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Case Report

Climate and Hurricanes

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ABSTRACT

A diversity of opinion exists concerning the effect of climate change on tropical storms and hurricanes. Some of the information appearing in the media is part opinion, part science, and can be misleading.

This paper briefly examines two natural climate cycles that influence tropical cyclone activity in the Atlantic, Caribbean, and the Gulf of Mexico.

Using current available research, the paper illustrates the influence of natural variability on tropical cyclone activity in the Atlantic basin, and how this influence can mask the contribution of anthropogenic warming.

Keywords: Climate; Hurricanes; Anthropogenic warming; Meteorology

INTRODUCTION

Scientific data clearly shows that atmospheric and Sea Surface Temperatures (SST) have been increasing since the 1970's (Figure 1). It is also common knowledge that warmer oceans provide increased energy for tropical cyclonedevelopment. There are other factors that affect tropical cyclone development, such as vertical wind shear, dry air entrainment, and natural climate variability.

Two climate cycles that influence tropical storms and hurricanes in the Atlantic basin are El Nino Southern Oscillation (ENSO) and AMO (Atlantic Multi-decadal Oscillation).

Both of these patterns are cyclical in nature and should be distinguished from the anomalies associated with anthropogenic warming.

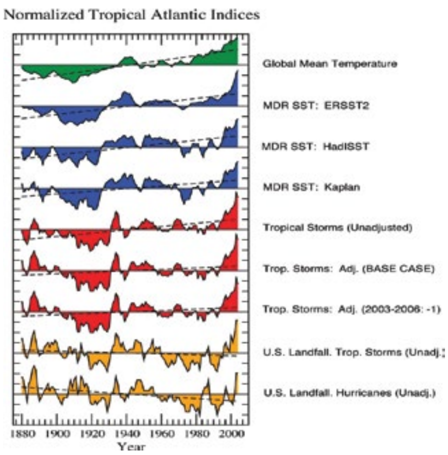

Figure 1: Historical trends: Global mean temperature, SST, tropical storms.

El Nino Southern Oscillation (ENSO)

There are a number of ocean/atmosphere cycles that affect weather patterns in the tropical Atlantic. One of the most common is El Nino Southern Oscillation (ENSO). Although ENSO is related to SST anomalies in the equatorial Pacific (Figure 2A), the primary effect on the Atlantic basin is the variation in the circulation pattern in the upper atmosphere.

El Nino patterns are associated with prevailing upper level westerly winds contributing to unfavorable vertical windshear. The result is

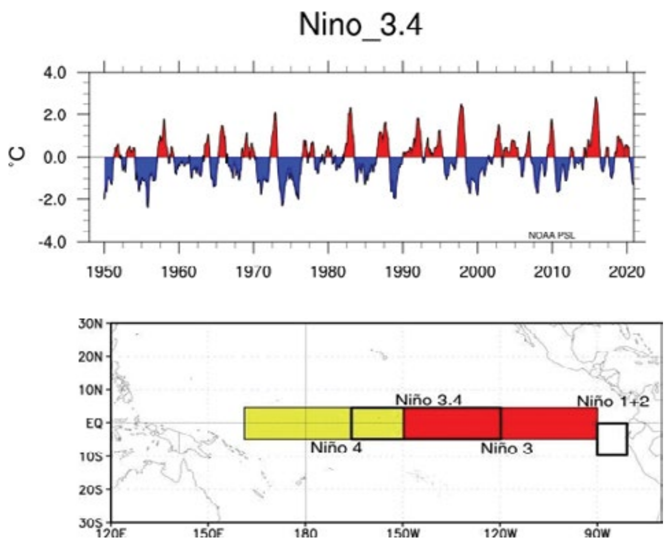

Figure 2: (a): Equatorial pacific SST anomalies (Region 3.4):1950-2020, (b): El Nino regions.

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Table 1: Atlantic Tropical Cyclones since 1851-2019.

AMO PHASE	Period (Years)	Tropical Storms	Annual Average	Hurricanes	Annual Average	Major Hurricanes	Annual Average	Anomalies
1851-1885 (CP)	33	241	6.9	173	4.9	34	1	1870, 1878
1886-1909 (WP)	24	215	9	124	5.2	36	1.5	1890, 1907
1910-1930 (CP)	21	130	6.2	81	3.9	31	1.5	1916, 1926
1931-1961 (WP)	31	353	11.4	183	5.9	80	2.6	1939, 1946
1962-1994 (CP)	33	290	8.8	175	5.3	57	1.7	1969
1995-2020 (WP)	26	403	15.5	192	7.4	90	3.5	1997, 2009*,2013

CP: Cold Phase; WP: Warm Phase* El Nino

Table 2: Atlantic tropical cyclones by decade: 1910-2019.

Decades	Tropical Storms	Annual Average	Hurricanes	Annual Average	Major Hurricanes	Annual Average	Anomolous Seasons
1910-1919 (CP)	61	6.1	37	3.7	14	1.4	1916
1920-1929 (CP)	71	7.1	41	4.1	15	1.5	1926
1930-1939 (WP)	115	11.5	53	5.3	22	2.2	1939
1940-1949 (WP)	104	10.4	54	5.4	19	1.9	1946
1950-1959 (WP)	119	11.9	68	6.8	32	3.2	
1960-1969 (CP)	95	9.5	62	6.2	28	2.8	1969
1970-1979 (CP)	95	9.5	50	5	16	1.6	
1980-1989 (CP)	93	9.3	52	5.2	17	1.7	
1990-1999 (WP)	111	11.1	64	6.4	25	2.5	1997
2000-2009 (WP)	151	15.1	74	7.4	36	3.6	2009 (El Nino)
2010-2019 (WP)	156	15.6	72	7.2	30	3	2013
2020-(WP)	30		13		6		

CP: Cold Phase; WP: Warm Phase

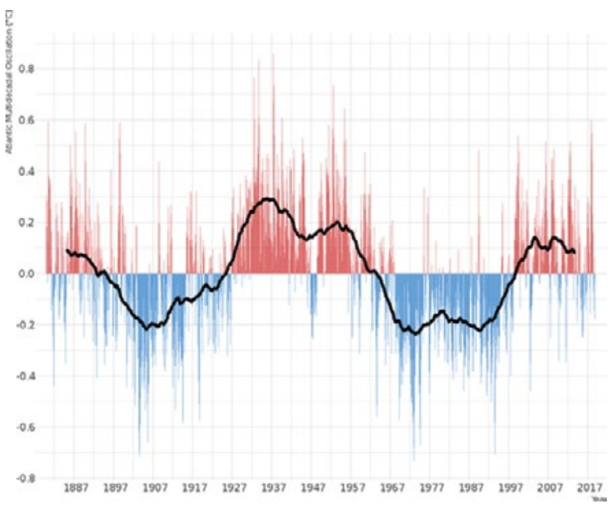

Figure 3: AMO warm and cold phases: 1887-2017.

typically an Atlantic hurricane season with fewer tropical cyclones. Conversely, a La Nina phase (reverse process) is characterized by upper level easterlies and weak vertical wind shear. This is conducive to an active hurricane season.

El Nino episodes typically last 9-12 months but can be as long as 2-4 years. La Nina phases usually range from 1-3 years. We are currently experiencing La Nina that officially began in the summer of 2020.

Atlantic Multi-decadal Oscillation (AMO)

One hemispheric cycle known as AMO (Atlantic Multi-decadal Oscillation) has a noticeable impact on the number of tropical cyclones in the Atlantic Basin. An examination of Atlantic SST's over the past 130 years reveals alternating warm and cold phases, each phase lasting approximately 2 to 3 decades (Figure 3). Warm phases are associated with above normal SST's and active hurricane seasons, while cold phases correlate with below normal SST's and fewer tropical cyclones (See Tables 1, 2).

We are currently in a warm phase which began in 1995.

Notes

1. Tables 1 and 2 do not reflect adjustments for unreported storms prior to 1965 resulting from lack of observational data in the pre-satellite era. (See Figure 1).

2. The current upward trend in global mean temperature began in the mid 1970's, and the increase in SST is most pronounced since 1990 (Figure 1).

3. Due to the above factors, when using tables 1 and 2 to examine the correlation between climate change and tropical cyclones, one should focus primarily on the period from 1970 through 2020.

DISCUSSION AND CONCLUSION

The combination of the 2020 La Nina and the current AMO warm phase is largely responsible for the record breaking 2020 hurricane season in the Atlantic, Caribbean, and the Gulf of Mexico. The season ended with 30 named storms, 13 hurricanes, and 6 major hurricanes.

Over the past 30 years there has been a substantial rise in Atlantic SST's and a corresponding increase in the number of tropical storms (Figure 1). Warming oceans have also contributed to increased rainfall from tropical cyclones and other storms.

A cursory examination of climate data might lead one to conclude that global warming is responsible for the increase in tropical cyclone activity since the 1970's. This conclusion would be premature however, since the climate signal is often masked by AMO and ENSO cycles, making it difficult to isolate anthropogenic warming from natural variability.

In addition, the effect of climate change on vertical wind shear and other inhibiting factors is not well known and needs additional study.

It is the author's opinion that there is not enough empirical evidence in the latest body of research to determine whether or not tropical cyclones will increase in frequency and intensity as a result of global warming.

Despite this uncertainty, the impact of global warming on day to day weather will continue to be in the forefront of academic research and public discourse.

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