUSLFH = 5. Also, it had PWS = 145 kt (Ivan) and LP = 910 mb (Ivan); mean PWS (<PWS>) equal to 82.3 kt and mean LP (<LP>) equal to 971.2 mb for the 15 tropical cyclones; mean latitudinal (<N. Lat.>) and longitudinal (<W. Long.>) onset positions equal to 20.0° N. and 57.8° W., respectively, for the 15 tropical cyclones; and total PDI and total ACE (i.e., the sum of all yearly individual storm PDI and ACE values) equal to 217.7 ($\times 10^6$ kt^3) and 226.7 ($\times 10^4$ kt^2), respectively. Because the LSD of the yearly hurricane season occurred on December 2 (DOY 337), the LOS for the 2004 hurricane season measures 124 days (i.e., LOS equals the inclusive elapsed time between FSD for Alex and LSD for Otto). The total NSD, total NHD, and total NMHD measure 93.00, 45.50, and 22.25 days, respectively. The highest individual storm PDI (HISPDI) and highest individual storm ACE (HISACE) measure 83.5 ($\times 10^6$ kt^3; Ivan) and 70.4 ($\times 10^4$ kt^2; Ivan), respectively. The longest individual storm in the number of storm days (LISNSD) measures 14.75 days (Ivan). Finally, the NTCA for the 2004 hurricane season measures 231.4%, meaning that it is more than double the mean NTCA for the base period 1950–2000. (The values for PWS and LP contained inside the parentheses are the actual PWS and LP values for the storms as recorded in the HURDAT2 dataset; however, because these values occurred at times other than the 0000, 0600, 1200, or 1800 UT time fiduciaries, they were not used in the computation of <PWS> or <LP>.)

Because this study deals primarily with the 34- and 64-kt wind radii as reported in the HURDAT2 dataset associated with the 164 tropical cyclones, including the 77 tropical cyclones that attained hurricane strength during the interval 2004–2013, most of the data presented in table 1 will not be discussed. Instead, the data are shown here merely for completeness.[3–6]

Table 2 gives the distributions of the (a) L34WR, (b) L34WA, (c) A34WA, (d) L64WR, (e) L64WA, and (f) A64WA. All distributions have rightward tails, with hurricane Sandy being the largest individual tropical cyclone in all distributions. For the 164 tropical cyclones that occurred in the interval 2004–2013, the largest single grouping for L34WR is L34WR = 50–99 nmi (50/164 = 30%), with 135 of the 164 tropical cyclones (82%) having L34WR <300 nmi. The two largest tropical cyclones in terms of L34WR are Igor (2010) and Sandy (2012), having largest 34-kt wind radii of 400 and 480 nmi, respectively.

Table 2. Distributions.

L34WR (*n* = 164)		L34WA (*n* = 164)		A34WA (*n* = 164)	
Range (nmi)	Frequency	Range (nmi^2)	Frequency	Range (nmi^2)	Frequency
0–49	10	0–49,999	99	0–24,999	102
50–99	50	50,000–999,999	30	25,000–49,999	32
100–149	33	100,000–149,999	15	50,000–74,999	16
150–199	20	150,000–199,999	10	75,000–99,999	9
200–249	22	200,000–249,999	4	100,000–124,999	3
250–299	13	250,000–299,999	1	125,000–149,999	1 (Florence, 2006)
300–349	8	300,000–349,999	3	150,000–174,999	–
350–399	6	350,000–399,999	–	175,000–199,999	–
400–449	1 (Igor, 2010)	400,000–449,999	1 (Igor, 2010)	200,000–224,999	1 (Sandy, 2012)
450–499	1 (Sandy, 2012)	450,000–499,999	–		
		500,000–549,999	1 (Sandy, 2012)		
L64WR (*n* = 77)		**L64WA (*n* = 77)**		**A64WA (*n* = 77)**	
Range (nmi)	Frequency	Range (nmi^2)	Frequency	Range (nmi^2)	Frequency
0–24	18	0–4,999	51	0–2,499	48
25–49	26	5,000–9,999	8	2,500–4,999	13
50–74	15	10,000–14,999	10	5,000–7,499	8
75–99	13	15,000–19,999	3	7,500–9,999	6
100–124	4	20,000–24,999	4	10,000–12,499	1 (Wilma, 2005)
125–149	–	25,000–29,999	–	12,500–14,999	–
150–174	–	30,000–34,999	–	15,000–17,499	1 (Sandy, 2012)
175–199	1 (Sandy, 2012)	35,000–39,999	–		
		40,000–44,999	1 (Sandy, 2012)		

For L34WA, the largest single grouping is L34WA $<50\times10^3$ nmi^2, accounting for 99 of the 164 tropical cyclones (60%). Again, the two largest tropical cyclones in terms of L34WA are Igor (2010) and Sandy (2012), having the largest 34-kt wind area of about 414×10^3 and 541×10^3 nmi^2, respectively.

For A34WA, the largest single grouping is A34WA $<25\times10^3$ nmi^2, accounting for 102 of the 164 tropical cyclones (62%). The two largest tropical cyclones in terms of A34WA are Florence (2006) and Sandy (2012), having the largest average 34-kt wind area of about 136×10^3 and 210×10^3 nmi^2, respectively.

For the 77 hurricanes during the interval 2004–2013, the largest single grouping for L64WR is L64WR = 25–49 nmi (26/77 = 34%), with 72 of 77 (94%) having L64WR <100 nmi. The largest storm in terms of L64WR is hurricane Sandy (2012), having the largest 64-kt wind radius of 180 nmi.

For L64WA, the largest single grouping is L64WA $<5\times10^3$ nmi^2, accounting for 51 of the 77 hurricanes (66%). Again, the largest storm in terms of L64WA is hurricane Sandy (2012), having the largest 64-kt wind area of about 43×10^3 nmi^2.

For A64WA, the largest single grouping is A64WA $<2.5\times10^3$ nmi^2, accounting for 48 of the 77 hurricanes (62%). The two largest hurricanes in terms of A64WA are hurricanes Wilma (2005) and Sandy (2012), having the largest average 64-kt wind area of about 12×10^3 and 16×10^3 nmi^2, respectively.

Figure 1 depicts the yearly variation of (a) LIS(L34WR), (b) <L34WR>, (c) LIS(L34WA), (d) <L34WA>, (e) LIS(A34WA), and (f) <A34WA> for the interval 2004–2013. Concerning LIS(L34WR), its mean measures about 345 nmi, having $sd = 64$ nmi and extremes of about 275 nmi in 2008 (Hanna) and 2009 (Bill) and 480 nmi in 2012 (Sandy). Concerning <L34WR>, its mean measures about 151 nmi, having $sd = 22$ nmi and extremes of 116 nmi in 2013 and 186 nmi in 2004. Although, to the eye, a downward trend in <L34WR> is suggested between 2004 and 2013, the inferred regression (not shown) is found to be only of marginal statistical importance (confidence level $cl > 90\%$). Concerning LIS(L34WA), its mean measures about 266×10^3 nmi^2, having $sd = 132\times10^3$ nmi^2 and extremes of 152×10^3 nmi^2 in 2007 (Noel) and 54×10^3 nmi^2 in 2012 (Sandy). Concerning <L34WA>, its mean measures about 60×10^3 nmi^2, having $sd = 19\times10^3$ nmi^2 and extremes of about 37×10^3 nmi^2 in 2013 and 89×10^3 nmi^2 in 2006. Concerning LIS(A34WA), its mean measures about 112×10^3 nmi^2, having $sd = 41\times10^3$ nmi^2 and extremes of about 65×10^3 nmi^2 in 2007 (Olga) and 210×10^3 nmi^2 in 2012 (Sandy). Concerning <A34WA>, its mean measures about 26×10^3 nmi^2, having $sd = 10\times10^3$ nmi^2 and extremes of about 2×10^3 nmi^2 in 2013 and 35×10^3 nmi^2 in 2004.

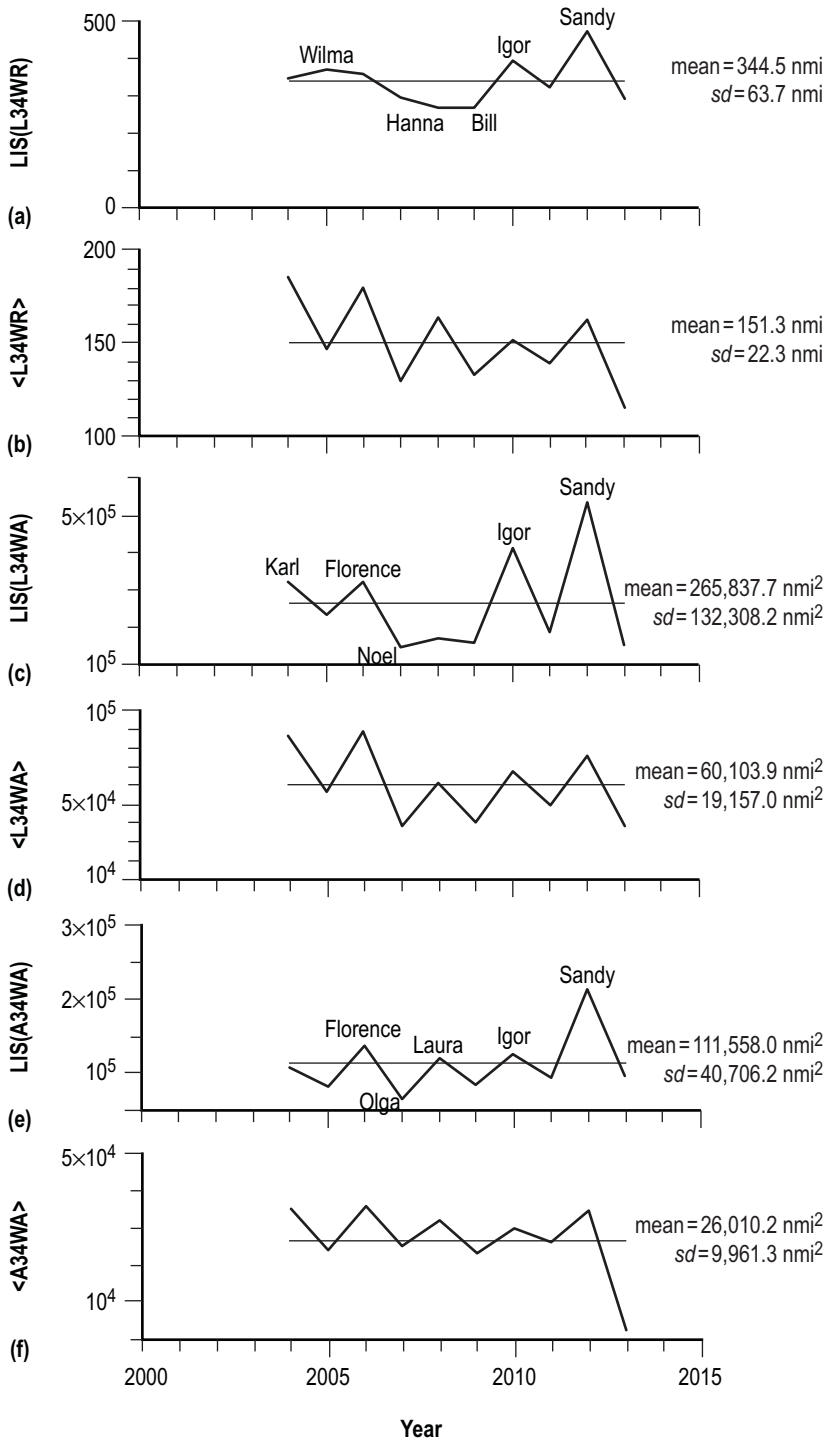

Figure 1. Yearly variation of (a) LIS(L34WR), (b) <L34WR>, (c) LIS(L34WA), (d) <L34WA>, (e) LIS(A34WA), and (f) <A34WA> for the interval 2004–2013.

Similarly, figure 2 depicts the yearly variation of (a) LIS(L64WR), (b) <L64WR>, (c) LIS(L64WA), (d) <L64WA>, (e) LIS(A64WA), and (f) <A64WA> for the interval 2004–2013. Concerning LIS(64WR), its mean measures about 95 nmi, having $sd = 37$ nmi and extremes of about 40 nmi in 2013 (Humberto) and 180 nmi in 2012 (Sandy). Concerning <L64WR>, its mean measures about 48 nmi, having $sd = 8$ nmi and extremes of 35 nmi in 2013 and 61 nmi in 2006. Again, although to the eye there possibly appears a downward trend in <L64WR> between 2004 and 2013, the inferred regression (not shown) is found to be only of marginal statistical importance. Concerning LIS(L64WA), its mean measures about 19×10^3 nmi^2, having $sd = 11\times10^3$ nmi^2 and extremes of 3×10^3 nmi^2 in 2013 (Humberto) and 43×10^3 nmi^2 in 2012 (Sandy). Concerning <L64WA>, its mean measures about 6×10^3 nmi^2, having $sd = 2\times10^3$ nmi^2 and extremes of about 2×10^3 nmi^2 in 2013 and 8×10^3 nmi^2 in 2006. Concerning LIS(A64WA), its mean measures about 8×10^3 nmi^2, having $sd = 4\times10^3$ nmi^2 and extremes of about 2×10^3 nmi^2 in 2013 (Humberto) and 16×10^3 nmi^2 in 2012 (Sandy). Concerning <A64WA>, its mean measures about 3×10^3 nmi^2, having $sd = 0.7\times10^3$ nmi^2 and extremes of about 2×10^3 nmi^2 in 2013 and 4×10^3 nmi^2 in 2004.

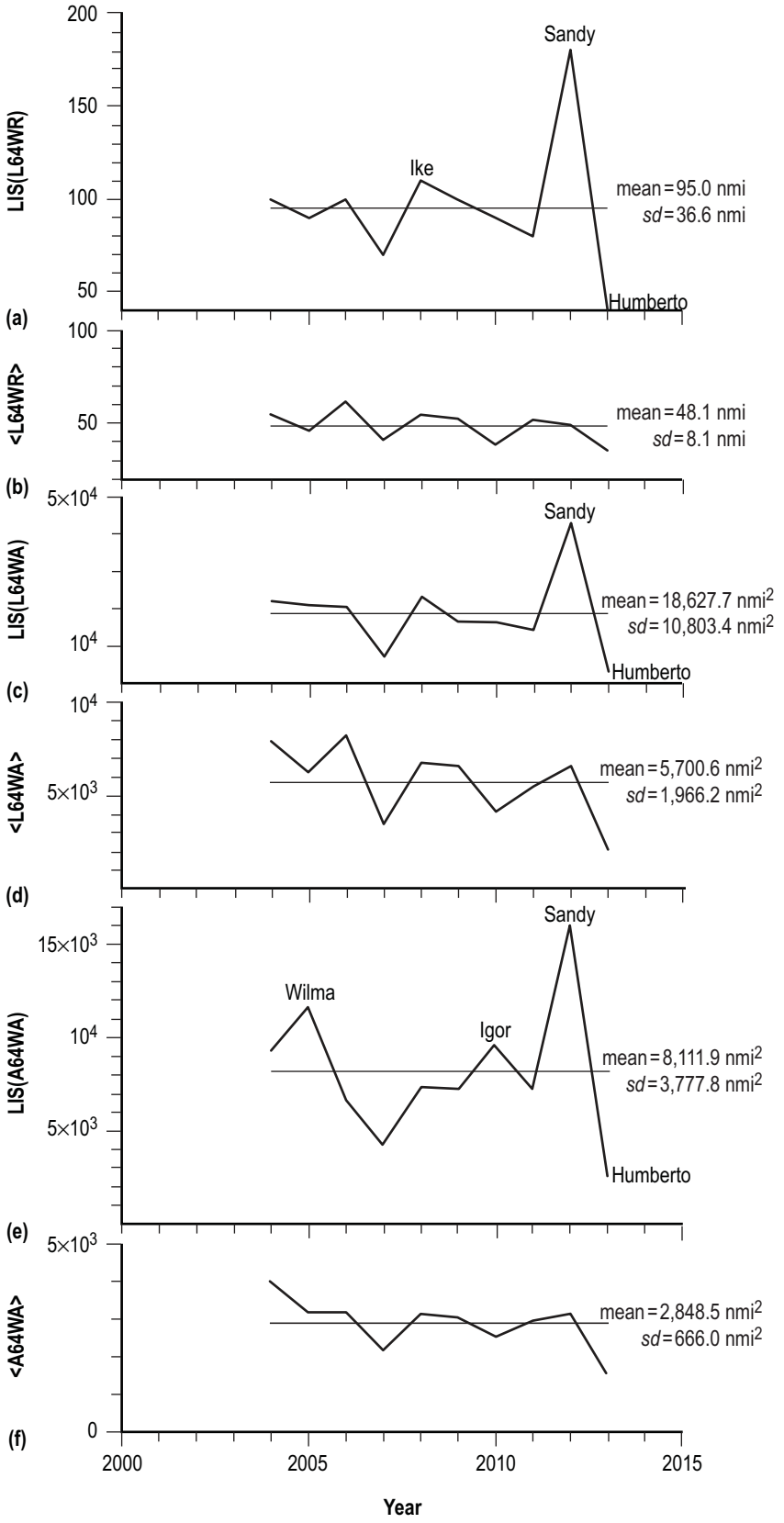

Figure 2. Yearly variation of (a) LIS(L64WR), (b) <L64WR>, (c) LIS(L64WA), (d) <L64WA>, (e) LIS(A64WA), and (f) <A64WA> for the interval 2004–2013.

Figure 3 displays the yearly variation of the (a) total 34WA, (b) total 64WA, and (c) ratio (i.e., total 64WA/total 34WA) for the interval 2004–2013. For total 34WA, its mean measures about 174×10^6 nmi^2, having $sd = 141\times10^6$ nmi^2 and extremes of 4.6×10^6 nmi^2 in 2013 and 423×10^6 nmi^2 in 2010. For total 64WA, its mean measures about 3×10^6 nmi^2, having $sd = 3\times10^6$ nmi^2 and extremes of 0.04×10^6 nmi^2 in 2013 and 9×10^6 nmi^2 in 2005. For ratio, its mean measures 0.017, having $sd = 0.008$ and extremes of 0.034 in 2004 and 0.008 in 2013. Interestingly, during the brief 10-year interval of 2004–2013, there possibly exists an apparent decrease in ratio over time, as given by the inferred regression equation $y = 4.338 - 0.002x$, having a coefficient of correlation $r = -0.847$, a coefficient of determination $r^2 = 0.717$, a standard error of estimate $se = 0.006$, and $cl > 98\%$. Hence, presuming the validity of the inferred regression, the year 2014 hurricane season is suggested to have a ratio of total 64-kt wind area to total 34-kt wind area equal to about 0.005 ± 0.006 (the ±1 *se* prediction interval). (The yearly total 34-kt wind area is found by multiplying the <A34WA> by the total number of time-tagged measurements, equal to 4 times NSD, then multiplying this quantity by the NTC. Similarly, the yearly total 64-kt wind area is found by multiplying the <A64WA> by the total number of time-tagged measurements, equal to 4 times NHD, then multiplying this quantity by the NH.)

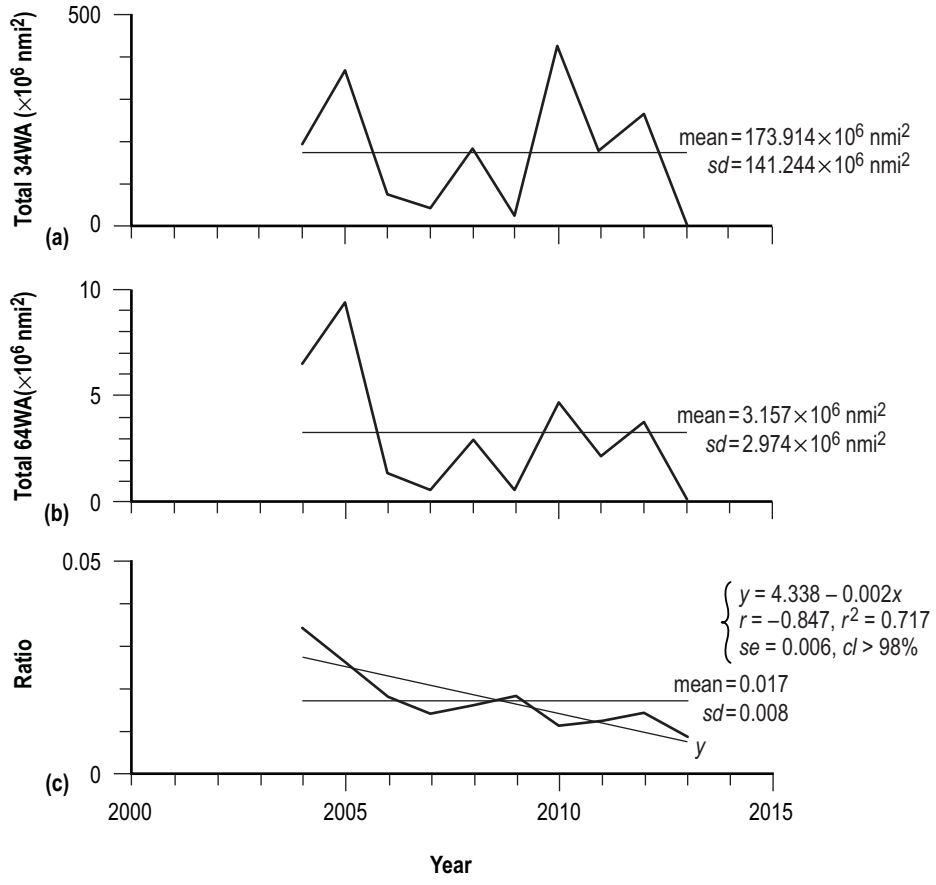

Figure 3. Yearly variation of the (a) total 34WA, (b) total 64WA, and (c) ratio (total 64WA/total 34WA) for the interval 2004–2013.

Figure 4 plots the yearly variation of several climate-related factors for the interval 2004–2013, including (a) <ONI>, (b) <SOI>, (c) <AMO>, (d) <MLCO2>, and (e) <GLOTI>. For <ONI>, large positive values tend to be associated with the occurrences of warm (El Niño-like) events and large negative values tend to be associated with the occurrences of cool (La Niña-like) events. For <SOI>, the opposite is true, with large positive values tending to be associated with the occurrences of cool (La Niña-like) events and large negative values tending to be associated with the occurrences of warm (El Niño-like) events. Hence, the years 2004–2006 and 2009 tend to be associated with warming in the Niño 3.4 region of the Pacific Ocean, while the years 2007–2008 and 2010–2011 tend to be associated with cooling. The mean (and *sd*) values of <ONI> and <SOI> for the interval 2004–2013 measure –0.16 °C (0.41 °C) and 2.5 (6.4), respectively, with extremes of about 0.44 °C in 2004 and –0.73 °C in 2011 for <ONI> and –4.8 in 2004 and 13.3 in 2011 for <SOI>. For the first 6 months of the year 2014, ONI has averaged about –0.3 °C, and for the first 7 months of the year 2014, SOI has averaged about 0.9, both values indicative of neutral El Niño-Southern Oscillation conditions, although El Niño is strongly anticipated to occur during the Northern Hemisphere fall and early winter by the Climate Prediction Center and the International Research Institute for Climate and Society.[7] (ONI and SOI are computed as anomalies relative to specific based periods.)

For <AMO> and <GLOTI>, they both appear to be rather flat in terms of yearly value during the interval 2004–2013, averaging about 0.199 °C (0.093 °C) and 0.583 °C (0.057 °C), respectively. The <AMO> is presently in the warm phase, having entered the warm phase about 1995 and being especially warm in 2010 (0.358 °C). The <GLOTI> has remained positive in value continuously since 1977. For the first 7 months of 2014, AMO has averaged about 0.023 °C and for the first 6 months of 2014, GLOTI has averaged about 0.647 °C.

For <MLCO2>, it has continuously risen in value every year since its first measurement in 1959. During the interval 2004–2013, it has risen from 377.49 ppm in 2004 to 396.48 ppm in 2013. The value for <MLCO2> is expected to be >398 ppm in 2014 and >400 ppm in 2015. (For the first 7 months of 2014, MLCO2 has averaged about 399.78 ppm.)

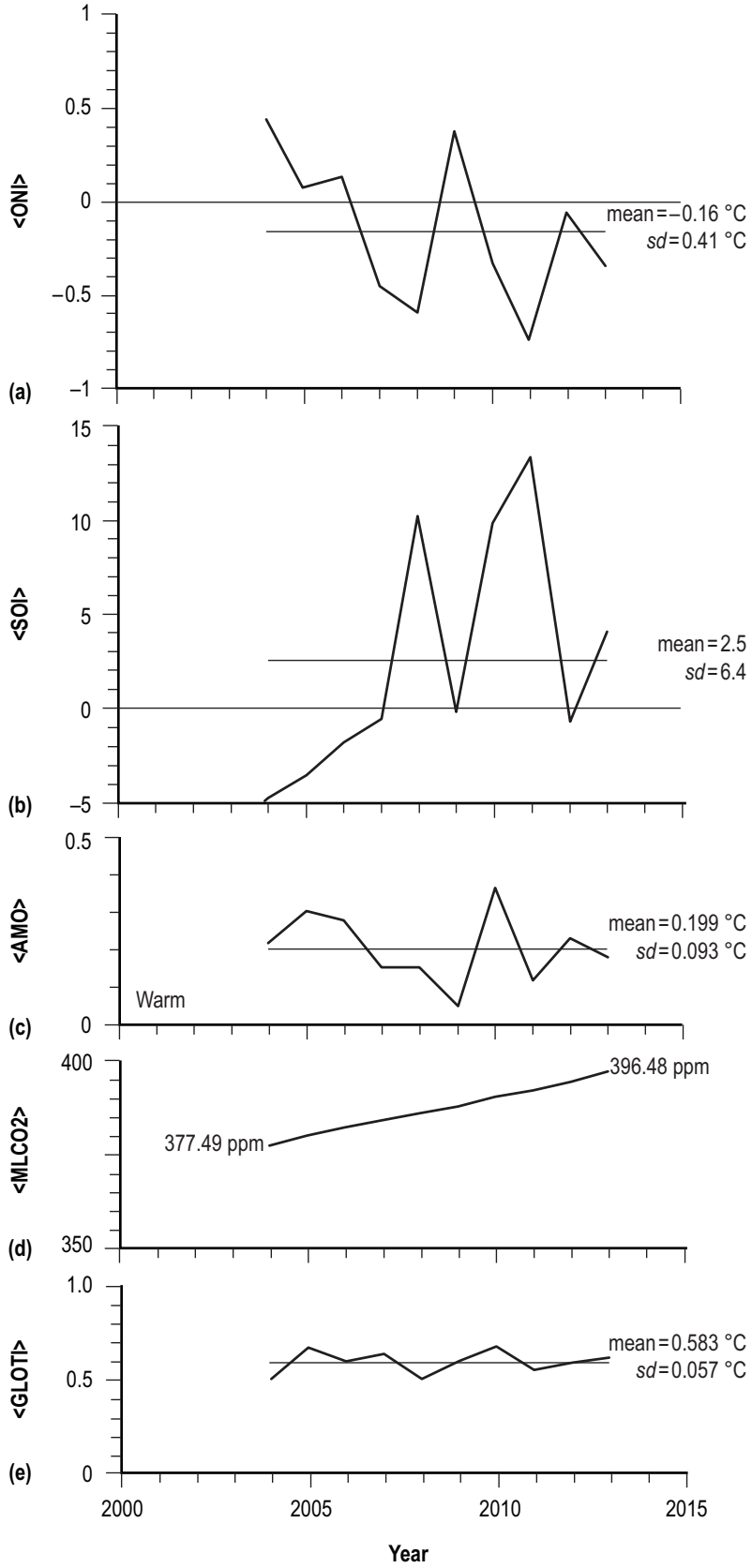

Figure 4. Yearly variation of total tropical cyclone wind areas (nmi^2) for the interval 2004–2013.

For convenience, table 3 is included to provide the yearly values, means and *sd*s for the tropical cyclone parameters NTC, NH, NSD, NHD, LIS(L34WR), <L34WR>, LIS(L34WA), <L34WA>, LIS(A34WA), <A34WA>, LIS(L64WR), <L64WR>, LIS(L64WA), <L64WA>, LIS(A64WA), and <A64WA> and for the climate-related parameters <ONI>, <SOI>, <AMO>, <MLCO2>, and <GLOTI> for the interval 2004–2013. Also, table 4 is included to provide the yearly variations, means and *sd*s for the 34- and 64-kt wind areas in nmi^2 for the interval 2004–2013 and table 5 is included to provide the results of linear regression analysis based on comparisons of each of the tropical cyclone parameters, including total 34WA, total 64WA, and the ratio total 64WA/total 34WA, against each of the climate-related factors.

Table 3. Yearly counts and averages of NTC, NH, 34- and 64-kt wind radii and wind areas from HURDAT2 dataset, and selected climate-related factors for the interval 2004–2013.

Year	NTC	NH	NSD	NHD	LIS (L34WR)	<L34WR>	LIS (L34WA)	<L34WA>	LIS (A34WA)	<A34WA>
2004	15	9	93.00	45.50	350	186	324,468	86,851	107,362	34,835
2005	28	15	131.50	49.50	375	148	236,601	57,219	83,037	23,998
2006	10	5	52.75	21.25	360	180	320,541	89,264	136,439	35,458
2007	15	6	37.75	12.25	300	130	151,975	39,216	64,686	20,490
2008	16	8	88.25	29.75	275	164	168,546	60,507	118,320	31,445
2009	9	3	30.00	12.00	275	134	162,067	41,113	82,425	22,800
2010	19	12	191.25	38.50	400	152	414,298	66,659	124,817	29,087
2011	19	7	89.75	26.00	330	140	185,197	48,958	92,686	26,028
2012	19	10	101.75	29.75	480	163	541,296	74,658	209,563	33,998
2013	14	2	42.25	3.25	300	116	153,388	36,594	96,245	1,963
sum	164	77								
mean	16.4	7.7	85.83	26.78	344.5	151.3	265,837.7	60,103.9	11,558.0	26,010.2
sd	5.4	4.0	49.38	15.04	63.7	22.3	132,308.2	19,157.0	40,706.2	9,961.3

Year	LIS (L64WR)	<L64WR>	LIS (L64WA)	<L64WA>	LIS (A64WA)	<A64WA>	<ONI>	<SOI>	<AMO>	<MLCO2>	<GLOTI>
2004	100	54	21,795	7,898	9,262	3,985	0.44	–4.8	0.213	377.49	0.51
2005	90	46	21,049	6,251	11,588	3,135	0.08	–3.6	0.298	379.80	0.66
2006	100	61	20,577	8,203	6,584	3,184	0.13	–1.9	0.273	381.90	0.59
2007	60	41	7,069	3,475	4,132	2,158	–0.45	–0.6	0.148	383.76	0.62
2008	110	54	23,110	6,695	7,332	3,045	–0.69	10.2	0.146	385.59	0.49
2009	100	52	16,513	6,466	7,188	3,023	0.37	–0.2	0.047	387.37	0.59
2010	90	38	16,081	4,135	9,488	2,505	–0.33	9.8	0.358	389.85	0.66
2011	80	51	13,980	5,377	7,168	2,875	–0.73	13.3	0.110	391.63	0.54
2012	180	49	43,118	6,503	15,908	3,066	–0.06	–0.8	0.222	393.82	0.57
2013	40	35	2,985	2,003	2,469	1,509	–0.34	4.0	0.176	396.48	0.60
mean	95.0	48.1	18,627.7	5,700.6	8,111.9	2,848.5	–0.16	2.5	0.199	386.77	0.583
sd	36.6	8.1	10,803.4	1,966.2	3,777.8	666.0	0.41	6.4	0.093	6.20	0.057

Table 4. Yearly variation of total tropical cyclone wind areas (nmi^2) for the interval 2004–2013.

Year	Total 34WA ($\times 10^6$)	Total 64WA ($\times 10^6$)	Ratio (total 64WA/ total 34WA)
2004	194.379	6.527	0.034
2005	353.443	9.311	0.026
2006	74.816	1.353	0.018
2007	46.410	0.634	0.014
2008	177.601	2.899	0.016
2009	24.624	0.435	0.018
2010	422.780	4.629	0.011
2011	177.537	2.093	0.012
2012	262.907	3.649	0.014
2013	4.644	0.039	0.008
mean	173.914	3.157	0.017
sd	141.244	2.974	0.008

From table 5, one finds that only three of the inferred regressions against <ONI> are considered to be of marginal statistical significance or better, with only one considered to be statistically important (*cl* >95%), ratio versus <ONI>. For comparisons against <SOI>, only one is considered to be statistically important, ratio versus <SOI>. For comparisons against <AMO>, eight of the inferred regressions against <AMO> are considered to be of marginal statistical significance or better, with four considered to be statistically important, including NH versus <AMO>, NSD versus <AMO>, LIS(L34WR) versus <AMO>, and total 34WA versus <AMO>. For comparisons against <MLCO2>, four of the inferred regressions are considered to be of marginal significance or better, with two considered to be statistically important, including <A64WA> versus <MLCO2> and ratio versus <MLCO2>. Lastly, for comparisons against <GLOTI>, only one inferred regression is considered to be of marginal statistical significance, <L64WR> versus <GLOTI>, with none considered to be statistically important.

Table 5. Summary of statistics based on comparison of tropical cyclone parameters and specific climate-related factors.

	<ONI>						<SOI>					
Parameter	*a*	*b*	*r*	r^2	*se*	*cl*	*a*	*b*	*r*	r^2	*se*	*cl*
NTC	15.945	–2.881	–0.222	0.049	5.563	<90%	16.237	0.064	0.077	0.006	5.689	<90%
NH	7.753	0.334	0.035	0.001	4.241	<90%	7.798	–0.038	–0.061	0.004	4.234	<90%
NSD	83.576	–14.237	–0.119	0.014	52.003	<90%	80.134	2.241	0.291	0.084	50.116	<90%
NHD	28.092	8.338	0.230	0.053	15.528	<90%	27.539	–0.301	–0.128	0.016	15.822	<90%
LIS(L34WR)	349.455	31.359	0.204	0.042	66.100	<90%	349.794	–2.084	–0.210	0.044	66.018	<90%
<L34WR>	154.624	21.036	0.391	0.153	21.739	<90%	153.760	–0.968	–0.278	0.078	22.683	<90%
LIS(L34WA)	280,383.878	92,064.418	0.288	0.083	134,380.244	<90%	275,961.730	–3,985.839	–0.193	0.037	137,697.662	<90%
<L34WA>	63,227.236	19,767.951	0.427	0.183	18,369.956	<90%	62,461.825	–928.317	–0.310	0.096	19,315.851	<90%
LIS(A34WA)	112,937.770	8,732.724	0.089	0.008	43,004.727	<90%	112,124.011	–222.839	–0.035	0.001	43,148.945	<90%
<A34WA>	26,948.204	5,936.736	0.247	0.061	10,238.605	<90%	26,463.462	–178.450	–0.115	0.013	10,495.762	<90%
Total 34WA	171.613	–14.561	–0.043	0.002	149.675	<90%	164.786	3.594	0.163	0.027	147.809	<90%
LIS(L64WR)	98.674	23.255	0.263	0.069	37.442	<90%	97.608	–1.027	–0.180	0.032	38.179	<90%
<L64WR>	49.153	6.664	0.341	0.116	8.065	<90%	48.755	–0.258	–0.204	0.042	8.400	<90%
LIS(L64WA)	19,779.032	7,286.914	0.279	0.078	11,002.524	<90%	19,615.068	–388.728	–0.230	0.053	11,150.345	<90%
<L64WA>	6,099.417	2,524.160	0.532	0.283	1,766.264	>90%	5,983.000	–111.181	–0.362	0.131	1,943.926	<90%
LIS(A64WA)	8,547.747	2,758.526	0.302	0.091	3,819.372	<90%	8,444.899	–131.102	–0.222	0.049	3,906.788	<90%
<A64WA>	2,985.921	869.753	0.541	0.293	594.199	>90%	2,939.929	–35.996	–0.346	0.120	662.775	<90%
Total 64WA	3.502	2.182	0.304	0.092	3.005	<90%	3.488	–0.130	–0.280	0.079	3.027	<90%
Ratio	0.019	0.013	0.689	0.475	0.006	>95%	0.019	–0.001	–0.645	0.416	0.007	>95%

	<AMO>						<MLCO2>					
Parameter	*a*	*b*	*r*	r^2	*se*	*cl*	*a*	*b*	*r*	r^2	*se*	*cl*
NTC	10.879	27.728	0.481	0.231	5.004	<90%	39.603	–0.060	–0.069	0.005	5.697	<90%
NH	1.959	28.836	0.672	0.452	3.143	>95%	93.853	–0.223	–0.345	0.119	4.098	<90%
NSD	7.543	393.181	0.742	0.551	35.113	>98%	178.041	–0.238	–0.030	0.001	52.185	<90%
NHD	7.755	95.527	0.592	0.351	12.856	>90%	528.235	–1.297	–0.535	0.286	13.701	<90%
LIS(L34WR)	255.403	447.500	0.655	0.430	50.993	>95%	–167.880	1.325	0.129	0.017	66.669	<90%
<L34WR>	132.156	96.153	0.403	0.162	21.623	<90%	947.661	–2.059	–0.573	0.329	19.334	>90%
LIS(L34WA)	91,754.726	874,349.441	0.616	0.380	110,527.347	>90%	–520,377.387	2,032.777	0.095	0.009	139,695.169	<90%
<L34WA>	36,982.054	116,131.823	0.565	0.320	16,761.621	>90%	594,788.313	–1,382.439	–0.448	0.200	18,169.743	<90%
LIS(A34WA)	81,499.004	150,974.365	0.346	0.120	40,511.539	<90%	–696,501.038	2,089.255	0.318	0.101	40,928.694	<90%
<A34WA>	20,083.159	29,769.164	0.279	0.078	10,147.039	<90%	331,146.093	–788.936	–0.491	0.241	9,202.648	<90%
Total 34WA	–42.149	1,085.197	0.716	0.513	104.523	>98%	1,179.989	–2.601	–0.114	0.013	148.766	<90%
LIS(L64WR)	84.987	50.290	0.128	0.016	38.491	<90%	59.653	0.091	0.015	–	39.036	<90%
<L64WR>	51.296	–16.053	–0.185	0.034	8.432	<90%	298.328	–0.647	–0.496	0.246	7.496	<90%
LIS(L64WA)	13,453.581	25,987.538	0.224	0.050	11,166.760	<90%	60,165.789	–107.398	–0.062	0.004	11,437.033	<90%
<L64WA>	5,450.570	1,255.799	0.060	0.004	2,081.767	<90%	80,605.699	–193.669	–0.611	0.373	1,651.042	>90%
LIS(A64WA)	4,946.995	15,896.056	0.392	0.154	3,685.720	<90%	25,192.225	–44.162	–0.073	0.005	3,996.658	<90%
<A64WA>	2,730.907	590.624	0.083	0.007	704.014	<90%	30,353.645	–71.115	–0.662	0.439	529.032	>95%
Total 64WA	–0.636	19.052	0.597	0.357	2.529	>90%	99.827	–0.250	–0.521	0.272	2.708	<90%

Table 5. Summary of statistics based on comparison of tropical cyclone parameters and specific climate-related factors (Continued).

	<GLOTI>					
Parameter	*a*	*b*	*r*	r^2	*se*	*cl*
NTC	–1.281	30.328	0.323	0.105	5.398	<90%
NH	–3.306	18.879	0.271	0.073	4.085	<90%
NSD	–59.241	248.826	0.289	0.084	50.143	<90%
NHD	28.266	–2.558	–0.010	–	15.953	<90%
LIS(L34WR)	171.923	296.015	0.267	0.071	65.076	<90%
<L34WR>	247.561	–165.113	–0.425	0.181	21.380	<90%
LIS(L34WA)	120,788.856	248,797.332	0.108	0.012	139,515.333	<90%
<L34WA>	109,695.069	–85,062.040	–0.255	0.065	19,648.969	<90%
LIS(A34WA)	190,012.946	–134,571.091	–0.190	0.036	42,392.160	<90%
<A34WA>	60,302.374	–58,820.196	–0.339	0.115	9,941.056	<90%
Total 34WA	–229.774	692.433	0.281	0.079	143.766	<90%
LIS(L64WR)	196.400	–173.928	–0.273	0.074	37.340	<90%
<L64WR>	95.807	–81.830	–0.580	0.337	6.987	>90%
LIS(L64WA)	47,590.671	–49,679.196	–0.264	0.070	11,052.931	<90%
<L64WA>	14,558.971	–15,194.461	–0.443	0.196	1,869.400	<90%
LIS(A64WA)	7,303.005	1,387.470	0.021	–	4,006.105	<90%
<A64WA>	5,887.444	–5,212.597	–0.449	0.202	631.254	<90%
Total 64WA	–1.303	7.650	0.148	0.022	3.120	<90%
Ratio	0.035	–0.031	–0.230	0.053	0.008	<90%

Figure 5 displays the scatterplots of ratio versus (a) <ONI>, (b) <SOI>, and (c) <MLCO2>. From figure 5(a) and (b), one finds that when <ONI> (<SOI>) is of positive (negative) value, the ratio of total 64-kt wind area to total 34-kt wind area usually is higher (lower) than when <ONI> (<SOI>) is of negative (positive) value. Thus, if an El Niño (warm event) should occur in the Northern Hemisphere fall-early winter during the year 2014, one expects the <ONI> (<SOI>) to be of positive (negative) value and the ratio to be larger (smaller) than about 0.016. While an El Niño was highly anticipated by the Climate Prediction Center and the International Research Institute for Climate and Society in earlier forecasts (May 8, 2014, June 5, 2014, and July 10, 2014), the most recent forecast (August 7, 2014)[7] has reduced the chance of an El Niño from 80% to 65%. If El Niño neutral conditions continue to prevail, this suggests a lower ratio of total 64-kt wind area to total 34-kt wind area for the year 2014 (≤0.016). Of the three correlations shown in figure 5, the strongest ($r = –0.85$) is the one against <MLCO2>. Since the yearly atmospheric concentration of CO_2 continues to grow, based on <MLCO2>, one expects that the ratio of total 64-kt wind area to total 34-kt wind area for the year 2014 will be of lower value (≤0.012). (Again, through June 2014, ONI averages about –0.3 °C, while through July 2014, SOI averages about 0.9 and MLCO2 averages about 399.78 ppm.)

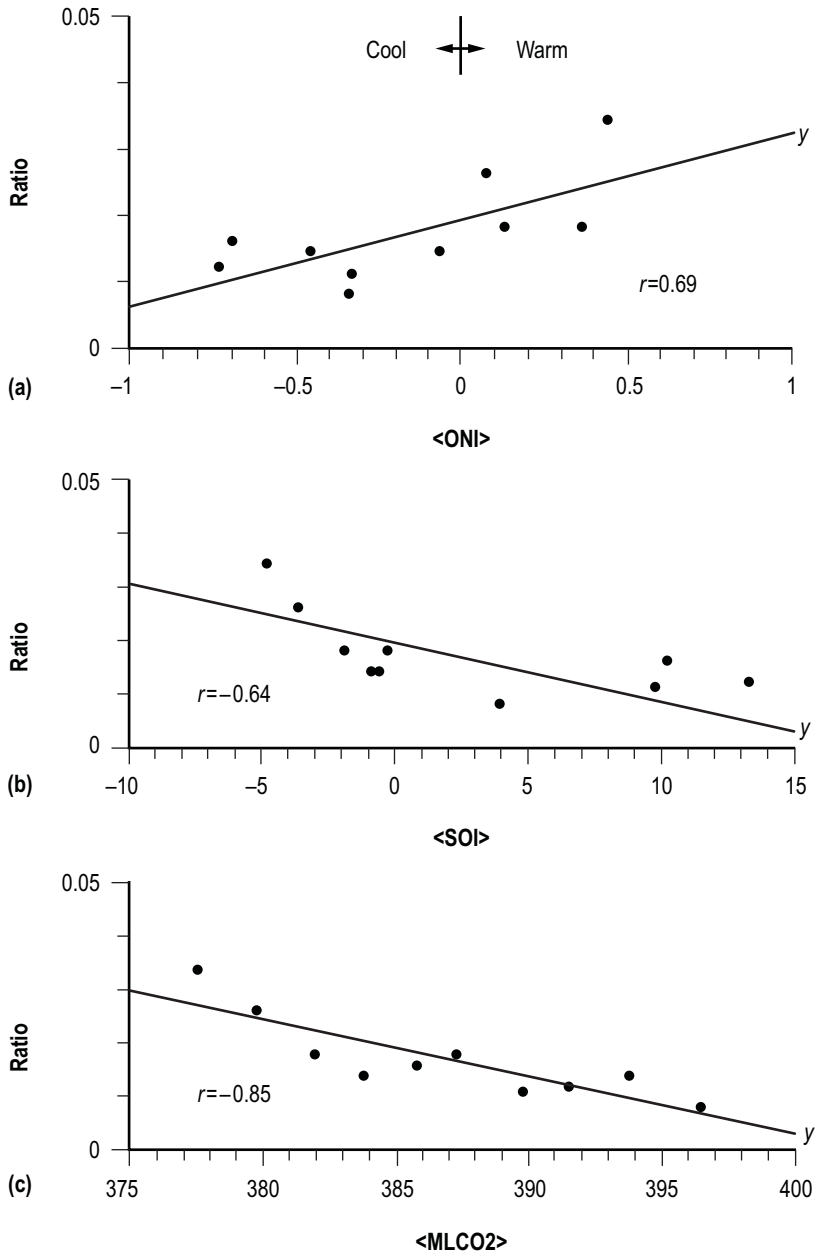

Figure 5. Scatterplots of ratio versus (a) <ONI>, (b) <SOI>, and (c) <MLCO2>.

Figure 6 shows the scatterplots of (a) NH, (b) NSD, (c) LIS(L34WR), and (d) total 34WA versus <AMO>. From the plots, one finds that warmer <AMO> tends to be associated with larger NH, NSD, LIS(L34WR), and total 34WA than cooler <AMO>. Of the four scatterplots, the one having the strongest correlation is the one between total 34WA and <AMO> ($r = 0.72$). Hence, dependent upon the value for <AMO> in the year 2014, yearly values for NH, NSD, LIS(L34WR), and total 34WA will be either above (below) their mean values if <AMO> ≥ 0.195 ºC (or <0.195 ºC). Presently, lower values for these parameters are expected. (Again, through July 2014, AMO averages about 0.023 ºC.)

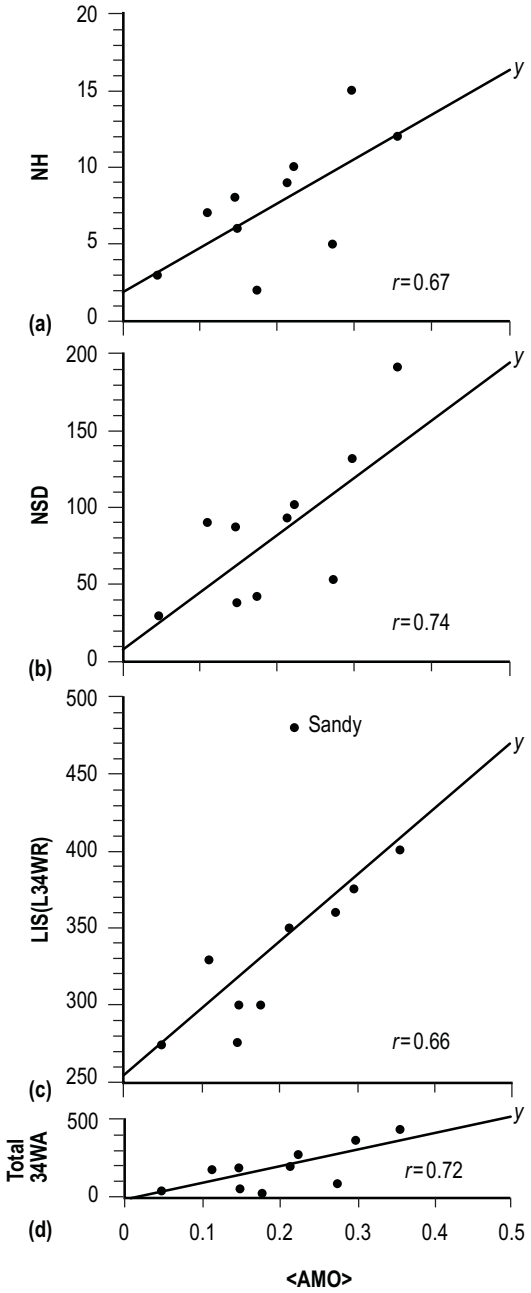

Figure 6. Scatterplots of (a) NH, (b) NSD, (c) LIS(L34WR), and (d) total 34WA versus <AMO>.

Figure 7 depicts the scatterplot of <A64WA> versus <MLCO2>. Assuming <MLCO2> = 398.48 ppm in 2014, one estimates <A64WA> for the 2014 hurricane season to be ≤2,545 nmi^2.

As noted above, through July 2014, MLCO2 is averaging about 399.98 ppm. Monthly values are expected to slightly decrease during the last 5 months of the year, due to seasonal effects, thereby causing the yearly <MLCO2> to be slightly smaller than 399.98 ppm. If the last 5 months of the year average higher (lower) than 396.38 ppm, then <MLCO2> for 2014 will be greater (smaller) than 398.48 ppm, suggesting that the estimated value for <A64WA> will be slightly lower (higher).

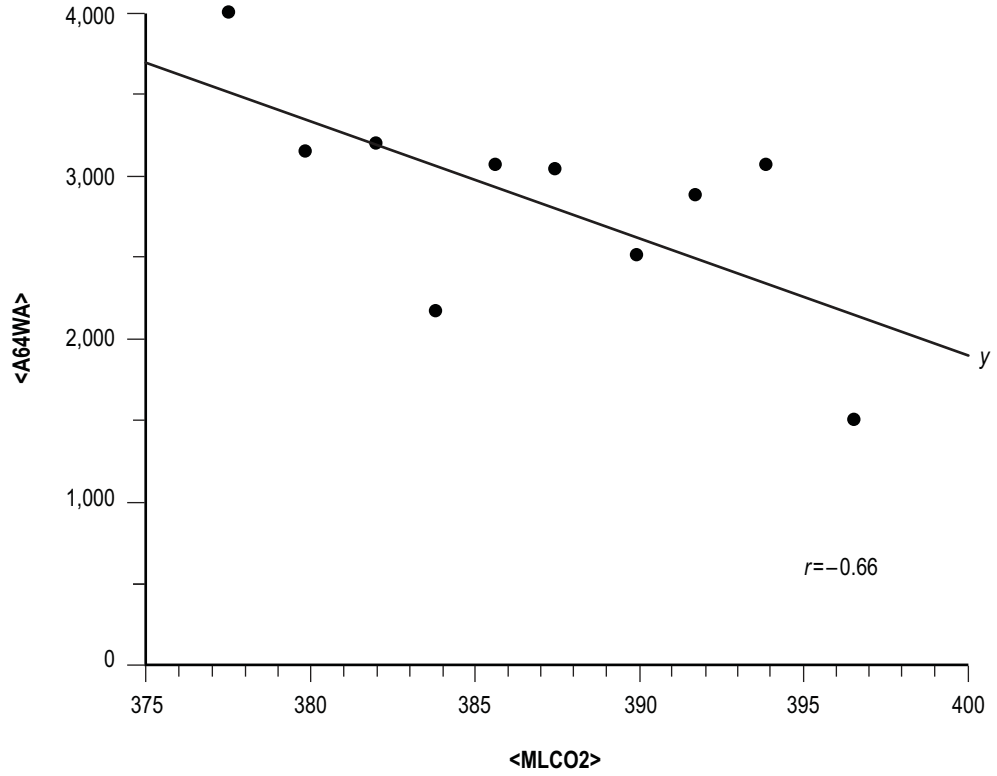

Figure 7. Scatterplot of <A64WA> versus <MLCO2>.

3. SUMMARY

The HURDAT2 database now includes estimates of the 34-, 50-, and 64-kt wind radii (by quadrant), where the 34- and 64-kt wind radii, respectively, show the extent of the tropical storm and hurricane-force winds from the center of circulation of the tropical cyclone. Knowledge of these radii then allows for the estimation of the actual sizes of the individual tropical cyclones. Unfortunately, the HURDAT2 database only covers the very brief 10-year interval 2004–2013.

During the interval 2004–2013, some 164 tropical cyclones are observed to have formed in the North Atlantic basin, of which 77 became hurricanes. This study has examined the 34- and 64-kt wind radii associated with these tropical cyclones to determine the sizes of their 34- and 64-kt wind fields. Also, this study has examined the distributions of the 34- and 64-kt wind radii and areas and examined possible trends in the radii and areas, especially in comparison against selected climate-related factors.

Interesting is that hurricane Sandy (2012) stands out as being the largest individual storm that occurred in the North Atlantic basin during this timeframe, both in terms of its 34- and 64-kt wind radii and wind areas, having maximum 34- and 64-kt wind radii, maximum wind areas and average wind areas each more than 2 standard deviations larger than the corresponding means. Also, in terms of the largest yearly total 34-kt wind area (i.e., the sum of all individual storm wind areas during the year), the year 2010 stands out as being the largest (about 423×10^6 nmi^2, compared to the mean of about 174×10^6 nmi^2), surpassing the year 2005 (35×10^6 nmi^2) that had the largest number of individual storms (28 tropical cyclones, with 15 becoming hurricanes), although in terms of the largest yearly total 64-kt wind area, the year 2005 stands out as being the largest (about 9×10^6 nmi^2, compared to the mean of about 3×10^6 nmi^2). Additionally, the ratio of total 64-kt wind area to total 34-kt wind area has decreased over time, from 0.034 in 2004 to 0.008 in 2013.

Regarding the distributions of the 34- and 64-kt wind radii and areas, the following was found:

(1) For the 164 tropical cyclones during the interval 2004–2013, the largest single grouping for L34WR is L34WR = 50–99 nmi (50/164 = 30%), with 135 of the 164 tropical cyclones (82%) having L34WR <300 nmi.

(2) The two largest tropical cyclones in terms of L34WR are Igor (2010) and Sandy (2012), having the largest 34-kt wind radii of 400 and 480 nmi, respectively.

(3) The largest single grouping for L34WA is L34WA $<50\times10^3$ nmi^2, accounting for 99 of the 164 tropical cyclones (60%).

(4) The two largest tropical cyclones in terms of L34WA are Igor (2010) and Sandy (2012), having the largest 34-kt wind area of about 414×10^3 and 541×10^3 nmi^2, respectively.

(5) The largest single grouping for A34WA is A34WA $<25\times10^3$ nmi^2, accounting for 102 of the 164 tropical cyclones (62%).

(6) The two largest tropical cyclones in terms of A34WA are Florence (2006) and Sandy (2012), having the largest average 34-kt wind area of about 136×10^3 and 210×10^3 nmi^2, respectively.

(7) For the 77 hurricanes during the interval 2004–2013, the largest single grouping for L64WR is L64WR = 25–49 nmi (26/77 = 34%), with 72 of 77 (94%) having L64WR <100 nmi.

(8) The largest storm in terms of L64WR is hurricane Sandy (2012), having the largest 64-kt wind radius of 180 nmi.

(9) The largest single grouping for L64WA is L64WA $<5\times10^3$ nmi^2, accounting for 51 of the 77 hurricanes (66%).

(10) The largest storm in terms of L64WA is hurricane Sandy (2012), having the largest 64-kt wind area of about 43×10^3 nmi^2.

(11) The largest single grouping for A64WA is A64WA $<2.5\times10^3$ nmi^2, accounting for 48 of the 77 hurricanes (62%).

(12) The two largest hurricanes in terms of A64WA are hurricanes Wilma (2005) and Sandy (2012), having the largest average 64-kt wind area of about 12×10^3 and 16×10^3 nmi^2, respectively.

Regarding comparisons against selected climate-related factors, the following was found:

(1) The ratio of total yearly 64-kt wind area to total yearly 34-kt wind area appears to possibly be related to the phasing of the El Niño-Southern Oscillation, as described by <ONI> ($r = 0.69$; *cl* >95%) and/or <SOI> ($r = 0.64$; *cl* >95%), and especially <MLCO2> ($r = -0.85$; *cl* >95%).

(2) NH, NSD, LIS(L34WR), and total 34WA all appear to be related to <AMO> ($r \geq 0.66$; *cl* >95%).

(3) <A64WA> appears to be related to <MLCO2> ($r = -0.66$; *cl* >95%).

APPENDIX

The wind fields associated with tropical cyclones are rarely symmetrical. Usually, one quadrant of the tropical cyclone has the more extensive wind field. This is readily seen in the HURDAT2 time measurements for Alex, the first tropical cyclone for the 2004 hurricane season, as shown in table 6. Clearly, the FSD for Alex occurred on August 1 at 1800 UT when its 1-min sustained PWS attained 35 kt and the storm was designated TS. Its onset location and LP at FSD measured 31.6° N. and 79.2° W. and 1,009 mb, respectively. At onset the 34-kt winds extended outwards from its center of circulation some 50 nmi in the SE and SW quadrants. Since the area of the wind field for each quadrant is computed as $\pi/4$ times the radius squared, the 34-kt wind area at FSD is computed to be $\pi/4$ times $(0^2 + 50^2 + 50^2 + 0^2)$ nmi^2, which equals 3,927 nmi^2 (A34WA). The largest 34-kt wind area occurred on August 5 at 1200 UT measuring 150,816 nmi^2 $(= \pi/4(80^2 + 300^2 + 300^2 + 75^2))$. The sum of the 20 individual time measurements of 34-kt wind areas equals 1,088,601 nmi^2, thus yielding the average 34-kt wind area per time measurement as 54,430 nmi^2 (= 1,088,601/20 nmi^2/20). (The largest 34-kt wind area tropical cyclone for the year 2004, however, was Karl, which occurred September 16–24, 2004. It is classified as MH and has L34WR = 350 nmi, L34WA = 324,468 nmi^2, and A34WA = 107,362 nmi^2; see tables 1 and 3.)

The total 34-kt wind area for the year is simply the sum of all the individual 34-kt wind areas for the tropical cyclones occurring during the year. Hence, the total 34-kt wind area for a hurricane season is equal to the average wind area per tropical cyclone per time measurement (<A34WA>) times the number of tropical cyclones (NTC) per year times the number of time measurements (= 4×NSD). For the 2004 hurricane season, the total 34-kt wind area is computed to be 194.379×10^6 nmi^2 (= 34,835 nmi^2 per tropical cyclone×15 tropical cyclones×4 time measurements per day×93.00 storm days).

For the 64-kt wind area, Alex attained hurricane force winds on August 3 at 0600 UT, marking its first hurricane day (FHD). At FHD, Alex had 64WA = 942 nmi^2 $(= \pi/4(20^2 + 20^2 + 20^2 + 0^2))$. Its largest 64-kt wind area occurred on August 5 at 0000 UT through August 5 at 1200 UT, measuring 3,691 nmi^2. The sum of the 13 individual time measurements of 64-kt wind areas equals 35,458 nmi^2, thus yielding the average 64-kt wind area per time measurement as 2,728 nmi^2. (The largest 64-kt wind area hurricane for the year 2004 was Ivan, which occurred September 3–23, 2004, and is classified as MH and has L64WR = 100 nmi, L64WA = 21,795 nmi^2, and A64WA = 9,262 nmi^2.)

The total 64-kt wind area for the year is simply the sum of all the individual 64-kt wind areas occurring during the year. Hence, the total 64-kt wind area for a hurricane season is equal to the average wind area per hurricane per time measurement (<A64WA>) times the number of hurricanes (NH) per year times the number of time measurements (= 4×NHD). For the 2004 hurricane season, the total 64-kt wind area is computed to be 6.527×10^6 nmi^2 (=3,985 nmi^2 per hurricane×9 hurricanes×4 time measurements per day×45.50 hurricane days).

Inspection of table 6 shows that Alex became a major hurricane on August 5 at 0000 UT (FMHD) and continued as an MH through August 5 at 1200 UT (LMHD).

Table 6. HURDAT2 data for Alex during the 2004 hurricane season, with comments.

							Wind Radii (nmi)														
							34 kt				50 kt				64 kt						
Date	UT	Class	Lat. (° N.)	Long. (° W.)	PWS	LP	NE	SE	SW	NW	NE	SE	SW	NW	NE	SE	SW	NW	Comment	34WA	64WA
07/31/2004	1800	TD	30.3	78.3	25	1,010	–	–	–	–	–	–	–	–	–	–	–	–		–	–
08/01/2004	0000	TD	31.0	78.8	25	1,009	–	–	–	–	–	–	–	–	–	–	–	–		–	–
08/01/2004	0600	TD	31.5	79.0	25	1,009	–	–	–	–	–	–	–	–	–	–	–	–		–	–
08/01/2004	1200	TD	31.6	79.1	30	1,009	–	–	–	–	–	–	–	–	–	–	–	–		–	–
08/01/2004	1800	TS	31.6	79.2	35	1,009	–	50	50	–	–	–	–	–	–	–	–	–	FSD	3,927	–
08/02/2004	0000	TS	31.5	79.3	35	1,007	–	50	50	–	–	–	–	–	–	–	–	–		3,927	–
08/02/2004	0600	TS	31.4	79.4	40	1,005	60	90	90	–	–	–	–	–	–	–	–	–		15,551	–
08/02/2004	1200	TS	31.3	79.0	50	992	75	90	60	20	30	30	–	–	–	–	–	–		13,607	–
08/02/2004	1800	TS	31.8	78.7	50	993	75	90	50	30	30	30	20	20	–	–	–	–		13,450	–
08/03/2004	0000	TS	32.4	78.2	60	987	75	90	50	30	30	30	20	20	–	–	–	–		13,450	–
08/03/2004	0600	HU	33.0	77.4	70	983	75	90	50	40	30	30	30	20	20	20	20	–	FHD	14,000	942
08/03/2004	1200	HU	34.2	76.4	85	974	75	90	50	40	30	50	30	20	20	20	20	–		14,000	942
08/03/2004	1800	HU	35.3	75.2	85	972	90	90	75	50	60	50	30	30	30	30	20	15		19,105	1,905
08/04/2004	0000	HU	36.0	73.7	80	974	80	100	75	50	40	50	40	20	15	40	30	15		19,262	2,317
08/04/2004	0600	HU	36.8	72.1	80	973	60	120	75	75	40	75	50	50	20	50	30	15		22,973	3,161
08/04/2004	1200	HU	37.3	70.2	85	973	60	120	75	75	40	75	50	50	20	50	30	15		22,973	3,161
08/04/2004	1800	HU	37.8	68.3	95	965	90	150	125	75	50	75	50	50	25	50	25	15		40,723	3,122
08/05/2004	0000	HU	38.5	66.0	105	957	80	150	125	75	50	80	60	50	30	50	30	20	FMHD	39,388	3,691
08/05/2004	0600	HU	39.5	63.1	105	957	80	225	200	75	50	80	60	50	30	50	30	20		80,621	3,691
08/05/2004	1200	HU	40.8	59.6	100	962	80	300	300	75	50	80	60	50	30	50	30	20	LMHD	150,816	3,691
08/05/2004	1800	HU	42.7	55.0	90	970	75	300	300	75	50	75	50	30	25	50	25	–		150,207	2,945
08/06/2004	0000	HU	44.5	49.3	75	978	75	300	300	75	50	75	50	30	25	50	25	–		150,207	2,945
08/06/2004	0600	HU	46.1	44.2	65	984	75	300	300	75	50	75	50	30	25	50	25	–	LHD	150,207	2,945
08/06/2004	1200	TS	47.0	37.5	50	987	75	300	300	75	50	75	50	30	–	–	–	–	LSD	150,207	–
08/06/2004	1800	EX	47.4	32.7	30	992	–	–	–	–	–	–	–	–	–	–	–	–		–	–
Mean																				54,430 (A34WA)	2,728 (A64WA)

Notes: TD = tropical depression
TS = tropical storm
HU = hurricane
EX = extratropical

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14. ABSTRACT

At end of the 2012 hurricane season the National Hurricane Center retired the original HURDAT dataset and replaced it with the newer version HURDAT2, which reformatted the original data and included additional information, in particular, estimates of the 34-, 50, and 64-kt wind radii for the interval 2004–2013. During the brief 10-year interval, some 164 tropical cyclones are noted to have formed in the North Atlantic basin, with 77 becoming hurricanes. Hurricane Sandy (2012) stands out as being the largest individual storm that occurred in the North Atlantic basin during the 2004–2013 timeframe, both in terms of its 34- and 64-kt wind radii and wind areas, having maximum 34- and 64-kt wind radii, maximum wind areas, and average wind areas each more than 2 standard deviations larger than the corresponding means. In terms of the largest yearly total 34-kt wind area (i.e., the sum of all individual storm 34-kt wind areas during the year), the year 2010 stands out as being the largest (about 423×10^6 nmi^2, compared to the mean of about 174×10^6 nmi^2), surpassing the year 2005 (353×10^6 nmi^2) that had the largest number of individual storms (28). However, in terms of the largest yearly total 64-kt wind area, the year 2005 was the largest (about 9×10^6 nmi^2, compared to the mean of about 3×10^6 nmi^2). Interesting is that the ratio of total 64-kt wind area to total 34-kt wind area has decreased over time, from 0.034 in 2004 to 0.008 in 2013.

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