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A NOTE ON RELATIONSHIPS BETWEEN WESTERN SAHEL RAINFALL AND U.S. HURRICANE ACTIVITY

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ABSTRACT. A recent research paper concluded that the probabilities of major hurricane strikes on the east coast of the United States, particularly the east coast of Florida, are greatly enhanced when rainfall over the Western Sahel is abundant and that these probabilities are substantially smaller when drought conditions prevail over the Western Sahel. This conclusion was based upon a 43-year sample of 1947–1989. In the work presented here, a search is made for simple, statistically significant (at the 5% or better level) relationships between Western Sahel rainfall for 1947–1990 and eight types of hurricanes that are defined in the text. When hurricane frequencies for the 11 wettest and 11 driest Western Sahel years are compared, statistically significant differences are found for all hurricane types studied, *except for Florida landfalling hurricanes*. Significant relationships are found for major hurricanes striking the east coast of the United States north of Florida, and for hurricanes of all intensities striking the east coast of the United States north of Florida. *However, no significant relationships are found for hurricanes striking Florida.* When the wetter 22 years are compared with the drier 22 years, a statistically significant relationship is found for the total of hurricanes of all intensities that strike the Florida Peninsula. For this type of hurricane, the largest frequency is found in the second quartile of Western Sahel rainfall years and not in the wettest quartile. This makes the interpretation of the results difficult.

1. INTRODUCTION

Gray (1990a) compared Atlantic Basin hurricane frequencies for the 43-year period 1947–1989 with a measure of Western Sahel rainfall anomaly[1] for June–September. He found that the wetter Western Sahel years had many more major[2] Atlantic Basin hurricanes than did the drier years. Gray concluded, "Seasonal and multidecadal variations of intense hurricane activity are closely linked to seasonal and multidecadal variations of summer rainfall amounts in the Western Sahel region of West Africa." Gray goes on to state, "When analyzed by intensity category, data for hurricanes of Saffir–Simpson categories 3, 4, and 5 striking the United States also show large multidecadel differences in frequency, particularly data for intense hurricanes making landfall on Florida and the U.S. East Coast."

These conclusions led Gray to predict that, "The apparent recent breaking of the 18-year Sahel drought during 1988 and 1989[3] suggests that the incidence of intense hurricanes making landfall on the U.S. coast and in the Caribbean basin will likely increase during the 1990's and early years of the 21st century to levels of activity notably greater than were observed during the 1970's and 1980's."

Before publication of Gray (1990a), numerous television, radio, and newspaper interviews were given that highlighted a potential for hurricane devastation in South Florida as a result of the predicted breaking of

[1]This measure was defined as the deviation from the mean normalized by the standard deviation averaged over 38 Western Sahel stations.

[2]Major hurricanes are defined as categories 3, 4, and 5 on the Saffir–Simpson intensity scale (Simpson and Riehl, 1981).

[3]It is noted that the Western Sahel returned to drought conditions during June–September 1990.

the Western Sahel drought. For example, in the Fort Lauderdale *Sun–Sentinel* of April 20, 1990, Gray is quoted as follows. "Florida has pressed its luck for too long....It is a sitting duck in the Sahel shooting gallery," and "No one knows for sure, but the odds are that Florida and the East Coast are going to get it." These statements understandably produced great concern among South Floridians. The latter generally have a high degree of hurricane awareness as the result of an excellent hurricane education campaign carried out by the National Hurricane Center over many years. However, Gray's work could indicate that public awareness should be increased even further. As a first step towards verification of Gray's conclusions, we examine the statistical significance of relationships between Western Sahel rainfall and hurricane frequency. Particular attention is paid to relationships between Florida hurricane activity and Western Sahel rainfall.

2. ANALYSIS

Gray's precipitation data (Gray, 1990b; see his table 8) and the hurricane data of Neumann *et al.* (1987) are used in this study. The latter were updated to include 1987–1990. Table 1 gives Gray's precipitation data for 1947–1990 and their rank order. The data for 1947 and 1948 were interpolated from figure 5 of Gray (1990b) because digital values were not given for these years. If one compares figure 5 of Gray (1990b) with figure 3 of Gray (1990a), there is an unexplained difference in the 1948 value. We chose to use the value from Gray (1990b) because it is based upon later calculations than Gray (1990a) and represents an improvement or correction to the original value.

In this analysis, we consider eight hurricane types. For ease of expression, it is convenient to refer to each type of storm with a shorthand notation. The notations are defined below.

Type 1 .. Atlantic Basin hurricanes of all intensities (categories 1–5).

Type 2 .. Major (categories 3, 4, and 5) hurricanes striking any part of the U.S. coastline from southern Texas to northern Maine.

Type 3 .. Major hurricanes striking anywhere on the Florida Peninsula[4].

Type 4 .. Hurricanes of all intensities striking anywhere on the Florida Peninsula.

Type 5 .. Hurricanes of all intensities striking the east coast of Florida.

Type 6 .. Major hurricanes striking the east coast of Florida.

Type 7 .. Hurricanes of all intensities striking the east coast of the U.S. to the north of Florida.

Type 8 .. Major hurricanes striking the east coast of the United States to the north of Florida.

Tables 2–10 compare frequencies of these hurricane types to the ranked four quartiles (11 years each) of Western Sahel rainfall. The hurricane frequency in the wettest quartile is found to be larger than that for the driest quartile for each of the eight hurricane types. However, it is necessary to estimate the probability that these differences occur by chance before conclusions can be reached.

We put forth the null hypothesis that the true, or population, probability of a hurricane falling into either of two categories that are being compared is 50%. Then we use the binomial distribution to compute the probability of getting as few, or fewer, occurrences as the category with the smaller number of hurricanes. When this probability is very small (in this study defined as 5% or less), we can reject the null

[4]When the term "Florida Peninsula" is used, the Florida Panhandle is excluded.

Table 1.--Western Sahel rainfall index and rank of index for 1947-1990

Rain Year	Rain index	Rank of index	Rain Year	Rain index	Rank of index
1947	0.18	20	1969	0.54	11
1948	0.40*	15	1970	-0.47	31
1949	-0.10	24	1971	-0.32	28
1950	1.48	1	1972	-1.19	42
1951	0.30	18	1973	-0.83	38
1952	0.99	4	1974	-0.25	27
1953	0.54	10	1975	0.34	17
1954	0.76	6	1976	-0.58	34
1955	1.46	2	1977	-0.93	40
1956	0.38	16	1978	-0.20	26
1957	0.51	13	1979	-0.56	33
1958	1.27	3	1980	-0.70	35
1959	0.04	23	1981	-0.36	29
1960	0.49	14	1982	-0.90	39
1961	0.76	7	1983	-1.34	44
1962	0.18	19	1984	-1.19	43
1963	-0.11	25	1985	-0.52	32
1964	0.87	5	1986	-0.39	30
1965	0.52	12	1987	-0.78	37
1966	0.06	22	1988	0.17	21
1967	0.74	8	1989	0.55	9
1968	-0.77	36	1990	-0.95**	41

*Value taken from Gray (1990b) and differs from Gray (1990a).

**Value taken from Gray (1990b).

hypothesis and conclude that the probabilities of getting hurricanes in both categories are not the same. When the binomial probability is large, the null hypothesis cannot be rejected and, based upon the available data, the difference between the categories could be a chance occurrence. We refer to this process as the "binomial test." The computed probability is called the "binomial probability."

The binomial probability when the first and fourth quartiles are compared for major hurricanes striking any part of the U.S. coast (table 3) is only 1%. The binomial probability of 53 or less Type 1 hurricanes in the driest quartile (table 2) is only 0.6%. The differences between the wettest 11 years and the driest 11 years for these two hurricane types, therefore, seem to be real. However, the binomial probability of getting 0 major hurricanes striking the Florida Peninsula (table 4) in the driest quartile is 25%. Therefore, the difference between major Florida hurricane frequencies during the 11 wettest and the 11 driest years could easily occur by chance. Intuitively, one would anticipate that no relation could be established from a sample of only 2 hurricanes.

It is of interest to compare (tables 2–4) the number of hurricanes occurring in the years that rank 12–22 (second quartile) and 23–33 (third quartile) in Western Sahel rainfall. For these three types of hurricanes, binomial tests indicate the differences between the middle quartiles could easily occur by chance. For major hurricanes striking the Florida Peninsula, however, binomial comparison of the wetter 22 years with the drier 22 years gives a result that is nearly significant. However, this results occurs because of a relative abundance of storms in the *second* quartile of Sahel rainfall years.

In summary, tables 2–4 show that significantly more major U.S. landfalling hurricanes and Type 1 hurricanes occur in the wettest quartile than in the driest quartile of Western Sahel rainfall years. However, this is not true for major Florida Peninsula hurricanes. Tables 2–4 also show that the frequencies of storms in the second and third quartiles are not significantly different from each other.

Therefore, the wettest (driest) Western Sahel years appear to occur, respectively, with larger (smaller) frequencies of major U.S. landfalling hurricanes and Type 1 hurricanes. *This data set is too small to determine whether Western Sahel rainfall has a significant relationship to the frequency of major hurricanes striking the Florida Peninsula when the 11 wettest years are compared with the 11 driest years*. However, for these hurricanes (Type 3), the second quartile of Western Sahel rainfall years shows twice as many storms as the first quartile and comparison of the wetter 22 years with the drier 22 years provides a result that has only a 6% probability of occurring by chance.

Table 5 shows frequencies of Type 4 hurricanes as a function of Western Sahel rainfall rank. There are 16 Florida Peninsula hurricanes in this sample. If the binomial test is used to compare the first quartile with the fourth quartile, we find that the probability of getting two or less occurrences in the fourth quartile is 23%. If we compare the frequencies for the wetter and drier halves of the sample, we find the binomial probability of obtaining four or less Florida Peninsula hurricanes in the lower half of the Western Sahel rainfall years to be 5% as the result of the abundance of Type 4 hurricanes in the second quartile of Western Sahel rainfall years. *These data do not support a statistically significant relationship between Florida Peninsula hurricane landfall frequencies and Western Sahel rainfall when the wettest 11 years are compared with the driest 11 years*. As in the case of Type 3 hurricanes, an abundance of storms in the second quartile leads to what appears to be a statistically significant relationship between storm activity and Western Sahel rainfall when the drier and wetter halves of the sample are compared.

Since Gray's work emphasizes the U.S. east coast, these analyses were repeated for hurricanes making landfall on the east coast of Florida and for those making landfall on the remainder of the U.S. east coast (excluding Florida). The same sample of 44 years was used in these analyses.

Table 6 shows the data for Type 5 hurricanes. A binomial comparison between the first and fourth quartiles yields a probability of 13%, while a comparison of the wetter 22 years with the drier 22 years yields

Table 2.--Frequency of Atlantic Basin (Type 1) hurricanes as a function of Western Sahel rainfall rank

Year	First quartile	Year	Third quartile
1950	11	1959	7
1955	9	1949	7
1958	7	1963	7
1952	6	1978	5
1964	6	1974	4
1954	8	1971	6
1961	8	1981	3
1967	6	1986	4
1989	7	1970	5
1953	6	1985	7
1969	12	1979	5
Total	86	Total	60

Year	Second quartile	Year	Fourth quartile
1965	4	1976	6
1957	3	1980	9
1960	4	1968	5
1948	6	1987	3
1956	4	1973	4
1975	6	1982	2
1951	8	1977	5
1962	3	1990	8
1947	5	1972	3
1988	5	1984	5
1966	7	1983	3
Total	55	Total	53

Binomial Tests:

First quartile versus fourth quartile: P = 0.6%
Second quartile versus third quartile: P = 64%
Wetter half versus drier half: P = 8%

Table 3.--Frequency of major hurricanes sriking anywhere on the U.S. coast (Type 2) as a function of Western Sahel rainfall rank

Year	First quartile	Year	Third quartile
1950	2	1959	1
1955	2	1949	1
1958	0	1963	0
1952	0	1978	0
1964	1	1974	1
1954	2	1971	0
1961	1	1981	0
1967	1	1986	0
1989	1	1970	1
1953	0	1985	2
1969	1	1979	1
Total	11	Total	7

Year	Second quartile	Year	Fourth quartile
1965	6	1976	0
1957	1	1980	1
1960	1	1968	0
1948	1	1987	0
1956	0	1973	0
1975	1	1982	0
1951	0	1977	0
1962	0	1990	0
1947	1	1972	0
1988	0	1984	0
1966	0	1983	1
Total	6	Total	2

Binomial Tests:

First quartile versus fourth quartile: P = 1%
Second quartile versus third quartile: P = 78%
Wetter half versus drier half: P = 12%

Table 4.--Frequency of major hurricanes sriking anywhere on the Florida Peninsula (Type 3) as a function of Western Sahel rainfall rank

Year	First quartile	Year	Third quartile
1950	2	1959	0
1955	0	1949	1
1958	0	1963	0
1952	0	1978	0
1964	0	1974	0
1954	0	1971	0
1961	0	1981	0
1967	0	1986	0
1989	0	1970	0
1953	0	1985	0
1969	0	1979	0
Total	2	Total	1

Year	Second quartile	Year	Fourth quartile
1965	1	1976	0
1957	0	1980	0
1960	1	1968	0
1948	1	1987	0
1956	0	1973	0
1975	0	1982	0
1951	0	1977	0
1962	0	1990	0
1947	1	1972	0
1988	0	1984	0
1966	0	1983	0
Total	4	Total	0

Binomial Tests:

First quartile versus fourth quartile: P = 25%
Second quartile versus third quartile: P = 19%
Wetter half versus drier half: P = 6%

Table 5.--Frequency of hurricanes striking anywhere on the Florida Peninsula (Type 4) as a function of Western Sahel rainfall rank

Year	First quartile	Year	Third quartile
1950	2	1959	0
1955	0	1949	1
1958	0	1963	0
1952	0	1978	0
1964	3	1974	0
1954	0	1971	0
1961	0	1981	0
1967	0	1986	0
1989	0	1970	0
1953	0	1985	0
1969	0	1979	1
Total	5	Total	2

Year	Second quartile	Year	Fourth quartile
1965	1	1976	0
1957	0	1980	0
1960	1	1968	1
1948	2	1987	1
1956	0	1973	0
1975	0	1982	0
1951	0	1977	0
1962	0	1990	0
1947	2	1972	0
1988	0	1984	0
1966	1	1983	0
Total	7	Total	2

Binomial Tests:

First quartile versus fourth quartile: P = 23%
Second quartile versus third quartile: P = 9%
Wetter half versus drier half: P = 5%

Table 6.--Frequency of Florida east coast landfalling hurricanes (Type 5) as a function of Western Sahel rainfall rank

Year	First quartile	Year	Third quartile
1950	1	1959	0
1955	0	1949	1
1958	0	1963	0
1952	0	1978	0
1964	2	1974	0
1954	0	1971	0
1961	0	1981	0
1967	0	1986	0
1989	0	1970	0
1953	0	1985	0
1969	0	1979	1
Total	3	Total	2

Year	Second quartile	Year	Fourth quartile
1965	1	1976	0
1957	0	1980	0
1960	1	1968	0
1948	1	1987	0
1956	0	1973	0
1975	0	1982	0
1951	0	1977	0
1962	0	1990	0
1947	1	1972	0
1988	0	1984	0
1966	0	1983	0
Total	4	Total	0

Binomial Tests:

First quartile versus fourth quartile: P = 13%
Second quartile versus third quartile: P = 34%
Wetter half versus drier half: P = 9%

a binomial probability of 9%. *Therefore, we cannot conclude, from these data, that Florida east coast hurricanes are closely related to Western Sahel rain.*

Table 7 shows similar data for major Florida east coast hurricanes. One notes that there have been only five such hurricanes in the 44-year sample--major hurricane landfalls on the Florida east coast have been a rare event during these 44 years. Binomial comparison of the first and fourth quartiles provides a probability of 50% (based upon a sample of 1). Comparison of the wetter 22 years with the drier 22 years yields a binomial probability of 19%. This provides no support for rejection of the null hypothesis. *One cannot conclude from these data that the frequency of major hurricanes striking the east coast of Florida is related to Western Sahel rainfall.*

Table 8 shows the statistics for Type 7 hurricanes. When the hurricane occurrences in the first and fourth quartiles of Western Sahel rainfall years are compared using the binomial test, we find only a 1% probability. This is strong support for rejecting the null hypothesis. When the second and third quartiles are tested against each other, we also find a binomial probability of 1%. However, this result occurs because the third quartile has seven hurricanes and the second quartile has no hurricanes. Finally, when the wetter half of the sample is compared with the drier half, the binomial probability is 45%. *For east coast hurricanes, excluding Florida, a relationship with Western Sahel rainfall in the extreme rainfall years seems to be present.* However, the relationship in the near normal rainfall years is statistically significant in the reverse sense; i.e., more storms in the drier years.

Table 9 shows the statistics for major hurricanes striking the U.S. coast from south Georgia to the northern tip of Maine. A comparison of the first quartile with the fourth quartile gives a binomial probability of 3% and, therefore, provides support for a relationship in the extreme rainfall years. The binomial probability obtained when the wetter half of the sample is compared with the drier half is 36%. As was the case in the previous paragraph, a statistically significant relationship is found in these data only for years with extreme rainfall deviations from the mean.

3. SUMMARY

Table 10 summarizes the results of the previous section. Of the eight hurricane types studied, four (Types 3-6) are concerned with hurricanes that strike Florida and two (Types 7 and 8) contain hurricanes that do not strike Florida.

When we compare the 11 wettest Western Sahel years (quartile 1) with the 11 driest years (quartile 4), only the Florida landfalling hurricanes (Types 3-6) do not show statistically significant differences. This result provides strong support for Gray's relationship between Western Sahel rainfall and the frequencies of hurricanes striking the U.S. east coast, *but at locations other than Florida*. For the non-Florida hurricane types, activity in very wet Western Sahel years is significantly greater than in Western Sahel drought years. It is curious that the binomial probability for Type 2 hurricanes is slightly less than for Type 8 hurricanes, despite the fact that the former contains many storms that made landfall on the Gulf coast.

For the Florida related systems (Types 3-6), no statistically significant relationships were found in the comparisons of quartiles 1 and 4. However, for each Florida type, we do find that more storms occur in quartile 1 than in quartile 4. While it is reasonable to suspect that relationships between Florida hurricanes and Western Sahel rainfall might be found in longer records, the data studied here are insufficient for such a conclusion.[5]

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[5]Major hurricanes striking the east coast of Florida were an extremely rare occurrence during the 44 years studied here. Only five such storms occurred and only one of these took place during the first quartile of Western Sahel rainfall years.

Table 7.--Frequency of major Florida east coast landfalling hurricanes (Type 6) as a function of Western Sahel rainfall rank

Year	First quartile	Year	Third quartile
1950	1	1959	0
1955	0	1949	1
1958	0	1963	0
1952	0	1978	0
1964	0	1974	0
1954	0	1971	0
1961	0	1981	0
1967	0	1986	0
1989	0	1970	0
1953	0	1985	0
1969	0	1979	0
Total	1	Total	1

Year	Second quartile	Year	Fourth quartile
1965	1	1976	0
1957	0	1980	0
1960	1	1968	0
1948	0	1987	0
1956	0	1973	0
1975	0	1982	0
1951	0	1977	0
1962	0	1990	0
1947	1	1972	0
1988	0	1984	0
1966	0	1983	0
Total	3	Total	0

Binomial Tests:

First quartile versus fourth quartile: P = 50%
Second quartile versus third quartile: P = 31%
Wetter half versus drier half: P = 19%

Table 8.--Frequency of east coast U.S. (other than Florida) landfalling hurricanes (Type 7) as a function of Western Sahel rainfall rank

Year	First quartile	Year	Third quartile
1950	0	1959	2
1955	3	1949	1
1958	0	1963	0
1952	1	1978	0
1964	0	1974	0
1954	3	1971	1
1961	0	1981	0
1967	0	1986	1
1989	1	1970	0
1953	2	1985	2
1969	1	1979	0
Total	11	Total	7

Year	Second quartile	Year	Fourth quartile
1965	0	1976	1
1957	0	1980	0
1960	0	1968	0
1948	0	1987	0
1956	0	1973	0
1975	0	1982	0
1951	0	1977	0
1962	0	1990	0
1947	0	1972	0
1988	0	1984	1
1966	0	1983	0
Total	0	Total	2

Binomial Tests:

First quartile versus fourth quartile: P = 1%
Second quartile versus third quartile: P = 1%
Wetter half versus drier half: P = 45%

Table 9.—Frequency of major east coast U.S. (other than Florida) landfalling hurricanes (Type 8) as a function of Western Sahel rainfall rank

Year	First quartile	Year	Third quartile
1950	0	1959	2
1955	2	1949	0
1958	0	1963	0
1952	0	1978	0
1964	0	1974	0
1954	2	1971	0
1961	0	1981	0
1967	0	1986	0
1989	1	1970	0
1953	0	1985	1
1969	0	1979	0
Total	5	Total	3

Year	Second quartile	Year	Fourth quartile
1965	0	1976	0
1957	0	1980	0
1960	0	1968	0
1948	0	1987	0
1956	0	1973	0
1975	0	1982	0
1951	0	1977	0
1962	0	1990	0
1947	0	1972	0
1988	0	1984	0
1966	0	1983	0
Total	0	Total	0

Binomial Tests:

First quartile versus fourth quartile: P = 3%
Second quartile versus third quartile: P = 13%
Wetter half versus drier half: P = 36%

Table 10.--Summary of tables 2-9†

	Quartile 1 versus 4	Quartile 2 versus 3	Wet half versus dry half.
All Atlantic Basin hurricanes (Type 1)	86 ** 53 P=1%	55 60 P=64%	141 113 P=8%
Major hurricanes with landfall anywhere on U.S. coast (Type 2)	11 ** 2 P=1%	6 7 P=78%	17 9 P=12%
Major hurricanes striking the Florida Peninsula (Type 3)	2 0 P=25%	4 1 P=19%	6 1 P=6%
Hurricanes of all intensities striking the Florida Peninsula (Type 4)	5 2 P=23%	7 2 P=9%	12 ** 4 P=5%
Hurricanes of all intensities striking the east coast of Florida (Type 5)	3 0 P=13%	4 2 P=34%	7 2 P=9%
Major hurricanes striking the east coast of Florida (Type 6)	1 0 P=50%	3 1 P=31%	4 1 P=19%
Hurricanes of all intensities striking the U.S. east coast north of Florida (Type 7)	11 ** 2 P=1%	0 ** 7 P=1%	11 9 P=45%
Major hurricanes striking the U.S. east coast north of Florida (Type 8)	5 ** 0 P=3%	0 3 P=13%	5 3 P=36%

†For each type of hurricane, the top line shows the number of storms in the quartiles or halves that are being compared. The binomial probability is shown on the second line. Comparisons that are statistically significant at the 5% or better level are marked with a double asterisk.

Of the eight hurricane types, only Type 7 showed significantly different hurricane frequencies when quartiles 2 and 3 were compared and this was an inverse relationship with more storms in the drier years. Consequently, we cannot conclude, from these data, that hurricane frequencies are larger in years with Western Sahel rainfall slightly above normal than in years with rainfall slightly below normal.

The relationships that involve the near–normal quartiles 2 and 3 are complex. Four of the eight hurricane types defined here show greater hurricane frequencies in quartile 3 than in quartile 2.

Table 11 shows that quartile 4 has less hurricanes than either quartile 3 or 2 for almost all of the eight hurricane types. While none of these differences are statistically significant at the 5% level, Types 3 and 5 are close. Consequently, while we cannot conclude that near–normal (quartiles 2 and 3) Western Sahel precipitation is associated with greater hurricane activity than is the case for drought (quartile 4) conditions, there is reason to suspect that this may be the case for major hurricanes striking the Florida Peninsula (Type 5).

Table 12 compares the hurricane frequency data for the very wet Western Sahel years (quartile 1) with the near–normal years (quartiles 2 and 3). Here we find significant differences for the frequencies of Type 7 and 8 hurricanes. Thus, east coast hurricanes north of Florida are significantly more frequent in the wettest Western Sahel years than in the near normal Western Sahel rainfall years. This is consistent with Gray's (1990a) conclusions. The lack of significant relationships for Florida hurricanes is inconsistent with those conclusions.

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Table 11.--Same as table 10, except that different quartiles are compared

	Quartile 4 versus 3		Quartile 4 versus 2	
All Atlantic Basin hurricanes (Type 1)	53	60	53	55
	P=50%		P=85%	
Major hurricanes with landfall anywhere on U.S. coast (Type 2)	2	7	2	6
	P=9%		P=14%	
Major hurricanes striking the Florida Peninsula (Type 3)	0	1	0	4
	P=50%		P=6%	
Hurricanes of all intensities striking the Florida Peninsula (Type 4)	2	2	2	7
	P=100%		P=9%	
Hurricanes of all intensities striking the east coast of Florida (Type 5)	0	2	0	4
	P=25%		P=6%	
Major hurricanes striking the east coast of Florida (Type 6)	0	1	0	3
	P=50%		P=13%	
Hurricanes of all intensities striking the U.S. east coast north of Florida (Type 7)	2	7	2	0
	P=9%		P=25%	
Major hurricanes striking the U.S. east coast north of Florida (Type 8)	0	3	0	0
	P=13%		P=100%	

Table 12. Same--Same as table 10, except that different quartiles are compared

	Quartile 1 versus 2	Quartile 1 versus 3
All Atlantic Basin hurricanes (Type 1)	86 ** 55 P=1%	86 ** 60 P=3%
Major hurricanes with landfall anywhere on U.S. coast (Type 2)	11 6 P=23%	11 7 P=49%
Major hurricanes striking the Florida Peninsula (Type 3)	2 4 P=34%	2 1 P=50%
Hurricanes of all intensities striking the Florida Peninsula (Type 4)	5 7 P=56%	5 2 P=23%
Hurricanes of all intensities striking the east coast of Florida (Type 5)	3 4 P=77%	3 2 P=50%
Major hurricanes striking the east coast of Florida (Type 6)	1 3 P=31%	1 1 P=100%
Hurricanes of all intensities striking the U.S. east coast north of Florida (Type 7)	11 ** 0 P=0%	10 7 P=48%
Major hurricanes striking the U.S. east coast north of Florida (Type 8)	5 ** 0 P=3%	5 3 P=36%

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