METEOROLOGY

OF

JAMAICA,

Including References to Sunshine Hours, Tides, Magnetic Declination, Standard Time, Sunrise and Sunset, Earthquakes, &c.,

WITH MAPS,

By

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January, 1936.

INTRODUCTION.

In the first Edition of the Handbook of Jamaica, for the year 1881, and in a subsequent publication, entitled "The Meteorology of Jamaica," by the late Mr. Maxwell Hall, M.A., F.R.A.S., F.R. Met. Society and Barrister-at-Law, (year 1904), quite an extensive range of subjects, appertaining to Meteorology and related matter, was dealt with, comprising instructions in the uses of the barometer and thermometer, as well as explanations of the terms such as vapour tension, precipitation, wind velocity, cloud formation and classification, including cyclones, which possibly met the requirements of over thirty years ago.

These treatises of the past included useful instructions for the maintenance of instruments and to their application to meteorology, to a limited extent, and to the need of persons interested in the pursuit of data for climatological or economic purposes.

On account of the yearly demand for these past compilations, there are very few copies remaining on hand, now, available on sale.

Consequently, owing to the great influx of visitors and tourists to this attractive Island, the need is apparent of issuing a revised Edition, bringing most of the subject matter up to date, as well as the inclusion of new subjects that have developed during the past thirty or forty years, which may embrace not only the study of Jamaica Meteorology, but also those of somewhat allied phenomena, such as local earthquakes, times of sunrise and sunset, tables of standard time in force around the Globe, tides, variation of the magnetic declination, twilight and that of the Constellation in the heavens known as the Southern Cross (Crux), when best visible in Jamaica.

Endeavour has been made to present this Treatise in a suitable, concise form, so as to facilitate convenient reference to each of the headings.

Should the reader be disposed to divert his reflections from the prosaic series of facts and figures embodied in the Tables in this Treatise, to the more sublime realization of the many attractions which the Island offers, it would not be in vain if the following expressions evolved from the pen of the Secretary of the Tourist Trade Development Board, Mr. Philip P. Olley, F.C.I.S., be quoted.

The Visitor or the Health Seeker to Jamaica, who may, already, have held visions of the charms of this Tropical Isle, are invited to fully absorb the word-picture conveyed in the following extracts:—

"Discovered in the year 1494 by Christopher Columbus, Jamaica—the most important British West Indian Island—offers an historic story of great interest—a colourful pageant of stirring events: The Spanish occupation, . . . passing of the aboriginal Arawak Indians . . . Conquest of the Spaniards by British forces . . . desperate deeds of Buccaneers and Pirates . . . the rise and fall of Port Royal (the "richest and wickedest city on earth") . . . the romance of the Caribbean Sea —"cradle of the British Navy."

"To-day may still be seen Spanish Town—the old city originally laid out by the Spaniards, with the oldest Cathedral in the Colonies—the "Valhalla of the British West Indies"; the memorial commemorating the victory of Rodney over De Grasse: and the tomb of Brave Benbow in Kingston Parish Church. A picturesque stage for a New World drama of colonial enterprise, Jamaica—"The Brightest Jewel in the British Crown"—has now become one of the world's premier tropic tourist resorts."

"Jamaica—Isle of Springs, land of sunshine and beauty; a feast of loveliness for the artist, the lover of the romantic, the seeker after health and re-vitalisation, the tourist in general.

"At any given altitude the temperature is wonderfully consistent, day and night, and its seasonal variations throughout the year, are very slight. Some parts of the Island are comparatively dry. In other parts there is a moderate, or fairly heavy rainfall, which gives life to rich and varied vegetation, where the coconut, the banana and numerous other tropic fruits grow to perfection.

"Throughout the year Jamaica offers a breeze-cooled ozone-laden air, charged with the vital sun-elements and he—especially the lover of a warm Clime—who ventures forth to stay awhile in the charm of this tropic isle, will add an experience to his treasure store of places visited and climates sampled, that will be a source of pleasant fire-side thought long after the vacation is over and wintry days come round again. And there will be few who visit this dreamland once who will not desire to re-live golden hours stolen from the work-a-day world."

(1) TEMPERATURE —FAH.°.)

The Island of Jamaica is Geographically situated in Latitude about 18° North, and Longitude about 77° West of Greenwich, in the Caribbean Region—comprising an area of 4,450 square miles. Owing to the varying altitudes of the mountain topography, from the sea level to a height of about 7,400 ft. where the Blue Mountain Peak is reached, which rises on the borders of the parishes of Portland and St. Thomas, there is experienced a fairly wide difference of mean temperature, amounting to about 23° Fah., from sea level to this Peak.

At Kingston, near to the sea level, the annual mean surface temperature, based upon 33 year's observation, gives 79° Fah., and at the Blue Mountain Peak the mean, derived from observations conducted between January, 1889 and December, 1895 (7 years), is 56° Fah., therefore, shewing that for about each 320 feet rise in altitude there is a corresponding fall in temperature of, approximately, one degree.

Along the coast line of Jamaica, the monthly *range* of temperature is found to be somewhat greater than at places situated at a high altitude. For example at Kingston, for the year, the mean daily range between the mean maximum and minimum temperatures is about 17° (88°-71°) whereas, at Hill Gardens (formerly Cinchona Plantation) to the N.E. section of St. Andrew, at an altitude of 4,900 ft., gives about 12° range.

At Kingston, the mean temperature derived from four observations per day for 33 years, the coolest month, which is February, shews 75.7°, and the warmest, which is July, shews 81.4° or an annual range of about 6°, only. By adopting the mean rate of 1° fall in temperature for each 320 ft. rise in altitude, the general mean temperature at such mountain resorts as Moneague, St. Ann (900 ft.) would be possibly 76°. Mandeville, Manchester (2,130 ft.) may be estimated at 71°, and Malvern. St. Elizabeth, about 2,000 ft., also at about 71°.

The maximum temperature usually occurs between Noon and 2 p.m., and the minimum temperature just shortly before sunrise. For a period extending over the past 55 years, from 1880 to 1934, the highest maximum recorded at Kingston was 97.8° on August 11th, 1923, and the lowest minimum 56.7° on December 4th, 1887. In the case of this high maximum there was about at the same hour the lowest relative humidity on record, of only 27% observed at 3 p.m. it was a very dry day, giving a day's mean of 46%. The rainfall at Kingston during this August of 1923 was only 0.77 inch for the month.

In the 33-year Table for Kingston, the mean highest maximum temperature is found in the months of July and August, giving 89.8°. On the other hand the mean lowest minimum occurs in the month of February, with 67.3°, when the coolest early morning land breeze is experienced. But later on in the year, as in August and September, the early morning temperature mean rises to 73.5°, or about 6° higher. The mornings then are not, therefore, so pleasant. In February, the mean maximum temperature falls to 85.8°, or 4° less than in July and August.

The formula employed by the late Mr. Maxwell Hall (Government Meteorologist) for obtaining the mean Fah. temperature for the day, is as follows:—

Let t_1 = 7 a.m. temperature; t_2 = 3 p.m. temperature; max. = maximum, and min. = minimum temp. Then T = mean temperature for the day.

$$T = \frac{t_1 + t_2 + \text{max.} + \text{min.}}{4} - 0.5°$$

This method has been in use ever since the year 1881.

As Jamaica is for the greater portion, a very mountainous country, ranging in altitude from sea level to over 7,000 ft., the subjoined Table of Annual Mean Temperatures may be of some interest.

As the temperature varies, nearly, according to height above the sea, it would prove useless to construct an isothermal map, as the lines of equal temperature would follow more or less the contour levels of heights.

Column 1 gives the successive altitudes, and Column 2 the mean temperature to be expected at different levels; 3, 4 and 5 follow the Mean Maximum, Minimum and Range.

Average Annual Temperature at Different Elevations in Jamaica.

Altitudes above sea-level (1)	Mean Temp. (2)	Mean Max. (3)	Mean Min. (4)	Mean Range. (5)
Feet.	°	°	°	°
0	78.7	87.6	71.0	16.6
500	77.1	85.1	69.8	15.3
1000	75.3	82.8	68.6	14.2
1500	73.6	80.6	67.4	13.2
2000	72.0	78.6	66.1	12.5
2500	70.3	76.7	64.7	12.0
3000	68.7	74.9	63.3	11.6
3500	67.1	73.2	61.7	11.5
4000	65.5	71.6	60.1	11.5
4500	64.0	70.1	58.5	11.6
5000	62.4	68.8	56.8	12.0
5500	61.0	67.5	55.0	12.5
6000	59.5	66.3	53.1	13.2
6500	58.0	65.2	51.2	14.0
7000	56.5	64.3	49.3	15.0
7500	55.1	63.6	47.3	16.3

This Table is taken from the "Meteorology of Jamaica," by Maxwell Hall, published by the Institute of Jamaica, Year 1904.

On account of the advent of Aircraft for passenger travel aloft, a Table giving the successive temperatures Fahrenheit, at more increasing altitudes may prove interesting. The following is extracted from a Table appearing on Page 109 of Elementary Meteorology, by W. H. Pick, B.Sc., (1930), giving the Equatorial temperatures at heights varying from sea level to about six miles.

Heights.		Degrees.
Kilometres.	Feet.	Fahrenheit.
10	32,800	— 36.4
9	29,500	— 22.0
8	26,200	— 7.6
7	23,000	+ 5.0
6	19,700	17.6
5	16,400	30.2
4	13,100	42.8
3	9,800	53.6
2	6,600	62.6
1	3,200	71.6
0	0	+ 80.6

(2) RELATIVE HUMIDITY.

Before entering upon the subject of the Relative Humidity determined usually at about four feet above the surface of the ground for different places widely apart—it seems desirable for individuals who may be not quite familiar with the question to be instructed as to the type of instruments employed, as well as to the definition used concerning the term "Relative Humidity."

The instruments in general use are a combination of two thermometers, of nearly similar construction, placed vertically about 4 inches apart on a stand; one thermometer is described as the "Dry," shewing the air temperature, and the other the "Wet" which is fitted with an envelope of muslin over its bulb proper, secured from which extends a short length of cotton wick leading into an adjacent small vessel containing distilled water. The object of this contrivance is to keep the "wet bulb" moistened, so that when the air is fully saturated, both thermometers read alike, but when the air is conditioned as dry, the thermometer with wetted muslin, owing to rapid evaporation of the water, falls in temperature, and therefore, cools the wet bulb. The dryer the air the greater the difference in reading between the dry and the wet bulb. A great range of different readings is experienced. If the air be very dry, the air temperature may read say 90° Fah., and the wet bulb indicates 75° (or 15° difference); under such circumstances the relative Humidity is low: about 48%. When the temperatures indicate alike, as during heavy rains, the air is fully saturated and the humidity becomes 100%. There are other types of hygrometers in use such as the psychrometer which revolves a wet bulb, and the hair

hygrometer which operates upon a different principle, whereby the human hair is employed, which tends to become longer with increase, and shorter with a decrease of humidity. Hemp rope, on the other hand, contracts with the increase of moisture, and lengthens with dryness. But the Dry and Wet bulb type of hygrometer is more in general use.

A brief elucidation will now be given as to the meaning of the term "relative humidity," used under this heading, as otherwise it may appear somewhat confusing to some. By way of illustration, we will take the case of the dry bulb (or air temperature) reading 70° Fah., and the wet bulb reading 68°, or 2° less. From the Tables published, a relative humidity of 90% is derived, but if it will be found, during the warmer hours of the day that the dry bulb indicates say 86° Fah., and the wet bulb reads 76° (or 10° difference), the relative humidity drops to 62%; this shows 28% lower than the 90%. In the former case the 90% means that the surrounding air needs 10% more water vapour for the point of saturation to be reached; and in the latter case of 62%, being much drier, would require 38% more water vapour for saturation. It merely demonstrates that by the air becoming more heated its capacity to absorb vapour is greater than when the temperature is lower, for the capacity to absorb becomes less until the difference reaches Zero.

But, besides this, it must be borne in mind that we are dealing only with the capacity of the air to absorb more vapour, and attention must be drawn to the fact that the amount of actual vapour contained in the air (absolute humidity) in these two instances is almost identical, and if measured or weighed will be found in each case to contain about 7 grains of moisture per cubit foot —even in the case where the Dry and the Wet bulbs read 66° Fah. alike during rain, the amount of vapour present in the air is kept at about 7 grains per cubic foot of air. It is only in cases when the dry bulb, as well as the wet bulb, read so high as say 83° Fah. the vapour content reaches to 12 grains per cubic foot, but this is very rare.

From the records of 33 years of observation made at Kingston, it has been found that the annual mean relative humidity (derived from the combination of the daily 7 a.m. and 3 p.m. readings) gives 78%, the 7 a.m. reading giving 82% and the 3 p.m. 69% being means for the year. Approximately, the 7 a.m. being 3% above the normal and the 3 p.m. 11% below the normal. The value of the normal 78% was computed by the late Mr. Maxwell Hall from the figures obtained some years ago, of a series including the 7a.m., 3 p.m. and 11 p.m. daily readings. The means of these were accepted as being the mean for the day. March and July gave the lowest, with 76%, and October, a rainy month, the highest, with 84%.

As there are but a few other places in Jamaica reporting the relative humidity data, the following three stations are the only typical ones available which give the annual means. A five-year period; 1930-1934 is herewith shewn:

	7 a.m.	3 p.m.
Morant Point, 8 ft. Altitude, East Jamaica.	82%	76%
Negril Point, Altitude 33 ft., West Jamaica.	84%	72%
Hill Gardens, Blue Mountains, Altitude, 4,900 ft.)	88%	87%

At a glance it will be apparent from the above that at Morant Point the 3 p.m. figure is only 6% below the 7 a.m., owing no doubt to the hourly persistence of the Easterly Trade Wind. Negril Point shows the 3 p.m. 12% below the 7 a.m. which is not so exposed to the continued Easterly Trade Wind. Then, at Hill Gardens, which is at a very high elevation (4,900 ft.) shews the 3 p.m. as only 1% below the 7 a.m. owing to the very low afternoon temperature, rendering the percentage result much higher than it would have been at places near to the sea level.

The following Table is given of Relative Humidity percentages, for seven widely separated places, arranged in the order of Latitude, commencing with the higher Latitudes (51° N. and ending with 7° N.) in the event of comparisons being desired.

Table of Relative Humidity, percentage, at seven different places over the Globe for the purpose of comparison, arranged in the order of Latitude North, commencing with 51½ and decreasing to 7° North.

Month.	London, England 51° N.	Montreal, Canada 45° N.	New York U.S.A. 41° N.			Havana, Cuba 23° N.	Honolulu, U.S.A. 21° N.			Kingston, Jamaica. 18° N.		Colombo, Ceylon 7° N.
	24 hours means.	24 hours means.	8 a.m.	noon.	8 p.m.	24 hours.	8 a.m.	Noon.	8 p.m	7 a.m.	3 p.m	24 hours.
January	88	79	73	61	68	74	71	64	72	85	66	74
February	82	77	72	61	66	72	70	62	72	83	66	72
March	79	75	71	55	64	70	69	62	71	82	66	73
April	75	67	69	53	63	69	67	62	71	79	68	76
May	73	66	71	54	65	72	66	60	70	78	72	79
June	73	70	74	57	68	75	66	60	70	78	70	80
July	73	71	75	59	69	73	66	60	69	77	67	80
August	76	73	77	61	71	75	67	60	70	80	70	78
September	79	75	78	61	71	78	67	60	70	84	73	78
October	85	75	75	58	68	77	68	62	71	87	74	80
November	86	78	74	61	68	75	70	64	72	87	71	79
December	86	80	73	62	68	74	72	65	73	86	67	75
Means for the year	79	74	74	59	68	74	68	62	71	82	69	77

In addition to the preceding Table, for seven different places, the following more extended Table consists of thirty places, also widely separated, giving the mean relative Humidity percentage, for the three years (1931 to 1933). The figures given refer to the forenoon means for the entire **year, and are derived from the Meteorological Magazine, London.**

Table of Relative Humidity percentages.

THREE-YEAR NORMALS.

	%		%
London (Kew) ...	86	Singapore ...	80
Gibraltar ...	82	Hongkong ...	76
Malta ...	74	Sandakan ...	83
St. Helena ...	94	Sydney (N.S.W.) ...	71
Sierra Leone ...	83	Melbourne ...	70
Nigeria (Lagos) ...	84	Adelaide ..	55
Nyassaland ...	65	Coolgardie ...	53
Rhodesia, Salisbury ...	58	Brisbane ...	66
Cape Town ...	77	Hobart, Tasmania ...	66
Johannesburg ...	54	Wellington, N.Z. ...	76
Mauritius ...	71	Sava, Fiji ...	80
Calcutta ...	86	Samoa ...	78
Bombay ...	78	Jamaica, Kingston ...	82
Madras ...	76	Toronto ...	74
Ceylon (Colombo) ...	77	St. John, N.B. ...	78

It has been the custom to employ the term "Relative Humidity," denoting a percentage value above Zero, of which zero signifies the complete absence of water vapour in the air surrounding the hygrometer in use. But as the limit of complete saturation is taken as 100%, it establishes the fact that beyond 100% is not possible. It would, therefore, appear more comprehensible if the humidity value be expressed as a percentage below the 100%, or saturation point. Instead of, for example, stating 83% of Relative Humidity, it would be more convenient if 17% below saturation point be substituted.

(3) RAINFALL.

It is generally recognized that there are two well-defined recurring rainy "seasons" for the Island during the year and are described in one case as the "May season" occurring about six weeks after the Vernal Equinox of March 22nd, and the "October season" making itself felt about a month after

the Sept. 21st, or the Autumnal Equinox. These are the two maxima periods of rainfall. The month of May giving a mean Island rainfall of 8.77 inches, and that of the month of October giving a mean rainfall of 10.21 inches. There are also two minima of rainfall, one in February with 3.35 ins., and the other in July with 4.75 ins. These figures are derived from the 60-year normals. But there are years when a deficiency departure occurs and the season's rainfall fails to identify itself.

Distribution.

The mean annual rainfall for the Island, computed from the 60-year data gives nearly 74 inches, having a mean of 122 days with rain.

From a 10-year Table recently prepared, it is shewn that the distribution of annual rainfall, in inches, for each Parish, arranged in the order of sequence, is as follows, fractions are omitted:—

Parish.	Inches.	Parish.	Inches.
Kingston ...	30	St. Andrew ...	68
Clarendon ...	60	Manchester ...	71
Trelawny ...	62	St. Thomas ...	80
St. James ...	64	Hanover ...	81
St. Catherine ...	65	St. Mary ...	84
St. Elizabeth ...	66	Westmoreland ...	84
St. Ann ...	66	Portland ...	136

The Parish of Portland gauged the highest with 136 ins., and Parish of Kingston, the lowest, with only 30 ins. About three-quarters of the Island area receives an annual mean precipitation ranging from 60 to 100 inches, for the most part in the mountainous region.

Generally, the driest month is February, shewing an annual Island rainfall mean of about 3 inches, whereas the wettest occurs in October with a little over 10 inches.

Along the Southern Coast, from Morant Bay proceeding westerly to Black River, and in the Northern section from Dry Harbour to Montego Bay, the annual rainfall mean is from 30 to 60 ins. In times of drought this extent of country suffers more acutely than in the hilly parts. February, for the Island, shews the least number of days with rain as 7, whereas October, the most, with 14. The annual mean being 122.

During the past 65 years the least annual rainfall was 45 ins. in the year 1872; and the most, 116½ ins., in the year 1933, with a mean of 138 rainy days.

The least monthly Island rainfall occurred in the year 1920, in March, with merely 0.29 inch, as against a normal of 3.35 ins., which is equivalent to about one-twelfth of the normal. Then, on the other hand, the greatest monthly rainfall occurred in 1933, in October, with 28.43 ins., as compared with the normal 10.14 ins., equal to nearly three times the normal.

For individual stations an excessive *annual* precipitation has appeared in the Table for 1931 (Weather Report 667) where at Millbank, in the Parish of Portland, a total of so much as 335.37 inches was measured, and followed by 326 inches at Moore Town, 600 ft. altitude, in the same year. Then, during a short period from 4th to 11th November 1909, very excessive rain occurred at Silver Hill Plantation on the Blue Mountain Range, at an altitude of 3,500 ft. when an aggregate of 135 inches was recorded.

During the excessive flood rains of August, 1933 there was a heavy hourly rate of fall at Kingston on August 15th to 16th, just after midnight when over four inches fell in one hour. But for the absence of other automatic recording instruments, probably much greater hourly rates would have been observed at such other station.

The following gives the varying characteristics of each month's mean Island Rainfall:—

Monthly Changes—Climatological.

January—Precipitation is more confined to the Northeast section (Portland and St. Mary) where it sometimes has heavy "winter rains"—and less marked along the Northern Coast towards Trelawny. The Southern Section of country is relatively dry with about a quarter that of the NE. Division.

February—The "winter rains" almost cease, for only at very high altitudes, such as the Blue Mountain Peak are found recording much rain. This is the driest month of the year, when the mean Island rainfall falls to 3.13 ins.

March—The NE. Division continues with a somewhat reduced rainfall, but the West-Central Division begins to increase its mean to 4.25 ins. The Southern and Northern Division remain still deficient, with an average barely over 2 ins.

April—The West-central Division improves in rainfall, from 4.25 ins. in March to 6.82 ins. in April. The North-eastern Division also increases from 4.61 ins. to 5.80 ins. in April, and the Rivers to Westward present higher levels of flow. The Southern and Northern Divisions, gauge only a little over 3 inches.

May—Relatively heavy rains occur in the West-central Division. The Parishes of Hanover and Westmoreland total about 11 inches, also Portland in the NE. Division maintains up to 9.96 ins. The remainder of the Parishes also benefit by the May "Seasons," with rainfall varying from 5.30 inches in St. Thomas to 8.79 ins. in St. James. The mean Island Rainfall is 8.77 inches for May based on the 60-year average.

June—This month shews a little decrease to an Island mean of 6.53 ins. The West-central and the North-eastern Divisions record about 8 ins., whereas the Northern and Southern Division shew about 5 ins. Hanover, to the Westward, appears to shew much above the Island normal with 10.83 ins., followed by Westmoreland with 8.58 ins.

July—The Island normal for July gives less than June, with 4.75 ins. But the West-central records 7.56 ins. as the highest, and the Southern Division, the least, with only 2.99 ins.

August—During this month enters the hurricane period, and the annual mean rainfall again increases to 6.93 ins. But in this month the West-central Division shews the greatest total of 10.17 and the Northern Division with only 4.89 ins.

September—The rainfall for September further improves to an Island mean of 7.94 ins. But the West-central again claims the greatest with 10.99 ins.—whereas, the Northern shews only 5.89 ins.

October—This month is recognized as producing seasonal rains over the entire Island. Here we have the West-central, claiming the greatest, with 12.31 ins., followed by the North-eastern with 11.72 ins.—then the Southern with 9.24 ins., and lastly the Northern with 7.57 ins. On the whole the mean Island Rainfall for 60 years shews 10.21 ins.

November—Presents a falling off to 8.29 ins. for the Island. The North-eastern Division claims 15.52 ins. when the "Winter Rains" commence to appear. The other Divisions shew between 5 and 6 inches.

December—This is a dry month on the whole. The NE. Division is, however, the wettest with 10.32 ins., and the least is shewn as 2.19 ins. in the Southern Division. The Island Mean Rainfall for December gives 5.20 inches.

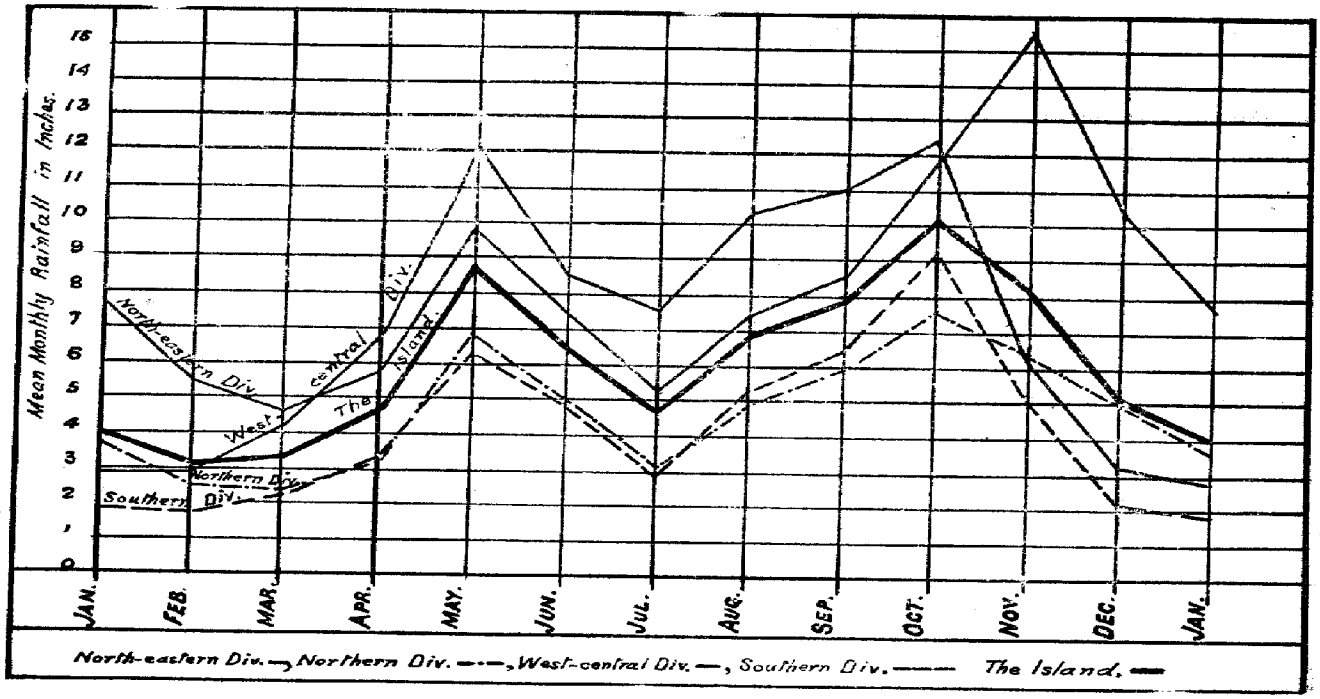
A Table follows shewing the average rainfall for each Division and for each month for the 60-year period, with a Diagram on page 8, also a Map A, on page 10, giving the location of the four Divisions.

MONTHLY AVERAGES OF EACH DIVISION OF THE ISLAND RAINFALL.

Division.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
North-eastern . .	7.68	5.48	4.61	5.80	9.76	7.51	5.25	7.41	8.48	11.72	15.52	10.32	99.54
Northern . .	3.67	2.48	2.37	3.17	6.90	5.10	3.19	4.89	5.89	7.57	6.42	5.03	56.68
West-central . .	2.80	2.84	4.25	6.82	12.06	8.57	7.56	10.17	10.99	12.31	6.21	3.26	87.84
Southern . .	1.83	1.72	2.19	3.28	6.35	4.93	2.99	5.27	6.42	9.24	5.01	2.19	51.42
Island Means . .	4.00	3.13	3.35	4.77	8.77	6.53	4.75	6.93	7.94	10.21	8.29	5.20	73.87

If the mean annual rainfall for the 60-year period be taken as 73.87 inches, and the mean annual number of rainy days as 122, a mean rainfall of 0.61 inch per rainy day is derived.

Diagram shewing the monthly means of the Divisional and Island Rainfall.



KINGSTON RAINFALL.

The Kingston mean annual Rainfall derived from a 60-year Period gives 31.57 inches. The month of October records the most with 7.11 ins. and February, the least, with 0.61 inch. The mean annual number of rainy days is 79.

The annual rainfall records at the Public Works Office, Kingston, present a wide range of results (no doubt similarly found at most stations) giving an extreme minimum of only 8.50 inches, with 63 rainy days, in the year 1914, being a year of great drought, to an extreme maximum of 78.58 inches, with 105 rainy days, in the year 1933, being a year of great floods and abnormal number of hurricanes in the Caribbean region.

It may prove valuable to state that the mention of a day's rainfall does not signify that rain fell during the entire 24 hours, for it is generally recognized that a day of rain must gauge any precipitation ranging from 0.01 of an inch and upward. The following examples have been selected, for the purpose of comparison, by presenting a year of normal total rainfall of the year 1935, as well as that of the abnormal maximum, occurring in the year 1933.

The following Table, referring to Upper Kingston, about one mile to the northeast of the rain gauge installed at the Public Works Office Building, will give the relative conditions.

UPPER KINGSTON—(East Street.)

Year.	Total rainfall.	Total days of rain.	Total hours of rain.	Converted into days.	Mean rate per hour.
	Ins.			Days. Hrs.	Inch.
1935 (normal) . .	32.23	79	145	6 1	0.23
1933 (abnormal) . .	85.93	117	406	16 22	0.21

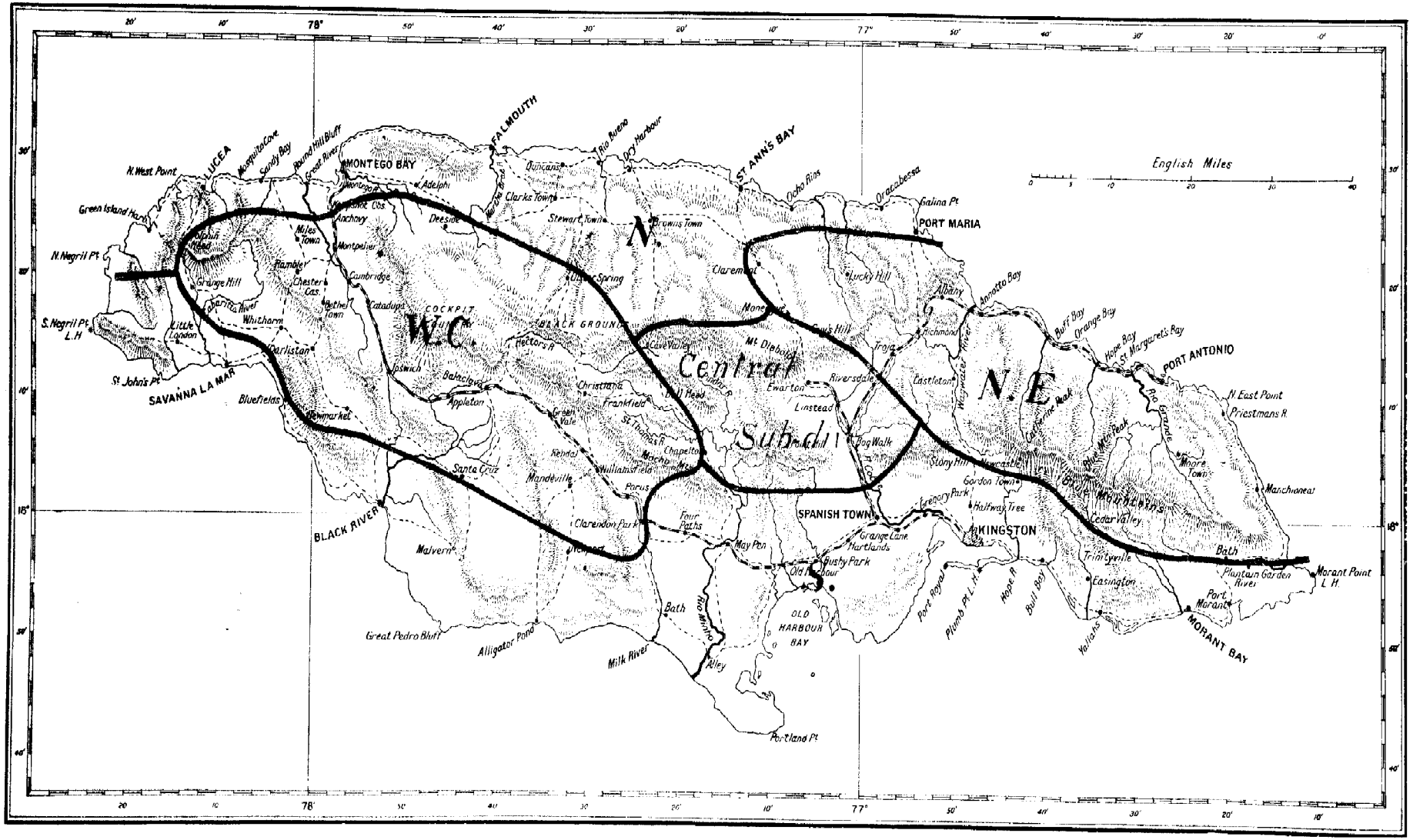
By the results it will be seen that during these two years, the mean rates of hourly rainfall, coincide fairly well with each other, notwithstanding the fact that the year 1933 recorded an aggregate fall of nearly three times that of the year 1935.

In the notes made of the dates of precipitation, it was found that there are occasions experienced when with very light rain only 0.01 of an inch has been gauged in one hour, and upon another record so much as 4.00 inches (Aug. 1933) fell in one hour: equivalent to 400 times greater rate.

Furthermore, taking the normal year 1935, it is given in the Table that there were in the aggregate 145 hours of rain, which represent about 1.6% of the entire number of hours, of 8,760, in a

(A) MAP OF JAMAICA,

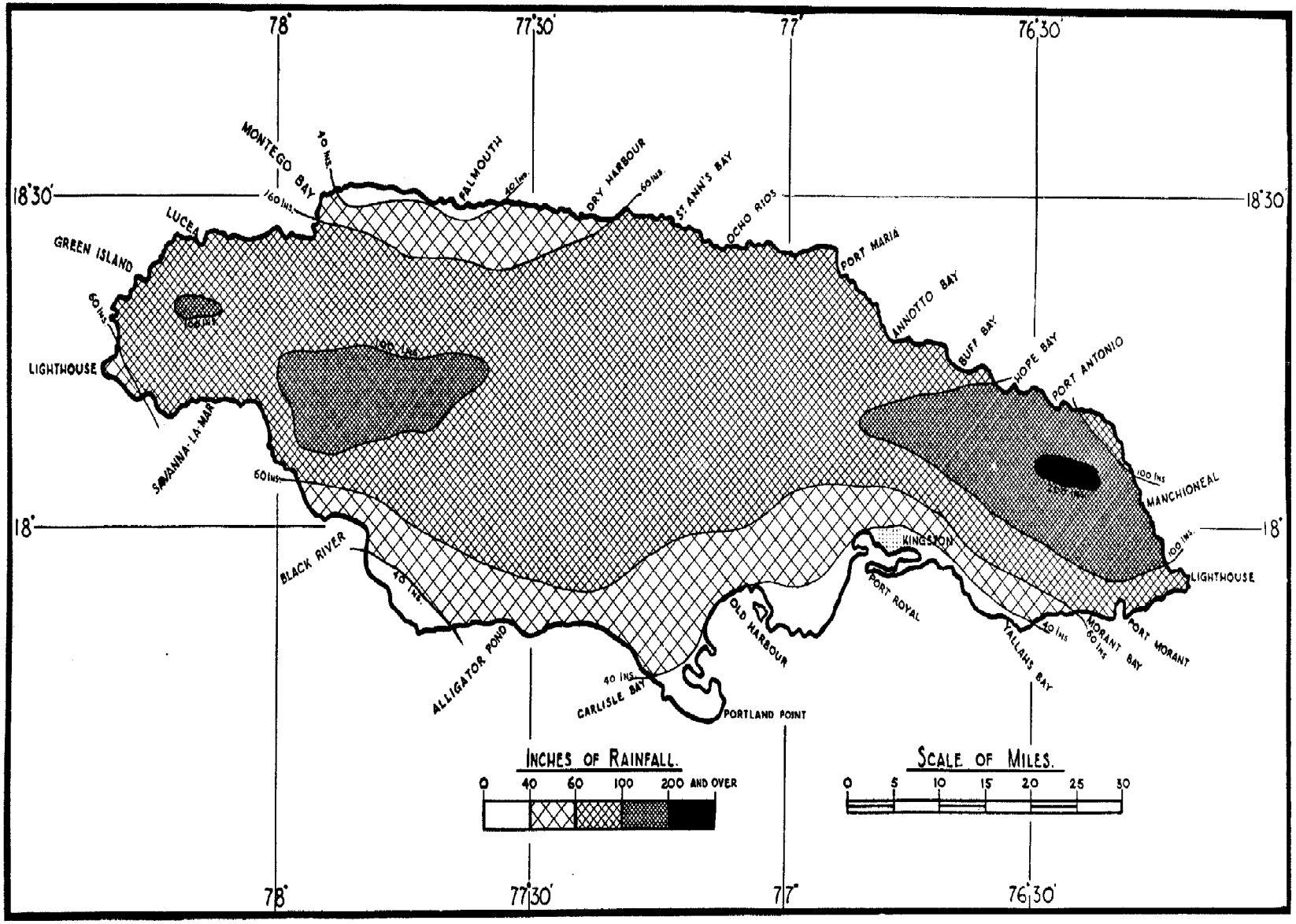
showing the Rainfall Divisions.



Divisions—N.E. = North-eastern; N = Northern;
W.C. = West-central; S = Southern.

(B) MAP OF JAMAICA,

Showing the distribution of the Annual Rainfall.



year. On the other hand, correspondingly, 98.4% of the year must be considered as having no rainfall. This illustrates the large proportion of dry period even in a normal year.

Rainfall Maps.

The accompanying Maps of the Island will serve, more clearly, to indicate the meaning concerning the subject matter embodied in the Tables.

Map (A) shews the Rainfall Divisions of the Island. There are four such Divisions, viz., the North-eastern, (NE); the Northern, (N); West-central, (WC); and the Southern, (S). The lines shewn in red give the boundaries, inland.

Map (B) shews the actual mean distribution of Rainfall, derived from the 60-year Tables of normals, given to the nearest integral inch. The Isopleths are confined to the mean rainfalls as follows: 40 inches and below; 40 inches to 60 inches; 60 inches to 100 inches, and finally from 100 inches upwards.

HAILSTORMS.

The fall of hail is not of frequent occurrence in Jamaica, and it has not been very destructive, with the exception of one or two storms affecting cultivation within a limited area.

During a period of ten years there were 35 places reporting, in the aggregate, the fall of hail-stones. The largest percentage appears to be confined to the month of May, when there is a preponderance of cirrus or cirro-stratus clouds beginning to develop, and very few reported in April, October and November. On the whole nearly all seem to occur in parishes to the westward of Kingston, and practically none to the eastward.

The following shew the total number of reports received for each month, during a period of ten years:—

April	1	August	5
May	14	September	4
June	4	October	1
July	5	November	1

(4) WIND.

The Island being to a large extent mountainous, the direction and force of the surface wind at different parts shew much departure from the normal wind experienced in the nearby open ocean, surrounding Jamaica. In the adjacent waters the general direction of the surface wind, as given in the wind roses on the U.S. Pilot Charts, is for the most part confined to compass bearings ranging from North-Eastward to Eastward. But, as the interference by hilly country gives a land breeze during the night followed by a sea breeze during the day, the Island experiences at most of the northside coastal region a land wind at night from the South, with a normal sea breeze in the day from the North or North-east; and then on the South Coastal Region the land breeze blows from the North, followed by a sea breeze from the South.

At Kingston the mean direction of the land breeze is somewhat more to North-northeast, and the sea breeze in day time is generally South-eastward, owing to the resultant of the South sea breeze with the Easterly Trade Wind. The land breeze has its origin from the cooling of the mountain slopes controlling the cooler (and heavier) air to glide to seaward and wedging below the upper Easterly Trade Wind. Then, after sunrise the mountain slopes begin to warm up, causing an indraught of air towards the hills which develops the sea breeze proper. A similar effect is experienced on the Northern Coast but in a contrary direction. The land breeze at Kingston blows at a rate ranging from about 1 mile per hour to about 8 miles per hour, shewing a normal of 5 m.p.h. The S.E. breeze, on the other hand, ranges from about 12 to 25 m.p.h. with a normal velocity at 3 p.m. of 13.4 miles per hour for the entire year; being the least in November and most in June and July.

The 25-year Table of wind normals, for Kingston (given in Weather Report 689) shews that the annual normal is 183 miles per day. June shewing the highest, as 239 miles per day, and November the lowest, as 141 miles per day. The general hourly average for the year gives 7.6 miles per hour.

The following Table, for Kingston, gives in detail the mean daily miles of Wind for each Month during every Year, from 1908 to 1932, covering a period of 25 years.

KINGSTON, JAMAICA.

Shewing the daily mean total miles of Wind registered for each month, from the year 1908 to 1932, with the 25-year Normals.

Year.	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Means for the Year.
1908 ..	125	151	157	167	203	209	169	162	139	128	116	119	154
1909 ..	120	148	152	156	175	191	183	152	126	135	117	129	149
1910 ..	133	146	135	150	172	185	177	136	127	140	109	115	144
1911 ..	119	144	150	195	179	293	243	226	196	153	168	172	186
1912 ..	214	242	229	201	244	312	244	248	177	162	196	145	218
1913 ..	169	188	264	175	169	273	233	219	185	161	136	161	194
1914 ..	189	210	178	198	223	240	283	232	216	169	128	157	202
1915 ..	173	180	183	190	237	206	217	207	173	126	96	96	174
1916 ..	149	166	183	169	180	196	197	216	139	143	168	162	172
1917 ..	151	173	211	160	204	201	215	184	203	164	129	153	179
1918 ..	203	175	170	199	167	213	280	220	189	148	162	161	188
1919 ..	174	194	196	172	251	262	216	233	183	157	139	147	194
1920 ..	175	181	196	302	191	256	273	197	181	164	180	189	207
1921 ..	113	165	171	166	190	243	242	175	156	184	150	136	178
1922 ..	161	196	198	229	286	238	265	179	168	187	146	167	201
1923 ..	147	167	235	180	244	315	259	226	183	173	143	143	201
1924 ..	191	167	204	176	206	233	227	151	150	142	112	152	176
1925 ..	196	137	143	160	249	238	202	198	158	163	159	157	180
1926 ..	216	185	167	221	190	233	215	189	131	132	100	101	173
1927 ..	145	150	168	160	199	236	225	175	136	153	125	134	167
1928 ..	149	193	206	227	213	252	257	168	184	156	130	147	190
1929 ..	179	206	210	188	241	287	243	165	152	167	151	157	196
1930 ..	174	153	219	195	235	248	249	204	221	162	131	162	196
1931 ..	158	166	188	181	182	194	185	204	179	167	133	163	175
1932 ..	150	170	196	187	202	233	204	164	164	146	213	136	180
Daily Average for 25 years ..	**163**	**174**	**188**	**188**	**209**	**239**	**227**	**193**	**169**	**155**	**141**	**146**	**183**
Hourly Average	**6.8**	**7.3**	**7.8**	**7.8**	**8.7**	**10.0**	**9.5**	**8.0**	**7.0**	**6.5**	**5.9**	**6.1**	**7.6**

(5) RAIN-SQUALLS.

These are for the most part, winds blowing suddenly from Seaward towards the land in heavy gusts of a duration of from five to fifteen minutes, with a surface velocity varying from 15 to 30 miles per hour, and occasionally attaining nearly gale force, of 40 miles per hour. These occurrences are not very frequent, rarely more than 4 or 5 times in such months, which are most affected, viz, June, July and August. At Kingston and other South Coastal places the direction of the wind is from the South East and on the Northern Coast either East or North East. The effect is not much felt very far inland. When accompanied by rain the precipitation usually ceases awhile after the squall terminates. These winds are dangerous to small fishing crafts, especially far from shore.

(6) NORTHERS.

These visitations occur usually during the months of November, December, January and February, and organize as a North-west Wind off the Southern Coast of Cuba, and as they pass over certain "lanes" of the Atmosphere at times, only limited sections of the Island experience their destructive effect. At other times the entire Island receives the blow. These winds are known as "Wet" and "Dry" Northers. The Dry Northers destroy banana cultivation by battering away to shreds the leaves, which are of course detrimental to the growth of the plants. And on the other hand a "Wet Norther" overthrows the entire plant by uprooting them from the sodden yielding soil. This class of wind lowers the temperature of the air, and whenever there happens to be a very low minimum temperature, it is generally derived from the existence of a Norther.

These Northers are not of great thickness aloft. From actual determination made by pilot balloon ascents at Kingston, the wind from the North, which may attain a velocity of 25 m.p.h. at the surface, gradually decreases in speed aloft, until it ceases at an altitude of half a mile or over and terminating at a velocity of 1 or 2 miles per hour, changing in most cases in direction to an East-southeast wind at 1 mile per hour high above the ground.

Northers in these waters have been known to extend over large areas of land and sea, covering a distance from Southern Cuba over Jamaica and so far South across the Caribbean to Columbia on the South American Coast, affecting ocean navigation at times, as well as aircraft.

(7) CLOUDINESS.

There are only three permanent observing stations: Kingston, Negril Point and Morant Point, from which notes are made of the class of cloud and amount of cloudiness for each day throughout the year. At 7 a.m. and at 3 p.m., determinations are made as to the percentage of Clouds, (including the Lower, Middle and Upper) present in the sky during these moments. The printed Weather Service Tables adopt the recognized scale of describing the clouded area of the sky as 1 equals 1/10th and 10.0 equals 100% or complete cloudiness.

The following mean figures are computed for a short series of years, for the above stations, upon the basis of 10 equals overcast.

	7 a.m.	3 p.m.	
KINGSTON	4.2	6.4	(15 years)
NEGRIL POINT	6.1	7.6	(5 years)
MORANT POINT	5.5	5.4	(5 years)

It will be thus seen that at 7 a.m. Negril Point records 6.1 (or 61%) the highest, followed by Morant Point with 5.5 and finally Kingston with 4.2 (or 42%). For the 3 p.m. set, Negril shews the greatest 7.6 (or 76%) followed by Kingston 6.4 (or 64%), and lastly Morant Point with 5.4 (or 54%). These include all types of clouds.

If we take the class of clouds present, it is found that at Kingston at 7 a.m. the upper clouds of the Cirrus type preponderate with 1.8 followed by the Lower Clouds with 1.3 and then the Middle Clouds of the Cumulus type occur last with 1.1. In the afternoon the Lower Clouds preponderate with 2.6, then the Middle Clouds with 2.1, and lastly the Upper Clouds shew 1.7.

For Negril Point at 7 a.m. the Upper Clouds, similar to Kingston, preponderate with 3.9, followed by the Lower Clouds with 1.5 and the Middle shewing only 0.7. But with the 3 p.m. the Middle Cloud predominates with 3.9, followed by the Lower Cloud with 2.6, and only 1.0 for the Upper, corresponding in order of sequence with that of Kingston.

Morant Point at 7 a.m., places the Middle Cloud as the greatest, with 2.2, the Lower with 2.1 and the Upper 1.4. Then, for the 3 p.m. the Middle again takes the highest place, with 2.7, followed by both the Upper and Lower with 1.4.

Reviewing these three Stations, Morant Point at 7 a.m. shews the highest percentage of Lower Cloud with 2.1, also for the Middle Cloud with 2.2, and Negril Point gives the highest percentage with 3.9. Then for the 3 p.m. the Lower Clouds are seen most at Kingston and Negril Point, with 2.6. The Middle Cloud gives preference to Negril Point with 3.9, followed by Morant Point 2.2 and Kingston 2.1. For the Upper Cloud we have Kingston with 1.7, Morant Point with 1.4 and Negril with 1.0.

(8) SUNSHINE AT KINGSTON.

The Sunshine Recorder installed from the year 1911 is of a Type adopted by the United States Weather Bureau. It is constructed on the model of a black bulb thermometer with air in the bulb instead of mercury enclosed in a vacuum container. The principle of recording is that when the sun's rays fall on the black bulb the air in the glass chamber expands and forces a column of mercury in the stem so that the end of the column rises until it meets two metal contact terminals fused into the glass stem which closes an electric circuit whilst the sun shines; and when the sunlight is lost by cloud or at night time, the mercury recedes and the circuit is broken when no current passes. An automatic instrument, driven by clockwork, records continuously on a revolving drum every minute of sunshine during daylight hours.

The following Table, derived from eight years of daily record is given for each month. The first column of figures gives the total possible hours of sunshine. June gives the longest hours, 13.2 and December the shortest, 11.0. The second column shews the mean number of sunshine hours for each month. It will be at once apparent that March shews the greatest number of mean sunshine hours with 8.6. Though March does not give the longest daylight, this month is not so subject to cloudiness, throughout the day, as the month of June. June has the longest daylight hours but records only 7.5 hours of sunshine. On the other hand the month of October with 11.7 daylight hours gives the least sunshine hours with 5.9. October is the rainiest month, consequently, the small figure of 5.9 may be attributable to frequent cloudiness during the 11.7 hours of daylight. The last column of the Table shews the percentage of the possible sunshine hours, where March gives 72% of the possible 12 hours, and October gives only 50% of possible 11.7 hours. By constructing a graph it will be at once evident that there are two Maxima, one in March, 8.6 and the other in August, 7.8. Then there are also two Minima, one in May with 7.1 hours, and the other in October with only 5.9 hours.

From determination made in year 1925 it has been found that from about 9.30 to 10.30 a.m. the greatest amount of sunlight is registered at Kingston, as a mean for the 12 months of a year. This has been observed to be the case for nearly every month of the year.

Those requiring further details of the construction of the United States Sunshine Recorder are referred to "Instructions for the Management of Sunshine Recorders" W.B. No. 456 of July 15th, 1911 (by Dr. C. F. Marvin)—page 15.

TABLE——Kingston, 8-Year Means.

Month.	Possible hours Sunrise to Sunset.	Actual Hours of Sunshine.	Percentage of Possible.
	(1)	(2)	(3)
January ..	11.2	7.9	71
February ..	11.5	8.0	70
March ..	12.0	8.6	72
April ..	12.5	7.4	59
May ..	13.0	7.1	55
June ..	13.2	7.5	57
July	13.1	7.7	59
August ..	12.7	7.8	61
September ..	12.2	6.9	57
October ..	11.7	5.9	50
November ..	11.3	6.1	54
December ..	11.0	7.0	64
..			
Means ..	12.1	7.3	60

Individuals who consider that therapeutical benefits are derived from sun exposure, should expect at Kingston, the mean maximum number of hours per month of bright sunlight between the hours of 9.30 and 10.30 a.m. From 3 to 4 p.m., on acount of cloudiness, only about 50% of that of the 10 a.m. sunlight appears on the records.

For other places in the Island, however, there are no data in this respect, available.

Sunshine Hour Means for Twenty-one Other Courtries will now be introduced.

To enable comparisons to be made with a number of widely separated places, the following Table of average daily sunshine hours, derived from the data given in the Meteorological Magazine (London) from the year 1931 to 1934, is supplemented.

Table of 4-Year Averages.

Place.	Average Sunshine Hours.	Percentage of possible.	Place.	Average Sunshine Hours.	Percentage of possible.
London ..	4.0	33%	Perth, W. Australia	7.9	66%
Malta ..	8.3	69	Brisbane	7.7	64
Salisbury (Rhodesia)	7.7	64	Hobart, Tasmania	5.6	47
Johannesburg	8.7	72	Wellington, N.Z.	5.8	49
Mauritius ..	7.8	65	Suva, Fiji	5.2	43
Colombo, Ceylon	6.7	56	Apia, Samoa	6.8	57
Singapore ..	5.7	47	Kingston, Jamaica	7.3	60
Hongkong ..	5.2	43	Toronto	5.7	47
Sydney, N.S.W.	6.7	56	St. John, N.B.	5.1	42
Melbourne ..	5.3	44	Victoria, B.C.	6.4	53
Adelaide ..	6.8	57			

It will be gathered from the above twenty-one stations that there exist only six stations which shew more sunshine hours than Kingston, Jamaica. Johannesburg, for example, gives the greatest with 8.7 hours, and on the other hand, London, the least, with 4.0 hours. Whereas Kingston shews 7.8 hours, derived from eight-year means.

(9) THUNDERSTORMS.

For general purposes of interest the records for the past ten years 1925-1934 have been tabulated for each of the phenomena of local thunderstorms, distant lightning and distant thunderstorms as observed at Kingston, in order to arrive at the relative periods of frequency of atmospherics.

The following tables are prepared concerning the above :—

(a) Local Thunderstorms—(10 years.)

	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total 10 years.
10-year totals ..	1	1	2	1	7	5	14	22	25	24	11	2	115
Mean for one year	0.1	0.1	0.2	0.1	0.7	0.5	1.4	2.2	2.5	2.4	1.1	0.2	11.5

(b) Distant Lightning—(10 years.)

	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total 10 years.
10-year totals ..	0	0	0	11	35	56	86	107	120	89	27	16	547
Mean for one year	0	0	0	1.1	3.5	5.6	8.6	10.7	12.0	8.9	2.7	1.6	54.7

(c) Distant Thunderstorms—(10 years.)

	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total 10 years.
10-year Totals ..	2	2	2	25	48	89	104	142	152	123	45	8	742
Mean for one year	0.2	0.2	0.2	2.5	4.8	8.9	10.4	14.2	15.2	12.3	4.5	0.8	74.2

The Table (a), giving the number of days with local thunderstorms at Kingston, includes all such as have discharged overhead at Kingston or in close vicinity. They range from thunderstorms of one or two peals settling down in five or ten minutes, to such as persists for five or six hours (as in August, 1933). It would involve too much detail to discriminate in a table the periods of duration. Then, again, there is no distinction made between moderate peals of thunder and those which may be termed sharp or very intense. The object of the Tables (a), (b) and (c) is more

important for having some analysis made of the relative incidence of these atmospheric displays.

Upon inspection of Table (a) it will be readily seen that during this 10-year period there were 115 thunderstorm days in number, covering all the months. This is equivalent to only 11.5 local thunderstorms as an average, per year.

From January to April there are very few noted, and if the figures are followed each month it will be obvious there is a steady increase in number, month by month, until we arrive at a maximum or peak, in September, when a total of 25 in 10 years have been recorded, this is equivalent to 2.5 for this month alone. Then there is seen a steady decrease in number until December when there are merely two in ten years. The average number of these local thunderstorms shows 11.5 per annum at Kingston.

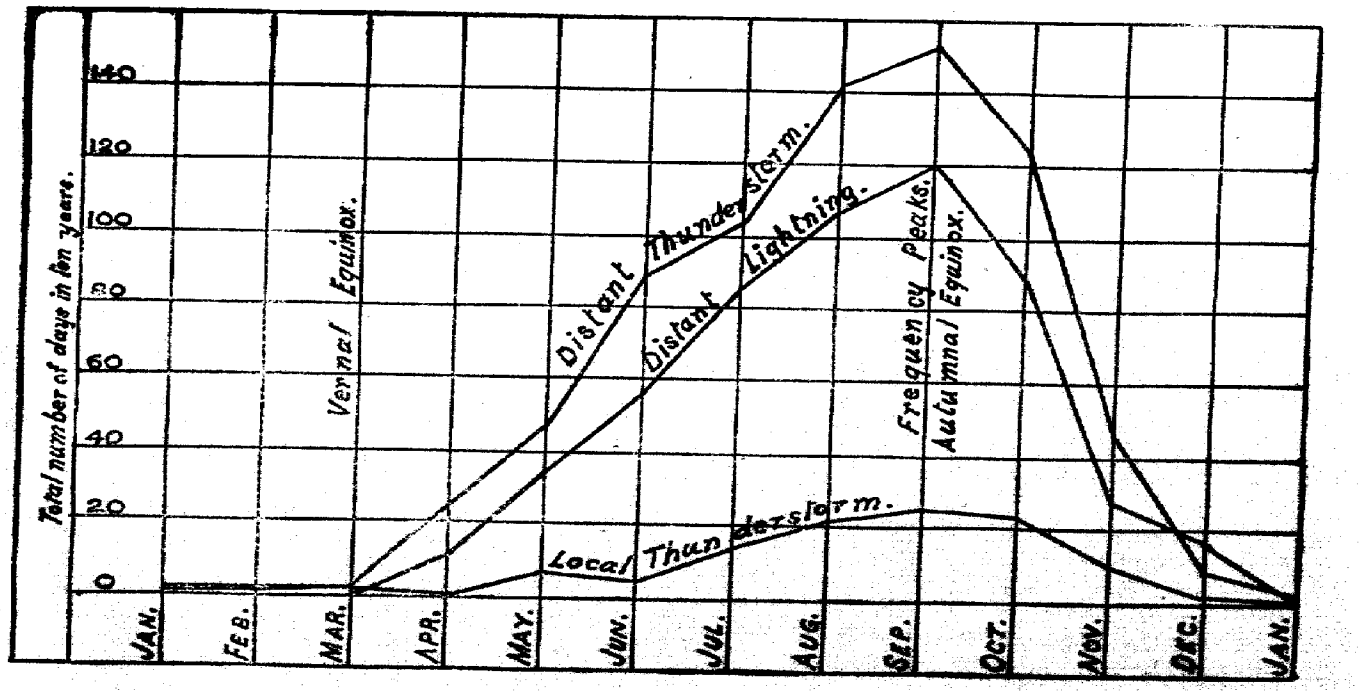
If we now take Table (b) giving the occurrences of distant lightning as visible (chiefly at night) from Kingston, there is seen a remarkable relationship with Table (a). In this the month of September also gives a preponderance, with 120 instances of days in 10 years, giving, of course, only 12 occurrences, as an average for this month, in one year. There is found a steady increase from zero in January, February and March until this same month of September, followed by a gradual decrease to 16 in December. In all, there were 547 instances of days of distant lightning observed during the course of ten years for the most part seen during the evening or night hours giving an average for one year of 54.7 instances. This tabulation embraces every character of a distant occurrence ranging from a faint distant lightning to vivid flashes (when thunder is not heard). The maximum distances may be as far as 20 to 30 miles away from Kingston. It serves, however, to accumulate data concerning atmospherics in relation, to studies in radio transmission in this region.

Table (c) will now be dealt with. It refers to distant thunderstorms which may be classed as any such display from any distance from 5 miles to about 20 miles, so long as they do not discharge, as in Table (a), overhead in Kingston. The figures of this Table also give the maximum of occurrence in the month of September. There is a gradual increase in number of two in January to 152 in September, the peak, over a period of 10 years, followed by a uniform decrease to 8 in December. The grand total of these gives 742 during the 10 years of records or equivalent to 74.2 per annum as an average.

The fact certainly appears to be established that around the region of Kingston the peak of atmospherics is encountered in the month of September, at the autumnal equinox when the frequency is ever so much greater than during any of the other months of the year. For example, in the case of distant thunderstorms as observed from Kingston, the month of September gives a yearly average of 15.2 thunderstorms as against 0.8 in December. Around the period of the vernal equinox (March) the frequency falls nearly to zero.

The following graph will enable the circumstances to be better compared.

Diagram shewing the monthly Frequency of "Atmospherics," observed from Kingston, during a ten-year period from which means have been derived. Years 1925 to 1934:—



The direction in which these Thunderstorms are seen from Kingston is greatest in a quadrant with bearings ranging from Northwest to Northeast, where the larger percentage preponderates. Hardly more than 20% however are ever noticed to seaward.

(10) MIST, FOG, &c.

The formation of low-lying Fog or Mist, is generally, attributed to the fall of temperature on the ground surface tending to cool the superposed air, thus causing light condensation of vapour into minute particles. The difference existing between the terms Mist and Fog is merely arbitrary or a degree term. Fog is much denser than mist and the expression depends upon the extent of visibility through the obscuring air medium. Both fog and mist also bear a strong relationship to clouds. In the case of their presence on the surface it is for the most part owing to ground radiation, thereby cooling the air near to the surface. Clouds aloft, on the other hand, develop, mostly from the cooling by ascending currents into cold air, especially applicable to the lower clouds.

In large manufacturing cities where coal is used as fuel, the air becomes polluted with microscopic soot or carbon particles distributed by the chimneys around, upon which nucleus of soot the vapour of the air is deposited forming dense black fog,—unlike the clear mist at other places.

The mist or fog experienced at times in certain parts of Jamaica is not so charged with soot particles, therefore, only a white variety is formed and encountered at a few isolated places. In this Island the localities of mist, situated within an altitude of about 1,000 feet down to sea level, are found chiefly in the Bog Walk and Linstead District, St. Thomas in the Vale, at times extending in many directions to the Southward or Northward, and it may be present at any time of the year during the night and continuing until 9 a.m. before it "lifts." The same phenomenon occurs around Moneague area, in the Parish of St. Ann and covers a wide extent of country. Montpelier and Shettlewood in St. James, where there is flat country, mist is frequently met. Then, there are sundry places as at New Market in St. Elizabeth, as well as other localities. During the time of such occurrence the wind has very little movement, and is nearly calm or still; the air is, of course, somewhat humid. In some instances it has the characteristic of a "Scotch Mist," when slight precipitation is noticed. The City of Kingston is almost free of such occurrences of weather condition.

Upon the high Mountain Ranges, such as the Blue Mountains, where the altitudes are relatively greater, from 2,000 to 7,000 feet, frequent dense white fog is met; the extent of visibility may be limited to ten or fifteen feet, when distant objects beyond are completely obscured. This description of fog, apparently, belongs to the Stratus class of cloud, lowering to ground surface level on the mountain slopes, and may be persistent for a much longer number of hours than the mist seen upon the plains of lower levels, such as at Bog Walk, &c.

Somewhat associated with the phenomenon of haze, or fog, which obscures good visibility there are at times the prevalence of a type of ground haze, which is apparently confined to low-lying contamination of the air, ascribed to floating dust particles, distributed through the atmosphere by wind, and chiefly noticed during the occasions of dry months. At Kingston such haze around has been observed to identify itself during the months of deficency of rainfall: January, February, March and April, and at times in December. Looking from Kingston, the distant mountain ranges, including the panorama encompassing views from the bearings of South-west, around to Northward, to East and East South East, become uniformly obscured from distinct vision, of varying degrees of invisibility. Also the entire length of the Palisadoes to the seaward of Kingston becomes at times hazy owing to the same cause.

There is another cause existing, where clear vision suffers, owing to the formation of stratified low levels of atmosphere of marked difference of density or to the unequal temperature effect, due to ascending air currents. But this latter is unrelated, by its characteristic of changes of refraction which produces the "Mirage" effect, as may be exemplified by looking at objects through the air surrounding a heated stove. To a close observer the difference between these two kinds of phenomena is unmistakable.

Other parts of the Island, especially in low-lying country, also experience haze in a varying degree of intensity.

By the frequent observation made of pilot balloon ascents, in the City of Kingston it has been noticed that whenever the balloon, decreases in elevation angle to 20° or less, viewed at a distance of about two or more miles, the failing effect of visibility becomes very marked, especially at periods of haze obscuration.

Evidence of the cause of haze, being due to dust particles, has been on occasions demonstrated after a moderate rainfall around. The effect of rain is to clear the atmosphere of dust so that obscuration at once disappears, and fair visibility is restored. This would not be the case if the formation of haze was dependent on moisture as in the case of mist, &c.

This matter, however, needs some research work.

(11) DROUGHTS.

Through the interest taken by the late Mr. Maxwell Hall, M.A., F.R.A.S. and with the aid of Mr. F. Cundall, O.B.E., F.S.A.—by pursuing searches into the early histories of Jamaica—discovery was made of several notes referring to droughts experienced in the past over the Island, from the year 1768 to 1845. During this period (of 77 years) there were found brief data relating to seven occurrences. Then from 1882 to 1934, which are comparatively recent years, there are on record twelve different years when such ruinous visitations were experienced. The population as well as cultivation and cattle pens of the Island suffered, in different degrees of loss.

The following give in as much detail as is available, the accounts of the several years of drought detrimental to the Island.

For the most part the northern and southern divisions of the Island suffer more so than the regions where the average rainfall is greater. For should a drought affect the rainfall by 50% all the divisions as a rule suffer proportionately, so that if the southern division with only 51 inches normal rainfall be taken and reduce it to one half, we have 25 ins., whereas, with the north-eastern division with a 60-year normal of 100 ins. if reduced to one half, it becomes equal to that of the southern in normal conditions. It will be obvious that the parishes of Portland and St. Mary can endure a "drought" more unconcernedly than at other less favourable localities, although these two rainy parishes have been known to suffer at times from drought.

In all likelihood there may be a few other occasions of drought conditions affecting this country in the remote past years prior to 1768 and when records are lost to history, also long before the Jamaica Weather Service was established in the year 1881; but if the notes following from say 1876 to date, be read, it will be seen that there were 13 drought years, in a period of 58 years or equivalent to about one drought in 4½ years.

On taking the whole period from 1768 to 1934 (166 years) there were 20 instances of severe droughts, showing average recurring periods of about 8 years, which would be very approximate. The 4½ year period during more recent years should be more reliable.

In the foregoing (especially from the year 1882) merely such cases of drought, either affecting nearly the entire Island, or a few parishes, are tabulated or dealt with. Instances of a very local character, as are frequently experienced at Kingston or Lower Liguanea Plains may be omitted. For example in the year 1921, middle Clarendon suffered much from the effects of rainfall deficiency in January and February. Such as these isolated cases hardly justify notice being taken of them in this article.

The following is a tabulated account of all the major droughts found on record.

YEAR.	DROUGHTS IN JAMAICA.
	(Eighteenth Century.)
1768 / 1770	"From October 1768 to May 1770 was the longest and severest drought ever remembered in the Island." (Long's Hist. of Jamaica Vol. III, p. 615, vide also Vol. II of Jamaica Weather Reports, page 8.)
1786	"Drought"—Handbook of Jamaica, 1920 p. 60. No details.
	Nineteenth Century.
1822.	"Severe drought." Handbook of Jamaica, 1920, p. 64. No details.
1840 / 1841	"Great Drought lasting till Spring, 1841." See Handbook of Jamaica, 1920, p. 68. also Vol. II, Jamaica Weather Reports, p. 11.
1845.	"Severe Drought." Note by Mr. Maxwell Hall, Vol. II, Weather Report, p. 12. No details.
1876.	"Severe Drought." Handbook of Jamaica, 1924, p. 74. No details.
1882 / 1884	"Rainfall below the average from 1882, 1883 and April 1884, and the long-continued effect, dried up Springs and wells so that certain Estates can not take off their crops for want of water." Weather Report No. 40 for May 1884.
1885.	"Long continued Drought," Weather Report No. 56 Sept. 1885, "gave place to average Rains in August. Rainfall one-half the average in all the divisions, May, June and July.
1897.	Severe drought in all the divisions in January and February when the rainfall was one-fifth the normal. See Jam. W. Reports Nos. 209 and 210 Jany., and Feby., 1897.

Twentieth Century.

1907. The deficient rainfall commenced in December, 1906, followed by January 1907 and in March 1907, when the aggregate Island rainfall registered only 5 inches as against the aggregate normal of 14 inches—severe drought.
(January 14th, the great Earthquake). See Weather Reports 335, 336 & 339.

1912. A moderate drought was experienced during May and June, when the rainfall was less than one-half of the average—but recovered during the ensuing months.

1920. Moderate drought from January to April when the aggregate total of 8.92 ins. for the Island showed only a little above one-half the aggregate normal. But in the southern division it was severe, registering only 5.30 ins. for the 4 months. The Island total rainfall for 1920 showed the least as 51.16 ins. for the past 65 years, with the exception of year 1872 with a mean of only 45 inches.

1923. During the four months, June to September, the Island rainfall was exceedingly deficient when a total of not more than 14 ins. was registered, as compared with the 60-year aggregate normal of 26.15 inches representing about one-half the average. The drought was more acute in the northern and southern divisions.

1924. The first four months of this year showed a marked deficiency, occasioning drought conditions, especially in the southern division, but recovered during subsequent months.

1928. The first three months showed a marked deficiency, particularly so in the southern and northern divisions, almost approaching severe drought conditions. It extended from December 1927 to April 1928. The North-eastern division as well as the extreme west end of the Island did not experience the rainfall deficiency so acutely. Only 63 inches of rain fell, as a mean, out of a normal of 73 ins. The shortage was keenly felt however, in the southern division from January to March.

1929. The drought of this year was more marked than during the previous year, for the shortage was 13 inches, for the Island. The rainfall was somewhat deficient in all the divisions.

1933. A severe drought was experienced from the effect of the January and February rainfall shortage, during these two months only about one-quarter of the normal rainfall was registered. In January seven parishes had less than one inch, six had less than 2 ins., and one (Portland) had about 3 ins. In February all the parishes (except Portland) had a mean below one inch rainfall. Quite a reverse condition was recorded from June to December (7 months) when the actual rainfall for the Island was in the aggregate for these months 102.69 ins., representing nearly 53 inches in excess of the 60-year normal. The total mean rainfall for 1933 was 116.53 ins., the greatest in history for 65 years.

Too much value ought not to be placed upon the actual amount of rainfall derived from any particular month's record and its relationship with drought conditions. For example with one inch of rainfall occurring in the course of one day within a short interval of hours during a month, and denoted as "one rainy day for a month," as compared with another occasion when one inch of precipitation is extended, or distributed, over 8 or 10 rainy days, in light showers during a month. In the latter instance it will be admitted that far more benefit to cultivations arises. Consequently, the amount of total rainfall hardly forms an adequate index or criterion of its value. On the other hand, when very heavy rainfall occurs, a considerable amount of "run-off" (by the course of rivers) is lost, and the land fails to derive the full advantage, beyond perhaps to a limited extent of 15% to 20% of the total: the greater volume passes into the sea. In order to illustrate this point more forcibly, it may be assumed that should the Island's annual mean rainfall have been 40 inches with 244 rainy days, instead of as at present, 73 inches with 122 rainy days evenly distributed, far better agricultural results would be derived even with this less rainfall, but with double the days of rain.

In estimating the severity of a drought, the only reliable method appears to be derived from the actual data estimated from the extent of failure of crops etc., and the ensuing suffering.

(12) EVAPORATION.

Besides possessing a knowledge of the degree of relative humidity for any given place, the gauging of the monthly amounts of water evaporation, determined by means of an evaporimeter, appears interesting, perticularly where the question of health, manufactories, storage reservoirs for water or petroleum, or for cultivation, are concerned. As is generally admitted, excessive precipitation induces less evaporation, and upon occasion of drought the water evaporation, correspondingly, entails an appreciable excess of gauging over the normal.

There are two evaporimeters installed in Jamaica, for obtaining daily and monthly returns for the weather reports, one at Kingston, since the year 1924, and the other maintained at the Negril Point Light House, by the Superintendent. The annual mean total of evaporation at Kingston gives 71.71 inches, derived from ten years of gauging; and that at Negril Point gives 80.04 inches, being the normal for seven years. Negril, therefore, shows about 10% greater evaporation than Kingston, possibly owing to being much nearer to the sea-coast where, on account of the greater exposure to wind inducing greater evaporation. The Kingston evaporimeter stands about half a mile from the sea, at an altitude of 100 ft. A gauge situated at much greater altitude of country, where the rainfall may be much more, will be expected to, certainly, show far less evaporation than on the plains It has been found throughout the year that about 90% of the total evaporation occurs between sunrise and sunset, and the remainder 10% takes place during the night hours.

Loss by evaporation is governed, for the most part, by the number of miles of wind passing over as well as to the air temperature. At times of brisk sea breeze and excess of surface temperature, an increase in the quantity of evaporation is quite appreciable.

It may serve some purposes, if the following Tables be given for the two stations above mentioned:—

Kingston, Monthly normals of evaporation, in inches, derived from decade 1924 to 1933.

	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
10-year Normals ..	5.06	4.90	6.64	7.75	7.91	6.93	7.87	7.56	5.12	4.05	3.55	4.37	71.71

Negril Point Lighthouse—Monthly normals for evaporation, in inches, derived from period 1928 to 1934 (7 years).

	Jan.	Feb.	Mar	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
~~10~~-year Normals ..	6.17	6.80	8.06	7.44	7.28	6.69	6.55	6.95	6.68	5.59	5.81	6.02	80.04

There will be found from these Tables, an appreciable difference of evaporation between the long and the short days.

At Kingston from May to August (the long days) the mean total shows 30.27 ins., whereas in the short days, November to February, only 17.88 ins. is gauged.

Then at Negril Point the difference is not so much in evidence, for during the four-month period, from May to August, the total shews 27.47 inches, whereas during the short days, from November to February of the following year, the total shews 24.80 inches.

At Kingston the month of May shews 7.91 ins., being the highest for any month, and at Negril Point the highest appears in the month of March with 8.06 inches.

(13) HURRICANES.

Under this heading it appears desirable that certain definitions should be rendered clear before presenting tables of the periods giving the years in which such tropical disturbances visit the Island.

The term "Hurricane" refers to a revolving wind of great violence which blows at a rate ranging from about 75 miles per hour and over, and progresses along a curved track from its point of origin. It is of a destructive nature. The expression "cyclone" signifies any revolving wind system, irrespective of velocity. A moderate tropical disturbance with a velocity of say 50 to 60 miles per hour is entitled to be classed as a Cyclone but not as a hurricane. A definition of cyclone is also applicable to the Typhoon of the Indian Ocean as well as of the Chinese waters. A Tornado, as felt in the United States, despite being a revolving storm of great velocity which attains a speed of 300 miles per hour occasionally, also comes under the term of Cyclone.

According to the publication "Hurricanes of the West Indies" by Dr. Oliver L. Fassig (1912), on page 11 is given a statement that conditions favourable to the formation of hurricanes in the West Indies, begin in the month of June, but do not become well developed until the month of August. From August to the close of October is the real period for these storms, as is shown by the following figures of frequency, during a period of 35 years.

Percentage of frequency in the West Indies:—

May	...	...	1%	September	...	...	32%
June	...	...	6%	October	...	...	31%
July	...	...	4%	November	...	...	1%
August	...	...	25%				

Authority on the subject states that 88% of all the hurricanes recorded during 35 years occurred during the months of August, September and October, leaving but 12% for the remainder of the season

The above applies to the entire Caribbean region.

It will be found upon charts of West Indian Hurricanes, during the course of many years of study, that the *August* storms originate, for the most part, in a region easterly of the Little Antilles (which include the Leeward and Windward Islands) and then move on a storm track somewhat west-north-westerly.

The September hurricanes, although they originate about the same region, are not so definite in their movements, for their tracks have a tendency to incurve to north-westward into the Atlantic Ocean instead of reaching near to Jamaica, and about one-third of these September storms appear to originate to the south or south-east of this Island.

The October hurricanes, for the greater part, are confined both in origin and their track movement, to the westward of Jamaica.

The November hurricanes also appear to develop in the western Caribbean.

So far as Jamaica is affected by these occasional visitations, which either passed over some part of the Island or moved within a short distance from it, so as to have experienced some appreciable damage, the following gives the number of such storms occurring during each of the hurricane season months, from the time of the British occupation in the year 1655 to the present time, 1934.

June	...	1692 — (1)
July	...	1784 — (1)
August	...	1689, 1712, 1714, 1722, 1772, 1781, 1785, 1813 (2), 1832, 1880 1886, 1903, 1915, 1916 (2)—total 16.
September	...	1751, 1837, 1915, and 1917—total 4.
October	...	1726, 1744, 1780, 1786, 1812, 1815, 1844, 1874, 1916, and 1933—total 10.
November	...	1818, 1912, and 1933—total 3.

It will be seen that from the year 1655 to 1934, a period of 279 years has elapsed. During these years, there is on record an aggregate total (from June to November) of only 35 hurricanes disastrous to this Island, which gives a general average of one hurricane in eight years.

It should be made clear that most of these storms which organized at some distance travelled over only a limited area of the Island. The majority moved on a track over eastern Jamaica through the parishes of Portland, St. Mary and St. Ann. Others confined their havoc over western Jamaica. Only two have crossed the Island in the recent century (19th) from the sea to southward, moving northward (1880 and 1886) across to the northern coast.

Special attention is drawn to the fact that there have been occasions of long lapses of time devoid of hurricane activity. The following are given in Chronological order of the longest four gaps or periods of storm tranquillity:—

34	years	no	hurricane	from	1655	to 1689
26	"	"	"	"	1786	to 1812
30	"	"	"	"	1844	to 1874
16	"	"	"	"	1917	to 1933

Hence it can be advanced with certainty that Jamaica is rarely exposed to these atmospheric disasters. Other places, not so favourably located, such as Porto Rico, Nassau and Florida, appear to suffer far more severely by these unwelcome visitations. Jamaica has not suffered by such appalling loss of life as has been the misfortune of some other countries in the Caribbean region. Kingston and surrounding parishes can properly claim immunity from disastrous hurricanes for a protracted period of at least 50 years. The last disastrous hurricane in the year 1880, which traversed this city of Kingston moving north-west, caused a certain amount of damage, for the most part along the water-front, where the wharves of frail construction suffered nearly total damage, chiefly owing to heavy seas in the harbour of the City. The centre of the 1903 hurricane, of August 10th, passed to the north of Kingston, moving to westward.

On account of the limited space assigned to this article, certain subjects, appertaining to hurricanes, such as their genesis, vortex, formation and persistence, as well as to regions of low and high atmospheric pressure, have, necessarily, to be omitted. These subjects appear to be still

undergoing a transitional stage of investigation, consequently, any reference to them may serve little purpose for the present.

(14) HURRICANE WARNINGS.

From the year 1880 to 1898 there was a system in force, controlled by the late Mr. Maxwell Hall, Government Meteorologist, to issue hurricane warnings based upon instrumental observations made solely in this Island, to the Shipping and to the general Public, through the local Telegraph Stations and Ports around Jamaica.

Owing to the United States Weather Bureau establishing a First Class West Indian Meteorological Station, with an adequate Staff, in the vicinity of Halfway-Tree, St. Andrew, in the year 1898, for the purpose of distributing hurricane warnings to most of the Islands in the Caribbean, the Jamaica Weather Service ceased to function, and this important work was relegated to this new Service, and was continued for some years near Halfway-Tree: eventually transferred their meteorological instruments to the Offices of the Direct Cable Co. in Port Royal Street, Kingston, to operate in a modified manner. The great Earthquake of January, 1907 wrecked the buildings, and the equipment of instruments suffered damage. Instrumental observations were, therefore, suspended.

Then about August, 1907 an Officer of the United States Weather Bureau approached the Jamaica Government with a view to co-operate with them in re-establishing a station at the Public Works Building in Kingston, and for supplying to the Bureau, by Cable, the daily weather messages to Washington, during the hurricane months. Mr. Maxwell Hall resumed as Government Meteorologist, and was entrusted with the direction of operations. Kingston was one station among quite a few other reporting stations of the West Indies joining in.

As time advanced, in the year 1921, a large accession of observing points in the Caribbean Region was instituted, bringing up the total to about sixteen stations, under the direction of the U.S. Weather Bureau.

With additional advantage of a few ships which may happen to be passing in the vicinity of a disturbed weather area, possessed of wireless equipment, and able to communicate through some source to Washington, provided the United States Weather Bureau with an organization that is unsurpased by any other geographical situation in the World, which may happen to be periodically menaced by storms.

The cost of upkeep of this entire system is borne by the United States Government.

From the 1st of June to the 30th November, each year, has been the acknowledged period for the transmission of all daily weather messages to Washington, U.S.A., and it has been in force up to the present time.

In Jamaica, so soon as a storm warning becomes necessary to be issued, which may be determined either from local observations or from reports received from Washington, the Shipping at all Ports of the Island, as well as all the Interior Telegraph Stations are supplied with weather notices, from day to day, when essential, of the existence of a Tropical Disturbance and its movements, intensity &c., so long as it lasts.

(15) EARTHQUAKES.

Under this heading reference in detail will be, so far as possible, restricted to data appertaining to this Island. It may, however, be stated that there are certain well recognized zones or areas irregularly situated around the globe, necessarily confined to places on land and to a minor extent to the open ocean, which have exhibited, for centuries, definite seismic activity at one time or another, with a wide range of intensity and character, as are exemplified in the Japan and the Philippine Islands group, New Zealand and the region occupied between Borneo and Northern Australia, the southern parts of Italy and Spain, a long belt covering a distance of over 8,000 miles extending from California (U.S.A.) through Mexico, Central American States, then along the Isthmus of Panama and continuing along the western coast of South America, following the Andes range, and terminating in Southern Chili, with a separate branch leading from Columbia along the northern coast of South America to the Guianas, then proceeding on a line following the Windward and Leeward Islands of the Caribbean, continuing through Porto Rico, San Domingo, Haiti, terminating at the western end of Cuba. In this latter zone it will be found that Jamaica is included as occupying a position on the southern border line or zone near to its termination.

A map constructed by Professor John Milne in his work on Earthquakes, which is really a reproduction, with certain improvements, of Mallet's chart of Seismic Regions, gives these Zones. On the other hand there are other regions on the Globe, vast in extent, which are very favourably located, where destructive earthquakes are practically unknown to occur, such as charted in the entire section of the South American Continent covering a wide area from Brazil to so far south as

Patagonia, including places bordering along the eastern sloping country of the Andes range, where earthquakes are relatively few. And, furthermore, nearly all the eastern Continent of Africa, also a zone located in North America, are fairly free of such disasters.

The areas not relatively subject to seismic activity are vast when compared with zones exposed to, and more affected by, this destructive agency of nature.

So far as the Island of Jamaica is concerned, notwithstanding its situation on the southern border line of the Caribbean earthquake zone, it may be classed as a spot which by no means shares a place of much seismic activity, when it is compared with dreaded situations such as Japan or countries running along the western slopes of the Andes. For in Jamaica, there have been but two great earthquakes experienced, occurring in June 1692 and in January 1907, giving an interval or gap of nearly 215 years. Even in these two cases, the extreme disastrous effect was chiefly confined to Port Royal, and in the subsequent calamity of 1907 to the City of Kingston, the far outlying parishes of the Island suffered in comparison inappreciably.

Opinion has been expressed by Seismologists that the origin of the Jamaica earthquake of 1907 is supposed as having occurred in the Bartlett Deep, lying between the Cayman Islands and Jamaica. This Bartlett Deep, from deep-sea soundings undertaken, is found to have a submergence, below sea-level, at its greatest depth of 3428 fathoms (or nearly 4 miles). It presents evidence of a great subsidence of strata, happening at some remote period, inducing occasional displacements of its unstable geological formation. Hence a sudden dislocation of its steep sides, establishes a point of origin so as to communicate its seismic action to nearby places. Now, at Bull Bay, about 8 miles to the eastward of Kingston, it has been known from the charts to possess a steep anticline to the seaward, where at a distance of half-a-mile to the southward, the depth of sea bottom is 104 fathoms and at three miles still further south the depth increases to 400 fathoms (or nearly half a mile); consequently, it would appear that an unstable accumulation of detritus of large proportions reposed on this steep slope near to Bull Bay, evidently dislodged, as would a landslide. The distant earth movement originating at the Bartlett Deep being responsible, which in all likelihood occurred on January 14th, 1907. The evidence of the cable leading from Bull Bay to South America having been disrupted and partly buried, in extensive detritus for several miles, supports the theory that a great landslide below sea level contributed to accentuate the intensity of this earthquake which ruined Kingston in the year 1907.

The Jamaica great Port Royal earthquake of June 1692 was for the most part due to the shelving of the North-west portion of the town suffering underscour, which eventually dislodged, causing that section of the town to become entirely submerged. Soundings made near to the site of the Naval Hospital reveals the fact that an abrupt shearing of ground in this section and of considerable depth, occurred.

Jamaica and the Islands immediately adjacent do not happen to be situated within a volcanic region, such as countries mapped along the Andes range, of South America, hence the Island's two great earthquakes cannot justly be attributed to volcanic activity.

Besides the above-mentioned two notable earthquakes, there are on record, a few minor subsidiary occurrences experienced each year which create no appreciable damage, and may be termed local shocks, affecting merely a limited radius of country. It is interesting to study a table prepared from a selection of 27 years of entries in the Register, commencing from January 1908 (the year succeeding the great earthquake of 1907), to December 1934, which includes all of such small intensities ranging from Class I to Class III of the Rossi-Forel Scale.

By inspection of this table giving the total having occurred, for each month, during all these 27 years, it will be perceived that the greatest total number occurred in the month of February, showing 60, whereas the least number occurred in the month of May with only 25, representing less than one-half that of February. These appear as the extreme maximum and minimum during 27 years. But there is also a secondary maximum number of less extent totalling 46, for July and another minimum of 31 falling in October. These fluctuations of periods are certainly remarkable. February is admitted to be on an average the driest rainfall month of the year when as it happens also to be when the greatest frequency of earthquakes occurs. Then, it will be seen that the second maximum of July similarly coincides with a relatively dry month. There is, again, a secondary minimum in October with 31, which, similar to that of May, occurs during a noted wet weather month. The graph on page 25, showing the monthly totals, will enable this extraordinary characteristic to be more scientifically studied and understood.

It becomes somewhat perplexing to ascribe the causes instrumental in producing these recurrent features of maxima and minima frequency. The Island of Jamaica is well known to consist, for about three-quarters of its area, of a geological formation of limestone. Such strata in many places are estimated to be about 2,000 ft. in thickness.* There is also abundant evidence existing to disclose the fact that there are numerous subterranean water courses, supplemented by small lakes, or pockets of impounded water. These streams are known either to discharge from the rock caverns

*"Geology of Jamaica," by James G. Sawkins, F.G.S., (1869), pages 307 and 315.

to some surface river courses not far distant from the sea, or to be conducted entirely under the surface and emerging below sea-level to the open sea. A few of the more important of these surface streams, which are maintained by such underground water courses, are listed below.

For example:—

Kingston	...	Rock Fort Mineral Spring, Spanish Town Road, Middle River.
St. Thomas	...	Bath Mineral Spring.
St. Ann	...	Pedro River, Belmont, Roaring River, Llandovery River.
Trelawny	...	Dornock Spring.
St. James	...	Mafuta Springs.
St. Elizabeth	...	Y. S. River near Ipswich and Black River head.
Clarendon	...	St. Jago River.
St. Catherine	...	Black River from Worthy Park, and the Ferry River, Caymanas and Red Hills.

If speculation be resorted to in order to explain the water flowing action of these underlying streams, it may present a solution, by considering that when underground water channels or reservoirs become surcharged by percolation or through a "sink hole," derived from the accumulation of water during the rainy seasons of May and October, the hydrostatic head thus created, due to filling, tends to saturate by pressure, the surrounding sides and roof (or otherwise the "wetted perimeter") of such channels, for a duration of weeks very likely, and then becoming released during the ensuing dry months, the pressure disappears by the evacuation or discharge, and large limestone boulders or huge rocks of the order of 1,000 tons, and over, seem susceptible to becoming dislodged from their seatings, hence fall with sufficient impact as to produce most of the essentials of a centre creating a minor earth tremor and communicating ample energy, to disturb the surrounding areas. A 26 ft. cube of limestone weighs about 1,000 tons.

Most persons visiting a limestone country in this Island can hardly fail to be impressed with the variety of contorted strata existing, and to subsidences which must have evolved during a remote past, tending to continue to disintegrate in such a way as to permit space for underground streams to be established, and so pursuing their courses of water flow for long period of time, inducing an erosive effect upon the sides of these channels.

The Island of Jamaica, similar to many other Islands, has been pronounced by Geologists to have been subjected to major periodic subsidences and upheavals, alternatively, during great epochs. This has been supported by the discovery of the presence of Marine Fauna present as fossils, shells, &c., embeddied in limestone at altitudes up to 2,000 feet or more. Limestone strata, which are of recent geological formation appear to have suffered greater contortion than of the older geological periods underlying this group.

It is obviously, therefore, reasonably conclusive that most of our minor earthquakes are consequent upon the intermittent intrusiveness of seepage water from rainfall feeding streams not too far below the ground surface.

During this period of 27 years of tabulated records of minor earthquakes, under review, there occurred, also, only six of such intensity, ranging from Class IV to V of the Rossi-Forel Scale so as to be felt throughout the Island, but occasioning no appreciable damage. They are given as follows:—

Year	1908	... ...	January
"	1914	... ...	October.
"	1924	... ...	January.
"	1925	... ...	December
"	1930	... ...	March.
"	1930	... ...	July.

Five of these occurred during dry months, and one during a wet month, October, which again demonstrate as confirmation of the theory that most of our Earthquakes are organized during the dry months of the year.

Mention must be made that during these 27 years, 1908 to 1934, (inclusive) there is a total of 480 of these minor earthquakes recorded, which is equivalent to a general average of about 18 per year.

But the former half of this period (1908-1920) figures out to 28 per annum, whereas for the latter half (1921-1934) there were only 8 per annum, clearly revealing the condition, that this Island is subject to the occurrence of fewer Earthquakes the more remote we become from the date of the eventful great catastrophe of 1907.

It is worthy of note that the Jamaica great earthquakes of 1692 and 1907 occurred nearly at the time of the driest months of February and July.

A further study of the incidence of the four maximum and minimum frequencies appearing in the Table and the Graph, has also brought to evidence that both of the maxima of February and of July coincide with the two periods of high barometric pressure over Jamaica, and, conversely, the periods of minima frequency of May and October coincide exactly with the same months of minimum barometric pressure. We are therefore confronted with two problems which are either conjoint governing factors, or causes contributing independently.

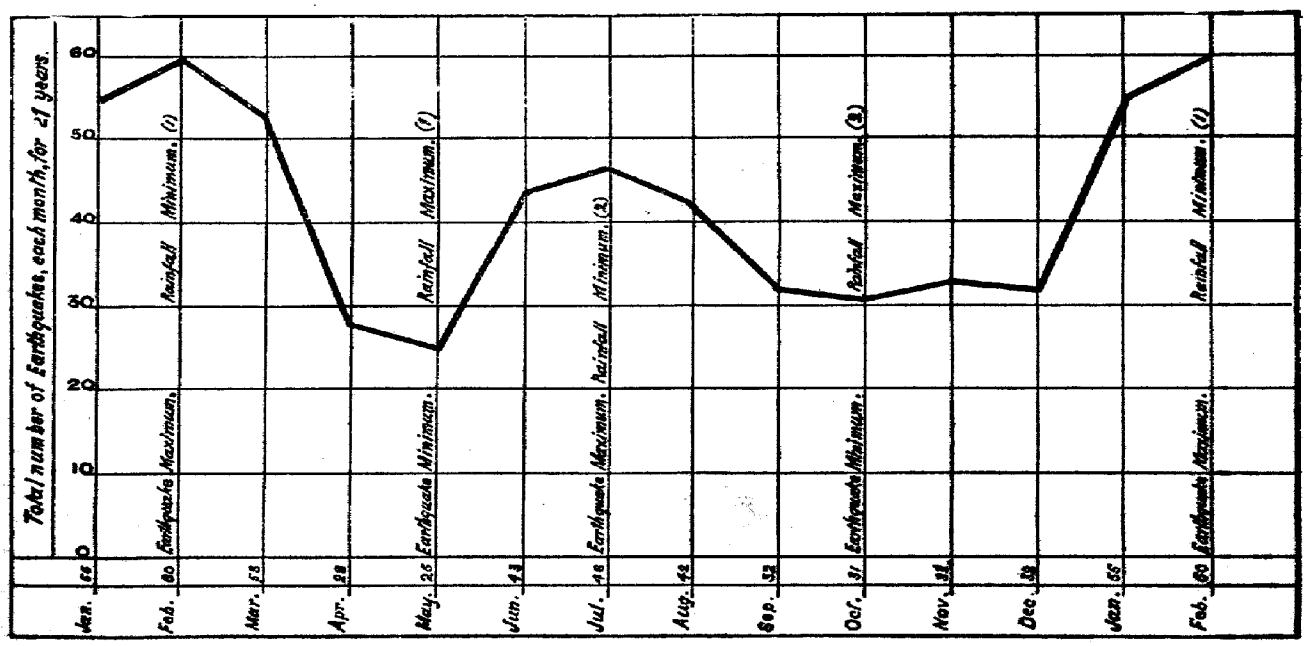
The Table of frequencies is as follows:—

Total Number of Minor Earthquakes, Each Month and Their Yearly Means.

	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Total ..	55	60	53	28	25	43	46	42	32	31	33	32	480
(Mean per year) ..	2.0	2.3	2.0	1.0	0.9	1.6	1.7	1.6	1.2	1.1	1.2	1.2	17.8

It is, obviously, also quite likely that the flooding and discharge of the relatively large underground water channels may contribute towards the development of shearing of strata, so as to create these minor local earthquakes.

Graph showing the Jamaica Earthquake Periods of Maxima and Minima, derived from the Means of 27 Years, 1908 to 1934.



BAROMETRIC PRESSURE.

Systematic barometer readings in connection with the Weather Service have been carried out at Kingston from the year 1881 until the present time with the exception of a period of 1898 to 1907 when this service, owing to financial stringency, was disestablished, and the U.S.W.B. equipped their own observation station near Halfway-Tree, St. Andrew.

Shortly after the great Earthquake of January, 1907, the Jamaica Weather Service was to some extent re-established, with the co-operation of the U.S.W. Bureau until the present time, (see Handbook of Jamaica, 1934, page 62 for particulars). Barometer readings have been, also, maintained for a number of years at Hill Garden, (formerly Cinchona Plantation) Kempshot, Negril Pt., Morant Point and Hope Gardens, results of which are to be found in the printed Weather Report.

The usual corrections are applied to nearly all the readings of the several barometers, which include instrumental error, temperature, altitude above sea-level and to gravity at 45° Lat. (—0.06 inch for Lat. 18° N.)

The following Table shews the mean barometric pressure at 7 a.m. and at 3 p.m. for Kingston derived from a period of 33 years (as in Weather Report 553A page 17). February has the greatest pressure and October the least.

KINGSTON, JAMAICA—33-YEAR

Barometric Pressure Normals Reduced to Temperature, Sea-level and Gravity 45° Latitude.

Month.	7 a.m.	3 p.m.	Month.	7 a.m.	3 p.m.
	Ins.	Ins.		Ins.	Ins.
January	29.99	29.93	July ..	29.97	29.92
February	29.99	29.94	August ..	29.94	29.89
March	29.98	29.93	September	29.90	29.85
April	29.96	29.90	October ..	29.88	29.82
May	29.93	29.88	November	29.91	29.85
June	29.95	29.90	December	29.96	29.90

The General Mean Barometric Pressure for the year gives 29.93 inches.

It should be generally understood that the barometer, during each month of the year, reads a minimum at about 3 a.m. and a maximum at about 9 to 10 a.m.; then, again, a minimum at about 4 p.m. and again a maximum at about 10 p.m. This daily fluctuation is termed the "Diurnal Variation" of the barometer. Therefore, anyone taking an observation at a particular hour, should apply the necessary correction which may be either plus or minus according to the time of the day and month in each case, in order to adjust the reading to the normal for the day.

The following Table has been prepared giving the corrections to be made for each reading to the nearest hundredth part of an inch, for every two-hour interval.

Table giving correction for Diurnal Variation, in fractions of an inch.

Month.	Hour of the Day.											
	2 a.m.	4 a.m.	6 a.m.	8 a.m.	10 a.m.	Noon	2 p.m.	4 p.m.	6 p.m.	8 p.m.	10 p.m.	Mid-night.
January ..	+01	+01	00	−03	−04	−01	+04	+04	+02	−01	−02	−01
February ..	+01	+02	00	−03	−04	−01	+03	+04	+03	−01	−02	−01
March ..	+02	+02	−01	−03	−04	−01	+03	+04	+02	00	−02	−01
April ..	+01	+02	−01	−03	−04	−01	+02	+04	+03	00	−02	−01
May ..	+01	+02	−01	−03	−03	−01	+02	+04	+03	00	−02	−01
June ..	+01	+02	00	−02	−03	−01	+02	+04	+03	00	−03	−02
July ..	+01	+02	00	−02	−03	−01	+03	+04	+03	−01	−04	−02
August ..	+01	+02	+01	−02	−03	−01	+02	+04	+03	00	−04	−02
September ..	+01	+01	00	−02	−03	−01	+03	+04	+02	00	−02	−02
October ..	+02	+02	00	−03	−05	−01	+03	+04	+02	−01	−03	−01
November ..	+01	+02	00	−03	−04	00	+03	+04	+02	−01	−02	−01
December ..	+01	+02	00	−03	−04	00	+04	+05	+02	−01	−02	−01
Mean for the year ..	+01	+02	00	−03	−04	−01	+03	+04	+03	−01	−03	−01

At this Latitude for Jamaica, 18° North, owing to the relatively higher temperature of the Atmosphere aloft, and to the tangential motion due to the rotation of the Earth, it has been found that for each 1,000 ft. altitude above sea level the barometric pressure decreases one inch up to certain limits. Unlike the experience derived for places of higher Latitude, say 45° or 50° Latitude. The scales of aneroid barometers on the market are graduated shewing that for each 900 ft. rise in altitude the pressure falls 1 inch, which if applied to Jamaica would shew an error of 100 ft. short. That is, an aneroid indicating say an altitude as 900 ft. would require about 11% added in order to obtain the correct height above the sea level, which would bring the figure to 1,000 ft. This fact is not generally known, hence frequent errors arise. The manufacturers of Aneroids do not appear to give sufficient consideration, when graduating the scale for altitude so as to also serve the needs of places of Low Latitude.

It is advised for our latitude 18° to employ the inch divisions on this instrument for each 1,000 ft., up to say, 2,000 ft., instead of using the graduations on the outer altitude circular scale, giving corresponding heights. This course simplifies calculation.

Quite a few aneroids, which are not obtained from reliable makers become easily deranged and unfit for use. A convenient method of testing for efficiency is to place the instrument in a re-

frigerator for about a quarter of an hour, which lowers the temperature to about 60°, and note whether the needle indicates the same reading. If there is much shifting of the needle the aneroid is certainly unserviceable.

The foregoing notes upon barometer readings are confined, chiefly, to places near to sea level, or up to a few thousand feet above. It may prove of interest to mention here that the extreme height of the atmosphere may reach, probably, about 200 miles (derived from observations of meteor path). At such an extreme elevation the barometric pressure would fall to zero. But one half of the weight of the atmosphere is limited to about four miles above the sea level. At this altitude the pressure would evidently fall to about 15 inches; allowing that the sea level pressure is about 30 ins. According to the Smithonian Tables No. 20 (U.S.A.) it is stated that where the barometer falls to a pressure of 15 ins. the point coincides with a height of 18,749 feet, or about 3.6 miles.

In the year 1933 (November and December) the writer carried out a series of experiments with rubber pilot balloons, at Kingston, which gave when inflated an initial mean diameter of about 25.5 ins., containing nearly 5 cubic feet of hydrogen gas. After release, when such a balloon reached an altitude of 4.1 miles the diameter was found to increase from 25.5 ins. to 32.1 ins. which will be seen to then contain about 10 cubic feet of expanded gas, or double the volume of that at ground level, shewing the atmospheric pressure was reduced to one-half.

The course adopted in order to determine the expanded diameter aloft was by means of a narrow paper belt, provided with a shifting buckle, placed on a perimeter of the balloon. As the balloon ascends the belt was automatically pulled through the buckle (sufficient extra length of belt being allowed for). When the balloon arrived at a height of 4.1 miles the belt slipped off, which event was seen in the telescope of the balloon theodolite. At that instant the altitude of the balloon was noted. This result gives about half a mile higher than that of the Smithsonian Table. This measurement must however be accepted as being approximate.

(17) TIDES.

The Ocean Tides around Jamaica are relatively insignificant, being but a few inches when compared with the great tides such as are met with in the Bay of Fundy where the flow, at times, reaches a height of 70 feet, and at some other places to a less extent. At such places where tides are great it has been noticed that there is a bay which becomes narrower, similar to a funnel. The tides from the open ocean moving towards the land, by its impact, causes the water to rise higher as the entrance of the Bay contracts in width.

Owing to great tidal action at certain shipping places much impediment is encountered in what is known in the "Establishment of the Port," where advantage has to be taken of normal tide so as to facilitate berthing.

It is generally known that the rise and fall of the ocean as tides are consequent upon the gravitational attraction of the Sun and Moon. On account of the Sun's distance from the Earth, being at times nearly 400 times that of the Moon from the Earth, despite the great mass of the Sun, the attractive force of this great luminary, acting alone, is only one-half that of the Moon, in tidal action.

In the years 1894 to 1898 the heights of the Tides in the Kingston Harbour were tabulated by the Harbour Master for Kingston. The tide-gauge used was not a self-recording one, and he had to depend upon the eye readings, taken throughout the day, upon a rod attached to a copper ball float.

The results of all the observations taken were compiled and studied by the late Mr. Maxwell Hall who published a special article in the Jamaica Weather Report No. 227 (17 pages) in May, 1898. Reference should be made to this Report should particulars for each year be required.

For general use, a Condensed Table as compiled by Mr. Maxwell Hall is herewith given. It tabulates the Semi-Diurnal as well as the Diurnal Tides, for each day of the Moon's age. This Table is repeated yearly in the Handbook of Jamaica as follows:—

TIDES ON THE COASTS OF JAMAICA.

The rise and fall of the tides round Jamaica do not exceed 16 inches.

From the late Mr. Charlton Thompson's observations in Kingston Harbour it appears there are two kinds of tides on the coasts of Jamaica. The first and more important kind are *diurnal*, giving high and low water once in every 24 hours; they occur when the moon's declination is greater than 9° north or south. The second kind are *semi-diurnal*, giving high and low water twice in every 24 hours; they occur when the moon's declination is 9° or less, north or south.

For the diurnal tides, when the moon's declination is north, the time of high water does not greatly differ from the time of the moon's lower meridian passage; and when the moon's declination is south, the time of high water does not greatly differ from the time of the moon's upper meridian passage.

For the semi-diurnal tides the times of high water do not greatly differ from the time of the moon's upper and lower meridian passage.

Semi-Diurnal Tides. Moon's Decl. Small.				Diurnal Tides. Moon's Decl. more than 9 North*							
Moon's Age.		First High Water.	Second High Water.	Moon's Age.	High Water.	Low Water.	Moon's Age.	High Water.	Low Water.
d.	d.	hr.	hr.	d	hr.	hr.		hr.	hr.
0	15	11½ a.m.	11½ p.m.	0	12½ a.m.	3 p.m.	15	12½ p.m.	2½ a.m.
1	16	12 noon	"	1	1 "	3½ "	16	1 "	3 "
2	17	12½ a.m.	12½ p.m.	2	1½ "	4 "	17	2 "	4 "
3	18	1 "	1 "	3	2 "	5 "	18	2½ "	4½ "
4	19	1½ "	2 "	4	3 "	6 "	19	3½ "	5½ "
5	20	2½ "	2½ "	5	4 "	7 "	20	4½ "	6½ "
6	21	3 "	3½ "	6	5 "	8 "	21	5½ "	7½ "
7	22	4 "	4½ "	7	6 "	9½ "	22	7 "	9 "
8	23	5 "	5½ "	8	7½ "	10½ "	23	8 "	10 "
9	24	6 "	6½ "	9	8½ "	11½ "	24	9 "	11 "
10	25	7½ "	8 "	10	9½ "	12 mnt.	25	9½ "	11½ "
11	26	8½ "	9 "	11	10 "	"	26	10½ "	12½ p.m.
12	27	9½ "	10½ "	12	10½ "	12½ a.m.	27	11 "	1 "
13	28	10 "	10½ "	13	11½ "	1½ "	28	11½ "	1½ "
14	29	11 "	11 "	14	12 noon	2 "	29		2½ "

* When the Moon's Declination in South, change a.m. into p.m. and vice versa.

Corrections to Be Applied to the Above Times for the Annual Inequality.

	Semi-diur.	Diurnal.		Semi-diur.	Diurnal.
	Hr.	Hr.		Hr.	Hr.
January	— 1	— 1	July	+ 2	+ 1
February	— 1½	— 1	August ...	0	+ 1
March	— ½	— 1½	September ...	— ½	+ 1
April	— ½	+ ½	October	+ 1	0
May	— ½	+ ½	November ...	+ 1	0
June	+ 1	0	December ...	— ½	— ½

In Kingston Harbour the range of the diurnal tide is only 8 inches; and the range of the semi-diurnal tide is only 3 inches; but these small ranges are frequently obscured by larger irregular fluctuations in the ocean level which cannot be attributed to the action of the sun or moon. Further particulars will be found in Weather Report, No. 227.

(18) MAGNETIC COMPASS, VARIATION.

The magnetic poles of the Earth are situated some distance from the Geographical Poles. The North Magnetic Pole being about 20 degrees away. They are not fixed points, but are known to be continuously changing in a certain direction, yearly, describing a somewhat circular path around the vicinity of the True North. Similarly with the South Pole of the Earth, the North Pole has been estimated, by Sylvanus P. Thompson, F.R.S., to have been situated on a certain Meridian where the compass needle pointed to Zero, and from this point to continue moving in a westerly direction, then to return to the original point on the Meridian after a lapse of 320 years.

As the North Magnetic Pole was found by Sir J. C. Ross, in the year 1831 to be, approximately, 1,000 miles distant from the True Pole, it will be obvious that only upon occasions, when the Magnetic Pole happens to coincide with the Meridian of any place on the earth, that the needle of a compass will indicate Zero difference.

Edmund Halley, the Astronomer Royal of England, in the year 1700 determined the magnetic variation of the needle at Kingston, Jamaica and reported it as being 6° 30′ to the East of the True Meridian. Also in the year 1804 James Robertson, the Island Land Surveyor, found it to be 6° 30′ East. The Magnetic Pole, so far as the compass at Kingston is concerned, was then, for 100 years almost stationary, very probably then at a region of its extreme Eastern Elongation so far as observed from Jamaica. The variation has been gradually decreasing ever since 1804, as deduced by many subsequent observers, until it now shews evidence of nearly coinciding with the Meridian of Kingston, and after this it may be expected to shew a magnetic variation pointing to Westward continually increasing to West for some 200 years in the distant future.

For the purpose of shewing the rate of progress during the past 230 years the following Table, computed (for the most part by the late Mr. Maxwell Hall) is presented:

Magnetic Declination.

The Variation of the Magnetic Needle at Kingston as Determined by Successive Observers.

Year	Observed Var. East.		Year	Observed Var. East.	
1700	6° 30′	Edmund Halley	1906	1° 24′	Colin Liddell
1804	6° 30′	James Robertson	1922	1° 17′	H. W. Bowker (1)
1876	3° 45′	Commander Green	1922	1° 10′	Carnegie Institution (2)
1891	2° 16′	J. F. Brennan	1931	0° 55′	do.
1895	2° 00′	do.			

In the year 1922 (1) Observations made on the Long Mountain Road about 2½ miles to N.E. of Kingston. (2) Observation made at Greenwich Pen about 1 mile to West of Kingston. (These happen to vary by 0° 07′ of an arc.)

If a curve be drawn to represent this successive variation, the following Table is derived:—

Year.	Variation East.	Year.	Variation East.
1700 to 1800	6° 30′	1870	4° 48′
1810	6° 27′	1880	3° 18′
1820	6° 21′	1890	2° 18′
1830	6° 12′	1900	1° 42′
1840	5° 54′	1910	1° 21′
1850	5° 30′	1920	1° 15′
1860	5° 03′	1930	0° 55′

This progressive change should be regarded as being merely approximate.

Owing to the existence of an Electric Trolley Car System in Kingston and Lower St. Andrew, the Compass Needle becomes seriously affected.

At the Western parts of the Island the Magnetic Variation is deflected somewhat more Easterly, and at the Eastern part of Kingston more Westerly. There is no Table published shewing the yearly variation of the Compass for the different localities over the Island.

(19) STANDARD TIME.

Before proceeding to include a Table giving the time of Sunrise and Sunset for Kingston, Jamaica, for each month of the year, it appears essential that some reference might be made to the subject of the adoption of Standard Civil Time throughout the Globe.

The following statement is given in the Nautical Almanac (1935) page 770. "The Time used for Civil purposes, from the introduction of clocks till the close of the eighteenth century, was local Solar Time. The substitution of Mean Time took place in most Countries late in the Eighteenth Century or early in the Nineteenth Century. At London in 1792."

"The development of railways led to the adoption of a single Meridian for each country, or each railway administration, Greenwich Time being made the legal Time in Great Britain in 1848. Afterwards, the time referred to local meridian gave place, in most countries, to Zone Time, differing from Greenwich time by a whole number of hours (or occasionally half hours) adopted in Sweden in 1879, on most of the American railways in 1883, and in most European Countries before the end of the Nineteenth Century.

Kingston mean time was in use throughout Jamaica until 31st January, 1912, when on February 1st, 1912, and from that date the 75th Meridian Time West of Greenwich has been enforced by Gazette Notice throughout the Island.

Greenwich Mean Time (Zero Meridian) has been in use on a Zone 7½ degs. on both East and West sides of Greenwich longtitude. A few of the names of places using this Zone Time are North Ireland, Irish Free State, Channel Islands, Belgium, France, Luxemburg, Spain, Portugal, Corsica, Algeria, Morocco, Gold Coast, Togoland and most other places included in the Zone.

The 75th Meridian Time, which is five hours slow on Greenwich, is the Standard time used in Jamaica. The Countries which have also joined in this scheme, by adopting the 75th Meridian, are such parts of Canada between the 68th and 90th Meridian, the Northwest Territories, from 68 degs. to 85 degs. Meridian West. The Eastern States of America (U.S.A.) including New York State and Washington. The Bahama Islands, Cuba, Haiti, Columbia, Dominican Republic, Panama Canal Zone, Chili, Peru, Western Brazil, Turks Islands and other places.

This is, of course, quite apart from the Annual temporary introduction of Summer Time, the duration of which in Great Britain, is from about the middle of April to the early days in October, when the clock is advanced one hour.

Summer time is not used in Jamaica and most places in the Tropics.

The day commences virtually 180 degs. East of the Long. of Greenwich, or 12 hours in advance of Greenwich Mean Time.

In the Southern Hemisphere this Meridian of 180 degs. is situated about 120 miles to Eastward of Wellington, New Zealand, Antipodes Island, and is at Latitude about 50 degs. South. In the Northern Hemisphere the 180 degs. Meridian passes the open North Pacific Ocean, about 150 miles to East of a very remote Island del Patrocino, Lat. 28 degs. N. Then also near to Wrangell Islands about 70 degs. North. All Meridians to East Greenwich are fast, and those to West are slow on Greenwich Time. For example, New Zealand is 11 hrs. 30 mins. fast on Greenwich, (and 12 hours fast from October to March). New South Wales (Australia) is 10 hours fast on Greenwich, therefore, when it is Noon in Jamaica, it is 5 p.m. at Greenwich the same day, and 3 a.m. at Sydney, New South Wales, the day following.

Standard Time used around the Globe.

For the purpose of comparing the time in other countries in relation to Jamaica Time, the following Table has been compiled giving the Standard Time used in those Countries and their corresponding Longitudes from Greenwich. This information should be useful in connection with events or happenings such as Political Changes, Sports, Radio Transmission, Storms, Earthquakes, &c.

Table.

Countries. (1)	Longitude used for Standard Time. (2)	Greenwich Mean Time. (3)	Jamaica Standard Time. (4)	75th Mer. When Noon in Jamaica. (5)
	°	Hours fast on	Hours fast on	Following day
Fiji Islands	180 East	G.M.T. 12	Jamaica 17	5 a.m.
New Zealand	172½ "	11½	Time 16½	4½ "
Caroline and Solomon Islands	165 "	11	16	4 "
Victoria, N.S. Wales and Queensland, Australia	150 "	10	15	3 "
Japan	135 "	9	14	2 "
Hong Kong, Philippine Ils.	120 "	8	13	1 "
Straits Settlements	105 "	7	12	Midnight same day
Burma	97½ "	6½	11½	11½ p.m.
India and Ceylon	82½ "	5½	10½	10½ "
Chagos Archipelago	75 "	5	10	10 "
Mauritius	60 "	4	9	9 "
Madagascar, Kenya	45 "	3	8	8 "
Turkey, Cyprus and Egypt	30 "	2	7	7 "
Sweden, Denmark and Germany	15 East	1	6	6 "
Great Britain, France, Spain	0		5	5 "
		Hrs. slow on		
Sierra Leone, Gambia	15 West	G.M.T. 1	4	4 "
Azores, Cape Verde Is.	30 "	2	3	3 "
Eastern Brazil	45 "	3	2	2 "
Trinidad, Canada East of 68° Porto Rico	60 "	4	1	1 "
Canada, 68° to 89° Eastern U.S.A., New York, Jamaica, Cuba and Haiti	75 "	5	0	Noon
			Hours slow on Jamaica Time	
Central Canada, Honduras and parts of Mexico	90 "	6	1	11 a.m.
Canada (W), and Mexico (W)	105 "	7	2	10 "
British Columbia, California	120 "	8	3	9 "
Sitka	135 "	9	4	8 "
Yukon, Alaska	150 "	10	5	7 "
Hawaii or Sandwich Is.	157½ "	10½	5½	6½ "
Samoa	165 West	11	6	6 "

Explanation of the Table.

Column 2 indicates the Longtitude, or Meridian, adopted for applying the Standard Time at the respective Countries shewn in Column 1.

Column 3 shews the number of hours the place may be fast or slow upon Greenwich Mean Time, for the places mentioned in Col. 1.

Column 5 gives, when it is Noon in Jamaica, the corresponding hour whether at a.m. or p.m. as it may occur on the following day or on the same day, for the several countries.

Method of Using the Table.

Example 1. A radio broadcast given out say at 5 p.m. on the 15th January from Queensland, Australia, being 10 hours fast on Greenwich Mean Time, as seen in Col. 3, and likewise 15 hours fast on Jamaica Standard Time, in Col. 4. Jamaica will be then 15 hours slow on Queensland. Consequently, it will be 15 hours earlier than that of 5 p.m., giving 2 a.m. on the 15th January, when the message should be received in Jamaica.

Example 2. A broadcast from the same place (Queensland) at 3 a.m. on 15th January will be received in Jamaica at Noon on the 14th January, or the day before, at Jamaica, for being 15 hours earlier than 3 a.m. on the 15th gives Noon on the 14th.

Example 3. Take a different case. California, which is situated 120 degs. Longitude West of Greenwich, is equivalent to 8 hours slow on Jamaica Time. A message broadcast, say, at 10 p.m. on the 15th January should be received at Jamaica at 1 a.m. on the 16th January.

(20) KINGSTON.—Sunrise and Sunset. (Sun's Upper Limb) 75th Meridian Time.

Date.	January.		February		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.		Date.
	Sun-rise.	Sun-set.	Sun-rise.	Sun-set.	Sun-rise.	Sun-set.	Sun-rise.	Sun-set.	Sun-rise.	Sun-set.	Sun-rise	Sun-set.	Sun-rise.	Sun-set.	Sun-rise.	Sun-set.	Sun-rise.	Sun-set.	Sun-rise.	Sun-set.	Sun-rise.	Sun-set.	Sun-rise.	Sun-set.	
	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	
1	6 38	5 43	6 40	6 02	6 26	6 13	6 02	6 20	5 40	6 28	5 31	6 39	5 35	6 46	5 45	6 41	5 52	6 22	5 58	5 56	6 06	5 35	6 23	5 29	1
2	6 38	5 44	6 40	6 02	6 26	6 13	6 01	6 20	5 40	6 29	5 31	6 39	5 35	6 46	5 45	6 41	5 52	6 21	5 58	5 55	6 07	5 34	6 23	5 30	2
3	6 39	5 44	6 39	6 03	6 25	6 14	6 00	6 21	5 39	6 29	5 31	6 39	5 35	6 46	5 46	6 40	5 53	6 20	5 58	6 55	6 07	5 34	6 23	5 30	3
4	6 39	5 45	6 39	6 03	6 24	6 14	6 00	6 21	5 39	6 29	5 31	6 40	5 35	6 46	5 46	6 40	5 53	6 19	5 58	5 54	6 08	5 33	6 24	5 30	4
5	6 39	5 46	6 39	6 03	6 23	6 14	5 59	6 21	5 39	6 29	5 31	6 40	5 36	6 46	5 46	6 39	5 53	6 18	5 58	5 53	6 08	5 33	6 25	5 30	5
6	6 39	5 46	6 39	6 04	6 22	6 15	5 58	6 22	5 38	6 29	5 31	6 40	5 36	6 46	5 47	6 39	5 53	6 17	5 58	5 52	6 08	5 33	5 25	5 30	6
7	6 40	5 47	6 39	6 04	6 22	6 15	5 57	6 22	5 38	6 30	5 31	6 41	5 37	6 46	5 47	6 38	5 54	6 16	5 58	5 51	6 08	5 33	6 25	5 31	7
8	6 40	5 47	6 38	6 05	6 21	6 15	5 56	6 22	5 37	6 30	5 31	6 41	5 37	6 46	5 47	6 38	5 54	6 16	5 58	5 51	6 08	5 32	6 26	5 32	8
9	6 40	5 48	6 38	6 05	6 20	6 16	5 56	6 22	5 37	6 30	5 31	6 41	5 37	6 46	5 47	6 38	5 54	6 15	5 59	5 50	6 09	5 32	6 27	5 32	9
10	6 40	5 48	6 37	6 06	6 19	6 16	5 55	6 23	5 36	6 31	5 31	6 42	5 38	6 46	5 47	6 37	5 54	6 14	5 59	5 49	6 10	5 32	6 27	5 32	10
11	6 41	5 48	6 37	6 06	6 19	6 16	5 54	6 23	5 36	6 31	5 31	6 42	5 38	6 46	5 47	6 37	5 54	6 13	5 59	5 48	6 10	5 32	6 28	5 33	11
12	6 41	5 49	6 36	6 07	6 19	6 16	5 53	6 23	5 35	6 32	5 31	6 42	5 38	6 46	5 48	6 36	5 55	6 12	6 00	5 47	6 11	5 31	6 28	5 33	12
13	6 41	5 50	6 36	6 07	6 18	6 16	5 52	6 23	5 35	6 32	5 31	6 43	5 38	6 46	5 48	6 35	5 55	6 11	6 00	5 46	6 12	5 31	6 29	5 33	13
14	6 41	5 50	6 35	6 08	6 17	6 16	5 51	6 23	5 34	6 32	5 31	6 43	5 39	6 46	5 48	6 35	5 55	6 10	6 00	5 46	6 12	5 31	6 29	5 34	14
15	6 41	5 51	6 35	6 08	6 16	6 17	5 51	6 23	5 34	6 33	5 31	6 43	5 39	6 46	5 49	6 34	5 55	6 10	6 01	5 45	6 13	5 30	6 30	5 34	15
16	6 41	5 52	6 34	6 09	6 15	6 17	5 51	6 23	5 34	6 33	5 31	6 44	5 39	6 46	5 49	6 33	5 55	6 09	6 01	5 44	6 13	5 30	6 31	5 34	16
17	6 41	5 52	6 33	6 09	6 14	6 17	5 50	6 24	5 33	6 33	5 31	6 44	5 39	6 46	5 49	6 32	5 55	6 08	6 01	5 43	6 14	5 30	6 31	5 35	17
18	6 41	5 53	6 33	6 09	6 13	6 17	5 49	6 24	5 33	6 34	5 31	6 44	5 40	6 46	5 50	6 32	5 55	6 07	6 02	5 43	6 14	5 30	6 32	5 35	18
19	6 41	5 54	6 32	6 10	6 13	6 18	5 48	6 24	5 33	6 34	5 32	6 44	5 40	6 46	5 50	6 31	5 55	6 07	6 02	5 42	6 15	5 30	6 32	5 36	19
20	6 41	5 54	6 32	6 10	6 12	6 18	5 48	6 25	5 32	6 35	5 32	6 45	5 40	6 46	5 50	6 30	5 55	6 06	6 02	5 42	6 16	5 30	6 33	5 36	20
21	6 41	5 55	6 31	6 11	6 11	6 18	5 47	6 25	5 32	6 35	5 32	6 45	5 41	6 45	5 50	6 30	5 55	6 05	6 02	5 41	6 16	5 29	6 33	5 37	21
22	6 41	5 56	6 31	6 11	6 10	6 19	5 46	6 25	5 32	6 35	5 32	6 45	5 41	6 45	5 51	6 29	5 56	6 04	6 02	5 41	6 17	5 29	6 34	5 37	22
23	6 41	5 56	6 31	6 11	6 09	6 19	5 45	6 25	5 31	6 36	5 33	6 45	5 42	6 45	5 51	6 28	5 56	6 03	6 03	5 40	6 18	5 29	6 34	5 38	23
24	6 41	5 57	6 30	6 11	6 08	6 19	5 45	6 26	5 31	6 36	5 33	6 45	5 42	6 44	5 51	6 28	5 56	6 02	6 03	5 40	6 18	5 29	6 35	5 38	24
25	6 41	5 58	6 30	6 12	6 07	6 19	5 44	6 26	5 31	6 36	5 33	6 46	5 42	6 44	5 51	6 27	5 56	6 01	6 03	5 39	6 19	5 29	6 35	5 39	25
26	6 41	5 58	6 29	6 12	6 06	6 20	5 43	6 27	5 31	6 37	5 33	6 46	5 43	6 44	5 52	6 26	5 57	6 00	6 04	5 38	6 19	5 29	6 36	5 39	26
27	6 41	5 59	6 28	6 12	6 05	6 20	5 43	6 27	5 31	6 37	5 33	6 46	5 43	6 43	5 52	6 25	5 57	5 59	6 04	5 38	6 20	5 29	6 36	5 40	27
28	6 41	5 59	6 27	6 13	6 05	6 20	5 42	6 27	5 31	6 38	5 34	6 46	5 44	6 43	5 52	6 25	5 57	5 58	6 05	5 37	6 21	5 29	6 37	5 41	28
29	6 41	6 00	..	..	6 04	6 20	5 41	6 27	5 30	6 38	5 34	6 46	5 44	6 42	5 52	6 24	5 57	5 57	6 05	5 37	6 21	5 29	6 37	5 41	29
30	6 41	6 01	..	..	6 04	6 20	5 41	6 28	5 30	6 38	5 34	6 46	3 44	6 42	5 52	6 23	5 57	5 57	6 05	5 36	6 22	5 29	6 37	5 42	30
31	6 40	6 01	..	..	6 03	6 20	5 41	6 28	5 31	6 38	..	..	5 45	6 41	5 52	6 22	..	..	6 06	5 35	..	..	6 38	5 42	31

The times of Sunrise and Sunset at Morant Point being 2 minutes earlier; and at Negril Point 7 minutes later, than the above figures. Times for intermediate places can be estimated.

The following Tables give the 75th Meridian Times of Sunrise and Sunset for each day of the year for Kingston. For other places in the Island see foot-note of Table. This Table can be used for many years hence, for the changes will be inappreciable.

Daylight Particulars for Kingston.

				Hrs.	Mins.
1. Shortest Day	...	December 21	... ...	11	04
2. Longest Day ...	...	— June 21st	6.33 a.m. to 5.57 p.m.	13	13
3. Earliest Sunrise	...	May 30th	5.32 a.m. to 6.45 p.m.	5	30
4. Latest Sunrise	...	January 20th	... ...	6	41
5. Earliest Sunset	...	November 26th	... ...	5	29
6. Latest Sunset	...	July 10th	... ...	6	46

The above refers to the Sun's Upper Limb on the horizon, and the local civil time at 18 degs. Latitude North, with seven minutes added, giving the 75th Meridian Time, West of Greenwich, in use.

(21) TWILIGHT.

It is customary to adopt the ending of Civil Twilight as the time when the Sun's centre is 7½ degs. below the horizon. Day breaks and night begins, however, when the sun is 18 degs. below the horizon. In the former ruling it would be about half an hour before sunrise and after sunset.

But the following Table derived from data given in the Nautical Almanac referring to Lat. 18 degs. North, (for Jamaica) for the beginning of morning twilight before sunrise, and the ending of evening twilight may be of service where the times are given.

Date.	Beginning of Morning Twilight Time before Sunrise.	Date.	Ending of Evening twilight, Time after Sunset.
January 1	1 hr. 18 mins. before Sunrise	January 1	1 hr. 18 mins. after Sunset
February 1	1 " 15 " " "	February 1	1 " 15 " " "
March 1	1 " 13 " " "	March 1	1 " 13 " " "
April 1	1 " 15 " " "	April 1	1 " 15 " " "
May 1	1 " 17 " " "	May 1	1 " 17 " " "
June 1	1 " 22 " " "	June 1	1 " 22 " " "
July 1	1 " 23 " " "	July 1	1 " 23 " " "
August 1	1 " 19 " " "	August 1	1 " 19 " " "
September 1	1 " 15 " " "	September 1	1 " 15 " " "
October 1	1 " 13 " " "	October 1	1 " 13 " " "
November 1	1 " 14 " " "	November 1	1 " 14 " " "
December 1	1 " 18 " " "	December 1	1 " 18 " " "

(22) THE CONSTELLATION ORION.

Right Ascension V ½, Hours. Declination about 2° South. (The Belt.)

Although observers of the sky situated much further in North Latitude than Jamaica, have the advantage of obtaining a view of this finest Constellation of the heavens, during the winter months, they will, nevertheless, secure still better advantage to observe this brilliant object from the Latitude of Jamaica. For at Meridian Passage the Belt in Orion occupies a position nearly overhead (about 20° South of the zenith) on September 24th at 5 a.m., then rising an hour earlier every fifteen days, until February 28th when it will be visible on the Meridian at about 7 p.m.

The following Table gives the respective times, just after rising, at culmination or Meridian Passage, and just before setting:

Table.

Date.		Time after rising.	Culmination.	Time before setting.
September	30th	Midnight	5 a.m.	
October	15th	11 p.m.	4 a.m.	
"	31st	10 p.m.	3 a.m.	
November	15th	9 p.m.	2 a.m.	
"	30th	8 p.m.	1 a.m.	
December	15th	7 p.m.	Midnight	5 a.m.
"	31st	6 p.m.	11 p.m.	4 a.m.
January	15th	..	10 p.m.	3 a.m.
"	31st	..	9 p.m.	2 a.m.
February	15th	..	8 p.m.	1 a.m.
"	28th	..	7 p.m.	Midnight

(28) THE SOUTHERN CROSS.

(Constellation.)

For the interest of Visitors, or Tourists, from the Northern Hemisphere, to the Island of Jamaica, who may never have had the opportunity presented to travel sufficiently to be southward, so as to be fortunate to secure the advantage of viewing the South Polar Region of the heavens, the following guide table has been prepared, giving particulars concerning one of the most interesting Constellations known as the Southern Cross, or, otherwise shewn on a Star Map as "Crux."

From this unmistakable figure of a cross will be seen at the foot the star Alpha Crux, and to the left arm the star Beta Crux, being the most brilliant of the group, and are nearly of the First Magnitude in the sky. The stars to the right and at the head are slightly less brilliant, then, there is a small star near to the centre which completes the Cross group. When this Cross rises to a point on the Meridian, or, otherwise known as the southern culmination, the centre of this figure arrives at an elevation of 12 degrees above the southern horizon, as seen from the City of Kingston. This beautiful spectacle is rendered still more attractive by the proximity of the Stars Alpha and Beta Centauri, which lie to the eastward of the Cross, and are stars of nearly the first magnitude, Alpha being the farther star from the Cross.

Alpha Centauri which was, up to recent years, considered the nearest fixed star in relation to the Earth, presenting a parallax 0.75 of a second of arc, was determined by the base line, across the mean radius of the Earth's Orbit of about 92.9 million miles being the astronomical unit employed. This parallax of 0.75 Second is equivalent to 4.35 "Light Years," or equivalent to a distance of 25.58 billion miles (British) from the Earth.

Subsequently, about the year 1929, a star of the 10th magnitude was reported to have been discovered, giving a parallax of 0.765 of a second of arc; this star would then be about 5 per cent nearer than Alpha Centauri, and it has been named "Proxima Centauri." It would, of course not be visible to the unaided eye.

The constellation Crux happens to appear above the horizon, at night time, only during the months of from January to June. This period should be found more convenient to the Winter Tourists and others visiting this Island at that time of the year. The Southern Cross will be then seen to advantage. It culminates at about midnight on March 30th, and at 9 p.m. on May the 15th, presenting favourable conditions for observation.

To enable observers to select other times most convenient to them, the following Table has been computed to give the times of rising, Meridian Passage and Setting of the Cross. The remainder of the months of the year this constellation will be situated above the horizon during daylight hours and not visible.

Although the diurnal arc described from the time of rising to that of setting occupies a period of nearly 7 hours and 40 minutes, the following Table has been arranged to give the changes by successive stages of its position, for the nearest each half month, which should be sufficiently accurate to meet the requirements of the casual observer.

As viewed from the Latitude of Jamaica this Constellation rises somewhat to the Southeast, and sets somewhat to the Southwest.

THE SOUTHERN CROSS.

R.A. XII ½ Hours, and Dec. 60° S.

As Jamaica is about 18° Lat. North the centre of the Cross at culmination, or Meridian Passage, will be visible then with an elevation angle of about 12°.

The Table below gives the times of rising, Culmination and setting during such months when above the horizon at night time, which happen to be between January and June.

Date.		Time of rising.	Time of Culmination.	Time of setting.
January	15th	1.30 a.m.	5 a.m.	
"	30th	12.30 a.m.	4 a.m.	
February	14th	11.30 p.m.	3 a.m.	
"	28th	10.30 p.m.	2 a.m.	5.30 a.m.
March	15th	9.30 p.m.	1 a.m.	4.30 a.m.
"	30th	8.30 p.m.	Midnight	3.30 a.m.
April	15th	7.30 p.m.	11 p.m.	2.30 a.m.
"	30th	..	10 p.m.	1.30 a.m.
May	15th	..	9 p.m.	12.30 a.m.
"	30th	..	8 p.m.	11.30 p.m.
June	15th	..	7 p.m.	10.30 p.m.

From July to December the Culmination occurs during daylight hours and invisible to ordinary eye observation.

The Cross will be seen to better advantage at the time of Culmination or, otherwise, when on the Meridian.

The following publications, which have been issued from time to time, deal in a more exhaustive manner, with most of the subjects included in this treatise.

The Kingston Barograph	Weather Report	No. 192
Wind Movement, Kingston	do	No. 385
The Diurnal Variation of Rainfall	do	No. 358
Geology of Jamaica	do	No. 420
Notes of Hurricanes, Earthquakes &c.	do	No. 455
Cloud Drift	do	No. 468
The Diurnal Variation of Rainfall	do	No. 521
Meteorological Results for 33 years	do	No. 558A
Tables of Rainfall Records for Kingston for 60 years ...	do	No. 665
Table of Wind Milage for Each Month for 25 years ...	do	No. 689
Evaporation Tables for 10 years	do	No. 690
Parish Rainfall Normals for 10 years	do	No. 701

PUBLICATIONS OTHER THAN THE WEATHER REPORTS.

Earthquakes in Jamaica, Year 1688 to 1919	(Ed. 1922)
Jamaica Yearly Meteorological Observations for the Meteorological Office London.	
The Rainfall of Jamaica, 60-Year Normals	(Ed. 1934)
Meteorology of Jamaica (Maxwell Hall)	(Ed. 1904)

Most of the above articles and works may be had access to at the Institute of Jamaica, Library.