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THE CLIMATE OF PORTO RICO

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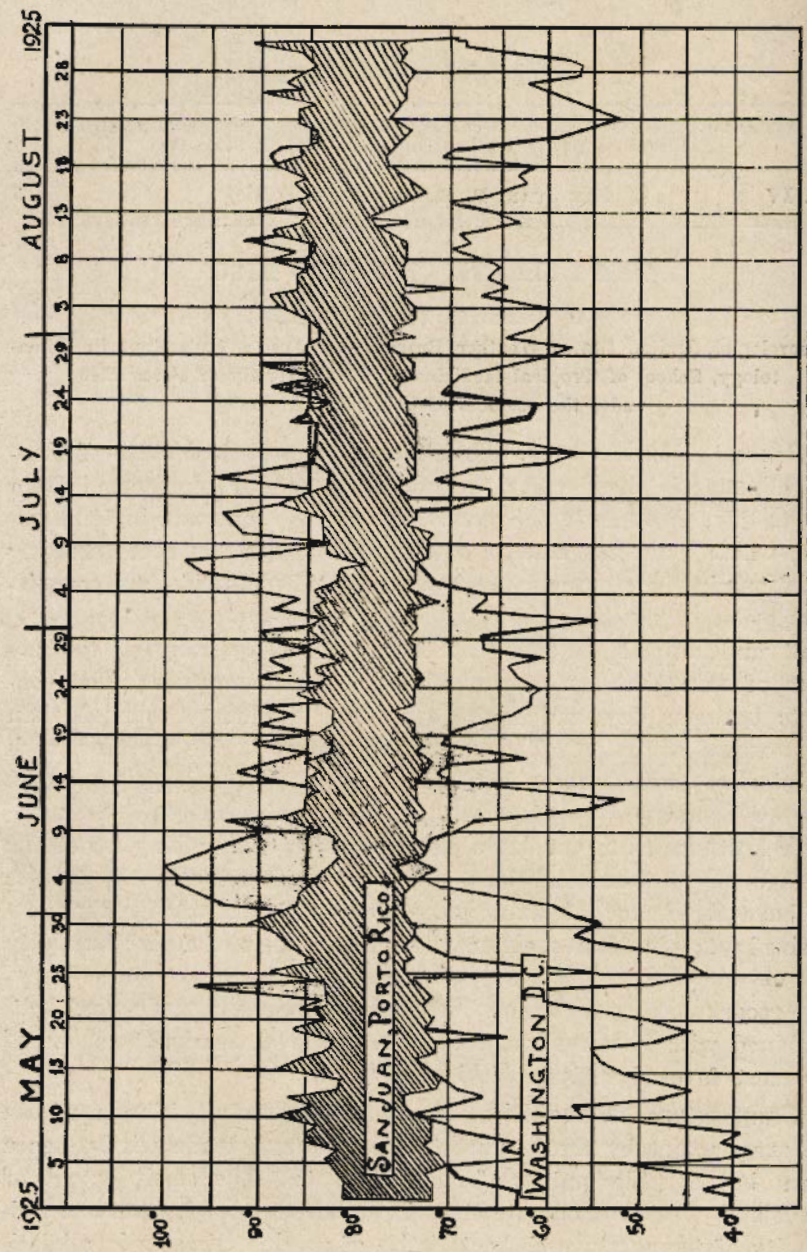
General Characteristics:—The most characteristic feature of tropical climates is the regular recurrence of similar phenomena from day to day, throughout the year. The strong contrasts in temperature, which mark the seasons of the north, with the accompanying variations in the abundance and character of plant life, are conspicuous by their absence in the tropics. The periodic recurrences in plant and animal life are determined more by rain or the absence of rain than by marked changes in temperature. The contrasts between day and night conditions are more marked than the seasonal contrasts. The irregular changes in the weather, such as storms, cold waves, hot waves, etc., which largely control weather conditions in the United States, are so infrequent in the lower latitudes as to cut but a small figure in the making up of the average of weather conditions. Next to uniformity in the tropics we have the factor of abundance—abundant heat, rather than excessive heat; abundant moisture, both in the form of a high humidity and of rainfall, and abundant and perennial plant and animal life. The geographical position of Porto Rico within the trade-wind belt, combined with its elevation above the sea level, marks it as one of the most favored regions within the tropics.

Temperature.—Porto Rico, in common with all islands within the areas swept by the northeast and southeast trade winds, has a warm but equable and comfortable climate. The small extent of the Island, with its moderate elevations above sea-level, insures a uniformity of temperature characteristics of marine climates in all latitudes. The carefully made daily observations of the United States Weather Bureau in fifty selected localities upon the Island cover a period of more than thirty years, a period sufficiently long, in the



DAILY MAXIMUM AND MINIMUM TEMPERATURES
SUMMER DAYS IN SAN JUAN, P. R., AND WASHINGTON, D. C.

tropics, to include all the variations in the temperature likely to be experienced in any portion of the Island.

The simplest expression for the temperature of a given region is the average temperature for a series of years, usually derived from daily observations of the highest and lowest readings of good thermometers. Such a record covering a period of more than 30 years at over forty selected stations shows a mean annual temperature for the Island, combining the records at all stations, of 76°, and during the warmest month of summer it is 79°.

The above values represent average conditions for the Island as a whole, coast stations and mountain stations combined. The figures will vary somewhat with elevation and other topographic conditions. For the towns situated upon the narrow coastal plain encircling the Island the average annual temperature is 78°, the average for January 75°, and for August 81°; at island stations the average annual falls to a minimum of 72°, with 69° during January and 75° during August. The lowest temperature are naturally those experienced along and near the summit of the main divide, at elevations varying from 2,000 to 3,000 feet; here the mean annual temperature falls below 72°. At Aibonito the mean temperature for the year is 71°, with a January mean of 68° and a mean for July or 74°; the highest mean temperature for July was 77° and the lowest January mean was 66°.

The small variations in the mean temperature noted in tropical localities are characteristics of the Islands within the tradewind belts. They are due to the slight difference in the elevation of the sun from season to season, to the small geographical extent of the land areas, and to the constant wind movement throughout the day and night. In the tropics the difference between the afternoon temperatures and the night temperatures is decidely greater than the difference between the mean summer and mean winter temperatures, while in the higher latitudes the annual range in temperature in nearly all cases is larger than the diurnal range. Relief from the heat of the day in the tropics may almost always be found in the comparatively low night temperatures. During the middle of the day the sun's rays are tempered by the increasing force of the wind and by the decreasing relative humidity, which always accompanies a rising temperature.

San Juan has a more equable temperature than any other portion of the Island, due to the fact that the city is almost surrounded by water—the ocean to the north and the harbor to the south. But

AVERAGE ANNUAL EXTREMES OF TEMPERATURE IN PORTO RICO

few of the cities and towns of Porto Rico were built upon the immediate coast; the coastal plain towns have their "playas" or beaches, but the towns themselves are located two or more miles inland, beyond the reach of chance shots from passing vessels in the early days of the Island's history. Hence the temperature records of the coastal towns show a diurnal range much greater than that of San Juan. The inland stations show a much larger difference between the early morning and the afternoon temperature.

To those accustomed to the strong climatic contrasts of the northern latitudes, the difference between winter and summer temperatures in the tropics seem small and insignificant; they are however, large enough to make a decided difference in personal comfort, especially at inland stations.

January is, on the whole, the coolest month of the year, although there is but a fraction of a degree difference between the mean values of January and February. From March there is a steady rise in the mean temperature, until a maximum is reached in August, generally, although frequently in July or September. The difference between the mean temperatures of July, August, September and October, are very slight, and probably are due to differences in the rate of wind movement, or variations in the amount of cloudiness. During the winter months the mean daily temperature is 75° to 76° along the coast, decreasing to 74° over most of the coastal plain. At stations farther inland the mean temperature ranges between 72° and 68°, depending upon the elevation above sea level. During the summer and early fall the mean temperature along the coast is 80° to 81°, although it frequently rises to 82° or 83° along the southeast coast. At the more elevated stations the mean summer temperatures vary from 76° to 74°. There is fairly constant difference of 6° to 8° between the coast temperatures and those of the higher inland stations throughout the year.

Rainfall:—The average annual rainfall for the entire Island is 71 inches. This value is based upon the records of 50 stations, covering a period of 25 years. The annual amounts vary greatly from year to year, and in geographical distribution. In 1901 the average amount for the Island as a whole was 94 inches, and in 1923, but 52 inches. The variations in geographical distribution are even greater. In the Luquillo Mountains, where rainfall is heaviest, the average annual amount exceeds 135 inches, with a maximum in 1901 of 169 inches; along portions of the south coast the average annual amount is less than 30 inches, with a minimum at Guayanilla in

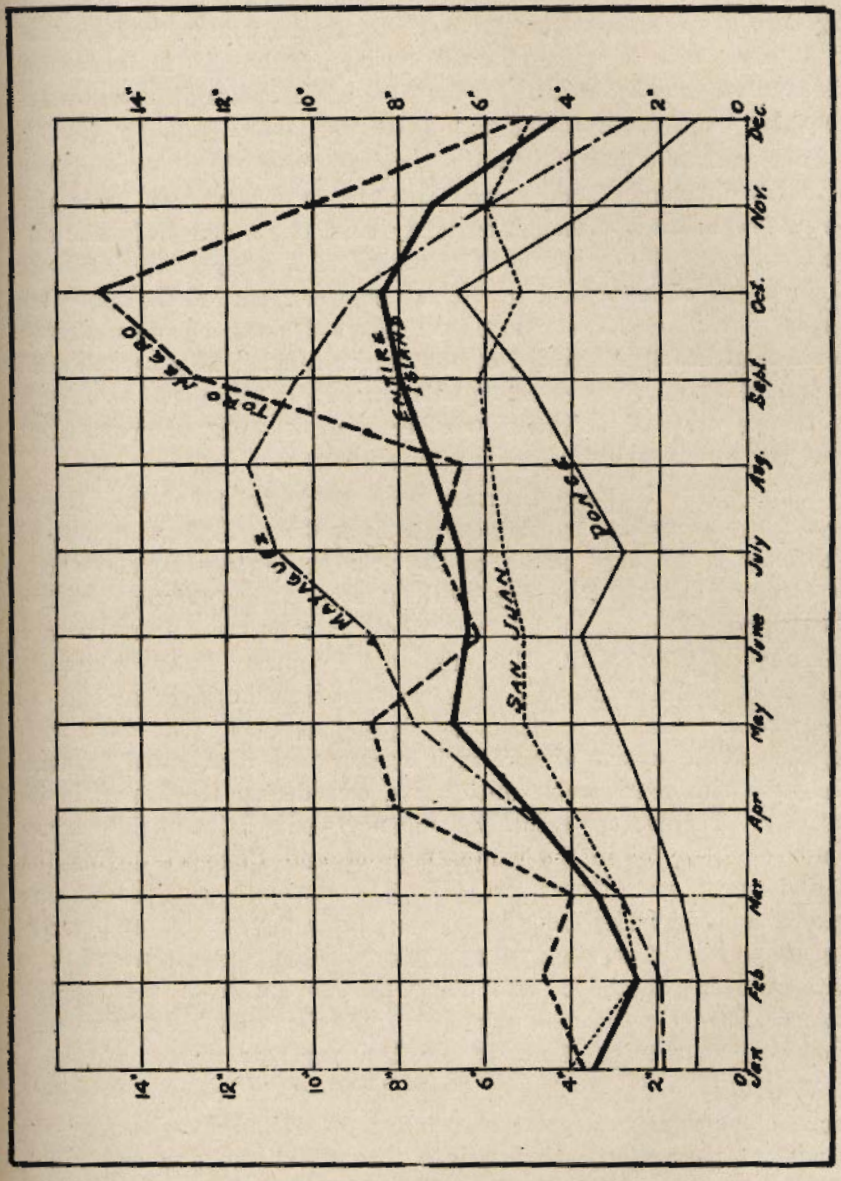
1921, of 10 inches. At stations along and near the south coast the average annual rainfall is about 35 inches: along the north coast, the average is about 60 inches. Along the west coast the rainfall is greater, the annual fall being 75 inches, while along the east coast and at inland stations the average increases to 85 inches. These variations in the annual rainfall are due to differences of elevation, and to the trend of the mountain ranges with reference to the prevailing winds.

There are three well-defined areas of heavy rainfall, in each of which the annual amount exceeds 100 inches: (1) The Luquillo Range, a heavily wooded and comparatively inaccessible region in the northeast portion of the Island; (2) the peaks about Adjuntas, near the southcentral part of the Island; (3) the mountains radiating from the western extremity of the main divide, in the vicinity of Las Marias and Maricao.

The most striking feature of the rainfall distribution is the contrast between the heavy and perennial rains north of the main divide and the light and irregular rains of the southern coastal plain. Over the north side, comprising over two-thirds of the entire Island, an abundant rainfall may be counted upon in all seasons of the year, and protected droughts are of rare occurrence; along the south coast the rainfall is not only comparatively light but unevenly distributed throughout the year, and periods of several months with little or no rain are frequent.

The irrigation system along the south coast has in great measure overcome the disadvantages of an insufficient and irregular rainfall. In the mountains, but a few miles distant, there is an abundant water supply, available at all seasons of the year, which can be carried to the coastal plain at comparatively small cost. The main divide has been tunneled at two points, and the headwaters of the La Plata and Toro Negro rivers are being carried across the divide to the cane fields on the south side.

There are no well-defined wet and dry seasons on the Island. The winter rains are comparatively light, with a minimum in February at practically all stations. From February there is a steady increase in the average monthly amounts through May. From May to November the differences in the average monthly amounts for the entire Island are small. The maximum generally falls in September along the east coast, in October along the south coast, in November along the north coast, while in the mountains of the interior the time of maximum occurs in one of the summer months or as early as



NORMAL RAINFALL FOR THE ENTIRE ISLAND OF PORTO RICO AND SELECTED STATIONS

May. The seasonal distribution of rainfall shows a steady increase, for the Island as a whole, from 11 inches in winter to 24 inches in autumn, with 15 inches for the spring months and 21 inches for the summer months, making up the total of 71 inches, in round numbers, for the average annual rainfall of the Island.

The rains of Porto Rico, while frequently very heavy, are usually of short duration. The average duration of a shower is generally but a few minutes, although on many occasions a series of intermittent showers will extend over a period of several hours. During the passage of a tropical hurricane, or when one of the more extensive north Atlantic storms passes eastward along a more southerly route than usual, the period of continuous rainfall may be extended to several hours and even throughout the day, or there may be several successive days of unsettled weather with frequent showers. But such storms are of comparatively rare occurence.

Rain occurs in some quantity, over some portion of the Island, practically every day in the year; it is probable that the month of February is the only month of the year having occasional periods of three or possible four days without some rain somewhere within the Island. For the Island as a whole rain occurs on the average 162 days in every year. The minimum frequency in any one year was 28 at Guánica in 1907, while the maximum has been as high as 341, at La Perla, in the Luquillo Range, in 1900. The days with rainfall to the extent of 0.01 inch or more are distributed through the year with considerable uniformity, considering the Island in its entirety. The average monthly frequency varies between the narrow limits of 10 to 14 in the winter months, and 15 to 17 during the period from May to November. Along the southern coast the average annual number varies from 75 to 100; along the western and northern coasts, and generally in the interior, the average number of days with rain is about 175, and along the eastern coast the number exceeds 200. On the eastern slope of the Luquillo Mountains rain occurs on an average of nearly 300 days per year.

Humidity:—The feeling of lassitude which is common to warm, moist climates is to a great extent dissipated in Porto Rico by the persistent blow of the trade winds throughout the day and night, supplemented by the daily play of the land and sea breezes. While the large amount of moisture in the atmosphere becomes oppressive during periods when the winds fall, it is extremely favorable to the growth and development of vegetation throughout the year. On the dry south side of the Island the heavy dews of the night and early

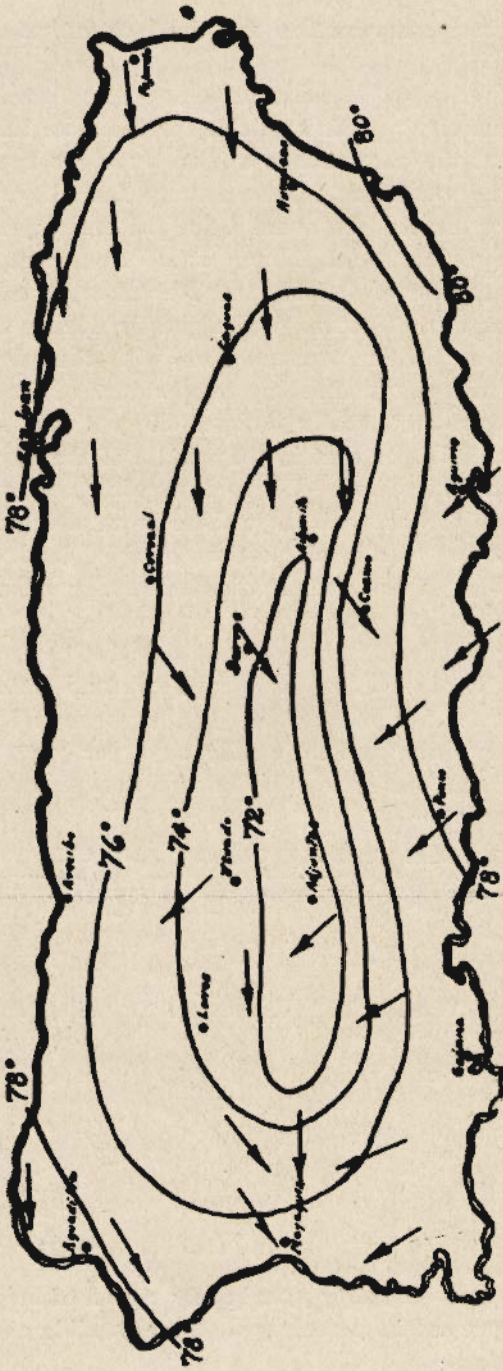
morning offer some compensation for the lack of rain. The high percentage of humidity also prevents the large and rapid fall of temperature during the night, so characteristics of drier climates. There are no official humidity records available for the drier inland stations of the Island, but the observations at San Juan are typical for the entire coast. The variations in the average humidity from month to month are not large. The average for the entire year is 78 per cent; during the driest month, March, it is 74 per cent, and during the most humid months of October and November, it is 80 per cent. The relative humidity, of course, varies greatly during the course of the day, falling as the temperature rises with the advance of the day, and rising with the diminishing temperature of the night. The diurnal fluctuations are usually between 80 per cent in the early morning hours and 75 per cent in the middle of the day.

Sunshine and Cloudiness:—While days with rain are frequent, and the rains are frequently heavy, there is an abundance of sunshine throughout the year in all portions of the Island. An inspection of the record of the comparative frequency of clear, partly cloudy and cloudy days will show a remarkable preponderance of clear and partly cloudy days over cloudy days. The record for San Juan, where hourly observations have been carefully maintained from sunrise to sunset for five years, shows on the average 139 clear days, 158 partly cloudy days, and 68 cloudy days per year. The variations at selected stations on the Island are shown in the following tabular statement:

RECORD OF CLEAR, PARTLY CLOUDY AND CLOUDY DAYS

Coast Stations	Clear	Partly Cloudy	Cloudy
San Juan	139	158	68
Ponce	125	168	72
Mayagüez	95	189	81
Humacao	170	42	153
Inland Stations			
Barros	220	108	37
Cayey	224	82	59
Coamo	216	53	96
Corozal	186	109	70
Lares	220	63	82

Bright Sunshine:—A thirty year hourly record of bright sunshine at San Juan, expressed in percentages of the possible amount, shows the following values:



MEAN ANNUAL TEMPERATURE AND PREVAILING WIND DIRECTION IN PORTO RICO

January	February	March	April	May	June	July	August	September	October	November	December	Year
62	68	68	63	59	61	63	68	62	63	61	63	64

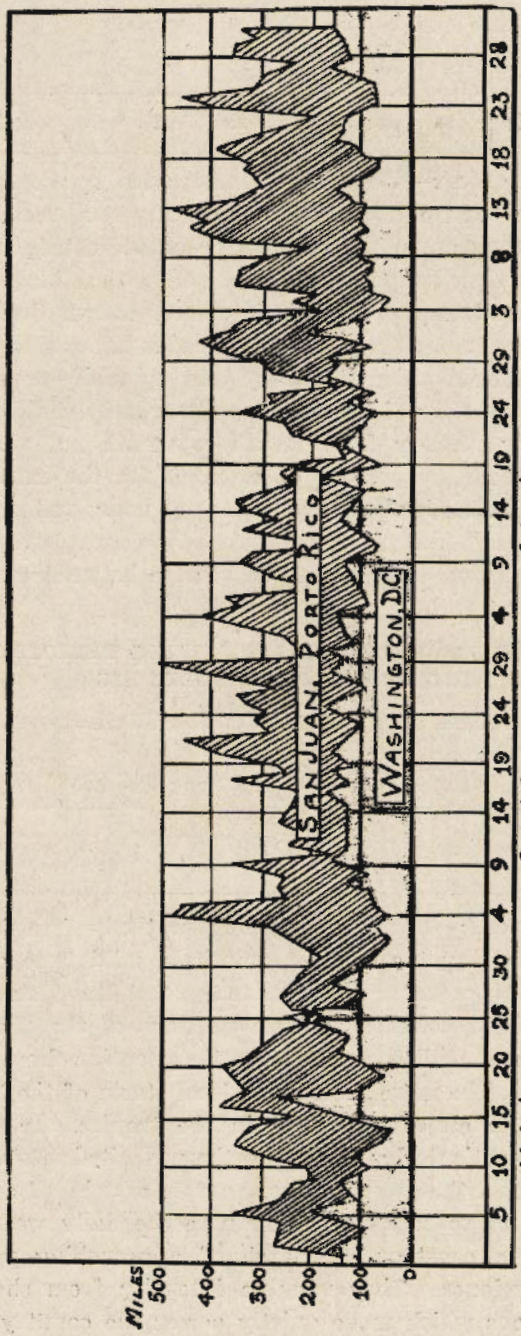
The Trade Winds:—The trade winds, aided by the daily recurrence along the coast of the cool, invigorating sea breeze, constitute a beneficient provision in the tropics for counteracting the enervating effects of a high temperature, combined with a large amount of moisture in the atmosphere. This is clearly shown during the occasional periods of a few days when the trades fail and light, variable winds prevail, accompanied by sultry and oppresive weather.

The average velocity of the winds is remarkably constant in Porto Rico, the hourly velocity from month to month not varying more than one mile from the average of 11 miles for the entire year, excepting in July, when it rises to 13 miles per hour, and in September and October, when it falls to 9 and 8 miles respectively. The prevailing direction of the wind throughout the year is between east-northeast and east-southeast.

AVERAGE HOUR VELOCITY AND PREVAILING DIRECTION OF THE WIND AT SAN JUAN, PORTO RICO
(Miles per Hour)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Velocity (25 years prevailing).	13	12	12.9	12.1	11.4	12.2	13.5	12.7	9.6	8 3	9 7	11.6	11.6
Direction .	ESE	ESE	ESE	ESE	ESE	ESE	E	E	ESE	SE	ESE	ESE	ESE

Tropical Storms:—Porto Rico is comparatively free from storms of all kinds. During the summer months a mild type of thunderstorm occurs with more or less frequency, but these storms seldom attain the intensity common to most portions of the United States during midsummer, and they attract little attention from the visitor from the north. The more destructive local storm of the type known as the tornado is almost unknown in the tropics. In the middle latitudes, and particularly in the northern United States, cyclonic storms pass accross the country from west to east in all seasons with such frequency as to completely dominate the daily weather conditions; there is a constant succession of approaching passing and disappearing cyclones. They vary in intensity from shallow barometric depressions which move quietly across the country producing



DAILY WIND MOVEMENT
SUMMER DAYS IN WASHINGTON, D. C., AND SAN JUAN, P. R.

only light winds and gentle showers, to storms of the greatest violence and of great geographical extent, at times covering more than half the area of the United States.

The tropics are singularly free from these cyclonic disturbances during the greater portion of the year, and there is a monotonous recurrence of similar weather conditions, interrupted only by light to heavy showers of short duration, or by the occurrence of a mild type of thunderstorm, or squall. During the months of July to October, however, that portion of the trade-wind belt containing the West India Islands and the Caribbean Sea, is subject to occasional visits from the destructive type of cyclonic storm known as the *West India hurricane*. These storms are similar in form and general character to the temperate region cyclones, but differ from them in being more restricted in area and in moving more slowly. Their general direction is from east to west, within the tropics, being carried along with the general westward drift of the tradewinds. They curve northward generally in the Gulf of Mexico, or over the Bahama Islands, and then recurve northeastward, either across the United States, up the east coast or over the Atlantic Ocean, where they can not be distinguished from the temperate region cyclones.

The recorded storms of this character within the limit of the area of the West Indies during the past 400 years number about 450, or an average of a little more than one per year. While they are liable to occur at any time from July to November, over 80 per cent of these storms during the past 50 years have occurred in the month of August, September and October. Porto Rico has been singularly free from the severer types of these storms. Only on three occasions in 50 years did the center of a hurricane pass over the Island—all of these in the month of August, namely, in August 1891, 1893 and 1899. By far the most destructive of these storms was that of August 8, 1899.

These storms generally first appear within the field of view in the neighborhood of the Windward or Leeward Islands, move in a direction between west and northwest at the rate of about 10 to 12 miles per hour, and then recurve to the northward and northeastward, increasing their velocity as they get into higher latitudes. The comparatively slow movement of these storms in the tropics is a fortunate circumstance, as it enables the official forecaster, after once locating the center, and determining the direction of movement, to give ample warning of their approach in the western waters of the Caribbean Sea and in the ports of the Gulf coast.