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THE METEOROLOGICAL OFFICE.*

THE Report of the Meteorological Committee of the Royal Society, recently presented to Parliament, contains a paragraph which is either of vital moment to the steady progress of meteorology and to that continuity of record which is so striking a characteristic of British observations, or else meaningless. We therefore lose no time in bringing the Report before our readers. Following our usual custom, we shall offer a few brief remarks on the Report in the order in which they arise; the important paragraph to which we desire to call attention being near the end of the Report, will therefore be noticed at the close of this article. The following paragraph rather amusingly illustrates the distinction without a difference between the Hydrographical and Meteorological Offices:—

“The Hydrographic Office of the Admiralty, having expressed a wish to undertake the entire management of the deep sea thermometers, to which allusion was made in the last Report, on the ground that these instruments were essentially hydrographical and not meteorological, the Committee have at once acceded to the request, and no addition has been made to the stock of these thermometers during the year.”

We are glad to see promised a thorough discussion of the weather in the Atlantic at the time of the loss of the “City of Boston;” this to our mind is exactly the class of work which the attention of the office should be directed.

We also consider nearly all the changes in the telegraphic reporting stations improvements, especially the substitution of Scilly for Penzance, and the addition of Sumburghead.

Our readers may recollect a short article on “Weather Maps” in our July number. We had not then seen the very primitive effort referred to in the following paragraph in terms with which we by no means agree. We hope that the Committee will see that something more worthy of this country is promptly issued.

“A very important step in advance has been made by the enterprise of Sir W. Mitchell and Capt. Chas. Chapman of the “Shipping and Mercantile Gazette.” These gentlemen have proposed to publish daily in that paper, which appears at

* Report of the Meteorological Committee of the Royal Society, for the year ending 31st December, 1870. 8vo, 57 pages, 1 plate. Eyre & Spottiswoode.

3 p.m., a chart of the winds at the principal stations on the coasts. This plan, which was set in operation at the beginning of the year 1871, is calculated to be of great value to the cause of meteorology. It may be hoped that, ere long, the barometrical and thermometrical readings may be given, as well as the wind, but the serious difficulties which are met with in adapting such a chart to the exigencies of newspaper printing, though they have been satisfactorily surmounted by Sir W. Mitchell, are a sufficient reason for proceeding with caution."

The Committee having incurred an enormous expenditure, and bestowed the major part of their attention on the establishment of their self-recording observatories, seem to us rather to over-estimate the utility of the results which they expect to deduce from them. For instance, take the following paragraph with reference to starting another observatory :—

"Such an addition to their system would be, in every way, desirable, and the more so as *it is now universally admitted that the study of continuous automatic records is indispensable for all investigations connected either with climate or with weather.*"

We have italicized words which surely the Committee cannot have fully considered. We have so often expressed our approval for some purposes of automatic registration, that we shall not be misconstrued as condemning its adoption, although we meet the above paragraph with a flat denial. It is not "universally," and we do not believe that it is at all "generally" admitted, that the study of continuous automatic records is indispensable for all investigations connected either with climate or weather." If the term climate had not been so distinctly separated from weather, it might have been supposed to be a *lapsus stylæ*, to which everybody is liable. But as it is, it evidently expresses the settled conviction of the Committee, or at any rate of the writer of the Report.

If automatic records are *indispensable* for all investigations connected with climate, it is evident that Blodget's "Climatology," Mühry's "Klimatologische," Sir J. Clark's "Climate," Scoresby-Jackson's "Medico-Climatology," and scores of other works, are useless. We do not think so.

Again, if they were indispensable, we might at once abandon all hopes of investigating the climates of our health resorts. Take the Isle of Wight: we hold that there are half-a-dozen different climates in that small island: Ryde, Sandown, Ventnor, Black Gang, Newport, and Yarmouth. Will anyone name two of these which are identical? But, if not, are we to start self-recording apparatus at each, and who would undertake to reduce the mass of sheets?

The Committee have wisely provided a supplementary set of apparatus at Kew, for replacing breakages without delay. It would be very useful if they would set the thermometers to work in the temporary shed, and compare them with those outside the Observatory window.

Considerable stress is laid by the Committee on the fact that they are now supplied with returns from some private observers, and they state that they have been entrusted by Her Majesty's Government

with the superintendence of the general system of British meteorology.* We were not aware that this was the case, but if so, it is centralization with a vengeance, and we have yet to learn how far either the Meteorological Committee are able to superintend the general system of British meteorology, or what right Her Majesty's Government possesses over it. We have heard of many changes lately, but it is generally supposed that when things work well, it is undesirable to interfere with them. If this paragraph means anything it means this: that the Committee intend to superintend the British and Scottish Meteorological Societies, the Meteorological Department at Greenwich, the Rainfall Committee of the British Association, as many private observers as they can, and we suppose kindly to control ourselves as well. We thank the Committee for this paragraph, which we submit to the attention of our Parliamentary readers, to the officials of the various societies, and to private observers.

THE BRITISH ASSOCIATION AT EDINBURGH.

(Continued from page 113.)

Report by Mr. Glaisher on Luminous Meteors.—MR. GLAISHER read this report, of which the following is an abstract:—The object of the Committee, he said, was, as last year, to present a condensed report of the observations which they have received, and to indicate the progress of meteoric astronomy during the interval that has elapsed since the last report. A valuable list of communications on the appearances of luminous meteors and regular observations of star-showers have been forwarded to the committee in the course of the year. The heights and velocities of thirteen shooting stars obtained by the co-operation of Mr. Glaisher's staff of observers at the Royal Observatory, Greenwich, during the watch for meteors on the nights of the 5th to the 12th of August last, are sufficiently accordant with the velocity of the Perseids, as previously obtained by similar means in 1863, to afford the satisfactory conclusion that the results of direct observation are in very close agreement with those derived from the astronomical theory of the August meteor-shower. On the mornings of the 13th to the 15th of November last, a satisfactory series of observations of the November star-shower (as far as its return could be identified), recorded at the Royal Observatory, Greenwich, and at several other British stations, concurs with very similar descriptions of its appearance in the United States of America, in showing the rapid decrease of intensity of this display since the period of greatest brightness in 1866 and 1867. Notices of the appearance of more than twenty fireballs and small bolides have during the past year been received by the committee. Fourteen of the former were compared to the apparent size and brightness of the moon, and the latter include three detonating meteors of the largest class. Descriptions of some of the largest of these meteors are contained in the report and the accompanying list. No notice of the fall of an aerolite during the past year has been received, although the occurrences of large meteors during the autumn and spring months were unusually frequent. The locality of one of these, which appeared with unusual brilliancy in the south of England on the evening of the 13th of February, can be determined at least

* The exact wording of the paragraph is:—"It is in this direction that they venture to look forward to the most important development of the general system of British meteorology with the superintendence of which they have been entrusted by Her Majesty's Government—a system which was contemplated by the Board of Trade, under the presidency of Mr. Cardwell, so long ago as in the year 1855, but was not brought into practical existence until eleven years later, when in the year 1866 the Royal Society was requested by that Board to make arrangements for taking charge of the Meteorological Department."

approximately, as also the elevation of its flight. A table of the height of sixteen shooting stars doubly observed in England during the meteoric shower of August, 1870 (independently of the observations recorded at the Royal Observatory, Greenwich), appeared in the last volume of the British Association reports. A comparison of the observations made at the Royal Observatory, Greenwich, on that occasion, with those recorded at the other stations, enables the paths of 13 meteors (ten of which are new to the former list), seen by Mr. Glaisher's staff of observers, to be determined; and the heights and velocities of the meteors thus identified are entered in the report. The results are as follows:—The average height of 16 meteors (referred to in the last report) was 74 miles at first appearance, and 48 miles at disappearance; of 13 meteors (given in the present list), 72 miles at first appearance, and 54 miles at disappearance; of 20 meteors (observed in August, 1863), 82 miles at first appearance, 58 miles at disappearance. The present average heights are thus somewhat less than those observed in 1863, but they agree more closely with the general average height at first appearance, viz., 70 miles, and that at disappearance, viz., 54 miles. The average velocity of the Perseids (relatively to the earth) observed in the year 1863, was 34 miles per second, and that of three Perseids in the present list was 37 miles per second; while the velocity which Professor Schiaparelli obtained from the cosmical theory was 38 miles per second. A considerable shower of shooting-stars was also noted on the night of the 20th April last, for which preparations were made, which were attended with satisfactory results. The report, which was very elaborate, also contained a discussion of the new meteor showers noted during the last few years by Professor Schiaparelli, agreeing in many points with previous determinations by the committee from the observations contributed to the British Association, and suggesting considerations of novel and important interest in relation to their probable explanation. The committee, desiring to contribute to the inquiry by continued observations of the principal meteor-showers during the coming year, will provide means of registry of meteors on each of the following dates:—viz., January 2nd and 3rd; April 19th to 21st; August 9th to 11th; October 18th to 21st; November 13th to 21st; and December 11th to 13th, to assist in determining the direction and the hourly numbers of meteors on those days.

On the general Circulation and Distribution of the Atmosphere. By Professor J. D. EVERETT, D.C.L.—The object of this paper was to call the attention of meteorologists to a theory which is jointly due to Prof. J. Thomson of Belfast, and Mr. Ferrel of Boston, U.S.A., and which gives the only satisfactory account of the grand currents of the atmosphere, and of the distribution of barometric pressure over the earth's surface, the irregularities arising from the distribution of land and water being neglected. Independent proofs were also given of some of Mr. Ferrel's results.

A body moving along the earth's surface with relative velocity v (units a foot and second) tends to describe a curve concave to the right of the body in the northern and to its left in the southern hemisphere, the radius of curvature being $\frac{6850}{\sin \lambda} \frac{v}{\sin \lambda}$ feet. The deflection from a parallel of latitude into a great circle is usually negligible in comparison, being represented by the curvature of a circle of radius $R \cot \lambda$, R being the earth's radius.

To keep, therefore, the moving body in a great circle or in a parallel of latitude, requires a constraining accelerating force equal to $\frac{v \sin \lambda}{6850}$ and this formula applies alike to all horizontal directions of motion.

The air over the extra-tropical parts of the earth has a relative motion towards the east, and therefore passes towards the tropics with a force which can be computed from the above formula. If v be the eastward velocity at any parallel, the increase of pressure per degree of latitude is $\cdot 0019 v \sin \lambda$ inches of mercury, and this accounts for the observed increase of pressure from the poles to the tropics, which is roughly $\cdot 01$ inch per degree.

If any stratum of air have less than the average eastward or westward velocity which prevails through the strata above it, it will not be able to resist the diffe-

rential pressure from or towards the equator which their motion produces. For this reason the lowest stratum of air having its velocity relative to the earth kept down by friction, generally moves from the tropical belts of high barometer to the regions of low barometer at the poles and equator. This is the origin of our S.W. winds and of the prevalent N.W. winds of the Southern Ocean.

The tendency of a moving mass of air to swerve to its own right in the northern hemisphere, explains Buys Ballot's law that the wind, instead of blowing at right angles to the isobaric lines, usually makes an angle of 20° or 30° with them, keeping the region of lower barometer on its left. The rotation of cyclones is an example of this law, and the pressure which the spirally-flowing streams exert to their own right in virtue of the earth's rotation, is the main cause of the excessive central depression. The author referred to Prof. J. Thomson's paper (B.A. report, 1857), to Mr. Ferrel's papers, and to *Nature*, July 20, 1871.

Professor COLDING read a portion of a paper, entitled "*Remarks on Aërial Currents*," in which formulæ were given for the velocities of the different particles of a fluid circulating in the annular space between two vertical cylinders, and for the form of the surfaces of equal pressure. The formulæ had been tested in the case of a hurricane at St. Thomas's.

Professor EVERETT read the *Report of the Committee on Underground Temperature*.—The intended boring at the bottom of Rosebridge Colliery has not been executed, recent occurrences in a neighbouring pit having given reason to fear an irruption of water in the event of such a boring being made. Careful observations of temperature have been taken by the engineers of the Alpine tunnel under Mont Fréjus (the Mont Cénis tunnel). The highest temperature in the rocks excavated, $85^{\circ}\cdot1$ Fahr., was found directly under the crest of the mountain, which is just a mile overhead; the mean annual temperature of the crest over it being estimated, from comparison with observed temperatures at both higher and lower levels (San Theodule and Turin), at $27^{\circ}\cdot3$ Fahr. Assuming this estimate to be correct, the increase of temperature downwards is at the rate of 1° in 93 feet, which, by applying a conjectural correction for the convexity of the surface, is reduced to about 1° in 81 feet as the corresponding rate under a level surface. This is about the rate at Dukenfield Colliery, and much slower than the average rate observed elsewhere. The rocks are extremely uniform, highly metamorphosed, and inclined at a steep angle. They contain silica as a very large ingredient. They are not faulted to any extent, and are very free from water. It is proposed to sink two bores, to the depth of from 50 to 100 feet, at the summit and another point of the surface over the tunnel, with the view of removing the uncertainty which at present exists as to the surface-temperature. Mr. G. J. Symons has repeated his observations at every fiftieth foot of depth in the water at the Kentish Town well, between the depths of 350 and 1,100 feet, the surface of the water being at the depth of about 210 feet. The observations which have been repeated are thus completely free from the disturbing effect of seasonal changes. The results obtained agree closely with those previously found, and show between these depths a rate of 1° in 54 feet, which, from the estimated mean temperature of the surface of the ground, appears to be also very approximately the mean rate for the whole 1,100 feet. The soil, from 325 to 910 feet of depth, consists mainly of chalk and marl, and shows a mean rate of 1° in 56 feet. From 910 to 1,100 feet, it consists of sandy marl, sand, and clay, and shows a mean increase of 1° in 54 feet. The former of these is in close agreement with trustworthy determinations made by Walferdin from observations in the chalk of the Paris basin. These are as follows:—Puits de Grenelle, Paris, depth, 1300 feet; rate, 1° F. in 56·9 feet. Well at Military School, Paris, depth, 560 feet; rate 1° F. in 56·2 feet. Well at St. André, 50 miles west of Paris, depth, 855 feet; rate, 1° F. in 56·4 feet. General Helmersen, of the Mining College, St. Petersburg, informs the secretary, that in sinking a well to the depth of 540 ft. at Yakoutsk, in Siberia, the soil was found to be frozen, probably to the depth of 700 feet. The rate of increase from 100 to 540 feet, was 1° F. in 52 feet. A new pattern of thermometer, recently constructed for the Committee, promises to be of great

service—a maximum thermometer, on Negretti's principle, adapted to be used in a vertical position with the bulb at the top. The contraction in the neck prevents mercury from passing into the stem when the instrument receives moderate concussions. Before taking a reading, the instrument must be gently inclined, so as to allow all the mercury in the stem to run together into one column near the neck. On restoring the thermometer to the erect position, the united column will flow to the other end of the tube (that is, the end furthest from the bulb), and it is from this end that the graduations begin. It is set for a fresh observation by holding it in the inverted position, and tapping it on the palm of the hand. This instrument, like that heretofore used, is protected against pressure by an outer case of glass, hermetically sealed.

On Wet and Dry Bulb Formulæ. By Prof. EVERETT.—He said, August, Apjohn, and Regnault have investigated formulæ for determining the dew point, by calculation, from the temperatures of the dry and wet bulb thermometers; but Regnault's experiments on the specific heat of air were not performed till a later date, and all three authors have adopted in their investigations the value obtained by Delaroche and Berard, which is $\cdot 267$, whereas the correct value is $\cdot 237$. But when this correct value is introduced into Regnault's formula, the discrepancies which he found to exist between calculation and observation are increased, and amount, on an average, to about 25 per cent. of the difference between wet bulb temperatures and dew point. August and Apjohn erred in assuming that the air which gives heat to the wet bulb falls to the temperature of the wet bulb, and becomes saturated. These two false assumptions would jointly produce no error in the result if the depressions of temperature in the different portions of air affected were exactly proportional to their increments of vapour-tension, and if some of the air were saturated at the temperature of the wet bulb. But it is probable that, when there is little or no wind, the mass of air which falls sensibly in temperature is larger than that which receives a sensible accession of vapour, and that, in high wind, the supposition that some of the air has fallen to the temperature of the wet bulb, is more nearly fulfilled than the supposition that it has taken up enough vapour to saturate it. The effect of radiation, which is ignored in the formulæ, leads in the same direction as these two inequalities, and all three are roughly compensated by attributing to air a greater specific heat than it actually has. The discrepancies above referred to are thus explained.

Dr. APJOHN said it was true his formula was obtained by employing what is now believed to be an erroneous value of the specific heat of air, but it nevertheless gave results conformable to observation. He thought that the erroneous point in his hypothesis probably consisted in the assumption that the film of air which is cooled down to the temperature of the wet bulb is saturated with vapour.

Prof. J. CLERK MAXWELL said there was reason to believe that the rate of diffusion of heat was nearly the same as that of vapour, the difference being about 6 per cent. If the air were perfectly still, the equilibrium of temperature for the wet bulb would depend on diffusion. In all investigations that he had met with, a convective equilibrium was assumed. He thought the action which really occurred was a mixture of the two. The subject was important, not, however, so much for the sake of its application to the wet and dry thermometers, as for its bearing on the conduction of heat in air, a subject of great experimental difficulty.

Mr. C. BROOKE said that Mr. Dines was engaged in experiments on the subject. His own experience had led him to believe that the correction for barometric pressure was not properly applied.

Mr. PENGELLY gave an account of an analysis which he had made of the daily rainfall at Torquay, for the purpose of determining "*the influence of the moon on the rainfall.*" He thought he had detected such an influence. The dry portion of a lunation extends from the first day before the full moon to the first day before the first quarter, and the wet part from the day of the first quarter to the second day before the full moon.

On the Rainfall of the Northern Hemisphere in July, contrasted with that for January. By Mr. A. BUCHAN.—The paper was illustrated by charts, showing the distribution of rain in inches over the greater portion of the northern hemisphere in July. Mr. Buchan described the principles which guided him in drawing lines representing the rainfall of the globe—namely, to reject all places which, being in the immediate vicinity of hills or rising grounds, did not represent the average rainfall of the district; secondly, he drew lines of rainfall for each month separately. The months of July and January were selected, because in these months the greatest effect of heat and cold on the earth's atmosphere and its movements occurred. In July the line of the rainfall passed through the south of Spain, the north of Africa, through Syria, and thence westwards into the desert of Cobi, thus forming the northern boundary line of the rainless region of this part of the globe in July. The map further showed that the greatest amount of rainfall occurred in the centre of the continent of Asia and Europe, taking them both as one continent; and that the line of greatest rainfall passed through the centre of Europe and towards the centre of Asia, to some distance north of the Caspian. In India, the line of the rainfall passed a little to the west of the Ganges, east of which the lines representing inches could not be shown; and the whole of this region was therefore marked by a deep red, to show the rainfall was enormous; and the rainfall was also very excessive in further India, and in the east of Asia generally. In America the line of the rainfall included California and the neighbouring regions. Very heavy rainfall occurred in the lake district of the north-western sides which sloped eastward—that is, those to the east of the mountains; but the heaviest rainfall occurred in the sides bordering on the Gulf of Mexico, and the whole of the eastern slope of Central America. In the map contrasting the rainfall of July with that of January, there were two sets of lines—blue and red, the red showing those regions at which the rainfall of July exceeded that of January, and the blue those regions where the rainfall was less than that of January. Mr. Buchan showed that where there were prevailing winds blowing into warmer latitudes, the rainfall was not defective, even though those winds came from the ocean, and illustrated his remarks by the summer rainfall of the south of Europe and the north of Africa, and by that of California. The greatest excess of the rainfall in July was in those regions to which the prevailing winds arrived after having traversed a vast extent of ocean, India and Central America.* Illustrating this connection, on the western slopes of the British Isles the rainfall in July was less than that of January, but on the eastern slopes it was greater in July. When the prevailing winds blew from the Atlantic eastwards into the centre of the great continent, the rainfall of the hills of this immense tract was greatly in excess in July of what it was in January. Mr. Buchan also pointed out the importance of inquiry in reference to the great movement of the atmosphere, especially the vapour which was condensed into rain, and which must come from some neighbouring surface. The important bearing of the subject on physical geography and climate, and the distribution of vegetable and animal life on the globe, was also pointed out.

On the conclusion of the paper, Colonel Yule remarked that Mr. Buchan had not gone beyond six inches in his calculations, but he wished to state that in the place where his earliest service began—in the district of Assam—there fell, in the month of August, 1841, 30 inches of rain on six days continuously, or 180 inches in all, while the whole rainfall of Edinburgh for a year was about 26 in. During that same month of August the rainfall was 264 inches, or 22 feet. He thanked Mr. Buchan heartily for his paper, and hoped that his maps and observations would be published before long, in a shape in which they could all have access to them.

Dr. BUYS-BALLOT gave a short address "*On the importance of a Telegraphic Meteorological Station at the Azores.*" He spoke of the importance that a telegraphic station in the midst of the Atlantic would have in giving warning of the approach of storms to the shores of Europe. The cable could be laid from the Azores to the Portuguese coast; but it would not be for the interest of Portugal alone, but of all the European nations, and particularly Great Britain, which had

the greatest amount of shipping. He suggested that the Scottish Meteorological Society, which had done great service to meteorological science, should take up the matter, with the view to an international fund being raised to promote the object of his address. He was authorized to say that every encouragement would be given by the Portuguese Government, and the rates would be only £1 per message.

Mr. G. J. SYMONS said he had that morning had the pleasure in Committee of the Section of moving that the excellent proposal of Dr. Buys-Ballot should receive the support of the Association. He considered the merits of the proposal so great, and the expense (£400 per annum, to be divided among all the nations of Europe,) so trivial, that he felt sure it was a foregone conclusion that it must be adopted.

Mr. RUSSELL read a paper "*On the Inferences Drawn by Drs. Magnus and Tyndall from their experiments on the Radiant Properties of Vapour,*" in which he agreed in the main with Tyndall's deductions, pointing out, however, that vapour had no power of transmitting its radiant heat into space. This proposition was supported by arguments from natural phenomena.

Mr. W. A. TRAILL described, with the aid of a coloured diagram, a beautiful display of Parhelia, seen by him in County Down, Ireland.

DECREASE OF RAINFALL WITH ELEVATION.

To the Editor of the Meteorological Magazine.

SIR,—Would it be asking too much of Mr. Stow to request him to lay aside his light and flippant style, and answer Dr. Burder's "fair and temperate" objections to his new theory in an honest and straightforward manner? Ridicule is a poor substitute for argument under any circumstances: in a discussion such as the present, I submit it is altogether out of place.

I do not understand Mr. S.'s allusion to the theory "unfounded on experiment" of Sir J. Herschel. I am not aware that Sir John proposed any theory at all on the subject. On the contrary, he states, in his "*Meteorology*," page 105, par. 109, "The real cause" (difference of rainfall with elevation) "is yet to seek, and no more interesting problem can fix the attention of the meteorologist." It certainly did not require the genius of a Herschel to discover the fallacy contained in the proposition that the "decrease of rainfall with elevation is caused by the difference of angle at which the rain falls."

I cannot but consider it a very severe tax on my understanding to be called upon to believe that 30 per cent. of the rain that leaves the clouds *does not reach the earth at all!* Such, if I read him aright, is what Mr. Stow asks us to do. At page 71, of your June number, Mr. S. says, "I prefer the theory that the ratio of the amount caught by a horizontal gauge varies as the cosine of the angle which the rain makes with the vertical. This gives 30 per cent. for 45°, 50 per cent. for 60°," &c. Farther on, he says, "It is likely that the bulk of the rain at Aldershot falls at an angle of about 45°." Now, what I want to know is,—*if* the bulk of the rain at Aldershot falls at an angle of 45°, and *if* a horizontal gauge catches only 70 per cent., *what becomes of the remaining 30 per cent.?* To say that it is not collected in a horizontal gauge is, of course, to say that it does not fall at all, for a

garden, a field, or a town, is only a horizontal gauge of larger dimensions. The observations at Calne and Rotherham prove most conclusively that the difference in the quantity of rain collected by two horizontal gauges at different elevations is in proportion to the force of the wind. In what way the wind operates in producing the difference is not yet shown unless the theory of Mr. Jevons, alluded to in your June number, page 72, is sufficient for the purpose.

I believe this theory to be amply sufficient for the solution of the problem, and that the wind, (1) by causing eddies and preventing the rain entering the gauge; (2) by blowing away the rain-drops as they alight on the rim; and, (3) by greatly increasing evaporation, is the sole cause of the difference in question.

Would it not be possible to fill up the rim of a gauge with *sponge*, or some other porous substance, so as to leave a level surface, representing the surface of the ground? The difficulty, I apprehend, would lie in getting the "porous substance" to give the rain up again to be measured or weighed.—Yours truly,

JOHN THRUSTANS.

Merridale, Wolverhampton, Aug. 23rd, 1871.

To the Editor of the Meteorological Magazine.

SIR,—I hope I correctly understand that the debated point in this controversy is, whether "a difference of the angle at which rain falls causes an alteration in the amount of rainfall upon a horizontal surface." This seems to me to be a purely mechanical problem. The case may be stated as follows: Two forces act on the rain-drops, (1) Gravitation, and (2) Wind. The first acts vertically, and alone produces the fall of the rain; the second acts at right angles to the first force, and alone produces horizontal motion. Acting at right angles to the vertical force, wind cannot in the slightest degree accelerate or retard the downward motion of the rain; acting, also, uniformly on neighbouring particles of rain, it cannot alter their horizontal position, *inter se*, and consequently it cannot affect the amount of rain falling on a horizontal surface. The amount of rain received on a vertical surface (or, may I say, in a vertical gauge) will vary directly with the horizontal velocity of the rain-drops, or, as we should say in ordinary parlance, with the force of the wind. And herein is the answer to Mr. Stow's question, why the angle of rainfall should affect the amount of rain on a vertical surface, but not on a horizontal surface? The angle is the product of the wind, a variable quantity, but the cause of the varying amount on the vertical surface. On the other hand, gravitation, the cause of the fall on the horizontal surface, is a constant quantity, and the angle can indicate no change with reference to this cause, simply because it is invariable.—I am, Sir, your obedient servant,

P. P. PENNANT.

August 21, 1871.

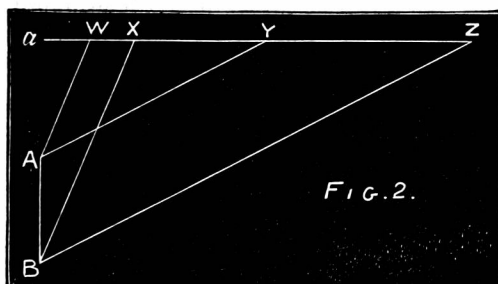
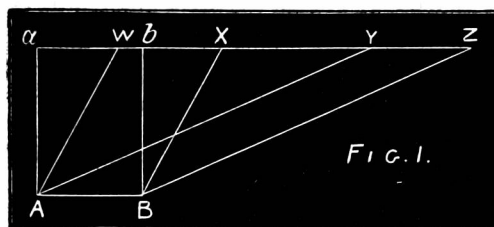
To the Editor of the Meteorological Magazine.

SIR,—I quite agree with Mr. Stow that if we are going to try to determine the actual path of a single rain-drop we shall be met with

enormous difficulties ; we shall then be plunged into all the intricacies of Hydrodynamics in seeking to determine the path of a body moving in a fluid—a problem in itself difficult enough, and in this case complicated by the fact that the moving body is itself a fluid, and probably changes its size as well as its shape, while the fluid within which the body moves is itself in motion also. I doubt if these variations are very large, but at all events I do not think that I underrate the difficulties of the problem ; the point for which I have been contending, however, is something quite different ; it is a mere question of geometry. The statement which I have been endeavouring to prove erroneous, is that contained on page 23 of *British Rainfall* for 1871 : “ The cause of this decline of amount with increase of height is doubtless to be found in the angle at which the rain-drops fall,” or, as Mr. Stow more definitely puts it, on page 69 of *Magazine*, “ It is impossible to deny that a horizontal gauge presents a smaller area of aperture to rain falling obliquely than to that which falls vertically.” It was not to establish any pet theory of my own, for I have none, but to clear the ground for some future theorist, by proving that Mr. Stow's theory was inconsistent with the plain truths of geometry, that I suggested the experiment “ with knitting needles and strings, and a few parallelograms as a mathematical sauce,” hoping that with “ this potent weapon of common sense,” I might make evident a geometrical truth which had evidently been overlooked, and which I thought required illustration. The point in dispute, as far as I am concerned, is this : Does a horizontal gauge present a smaller aperture to rain falling obliquely than to rain falling vertically ? We cannot advance a step until this is settled ; and this question has nothing to do with the equality or inequality of the rain-drops, or with “ the great irregularities which render parallelograms inapplicable (?) to the case.” I will state the question mathematically, for the sake of greater clearness : Let α be the angle which the rain makes with the vertical, h the very small height through which the rain falls in any small time (the time being small enough for the motion to be considered uniform), l the length of the path of the rain in this time, A the area of the gauge : it is clear that in this small time the rain is contained in an oblique cylinder, which, its base being A and height h , has therefore for its volume $A h$: now h cannot vary while the time is constant, and A is constant, therefore $A h$, the quantity of rain caught in the gauge is independent of α .

Again, since $l \cos. \alpha = h$, therefore $l \cos. \alpha$ is constant ; therefore l varies as $\sec \alpha$, and therefore when $\alpha = 90^\circ$ and $\sec. \alpha$ becomes infinite, l becomes infinite too : that is, if it were possible ever to have so violent a wind as that the path of the rain was horizontal, the space through which the rain would be carried by the wind would be infinite, compared with the small space through which it would have fallen by the action of gravity in that short time. This surely accords with the laws of falling bodies, and this I call a crucial test, because it explains a limiting case, which, at first sight, might have been thought to confirm an erroneous assumption.

Now, as to vertical gauges, I am quite ready to admit that if rain were discharged from the vertical face of a cloud, then, whatever the force of the wind, and therefore whatever the inclination of the rain to the horizon, the quantity caught by the vertical gauge would always be the same if the initial horizontal velocity were the same: but everybody, including Mr. Stow himself (page 69), supposes the discharging surface to be horizontal, a supposition doubtless not very far from the truth, though not perfectly exact, and we are all agreed that perfect exactness is not attainable: we try to get as near to the truth as we can. The accompanying diagrams will illustrate my meaning,



when I wrote "the properties of a parallelogram dispose of Mr. Stow's question, Why not for vertical gauges?" AB are the mouths of the horizontal and vertical gauges, $awbxyz$ the horizontal discharging surface. In fig. 1, the parallelograms $awbB$, $wABx$, $yABz$, are all equal: in fig. 2, the trapeziums $wABx$, $yABz$, are not equal. The diagram which Mr. Stow supplies does not help me much, for these two reasons, first, that if $H_1 H_2 H_3 H_4$ were not all equal, as also $V_1 V_2 V_3 V_4$ then would the figures cease to be parallelograms and, secondly, that we are not concerned with the sides but with the areas of the parallelograms.

I have one other little objection to Mr. Stow's language; he calls "the assumption on which his theory is based," pp. 70 and 114, an *axiom*. An axiom is a self-evident proposition — a term hardly applicable to a statement about which so many of us are wrangling, albeit most good-humouredly.

My letter is too long for me to touch upon the "Position Gauges;" nor am I tempted to do so to-day, interesting as those observations are, because these results do not affect the point in dispute.

J. M. DU PORT.

Mattishall, Norfolk, Sept. 1st, 1871.

To the Editor of the Meteorological Magazine.

SIR,—I have been lately chewing the cud over Mr. Stow's paper in the *Annual*, and the letters in the last four numbers of the *Meteorological Magazine*. I am surprised that Mr. Stow's remark, at page 18 of the *Annual*, that "it would be interesting to investigate, both theoretically and by experiment, the path of the rain-drop," has been passed over unnoticed. Of course it would, and if it had only been done, it would have ended the matter one way or other at once. That this should have been neglected, and the argument carried on without such investigation, and upon an assumption or supposition which is, to say the least, a very peculiar one, and, as far as I know, without the authority of facts, seems to me an unscientific method of proceeding.

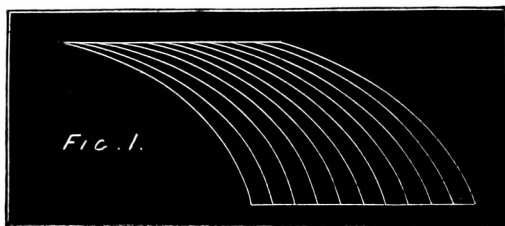
The supposition I allude to, and to which I have seen no objection, is that made by Dr. Burder, at page 64 of the *Magazine*, in the May number, where he supposes the case of a cloud "discharging rain uniformly from every part of its lower surface."

Now, I confess, I do not know the method of generation of rain-drops from vapour, nor the positions in a given cloud-mass at which such generation takes place. But, if I am to suppose anything, I can far more easily suppose rain-drops generated at many points, at various altitudes in the cloud-mass, than only uniformly at its lower surface. And I think this supposition likely to be true, not only from its seeming to me more probable, but also because the result of such a hypothesis would agree with the facts observed. Let us, then, consider the path of the rain-drop. Now, the rain-drop is a projectile. It is up to the moment of its generation a portion of vapour, travelling with nearly or quite the velocity of the wind at the time. When this portion of vapour becomes a drop its course becomes that of a projectile, projected horizontally with the velocity of the wind for its initial velocity, and subject to the force of gravity. Its path will therefore be a parabola, having the point where the drop is generated for its vertex, and a vertical line through that point for its axis. The velocity of the wind, after the drop starts, will not affect its course unless that velocity be increased or decreased. Any deflection from its parabolic course could be caused only by variation of velocity in the successive strata through which it passes, or by the vertical resistance upwards of the atmosphere. Of these causes and their effects more by-and-bye.

Now let us take Dr. Burder's hypothetical case of "a cloud discharging rain uniformly from its lower surface." I presume the lower surface is supposed perfectly horizontal.

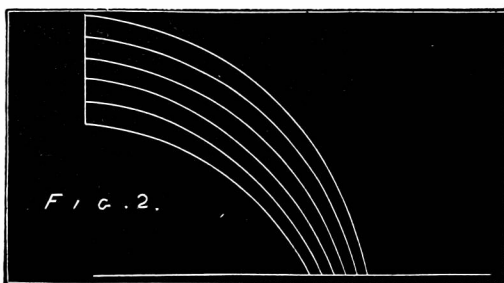
In this case the drops would describe parallel curves, the horizontal distances between them at every point of their fall remaining the same as at the moment of projection, any variation of velocity of wind, and any resistance of atmosphere affecting all their paths alike, [as in fig. 1.

Next, let us take another case, which I think we are at least equally



justified in supposing. Suppose a cloud of considerable thickness to discharge rain uniformly from all parts of its mass. Manifestly, if horizontal lines be drawn through it, the drops which start from each such horizontal line will keep their own distances in their downward paths : but how will these several systems of drops affect one another ?

Take one vertical line through our hypothetical cloud, and assume rain-drops to be generated at various points of that line. It will be found that the parabolas described by these projectiles will approximate horizontally, and that though in theory they would never actually coincide, they would ultimately become indefinitely near to each other. They would describe the curves represented in fig. 2.



I apprehend, then, that what I have already written justifies the following conclusions :—

1. Rain-drops falling from the same altitude, and under the same circumstances of wind and atmosphere, preserve their horizontal distances throughout unaltered.

2. Rain-drops falling from different altitudes, under the like circumstances, approximate as they fall.

3. The greater the force of wind, *i. e.*, the initial velocity of projection, the longer the path described, and the less the approximation between drops falling from different altitudes, and conversely.

4. Drops falling from different altitudes will be travelling with different velocities when they approach the ground ; those starting at a greater elevation travelling faster than those which start at a lesser.

5. On passing into the strata of air near the earth's surface, which are travelling slower than the upper strata, the paths of the drops will be altered, and those drops which travel slowest will be most retarded. The drops which begin to fall at the least elevation will be retarded in the direction of those which had started above and behind them.

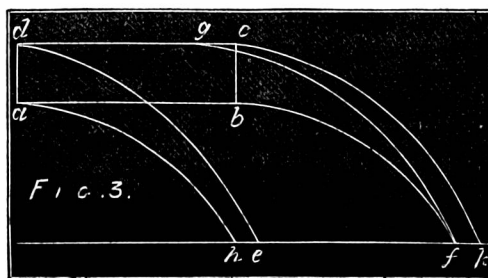
6. The vertical resistance of the atmosphere will affect the paths of

the drops in the opposite direction, tending to lengthen most the paths of the drops which start highest, and to send them forward towards the paths of those drops which had started below and in front of them.

7. Both these last will tend to increase the approximation while the drops are passing through the very lowest and slowest strata, *i. e.*, while very near the ground.

On the theory expressed in the above conclusions, it would happen that if a cloud at rest discharged rain from all points of its mass, or more correctly from many points distributed through all parts of its mass, there being no wind, the same amount of rain would be collected at all altitudes. The drops all falling vertically through a calm air would preserve their horizontal distance, unless there were a sufficient attractive force between the falling drops to render the shower gradually denser towards its centre. In every case, however, of a cloud discharging rain while in motion, the rain-drops in any given horizontal space in the air would be more numerous near the earth's surface than higher up.

Taking a hypothetical volume of cloud in motion, say one mile square and a quarter of a mile thick, and discharging drops, not only from its under surface but from points in various horizontal planes within its mass, it is clear that while each system of drops starting from one plane would cover its own square mile of ground, the whole rainfall from such a cloud must cover a greater space than one square mile. There would be many such systems of drops falling at the same time, and the space covered by the shower, from the line marked by the drops falling from the *hindmost lowest horizontal* edge to that marked by those falling from the *foremost highest horizontal* edge, would be a mile wide, but more than a mile long, and this increase of space would be dependent on the velocity with which the cloud was travelling. Between these two limits there would be a space a mile wide, but not a mile long, in which the shower would be uniformly dense at each horizontal line drawn through it, but diminishing in density from the surface of the earth to the upper surface of the cloud, where it would vanish altogether. In front of and behind this space of uniform horizontal density, would be other spaces in which the horizontal density would be less and also variable, greatest near the volume of constant density, and thinning out before and behind to the few drops with which such a shower would begin and end. See fig. 3.



This theory seems to me to account for the facts observed, but it depends of course upon the supposition that when it rains the drops are not discharged from the lower surface of the clouds, but are generated at and discharged from points at different altitudes in the cloud mass. Perhaps somebody "up in a balloon" will notice whether the rain ceases at the moment of passing through the under surface of a cloud, or continues to start as long as there is any cloud for it to fall from.

T. E. CRALLAN.

Hayward's Heath, Sept. 5th, 1871.

To the Editor of the Meteorological Magazine.

SIR,—What surprises me most in this discussion is to find how complicated a simple question may become through the exercise of misdirected ingenuity. This "simple question," be it observed, is not the general question of the cause of the decrease of rainfall with elevation, but it is the question of the soundness or unsoundness of Mr. Stow's solution of that problem. It is necessary to bear this distinction in mind. The general question is full of difficulty. The particular question of the soundness of Mr. Stow's theory is, I still maintain, an exceedingly simple question. To my mind it takes this form: Given a certain quantity of rain to fall over a certain area, can you, by altering the inclination at which it falls, increase or diminish its quantity? In other words, the quantity being the same, can it be different? To settle a question of this kind, mathematics are superfluous, and experiments are worse than useless. Considerations respecting the size of the rain-drops are equally irrelevant. I do not forget that at the outset of the controversy it was maintained that the quantity of rain at the higher elevation is not really less than at the lower, but that the receipts of a horizontal surface, at the higher level, are not a true measure of the quantity falling there, by reason of the inclination at which it falls. I am willing to hope, however, that this position has been abandoned as untenable. Sir John Herschel, when he wrote, with evident reference to a theory identical with Mr. Stow's, "Still less can the effect be due to a greater obliquity of fall at a higher than at a lower level, since the same quantity of rain must fall on the same horizontal surface after changing its obliquity as before," committed himself to no rash proposition which later investigations might disprove, but stated a truth which will hold good to the end of time, any number of experiments notwithstanding.

Mr. Stow's diagram and connected argument are extremely clever, and, *as an exercise*, worth confuting, but this I leave to Mr. Du Port, who is more immediately concerned. I will only remark that when Mr. Stow insists that whatever mathematical principle applies to a horizontal gauge must equally apply to a vertical gauge, he ignores the very important fact that the normal course of the rain is to *fall* and not to pass horizontally. If the average path of the rain were parallel with the earth's surface, sometimes inclining upwards and sometimes

downwards, and if the mouth of the gauge were kept constantly to face the rain, then the same law would hold good for vertical gauges which is now true of horizontal gauges. But, as matters are, it is only by a kind of accident that any rain at all falls into a vertical gauge. The destination of rain is not a vertical surface, but a horizontal surface—the surface of the earth.

Mr. Strachan's criticism on one of my former illustrations is ingenious, but does not touch my argument. I purposely supposed the deflection of the rain-drops to take place on a level plane, to avoid complication. It is quite true, as Mr. Strachan says, that if we suppose the deflection to take place on a plane which is not level, we get a different result. We may, indeed, in this way get any result that we please. We have only to suppose a slanting shower and a vertical plane of deflection, and we shall find the whole body of the shower concentrated into a single sheet of water. But evidently this is a great deal more than altering the inclination, and my argument remains intact, that the inclination of the drops cannot, *per se*, affect the quantity which falls on a horizontal surface.

It will scarcely be a satisfactory conclusion to this controversy if nothing more should come of it than to show that Mr. Stow's solution is erroneous. That I take to be the first and most urgent business, but it may be hoped that we shall not rest there. Sir John Herschel has pointed out what seems a fatal objection to the theory of the condensation of vapour by the falling drops. But how about the *coalescence of spray*? By "spray," I mean particles of rain too fine to fall, and only likely to reach the earth through being licked up by the larger drops in their descent. The idea is not free from difficulties. In the first place, it would be necessary to show the probable existence of this spray. Then, granting its presence, whence does it come? In so far as it may be produced by the clashing of the drops, *inter se*, the objection may be raised that the drops would gain by accretion no more than they lost by dispersion. But the spray may be caused by the impact of the drops upon terrestrial objects, and if we may only suppose that the portion of rain, which falls in a gauge, suffers less than the average loss from this cause, we seem to have at least some promise of an adequate explanation. An analysis of existing records of rainfall at different elevations, might be so conducted as to show the probability or otherwise of the theory I have suggested. If there is any truth in it, then I should expect to find, first, that the elevation differences are greatest with heavy rain; secondly, that they are increased by wind; and, thirdly, that they diminish in ascending. Writing in haste, I have no time for reference, and this letter is already too long.

GEORGE F. BURDER, M.D.

Clifton, Sept. 6, 1871.

AUGUST, 1871.

Div.	STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL.				Days on which 1 or more fell.	TEMPERATURE.				No. of Nights below 32°		
		Total Fall.	Difference from average 1860-5	Greatest Fall in 24 hours.			Max.		Min.				
				Dpth.	Date.		Deg.	Date.	Deg.	Date.			
		inches	inches.	in.								In shade	On grass.
I.	Camden Town	·85	— ·79	·62	17	7	90·0	13	46·2	5	0	0	0
II.	Maidstone (Linton Park).....	1·09	— 1·62	·94	18	7	93·0	12+	49·0	5	0	0	...
	Selborne (The Wakes).....	2·29	— ·89	·90	17	8	85·0	13	40·5	2	0	0	...
III.	Hitchen	·62	— 1·73	·26	17	8	82·0	13	45·0	27	0	0	...
	Banbury	·75	— 1·38	·21	25	7	84·0	13	42·0	28	0	0	...
IV.	Bury St. Edmunds (Culford).....	·29	— 2·15	·25	17	3	86·0	12	43·0	4, 26	0	0	0
V.	Bridport	·80	— 1·79	·35	17	6	83·0	13	43·0	27	0	0	...
	Barnstaple	1·75	— 2·44	·67	17	7	86·0	11+	49·0	1, 27	0	0	...
	Bodmin	2·66	— 1·20	·98	17	13	79·0	14	52·0	27	0	0	0
VI.	Cirencester	2·78	— ·06	1·86	13	5	...	...	...	...	...	...	...
	Shiffnal (Haughton Hall)	1·49	— 1·38	·54	17	7	79·0	6, 11	41·0	22	0	0	...
	Tenbury (Orleton)	1·29	— 1·59	·43	13	8	84·8	12	40·2	22	0	0	0
VII.	Leicester (Wigston)	·88	— 1·31	·30	19	9	89·0	12	40·0	21	0	0	...
	Boston	·98	— 1·31	·79	17	5	84·0	12	47·0	22	0	0	0
	Grimsby (Killingholme)	1·26	...	·80	17	4	82·0	12	47·0	22§	0	0	...
	Derby	1·35	— 1·25	·74	17	8	82·0	10+	42·0	22	0	0	...
VIII.	Manchester	1·60	— 1·90	...	...	11	...	...	...	...	...	...	...
IX.	York	1·03	— 1·68	·32	17*	7	82·0	10	44·0	22	...	...	...
	Skipton (Arnccliffe)	2·86	— 3·08	·67	20	9	...	...	...	...	0	...	...
X.	North Shields	·96	— 1·89	·45	20	6	76·0	10‡	45·0	22	0	0	0
	Borrowdale (Seathwaite).....	9·10	— 4·98	2·85	21	14	...	...	...	...	...	...	...
XI.	Cardiff (Town Hall).....	...	...	...	...	...	...	...	...	...	...	...	...
	Haverfordwest	2·18	— 2·70	·70	17	8	79·0	14	39·0	27	0	0	0
	Rhayader (Cefnfaes).....	2·97	— 1·69	1·00	16	7	81·0	...	40·0	...	...	...	...
	Llandudno	1·24	— 2·58	·43	17	11	83·4	8	46·6	22	0	0	...
XII.	Dumfries	2·54	— 1·34	1·15	20	10	79·5	14	43·0	22	0	0	...
	Hawick (Silverbut Hall).....	2·10	...	·73	20	9	...	...	...	...	...	...	...
XIV.	Ayr (Auchendrane House)	5·15	+ 1·18	2·36	20	14	76·0	30	40·0	22	0	0	0
XV.	Castle Toward .....	...	...	...	...	...	...	...	...	...	...	...	...
XVI.	Leven (Nookton)	2·32	— ·67	1·30	20	9	77·0	10	40·0	20	0	0	0
	Stirling (Deanston)	4·12	— ·50	·84	20	13	75·2	9	37·8	22	0	1	...
	Logierait	3·28	...	·82	20	11	...	...	...	...	...	...	...
XVII.	Ballater	1·98	...	·76	20	7	76·5	12	36·5	20	0	0	...
	Aberdeen	2·60	...	·88	20	11	73·7	10	43·9	22	0	3	...
XVIII.	Inverness (Culloden)	1·82	...	·60	19	10	71·0	7	49·5	...	0	0	0
	Portree	5·70	— 1·75	1·33	24	20	...	...	...	...	...	...	...
	Loch Broom	3·44	...	·66	24	18	...	...	...	...	...	...	...
XIX.	Helmsdale	2·20	...	·92	24	15	...	...	...	...	...	...	...
	Sandwick	2·93	— ·78	·85	24	17	70·6	10	41·8	16	0	1	...
XX.	Cork	2·05	...	·38	16	10	...	...	...	...	...	...	...
	Waterford	3·57	— ·38	·94	14	19	75·0	14	47·0	22	0	0	...
	Killaloe	2·81	— 2·12	·58	19	17	82·0	9	40·0	22	0	0	...
XXI.	Portarlinton	1·97	— 2·53	·62	20	19	77·0	10	45·0	27	0	0	0
	Monkstown	1·13	— 2·08	·35	17	9	...	...	...	...	...	...	...
XXII.	Galway	3·64	...	·96	19	19	75·0	13	52·0	9, 20	0	0	...
	Bunninadden (Doo Castle)	2·41	...	·52	19	19	70·0	6	36·0	4	0	0	...
XXIII.	Bawnboy (Owendoon) .....	...	...	...	...	...	...	...	...	...	...	...	...
	Waringstown	2·47	...	·85	17	12	82·0	9, 12	42·0	14	0	0	...
	Strabane (Leckpatrick)	2·49	..	·44	20	16	76·0	8, 9	..	...	...	...	...

* And 18.

+ And 13.

‡ And 11.

§ And 26.

+ Shows that the fall was above the average ; —that it was below it.

METEOROLOGICAL NOTES ON AUGUST.

ABBREVIATIONS.—Bar for Barometer; Ther. for Thermometer; Max. for Maximum; Min. for Minimum; T for Thunder; L for Lightning; TS for Thunderstorm; R for Rain; H for Hall, S for Snow.

ENGLAND.

LINTON PARK.—A very fine, dry, warm, sunny month, favourable to the harvest, and more especially to the hops and fruits. Very little T, but frequent fogs in mornings, followed by hot sunny days. A rather high wind on the 24th, otherwise the month generally calm. Heavy steady R on night of 17-18th and following day, when almost all the R of the month fell (0.94 in.) Bar. generally high; winds mostly S.W. and W. A fine month in every respect.

SELBORNE.—L at night on 11th, 12th, 13th, 14th, and 24th; T on 13th and 24th; fogs in early morning, followed by fine and hot days, on 7th, 8th and 9th; min. temp. on 21st, 60°; heavy shower with H at 6 p.m. on 4th; between noon on 17th and noon on 18th, 1.561 in. of R fell; fine harvest weather from the 26th; winter oats cut on 5th.

BANBURY.—A fine warm month; harvest commenced in second week; considerable quantity of wheat not cut, and a good deal more not carried, at the end of the month, chiefly owing to the scarcity of labour; distant T and L on 13th.

CULFORD.—A month of very dry and warm weather, with a high bar. and S.E. winds; T has not been heard here during the month. From the 9th to the 13th excessively hot; the rainfall of the entire month was only .29 in., .25 in. of which fell on the 17th.

BRIDPORT.—Harvest began on 7th; shooting stars seen on the 9th, and on 10th counted 20 between 10 and 11 p.m., mostly disappearing quickly, leaving a slight train; one very brilliant one seen in the S., about 10.30 p.m. Distant T and L on 13th, 14th, and 15th. On the 13th heavy T clouds gathered in the E., and for a short time the L was vivid and T heavy, but very little R fell here, whilst in the neighbourhood R fell very heavily, flooding the rivers here; and three miles distant turnips were washed out of the ground into the high road; heavy S.W. gale on 24th; gale on 20th.

BODMIN.—On the 14th, during a heavy TS, which lasted with little intermission for 12 hours, there fell at 10 p.m. .60 in. of R in 10 minutes, by far the heaviest fall every witnessed here in so short a time.

CIRENCESTER.—Great TS on 13th, 1.86 in. of R falling.

HAUGHTON HALL, SHIFNAL.—The month opened with a sudden change, from clouds and R to sunshine. Fine harvest weather till the 16th, when R fell heavily again for two days, but without injury to the grain, and with much good to the swedes and green crops, of which there is not a failure, and all growing fast. From the 6th to the 13th inclusive great heat, averaging 77°. The nights of 5th and 22nd very cold, 42° and 41°; fog on morning of 7th and 12th; TS on 13th and 17th, with heavy R on the latter, and dark as night at 10 a.m. Winds variable throughout the month. Harvest all cut but not gathered by the end; wheat barely an average, but ears well filled; oats and barley excellent. *Sirex Gigas*, a formidable hornet-like insect, captured on 8th; wasps in great numbers on 20th; peacock butterfly first seen on 23rd; red admiral butterflies in numbers on 28th, feed on apricots and sap exuding from an oak. Few mushrooms, the crop having sprung in June.

ORLETON.—A beautiful harvest month, bright, dry and very hot; temp. about 3°·5 above the average of the month; T on 13th, 14th, 16th and 17th. Great TS from 7.30 p.m. to midnight on 13th; rough winds on 20th and 24th.

WIGSTON.—The weather of this month, taking it as a whole, has been very favourable for harvest work, and but little corn in the Midland counties that was not ripe at the end. Wheat is expected to be below the average, barley and oats above.

KILLINGHOLME.—A very fine month for the harvest; wheat harvest began generally on the 21st; the yield is likely to be deficient; potato disease more prevalent than for several years past, other root crops excellent. Shooting stars on 9th, 11th and 12th. TS and heavy R on 17th; high wind on 20th, 24th, 25th and 26th; fog on 9th and 31st; gossamer on 9th, 30th and 31st.

DERBY.—The rainfall about half the mean, and has scarcely at all interfered with the vigorous harvest operations; temp. about 3° above the mean; such weather coming after the wet early summer months, has marvellously promoted the growth of shrubs. Sad report of the extent of the potato disease.

MANCHESTER.—The fall for August unusually small.

YORK.—Severe TS on 18th.

NORTH SHIELDS.—Fine month; aurora on 24th.

W A L E S.

HAVERFORDWEST.—Very hot fine month, splendid weather for the crops; the first 19 days the temp. much above the average; heavy TS on 13th, 14th, and 15th; 13th, TS and R during the night, intense heat and threatening appearance of the sky towards 4 p.m.; about 7 p.m., sky of ominous blackness, vivid L and continuous T for three hours; the most terrible storm occurring here for many years, several cattle killed, a man struck with blindness, mows of corn set on fire; the display of L, forked and sheet, of the grandest description; storm proceeded from N.E. to S.W.; storm renewed on succeeding night, thought by some to have been more severe than the first one. L almost entirely forked; only .09 in. of R fell in the second storm in this locality; in places a few miles distant it fell in torrents; the storm was general throughout the county.

CEFNFAES.—Occasional TS during the month; wind N.W. and S.E.; weather unsettled during the last half. Potato disease very general.

LLANDUDNO.—Barley cut on 1st; on 9th, cutting hay in one field and wheat in the next. L on 12th, 13th and 14th; TS at 6 p.m. on 17th: thick fog over the sea and hills from 3 to 5.30 p.m. on 18th.

S C O T L A N D.

DUMFRIES.—With the exception of slight showers on the 1st and 3rd, the first half of the month was fine. From 16th to 26th the weather was unsettled; excessive R and storm on 20th; on 24th a violent storm; T on 17th; temp. at night higher, but by day $2^{\circ}8$ lower than last year, but mean nearly the same, being $61^{\circ}5$. Harvest commenced on 7th; corn crops good; potatoes abundant, but some diseased; fruit very scarce.

HAWICK.—A fine harvest month; very stormy on 23rd, 24th, 25th and 26th, fruit is a comparative failure here this season; wasps very numerous and very annoying; harvest is now pretty general, and the crops are such as to gladden the hearts of the husbandman.

AUCHENDRANE.—In 24 hours ending at 9 a.m. on the 21st, the rainfall was 2.36 in., the greatest amount measured here since 1865, and in the week ending on the 26th, the amount measured was 3.47. The largest flood in the river was on the 21st; there was also another smaller one on the 25th. The great equatorial storm reached its height here on the evening of the 24th, but it seems to have been felt earlier in the day on the Scandinavian and eastern coasts of Scotland.

DEANSTON.—First three days showery, then dry and hot till the 17th, 18th and 20th, which were wet and cold; heavy R on 23rd and 24th, with gale of wind from W.S.W. on latter day; then to the end of the month very fine harvest weather; much grain reaped, but very little carried to stack yards.

LOGIERAIT.—With the exception of seven wet days, a fine harvest month. Temp. high. Potato disease very general.

BALLATER.—Very little R has fallen, weather very favourable for harvest purposes; crops look well. Brilliant aurora on 24th.

ABERDEEN.—A month of fine warm weather, during which the crops have advanced with unexpected rapidity. Fog on 6 days. Aurora on 18th, 21st, 23rd, 24th, and 27th.—*Erratum*: In last month for "Inverruie" read "Inverurie."

PORTREE.—Wet and squally month; heavy gale on the 24th, from S., accompanied with heavy R. Potatoes much diseased. Harvest began on the 18th, and is now general over the country, and fully an average crop.

LOCHBROOM.—This has been a particularly fine month; farm operations are much advanced, some have the crops cut and half stacked; the harvest is considerably earlier than usual. There is no sign of the potato disease in this locality,

and, with a steady and profitable herring-fishing, things look well for the poor man.

SANDWICK.—Auroræ on 13th, 21st, 23rd, and 26th. Gale, 50 miles an hour, from 5 till 8 a.m. on 25th. Sea roaring on 31st August. Has been a fine month, 2° warmer and slightly drier than the average.

I R E L A N D.

GALWAY.—Severe TS on 29th, much damage done by it.

DOO CASTLE.—A good month for farming operations. The oat crop, after all, a pretty good one; but I regret to say the potatoes are a failure. TS on 29th, some damage done, and I see, by the papers, some lives have been lost.

WARINGSTOWN.—A fine warm month; considerable progress made with harvest, although the third week was very wet. Crops, on the whole, very good in this district.

LECKPATRICK.—First half of month dry. On the whole a good harvest month.

THE HEAT OF AUGUST.

To the Editor of the Meteorological Magazine.

SIR,—I beg to forward to you the readings of various thermometers during the hot period which prevailed from Aug. 9th to the 15th. The shade maximum of the 13th and 14th are the highest readings which have ever been registered here since the present series of meteorological observations were commenced in 1851, and such a high shade temperature for August has not been observed since the year 1856, when the maximum thermometer in shade registered 81°·1.

Date.	9 a.m.		SELF-REGISTERING THERMOMETERS.		
	Dry Bulb.	Wet Bulb.	Max. in Air, in shade.	Solar Black Bulb (in vacuo.) At 4 ft.	On Grass.
Aug. 9	74°·3	66°·6	79°·5	134°·5	144°·7
" 10	77°·6	68°·8	80°·1	127°·8	138°·0
" 11	74°·9	65°·6	76°·0	126°·5	141°·5
" 12	76°·2	68°·0	80°·2	128°·0	141°·8
" 13	80°·9	71°·4	84°·0	130°·0	143°·0
" 14	74°·9	68°·4	85°·1	133°·5	145°·0
" 15	70°·2	63°·8	78°·2	128°·6	142°·2

Yours obediently,

WM. J. HARRIS, F.M.S.

Worthing, Sept. 2nd, 1871.

THE EXPERIMENTAL RAIN GAUGES.

Owing to the unexpected speedy removal of the Rev. F. W. Stow, from Hawsker to a locality where he will be unable to continue to observe the above instruments, they are now offered, on loan, to any person or persons who may have facilities for, and be desirous of continuing in any form the experiments for which these instruments have been constructed. All communications on the subject should be promptly addressed to Mr. SYMONS, 62, Camden-square, N.W.

NOTE.—Although this number contains four extra pages, several valuable notes are unavoidably postponed.