

11C.5 A CURRENT REVIEW OF THE HISTORICAL INFORMATION ON TROPICAL CYCLONES IN CUBA.

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1. INTRODUCTION.

Among the severe events that affect the territory of Cuba, tropical cyclones are the most important. The economic and social development of Cuba, mainly of the City of Havana as the capital of the country and their neighboring sites, rendered possible the realization of meteorological observations and descriptions of the events related with the passage of tropical cyclones since the first half of the XIX century. The creation of the Observatory of the Royal College of Belén in 1858 and the National Observatory in 1906 allowed this work to be developed in a more systematic way and with a higher quality scientific approach. Diverse chronologies have been developed since the 1800's. However, the development of the knowledge about tropical cyclones and the accumulated historical information compelled to carry out new studies with the objective of obtaining a more precise chronology of tropical cyclones in Cuba. The present paper is dedicated to present a methodology and the way the analyses were carried out for listing tropical cyclones in Cuba from 1799 through 1998.

2. INFORMATION SOURCE AND METHODOLOGY.

The Rodríguez Ramírez (1976), Rodríguez Ramírez and Ballester (1985), Ortiz (1975) and Ortiz (unpublished) were utilized as the primary source of information on tropical cyclones affecting Cuba. However, others important sources were also taken in account, as Fernández de Castro (1872).

Hurricanes are the deadliest storms of the North Atlantic area. Their usually severe impacts and the nature of available data led consider for Cuba the period 1799-1998 for a reliable hurricane time series, covering exactly 200 years. A shorter period (1899-1998) was taken for tropical storms, being weaker storms with minor impacts and scarce historical description; a future work will attempt to extend backward this series. The main methodological aspect to consider is related with the definition of tropical cyclones directly affecting Cuba: any tropical storm or hurricane crossing over Cuba or neighboring seas or territories having sustained surface winds in some place of, at least, 17.4 m/s (1 min mean and 10 m over the ground). However, the instruments that have been used in Cuba to measure the wind speed are not capable for obtaining maximum sustained winds in a 1min interval. Then, it is necessary to estimate this value starting from the reported maximum gust (peak) using appropriate coefficients. The

exact values of maximum gusts began to be reported in the first years of the XX century and the spatial distribution of the anemometers in Cuba has not been sufficiently dense for detecting absolute maximum gusts due to the mesoscale character of this variable. Consequently, it is necessary to use data of minimum pressure as an index of the intensity of the hurricanes; these data are more frequent than those of maximum winds.

Landsea et al. (2001) have developed a new equation for the minimum pressure - maximum sustained wind relation. This equation is used to estimate the maximum sustained winds of hurricanes in Cuba when the values of minimum pressure are known and reliable maximum gusts are not available. Unfortunately, many pressure data associated to hurricanes in Cuba are not representative of the absolute minimum pressure because they were obtained in places located at certain distance of the center. Furthermore, it is necessary to take in account that in some cases (intense hurricanes) the needle of the barometer (aneroid type) frequently delayed when the pressure descended abruptly, resulting that the exact value of absolute minimum pressure is not known. In all these cases, an estimation of the minimum pressure corresponding to the center of the hurricanes is given through the equation of Schloemer (1956).

In spite of the combined use of maximum gusts and minimum pressures for the classification of the hurricanes hitting Cuba, the available information is not enough for all the cases. The analysis based on the available descriptions of damages caused by a hurricane is needful for the best knowledge on the characteristics of the storm. **Then, the criteria established to classify tropical cyclones in Cuba might be summarized in the following way:**

1. *For a tropical storm:*
 - 1.1. *Maximum sustained winds (1-minute mean) ? 17.4 and less than 33 m/s (estimated from the peak gust recorded) or:*
 - 1.2. *Minimum pressure from 991 hPa to 1007 hPa if the maximum gust is non available and/or unreliable, or:*

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1.3. *Some damages, at least, in shrubbery and breaks twigs off trees. Slight structural damage (poorly constructed signs).*

2. *For a hurricane:*

2.1. *Maximum sustained winds (1-minute mean) ? 33 m/s (estimated from the peak gust recorded), or:*

2.2. *Minimum pressure ? 990 hPa, if maximum gust is not available and/or unreliable, or:*

2.3. *Damages, at least, shrubbery, foliage, trees, poorly constructed signs; low-lying coastal zones may be inundated, minor pier damage and some small craft in exposed anchorage torn from moorings. The gradation of damages depends on the intensity of a hurricane. These aspects are taken into account when data of maximum winds and minimum pressures are non-existent or unreliable.*

The hurricane intensity scale of Rodríguez Ramírez (1985) and also the Saffir-Simpson scale (Simpson 1974) were utilized in the classification of hurricanes.

3. HURRICANES IN CUBA.

In the period 1799-1998, Cuba was affected by 104 tropical cyclones reaching hurricane category. The occurrence of hurricanes is most frequent in October and September; there were no cases reported in December through May (but some tropical storms hit Cuba during this last period). The highest frequency is reached in the interval September 21st - October 20th, covering about 41% of the total of cases. The number of cases for intervals of 50 years length is presented in table 1. The distribution of the hurricanes corresponding to their intensities is shown in Table 2.

Table 1. Hurricanes in Cuba (1799-1998). Stratification (number of cases) by subperiods of 50 years length.

SUBPERIODS	TOTAL
1799-1848	17
1849-1898	33
1899-1948	35
1949-1998	19
TOTAL	104

Remarkable category 5 hurricanes affecting western region are "La Tormenta de San Francisco de Borja" in October 11th of 1846 and the "Huracán sin Precedentes" in October 19th of 1924. The most intense hurricanes (categories 4-5 in Saffir-Simpson scale) were recorded in September (1 case), October (8 cases) and November (1case).

Table 2. Distribution (number of cases) according to intensity, using two different classifications.

RODRÍGUEZ RAMÍREZ SCALE	NUMBER OF CASES	SAFFIR SIMPSON SCALE	NUMBER OF CASES
Great Intensity	15	Category 5	2
		Category 4	8
Moderate Intensity	35	Category 3	14
		Category 2	26
Small Intensity	54	Category 1	54

CONCLUDING REMARKS.

Cuba has been affected by hurricanes in June through November, but mainly during the months of October and September. This study established a methodology as the primary base for a more precise chronology of tropical cyclones hitting Cuba, according to the historical information.

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