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PRODUCING RAIN ARTIFICIALLY.*

SOME of our readers may have seen that the Congress of the United States, on the motion of the Hon. C. B. Farwell, of Illinois, recently voted a sum of money for experiments, to ascertain whether heavy artillery firing will produce rain at times when otherwise it would not occur.

The Hon. member's action seems to have been promoted by the persistent efforts of Mr. E. Powers, C.E., of Delavan, Wisconsin, who has kindly sent us a copy of his work upon the subject. It is the second edition, as nearly all the first edition was destroyed in the great Chicago fire of 1870. After that disaster the author took to pushing the subject by lectures, and in 1890 he brought out the revised edition, which we have just received. It is chiefly composed of accounts of battles followed by thunderstorms and more or less heavy rain—with a few pages of theoretical matter. It contains the authors petition to Congress, asking it to order experiments to be tried, and an estimate of their probable cost.

The author does not seem to be aware that the matter has already often been discussed on this side of the Atlantic—the titles of two papers at once occur to us "Cannons and Tempests" and "Suggestions for causing rain at will," and on referring to the "Bibliography of Meteorology" we find the titles of 24 books and articles upon the subject, only two of which (and one of them his own) appear to be mentioned by the author. His book therefore must be regarded not as a monograph upon, but merely as a plea for attention to, the subject.

Our United States friends have a far better country in which to try the experiments than we have, and we are glad that they are doing it. Congress has voted £1800 for the cost of the experiments and we wish them success. We learn from *Iron* that the first experiments will be made in Western Kansas this month, under the direction of Colonel Dyrenfurth, of Washington. Balloons filled with hydrogen and oxygen gas will be sent up and exploded by a

* "War and the Weather." By Edward Powers, C.E. Revised Edition, 8vo., 1890. E. Powers, Delavan Wisconsin.

steel wire attached to the balloons and connected with an electrical apparatus on the ground. Senator Farwell favours this idea, because the concussion will be greater, and the greater the concussion, the more copious will be the fall. The balloons will also be aided in their work by the explosion of dynamite on the ground. Drought is the curse of the Western farmer. In the state of Kansas, the western part especially, the eastern part of Colorado, the South-west Territories, Texas, the two Dakotas, Nebraska, Minnesota, and, indeed, in nearly all the country west of the Mississippi River, the dry seasons are frequent and dangerous to the welfare of the crops. The removal of this great incubus of the farmer would be a decided boon.

Our friends however, must not run away with the idea that it is a new discovery, because in the very first book that we took down after reading Mr. Powers', viz., Steinmetz's *Sunshine and Showers*, 1867, we read as follows, p. 336:—

"There may be few or no localities in our agricultural districts exactly adapted to produce rain by a conflagaration of waste materials, long grass, &c.; but we see no reason why the Government might not permit the trial of artillery in various parts of the country during seasons of protracted drought—when the skies are often crowded with tantalizing clouds which will not send down their moisture. This would be a much better use of gunpowder than when blazed away on field days and in bloody battles. A hundred or two of our guns might be sent off and posted in various parts of the country, and fired after the manner of a siege, when no doubt the same result will ensue as on the occasions we have instanced,—at the same time giving 'practice' to the men in working the guns."

In conclusion we offer Mr. Powers one hint which may be useful when the experiments come off. We cannot at this moment put our hands on *Cannons and Tempests* which appeared *about* 1863, but we think that the author held that the rain did not fall precisely where the explosions occurred. We think that the cannon to control London weather were to be in the Isle of Lewis—but perhaps that was to increase the rainfall thereabouts and thereby to diminish that in London.

Since this article was written two things have happened.

A first experiment has been made by exploding a balloon—and rain fell afterwards.

A long and careful report upon the subject, by Mr. Fernow, Chief of the Division of Forestry, U.S.A., has appeared in the June number of the *American Meteorological Journal*.

THE UNITED STATES WEATHER BUREAU.

UPON the wisdom or otherwise of the Act of the United States Congress in separating the Weather Service from the Signalling branch of the War Department, by which it has hitherto been conducted, it would be presumptuous for us to offer any opinion. Meteorological offices have relations with so many of the affairs of life, that it is not remarkable that political chiefs do not know where to put them. The English one was first put jointly under the Board of Trade and Admiralty, and is now a complete anomaly—being paid for by the State, and adminstered by an Honorary Council who accept Honoraria for their services. In France the excellently managed Bureau Central is under the Minister of Instruction. In America the meteorological service has been under the War Department, henceforth it is to be under that of Agriculture. On the whole it seems to us that the influence of the original Brussels conference and of such men as Maury, FitzRoy and Buys Ballot is waning, and Marine meteorology, except by Dr. Neumayer, is being pretty much left to take care of itself—of course if our impression is wrong it can be corrected. In the United States we believe that Marine Meteorology is dealt with by the Coast Survey Department, so that, as in Germany, there are practically two Meteorological Offices in the United States.

However, our present object is personal rather than adminstrative. We have to "speed the parting, welcome the coming" chief. General Greely is one of those who needs no commendation, his name will be remembered not merely for his Arctic trials and successes, but as an able administrator, particularly careful that his subordinates should have the credit. each of what he did. In fact Greely much resembles Father Perry in his tendency to self-abnegation. All workers in Meteorology have suffered through the non-fulfillment by General Greely's office of the distinct pledge of his predecessor to print the Bibliography of Meteorology, but we are quite aware that this was not through any failure of interest, or of will, on the part of General Greely, but the result of an act of Congress passed with a good intention, but having a very bad result.

General Greely retains the supervision of the Signal Service, retains his interest in Meteorological work and (as already intimated on p. 43) the approbation of many friends on both sides of the Atlantic.

Prof. Harrington, F.L.S., F.R.Met.Soc., who has been appointed Chief of the U. S. Weather Bureau, is best known in this country through the *American Meteorological Journal*, which he started in 1884, and has edited up to the present time (latterly being joined by Mr. A. Lawrence Rotch and by Dr. Herdman). Prof. Harrington was born in Illinois in 1848, graduated at Michigan in 1868, and became Instructor in Biology in that University. From that duty he was for a time detached, in order to go as Astronomical Assistant

to Mr. Dall in his reconnaissance of Alaska in 1870. Six years later Harrington went to Leipzig for further study, but within a few months was appointed Professor of Astronomy and Mathematics at Pekin; the climate, however, did not suit him, and he was obliged to return to America. In 1879 he was made Professor of Astronomy and Director of the Observatory at Ann Arbor, Michigan, and, lastly, as above stated, he in 1884 started the *American Meteorological Journal.*

Professor Harrington has accepted a position of high honour, for it puts him side by side with Hann, Mascart, Mohn, Neumayer, Russell, Scott, Tacchini, Von Bezold, Wild, and other leaders of meteorological work, but far in front of them all as regards the funds at his disposal. With an unfettered control over 879,753 dollars or £175,950 a year, and freedom to launch out in any direction he likes, the power now placed in Prof. Harrington's hands is unique. May he justify the selection, and may the prediction of one of his colleagues be fulfilled, that "under his direction the American Weather Bureau will hold the first place among the meteorological services of the world."

ROYAL METEOROLOGICAL SOCIETY.

THE concluding meeting of this Society for the present session, was held on Wednesday evening, the 17th instant, at the Institution of Civil Engineers, 25 Great George Street, Westminster; Mr. Baldwin Latham, M.Inst.C.E., President, in the chair.

Mr. J. J. Colman, M.P., Mr. E. B. Duhoff-Gordon, B.A., Mr. G. E. Leon, Mr. F. de C. Meade, Assoc.M.Inst.C.E., and Mr. F. Russell, F.R.G.S., were elected Fellows of the Society.

Mr. A. J. Hands, F.R.Met.Soc., gave an account of a curious case of damage by lightning to a Church at Needwood, Staffordshire, on April 5th, 1891. The Church was provided with a lightning conductor, but Mr Hands thinks that when the lightning struck the the conductor, a spark passed from it to some metal which was close to, but not connected with it, and so caused slight damage to the building.

Mr. W. Ellis, F.R.A.S., read a paper "On the Mean Temperature of the Air at the Royal Observatory, Greenwich, as deduced from the photographic records for the forty years from 1849 to 1888," and also gave some account of the way in which, at different times, Greenwich mean temperatures have been found.

Mr. Ellis also read a paper "On the comparison of thermometrical observations made in a Stevenson screen, with corresponding observations made on the revolving stand at the Royal Observatory, Greenwich." From this it appears that the maximum temperature in the Stevenson screen is lower than that of the revolving stand, especially in summer, and the minimum temperature higher; whilst

the readings of the dry and wet bulb thermometers on both the screen and the stand, as taken at stated hours, agree very closely together.

Mr. W. F. Stanley, F.R.Met.Soc., exhibited and described his "Phonometer," which is really a new form of chronograph designed for the purpose of ascertaining the distance of a gun from observations of the flash and report of its discharge, by the difference of time that light and sound take in reaching the observer. The instrument can also be used for measuring the distance of lightning, by determining the time interval between the flash and the report of the thunder.

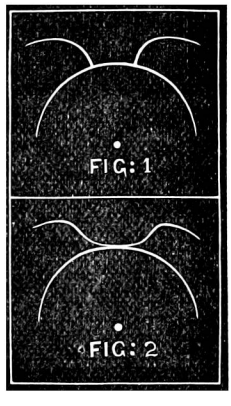
A paper was also read by Mr. A. B. MacDowall, on "Some suggestions bearing on weather prediction".

On Tuesday evening, July 7th, the Society held a dinner at the Holborn Restaurant, in commemoration of its entry into new premises at 22, Great George-street, S.W. The chair was occupied by the President, Mr. Baldwin Latham, C.E., who was supported by four Past Presidents, by three out of the four Vice-Presidents, by the three Secretaries, and by the Treasurer. After the usual loyal toasts, that of the Navy being responded to by Rear-Admiral Maclear, the toast of the evening—"Success to the Royal Meteorological Society"—was proposed by Mr. A. R. Binnie, Engineer-in-Chief to the London County Council, who pointed out the relations of meteorology to practical work, and the necessity of promptly and thoroughly discussing the data already collected. Mr. Symons (General Secretary) in replying, drew attention to the remarkable vitality of meteorologists, quoting the names of eleven of the present Fellows who had joined the Society in 1850, including Lord Ebury, Mr. Glaisher, and the Treasurer, who, though in his ninety-first year, was present to prove his argument, and to speak for himself, which he subsequently did. Mr. Symons urged that the scientific turn of mind and the regularity of life indispensable in a good observer, coupled with some little time spent in the open air, was doubtless the cause of the longevity of meteorologists, of which he gave other illustrations. Among points dwelt upon by other speakers, we may note that Dr. Barnes called attention to the general good character of English weather, although it was so frequently abused, and Dr. Theodore Williams expressed his concurrence, quoting in support thereof the physique of English men and women. The President and some other speakers referred to the comfort of the Society's new rooms, the excellence of its Library, and the satisfactory way in which its venerable Treasurer administered its finances. The last toast, "The Visitors," was proposed by Mr. H. J. Marten, C.E., and coupled with the name of Mr. F. J. Jackson, who, in responding, expressed the hope that it was the last time that he should be there as a visitor, as he should prefer to reappear as a Fellow.

THE THEORY OF HALOS AND PARHELIA.

To the Editor of the Meteorological Magazine.

SIR,—I have been much interested in the account of halos in your magazine, which is mostly very clear, but I should like the following points explained. A certain halo is spoken of as "the tangent to the inner circle," p. 54 and elsewhere; but the varying shape of this halo is not made sufficiently clear. When the sun is low the expression *tangent* appears to be quite incorrect. I have used the term *branch-halo* myself for describing this halo, as it usually starts at an angle from the ordinary halo at a little distance on each side of the vertex, as shown in fig. 1; though I do not know whether



theoretically it might be drawn as in fig. 2, in which case the term "tangent" would be correct. I think the term "arc" which is used on p. 50, also cannot fairly be applied to its usual appearance. Only some of the varying shapes af this halo are alluded to on p. 51, top paragraph. I conclude that the word "eclipsed" near the bottom of that paragraph is a misprint for "elliptic." While the exact shape is not given on p. 54, line 10, from the bottom, one might also infer that it was the arc of a circle with the zenith at the centre.

There are one or two other misprints; on p. 72, line 13 from the bottom, *or* should be *of*.

The sentence in the middle of p. 72, beginning—"This accounts" is not very clear; and as a matter of fact, I should have said the fringe to the ordinary halo is usually visible, whether it is accompanied with parhelia or not. No explanation is given why the parhelia, as well as the halo, are occasionally without tails or fringe, even when bright.

Yours truly,

T. W. BACKHOUSE.

West Hendon House, Sunderland,
24th June, 1891.

SUNSHINE RECORDERS.

To the Editor of the Meteorological Magazine.

SIR,—On p. 152 of the last vol. of the *Met. Mag.* you drew attention to a paper entitled, "A comparison between the Jordan and Campbell-Stokes Sunshine Recorders." By F. C. Bayard, L.L.M., F.R.Met. Soc. (From *Quar. Jour. Roy. Met. Soc.*) You remarked "We call attention to this paper because we believe that few persons are aware of the difference between the records of *sunshine* by the Campbell-Stokes burning instrument, and of the *sunlight* by the Jordan photographic one."

"Mr. Bayard, as the result of observations on 355 days during 1888 and 1889, found the per centage of duration to be :—

[Here followed details as to the seasons.]

	Sunshine.	Sunlight.
"Year.....	100	130

"Stronger evidence of the necessity for avoiding confusion between the two modes of observation could hardly be imagined."

The matter being one of importance, I recently caused an ordinary Jordan photographic sunshine recorder, made by Messrs. Negretti and Zambra, to be examined at Kew Observatory, and a certificate relating to it, of which the following is an exact copy minus the headlines, has just been issued by Mr. Whipple, at a charge of 10s. 6d. :—

"I hereby certify that the Jordan Sunshine Recorder, No. "208, by Negretti and Zambra, London, has been compared "with the Stokes-Campbell Recorder of this Observatory, and "found to give practically identical results."

(Signed) G. M. WHIPPLE,
Kew Observatory, June, 1891. *Superintendent.*

What are poor Observers to conclude from such contradictory asseverations ?

Yours faithfully,

JOSEPH BAXENDELL.

The Observatory, Birkdale, Southport.
22nd June, 1891.

[If the above does not justify our protest against the results from these two types of instrument being grouped together we do not know what would. It is not for us to impugn the accuracy of either Mr. Bayard or Mr. Whipple, we merely print what is certainly "Stronger evidence of the necessity for avoiding confusion between the two modes of observation than" we anticipated. ED.]

A CHANGEABLE MAY.

To the Editor of the Meteorological Magazine.

SIR,—I have just received the June number of your *Magazine*, and may inform you that here, in part of Lorraine, in the N.E. of

France, 1100 ft. above sea-level, we have had similar changes, not merely in May but also in June.

On May 13th the max was	75°·9
In the night, 17th–18th, the min. was.....	35°·1
Range	40°·8
On June 4th the max. was	78°·1
In the night, 12th–13th, the min. was	37°·8
Range	40°·3

On this night there was a white frost in some gardens.

Yours very truly,

V. RAULIN.

Montfaucon d'Argonne (Meuse), France.
June 18th.

ON CLOUD AT GREENWICH.

To the Editor of the Meteorological Magazine.

SIR,—In the valuable address on this subject, delivered by Mr. Ellis at the Royal Meteorological Society a few years ago (*Qu. Jo.*, July, 1888), he gives (p. 189) as the ascending order of the seasons in respect of cloud (70 years being considered): Autumn, spring, summer, winter. This is based, I suppose, on the fact that the least cloudy month (on a 70 years' average) is September, the next May, &c. Between those two minima, the curve rises to a low secondary maximum in July.

If we take the average of the three months of each season, we get, I find, a somewhat different order, viz.: Summer (6·48), Spring (6·57), Autumn (6·63), Winter (7·32). And examining each of the seven decades separately, summer comes out the least cloudy season in five of them, and spring in two; never autumn. The differences between these three seasons are obviously small.

While September is the least cloudy month (on an average), those 70 years show the minima to fall in various months. They fall about as often in one half of the year as in the other. Not so the maxima. The month of maximum cloud is (on a 70 years' average) January, the next December; and, taking the years separately, one finds maxima about twice as often in the earlier half of the year as in the later.

In meteorological studies, we are naturally on the outlook for some trace of sun spot influence. A curve of the annual figures for cloud does not appear to indicate such influence. I compared the distribution of cloud in the years of maximum and minimum sun spots, and may note the fact (though possibly without significance), that in all the maximum sun spot years of the series (viz., 1829, '37, '48, '60, '70, and '83,) the absolute minima of cloud were in the earlier half of the year, (viz., three times in May, and one each in March, April, and June). In the minimum sun spot years, the cloud

minima occurred three times in one half and three times in the other.

As regards the cloud maximum this falls in four of the sun spot maximum years in the second half, and in two in the first. In the sun spot minimum years, it falls four times in the first half, once in the second, and in one year the lowest value appears in two months, one in each half of the year.

Mr. Ellis has chiefly considered months; we may here briefly look at *seasons*, a little further.

While summer, according to our way of reckoning, is the least cloudy season, not only are there some years in which it has been *less* cloudy than any autumn month, but there are some years in which it has been *more* cloudy. The range is greater: in autumn from 5·2 to 7·4, in summer from 4·6 to 8·2.

It occurred to consider the question as to sequence in weather of seasons. Is there any tendency for a season with cloud above or below the average, to be followed by a season of like character? The figures seem to favour this idea in the case of seasons with excess of cloud. That is, in all four sequences of seasons, there were more cases of a season with more than the average cloud being followed by a season with also more than the average of cloud, than by a season with deficiency of cloud. The tendency (if one may infer its existence), seems most pronounced in spring and summer. Of 33 years in which spring had an excess of cloud, 25 showed the summer to have also an excess, and only 8 a deficiency.

The corresponding figures for summer and autumn were 23 and 15; for autumn and winter 19 and 11, for winter and spring 18 and 14 (not far from equality).

On the other hand, there have been (in each of the four seasonal sequences) about as many cases of a season with deficiency of cloud being followed by one with excess as by one with deficiency, except in the case of winter and spring. While 8 winters with deficiency of cloud were followed by springs with excess, 17 were followed by springs with deficiency.

Perhaps we may at least say, on the strength of these figures, that a cloudy spring tends to be followed by a cloudy summer, and a winter with little cloud by a spring with little cloud. It would be interesting to know how far this corresponds with the experience of your readers.

In a paper to the British Association at Aberdeen in 1885 (*Report* p. 913) Mr. Fox finds (1) a very cold spring tends to be followed by a cold and wet summer; a very cold summer tends to be followed by a cold autumn; (3) very warm summers are prone to be succeeded by warm autumns.

The first two seem to agree with what we should expect from the phenomena of cloud as above represented.—Yours faithfully,

A. B. M.

DRY YEARS AND CROYDON SPRINGS.

The following little table, for which we are indebted to Mr. Baldwin Latham, C.E., President R.Met.Soc., affords a striking illustration of the effect of dry years upon the yield of the Croydon springs. The measurements have been made under identical conditions in each of the last ten years, and always on the same date.

Yield of Croydon Springs on June 10th of each year.

1882.....	978·7	cube feet	per minute.
1883.....	1120·8	,,	,,
1884.....	849·2	,,	,,
1885.. ...	688·1	,,	,,
1886.....	933·7	,,	,,
1887.....	867·2	,,	,,
1888.....	796·2	,,	,,
1889.....	1039·2	,,	,,
1890.....	896·6	,,	,,
1891.....	597·4	,,	,,

REVIEW.

The Meteorological Results of the "Challenger" Expedition in relation to Physical Geography. By A. BUCHAN, M.A., LL.D., Secretary, Scot. Met. Soc. (Excerpt Proc. Roy. Geog. Soc., March, 1891.) 8vo, 22 pages, 6 plates.

As the officials of the "Challenger" office, and of the Royal Society of Edinburgh, and the publishers of the "Encyclopædia Britannica," alike ignore the existence of the *Meteorological Magazine*, we editorially have not had the pleasure of following Dr. Buchan's work for some years past. The above little pamphlet having arrived, we are, as ever, ready to give it a hearty welcome.

In the opening paragraph Dr. Buchan recounts the circumstances attending and following the preparation (more than twenty years since) of his first paper on the mean atmospheric pressure upon the globe. There is no doubt that, by that one paper he did more towards promoting accurate knowledge of the elevation of various parts of the earth's surface than any traveller (unless, indeed, it be Humboldt), has ever done, and he is perfectly justified in reminding his hearers of the fact, but he puts it far too mildly. "A more exact method" is an expression doubly erroneous: (1) "exact" cannot be qualified; if a thing is exact, it is exact, and nothing can make it "*more* exact"; (2) "more exact" implies that the previous process was not exact and the lines which follow those words show how bad the old method was. Dr. Buchan should have said, "an approximately correct method was substituted for the previous very unsatisfactory one."

It is impossible for us to follow the whole paper, which, as its title implies, is chiefly a summary of the volume published in the "Challenger" series, but we can pick out a few facts,—*e.g.*:

"Observations on the temperature of the surface were made every two hours of the day as part of the scientific work of the expedition. From 1512 observations made in the North Atlantic, the mean latitude being 30° and longitude

42°, it is conclusively shown that the daily change of the temperature of the surface of this ocean is only 0°·8. Similarly in the South Atlantic, lat. 33° and long. 20° W., it was 0°·8; in the North Pacific, lat. 37° and long. 170° W., it was 1°·0; and in the South Pacific, lat. 36° and long. 87° W., it was 0°·9. In the equatorial portions of the Atlantic and Pacific the daily variation was 0°·7; and in the higher latitudes of the Southern Ocean it was only 0°·2. Hence, in the great oceans away from land, and between lat. 40° N. and 40° S., the surface temperature nowhere shows a daily variation exceeding a degree Fahrenheit. Near the equator the daily range falls to three-fourths of a degree, and still further to one-fifth of a degree in high latitudes."

"Over the open sea the humidity curve closely follows that of the temperature, being at the minimum at four in the morning, and at the maximum at two in the afternoon. But near land very different conditions prevail; here a second minimum takes place from about 10 a.m. to 2 p.m.—a feature altogether absent over the open sea."

"Over the open sea the diurnal oscillations of the barometer are shown in their simplest and exactest [*sic*] form, the disturbing influence of land being wholly wanting. The remarkable result is this, though the atmosphere there overlying the ocean, and, therefore, resting on a floor whose diurnal variation of temperature does not exceed a degree Fahrenheit, yet the diurnal oscillations of the barometer are as marked, and as decided as they are over the land where the diurnal variation of temperature is great. In accounting, therefore, for these oscillations, it is virtually unnecessary to take the temperature of the surface into consideration. What is insisted on here is that while the temperature of the surface leaves its impress on the diurnal barometric curve by important modifications thereby produced, yet the barometric oscillations themselves are independent of the temperature of the earth's surface. Hence the cause must be sought in the daily changes which take place in the temperature and humidity of the air through all its height, due to solar and terrestrial radiation."

We do not remember having seen the fact stated elsewhere that at sea the velocity of the wind has no diurnal curve. On land, as we have often mentioned, the greatest velocity occurs usually shortly after noon; but it will be remembered that we gave a diagram showing, on the authority of M. Angot, that at the top of the Eiffel Tower, this law did not hold good, and now Dr. Buchan says that at sea there is no regular curve.

Dr. Buchan devotes a page to the consideration of the hour of greatest frequency of TS and of L over land and over sea, but he makes no reference to the difficulty of seeing faint lightning during daylight, and it seems to us that this serious disturbing cause diminishes the value of the conclusions arrived at.

As regards the isobars, the author points out the causes which, in his opinion, render observations from stations in narrow valleys useless, and he gives instances which support his view.

Referring to the isothermal map for January, Dr. Buchan points out the extreme cold of Werkojansk, in N.E. Siberia (67° 34′ N. and 133° 51′ E.), where the January average is —61°·2, *i.e.*, 93°·2 below freezing, and where in January, 1886, the absolutely lowest air temperature ever known occurred, viz., —88°·8, or —120°·8 below the freezing point of water, and nearly 50° below the freezing point of mercury. In fact, with an average of —61°·2, there is nothing but the cost, to prevent quicksilver being generally used there both for bullets and for small shot.

CLIMATOLOGICAL TABLE FOR THE BRITISH EMPIRE, DEC., 1890.

STATIONS. (*Those in italics are South of the Equator.*)	Absolute. Maximum. Temp.	Maximum. Date.	Minimum. Temp.	Minimum. Date.	Average. Max.	Min.	Dew Point.	Humidity.	Absolute. Max. in Sun.	Min. on Grass.	TotalRain. Depth.	Days.	Aver. Cloud.
	°		°		°	°	°	0-100	°	°	inches		
England, London	43·7	4	14·9	22	34·0	25·5	26·8	86	49·3	5·5	·68	9	8·1
Malta	67·2	1	45·8	15	61·2	50·5	46·8	77	116·9	39·0	4·11	19	5·7
Cape of Good Hope	97·2	3	53·5	31	80·0	59·7	...	...	...	...	·64	...	4·8
Mauritius	83·9	29	66·3	12	81·5	71·3	67·5	76	137·0	58·7	2·18	12	6·5
Calcutta	83·5	10	47·5	29	77·4	56·8	57·6	74	143·4	37·9	·03	1	0·9
Bombay	86·4	28	65·2	14	83·6	70·5	66·0	69	133·0	49·1	·13	1	2·7
Ceylon, Colombo	89·2	29	68·3	29	86·7	73·1	68·5	73	150·0	62·5	8·47	17	5·3
Melbourne	88·9	5	42·7	17	70·8	52·3	50·0	66	142·3	34·0	1·40	10	6·2
Adelaide	95·6	5	48·5	8	80·6	58·3	49·2	49	160·5	39·2	·20	4	4·1
Wellington	73·3	18	44·0	3	68·0	55·1	51·7	72	137·0	35·0	5·07	12	3·8
Auckland	78·5	14	50·0	3	72·3	57·5	54·5	70	142·0	41·0	1·98	10	5·0
Jamaica, Kingston	88·9	12	63·3	2	86·6	68·5	66·3	71	...	...	·31	...	...
Trinidad	89·0	*a*12	65·0	*Var*	85·9	68·1	69·7	80	152·5	58·0	5·28	18	...
Toronto	41·1	23	— 1·2	28	30·2	14·9	19·4	81	...	—6·0	1·94	23	7·3
New Brunswick, Fredericton	46·4	4	—16·8	9	18·8	—2·5	5·0	74	...	...	4·25	13	4·6
Manitoba, Winnipeg	44·8	17	—24·6	1	24·1	1·9	15·5	94	...	...	·46	10	4·8
British Columbia, Esquimalt	55·1	18	32·0	5	47·6	39·4	42·6	95	...	...	8·28	23	8·6

a. And 24th.

DECEMBER REMARKS.

MALTA.—Mean temp. 54°·9; mean hourly velocity of wind, 10·7 miles; sea temp. fell from 65°·0 to 60°·5. TSS on 5 days; L on 3 days; H on 29th. J. SCOLES.

Cape of Good Hope.—The 2nd, 3rd and 4th very hot; max. temp. 91°·2, 97°·2 and 91°·7 respectively. D. MAY.

Mauritius.—Mean temp. of air, 1°·0 below, dew point 0°·4 below, and R 3·13 in. below, their respective averages; mean hourly velocity of wind, 9·4 miles, or 1·8 below average; extremes 21·3 on 26th, 1·2 on 2nd; prevailing direction, S.E. by E.; L on 7th and T and L on 29th. C. MELDRUM, F.R.S.

Ceylon, Colombo.—TSS occurred on 7 days; L only, was seen on 3 days. J. C. H. CLARKE, Lieut.-Col., R.E.

Melbourne.—Mean temp. of air 1°·7, of dew point 0°·7, and R 1·07 in. below, humidity 2, and amount of cloud 0·6 above, their respective averages. Prevailing winds S. and S.W., strong on 8 days; heavy dews on 12 days; TS and heavy R on 28th, L on 6th, 7th, and 29th, lunar halo on 20th. R. L. J. ELLERY, F.R.S.

Adelaide.—Temp. 1°·8, and R ·62 in., below the average of 33 years. The summer so far has been unusually cold, with only a few warm days and no continuous heat. C. TODD, F.R.S.

Wellington.—Heavy R in the early part of the month, and strong N.W. wind; on the 1st, in two hours, 2 in. of R fell, and the fall in 24 hours was 2·40 in., causing floods. Fine from 6th to 17th, when heavy showers fell, and also on 18th; strong N.W. winds on 13th and 14th, though fine; very strong N.W. wind from 23rd to 27th, and showery during the latter part of the month. Slight H on 2nd. Prevailing wind, N.W. Mean temp. 0°·7 above the average. R. B. GORE.

Auckland.—A mild, warm month, with small R and light variable wind. T. F. CHEESEMAN.

ESQUIMALT.—On 31st, roses, violets, and many other flowers were in bloom in the open air. C. CARPMAEL.

SUPPLEMENTARY TABLE OF RAINFALL, JUNE, 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.	1·49	XI.	Builth, Llanwrtyd Wells	3·48
,,	Margate, Birchington...	1.66	,,	Rhayader, Nantgwillt..	3·63
,,	Brighton, PrestonvilleRd	1·96	,,	Corwen, Rhug	4·21
,,	Hailsham	1·46	,,	Carnarvon, Cocksidia ...	2·92
,,	Ryde, Thornbrough	1·91	,,	I. of Man, Douglas	3·00
,,	Alton, Ashdell.....	1·22	XII.	Stoneykirk, Ardwell Ho.	·79
III.	Oxford, Magdalen Col...	1·27	,,	New Galloway, Glenlee	1·34
,,	Banbury, Bloxham	1·34	,,	Melrose, Abbey Gate...	·90
,,	Northampton	1·66	XIII.	N. Esk Res. [Penicuick]	...
,,	Cambridge, Fulbourne..	2·52	XIV.	Ballantrae, Glendrishaig	1·26
,,	Wisbech, Bank House..	1·42	,,	Glasgow, Queen's Park.	·92
IV.	Southend	1·48	XV.	Islay, Gruinart School..	1·86
,,	Harlow, Sheering	·48	XVI.	Dollar.....	·61
,,	Rendlesham Hall	·67	,,	Balquhidder, Stronvar..	2·58
,,	Diss	·96	,,	Coupar Angus Station..	·64
,,	Swaffham	·71	,,	Dunkeld, Inver Braan..	·67
V.	Salisbury, Alderbury...	1·39	,,	Dalnaspidal H.R.S. ...	1·74
,,	Warminster	1·83	XVII.	Keith H.R.S.	·81
,,	Bishop's Cannings	1·22	,,	Forres H.R.S.	·43
,,	Ashburton, Holne Vic....	4·33	XVIII.	Fearn, Lower Pitkerrie.	1·12
,,	Okehampton, Oaklands.	2·27	,,	Loch Shiel, Glenaladale	...
,,	Lynmouth, Glenthorne.	2·43	,,	N. Uist. Loch Maddy ...	2·97
,,	Probus, Lamellyn	2·51	,,	Invergarry	1·34
,,	Launceston, S. Petherwin	...	,,	Aviemore H.R.S.	·47
,,	Wincanton, Stowell Rec.	1·36	,,	Loch Ness, Drumnadrochit	1·25
,,	Wells, Westbury.....	...	XIX.	Lairg H.R.S.	1·81
VI.	Bristol, Clifton	2·32	,,	Scourie	...
,,	Ross, the Graig	...	,,	Watten H.R.S.	1·39
,,	Wem, Clive Vicarage ...	2·67	XX.	Dunmanway, Coolkelure	4·64
,,	Cheadle, The Heath Ho.	3·63	,,	Fermoy, Gas Works ...	3·52
,,	Worcester, Diglis Lock	2·56	,,	Darrynane Abbey.....	3·89
,,	Coventry, Coundon	2·50	,,	Tipperary, Henry Street	2·71
VII.	Ketton Hall [Stamford]	2·10	,,	Limerick, Kilcornan ...	2·80
,,	Grantham, Stainby	2·95	,,	Ennis	2·58
,,	Horncastle, Bucknall ...	2·73	,,	Miltown Malbay.....	3·09
,,	Worksop, Hodsck Priory	3·20	XXI.	Gorey, Courtown House	2·88
VIII.	Neston, Hinderton	4·53	,,	Mullingar, Belvedere...	2·20
,,	Knutsford, Heathside...	2·24	,,	Athlone, Twyford	2·41
,,	Lancaster, Southfield...	...	,,	Longford, Currygrane...	2·10
,,	Broughton-in-Furness..	1·99	XXII.	Galway, Queen's Coll...	2·13
IX.	Ripon, Mickley	1·03	,,	Crossmolina, Enniscoe..	2·76
,,	Scarborough, West Bank	·40	,,	Collooney, Markree Obs.	2·21
,,	East Layton [Darlington]	1·42	,,	Ballinamore, Lawderdale	2·44
,,	Middleton, Mickleton..	1·22	,,	Lough Sheelin, Arley ..	2·50
X.	Haltwhistle, Unthank..	·76	XXIII.	Warrenpoint	1·84
,,	Bamburgh.....	·66	,,	Seaforde	3·41
,,	Shap, Copy Hill	...	,,	Belfast, New Barnsley..	2·50
XI.	Llanfrechfa Grange	2·54	,,	Bushmills, Dundarave...	·83
,,	Llandovery	2·66	,,	Stewartstown	3·75
,,	Castle Malgwyn	2·86	,,	Buncrana	2·37

JUNE, 1891.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average. 1880-9.	Greatest Fall in 24 hours. Dpth	Date	Days on which ·01 or more fell.	TEMPERATURE. Max Deg.	Max Date	Min. Deg.	Min. Date	No. of Nights below 32°. In shade.	On grass.
			inches.	inches.	in.								
I.	ENGLAND.	London (Camden Square) ...	·86	— 1·15	·32	22	10	79·0	22	44·9	10	0	0
II.		Maidstone (Hunton Court)...	1·73	+ ·11	·66	22	11	...	...	...	...	...	...
,,		Strathfield Turgiss	1·12	— ·68	·41	22	14	81·4	19	37·0	12	0	2
III.		Hitchin	1·73	— ·13	·55	4	11	78·0	26	40·0	8*e*	0	...
,,		Winslow (Addington)	1·09	— ·77	·29	4	11	77·0	17	39·0	12	0	0
IV.		Bury St. Edmunds (Westley)	·80	— ·99	·38	4	5	...	...	...	...	...	...
,,		Norwich (Cossey)	·87	— ·68	·50	4	8	75·0	26*a*	...	...	...	...
V.		Weymouth(LangtonHerring)	2·24	+ ·01	·76	3	11	76·0	20	45·0	8*f*	0	...
,,		Barnstaple	1·42	— ·74	·36	25	11	80·0	21	41·0	12	0	...
,,		Bodmin (Fore Street)	2·96	+ ·21	·56	3	18	...	...	...	...	...	...
VI.		Stroud (Upfield)	1·82	— ·57	·72	24	12	80·0	19	39·0	23	0	...
,,		ChurchStretton(Woolstaston)	3·14	+ ·59	·59	4	14	76·0	21	39·0	7	0	0
,,		Tenbury (Orleton)	2·48	— ·13	·64	4	11	78·3	19	37·0	12	0	0
VII.		Leicester (Barkby)	3·36	+ 1·01	1·29	4	13	83·0	13	36·0	12	0	0
,,		Boston	1·81	— ·08	·70	4	10	81·0	19	40·0	13	0	...
,,		Hesley Hall [Tickhill].....	2·64	+ ·72	1·50	4	13	77·0	24	37·0	10	0	...
VIII.		Manchester(PlymouthGrove)	3·29	+ ·64	1·15	2	11	81·0	24	40·0	10	0	0
IX.		Wetherby (Ribston Hall) ...	·93	— ·96	·41	2	4	...	...	...	...	...	...
,,		Skipton (Arncliffe)	2·18	— 1·18	·54	29	11	81·0	20	37·0	9	0	...
,,		Hull (PearsonPark)	1·10	— ·65	·37	4	8	...	...	..	...	..	...
X.		Newcastle (Town Moor)	·54	— 1·10	·25	15	9	...	...	...	...	...	...
,,		Borrowdale (Seathwaite).....	3·08	— 3·50	·87	27	13	...	...	...	...	...	...
XI.	WALES.	Cardiff (Ely).....	2·08	— ·35	·95	24	13	...	...	...	...	...	...
,,		Haverfordwest	2·05	— ·51	·64	27	13	80·0	23	40·7	11	0	...
,,		Carno (Tybrith)	3·07	+ ·33	1·07	4	13	72·0	19	32·0	10*g*	2	...
,,		Llandudno.....	3·34	+ 1·57	·91	24	12	72·6	20	42·0	7	0	...
XII.	SCOTLAND.	Cargen [Dumfries]	1·24	— ·71	·38	25	7	81·2	20	35·0	11	0	...
,,		Jedburgh (Sunnyside).....	·90	— ·84	·38	26	6	75·0	19*b*	40·0	10	0	...
XIV.		Old Cumnock	·87	— ·99	·20	14	11	...	...	...	...	...	...
XV.		Lochgilphead (Kilmory).....	2·00	— 1·10	·58	29	12	...	...	36·0	7	0	...
,,		Oban (Craigvarren)	1·98	...	·35	30	11	80·9	25	41·0	8	0	0
,,		Mull (Quinish).....	2·02	— 1·27	·51	26	11	...	...	...	...	...	...
XVI.		Loch Leven Sluices	·90	— ·85	·50	27	4	...	...	...	...	...	...
,,		Dundee (Eastern Necropolis)	·75	— ·75	·50	15	6	76·1	23	37·6	11	0	...
XVII.		Braemar	·87	— 1·12	·31	30	8	75·4	20	30·4	11	2	6
,,		Aberdeen (Cranford)	·35	...	·07	28	7	74·0	26	41·0	21	0	...
XVIII		Strome Ferry.....	2·24	— ·82	·50	18	11	...	..	...	...	...	...
,,		Inverness (Culloden)	·25	— ·71	·16	27	3	77·0	26	37·0	9*g*	0	5
XIX.		Dunrobin	1·68	— ·34	·63	27	6	67·0	26	39·0	9	0	...
,,		S. Ronaldsay (Roeberry).....	1·74	— ·02	·74	26	9	70·0	25	42·0	6*f*	0	...
XX.	IRELAND.	Dromore Castle	2·53	— ·63	1·02	1	11	90·0	22	48·0	9*h*	0	...
,,		Waterford (Brook Lodge) ...	2·40	+ ·33	·63	3	11	75·5	20	39·0	10	0	..
,,		O'Briensbridge (Ross)	1·20	...	·21	30	14	80·0	19*c*	44·0	1	0	...
XXI.		Carlow (Browne's Hill)	2·59	+ ·75	·72	2	13	...	...	...	...	...	...
,,		Dublin (FitzWilliam Square)	2·75	+ 1·09	·60	24	14	73·8	23	43·9	10	0	0
XXII.		Ballinasloe	2·34	+ ·04	·61	30	17	72·0	20	40·0	12	0	...
,,		Clifden (Kylemore)	4·27	...	1·70	29	10	..	...	...	...	...	...
XXIII		Waringstown	2·68	+ ·61	1·28	25	14	84·0	19	37·0	11	0	0
,,		Londonderry (Creggan Res.).	1·79	— ·63	·56	25	13	...	...	...	...	..	..
,,		Omagh (Edenfel)	1·82	— ·65	·52	25	13	78·0	20*d*	41·0	5*f*	0	0

a And 29. *b* And 20. *c* And 20, 21, 22, 23. *d* And 21, 22, 23. *e* And 12. *f* And 10. *g* And 11. *h* And 19

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

METEOROLOGICAL NOTES ON JUNE, 1891.

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

ENGLAND.

STRATHFIELD TURGISS.—On the whole a genial and seasonable month, but from the long continued cold and subsequent dry weather, crops are backward and hay will be scarce. L on the 1st and T on the 3rd.

ADDINGTON.—A very moderate quantity of R fell in this district. On the afternoon of the 24th a heavy TS raged to the S., eleven sheep and lambs being killed under one tree in the adjourning parish of Claydon. The nights of the 10th, 11th and 12th were cold, the min. on grass falling to 36° 35° and 34°. T on the 1st, 3rd, 4th, 15th, 24th and 25th.

BURY ST. EDMUNDS, WESTLEY.—Remarkable for its small R, but vegetation stood the drought well. A want of water may be soon expected in West Suffolk; the ponds are nearly dry, and the deep chalk wells are much lower than usual at this time of year. T on 2nd and 23rd.

LANGTON HERRING.—On the whole it was a very fine month; from the 7th to the 21st inclusive only ·01 in. of R fell. Mean temp. at 9 a.m. 60°·5, or 0°·2 above the average of 19 years. Fog on 15th and 29th; T on 25th.

BODMIN.—A very warm and genial month; very hot in the sun from the 14th to the 26th.

STROUD.—Very heavy TS to the N.W. over Gloucester on the 15th, but not severe here; TSS also on the 24th.

ORLETON.—A fine, favourable month for agriculture, with many warm days; the mean temp. being exactly the average of 30 years. All the R fell in the first and last weeks; none falling from 6th to 22nd inclusive. T on 6 days; L on the 4th, 24th and 25th.

LEICESTER, BARKBY.—Considerable R in the first and last weeks only. Wind frequently strong and cool, from N.E. T on 6 days.

MANCHESTER, PLYMOUTH GROVE.—Fine summer-like weather from 8th to 13th, also from 19th to 23rd; mean temp. 59°·1. Severe TS on 24th; TSS also on 2nd and 25th.

WALES.

HAVERFORDWEST.—Certainly one of the finest Junes during the last ten years. The nights were cold during the first 10 days, after which the day temp. rose suddenly and a period of great heat set in; storms threatened, but none occurred in this immediate neighbourhood. In the North East of the county severe TSS occurred, with loss of life amongst horses and cattle. From the 24th to the end a considerable amount of R fell. Prevailing winds N. and E.

SCOTLAND.

CARGEN.—The first 18 days were very cold for June, the mean temp. being only 54°·6; this was succeeded by a period of unusually warm weather, which lasted for 8 days, from 19th to 26th inclusive; the mean max. temp. being 78°·3. No R fell for 23 days, from 2nd to 24th inclusive. T was heard on the 2nd, 4th and 26th.

JEDBURGH.—The month was remarkable for the prevalence of N. and N.E. winds, with a considerable amount of sunshine. About the middle there was a good fall of R, which had a most invigorating effect on vegetation. Cereal and root crops look well. Hay will be a poor crop.

OBAN, CRAIGVARREN.—Dry and warm, with strong E. winds at the commencement. Pastures much burnt up in many parts.

MULL, QUINISH.—A very hot dry month; much needed R fell at the close. T and L on 26th.

INVERNESS, CULLODEN.—The R during the month was much under the average and pasture land, and crops generally, were suffering at the close. T on 16th, 27th, 28th and 30th ; much L on 28th.

S. RONALDSAY, ROEBERRY.—The first half of the month was very dry and cold ; winds S.E. to N.E. The latter part was warmer, with a good deal of fog, and towards the end R.

IRELAND.

WATERFORD, BROOK LODGE.—Mean temp. 57°·8. T on 1st and 15th. T and L on 24th. Sea Fogs on 5th, 16th and 17th.

O'BRIENSBRIDGE, ROSS.— R moderate, and below the average of 10 years. Warm and brilliant weather to the 24th, from thence lower temp. and moderate showers. Occasional T and L.

DUBLIN.—A generally favourable month of high mean temp. and pressure, showing a marked preponderance of N.E. and E. winds. The mean temp. was 58°·6 or 1·3 above the average of 25 years. High winds on 7 days, attaining the force of a gale on but one occasion, the 30th. Temp. reached or exceeded 70° in the screen on 6 days. T was heard on the 15th and 24th and H fell on the 15th. A heavy T shower occurred at 5.15 p.m. on the 24th followed by a severe TS half-an-hour later.

EDENFEL.—The weather of the first fortnight, although for the most part fine and dry, hardly helped the then backward vegetation, but from the begining of the third week a gentle R was followed by a whole week of ideal summer, hot days and warm nights with copious dews ; this again was followed in the last week by further sufficient rain, so that the 1st July saw covered with luxuriant promise, a country that on the 1st of June had given rise to the greatest fears for the coming harvest.

ERRATA IN METEOROLOGICAL MAGAZINE, 1890.

REGULAR TABLE.

Ely	Aug.....	should be	3·78 in.
,, ...	Sept. ...	,,	1·15 ,,

SUPPLEMENTARY TABLE.

Banbury, Bloxham	Dec.....	should be	·69 in.
Fulbourne Asylum	Oct.....	,,	2·18 ,,
,, ,, ...	Nov. ...	,,	2·10 ,,
Southend	Sept. ...	,,	1·08 ,,
Lancaster, Southfield ...	Jan.....	,,	6·86 ,,
Wakefield Prison	Mar. ...	,,	1·55 ,,
,, ,, ...	June ...	,,	2·71 ,,
,, ,, ...	July.....	,,	1·93 ,,
Dollar	Nov. ...	,,	7·60 ,,
Forres...	Sept. ...	,,	2·46 ,,
Fearn, Lower Pitkerrie	Mar. ...	,,	2·51 ,,
Galway, Queen's College	,, ...	,,	2·94 ,,
,, ,, ...	May ...	,,	2·31 ,,
,, ,, ...	Sept. ...	,,	2·73 ,,