

SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE.

CCLXVIII.]

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THUNDERSTORMS.*

It is evident that the study of thunderstorms is taking, and will take, a prominent place in meteorological work. In our February number we printed the circular recently issued by the Royal Meteorological Society. Since that we have had to report (p. 40), Dr. Marcet's address on Atmospheric Electricity at the meeting of the Society, and Mr. Symons's paper on Thunderbolts on the same occasion, and the grand collection of electrical apparatus, lightning conductors, &c., shown at the Society's exhibition. At the Royal Society Soirée on May 9th, between 50 and 100 photographs of lightning flashes were shown, and we understand that many photographers, both professional and amateur, are on the *qui vive* for a storm to obtain further views. Certainly they are necessary, for the enigmas are very numerous—the greatest of all being the so-called dark flash on one of the photos sent to the Royal Meteorological Society. The following list of the photographs exhibited at the Royal Society will show how widespread is the interest in the subject:—

4. Exhibited by the Royal Meteorological Society.

Photographs of Flashes of Lightning.

1881,	July 15th,	Brighton.
1884,	Aug. 9th,	Tynemouth. By M. Auty (2 photos.)
1886,	July	Ramsgate. By G. F. Harvey.
1886,	Oct. 6th,	Bournemouth. By Dr. Drewitt (2 photos.)
1887,	Aug. 17th,	Pimlico, London. By G. C. Baker.
"	"	London. By E. A. Barton (2 photos.)
"	"	Streatham. By J. H. Bateman.
"	"	Croydon. By G. Corden (5 photos.)
"	"	Brixton. By J. Gray.
"	"	Battersea. By G. J. Ninnies.
"	"	Regent Street. By J. Robinson & Sons.
"	"	Westbourne Grove, W. By E. S. Shepherd (7 photos.)
"	"	Belsize Park. By W. Shuter (3 photos.)
"	"	Highbury. By Capt. A. S. Thomson.
"	"	Wandsworth. By C. H. Wordingham.

* *Les Orages dans la Péninsule Scandinave.* Par H. Mohn et H. Hildebrand Hildebrandsson [Except Trans. Soc. Roy. d. Sciences]. Upsal, E. B. Erling, 1888, 4to, 55 pages and 12 maps.

- 1884, July 12th, Mount Vernon, New York. By G. R. Allerton
(2 photos.)
 " " " Enlargements of ditto.
 1885, Aug. 1st, Philadelphia. By W. N. Jennings.
 1886, July, Greenwich, Conn. By Dr. H. G. Pippard.
 " " " Enlargement of ditto.
 1887, June 22nd, Philadelphia. By W. N. Jennings.
 1887, July 17th, Dubuque, Iowa. By G. E. Davis (2 photos.)
 " " " Irvington-on-Hudson. By R. H. Lawrence
(2 photos.)
 1887, Aug. 2nd, Alleghany Mts. By L. S. Clarke (2 photos.)
 " " " Enlargements of ditto.
 1886, May 12th, Auteuil, Paris. By C. Moussette (photograph
and enlargements).
 1886, May 26th, Rougemont, near Tours. By H. Schleusner
and E. B. Vignoles.
 1887, June 25th, Auteuil, Paris. By C. Moussette (2 photos.)
 1887, July 13th, Fontainebleau.
 1884, Nov. 14th, On board H.M.S. Neptune, between Madeira
and Gibraltar. By Dr. Puddicombe, R.N.
 1885, Oct. Amzinto, Natal. By R. Harris.
 1887, Mar. 15th, Calcutta. By G. L. Molesworth.

Other indications of the activity prevailing respecting this subject are afforded by the hearty response accorded to the circular, which we have already mentioned, inviting co-operators, and by the fact that the Chairman of the Committee, the Hon. Ralph Abercromby, is understood to have visited the heads of several of the larger thunder-storm organizations in Northern Europe, so that the records may be worked up in the best manner possible.

We may also mention that Messrs. Richard Frères, of Paris, are constructing for Mr. Symons a very complicated apparatus (Brontometer)—*Βροννη* (thunder), *Μέτρον* (measure)—for recording the details of thunderstorms, so as to investigate the peculiar barometric oscillations which occur during them. A full description of this instrument will be given when it is completed, but some notion of its exceptional character will be afforded by our mentioning that the barometer curve for a single day would be 120 feet long. Most persons will recognize that as an unprecedentedly open sale. Then we have had the *Mann* lectures on Lightning Conductors, by Dr. Oliver Lodge, F.R.S., the remarkable experiments and statements in which will, undoubtedly, lead to a keen controversy as soon as they are published.

As for the literature, it is becoming very extensive—we cannot deal with it all. The Italian work is especially good, but on the present occasion we take only the report from Norway and Sweden.

We have a little rectification to make with respect to the first paragraph in this Scandinavian report. It is as follows:—

“C'est, comme on le sait, LE VERRIER, qui le premier organisa pour l'étude des orages un réseau de stations pourvu des instructions

et des formulaires, qui dans la suite ont été, presque sans changements, adoptés dan la plupart des pays.”

Le Verrier had few, if any, greater admirers than the writer of these lines, but it is robbing Le Verrier of nothing worth his retaining to ask whether he *was* the first to issue rules and blank forms for the record of thunderstorms. Le Verrier's first *Atlas des Orages* was, we believe, for 1865 ; the February number of this magazine showed what Mr. Symons was doing seven years previously, or in 1858 ; but we have before us the stronger evidence of one of the blank forms prepared by him in 1856, and issued early in 1857, to all the observers then sending quarterly returns to Mr. Glaisher. We print the quarto form in 8vo by changing the type and reducing the blank spaces, but in all other respects it is *verbatim et literatim*. Considering that the form was issued thirty-two years ago, there is not perhaps much fault to be found with it, and until we have some fresh evidence, we hold that Le Verrier was *not* the first. Perhaps, however, somebody can unearth a form older still ; if so, we shall be happy to be the means of bringing it forward.

STORM REPORT

— :o: —

Station at _____ Observer _____ Date _____

A Storm Cloud was observed in the _____ at _____ it passed _____ and disappeared in the _____ at _____

Thunder was first heard at _____ most violent at _____ last heard at _____

Lightning was first seen at _____ most brilliant at _____ last seen at _____

its colour was _____ and it was mostly _____

Rain began at _____ most violent at _____ ceased at _____

Hail fell at _____ its size was _____ its shape was _____

Yesterday the weather was _____ and the wind was _____ during the storm

the wind became _____ and after it was _____ and the weather was _____

Remarks.

Day	Barometer Corrected.		Max.	Temperature.		Rain	Ozone
	at _____ a.m.	at _____ p.m.		Min.			
“ Before	_____	_____	_____	_____	_____	_____	_____
“ of Storm	_____	_____	_____	_____	_____	_____	_____
“ After	_____	_____	_____	_____	_____	_____	_____

Electrometer Observations. | Ozone Observations. | Miscellaneous Observations

Now we pass to the more pleasant duty of noticing the rest of this work.

Messrs. Mohn and Hildebrandsson tell us that while Le Verrier's first report was for 1865, the next countries to establish such a system were Norway in 1867, and Sweden in 1871, and the authors state that these observations led to the discovery of the general laws of the origin of these phenomena and of their extension, as well as to the determination of their daily and annual periods.

M. Fron, who has so long had charge of this class of work in France, early found that thunderstorms are not isolated phenomena, but are intimately related to barometric minima appearing in front of, and usually travelling from W. to E. with, them.

The authors' researches on Scandinavian storms have led them to detect two classes of thunderstorms—those already mentioned, which are always the most frequent, and in winter the only ones, and of which their name, "orages de tourbillon," may perhaps be translated into "cyclonic thunderstorms," and the others heat storms; these are largely due to intense solar radiation, and thence to an ascending current of heat and vapour, and they are the prevailing storms of summer. These heat storms are in Sweden more frequent and more violent than the cyclonic ones.

Similar organizations have since been established in other countries, in 1879 in Bavaria, and, soon after, another in Würtemberg, both under the direction of Prof. von Bezold. Here also the two classes are found. And from the thunderstorm maps of these countries it was noticed that storms generally occurred when the isobars indicated a tendency towards the creation of secondary depressions.

The important works of Ciro Ferrari on the thunderstorms of Northern Italy are then referred to, and it is shown that in Italy, as in Scandinavia, the thunderstorms may practically be reduced to the two types above quoted, and the same is reported for Belgium.

Details are next given of a few typical storms, with illustrative maps.

Section III. deals with variations in the indications of meteorological instruments during the passage of storms over Upsala Observatory, and is illustrated by several diagrams reproducing the indications of the self-recording instruments. This section is very interesting, but would, in our opinion, have been still better had the phenomena of thunderstorms and of V shaped depressions been kept distinct. However, we are much indebted to the authors for bringing together several valuable opinions respecting the cause of the peculiar barometric oscillations which we have already mentioned. We do not think that Prof. Mascart's views on the subject have yet been laid before English readers, and we therefore reproduce them :—

"The examination of these curves shows a very simple relation—*the barometer rises as soon as the rain begins.* It is, however, to be noticed that this is not the case if rain is frequent and abundant, and

if the sky is entirely overcast, but only when there are heavy partial showers, and when the sky is partly free from clouds.

“The cause of these rapid changes of pressure seems obvious. In the circumstances just indicated the air is not very damp. The rain in falling through a non-saturated atmosphere is partially evaporated, and the vapour thus locally developed produces a local increase of pressure—small it is true, but sometimes reaching 0.08 in. The influence of vapour suddenly and locally produced is sufficient to produce a slight variation.

“The diminution of pressure during storms may be explained by the opposite phenomena. Everybody has noticed that storm clouds are formed locally, and the conversion of a certain quantity of water from vapour into droplets may be expected to produce a diminution of pressure. As a rule, the decrease of pressure is more gradual than the increase.”

Upon these views by Prof. Mascart the authors proceed to remark as follows :—

“These ideas seem to us to give the explanation of the phenomena, and it seems all the more probable since we have shown that *every rain which falls torrentially (sous forme d'averse), and even hail at a temperature below 32°, is followed by identical variations in the indications of the instruments, whether it be followed by thunder or not.* We thus arrive at the surprising result that during a thunderstorm the thunder itself and the other electrical phenomena are the secondary and not the primary phenomena. This agrees with M. Edlund's explanation of the production of electricity during thunderstorms, where he states that “The intense and violent liquefaction of the water vapour in the atmosphere is the principle cause of the excessive electric tension in the disruptive discharges of thunderstorms.”

Section IV. explains the normal conditions which produce thunderstorms in Norway.

Section V. deals with the altitude of storm clouds, quoting Kaemtz (about 4,000 feet), Hann (about 4,600 feet), Reimann (that as seen from the Schneekoppe (5,246 feet), 55 per cent. pass below, while there is blue sky above the mountain, 30 per cent. envelop the summit in vapour, and only about 15 per cent. are wholly above it), Kolbenheyer (who from Babiagora (5,660 feet) saw a storm wholly below him). The authors then give an epitome of Sohneke's researches on the origin of the electricity of thunderstorms, showing that balloon experiments have indicated that during hot summer months the isotherm of 32° F. is usually at about 10,000 feet, and is rarely so low as 6,000 feet. Above this level clouds are necessarily formed of ice particles, below it of water particles. He has, moreover, demonstrated experimentally that a particle of ice becomes charged with electricity at 32° F. if a stream of warm and saturated air be directed upon it, and hence he argues that electricity is developed by the friction of two currents of air, one charged with

vapour, the other with ice needles. Ekholm and Hagström have found that at Upsala the tops of storm clouds are rarely 10,000 feet high, and their bases about 4,600 feet, or about the same as Hann found in the Alps. Another proof that the storm clouds are at a low level is afforded by the fact that whatever be their direction the motion of cirri is not thereby affected.

Section VI. deals with the question of lightning without thunder in Sweden, and shows that in that country almost every silent flash can be plausibly connected with some distant storm.

Section VII.—Statistics. This deals with the geographical distribution of storms in the Scandinavian Peninsula, with the hour at which they are most frequent (3 to 5 p.m.), and also the month (July). The authors then discuss the relation between storm frequency and mean barometric pressure. Finally, they give statistics respecting hail, which is rare in Scandinavia; in Norway hail only accompanies one storm in nine, and in Sweden one in eleven; and the records of insurance companies show that the loss is very small, the average loss being in Sweden 6 francs in 10,000, while at Berlin it is 63, and at Madgeburg 90 in 10,000.

RAINFALL AVERAGES.

To the Editor of the Meteorological Magazine.

SIR,—In this month's *Meteorological Magazine*, p. 48, it says for *Cork*:—"The seventeenth successive month with less than the average R." But on p. 46 the figures are 3·06 + ·30; and this appears to me correct, for referring to the rainfall during March in each of the four years, 1884-7, the "Total Fall" and "Difference from average" give the average for the month in question as 2·76.

Yours truly,

T. W. BACKHOUSE.

West Hendon House, Sunderland, April 24th, 1888.

[We are glad that Mr. Backhouse has called attention to this subject, as possibly others may have thought as he did that there was an error—whereas there is not. To ensure uniformity in the *table* the differences from the average are all taken from that during one period, 1870-79, and that average for March, is, as stated by Mr. Backhouse, 2·76, and March 1888, was therefore, correctly entered as + 0·30.

The *remarks* are however left as nearly as possible in the *ipsissima verba* of the observers. Our valued correspondent at Cork has a consecutive record for 23 years, and in his remarks referred to the average of that period, which is 3·34 in., and of course 1888, giving 3·06 in., was as he stated below the average. The difficulty would of course be obviated if the observers always stated to what average they referred, but whether or not, after the present explanation, it is necessary to repeat it every time that an observer refers to an average may be open to question.—ED.]

REVIEWS.

In pursuit of a Shadow. By a LADY ASTRONOMER. London :
Trubner & Co., 1888. 8vo, 130 pages.

THIS is a charming little book, which we believe that few who begin will leave until they have finished. There is not much meteorology in it, though it is written by a meteorologist who is also an astronomer, and is the daughter of an observer whose record goes back nearly half a century. It is a plain, but extremely interesting, account of an expedition undertaken by the author and a lady friend to Kineshma, N.E. of Moscow, in order to be on the central line of the Solar eclipse of August last. The pamphlet tells how they went, what they saw and did not see, and how they came back, and in so doing gives one a clearer idea of phases of Russian life than many a book of ten times its size and cost.

The Natural Law of relation between Rainfall and vegetable life and its application to Australia, by F. A. VELSCHOW, C.E. London :
Stanford, 1888, 8vo., 40 pages, 1 plate.

WE really can hardly deal seriously with this pamphlet. The opening sentence of the Preface is as follows :—

If the object of this paper has been obtained, it will appear from its pages why the regularity of downpour depends directly on one particular quality appertaining to vegetable life. It will also be proved that vapour rarefies the atmosphere instead of increasing its specific gravity, as is now supposed, for which reason the barometrical measurement of the height of mountains has hitherto turned out a failure.

It is news to some of us that the barometrical measurement of "the height of mountains has hitherto turned out a failure," and when we dive into the body of the pamphlet to find the data on which this sweeping assertion is made, we find the following paragraph :—

The mistake introduced into the calculation is sometimes very considerable. Professor Tyndall has thus found the astonishing difference in altitude of 500-600 ft. when taking measurements of mountains in the Alps, whose height had previously been exactly measured by trigonometrical (sic.) survey. How is this enormous variation in the result possible? Surely the instruments he used were the best that could be produced, and would show the difference in altitude, temperature and humidity to a fraction of a degree; and also there can be no doubt whatever that an observer of Professor Tyndall's acquirements would make most careful observations, but still the result has proved to be a failure.

There is no reference to tell us whence this statement is quoted, and until the author shows that he is familiar with, and demonstrates the fallacies in, one single good work on barometric measurements *e.g.*—Williamson's, we confine our remarks to saying that we at any

rate are not yet convinced that the barometrical measurement of the height of mountains is a failure.

The author has a theory as to the existence of what he calls an air cushion over central Australia—and this he says (p. 23) is protected against flowing off by the low coast mountains, and he gives a diagram to illustrate this. We fear that his diagram has misled him, because if the air cushion existed, and if its dimensions and those of the mountains were as represented, the said mountains might have the effect he supposes. But the diagram could not within any reasonable space be printed on the true scale, the vertical scale as given is enormously greater than the horizontal one. As drawn, the mountain range of Queensland is 35 miles high, whereas Silver's *Australia and New Zealand* states that "few points exceed 3,000 ft.," which agrees very well with the author's own expression, "low coast mountains." We believe that if the author were to redraw his diagram on the true scale, say for example 8 ft. long, and then were to draw the mountain ranges as they should be, about one twentieth of an inch high, he would see the improbability of such an undulation, keeping his cushion in its place even if it existed.

Although we cannot accept the author's theories, we are glad to be able to strongly support the object which he has in view, namely the desirability of endeavouring to increase the study and the practice of forestry in Australia, and we agree with him, that it is desirable to attempt the acclimatization of foreign trees, but the Colonists must be careful, some of the trees might be as prolific as the rabbits.

THE DROUGHT.

MARCH was wetter than the average at the majority of British stations, and April (except in the S.W. of England and in Ireland) has had nearly an average fall. The result has been that as regards town dependant upon storage reservoirs the prospects of holding out throughout the summer have greatly improved. From the *Gas and Water Review* and other sources we collect the following notes:—

Leeds Water Supply is now in a satisfactory state. Thanks to the rain, the reservoirs have filled, and the storage supply is equal to 166 days, as compared with 126 at the same period last year. The total storage is 3,446,000,000 gallons, contrasted with 2,593,000,000 gallons at the same time last year.

Bradford.—The total water stored on April 27th was 1,541,921,000 gallons, being 143,518,000 gallons more than on the same date in 1887.

Halifax.—On April 20th, 1,062,267,000 gallons were in the reservoirs, or about 15,000,000 gallons more than on the same date last year.

Manchester.—This city is at present supplied from a series of

Manchester. We understand that the city is now again enjoying constant service, and that the manager has no fear of serious deficiency this year. The following letter confirms this :—

“ To the Editor of the *Manchester Courier*.

SIR,—The rainfall here during April has been 2·48 inches, bringing up the total for the first four months of 1888 to 9·65 inches. Although this quantity is much below the average, still the reservoirs in the Longdendale Valley have filled up considerably during the last few weeks.—Yours, &c.,

JAMES SIDEBOTTOM.

Millbrook, Hadfield, May 1, 1888.”

From other parts of the country dependent on springs we have very different reports.

ROYAL METEOROLOGICAL SOCIETY.

The usual monthly meeting of this Society was held on Wednesday evening, the 18th ult., at the Institution of Civil Engineers, 25, Great George-street, Westminster, Dr. W. Marcet, F.R.S., President, in the chair.

Dr. E. Hale, B.A., F.C., Mr. R. Lawson, LL.D., F.S.S., and Mr. S. Walker were elected Fellows of the Society.

The following Papers were read :—

1. “ Jordan’s New Pattern Photographic Sunshine Recorder,” by Mr. J. B. Jordan. The improvement in this instrument over the previous pattern of Sunshine Recorder consists in using two semi-cylindrical or D-shaped boxes, one to contain the morning and the other the afternoon chart. An aperture for admitting the beam of sunlight is placed in the centre of the rectangular side of each box, so that the length of the beam within the chamber is the radius of the cylindrical surface on which it is projected; its path therefore follows a straight line on the chart at all seasons of the year. The semi-cylinders are placed with their faces at an angle of 60° to each other. They are fixed on a flat triangular plate, which is hinged to a suitable stand, having levelling screws attached, and fitted with a graduated arc as a means of readily adjusting and fixing the cylinders to the proper vertical angle for the latitude of the station where used.

2. “ On the Meteorology of South-Eastern China in 1886,” by Dr. W. Doberck, F. R. Met. Soc. This paper gives the results of observations made at the custom-houses and lighthouses by officers of the Imperial Chinese Maritime Customs. In summer there is very little change of temperature with latitude. The temperature depends upon the distance from the nearest seacoast, and is greatest at stations farthest inland. The highest mean temperature occurred in July and the lowest in January. The north-east monsoon blows from September to June, and the south monsoon during July and

reservoirs in the Longdendale Valley, between Woodhead and August; the latter does not blow with half the force of the former. Rainfall is greatest in Northern Formosa and least in Northern China. Along the east coasts of Formosa and Luzon the winter is the wet season, while in China July seems to be the wettest month of the year.

3. "Lightning in Snowstorms," by Prof. A. S. Herschel, F.R.S.
4. "Insolation," by Mr. Rupert T. Smith, F.R. Met. Soc.

PAMPHLET EXCHANGE.

Copies of the following pamphlets can be had on application, provided the cost thereof be enclosed in the same cover. When all the copies have been distributed, the stamps (less postage) will be returned.

Author.	Title.	Price.
HANN, DR. J.	Bericht erstattet dem zweiten Internationalem Meteorologen-Congress ueber die Beobachtungen auf hohen Bergen und im Luftballon.....	2½d.
" "	Theorie des Psychrometers.....	2½d.
" "	Bemerkungen zur täglichen Oscillation des Barometers	2½d.
" "	Ueber die Beziehungen zwischen Luftdruck und Temperatur-Variationem auf Berggipfeln	2½d.
HELLMANN, DR. G.	Die täglichen Veränderungen der Temperatur der Atmosphäre in Norddeutschland.....	2½d.
" " "	Feuchtigkeit und Bewölkung auf der Iberischen Halbinsel	3½d.
" " "	Vorschläge an den Meteorologencongress.....	3d.
" " "	Der zweite internationale Meteorologencongress abgehalten zu Rom im April, 1879	2½d.
" " "	Ueber den jährlichen Gang der Temperatur in Norddeutschland.....	3d.
" " "	Ueber gewisse Gesetzmässigkeiten im Wechsel der Witterung aufeinanderfolgender Jahreszeiten.....	2½d.
" " "	Klima des Brocken.....	2½d.
JELINEK, DR. C.	Ueber die Reduction der Kappeller'schen sogenannten Stations-Barometer, d.h. Gefäss-Barometer mit unbeweglichem Boden	2½d.
ROTCH, A. L.	The Blue Hill Meteorological Observatory; an Account of its Foundation and Work	2½d.
" "	Results of Observations at the Blue Hill Meteorological Observatory in 1886	3d.
SCOTT, R. H.	Notes on the Reports of Wind Force and Velocity during the Tay Bridge Storm, December 28th, 1879.....	2½d.
" "	On a Series of Barometrical Disturbances which passed over Europe between the 27th and the 31st of August, 1883	2½d.
" "	On the History of Thermometers	2½d.
" "	Climatology of the Sea.....	2½d.
WALLIS, H. SOWERBY	The Snow Storm of January 18th and 19th, 1881	3d.
ANON	Review of Dr. Wild's Regenverhältnisse des Russischen Reiches	2½d.

BRAZILIAN RAINFALL.

We are indebted to one of our English observers, Mrs. Behrens, for the valuable data in the following table:—
 The average, 142 inches, is very high, but the locality is apparently at a considerable elevation on the eastern or Atlantic slope of a chain of mountains. We cannot find any records kept in the same neighbourhood; the nearest are on the west side of, and far away from, the mountains, but they have 82 and 90 inches respectively. It would add much to the value of this record if our correspondent can obtain for us details as to the pattern of gauge, its position, height above sea level, &c.

*Rainfall in inches at Alto da Serra (between Santos and San Paolo) Brazil. Lat. 23° 40 S.; Lon. 46° 20' W.
 (about 200 miles W.S.W. of Rio de Janeiro.)*

Year	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887
January	14.0	14.7	18.1	6.7	15.4	12.4	19.5	31.4	20.2	20.1	27.8	7.5	23.2	8.1	30.0
February	7.3	17.5	19.1	15.8	20.1	12.1	14.1	28.0	22.5	26.9	11.7	22.4	6.3	29.1	5.2
March	27.8	6.9	17.0	14.6	10.4	17.2	10.2	16.0	27.6	13.3	14.5	9.7	10.8	13.8	10.9
April	8.4	31.5	10.5	4.5	13.0	12.6	7.1	13.3	19.7	21.8	13.3	2.7	7.3	15.9	7.6
May	7.2	8.5	5.2	6.7	10.5	12.0	4.3	7.4	4.2	6.6	4.7	17.0	7.4	1.2	11.3
June	6.7	10.8	7.9	7.2	7.2	9.6	6.4	6.6	14.7	10.8	2.0	6.3	6.5	5.2	2.2
July	6.8	11.0	8.6	0.8	5.3	6.9	2.5	2.7	8.9	14.2	6.1	17.5	5.3	9.1	7.8
August	9.0	4.9	3.1	8.8	13.9	12.0	5.4	3.1	9.7	5.3	11.0	12.1	4.8	12.9	1.2
September	9.4	9.7	8.9	5.3	7.0	10.8	5.4	11.7	9.4	9.2	9.7	6.8	12.1	7.7	17.7
October	10.3	13.8	9.3	17.8	13.7	9.7	3.7	9.6	4.8	12.3	7.8	19.8	13.2	11.7	25.0
November	10.5	8.7	8.1	14.7	14.1	13.9	2.9	13.4	12.8	12.3	13.1	18.1	4.3	12.3	7.4
December	14.0	19.0	28.1	18.1	11.0	16.1	11.8	17.3	14.4	12.2	17.0	15.9	13.0	19.7	22.9
Totals	131.4	157.0	143.9	121.0	141.6	145.3	93.3	160.5	168.9	165.2	138.7	155.8	114.2	146.7	149.2

ABSTRACT OF YEARLY TOTALS (15 YEARS.)

Max.	1881	168.9	20	119
Mean	1879	142.18	23	100
Min.	1879	93.3	21	66

MONTHLY MEANS.

Jan.	17.94	May ...	7.61	Sept. ...	9.39
Feb.	17.21	June ..	7.34	Oct. ...	12.17
March ...	14.71	July ...	7.57	Nov. ...	11.12
April ..	12.61	August..	7.81	Dec. ...	16.70

CLIMATOLOGICAL TABLE FOR THE BRITISH EMPIRE, OCTOBER, 1887.

STATIONS. <i>(Those in italics are South of the Equator.)</i>	Absolute.				Average.				Absolute.		Total Rain.		Aver. Cloud.
	Maximum.		Minimum		Max.	Min.	Dew Point.	Humidity.	Max. in Sun.	Min. on Grass.	Depth.	Days.	
	Temp.	Date.		Date.									
England, London	63°6	8	25·4	26	53·2	39·0	38·7	75	103·4	23·2	1·24	9	0·10
Malta.....	98·4	1	49·6	27	74·7	63·1	58·6	75	142·7	45·2	8·80	12	6·0
<i>Cape of Good Hope</i> ...	...	...	...	...	...	...	...	...	...	...	...	...	...
<i>Mauritius</i>	80·7	18	57·7	27	76·4	66·4	62·0	75	134·5	48·4	3·46	12	6·1
Calcutta.....	91·0	6	63·2	27	85·4	72·7	71·2	70	154·2	56·4	2·57	6	4·3
Bombay.....	92·1	27	71·7	31	87·8	76·3	73·3	76	145·2	63·0	2·79	4	3·2
Ceylon, Colombo	87·7	3	70·8	2	84·8	73·4	72·5	81	146·8	67·6	13·43	25	7·5
<i>Melbourne</i>	82·1	26	38·1	24	65·7	47·8	48·0	73	133·0	33·3	2·83	11	5·6
<i>Adelaide</i>	90·5	25	43·2	23	71·5	52·1	46·9	58	152·0	34·1	2·73	13	4·4
<i>Wellington</i>	71·0	29	36·0	7	58·9	45·6	45·5	78	131·0	32·0	7·24	17	4·0
<i>Auckland</i>	72·0	29	40·0	2	62·2	50·2	51·1	83	140·0	31·0	3·24	20	6·7
<i>Falkland Isles</i>	62·1	27	29·6	21	47·9	35·1	38·4	82	118·0	21·7	1·18	12	7·0
Jamaica, Kingston.....	91·5	2	66·6	24	88·0	71·1	72·0	79	...	...	9·59	...	...
Barbados	88·0	10	69·0	19	83·0	73·0	71·5	79	...	...	8·51	16	5·0
Toronto	63·9	8	19·4	30	52·1	35·5	38·6	76	...	12·2	1·63	16	6·3
New Brunswick, Fredericton	63·7	5	15·8	27	52·8	34·5	37·4	74	...	...	3·12	10	5·4
Manitoba, Winnipeg...	64·0		— 2·8	26	44·7	20·6	25·7	72	...	...	·46	9	5·7
British Columbia, Victoria	64·0	11a	30·0	23	55·3	40·0	...	...	...	...	2·75	12	...

a And 28.

REMARKS, OCTOBER, 1887.

MALTA.—Mean temp. 67°·6; starting at 81° on the 1st, it fell steadily to 56° on 27th. The total range, 48°·8, was 50 per cent. above the average. R more than double the average of 5 years. Mean hourly velocity of wind 10·6 miles. Sea temp. fell from 78°·5 to 69°·0. On the 19th a heavy storm with E.N.E. wind yielded 3·50 in. of rain in about 10 hours. Among the hills at Rabato and Torri Labiat 6½ in. and 7½ in. were registered. H on 27th. TS on 7 days. L on 4 other days. J. SCOLLS.

Mauritius.—Mean temp. of air 0°·7 below, and of dew point 0°·9 above the average. R 1·60 in. above the average. Mean hourly velocity of wind 11·1 miles, 0·9 mile below average; extremes 25·3 miles on 6th and 1·9 miles on 22nd; prevailing direction S.E. by E. to E. by S. C. MELDRUM, F.R.S.

Melbourne.—Mean temp. of air 0°·1, of dew point 1°·8, and mean humidity 3° above average. Rainfall, pressure, and cloud slightly below average. Prevailing wind W.; strong on 10 days. TSS on 2 days; L on 2; heavy dew on 14th and 26th; fog on 1 day. R. L. J. ELLERY, F.R.S.

Adelaide.—Mean temp. average, and pressure slightly above average. Rainfall an inch above average, making the total for the 10 months nearly three inches in excess of the annual average. C. TODD.

WELLINGTON.—On the whole unpleasant, changeable, and stormy. Prevailing wind N.W.; strong on 9 days. Mean temp. 1°·4 below, and rainfall 2·41 in. above average. Slight earthquake shocks on 6th; H on 1st; T on 21st; fog on 28th. R. B. GORE.

AUCKLAND.—An average spring month; rather showery, with variable winds, but no heavy rain or storms of importance. Mean pressure and mean temp. slightly below, rainfall slightly above, average. T. F. CHEESEMAN.

BARBADOS.—Pressure steady and slightly above average. Mean temp. (77°·4) 0°·5 above average; mean hourly velocity of wind 1·7 miles above average; rainfall considerably below average. R. BOWIE WALCOTT.

SUPPLEMENTARY TABLE OF RAINFALL,
APRIL, 1888.

[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	2·14	XI.	Castle Malgwyn	2·07
„	Margate, Birchington...	1·03	„	Rhayader, Nantgwillt..	2·49
„	Littlehampton	1·29	„	Carno, Tybrith	3·19
„	Hailsham	1·28	„	Corwen, Rhug	1·59
„	Ryde, Thornbrough	1·52	„	Port Madoc	3·57
„	Alton, Ashdell.....	1·76	„	I. of Man, Douglas	2·83
III.	Oxford, Magdalen Col...	1·59	XII.	Stoneykirk, Ardwell Ho.	1·45
„	Banbury, Bloxham	2·12	„	New Galloway, Glenlee	2·82
„	Northampton	1·81	„	Melrose, Abbey Gate...	2·20
„	Cambridge, Beech Ho...	1·47	XIII.	N. Esk Res. [Penicuik]	2·10
„	Wisbech, Bank House..	1·35	XIV.	Ballantrae, Glendrisaig	1·94
IV.	Southend	1·31	„	Glasgow, Queen's Park.	1·60
„	Harlow, Sheering	1·82	XV.	Islay, Gruinart School..	2·19
„	Rendlesham Hall	1·44	XVI.	St. Andrews, PilmourCot	1·42
„	Diss	1·73	„	Balquhider, Stronvar..	3·54
„	Swaffham	1·68	„	Dunkeld, Inver Braan..	1·50
V.	Salisbury, Alderbury ...	1·99	„	Dalnaspidal H.R.S. ...	2·57
„	Warminster	2·47	XVII.	Keith H.R.S.	2·12
„	Bishop's Cannings	2·31	„	Forres H.R.S.	1·35
„	Ashburton, Holne Vic....	3·47	XVIII.	Strome Ferry H.R.S....	3·06
„	Hatherleigh, Winsford.	1·51	„	Fearn, Lower Pitkerrie.	1·58
„	Lynmouth, Glenthorne.	1·88	„	Loch Shiel, Glenaladale	6·34
„	Probus, Lamellyn	1·56	„	S. Uist. Ardkenneth ...	2·38
„	Launceston, S. Petherwin	1·98	„	Invergarry	2·81
„	Wincanton, Stowell Rec.	2·16	XIX.	Lairg H.R.S.	2·19
„	Taunton, Lyleard Ho...	2·66	„	Forsinard H.R.S.	2·49
„	Wells, Westbury	2·45	„	Watten H.R.S.	2·03
VI.	Bristol, Clifton	1·77	XX.	Dunmanway, Coolkelure	3·87
„	Ross	1·70	„	Fermoy, Gas Works ...	1·75
„	Wem, Clive Vicarage ...	1·39	„	Tipperary, Henry Street	2·37
„	Cheadle, The Heath Ho.	1·46	„	Limerick, Kilcornan ...	1·39
„	Worcester, Diglis Lock	1·39	„	Miltown Malbay.....	1·99
„	Coventry, Coundon	2·02	XXI.	Gorey, Courtown House	1·71
VII.	Melton, Coston	2·18	„	Navan, Balrath	2·00
„	Ketton Hall [Stamford]	2·85	„	Mullingar, Belvedere...	2·42
„	Horncastle, Bucknall ...	1·90	„	Athlone, Twyford	2·12
„	Mansfield, St. John's St.	2·61	„	Longford, Currygrane...	2·46
VIII.	Knutsford, Heathside ...	1·47	XXII.	Galway, Queen's Coll...	1·48
„	Walton-on-the-Hill.....	1·18	„	Clifden, Kylemore	3·38
„	Lancaster, South Road.	1·95	„	Crossmolina, Enniscooe.	2·48
„	Broughton-in-Furness ..	2·19	„	Collooney, Markree Obs.	2·03
IX.	Shipleigh, Esholt Vic. ...	3·02	XXIII.	Rockcorry.....	2·14
„	Ripon, Mickley	2·71	„	Warrenpoint	1·97
„	Scarborough, West Bank	1·90	„	Seaforde	1·82
„	EastLayton[Darlington]	2·34	„	Belfast, New Barnsley..	1·95
„	Middleton, Mickleton..	1·59	„	Cushendun	1·95
X.	Haltwhistle, Unthank..	1·85	„	Bushmills	1·98
„	Shap, Copy Hill	2·77	„	Stewartstown	1·58
XI.	Llanfrechfa Grange	1·58	„	Buncrana	2·41
„	Llandovery	2·17			

APRIL, 1888.

Div.	STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL.					TEMPERATURE.				No. of Nights below 82°.	
		Total Fall.	Difference from average. 1870-9	Greatest Fall in 24 hours.		Days on which .01 or more fell.	Max.		Min.		In shade.	On grass.
				Dpth	Date.		Deg	Date	Deg	Date		
I.	London (Camden Square) ...	2.37	+ .35	.66	18	13	64.8	30	27.7	6	10	12
II.	Maidstone (Hunton Court)...	1.30	— .55	.34	23	17	...	...	...	...	...	...
III.	Strathfield Turgiss	1.96	+ .05	.44	23	13	62.2	30	23.5	6	10	18
IV.	Hitchin	1.78	— .17	.29	17	20	63.0	15	26.0	5	10	...
V.	Winslow (Addington)	2.06	— .25	.53	19	20	62.0	28	23.0	6	11	15
VI.	Bury St. Edmunds (Culford)	1.31	— .48	.34	23	14	60.0	16	20.0	6	13	...
VII.	Norwich (Cossey)	1.48	— .38	.27	23	17	...	...	...	...	...	...
VIII.	Weymouth(LangtonHerring)	1.33	...	.30	16	14	59.0	28 ^c	27.0	6	8	...
IX.	Barnstaple .....	.99	— 1.39	.22	16	11	57.0	17	27.0	9	...	...
X.	Bodmin	1.77	— 1.56	.48	16	17	54.0	13 ^e	27.0	10	8	10
XI.	Stroud (Upfield)	1.92	— .53	.35	17	16	62.0	13	28.0	6	6	...
XII.	ChurchStretton(Woolstaston)	2.68	+ .36	.70	20	20	59.5	14	27.0	3,6,7	10	13
XIII.	Tenbury (Orleton)	1.15	— 1.02	.34	19	16	64.6	28	23.8	7	9	12
XIV.	Leicester .....	...	...	...	...	...	...	...	...	...	...	...
XV.	Boston	2.22	+ .33	.64	19	19	65.0	14 ^f	26.0	7,10	10	...
XVI.	Hesley Hall [Tickhill]	1.31	...	.19	24	19	63.0	30	25.0	6	9	...
XVII.	Manchester (Ardwick)	1.57	— .46	.27	19	17	59.0	30	30.0	3	8	...
XVIII.	Wetherby (Ribston Hall)	2.78	+ .27	.82	21	14	...	...	...	...	...	...
XIX.	Skipton (Arneliffe)	3.25	+ .19	.57	29	21	58.0	14	26.0	7	7	...
XX.	Hull (People's Park)	1.69	— .04	.35	15 ^a	21	...	...	...	...	...	...
XXI.	North Shields	1.41	— .59	.26	20	19	64.0	28	28.0	7	8	11
XXII.	Borrowdale (Seathwaite).....	7.35	+ 2.41	1.46	28	17	...	...	...	...	...	...
XXIII.	Cardiff (Ely)	1.39	— .95	.22	16 ^b	13	...	...	...	...	...	...
XXIV.	Haverfordwest	1.70	— 1.12	.45	29	18	59.0	15	26.0	8	7	10
XXV.	Plinlimmon (Cwmsymlog) ...	4.88	...	.67	12	17	...	...	...	...	...	...
XXVI.	Llandudno	1.96	+ .08	.59	29	19	57.8	15	32.0	6	1	...
XXVII.	Cargen [Dumfries]	1.54	— .75	.29	16	10	59.4	28	26.0	7,9	9	...
XXVIII.	Jedburgh (Sunnyside)	1.95	+ .25	.47	18	19	62.0	14	26.0	9	12	...
XXIX.	Old Cumnock	1.81	+ .15	.36	12	17	60.0	14	22.0	2,8	10	...
XXX.	Lochgilthead (Kilmory)	3.03	+ .40	.69	26	17	...	...	...	...	...	...
XXXI.	Oban (Craigvarren)	2.62	...	.43	26	17	56.1	24	28.0	22	4	...
XXXII.	Mull (Quinish)	2.74	...	.47	26	17	...	...	...	...	...	...
XXXIII.	Loch Leven Sluices	1.50	— .71	.30	16	10	...	...	...	...	...	...
XXXIV.	Dundee (Eastern Necropolis)	1.25	— .87	.30	22	12	60.8	14	25.2	9	7	...
XXXV.	Braemar	1.35	— .73	.27	22	18	54.8	14	23.2	9	14	23
XXXVI.	Aberdeen	1.96	...	.46	15	21	60.0	14 ^g	30.0	7	5	...
XXXVII.	Lochbroom	4.56	...	.72	19	22	...	...	...	...	...	...
XXXVIII.	Culloden	1.06	— .29	...	...	...	57.0	14 ^h	28.0	9	9	19
XXXIX.	Dunrobin	1.96	...	.34	10 ^c	12	54.5	26	28.0	26	8	...
XL.	Kirkwall (Swanbister).....	2.73	...	.40	10	22	52.3	16	27.6	9	6	...
XLI.	Cork (Blackrock)	1.88	— 1.22	.60	30	15	62.0	27	27.0	1	4	...
XLII.	Dromore Castle	3.58	...	.83	30	13	...	...	...	...	...	...
XLIII.	Waterford (Brook Lodge) ...	1.63	...	.47	30	14	58.0	11 ⁱ	24.0	9	7	...
XLIV.	O'Briensbridge (Ross)	1.96	...	.21	10 ^d	17	59.0	28	30.0	3,6	6	...
XLV.	Carlow (Browne's Hill)	1.90	— .67	.43	30	19	...	...	...	...	...	...
XLVI.	Dublin (FitzWilliam Square)	1.99	— .12	.34	30	17	60.6	14	28.8	9	1	11
XLVII.	Ballinasloe	1.57	— .69	.38	30	16	58.0	14	24.0	9	8	...
XLVIII.	Waringstown	2.03	+ .14	.42	18	11	64.0	14	23.0	8	7	11
XLIX.	Londonderry (Creggan Res.)	2.32	...	.43	19	23	...	...	...	...	...	...
L.	Omagh (Edenfel)	2.13	+ .13	.46	19	21	57.0	16	29.0	2,8	5	...

a And 19. *b* And 17. *c* And 15. *d* And 30. *e* And 29. *f* And 18. *g* And 16. *h* And 16, 17. *i* And 13.

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

METEOROLOGICAL NOTES ON APRIL, 1888.

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.—More springlike. The excellent condition of the land enabled farmers to put in a large amount of seed. Wheat was doing well and grass assuming its spring livery of emerald green at the close. Sand martins seen on 3rd; humble bee on 11th; brimstone butterfly on 13th; first swallow on 16th; nightingale heard on 19th; cuckoo on 20th. H on 2nd.

ADDINGTON.—A great deal of very cold weather was experienced, especially from 22nd to 26th, with strong N.E. wind; summer visitors arrived about their usual time notwithstanding. Swallows on 15th; cuckoo on 21st. The max. temp. rose above 60° on three occasions. H on 3rd and 17th; S on 3rd, 5th and 8th.

CULFORD.—Cold most of the month. S showers on 7th, 8th and 9th.

LANGTON HERRING.—R .98 in. below the average; mean temp. at 9 a.m. (44°·0) 3°·2 below the average and the lowest in April for 17 years; the absolute min. temp. was also the lowest in April during the period. Vegetation very late. Parhelia on 9th; solar halo on 27th; fog on 12th, 17th and 28th.

BODMIN.—A singularly backward month. Mean temp. 44°·3.

WOOLSTASTON.—A cold, backward month. Mean temp. 42°·7; S on 24th.

ORLETON.—The first ten days were very cold, with severe frost each night and much cloud in the day; mean temp. 10° below the average of the month, and a strong wind from N. and E. The wind then changed to S. and W., and the following 9 days were warmer than the average of the month. Another cold period set in on the 19th, with rough N.E. wind, and continued till the 27th. The last 4 days were warm. Mean temp. 4° below the average of 27 years, being 0°·8 lower than in 1887, and only 1°·3 above that of April, 1879. Pressure was generally below the average, but the fluctuations were not great although strong winds were frequent. Chiff-chaff seen on 10th; swallows on 17th; cuckoo heard on 19th. S half an inch deep at 9 a.m. on the 4th; flakes of S fell on 5th and 10th. Fog on 12th.

BOSTON.—S on 2nd, 3rd and 4th; swallow seen on 22nd.

HESLEY HALL.—S on 2nd and 3rd; T and L on 17th, 18th and 19th.

MANCHESTER.—On the whole a cold April, cold E. winds prevailing; vegetation backward; T on 17th and 18th.

HULL.—Generally cold, with a great amount of cloud, and during the early part frequent, though not heavy, falls of sleet, S or H, and during the latter part showers of R or drizzle.

NORTH SHIELDS.—H on 1st, 2nd, 11th, and 17th; S on 2nd, 3rd, 4th, and 11th; TS on 17th.

WALES.

HAVERFORDWEST.—The first 9 days were of the same character as the preceding month, cold and wintry. From that date to the 23rd R fell every day in small quantities, and the temperature rose. The month on the whole was much finer and milder than any April for some years past; crops looking much better than could have been expected.

SCOTLAND.

CARGEN.—The mean temp. (42°·7) was 3°·4 below the average. The average temp. for the first four months of the year is 42°·2, this year it has been 38°·5. Vegetation very backward, no tree being in leaf at the close. L on 15th.

JEDBURGH.—Generally very cold and ungenial. Though much R fell the dry wind kept the ground dry, but agricultural work was retarded. There has

not been so late a seed time for several years. In high districts the lambing season was attended by much death, owing to the wet, cold weather. S on 1st, 2nd and 3rd; high winds from 20th to 25th.

OBAN.—Fair and seasonable weather prevailed until the 25th, the month closing with gales and R. Rainfall much below the average from the commencement of the year to the end of this month. All growth backward. Heavy H storm on 19th, and T heard within a few miles of Oban.

QUINISH.—A cold, backward month.

BRAEMAR.—Cold and unsettled. T on 19th, followed by S and sleet; heavy gale on 28th.

LOCHBROOM.—A very boisterous and wintry month. S on low grounds on 8 days and almost daily on the hills. Much seed was unsown at the close, and half the potatoes were not planted. Everything was very late and spring work has seldom been so backward. The last week was like mid-winter and floods prevailed. H on 11th, 12th, and 20th.

CULLODEN.—Very cold and ungenial. Vegetation made no progress, seed-time was late, and grass and all pastures were exceedingly backward. From 1st to 11th and from 20th to 27th dry, cold E. winds prevailed. T was heard once.

SWANBISTER.—Unusually wet and cold; agricultural operations very much retarded. S on 3rd, H on 11th.

IRELAND.

BLACKROCK.—A cold, harsh month and a late spring, though temp. fell below 32° only four times. The eighteenth month successively with R below average.

O BRIENSBRIDGE.—Frost occurred every night to the 7th, then cold showers with H and sleet, and generally wintry weather prevailed to the 20th. The close of the month was very stormy and harsh.

DUBLIN.—A generally cold, cloudy, changeable, showery month, with average pressure and a preponderance of polar winds. With the exception of 1879 and 1887 the coldest April since records commenced in 1860; mean temp. (45°·6) 2°·2 below average. Solar halos on 9th, 28th, and 29th; fog on 5th and 6th; high winds on 15 days; gale on 30th; S or sleet on 4th and 8th; H on 5 days. Mean humidity 80; mean amount of cloud 7·1.

BALLINASLOE.—Cold, raw, and very disagreeable. Winds principally N. and E.

EDENFEL.—With the exception of the third week, which was mostly soft and balmy, the weather was raw and backward, vegetation making but little progress and being at the close a full fortnight in arrear, even hedges being still brown. The swallow did not appear till the 25th, and of the cuckoo and land rail there was still no sound at the close.

EARTHQUAKE IN NORTH WALES.

Major Mathew has favoured us with the following note:—

The observer at Rhiwbrifdir, Merioneth, reports April 11th
“Gloomy, with a shock of earthquake at 7.10 p.m.”

From other sources we learn that it was felt as far south as Dolgelly, and as far east as Llangollen.