

# SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE.

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## INDIAN MONSOON FORECASTS.

WEATHER forecasting in its simplest form is probably contemporaneous with civilization, and long before Meteorology became a science, sailors, shepherds and others dependent on favourable weather had acquired considerable precision in judging the character of coming weather several hours in advance. The Meteorological Services of most nations were in a great measure founded with a similar object, more especially with regard to warning the seafaring portion of the community of the approach of dangerous storms. More recently several have arranged for the issue of forecasts for agricultural purposes, and probably the United States Service, under its new head, will greatly extend its work in this direction.

These forecasts are, we believe, rarely, if ever, issued for periods more than 30 hours in advance, and, as a rule, attempts to foretell the general character of seasons are looked upon with suspicion, although the literature of the subject, including that of cycles in the seasons, which is practically the same, is probably more voluminous than that of any branch of Meteorology except the tables of "millions of useless observations," which issue from some of the National Services of the old world.

The Indian Meteorological Office has for the past eight years issued forecasts of the probable character of the monsoon rains, the failure of which has in the past been the cause of the well-known famines which decimate the population of vast districts.

These forecasts are based upon the quantity of snowfall on the Afghan mountains and the Himalayas, and on the general character of the meteorological conditions in India during the preceding seasons, and as this year appears likely to afford an exceptional, and possibly lamentable, opportunity of judging of their value, we think it of sufficient interest to reprint the Forecast from the Official Memorandum, dated June 4th, 1891.\*

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\* Memorandum on the snowfall in the mountain districts bordering Northern India, and the abnormal features of the weather in India during the past five months, with a forecast of the probable character of the South-West Monsoon Rains of 1891.

*“ Probable character of the approaching South-West Monsoon.—*The combination of conditions which have obtained in India with remarkable persistency from the beginning of January to the present time, are the results of prolonged—probably the heaviest and most prolonged and extensive—winter snowfall in the Western and Central Himalayan area and Afghan mountains that has occurred during the past 25 years at least. The snowfall commenced in November, and has continued more or less steadily from that date until nearly the end of May. It was almost certainly as excessive in the Himalayas of the North-West Provinces as in those of the Punjab and Kashmir, and also, relatively to the normal, even more excessive in the Afghan mountain districts; hence, perhaps, also in Central Asia. In several respects the meteorological conditions strongly resemble those of the pre-monsoon of 1885, and in others those of the pre-monsoon of 1868. They resemble to a less extent those of the pre-monsoon periods of 1877 and 1878. The only favourable feature of the snowfall is that it does not appear to have been very excessive in May, although probably above the normal.

The conditions are such as are almost invariably accompanied by a considerable delay in the progress of the monsoon current up the Bombay coast, and into the interior of the North Deccan and Central India. They are also frequently accompanied by a weak Bombay current, and occasionally by the early withdrawal of that current from Upper India in the beginning of September.

The low pressure area in Assam and Burma will tend to draw the Bay of Bengal current more to the eastward than usual. The relatively high pressure conditions in Upper India, as well as the low pressure conditions in Bengal and Burma, will tend to deflect the Bombay current in the same direction, and cause it to sweep more directly across the peninsula than usual. The Bombay current will probably supplement the action of the Bay current to some extent in the North-West Provinces, Chutia, Nagpur, and perhaps South Behar. Hence the conditions are such that the Bombay current will very probably be largely diverted from North-Western India, and that Rajputana, Guzerat, and the adjacent districts to the north and east will have dry north-westerly winds to an unusual extent during the monsoon.

The chief meteorological factors of the season are so strongly marked that the minor features will probably have less influence than usual.

So far as can be judged, the trough of low pressure will occupy its normal position from Orissa through the eastern districts of the Central Provinces. Its probable position in North-Western India is very doubtful, but will probably be more easterly than usual.

There has been for some time a small area of deficient pressure in the North-West Provinces, extending from Allahabad to Lucknow. It is difficult to judge how far it will influence the distribution of the rains in the present year in Upper India, but it is an unfavourable feature so far as the East Punjab is concerned.

The following is a statement of the chief inferences respecting the probable character of the monsoon rains of the present year, drawn from the known antecedent conditions :—

1. Snowfall conditions on the Western Himalayas and Afghan mountains (and probably over a large portion of Central Asia) and the pressure conditions in India are very unfavourable to the establishment of a strong and early monsoon on the Bombay coast. It is very probable that the monsoon will not be established in full strength on the Bombay coast before the third or fourth week in June, and it is probable that it will be below its average strength, and may be withdrawn from Upper India earlier than usual in September.
2. The snowfall conditions in the Eastern Himalayas, and the pressure conditions in North-Eastern India and Burma, are favourable to the advance of a moderately strong or strong monsoon in the Bay of Bengal earlier than usual, and to its establishment in Burma and Bengal before or about its normal period.
3. Pressure and other conditions are very favourable in Burma and North-Eastern India (Bengal and Assam), and it is probable that these provinces will obtain normal or abundant rain (more or less in excess of the normal).
4. Conditions are slightly less favourable in Behar and the eastern districts of the North-West Provinces, but it is probable they will obtain about their normal rainfall. The local depression in the North-West Provinces may, if it intensifies, (which, however, does not appear, so far as can be judged from the other conditions, to be probable,) determine heavy local rain to the central and eastern districts of the North-West Provinces.
5. Pressure and other conditions are very unfavourable for Rajputana, and also to a somewhat less extent in Guzerat, the southern districts of the Punjab, and the western districts of the North-West Provinces. It is probable the rainfall will be more or less deficient over the whole of that area, and possible that the deficiency may be large and serious. If the Bombay current be strong (in consequence of at present unknown conditions in the Arabian Sea area), these provinces may receive moderate rain throughout the monsoon. In the East Punjab rainfall will probably be normal or slightly deficient, but may be unfavourably distributed in time, commencing late and terminating early.
6. Conditions are partly favourable and partly unfavourable in North Bombay and Berar, and the amount of the rainfall in these areas will depend chiefly on the strength of the Bombay current as determined by conditions in the Arabian Sea. The rainfall is on the whole more likely to be slightly deficient than to be up to its normal amount.

7. Taking into consideration the probable position of the trough of low pressure and the other known conditions, the rainfall in the Central Provinces will probably be fairly normal in character, any tendency to excess being most probable in the eastern districts.
8. In Southern India the pressure conditions are favourable for heavy rain on the Malabar coast. There may probably be some slight delay in the establishment of the monsoon on that coast, but the Malabar district and Southern India generally are likely to receive favourable rain during the monsoon.

It should be noted, as was the case last year, that one of the important factors, namely, the pressure conditions in the Arabian Sea, is again of unusual importance, and hence that the inferences stated above, more especially so far as they relate to North-Western India, are uncertain to that extent, and that this element of doubt should be carefully kept in view in judging the probabilities.

It will thus be seen that the conditions are most unfavourable for Rajputana and the districts adjacent to it, including Guzerat, South Punjab, the western districts of the North-West Provinces and some portions of Central India. The chances that the rains in that area will be more or less deficient are at least 5 to 1, and the chances that they will be largely deficient, at least 2 to 1."

## THE WINTER TEMPERATURE IN ENGLAND AND SCOTLAND.

*To the Editor of the Meteorological Magazine.*

SIR,—The mildness of December and January in Scotland last winter, compared with England, was very notable, but it appears to have been not an uncommon feature in bygone times. In reading Dr. Anderson's Report of Aberdeenshire, which was published in the end of last century, there are examples of severe weather in England, and the contrary in the northern kingdom. It is not an uncommon remark that when snow is one foot deep at Aberdeen, it is nearly 2 feet at Newcastle-upon-Tyne. Again, in the year 1762, when the Thames at London was frozen over for many weeks, the weather was so mild in Aberdeenshire as scarcely to interrupt the ordinary operations of agriculture, and ploughs could have been at work every day. Other examples might be named, and as showing what occurs in northern latitudes, the ice-bound vessels were released in Davis Straits at Christmas, 1835, is a memorable incident.

Yours truly,

D. ROBIE.

*Bedford, July 31st, 1891.*

# THE THEORY OF HALOS AND PARHELIA.

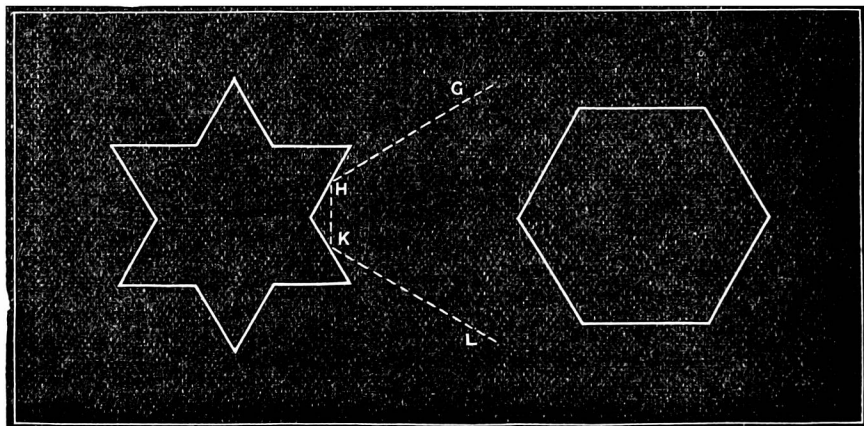
*To the Editor of the Meteorological Magazine.*

SIR,—Mr. T. W. Backhouse, in his letter of June 24th, suggests that the halo which I have spoken of as a tangent or tangent arc to the inner circle, should rather be called a branch halo. The form of this portion of the halo is very variable, and it is only at a certain altitude of the sun, about  $12^\circ$ , that it takes the form of an arc touching the circumsolar circle, and therefore I quite agree that the name branch halo would be in itself equally or more appropriate than the one I have adopted; but as I found the name tangent arc or contact arc adopted in all, or nearly all, the descriptions of the halo which I have seen, I did not feel justified in changing a name which appeared to be established. The fullest description of this part of the halo, which I have seen in any English work is contained in Loomis' Meteorology. Professor Loomis continues to use the name contact arcs while pointing out their variable forms. When the sun is near the horizon (he says), we sometimes see two branches of light like horns, rising from that part of the halo of  $22^\circ$  which is directly over the sun. As the sun rises higher, these two horns diverge from each other, and when it has an altitude of  $12^\circ$ , they approach in form to an arc of a circle, convex towards the sun. When the sun reaches an altitude of  $30^\circ$ , these arcs become concave towards the sun; they bend downwards and envelope the halo. At an elevation of  $25^\circ$ , a contact arc is sometimes seen at the point of the halo directly beneath the sun. At first it appears as an arc of a circle convex towards the sun. As the sun rises, its curvature diminishes, and at  $32^\circ$  it becomes concave towards the sun. At  $45^\circ$  the curvature of the two arcs is nearly the same, and they form together an elliptical figure surrounding the halo of  $22^\circ$ .

With regard to the tails of the parhelia and the fringe of the halo, my supposition is that we have short ice crystals floating in the air in all positions, and long crystals with their axes vertical. Hence there would be more crystals with their axes vertical than with their axes inclined at any given angle to the horizon, and therefore the parhelia, due to these vertical crystals, would be brighter than any given point of the halo. The tails of the parhelia are formed by the vertical crystals not in the position to produce minimum deviation. Now suppose we had a series of crystals,  $a, b, c, \dots l, m, n, \dots x, y, z$ , with their axes parallel,  $a$  in the position of minimum deviation,  $b$  rotated  $1'$  from this position,  $c$   $2'$ ,  $d$   $3'$ , and so on up to  $z$  in the position of maximum deviation. Then the crystals  $a, b, c$  at the beginning of the series would throw their images very near together,  $l, m, n$  in the middle of the series further apart, and  $x, y, z$  at the end further apart still. Hence the further we recede from the position of minimum deviation, the fainter the illumination becomes. This explains the diminishing brightness of the tail of the parhelion. The same explanation applies to the fringe of the halo; but inasmuch as the halo, to begin with, is not so bright as the parhelion,

it follows that the fringe of the halo, at any given distance from it, will not be so bright as the tail of the parhelia at the same distance. Hence the fringe does not extend so far as the tails, and sometimes the fringe may be too faint to be seen at all, or only for a very short distance, while the tails still remain visible.

Mr. Backhouse further remarks that "no explanation is given why the parhelia, as well as the halo, are occasionally without tails or fringe, even when bright." I have not met with any explanation of this, but I would venture, with some hesitation, to suggest one. May not the cause be the prevalence at the time of some other form of ice crystal in place of the more common hexagonal figure? One of the forms known to occur is the six-pointed star, formed by the crossing of two equilateral triangles. If a crystal having this form in section be compared with one of the ordinary hexagonal shape and of equal size, it will be seen (1) that the surface available for the entrance of rays passing with minimum deviation is somewhat greater in the pointed



than in the hexagonal form, so that the halo and parhelia would be brighter, and (2) that when turned away from the position of minimum deviation, many rays would be intercepted by the projecting points in the star-like form, either externally or internally, and thus the tails and fringe would be relatively fainter, and might either disappear altogether or be very much abbreviated.

It is to be noticed that paranthelia, or parhelia, at a distance of  $120^\circ$  from the sun, have been explained by two reflexions, internal or external,\* from crystals of this pointed form, and hence if the above explanation is correct, we should expect that paranthelia would be seen when the ordinary parhelia are without tails. G H K L represents the course of a ray forming a paranthelion by external reflexion. This theoretical connexion between the absence of tails and the occurrence of paranthelia will afford a means of testing the theory by observation.—Yours truly,

ALFRED K. CHERRILL, M.A.

123, *Adelaide Road, N. W.*

\* See Heath's Geometrical Optics and Loomis' Treatise on Meteorology.

# REVIEWS.

*Annales de l'Observatoire Impérial de Rio de Janeiro*, publiées par L. CRULS, Directeur. Tome IV., Part ii. H. Lombaerts et Cie., Rio de Janeiro, 1889. 4to, xii.—406 pages.

THIS handsome volume contains the observations at Rio *in extenso* for the three years 1883-85. It tells us nothing as to the instruments or their position, but that may have been given in an earlier volume. A work of this kind necessarily consists chiefly of tables, but a few pages of remarks would greatly increase its utility. For instance, almost the first entry we noticed was the rainfall of 223·01 mm. on one day, April 26th, 1883; surely a rain of 8·78 inches in one day must be exceptional even in Rio, so we turned to the summary for the month, but the only remark is as follows: "26th, Storm in the morning, squall from S.W. and heavy rain during the day." In 1884 the greatest daily fall was 5·02 inches on December 7th, and in 1885, 2·51 in. on December 30th; so evidently the 8·78 in. was far beyond the usual maximum.

We may give a few further figures:—

	1883.	1884.	1885.
Total Rain on roof .....	49·48 in.	46·76 in.	30·69 in.
" " on ground .....	55·41 "	50·20* "	33·89 "
Evaporation in sun .....	57·46 "	57·61 "	66·53 "
" in shade .....	31·96 "	33·48 "	43·41 "
Max. temp. in shade .....	99·5 deg.	99·0 deg.	99·1 deg.
Min. " " .....	55·2 "	58·1 "	58·5 "
Mean " " .....	73·2 "	72·7 "	74·1 "

As considerable interest is taken in Dr. Cruls' forthcoming "Climatology," it is important to know whether his assistants and printers are accurate. The errata which are given in the introduction are few; but, without making anything like a search, we have noticed that on p. 133, July. the max. temp. should be 26°·3 not 65°·3; on p. 260, two entries of 14°·5 are in wrong type, they should have been marked as minima; and on p. 270 we have the wrong casting already mentioned.

We do not see the utility of printing vapour tensions to hundredths of a millimetre, *i.e.*, 0·0004 inch or  $\frac{1}{2500}$ th of an inch, but as we find that in Prof. Hazen's tables he does not stop even at hundredths of a millimetre but gives thousandths, Dr. Cruls can easily refer us to Prof. Hazen to answer our objection. We wish that he would, and tell us of what practical utility 0·00004 inch of vapour tension is; and whether two wet bulb thermometers could indicate the difference between say 42·720 mm. and 42·721 mm.; we have an impression that it would be a difference of somewhere about a thousandth of a Fahrenheit degree, but suppose it were ten times that, does anybody believe in a wet bulb thermometer reading correctly to one hundredth of a degree?

\* Wrongly added in the volume as 1075·20 mm. should be 1275·20 mm. which gives 50·20 in.

*Die Blitzgefahr. No. 2. Einfluss der Gas-und Wasserleitungen auf die Blitzgefahr. Herausgegeben im Auftrage des Elektrotechnischen Vereins von F. NEESEN. 8vo, 43 pages. Berlin: J. Springer. 1891.*

THIS is a list (with a few explanatory woodcuts) of 128 accidents by lightning, grouped and discussed, in order to ascertain whether it is, or is not, wise to form an electric connection between the gas and water pipes leading into churches, houses and buildings, and the lightning conductors thereon. The result is to confirm the recommendation in the Report of the Lightning Rod Conference that such connection should be made. The pamphlet is a very interesting one, and should be read by all concerned with the efficiency of Lightning Conductors.

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*Annual Report of the Board of Regents of the Smithsonian Institution, showing the operations, &c., to July, 1888. xxxiii.—839 pages. Government Printing Office, Washington, 1890.*

ONE of the best volumes in this important series. We may call especial attention to the papers on "Astronomical Progress in 1887 and 1888" (92 pages), by Mr. Winlock, and on "Recent Progress in Dynamic Meteorology" (70 pages), by Prof. Cleveland Abbe, a paper which it is impossible to epitomize, but which all advanced meteorological students ought to read and study.

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### SUNSHINE AND SUNLIGHT.

*To the Editor of the Meteorological Magazine.*

SIR,—I have noticed Mr. Baxendell's letter in the July number of the *Meteorological Magazine*, in which he expresses some surprise at a certificate of verification of one of Jordan's photographic sunshine recorders given by the Kew Observatory, and if I may be allowed, I should like to trouble you with a few words thereon.

It is, I believe, a well known fact that the burning rays registered by the Campbell-Stokes recorder, and the actinic rays registered by the photographic recorder are not the same thing, and it is also a well-known fact in photography, that the ferro-prussiate paper can be washed nearly, if not quite, white by a sufficiently long immersion in water. This latter fact will explain the difference between my figures given in the *Quarterly Journal*, Vol. xvi., p. 22, and Mr. Whipple's certificate given to Mr. Baxendell, for I have not the slightest doubt that the photographic papers were washed before tabulation, which would give a practical agreement with the burning recorder cards, whereas my readings as given in my paper are the readings before the papers were washed. It comes to this, that on a whole year, practically 30% of the photographic record is washed away. I may remark that the Meteorological Office have also been investigating the properties of the two recorders, and I have been informed, though I have not seen the figures, that their results and my own are practically identical.



There are also other minor disturbing causes, viz., with respect to the burning recorder ; p is rain, dew, or frost on the sphere the burning rays will not penetrate it, and with respect to the photographic recorder, if the rain drifts at all, it goes in at the holes, and running down inside the drum, spoils the paper, so that no trace is obtained.

I quite agree with your editorial note that the values given by the two recorders should be kept distinct, and more especially is this the case when I find that if the papers are washed in a weak solution of sulphuric acid, more of the traces are preserved than if they are washed in plain water. Is there no chemist amongst the Fellows of the Royal Meteorological Society who would devote his leisure to improving the ferro-prussiate paper?—Yours faithfully,

FRANCIS CAMPBELL BAYARD.

*Wallington, 29<sup>th</sup> July, 1891.*

### ANOTHER CORPORATION OBSERVATORY.

BRIGHTON was, we believe, the first town to establish a second order station—others have followed—we do not remember all, but Middlesbrough, Southport, Eastbourne, Croydon, Nottingham, Macclesfield, Bolton, Rochdale, Sheffield, Harrogate, and Hull, occur to us as having taken steps in this direction—though in some cases the help of the Corporation has been limited to granting the use of a portion of a public park or garden. In other cases, the Corporations have found the site, purchased the instruments, and appointed a paid curator.

The town or city of which Dr. Tatham was Medical Officer of Health, would not be allowed to do things by halves, and with such a city as Manchester at his back, it goes without saying that things have been done as they should be. For that reason, and as suggestions for other places to follow, we devote a few lines to reporting what has been done at Manchester.

*Site.*—This is the most important feature, and Dr. Tatham has shown his usual sound sense in selecting, not an airy suburb, but a large yard in the heart of the city, one in fact surrounded by the very air which the teeming population have to breathe. We do not know its area, but it is large enough to ensure that no object subtends at the orifice of the rain gauge a greater angle than  $20^{\circ}$ .

*Instruments.*—These include standard barometer ; dry and wet bulb and max. and min. thermometers in Stevenson stand ; grass min. thermometer ; earth thermometers at 1 ft. and 4 ft. ; rain gauge ; recording aneroid and thermograph.

*Publication.*—It is of very little use making observations unless by publication they are made generally accessible. This is efficiently done in the city of Manchester *Weekly Health Return*, which is in all respects but one, perfect—and that is a word we rarely use.—The publication is admirable, worthy of the city with its 500,000 inhabitants, and one which can stand comparison with the *Weekly*

*Return of the Registrar General* without any hesitation. We said that there was one respect in which the *Manchester Weekly Health Return* failed to reach perfection; it is not a meteorological one but one closely connected therewith: there is not a word respecting the supply of water, either as to its quality or quantity.

### THE THUNDERSTORMS OF AUGUST 3RD, AND 4TH, 1891.

*To the Editor of the Meteorological Magazine.*

SIR,—On Monday, August 3rd, 1891, a severe storm passed over Sevenoaks. For fully half-an-hour before it came, thunder had been heard in the west, and the clouds had been very dark in the same direction. At 4.30 p.m. large drops of rain fell, and this was followed in a few minutes by a most tremendous fall of hail, which lasted about 20 minutes, and left the ground quite white. The hail fell almost straight down, but came rather from the W.S.W. The hailstones were large, and some measured fully half-an-inch across; one weighed over  $\frac{1}{4}$  oz. 20 minutes after it fell. They made large holes in the leaves of many plants (tomatoes, marrows, dahlias, &c.) Boys were able to make snowballs of the hail. Steady rain followed this until the second and less severe hailstorm came, about 6.30 o'clock. This lasted only a few minutes. The lightning was most severe about 4.45 p.m., when it struck a building about a quarter of a mile distant, doing, however, only slight damage. The barometer stood steady at 29°·65 in., corrected for sea level. There was little or no wind all the time. The damage done to the vegetation was considerable, and the roads were torn up by the rush of water down the hills. The total of rain and hail that fell measured ·71 of an inch. It is reported that no storm occurred at Ightham, 5 miles to the E.N.E., or at Maidstone 15 miles, but at Shipborne, 5 miles E.S.E., the storm was severe. Temperature fell to 43° afterwards.

Yours faithfully,

W. W. WAGSTAFFE.

*Purleigh, Sevenoaks, August 5th, 1891.*

*To the Editor of the Meteorological Magazine.*

SIR,—We had one of the sharpest storms of the series at Tenterden on the 4th at 11.45 a.m.; ·20 in. of R fell in 10 minutes; ·08 in. in three minutes. T continued in E. after the sun began to shine again, and it was only a short storm. A tree was struck at Rolvenden and nine sheep killed (3 miles W. of us), and another in a park  $1\frac{1}{2}$  miles E. and nine lambs killed there.

Another tree was struck about half a mile N.E. from the town, the bark cut out in a strip from top to bottom of the tree, two to four inches wide. A similar strip eight feet up and another on the branch of an adjoining tree, but not down the trunk, almost as if the lightning went across to the other tree where the main damage was done.

Yours truly,

J. ELLIS MACE.

*Dover, August 8th, 1891.*

## SOMETHING LIKE A SHOWER.

*To the Editor of the Times.*

SIR,—The importance with regard to house drainage and to sewerage of knowing the extreme rate at which rain falls is such that I am surprised that those interested in architecture and engineering so rarely try to ascertain it.

During a thunderstorm in 1878, I recorded here by far the highest intensity of rainfall observed in this country. You allowed me then to give the full details in *The Times*; perhaps, as we have just had a similar (but shorter) torrential fall, you will allow me to do the same now.

Rain had been falling at intervals during the afternoon, about a quarter of an inch falling in ordinary showers. At 5.58 p.m., I saw that it was becoming exceptional and began reading the storm rain-gauge each half-minute, with the following results:—

July 29, 1891.				Fall in the subsequent	
				Half minute.	Minute.
5.58 p.m.	...	...	...	·02 in.	·04 in.
5.58.30	...	...	...	·02 in.	—
5.59...	...	...	...	·01 in.	·03 in.
5.59.30.	...	...	...	·02 in.	—
6.0 ...	...	...	...	·02 in.	·07 in.
6.0.30.	...	...	...	·05 in.	—
6.1 ...	...	...	...	·04 in.	·07 in.
6.1.30	...	...	...	·03 in.	—
6.2 ...	...	...	...	·02 in.	·04 in.
6.2.30	...	...	...	·02 in.	—
6.3. ...	...	...	...	·02 in.	·04 in.
6.3.30	...	...	...	·02 in.	—
6.4 ...	...	...	...	·02 in.	·02 in.
6.4.30	...	...	...	·00 in.	—

From the above it will be seen that although in the even minutes the greatest fall was 0·07 in., yet from 6.0.30 to 6.1.30 the fall was 0·09 in., practically a tenth of an inch a minute, and at the rate for half-a-minute of six inches an hour.

It will probably render the volume of water precipitated better understood, if, instead of leaving it in the usual rainfall expressions of depth, I convert it into feet, gallons, and pounds.

Take an ordinary London house roof, say 20 ft. by 30 ft., the area would be 600 square feet—a tenth of an inch of rain over it would be five cubic feet, or 30 gallons, or 300 lb. weight—this on the roof of one ordinary house in one minute; and with a slate roof it runs off almost as quickly as it falls.

Take an acre of slated roofs, the fall of 0·09 in. gave 327 cubic feet, or 2,036 gallons, or rather over nine tons weight of water per acre in a single minute.—Your obedient servant,

G. J. SYMONS, F.R.S.

62, Camden-square, N. W., July 29.

## CLIMATOLOGICAL TABLE FOR THE BRITISH EMPIRE, JAN., 1891.

STATIONS.  (Those in italics are South of the Equator.)	Absolute.				Average.				Absolute.		Total Rain.		Aver.
	Maximum.		Minimum.		Max.	Min.	Dew Point.	Humidity.	Max. in Sun.	Min. on Grass.	Depth.	Days.	Cloud.
	Temp.	Date.	Temp.	Date.									
	°		°		°	°	°	0-100	°	°	inches		
England, London .....	53·0	31	16·9	11	39·4	28·9	31·4	88	78·2	12·5	1·80	14	6·6
Malta.....	63·0	8	37·8	20	56·5	46·0	41·8	78	116·5	32·5	4·52	17	6·0
<i>Cape of Good Hope</i> ...	96·1	25	55·8	5	79·8	61·2	...	...	...	...	·21	5	...
<i>Mauritius</i> .....	85·2	31	65·2	4	82·6	72·0	68·5	77	140·3	57·5	4·13	18	6·4
Calcutta .....	81·6	19	50·7	5	77·1	54·5	55·7	73	134·6	41·7	·00	0	4·4
Bombay .....	90·0	31	61·5	25	83·4	67·5	62·5	65	136·0	47·1	·00	0	0·2
Ceylon, Colombo .....	90·6	27	67·8	1	87·8	71·5	67·0	70	144·0	62·5	1·45	4	3·0
<i>Melbourne</i> .....	103·0	4	46·3	3	76·4	54·2	51·9	64	158·8	34·0	1·21	7	5·2
<i>Adelaide</i> .....	102·0	25	50·5	22	81·7	58·5	49·8	48	158·1	39·6	·54	4	2·7
<i>Tasmania, Hobart</i> ....	87·2	8	44·2	14	70·3	50·7	52·0	73	144·0	38·0	3·53	16	6·8
<i>Wellington</i> .....	72·0	1	44·0	13	67·4	53·6	54·4	82	139·0	35·0	4·77	16	3·9
<i>Auckland</i> .....	79·0	23	50·0	17	73·5	58·1	54·4	67	142·0	40·0	2·16	11	5·7
Jamaica, Kingston.....	90·4	7	61·5	27	86·6	66·5	65·7	72	...	...	·41	...	...
Trinidad .....	87·0	<i>Var</i>	62·0	10	85·4	67·4	67·6	75	152·0	59·0	3·17	16	...
Toronto .....	41·9	2	— 2·0	16	30·1	16·6	22·2	85	...	— 8·2	3·13	20	7·4
New Brunswick, Fredericton .....	48·8	12	— 15·8	17	26·5	5·8	14·5	79	...	...	6·88	19	6·0
Manitoba, Winnipeg ...	33·5	20	— 30·2	15	16·0	— 1·9	...	98	...	...	·78	15	7·5
British Columbia, Esquimalt .....	54·4	18	30·5	9, 10 & 12	45·9	38·2	41·1	95	...	...	5·22	20	8·2

## JANUARY, 1891, REMARKS.

MALTA.—Mean temp. 50°·3; mean hourly velocity of wind, 13·1 miles; sea temp. fell from 60°·5 to 56°·0. TS on 11th; L on 13th and 15th; H on 8 days. The coldest month known for more than 10 years. Temp. fell below 40°·0 in screen on 6 days, and remained below 47°·0 in the house for 4 days after the 16th. J. SCOLES.

*Mauritius*.—Mean temp. of air, 1°·6 below, mean dew point 1°·2 below, and R 2·70 in. below, their respective averages; mean hourly velocity of wind, 11·0 miles, or 0·2 miles below average; extremes 31·5 on 27th, and 0·0 on 6th; prevailing direction, S.E. by E. to E. T and L on 2nd, 12th, 14th, and 27th; T on 15th and 22nd.

C. MELDRUM, F.R.S.

CEYLON, COLOMBO.—TSS occurred on the 20th and 21st; L alone was seen on the 19th and 22nd.

J. C. H. CLARKE, Lieut.-Col., R.E.

*Melbourne*.—Mean temp. of air 1°·6, of dew point 1°·1, humidity 1, and R·65 in. below their respective averages; cloud same as the average. Prevailing direction of wind S., strong on 8th and 12th from N., on 13th, 18th and 27th from S.W. and S. Hot wind on 4th and 18th; heavy dews on 6 days; L on 3 days.

R. L. J. ELLERY, F.R.S.

*Adelaide*.—Temp. 4°·6 below the average of 34 years; only once has the mean temp. been lower in January, viz., in 1868. R·30 in. below the average. The summer has been a remarkably cool one.

C. TODD, F.R.S.

*Tasmania, Hobart*.—Mean temp. 2°·3 below the average of 7 years, due to the low minimum temperature.

J. SHORTT, CAPT. R.N.

*Wellington*.—On the whole a showery month, especially towards the end, when heavy R fell on 25th and 26th (1·30 in. and 1·25 in.) Prevailing wind N.W., frequently strong. T on 3rd. Mean temp. 2°·1 below the average. R 1·26 in. above average.

R. B. GORE.

*Auckland*.—An average month, with no unusual disturbances. Mean temp. 2° below the average of 24 years. R slightly less.

T. F. CHEESEMAN.

SUPPLEMENTARY TABLE OF RAINFALL,  
JULY, 1891.

[For the Counties, Latitudes, and Longitudes of most of these Stations,  
see *Met. Mag.*, Vol. XIV., pp. 10 & 11.]

Div.	STATION.	Total Rain.	Div.	STATION.	Total Rain.
		in			in.
II.	Dorking, Abinger Hall.	2·96	XI.	Builth, Llanwrtyd Wells	3·23
„	Margate, Birchington...	4·38	„	Rhayader, Nantgwillt..	4·21
„	Brighton Prestonville Rd	2·54	„	Corwen, Rhug .....	2·47
„	Hailsham .....	2·92	„	Carnarvon, Cocksidia ...	2·45
„	Ryde, Thornbrough .....	2·09	„	I. of Man, Douglas .....	1·31
„	Alton, Ashdell .....	2·77	XII.	Stoneykirk, Ardwell Ho.	·52
III.	Oxford, Magdalen Col...	2·14	„	New Galloway, Glenlee	1·22
„	Banbury, Bloxham .....	1·91	„	Melrose, Abbey Gate...	3·28
„	Northampton .....	2·17	XIII.	N. Esk Res. [Penicuik]	...
„	Cambridge, Fulbourne..	4·29	XIV.	Ballantrae, Glendrisaig	1·53
„	Wisbech, Bank House..	3·25	„	Glasgow, Queen's Park.	1·35
IV.	Southend .....	2·37	XV.	Islay, Gruinart School..	2·34
„	Harlow, Sheering .....	3·33	XVI.	Dollar .....	2·72
„	Rendlesham Hall .....	3·81	„	Balquhider, Stronvar..	2·86
„	Diss .....	3·62	„	Coupar Angus Station..	4·03
„	Swaffham .....	4·13	„	Dunkeld, Inver Braan..	3·08
V.	Salisbury, Alderbury ...	2·56	„	Dalnaspidal H.R.S. ...	4·19
„	Warminster .....	...	XVII.	Keith H.R.S. ....	7·07
„	Bishop's Cannings .....	2·45	„	Forres H.R.S. ....	5·84
„	Ashburton, Holne Vic....	4·25	XVIII.	Fearn, Lower Pitkerrie.	...
„	Okehampton, Oaklands.	3·03	„	Loch Shiel, Glenaladale	5·39
„	Lynmouth, Glenthorne.	3·05	„	N. Uist, Loch Maddie ...	...
„	Probus, Lamellyn .....	2·06	„	Invergarry .....	3·56
„	Launceston, S. Petherwin	...	„	Aviemore H.R.S. ....	3·72
„	Wincanton, Stowell Rec.	3·36	„	Loch Ness, Drumnadrochit	5·44
„	Wells, Westbury .....	...	XIX.	Lairg H.R.S. ....	4·57
VI.	Bristol, Clifton .....	3·19	„	Scourie .....	4·68
„	Ross, the Graig .....	1·70	„	Watten H.R.S. ....	3·34
„	Wem, Clive Vicarage ...	2·29	XX.	Dunmanway, Coolkelure	2·13
„	Cheadle, The Heath Ho.	2·99	„	Fermoy, Gas Works ...	2·53
„	Worcester, Diglis Lock	2·30	„	Darrynane Abbey .....	2·81
„	Coventry, Coundon .....	3·06	„	Tipperary, Henry Street	2·10
VII.	Ketton Hall [Stamford]	2·60	„	Limerick, Kilcornan ...	1·70
„	Grantham, Stainby .....	2·75	„	Ennis .....	·77
„	Horncastle, Bucknall ...	2·33	„	Miltown Malbay .....	1·19
„	Worksop, Hodsck Priory	2·42	XXI.	Gorey, Courtown House	1·87
VIII.	Neston, Hinderton .....	2·72	„	Mullingar, Belvedere ...	1·02
„	Knutsford, Heathside...	2·32	„	Athlone, Twyford .....	1·38
„	Lancaster, Southfield ...	...	„	Longford, Currygrane...	1·96
„	Broughton-in-Furness..	3·42	XXII.	Galway, Queen's Coll...	·87
IX.	Ripon, Mickley .....	3·33	„	Crossmolina, Enniscoe..	2·33
„	Scarborough, West Bank	3·70	„	Collooney, Markree Obs.	2·47
„	East Layton [Darlington]	3·94	„	Ballinamore, Lawderdale	1·42
„	Middleton, Mickleton..	3·70	„	Lough Sheelin, Arley ..	2·12
X.	Haltwhistle, Unthank..	4·02	XXIII.	Warrenpoint .....	1·89
„	Bamburgh .....	1·66	„	Seaforde .....	2·30
„	Shap, Copy Hill .....	...	„	Belfast, New Barnsley..	2·40
XI.	Llanfrechfa Grange .....	2·48	„	Bushmills, Dundarave...	3·58
„	Llandovery .....	4·44	„	Stewartstown .....	1·92
„	Castle Malgwyn .....	2·96	„	Buncrana .....	3·57

JULY, 1891.

Div.	STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL.						Days on which .01 or more fell.	TEMPERATURE.				No. of Nights below 32°	
		Total Fall.	Difference from average 1880-9.	Greatest Fall in 24 hours.		Max.	Min.		In shade.	On grass.				
				Dpth	Date						Deg.	Date	Deg.	Date
		inches.	inches.	in.			Deg.	Date	Deg.	Date				
I.	London (Camden Square) ...	3.82	+ 1.14	.76	8	17	84.3	17	44.6	28	0	0		
II.	Maidstone (Hunton Court)...	3.16	+ .98	.84	27	16	...	...	...	...	...	...		
III.	Strathfield Turgiss .....	2.60	+ .21	.73	27	18	80.5	17	40.5	28	0	0		
III.	Hitchin .....	2.52	— .20	.39	29	21	82.0	17	44.0	28	0	0		
IV.	Winslow (Addington) .....	2.13	— 1.16	.42	6	20	81.0	17	42.0	28f	0	0		
IV.	Bury St. Edmunds (Westley)	3.50	+ .93	.70	7	18	...	...	...	...	...	...		
V.	Norwich (Cossey) .....	4.13	...	.81	29	17	...	...	...	...	...	...		
V.	Weymouth (Langton Herring)	1.79	+ .36	.62	26	13	72.0	13a	48.0	4	0	0		
"	Barnstaple .....	3.00	— .47	.95	20	12	76.5	17	46.0	22	0	...		
"	Bodmin (Fore Street) .....	2.66	— 1.95	.38	4	17	...	...	...	...	...	...		
VI.	Stroud (Upfield) .....	3.32	— .25	.78	1	18	80.0	17	50.0	23g	0	0		
"	Church Stretton (Woolstaston)	2.57	— .40	.36	29	17	73.0	16	45.0	28	0	0		
"	Tenbury (Orleton) .....	1.73	— 1.13	.28	3	17	77.6	16	40.0	28	0	0		
VII.	Leicester (Barkby) .....	2.24	— .75	.43	1	18	84.0	17	41.0	3, 27	0	0		
"	Boston .....	2.69	— .10	.55	29	13	85.0	17	43.0	29	0	0		
"	Hesley Hall (Tickhill) .....	2.01	— .66	.92	30	14	79.0	17	43.0	5	0	0		
VIII.	Manchester (Plymouth Grove)	2.53	— 1.26	.34	1	18	80.0	17	47.0	1, 4	0	0		
IX.	Wetherby (Ribston Hall) ...	4.53	+ 1.35	.96	2	13	...	...	...	...	...	...		
"	Skipton (Arncliffe) .....	5.91	+ .27	1.48	7	16	75.0	19	44.0	27	0	...		
"	Hull (Pearson Park) .....	2.87	+ .28	1.35	30	16	...	...	...	...	...	...		
X.	Newcastle (Town Moor) .....	4.75	+ 1.23	.87	22	16	...	...	...	...	...	...		
"	Borrowdale (Seathwaite) .....	5.82	— 5.17	1.21	6	19	...	...	...	...	...	...		
XI.	Cardiff (Ely) .....	2.41	— 1.65	.44	2	17	...	...	...	...	...	...		
"	Haverfordwest .....	2.33	— 1.88	.50	2	18	75.2	16	42.7	12	0	0		
"	Carno (Tybrith) .....	2.58	— 1.50	.45	1	15	68.0	17	36.0	27	0	...		
"	Llandudno .....	1.80	— 1.20	.36	28	13	72.7	17	49.6	2	0	0		
XII.	Cargen [Dumfries] .....	1.68	— 2.25	.62	6	14	74.8	14	45.0	31	0	0		
"	Jedburgh (Sunnyside) .....	3.74	+ .30	.81	22	19	72.0	17	47.0	4h	0	...		
XIV.	Old Cumnock .....	1.03	— 2.49	.20	2	15	...	...	...	...	...	...		
XV.	Lochgilthead (Kilmory) .....	1.57	— 2.73	.35	2	19	...	...	44.0	6, 8i	0	...		
"	Oban (Craigvarren) .....	2.70	...	.57	2	22	73.0	14	47.1	9	0	...		
"	Mull (Quinish) .....	2.36	— 1.69	.49	6	19	...	...	...	...	...	...		
XVI.	Loch Leven Sluices .....	2.10	— 1.52	.50	16	11	...	...	...	...	...	...		
"	Dundee (Eastern Necropolis)	3.45	— .01	1.25	22	13	80.9	13	44.1	7	0	0		
XVII.	Braemar .....	2.93	— .28	.54	3	21	70.0	10b	43.8	28	0	0		
"	Aberdeen (Cranford) .....	2.96	...	.89	17	16	70.0	1, 18	43.0	31	0	0		
XVIII.	Strome Ferry .....	4.11	— .18	.79	6	26	...	...	...	...	...	...		
"	Inverness (Culloden) .....	6.51	+ 3.52	1.50	8	10	70.0	18	46.0	27f	0	0		
XIX.	Dunrobin .....	3.97	+ 1.12	1.44	8	13	69.0	19	44.0	27	0	...		
"	S. Ronaldsay (Roeberry) .....	3.81	+ 1.45	.48	28	20	65.0	14c	45.0	26	0	0		
XX.	Dromore Castle .....	2.19	— 2.79	.55	4	9	75.0	12d	53.0	1, 23	0	...		
"	Waterford (Brook Lodge) ...	3.13	— .40	.94	17	13	74.0	13	42.0	3	0	...		
"	O'Briensbridge (Ross) .....	1.13	...	.27	1	13	78.0	15	50.0	31g	0	0		
XXI.	Carlow (Browne's Hill) .....	2.53	— .99	.37	17	18	...	...	...	...	...	...		
"	Dublin (Fitz William Square)	2.19	— .49	.40	3	15	72.8	16	46.8	10	0	0		
XXII.	Ballinasloe .....	1.34	— 2.21	.41	1	17	70.0	14e	45.0	9	0	...		
"	Clifden (Kylemore) .....	4.23	...	.64	1, 17	21	...	...	...	...	...	...		
XXIII.	Waringstown .....	3.09	— .43	.43	1	19	81.0	17	45.0	9, 29	0	0		
"	Londonderry (Creggan Res.)	3.67	— .45	.71	7	22	...	...	...	...	...	...		
"	Omagh (Edenfel) .....	4.29	+ .57	1.10	2	21	73.0	15	47.0	5	0	0		

*a* And 17. *b* And 13. *c* And 21. *d* And 14, 25. *e* And 15. *f* And 29. *g* And 30. *h* And 11, 29. *i* And 9, 28  
 + Shows that the fall was above the average; — that it was below it.

# METEOROLOGICAL NOTES ON JULY, 1891.

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 Hail. S for Snow.

## ENGLAND.

STRATHFIELD TURGISS.—After an opening week of wet, July was fairly fine and dry up to the 19th, with two hot days—the 16th and 17th. From the 19th to the close of the month was wet and cold, with a heavy TS on the 27th. T and H on the 8th; slight TS on the 21st.

ADDINGTON.—Unglenial weather for July and a great want of sunshine. The rains after the 20th were hindering for haymakers, but of great advantage to root and garden crops. Several very cold nights occurred at the end of the month. Ther. on grass  $36^{\circ}$  on 28th; T heard on 4th, 6th, 29th and 30th.

BURY ST. EDMUNDS, WESTLEY.—The usual July weather, with R on 18 days. Cold for the time of year from the 27th to the end of the month. Harvest about 10 days late. No heavy TSS; T heard on 5 days; TS on 23rd.

LANGTON HERRING.—Mean temp. at 9 a.m.  $1^{\circ}9$  below the average of 19 years. The fine weather from the 8th to the 16th was favourable for the hay harvest. TSS at night on 26th, 27th, and 30th. Fogs on 5th and 6th.

BODMIN.—A remarkably dry and fine month for July; most welcome showers to the 8th, and from the 17th to the 29th. Very hot on the 16th and 26th. Temp. rather high by day, but cold nights. T and L on the 26th. Fresh wind from the N.W. from the 28th to the end of the month. The crops all around are looking very good and prosperous.

STROUD.—Heavy TS to the N. from 2 p.m. until 7 p.m. on 3rd. T and L with heavy R on 29th at 2.30 p.m. and on 30th at 5 p.m.

WOOLSTASTON.—The first week was wet and stormy, a fortnight of fine summer weather followed and the last week was cold, wet and stormy, disastrous for the later hay crops. Mean. temp.  $57^{\circ}6$ .

ORLETON.—A rather stormy month, with little good haymaking weather, except from the 8th to the 18th. The temp. rather below the average, particularly during the last week. T frequent, but no L seen during the month. Most of the R fell in heavy storms.

LEICESTER, BARKBY.—Rather awkward weather for hay getting; few intervals of any length without R. Temp. below the average except 3 days in the middle of the month. Mean. temp.  $55^{\circ}3$ . T on 9 days.

MANCHESTER, PLYMOUTH GROVE.—Summerlike weather prevailed on the 4th and from the 14th to the 19th. The rest of the month was dull, cold and unsettled; some days as cold as winter—top coats and fires very acceptable. Mean temp  $59^{\circ}$ ; the lowest in July for 24 years, excepting 1871, when it was  $58^{\circ}$ . T on 8th and 21st.

HULL, PEARSON PARK.—TS on 6th; T and L on 21st and 22nd.

## WALES.

HAVERFORDWEST.—A cool fine July, the temp. only reaching or exceeding  $70^{\circ}$  on 4 days, while the max. on the 9th was only  $56^{\circ}8$ . The days were mostly fine and clear, with small rainfalls at night. As the wind was for the most part from the N., evaporation was rapid, and consequently it was good haymaking weather. Lowest temp. on grass  $39^{\circ}1$  on the 11th and 13th.

## SCOTLAND.

CARGEN.—Notwithstanding the mean temp. was below the average ( $1^{\circ}1$ ) and the hours of sunshine were also below it, the month was very favourable for vegetation, and crops of all kinds made rapid growth. All green crops looking remarkably well at the close. Hay very short in quantity, but the crop was secured in excellent condition. Towards the end of the month the caterpillar of the diamond moth made its appearance in some of the turnip

fields in the district, and is reported to be doing considerable damage. T on 21st; T and L on 22nd.

JEDBURGH.—Much T and L on 3rd; T and L on 7th, 17th and 29th. Vegetation vigorous; the turnip and potato crops were never in finer condition, and cereals are good. There is no appearance yet in this district of the turnip caterpillar.

OBAN, CRAIGVAREN.—A very fine month with moderate R after the previous drought; green crops give good promise, but hay and straw will be very light.

MULL, QUINISH.—The R of the month was not sufficient to fill either springs or streams, and there is considerable scarcity of water in the West Highlands generally.

DUNDEE, EASTERN NECROPOLIS.—On the 22nd 1.00 in. of R fell in an hour, between 1 and 2 p.m.

BRAEMAR.—On the 21st T and L from 4 p.m. to 6 p.m.

CULLODEN.—The R was greatly in excess of the average, being the largest in July for at least 40 years.

S. RONALDSAY, ROEBERRY.—The first week wet, the second dry and warmer, but the last part of the month very wet and cold.

### IRELAND.

WATERFORD, BROOK LODGE.—Mean temp. 58°·6. .94 in. of R fell in about 2 hours on the 17th.

O'BRIENSBRIDGE, ROSS.—A perfect month for hay harvesting. R fell mostly at night, and the sunshine was brilliant almost every day. Mean temp. of the month lower by 3° than that of June.

DUBLIN.—A changeable, squally, showery month of average R, with a great preponderance of N.W. winds—a very common state of things in an Irish July. The mean temp 59°·0 was decidedly below the average. High winds were noted on 10 days, and attained the force of a fresh or moderate gale on two occasions, viz.: 6th and 8th. Temp. reached or exceeded 70° in the screen on only 3 days. TSS occurred on the 3rd and 26th. The R during the seven months ending July 31st, has amounted to 10.94 in. on 92 days; compared with 15.59 in. on 118 days for the same period in 1890.

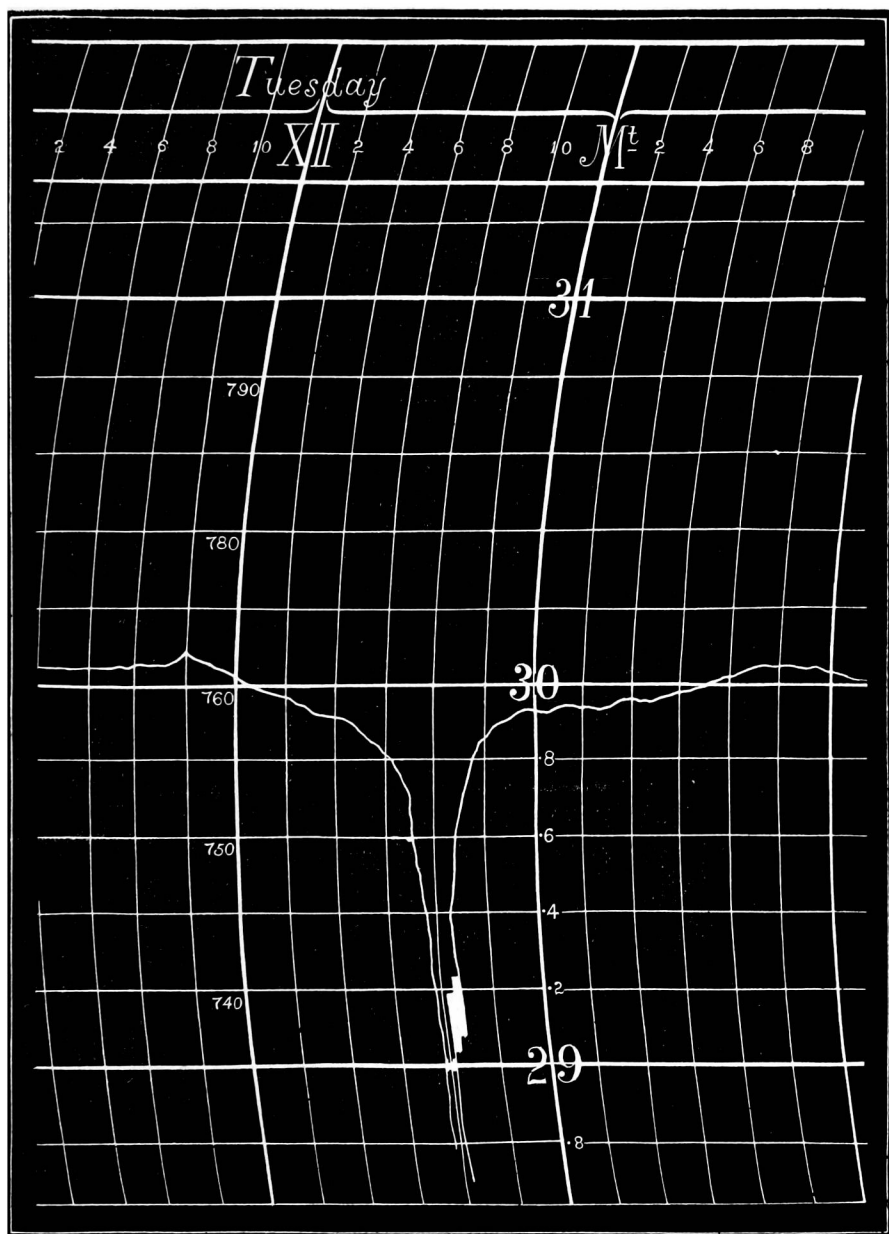
WARINGSTOWN.—Great alternations of heat and cold occurred, but on the whole the month was very fine and seasonable. All crops remarkably good; oats, the heaviest crop for many years; turnips were middling in the beginning of the month, but are now promising well and the potato crop is luxuriant.

EDENFEL.—The first week was unsettled, with frequent torrential rains; the second, fine, warm and mostly clear; the third, fresh and showery, with fine intervals and the fourth, similar, accompanied by cool polar winds. On the whole the month was very favourable, a good average hay crop was saved in excellent order, and both cereal and green crops improved into the promise of an abundant harvest.

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TWO MEN STRUCK BY LIGHTNING.—Two labourers, named Samuel Litten and Samuel Fox, who were employed on a farm, in the vicinity of Castle Cary, called Rat's Castle, were on Monday working in the fields near the farm. A severe thunderstorm came on, and they ran for shelter to an elm tree, beneath the branches of which they remained for a time. Unfortunately for the men the tree attracted the electric current and they were struck by the lightning. Fox was severely burned in the back, his injury having the appearance of a shot wound. Litten was fearfully burnt all down one side of his body from the shoulder. A doctor was quickly in attendance, but it is reported that when the clothes were removed from the unfortunate man the burnt flesh came off with them. There is every probability of the recovery of Fox, but in the case of Litten the prospects are much less hopeful. At Yatton a lad named Gilbert Bellamy was resting on his bicycle beneath a tree when it was struck by lightning; he was knocked over and partially stunned, but luckily sustained no further injury.—*Clevedon Mercury*, 8th August, 1891.





REPRODUCTION OF TRACE OF RICHARD BAROGRAPH.

ST. PIERRE, MARTINIQUE.

AUGUST 18TH 1891.