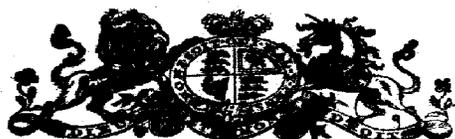


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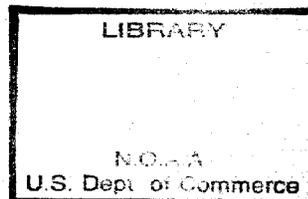


# CLOUDS AND CLOUD-DRIFT

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# THUNDERSTORMS IN JAMAICA.



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## CLOUDS AND CLOUD-DRIFT.

There is considerable confusion among writers on Meteorology in the naming and classification of Clouds. Early in the present century Luke Howard proposed a system based upon the three primary forms, *cirrus*, *cumulus*, and *stratus* and their compounds *cirro-stratus* and so on. I believe that it was the want of proper definition of the form and compound forms which led to the confusion. There is at present, however an International movement towards uniformity in cloud nomenclature based upon Howard's system as applied to clouds observed in northern Europe. Professor Hildebrandsson of Upsala published a Cloud-Atlas a few years ago, and his classification has recently been approved by the International Committee. It is therefore advisable to state what clouds have hitherto been registered in Jamaica, what modifications should now be introduced, and to describe each cloud as carefully as possible.

Between 1880 and 1890, the Weather Service in Jamaica followed the Instructions to Observers of the United States Signal Service:—

“Clouds will be recorded on a scale of from zero to ten, zero being clear, and ten cloudy.

The following will be recorded as *Upper* clouds: *cirrus*, *cirro-stratus*, *cirro-cumulus*, and *cumulus*.

The following will be recorded as *Lower* clouds: *cumulus*, *stratus*, *cumulo-stratus*, *nimbus*, and *fog*. *Cumulus* clouds may be reported either as upper or lower clouds, depending upon the position they occupy.”

The clouds are not described, but there are several wood-cuts illustrating clouds as classified by Howard.

But Howard's *cirro-stratus* has never seemed satisfactory to me, and the term has always been applied here to thin sheets of fibrous texture as described further on. Again our *cumulus* here is often in the summer months a gigantic mass of cloud 10 miles in diameter and 6 miles high; and I have always regarded *cumulo-stratus* as a number of small irregular *cumuli* whose bases are all on the same plane. But according to the Cloud-Atlas *cumulo-stratus* should be omitted; and we must now include as *cumulus* what we have hitherto considered as *cumulo-stratus*.

With regard to the division of clouds into Upper and Lower by the U. S. Signal Service, I think it would be an improvement to divide them into the three primary divisions, *cirrus*, *cumulus* and *stratus*. It is true that three columns would thus be required in the register for clouds; but then the average cloud-drift of each division could be far more easily studied than at present. During the hurricane months in Jamaica, clouds of the *cirrus* class move from the ENE., clouds of the *cumulus* class move from the SE, and clouds of the *stratus* class move from the E. The importance of such generalization cannot be over-estimated: for instance with a slightly falling barometer and *cirro-stratus* drifting from the ENE an observer would be justified in supposing that a cyclone was approaching Jamaica from the Windward Islands on the usual cyclonic path if it were not for the fact that *cirro-stratus* generally *does* come from the ENE at that time of the year.

Since 1890 we have further adopted the *Alto-stratus* of the Cloud-Atlas, a watery looking cloud; and also *Strato-cirrus* which has been referred to by Mr. Abercromby.\* And we can now easily adopt three other clouds from the Atlas:— *Alto-cumulus*, or small *cumuli* at a considerable altitude; *Strato-cumulus*, or long rolling waves parallel to the horizon; and *Cumulo-nimbus*, or *Cumulus* from which rain is falling. But *Stratus* requires further consideration. We have very little fog, and therefore very little “lifted fog”, the new definition of *stratus*. But we almost always have some broken *strati-form* cloud moving along with the lower and easterly atmospheric drift, especially in the mornings. This may soon change into *Cumulus* in the summer time, or it may thicken in the winter time into what has hitherto been called *Cumulo-stratus*, or into *Stratus*. Now if we omit *Cumulo-stratus*, we are obliged to call this cloud *Stratus*, and to adopt the term *Fracto-stratus* for the small detached fragments.†

It now remains to describe these clouds as distinctly as possible.

As a rule *Cirrus* in its various forms is seen in Jamaica daily during the summer and autumn months especially between 6 and 7 o'clock in the morning: it is hardly seen during the rest of the year. *Cumulus* may be seen all through the year but receives its full development only during the summer and autumn months. The conditions under which *stratus* is seen have just been described. The following notes and remarks therefore chiefly refer to the Clouds and Cloud-drift usually seen over Jamaica during the hurricane months of August, September and October, when the subject is of great importance in connection with Storm-warnings and in tracing the paths of distant Cyclones, and they were made from actual observations extending over some years at the Kempshot Observatory..

(1.) *CIRRUS*. This cloud consists of long fibrous threads, often blown by the upper currents into such forms as feathers, mares' tails &c. When the threads or feathers point towards the observer they appear like wisps of hay or straw. This is the pure form of *cirrus* and it is caused by the condensation of thin ascending streams of vapour, and by the freezing of the particles of water.

But there is a modified form, to which Mr. Abercromby has paid great attention, consisting of long thin stripes of threadlike *cirrus*; and these *cirrus-strips* are formed by small compact cloudlets which leave these threads behind them as they move along.

These ice-clouds are often at great elevations; from the rate of decrease of temperature with the height above sea-level it appears that the freezing point of water is reached at an elevation of about three miles; this height is therefore the lower limit of *cirrus* over Jamaica.

\* *Weather* p. 101.

† It will be shown further on that the new definition really includes our *Stratus*.

Cirrus is often seen in the morning about sun-rise during the summer and autumn months, but they rapidly disappear as the temperature of the day increases; under these circumstances they are fine weather clouds, and it is only when they increase in extent and develop into cirro-stratus that they can be connected with bad weather.

According to the following table there seems to be a well-marked upper current from the ENE during the autumnal months:—

			Average drift.
N	...	...	7
NE	...	...	26
E	...	...	28
SE	...	...	8
S	...	...	4
SW	...	...	7
W	...	...	13
NW	...	...	7
			100

(2.) CIRRO-STRATUS. This cloud consist of thin sheets of fibrous texture; the threads often seem to interlace, when the clouds appears to be woven. Solar halos, mock suns &c. are caused by the ice-particles of which this cloud is composed.

Cirro-stratus is always found to surround the advancing half of a cyclone: and hence its importance in forecasting the weather. The lower limit is the same as that of cirrus; and it also shows the existence of the ENE current.

			Average drift.
N	...	...	9
NE	...	...	25
E	...	...	27
SE	...	...	18
S	...	...	6
SW	...	...	6
W	...	...	5
NW	...	...	4
			100

(3) CIRRO-CUMULUS. This cloud consists of thin sheets of small and separate flakes arranged more or less regularly along two sets of parallel lines. When seen at great elevation the arrangement or the flakes resembles that of the scales of mackerel; when seen lower down the larger square of lozenge-shaped flakes give the sky the appearance "of a gigantic chess-board."

The flakes have no fibrous texture, but the parallell lines refer them to Cirrus; for long Cirrus stripes are often striated, or cut off into small and equal lengths, and if a number of such stripes were placed side by side we would have the form but not the texture of Cirro-cumulus. This may be some apology for the word *cirro*; but there can be little or none for the word *cumulus*; because the new cloud Alto-cumulus is very similar to (3) with this difference that the component parts are soft rounded masses—small cumuli in fact.

(4) STATO-CIRRUS. A cloud somewhat resembling cirro-stratus but thick and woolly. It is a purely Tropical cloud according to Mr. Abercromby, and naturally enough it has not received much attention from the meteorologists of northern latitudes.

When rain begins to fall from a large cumulus, a quantity of cloud is poured into the air from the top of the cumulus, as smoke from a factory chimney; This takes place in all parts of the world when rain falls from cumuli, but in the temperate zones only a little *false cirrus*, or cirri-form cloud, is thrown off. In Jamaica the process is on a gigantic scale, and the cloud is spread out as a sheet far and wide so as to shade the land for some hours from the direct rays of the afternoon sun. It is therefore a common cloud in the west-central district of Jamaica during the summer and autumn months.

Its texture at first is thick and woolly, but as it spreads, the sheet becomes thinner; it then generally settles down as Stratus, and finally it disappears a little after sun-set leaving the evening sky perfectly clear. As it spreads and settles the typical features of Cirro-stratus and of Alto-stratus may sometimes be seen, but such features are not lasting.

Now by means of a sextant some careful observations were made of the altitude of the tops of well formed Cumuli whose distances could be ascertained by this rain falling on mountain ranges or by the average interval between the distant thunder and lightning; and it was found that the average height of such well formed Cumuli during the autumn months was as much as six miles! At this elevation the temperature is below zero, and strato-cirrus when spread out as described above must be very fine *snow* as distinguished from the very minute particles of ice which form cirrus and cirros stratus. This very fine snow then falls slowly by its own weight; and melting, it often produces those quiet after-rains which follow the heavy rains and squalls of the Cumuli.

From what has been said about the spreading out of this cloud and its shading the land from the afternoon sun it might be supposed that it had no average drift; but if well formed cumuli at considerable distances be watched, it will be found that while their average drift is from the SE at this time of the year over the western half of Jamaica, the drift of the strato-cirrus issuing from them is generally NE.

(5) CUMULUS. This cloud consists of large rounded masses resting on flat bases; it is often called the thunder cloud. Its texture is apparently very solid; and it is formed by ascending columns of heated vapours which no doubt increase the temperature of the clouds far above that of the surrounding air, and which move along with the cloud.

It has been already said that these clouds are formed on an enormous scale over Jamaica; and Plate 8 of the Cloud Atlas is therefore hardly adequate.

When rain falls from the base of the cloud it is called

(6) CUMULO-NIMBUS, and this rain takes up the drift of the whole Cumulus. The velocity of the wind accompanying the rain is thus the same as the velocity of the whole cloud; and these squalls are sometimes very severe especially in the mountains.

When rain begins to fall from the base, the symmetrical form of the clouds gives way, the top spreads out, and the result is an anvil-shaped cloud. Let this process be continued on a large scale and we have Strato-cirrus as described above, from which all trace of cumulus has disappeared. On a small scale the tendency of the small cumuli is to spread over the sky as stratus and to fall as rain; and this cloud was called Cumulo-stratus by Sir John Herschel and other writers. We have hitherto taken a wider view of cumulo-str. and applied it to a collection of small stratified cumuli, which may develop into cumuli, especially in summer and autumn, or which may degenerate into stratus, especially in winter.

Over the western half of Jamaica the drift of this cloud accompanied by its rain is from the SE. Lucea is the best place of observation; because the surface wind there almost invariably sweeps in from the NE or ENE; and the approach of the heavy rains at right angles to the fresh sea-breeze cannot escape attention.

Comparing the drift of the surface wind, E to NE, with the SE drift of cumuli, we have apparently a well marked example of the law of veering of upper currents; but the still higher currents are NE, or contrary to that law; and the boundary plane is so clearly marked at times that, as already said, cumulus may be moving from the SE throwing out a quantity of Strato-cirrus from the NE. A systematic study should be made of the three division of clouds and their drift.

(7) ALTO-CUMULUS. A thin sheet of small separate clouds arranged more or less regularly into groups or lines. The clouds are soft rounded masses like fleeces of wool; and the whole cloud often resembles a flock of sheep.

Its average drift is from the SE.

(8) ALTO-STRATUS. "A thin sheet of a grey or bluish colour showing a brilliant patch in the neighbourhood of the sun and moon, and which without causing halos may give rise to coronæ"\* Thick and thin are merely relative terms; and this cloud is *thin* when compared with Strato-cirrus. It has a soft watery look. It is not often seen in Jamaica.

(9) STRATO-CUMULUS. "Large globular masses or rolls of dark cloud, frequently covering the whole sky, especially in winter, and occasionally giving it a wavy appearance. The layer of Strato-cumulus is not, as a rule, very thick, and patches of blue sky are often visible through the intervening spaces."\* Mr. Abercromby writes, "Another form of Strato-cumulus is very common in the tropics. The component masses of cloud are more isolated than in Great Britain, and so thin that when seen in perspective each only looks like a dark thin bar, and, with the brighter intervening spaces, the whole sky near the horizon is striped like a Venetian blind. Nearer overhead we see only the irregular flat base of scattered clouds without any trace of arrangement or bars. The difference between these apparent long bars and real stripes of cirrus can be detected in a moment by turning in any direction. The bars of strato-cumulus follow you by remaining parallel to the horizon whichever way you look, for the linear arrangement is only an effect of perspective; while cirrus-stripes always converge to the same point on the horizon."†

(10) NIMBUS, simply means the rain-cloud; and as we have already discussed Cumulo-nimbus, or Cumulus as a rain cloud, this form should certainly be called strato-nimbus; we give the definition adopted by the Cloud-Atlas Committee:—"a thick layer of dark clouds without shape and with ragged edges from which continued rain or snow generally falls. Through the openings in these clouds an upper layer of cirro-stratus or alto-stratus may almost invariably be seen."

(11.) STRATUS:—"a horizontal sheet of lifted fog. When this sheet is broken up into irregular shreds by the wind, or by the summits of mountains, it may be distinguished by the name of *fracto-stratus*."

Fogs lie during the night in the valleys in Jamaica, especially in St. Thomas-in-the-Vale and in the interior part of Hanover, Westmoreland and St. James; and the morning sun dispels them about two hours after sun-rise: if the morning be still and calm a cloud will be subsequently observed high above the valleys which the fog had previously filled; and the above definition should be considered to include any low horizontal sheet of smoke like cloud condensed out of lifted invisible vapour. In consequence

(12.) FRACTO-STRATUS is the commonest cloud in Jamaica, winter and summer alike. In summer it develops into Cumulus, in winter it develops in accordance with the above nomenclature, into Cumulus, or Stratus, or perhaps Strato-cumulus.

The last three classes of cloud form the lowest division. Its easterly drift is of course due to the great anti-cyclone in the North Atlantic; and this lowest current may be termed the Trade-wind current. It extends upwards from the surface of the sea to about one mile, but between the surface and 1,000 feet the current is greatly affected by sea and land breezes. The easterly drift varies with the time of year; in the winter it is E.N.E. or even N.E.

\* Report of the Committee on the Cloud Atlas.

† Weather, p. 109.

A brief summary or description of the twelve clouds named above is here given :—

Cloud.	Brief Description.	Primary Form.	Drift.
1. Cirrus	... Fibrous threads ; mares' tails.	} Cirrus.	E.N.E.
2. Cirro-stratus	... Thin sheets of fibrous texture.		
3. Cirro-cumulus	... Flakes ; mackerel-back.		
4. Strato-cirrus	... Thick sheets of woolly texture.	} Cumulus.	S.E.
5. Cumulus	... Rounded solid masses.		
6. Cumulo-nimbus	... Cumulus discharging rain.	} Stratus.	E.
7. Alto-cumulus	... Fleeces of wool ; flock of sheep.		
8. Alto-stratus	... Watery veil.		
9. Strato-cumulus	... Long rolling waves parallel to the horizon.		
10. Nimbus	... Stratus discharging rain.		
11. Stratus	... Low horizontal sheets of smoke-like cloud.		
12. Fracto-stratus	... Fragments of stratus.		

MAXWELL HALL.

September, 1895.

### THUNDERSTORMS IN JAMAICA.

Throughout the West Indies thunderstorms occur daily during the wet season : the following remarks apply more particularly to Jamaica.

The late Prof. J. C. Houzeau lived in Jamaica between the years 1869-73 ; his residence was about 6 miles NE of Kingston at the foot of the St. Andrew's mountains, and he made certain meteorological observations which were published in Brussels, from which the following table is taken ;—

*Number of days of Thunder.*

		Totals for 5 years.
Jan.	...	4
Feb.	...	3
Mar.	...	2
Apr.	...	2
May	...	28
June	...	31
July	...	42
Aug.	...	50
Sept.	...	59
Oct.	...	23
Nov.	...	9
Dec.	...	16
Total for 5 years	...	269

Now all along the central line of hills in Jamaica heavy rains accompanied by thunderstorms occur every afternoon from the beginning of May to the end of October\* ; and at the Kempshot Observatory where I have lived more or less continuously for twenty years, thunderstorms occur so frequently that unless some recognised system of recording their number be established there is but little use in making notes. Three or four thunderstorms may often be seen and heard in progress at the sametime ; two or three thunderstorms often pass over the place of observation during the same day ; and sometimes a number of small storms join together, intensify, and sweep the Island from its middle westwards, the rain-curtain being at least 30 miles in length, and the lightning being incessant along the line of advance.

Consequently the numbers in the table above must be accepted with the greatest caution : for instance it is perfectly true that a little distant thunder may often be heard in December, and I have no doubt that such thunder has been heard on 16 days during the 5 years in question ; but the numbers 16 and 59 applying to December and September are wholly misleading as to the frequency and intensity of thunderstorms during those months ; 16 and 5,000 would be much nearer the mark in the west-central parts of Jamaica !

Thunderstorms rarely occur in Jamaica except when rain is falling, or is about to fall, from large cumuli ; and the lightning is almost invariably straight down to the ground. As a rule the heavier the rain, where time and quantity are both considered, the greater the thunderstorm ; but there are marked exceptions to this rule ; so that the quantity of electricity in the cloud has to be taken into consideration, as well. Lightning consequently easily " makes earth " in Jamaica by means of the wet trees ; and it is only during the month of September when thunderstorms are at their maximum that any anxiety need be felt. For the protection of buildings I have recommended an arrangement which has answered well for many years at Kempshot : † a copper rod  $\frac{3}{8}$  of an inch thick is attached to a pole (or flag staff) which is much higher than the surrounding buildings ; the rod terminates in a few copper spikes, and is well connected with a large copper earth-plate. This lightning conductor is not connected with the buildings.

\* A mistake occurs in Sir J. Herschel's Meteorology ; Reprint from Encyc. Brit. Second Ed. 1862, p. 135.

† See Weather Report No. 136.

The buildings have all the metallic gutters connected together and with the earth by means of a small rod attached to the kitchen chimney, this second rod also having spikes above and an earth-plate below. And then by means of the two earth-plates and some very simple galvanic apparatus,\* it becomes easy to test the conducting power of the rods and plates from year to year.

The taller rod is often struck, when it makes a sound like a dull crack of a whip, and then thunder is heard in about 2 seconds from over head. It often happens that the rod is thus struck twice in 5 minutes.

Hail does not often fall in Jamaica; tornadoes are almost unknown; and waterspouts are seldom seen at sea.

But although hail does not often reach the ground it can sometimes be heard falling at a great height in the air; the sound is like that of the rushing of a railway train at the distance of a mile or so; and the rain which reaches the ground is cold at Kempshot, 1,773 ft. above the sea-level, and cool at the sea-level, the temperatures being about 65° F. and 75° F. respectively. Now 65° is below the usual daily minimum at Kempshot, and the anomaly of having a min. reading at the hottest time of the day is got over by resetting the min. thermometer after every such shower. But as 75° is above the min. near the sea-level, no such resetting is there required.

Now as far as altitude is concerned the temperature decreases under normal circumstances in Jamaica at the rate of 1° for every 315 ft.; but when rain is falling from a thunder cloud the rate is 1 for every 177 ft. according to the circumstances stated above.

The barometer rises about 0.03 inch in a quarter of an hour before the passage of the centre of the storm, and then falls to the same extent in half an hour after the passage of the centre.

As the cumulus and nimbus approach the sound of the rain on the leaves of the forests may be heard at a distance of two or three miles; then the surface wind begins to blow towards the storm, and no doubt upwards at the same time: then there is a calm; then cool wind blows from the storm; and finally the wind and rain come together in squalls. This rain-wind is merely due to the passage of the cumulus and nimbus taken as a whole: that is to say, if the cumulus rain and all be drifting through the atmosphere at the rate of 20 or 30 miles an hour this will be the velocity of the rain-wind at the surface.

In the case of large cumuli which discharge rain and lightning we have therefore mechanism different to that which produces tornadoes and cyclones. It may be asked if I have never observed rotatory motion round the axes of cumuli, and my reply is, only on one or two occasions when if the action had been continued some minor form of whirlwind would have been experienced. For the origin of cyclones we must undoubtedly look to large areas of low pressures round which the winds may begin to sweep urged by the differential effect of the earth's rotation upon moving currents of air.

MAXWELL HALL.

\* A circuit is completed as in a telegraph and the resistance is measured with a rough tangent galvanometer.

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