METEOROLOGY.

Rainfall—as Variation with Elevation of the Gauge.

By CHARLES CARRENS, F.R.S.

The fact is well known to meteorologists that the quantities of rain received in gauges placed at different heights above the ground diminish as the elevation of the gauge increases. Several attempts have been made to explain this phenomenon, but none of them are so satisfactory as to discourage the search for other causes that may contribute substantially or mainly to its production. Hence the submission of the following communication to the British Association for this further attempt.

One of the principal causes of rain is undoubtedly the transfer, effected by means of air charged with moisture in a warm damp district to a colder region, where the vapour remains in the atmosphere being reduced by this transfer, it may easily be inferred that condensation of vapour may also occur in the lower strata, as well as the strata of higher strata of the atmosphere being reduced by this transfer, it may easily be inferred that condensation of vapour may also occur in the lower strata, as well as the higher strata. The rain caught by a gauge at any given elevation will, therefore, be the sum of the condensations in all the strata above it, and thus the lower a gauge be placed, the greater will be the quantity of rain received by it. Again, it is known by observation that at all times greater or lesser diminution of electrical tension between the atmosphere and the surface of the ground. If, then (in accordance with the views of Prof. Andrews as to the continuity of the liquid and gaseous states of matter, from which it follows that the change of state of additional physical properties must also be continuous), we regard the particles of vapour suspended in the air as electric bodies in relation to the electric principal current of the atmosphere, then the variation of intensity of electric polarization of the ground. This polarization will give rise to an attraction between every particle and the neighboring particles above and below it, and being stronger in the particles nearer the ground than in those more remote, the tendency of the particles to coalesce (which will increase, by their mutual attraction, as two neighbors approach each other) will be greater near the ground. Thus it may be that each particle gathering to itself its neighbors successively till their united effect exceeds that of the atmospheric current generally, that some rain-drops are formed, and that in greatest abundance, near the ground. If this be the true cause of any substantial part of the phenomenon in question, then the variation of intensity of electrical polarization of the particles will vary with height most rapidly near the ground, so that the variation in the rainfall near the ground should be more rapid than at a greater elevation; and such is indeed the fact. Also, if this idea be correct, it will probably serve to explain other phenomena which it was not specially intended to meet; and so it does. For instance, it requires that the rainfall over even portions where the electrical tension is relatively weak, should be less than over similarly associated forest-land, where, at the tops of the trees, ends of branches, and edges of leaves, the tension is high; and this is in accordance with observation. And usually, the tension being relatively high at the tops of the elevations of a mountainous district, the rainfall should be greater there than in the valleys, as it is, in accordance with observation. Further, at the commencement of a rising thunder-storm, a sudden heavy shower of rain will often fall for a few moments, and then suddenly cease. May not this arise from the approach, by the agency of opposite wind-currents, of detached masses of oppositely charged clouds, the former, just described, of formation of rain-drops going on rapidly in each mass as the two come near each other, and stopping when, by a flash of lightning between them, the two masses are brought into the same electrical condition?

Barometric Predictions of Weather. By FRANCIS GALTON, F.R.S.

In solution that the movements of the barometric column correspond in some way to the changes of the weather, and that there is certainly no notice of the rapid and tumultuous changes of its velocity which are recorded by the jagged lines of a pressure-stationer. They therefore correspond to mean values of the weather; but the way in which, and the time of days for which those means are taken, has yet to be determined. The equation was made between a curve formed on the earth's surface and a point representing the mean velocity of the wind for half an hour previous to it, if half an hour subsequently to the mean velocity of the wind for half an hour previous to it, then the mean for the same time-scale as the corresponding barogram; the time-scale was so adjusted as to allow about the same length in the diagram for the two curves, and the ordinates were measured from above down (generally) or at the extreme of that period. The mean for the same time-scale as the corresponding barogram; the time-scale was so adjusted as to allow about the same length in the diagram for the two curves, and the ordinates were measured from above down (generally) or at the extreme of that period.

The movement of the air is not the only thing to be considered; the temperature of the atmosphere also. It is possible that there is a certain and specific temperature corresponding to the given rising humidity. The scale is based on the observations of the daily and monthly means of the daily and monthly means which may be represented by a scale constructed on the same plan. Interpolation in each case with such a scale than with a table.
The correspondence was equally good at all periods, for which trial was made, between 12 and 16 hours, some parts agreeing better at the shorter, others at the longer period. The former period is selected for discussion in this memoir. The data are derived from some of the continuous weather-records lately published by the Meteorological Committee for the first quarter of 1809, on so far as they refer to Plymouth. The correspondence of the 12-hour period for wind rose curves as well as barograph, is fairly satisfactory. The curves of the two vortices are, on the whole, simultaneous, since neither curve habitually anticipates the other; but they are seldom absolutely simultaneous.

They correspond in extreme positions as closely as in near ones, giving that it is not the absolute height of the barometer, but the variation in its height, which indicates change of weather. The dominant influence of the wind-velocity upon the barometer was made manifest by undertaking different courses at sea and on land. The barometer is, so to speak, a measure of the pressure caused by the winds, and it was observed that the pressures of the two curves were, on the whole, much the same, whatever might be the quality of the wind.

The reason of the correspondence of the barograph with a 24-hour average curve was thus discussed, and was described as similar to that which causes a meteoro-metric barograph, when plunged into, or choked by, a height of sea water, to sympathize, not with the height of the wave exactly above its center, but also with that of every point in the surface area whose diameter is a function of the depth of immersion. As the barometer sympathizes with the condition of the air for some distance on all sides of it, and as there is a general easterly movement of the air over England, it appears that the diameter of the circle of air which affects the barometer is such as to require, on the average, 12 hours to pass over an observatory. A barometer would therefore be affected by an atmospheric wave of exceptional magnitude before it reached the observatory. According to this argument, the effect of the independent variables, temperature, and damp must be treated as the same system of 12-hour period of average as the wind's velocity. Consequently the following formula is deduced. Let A, B, C, be the average heights of barometer, atmospheric pressure, and temperature, and use a similar notation for k and c. The units adopted were hundreds of an inch for barometer and vapour-pressure, and one degree Fahrenheit for temperature. The general formula was:

\[ A = \frac{(y_2 - y_1) + (c_2 - c_1) + (d_2 - d_1)}{a + b + c}. \]

The coefficient of \( x_2 - x_1 \) and \( y_2 - y_1 \) by taking a number of selected equations in which neither \( x_2 \) nor \( y_2 \) had materially varied during the period discussed; a was found to be 1 by taking the extreme range of the barometer under the influence of changes, and \( d \) and \( y \) were also 1, so that, if the velocity was not at all real, that it was taken at its real value, but with a negative constant; all the other relations are negative, because \( x_2 \) and \( d \) all a decrease as it increases.

\[ A = \frac{(y_2 - y_1) + (c_2 - c_1) + (d_2 - d_1)}{a + b + c}. \]

It will be observed that \( y_2 \) is necessarily eliminated. Comparison was made between the value of \( y_2 \) by this predicted by the curve, with its influence on barometric, and above the other variables being constant, \( d \) was assumed as \( c \), and the sign for \( a + b + c \) is subtracted. About 100 cases of marked changes of weather were taken, and it appeared that the average error was one-third greater than that \( y_2 \) had been predicted as simply equal to \( y_1 \). The reason why the average error is so large, notwithstanding the