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THE FROST—EARTH TEMPERATURES & WATER PIPES.

Continued from page 40.

IT would be beyond the scope of a note in this Magazine to prepare an analysis of all earth temperature records, but Mr. Rogers Field has directed our attention to some given in an American work,† which is hardly likely to be generally known to meteorologists, and from which we have therefore formed the following table:—

Winter Earth Temperature Observations in the United States.

Place.	Year	Month.	Air.			Minimum in Soil.							
			Max.	Min.	Mean	3 in.	6 in.	1 ft.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.
			°	°	°	°	°	°	°	°	°	°	°
State College Philadelphia.	1890	Nov.	66	17	41·2	33·5	35 0	37·5	40·5	...	...	...	...
	,,	Dec.	47	1	25·6	32·0	33·0	34·5	36·5	...	...	...	...
	1891	Jan.	49	1	28·9	23·0	27·0	33·0	34·5	...	...	...	...
	,,	Feb.	58	4	33·1	23·5	27·5	33·0	34·0	...	...	...	...
	,,	Mar.	54	0	31·6	24·0	30·0	33·0	34·0	...	...	...	...
	,,	April	82	20	49·5	31·5	33·0	35·0	36·5	...	...	...	...
S. Anthony Park, Minnesota	1890	Jan.	38	10	25	15	...	18	24	31	34	36	37
	,,	Feb.	46	—3	17	6	...	18	18	25	30	33	34
	,,	Mar.	62	14	44	21	...	26	25	26	30	32	34
	,,	April	68	42	56	46	...	35	32	32	32	33	39
Lincoln, Nebraska.	1890	Nov.	66·0	20	38·9	32·0	...	40·0	45·0	48·0	...	...	...
	,,	Dec.	59·5	5	30·9	23·0	...	34·0	39·0	41·7	...	...	...
	1891	Jan.	...	...	27·9	22·7	...	31·4	35·7	38 5	...	...	...
	,,	Feb.	...	...	20·1	14·6	...	24·2	31·4	34·8	...	...	...
	,,	Mar.	...	...	28·4	16·4	...	22·8	30·0	33·2	...	...	...
	,,	April	...	...	53·4	33·7	...	35·7	36·2	36·5	...	...	...
	,,	Nov.	78·0	3·0	34·5	26·3	...	37·3	42·8	46·0	...	...	...
	,,	Dec.	64·5	—1·0	32·6	29·2	...	35·0	39·0	42·0	...	...	...
Fort Collins, Colorado.	1890	Jan.	39·8	9·6	24·7	28·0	29·4	31·1	33·8	36·2	...	...	42·0
	,,	Feb.	45·0	15·0	30·0	32·5	33·3	33·6	34·6	36·0	...	...	46·0
	,,	Mar.	52·9	23·2	38·0	39·2	39·5	38·6	38·2	38·3	...	...	40·8
	,,	April	60·0	33·1	46·6	47·1	47·7	47·3	46·1	45·2	...	...	44 6
	,,	Nov.	54·9	21·3	38·1	36·7	38·2	40·8	44·2	46·7	...	...	52·1
	,,	Dec.	49·6	18·3	34·0	32·1	33 3	35·5	38·0	40·5	...	...	46·7

† Sewage Disposal in the United States, by G. W. Rafter, M.Am.Soc.C.E.; and M. N. Baker, Ph.B.: New York, 1894.

REMARKS.

Philadelphia.—Nearly 3 ft. of snow in December, 1890.

S. Anthony.—The max. and min. mean are merely those of daily readings at 2 p.m. The soil was bare of snow during February, hence the great penetration of the frost. The authors say:—"These Minnesota observations are of special interest, as illustrating the time required for the ground to free itself from frost when once frozen. The mean air temperature for March [at 2 p.m. ED.] was 44°, with a mean soil temperature at the depth of three inches of 41°. At the depth of two feet, 32° was not reached until March 28th, and it remained at that point till April 5th. These results show the considerable length of time required for the soil, and entrained moisture, to recover its lost latent heat. In winters of extreme cold the soil of Minnesota is said to freeze to the depth of six feet."

Before concluding our remarks upon the above subject, we have to insert a few further particulars respecting soil temperature.

To the Editor of the Meteorological Magazine.

SIR, — Referring to your article in the *Monthly Meteorological Magazine* of April on Earth Temperatures, perhaps the following may be found interesting from the temperatures having been taken in a different way from usual. I use a Negretti and Zambra's slow action thermometer, having the bulb encased in paraffin, as used by the British Association Committee on Rock (Underground) temperatures. This is buried in ground exposed to, and on a slope facing, S.E. at a depth of 1 ft., and is dug up twice a month. On February 15th the ground was frozen to the depth of 10 or 11 inches. The following are the temperatures this year and last:—

	1895.	1894.
	°	°
January 1	39·8	42·0
,, 16	36·2	41·8
February 1	36·2	43·2
,, 15	33·0	44·0
March 1	34·2	43·2
,, 16	43·4	44·0
April 1	44·1	50 1
,, 15	47·8	50·1

The soil is a decomposed clay slate, with many fragments of the rock, and the slope is a sharp one.—Yours truly,

ALFRED O. WALKER.

Nant-y-Glyn, Colwyn Bay.—April 22nd, 1895.

To the Editor of the Meteorological Magazine.

SIR,—If you could spare time to glance at the daily readings of our Southport 1-ft., 4-ft., and 10-ft. earth thers. which are printed in the weekly returns I send you, you would, I think, see that they agree *well* with Blackpool, and *fairly* with Bolton. But much must depend on the freedom (artificial or natural) of the ground around the thers. *from snow.* Some observers clear it away. Others (the majority, I hope) do not. But I doubt the desirability of allowing the iron tubes and caps to project six inches or so out of the ground. The snow soon melted away for some distance around mine.

Yours faithfully,

JOSEPH BAXENDELL.

The Observatory, Birkdale, Southport, April 18th, 1895.

Mr. Baxendell's values are within a tenth of a degree of those for Bolton. The entry for the table on p. 39 would be—

Southport Observatory, Lancashire 32°·3 31°·1 1°·2

and for the table on p. 40 –

Lancashire, Southport Observatory

31°·1 —— 36°·4 31°·1 32°·9 34°·3 35°·3

We therefore see no probability whatever that the natural soil at Southport was frozen 2 ft. below the surface.

Looking back over all the thermometric records we adhere to our original opinion that at no spot in England did the natural soil in its normal condition become frozen at the depth of 2 ft.

BURST WATER PIPES.

We now turn to the evidence on the other side, proving that water-pipes and mains were frozen at 2 ft. and at much greater depths.

We give, first, a few notes as to the mischief wrought in different towns. This list is not to be assumed to be complete or authoritative. No effort has been made towards ensuring either, as the sole object is to give typical information.

WEST HAM.—March 28th.—More than half our houses are waterless, and some have been in this state for nearly eight weeks.

BRIGHTON.—Serious splits occurred along the London Road, and the engineer reported on April 2nd that he had already relaid 440 yards of 4-inch and 100 yards of 3-inch mains at the depth of 2 ft. ; the old ones had been at from 1 ft. 2 in. to 2 ft.

READING.—Since the end of February 250 fractures in 4 in. mains, and 665 fractures in 3 in. mains, have been discovered and repaired, and during the same period over 500 service pipes have been made good. There are still (May 2nd) many leakages.

In the village of Burghfield all the mains near the Hatch Gate were burst, and have been replaced by new ones.

MAIDENHEAD.—The mains are mostly laid at 2 ft. 6 in. and many of them are burst.

FENNY STRATFORD (BUCKS).—March 29th.—The overtime worked in pumping was reasonable considering the amount of water required, owing to some extent to the bursts in the mains.

HONITON.—Water supply very much interfered with, the mains in the principal streets having been burst.

SHREWSBURY.—The pipes supplying Severn water burst in more than 50 places and the conduits in about 10. The bursts have been chiefly in the suburbs. On March 21, mains 2 ft. 6 in. below the surface were still blocked.

WOLVERHAMPTON.—The breakages were 135 two-inch pipes,

209 three ,, ,,

37 four ,, ,,

1 six ,, ,,

1 eight ,, ,,

and about 350 street services.

BIRMINGHAM.—The estimated number of bursts in private houses is put at 2,000, and the cost to the Corporation for repairs and for supply (£100 a day up to February 27th) about £3,000.

LEAMINGTON.—Cost of injury to mains about £900.

COVENTRY.—The severe frost caused considerable damage to the water mains. The water became frozen, even at more than 2 ft. below the surface.

CHESTERFIELD.—March 21st.—Frost not yet entirely out of the system. One pipe at Newbold was frozen at the depth of 28 inches. Total bursts about 600, but not many mains.

DERBY.—The total bursts in private houses were 3,490, and of street mains, 40.

LIVERPOOL.—There are in Liverpool 1,030 courts, containing 6,180 houses, supplied by standpipes, these often freeze, and about 20 men were engaged continually in trying to keep them in action. 128 men were engaged in connection with temporary standpipes, they rang bells when the pipes were delivering. At the time of greatest severity probably (besides the courts already mentioned) 27,000 houses were without supply—they were, however, all supplied by standpipes, except four blocks in the suburbs where the main was frozen and a cart service was substituted. The smallness of the number of mains frozen is attributed to (*a*) their depth, (*b*) the maintenance of constant supply and therefore continuous motion. Besides the above-mentioned 148 men, about 200 were employed in packing, and keeping free, the fire hydrants. Of street pipes 407 were burst, all but 15 being of less than 5 inches diameter, and most of them old ones laid at shallow depths; the total of lead pipes burst is put at 19,536, and more than 600 hydrants were damaged. The total cost to the Corporation was about £6,000.

OLDHAM.—March 30th.—It was reported that nearly all breakages had been made good.

BACUP.—The pipes conveying the water from the source to the main were split in many places.

KEIGHLEY.—There had been hundreds of bursts.

SHEFFIELD.—In the second week of March, and notwithstanding the thaw, nearly 170,000 persons were without proper water supply, and according to the report of the Engineer, published March 11th, the district service pipes had been frozen in 21 places at depths of and exceeding 1 ft. 6 in.

April 27th.—Nearly 500 men have been at work during the week repairing mains, but fresh fractures reveal themselves.

HUDDERSFIELD.—Repairs of burst pipes cost the Corporation £250, and extra labour in delivering water cost £550.

RIPON.—Water mains burst in several parts of the city, but they were mostly only 2-inch.

WORKINGTON.—Even on April 20th the supply is intermittent as, though the mains are all repaired, many services remain leaky.

BUILTH.—Much inconvenience has arisen from the water mains being frozen.

ST. ASAPH.—The service main burst in more than 20 places.

COLWYN BAY.—The bursts along the promenade at Rhos were so numerous that the main was practically useless.

SELKIRK.—March 28th.—So many bursts have occurred that no attempt will be made to repair, but new mains will be laid throughout.

MUSSELBURGH.—On February 27th a service pipe was found frozen at the depth of 37 inches in soil under whinstone blocks, and nearly at sea level.

ALLOA.—Roads reported in very bad state owing to numerous burst pipes.

INVERNESS.—Mr. Macdonald, water manager, on May 1st, reported:—"Every effort is being made to carry out your instructions as regards the restoration of the water supply to its normal state; but this is found to be a most difficult undertaking, as leaks and bursts, both in main and service pipes, are found to be universal. However, with the exception of Kessock Road, where men are employed uncovering the pipes, the supply of water is restored, but the pressure is not yet sufficient in many cases to rise to the cisterns. Almost in every case where the pipes were frozen they were also burst, and their renewal thus became imperative. If the leaks showed any indication on the surface of the ground it would be an easy matter to overcome them, but in most cases there was no appearance of leakage. For instance, on April 30th, in King Street, a 3-inch pipe was discovered with about two feet by two inches of the metal entirely severed from the pipe, yet not a drop came to the surface, and its discovery was due to an all-night inspection of the sewers. Again, in Glen Urquhart Road, the pipes were nearly all found split, and the water not rising above the pipes. The same remarks apply to many other roads in and around the town. I suspect that there are leakages at present going on in Kenneth Street, Telford Street, Attadale Road, Harrowden Road, Culduthel Road, and probably many other places, in addition to a host of service pipes. Strenuous efforts will continue to be made to overcome this serious state of matters."

The above extracts will suffice to prove—

(1) The wide area of the trouble—from Devon to Inverness.

(2) That pipes were found containing ice 28, 30, and 37 inches below the surface. In the report (on p. 62) of the meeting of the Royal Meteorological Society, 42 inches is mentioned, and in the subjoined note* 54 inches.

(3.) The great cost which has fallen upon most of the large towns.

Several correspondents have suggested that which we believe to be the real explanation of the apparent contradiction, but before proceeding to sum up the evidence, we reprint two letters, which tell a story very different from the above.

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* A correspondent, signing himself "Amateur," stated that in the South of London the ground was frozen to a depth of 4 ft. 6 in. As our lowest temperature at 4 ft. was 37°·1, corresponding to nearly 38° at 4 ft. 6 in.. we doubted the statement and wrote for particulars. They are most precise and positive; our correspondent says that it was in digging down to repair a large driving main at Upper Tulse Hill, that the man was positive as to the correctness of the depth, and added that in Lower Tulse Hill the penetration was 3 ft. 5 in. to 3 ft. 7 in.

DEPTH OF WATER MAINS.

To the Editor of the "Standard."

SIR,—About the depth to which water-mains should be laid, I venture to ask space in *The Standard* for the following experiences relating thereto.

The mains of Lord Salisbury's Hatfield and district water supply, which now have been in use for about four years, have a minimum depth from the surface to the tops of the sockets of two feet six inches. But, nothwithstanding this exceptional depth, we have a three-inch main, in which for a short distance, and in an exposed situation, the water became frozen on the 23rd of last month. On opening the ground, this partially frozen main was found to be three feet three inches below the surface of the London road, showing how necessary it is to lay water mains so that the tops of their sockets shall, at least, be two feet six inches in depth.

This partially frozen main would have remained unfrozen but that it has a closed or "plugged" end, and thus the circulation of water through it was, for the greater part of the night, inappreciable.

Owing to the depth to which they were laid, Hatfield and district water mains, extending in town and country to about three miles, remained in a practical sense unaffected by this year's abnormally severe frost, so much so, indeed, that we have not had a burst pipe in any of the mains.

I am, Sir, your obedient servant,

JOHN MILLER.

Hatfield, March 28.

On seeing the above letter we asked the writer to favour us with replies to a few questions, which he kindly did, and they may be thus epitomized.

The water is pumped from a well 300 ft. deep, in which there is generally 150 ft. of water, the usual temperature is 51°, it is pumped into an uncovered reservoir, of which the surface became frozen, and the ice had to be broken to ensure proper pressure in the mains. The pipes are extra thick, and even the frozen one did not burst.

WATER PIPES AND THE FROST.

To the Editor of the "Surrey Advertiser."

SIR,—I have read so many letters in various newspapers on the subject of frozen water mains and consequent stoppage of supply, in some cases for several weeks, that I thought perhaps our experience here would not only interest, but might possibly be of use to some of your readers. This company has nearly eight miles of mains, none of which have been frozen this season, nor has the supply been interrupted for a single day. The mains were laid to a depth of 2ft. to the top of the sockets of the pipes, and in the few parts of the system where it was impracticable to do this, the main was wrapped with

felt or flannel, passed through a larger pipe, and the ends of this made secure. Moreover, during the late severe weather, the valves and hydrants were daily inspected and kept thawed where necessary. To these simple precautions I attribute our immunity from the troubles that appear to have overtaken so many water companies and their customers during the past winter.—I am, &c.,

STEPHEN ROWLAND.

Cranleigh Water Company, Limited, April 22, 1895.

We wrote also to Mr. Rowland, and his reply states :—

The water is derived from very deep seated springs from the Lower Greensand, it leaves the springs at about 50°, and then goes into a covered reservoir, whence it is distributed.

Hence, in both these cases the water was from deep sources ; and though at Hatfield it was allowed to cool so as to freeze on the surface, it is probable that the supply on entering the main was considerably above 32°.

Now we come to the end of the subject. We believe that the key to the contradiction is, not that the frost went down through the soil to the pipes, but that water was forced into the pipes at a temperature within a few degrees of freezing point, that the continued passage of this cold liquid chilled the pipes, and the ground around them, and so the soil between the pipes and the surface was chilled both from above and from below. This, however, of itself, would not turn water into ice—but there are two other facts which we believe completed the disaster. Every shallow service pipe is a metallic (and therefore excellent) conductor of heat and of cold, and every frozen service pipe was not merely useless to its owner, but was carrying cold down to the main. So also with the fire hydrants which swarm in our streets, but are designed rather for the climate of Madras than for that of St. Petersburgh. They are in perfect metallic connection with the mains, they come to the pavement at a temperature of, in many cases, 30° below freezing, and conduct some of that cold down to the mains.

When, as at Sheffield, and other towns, you draw water from a frozen reservoir, or, as at London, you draw it from a river on which we ourselves were walking within sight of the intake of some of the companies, you draw a liquid which may be said to need little more than repose to fly into the solid form. The deep laying of mains will be costly, and will, therefore, have many advocates, but when the pipes have to be filled with ice-cold water, we believe that the conduction of cold by service pipes and by hydrants will not be neutralized by an extra foot of depth.

Happily, on the authority of Messrs. Bayard and Marriott, we hear that there has not been such a frost for 80 years, may it be another 80 before Britons have a like experience.

AN EARLY RECORD OF SEA-SPRAY CARRIED BY A GALE.

To the Editor of the Meteorological Magazine.

SIR,—With reference to the correspondence in the *Met. Mag.* of January, 1895, I venture to send you the following extract from Hone's "Every Day Book," vol. ii. :—

"REMARKABLE STORM."

"The following remarkable letter in the *Gentleman's Magazine* relates to the present day seventy years ago.

'*Wigton, Oct.* 23, 1756.

'MR. URBAN,

'On the 6th inst., at night, happened a most violent hurricane; such a one, perhaps, as has not happened in these parts in the memory of man. It lasted full 4 hours, from about 11 till 3. The damage it has done over the whole country is very deplorable. The corn has suffered prodigiously. Houses were not only unroofed, but in several places overturned by its fury. Stacks of hay and corn were entirely swept away. Trees without number torn up by the roots. Others snapt off in the middle, and scattered in fragments over the neighbouring fields. Some were twisted almost round; bent, or split to the roots, and left in so shattered a condition as cannot be described.

'The change in the herbage was also very surprising; its leaves *withered, shrivelled up, and turned black.* The leaves upon the trees, especially on the weather side, fared in the same manner. The *evergreens* alone seem to have escaped, and the grass recovered in a day or two.

'I agreed, at first, with the general opinion, that this mischief was the effect of *lightning*; but, when I recollected that, in some places, very little had been taken notice of; in others none at all; and that the effect was *general*, I began to think of accounting for it from some other cause. I immediately examined the dew or rain which had been left on the grass, windows, etc., in hopes of being able, by *its taste*, to form some better judgment of the particles with which the air had been impregnated, and I found it as salt as any sea-water I had ever tasted. The several vegetables were also all saltish more or less, and continued so for 5 or 6 days, the saline particles not being then washed off; and when the moisture was exhaled from the windows, the saline christal *sparkled* on the outside, when the sun shined, and appeared very *brilliant*.

'The *salt water*, I conceive, has done the principal damage, for I find upon experiment, that common salt dissolved in fresh water affected some fresh vegetables, when sprinkled upon them, in the very *same manner*, except that it did not turn them quite so black, but particles of sulphurous, or other quality,* may have been mixed with it.

'I should be glad to see the opinions of some of your ingenious correspondents on this wonderful phenomenon—whether they think this water was brought from the sea,† and in what manner.

'Yours,

A. B.'

* 'In an adjoining bleach-yard, some clothes which had lain out all night was turned almost yellow. Other pieces also which were spread out the next morning contracted the same colour, which was not without great difficulty washed out.'

† 'The wind was easterly [?—ED.], and consequently in its passage swept the Irish Sea.'

Yours truly,

FRED. COVENTRY.

Ketton, Stamford, April, 13th, 1893.

Neudrucke von Schriften und Karten ueber Meteorologie und Erdmagnetismus, herausgegeben von PROF. DR. HELLMANN. No. 4. E. HALLEY, W. WHISTON, J. C. WILCKE, A. VON. HUMBOLDT, C. HANSTEEN. Die ältesten Karten der Isogonen, Isoklinen, Isodynamen, 1701—1826. 4to, Assher & Co., Berlin and London, 1895, 25pp., 7 Maps.

The Earliest Isoclinics and Observations of Magnetic Force, by L. A. BAUER [Bull. Phil. Soc., Washington.] 8vo., Washington, 1894. 14 pp.

Beitrage zur Kenntniss des Wesens der Säcular-Variation des Erdmagnetismus von L. A. BAUER. Berlin, 1895, royal 8vo, 56 pp. 2 folding plates.

WE have said so much as to the excellence both in knowledge and in typography of Dr. Hellmann's *Neudrucke* that we need do little more than mention the appearance of No. 4. But we have coupled with it the title of Dr. Bauer's paper read before the Philosophical Society of Washington, because he and Dr. Hellmann each deal with Whiston's pamphlet* and both seem to consider that its "discovery" is something new. We do not agree with this; the standard authority upon Electrical and Magnetical works (until our American friends fulfil their promise and publish the Bibliography of Meteorology), is the Ronald Catalogue; Whiston's book is duly quoted, and is itself in the Ronald library. Merely from catalogues on our own shelves we see that there are copies at the Royal Society, Royal Astronomical Society, University College, and the Institution of Civil Engineers; this, with the one in our own collection, makes six, irrespective of the British Museum and several other libraries in which we expect that it would be found, so that probably

* WHISTON, W., M.A. "The Longitude and Latitude found by the Inclinatory or Dipping Needle; wherein the Laws of Magnetism are also discovered." 8vo., London, 1721.

there are quite a dozen copies in London alone. If Dr. Hellmann is correct (and it will be wonderful if he is not) in saying, "sie in Keinem den Erdmagnetismus behandelnden Werke erwähnt werden," we think that a modification of George Stephenson's celebrated answer respecting the cow and the railway train, would be appropriate: "So much the worse for the —— works on Terrestrial Magnetism." Probably the real explanation is, that hitherto no one has attempted to work up the history of the progress of Magnetic observation; Dr. Hellmann's few pages are excellent as far as they go, and Dr. Bauer's second work shows both ability and interest in the same direction, so perhaps, ere very long, something may be done towards issuing a complete monograph.

ROYAL METEOROLOGICAL SOCIETY.

AT the meeting of this Society, on Wednesday evening, April 17th, which was held at the Surveyors' Institution, Westminster Messrs. F. C. Bayard and W. Marriott communicated a paper on "The Frost of January and February, 1895, over the British Isles," The cold period which commenced on December 30th, and terminated on March 5th, was broken by a week's mild weather from January 14th to 21st, otherwise there would have been continuous frost for 66 days. Temperatures below 10° Fahrenheit, and in some cases below zero, were recorded in parts of England and Scotland between January 8th and 13th, while from the 26th to the 31st, and from February 5th to 20th, temperatures below 10° occurred on every day in some part of the British Isles. The coldest days were February 8th to the 10th. The lowest temperature recorded were—17° at Braemar and—11° at Buxton and Drumlanrig. The mean temperature of the British Isles for January was about 7°, and for February from 11° to 14° below the average, while the mean temperature for the period from January 26th to February 19th was from 14° to 20° below the average. The distribution of atmospheric pressure was almost entirely the reverse of the normal, the barometer being highest in the north and lowest in the south, the result being a continuance of strong, northerly, and easterly winds.

The effect of the cold on the public health was very great, especially on young children and old people. The number of deaths in London due to diseases of the respiratory organs rapidly increased from February 2nd to March 2nd, when the weekly number was 1,448, or 945 above the average. Rivers and lakes were frozen, the ice being more than 10 inches thick.

The frost will long be remembered for its effect on the water-pipes all over the country, in many cases the householders being without water for more than nine weeks. As the result of enquiries the authors find that mains have frozen which have been laid as low as

3 ft. 6 ins. from the surface of the ground to the top of the pipe. It appears, however, that the nature of the soil had far more to do with the depth to which the frost penetrated than the intensity of the frost itself.

From a comparison of previous records, the authors are of opinion that the recent frost was more severe than any since 1814.

Mr. Southall spoke of the similarity of the frost to that of 1814, known in the West of England as the twelve weeks' frost, and said that in that year the snow was over the hedges, and everything was protected by it.

Mr. Leeson Prince said that the mean temp. of February, 1895, was the lowest recorded in any month from 1842 to the present time, but that owing to the height of Crowborough above sea level (774 ft.) the extreme minimum in shade was only 12°·8. At East Grinstead the ice on a pond was 13½ inches thick.

Mr. Percy Bicknell said that at the Skating Club in Regent's Park the members skated for 50 consecutive days. At Swavesey Fen, Cambridgeshire, his son found the ice to be two feet thick.

Mr. Symons referred to the protection afforded by snow, and to the effect of the pressure and motion of the water in mains, on the formation of ice therein.

Mr. C. Harding raised the question of the definition of a great frost—whether it should be reckoned by the period during which the min. was below 32°, or during which the max. did not rise above 32°, &c.; he also quoted various particulars relating to previous frosts. The President, Mr. Jackson, Mr. Dines, and Mr. Tripp also took part in the discussion.

Mr. Birt Acres also read a paper on "Some Hints on Photographing Clouds," illustrated by exceptionally beautiful photographs of clouds.

CLIMATOLOGICAL TABLE FOR THE BRITISH EMPIRE, OCTOBER, 1894.

STATIONS. (*Those in italics are South of the Equator.*)	Absolute.				Average.				Absolute.		TotalRain.		Aver.
	Maximum.		Minimum.										
	Temp.	Date.	Temp	Date.	Max.	Min.	Dew Point.	Humidity.	Max. in Sun.	Min. on Grass.	Depth.	Days.	Cloud.
	°		°		°	°	°	0-100	°	°	inches		
England, London	62·1	2*a*	31·2	17	56·9	45·2	45·8	85	101·9	29·2	4·45	17	7·6
Malta	90·1	19	59·4	15	81·1	67·8	65·3	79	136·9	55·2	1·62	4	4·7
Cape of Good Hope	...	...	...	...	...	...	...	...	...	...	...	...	...
Mauritius	82·3	26	60·3	16	79·0	66·1	61·2	72	133·6	49·9	1·11	14	5·3
Calcutta	88·4	7	65·9	31	85·8	75·4	76·0	87	155·3	60·5	4·41	12	4·5
Bombay	89·4	21	72·3	31	85·6	76·1	75·0	83	142·5	64·8	3·08	13	5·5
Ceylon, Colombo	87·9	12	72·8	...	85·3	75·7	72·6	82	147·2	68·0	20·81	23	7·0
Melbourne	87·1	23	39·3	12	70·1	50·3	51·0	76	143·7	33·9	3·84	17	5·8
Adelaide	91·5	22	43·1	19	72·0	53·0	48·8	64	153·5	36·5	2·97	14	5·9
Sydney	77·9	26	49·7	9	69·9	57·1	56·7	75	146·4	41·7	2·54	23	5·0
Wellington	71·0	28	36·3	6	61·9	49·0	46·3	72	132·0	23·0	·42	7	4·4
Auckland	71·0	22	42·5	4,5	65·6	51·0	51·5	78	138·0	40·0	1·16	10	4·0
Jamaica, Kingston	90·3	31	67·0	25	86·7	71·5	71·6	84	...	...	12·78	14	4·7
Grenada	85·8	11	17·8	5,6	32·8	74·6	72·0	76	157·2	...	10·55	18	4·0
Trinidad	90·0	*b*	68·0	6	87·8	72·1	70·9	79	170·0	66·0	3·92	22	...
Toronto	67·3	3	33·3	15	57·3	43·3	42·0	79	...	27·0	2·35	17	6·6
New Brunswick, Fredericton	61·0	8	25·4	13	54·6	36·3	39·6	79	...	...	4·32	15	6·3
Manitoba, Winnipeg	67·7	15	18·5	30	51·6	30·9	...	...	...	...	1·79	13	6·3
British Columbia, Esquimalt	62·1	15	32·7	18	54·0	41·4	45·6	92	...	...	4·60	19	7·6

a—and 11, 13. *b*—Various.

REMARKS.

MALTA.—Adopted mean temp. (73°·1), 4°·2 above the average. Mean hourly velocity of wind 7·5 miles. Sea temp. averaged 75°·0. Thunderstorms on 1st, 2nd, 12th, and 13th, and lightning on 6 other days. The max. in sun in July was 147°·4 on 12th, not as printed. J. F. DOBSON.

Mauritius.—Mean temp. of air 0°·1, of dew point 0°·5, and rainfall ·62 in. below, their respective averages. Mean hourly velocity of wind 10·5 miles, or 0·9 mile below average; extremes 32·0 on 29th and 2·2 on 28th; prevailing direction, E.S.E. to E. by N. C. MELDRUM, F.R.S.

Adelaide.—Mean temp. 0°·6 above, and rainfall 1·11 in. above, the average of 37 years. Good general rains this month. C. TODD, F.R.S.

Sydney.—Temp. 0°·2 above, humidity 5°·9 above, and rainfall ·40 in. below, their respective averages. H. C. RUSSELL, F.R.S.

Wellington.—Generally fine throughout the month; unusually small rainfall. Prevailing N.W. winds, and strong from that quarter during the middle of the month; also strong from S.W. in the beginning of the month. Mean temp. 1°·8 above the average; rainfall 3·95 in. below, or less than one-tenth of, the average. R. B. GORE.

Auckland.—An unusually fine and dry month, the only rain of consequence falling on the 28th and 31st. Barometric pressure and mean temp. both largely above the average; rainfall very small, and not one-third of the average. T. F. CHEESEMAN.

JAMAICA, KINGSTON.—Mean hourly velocity of wind 3·4 miles. Rains known as "Seasons" general all over the island, the fall being one-third in excess of the average and many stations having twice their average or more. R. JOHNSTONE.

TRINIDAD.—Rainfall 2·75 in. below the 30 years' average. J. H. HART.

SUPPLEMENTARY TABLE OF RAINFALL, APRIL, 1895.

[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.			
II.	Dorking, Abinger Hall.	2·38	XI.	Lake Vyrnwy	2·71
,,	Birchington, Thor	·99	,,	Corwen, Rhug	1·82
,,	Hailsham	2·24	,,	Carnarvon, Cocksidia ...	3·28
,,	Ryde, Thornbrough	2·56	,,	I. of Man, Douglas	2·98
,,	Emsworth, Redlands ...	2·34	XII.	Stoneykirk, Ardwell Ho.	2·12
,,	Alton, Ashdell.....	2·22	,,	New Galloway, Glenlee	3·67
III.	Oxford, Magdalen Col...	1·62	,,	Melrose, Abbey Gate ...	1·01
,,	Banbury, Bloxham	1·75	XIII.	N. Esk Res. [Penicuick]	1 50
,,	Northampton, Sedgebrook	1·37	,,	Edinburgh, Blacket Pl..	1·17
,,	Alconbury	1·04	XIV.	Glasgow, Queen's Park.	1·05
,,	Wisbech, Bank House..	1·59	XV.	Inverary, Newtown	5·03
IV.	Southend	·95	,,	Islay, Gruinart School..	·89
,,	Harlow, Sheering	·84	XVI.	Dollar.....	1·88
,,	Colchester, Lexden.....	·94	,,	Balquhidder, Stronvar..	7·20
,,	Rendlesham Hall	·77	,,	Ballinluig	1·78
,,	Diss	·88	,,	Dalnaspidal H.R.S. ...	4·46
,,	Swaffham	1·54	XVII.	Keith H.R.S.	·97
V.	Salisbury, Alderbury...	2·84	,,	Forres H.R.S.	1·38
,,	Bishop's Cannings	2·60	XVIII.	Fearn, Lower Pitkerrie.	...
,,	Blandford, Whatcombe.	2·95	,,	Loch Shiel, Glenaladale	6·22
,,	Ashburton, Holne Vic....	2·99	,,	N. Uist. Loch Maddy ...	3·96
,,	Okehampton, Oaklands.	2·53	,,	Invergarry	3·64
,,	Hartland Abbey	2·10	,,	Aviemore H.R.S.	1·69
,,	Lynmouth, Glenthorne.	1·87	,,	Loch Ness, Drumnadrochit	2·37
,,	Probus, Lamellyn	2·04	XIX.	Invershin	1·68
,,	Wellington, Sunnyside..	2·19	,,	Scourie	2·90
,,	Wincanton, Stowell Rec.	2·63	,,	Watten H.R.S.	1·96
VI.	Clifton, Pembroke Road	2·63	XX.	Dunmanway, Coolkelure	5·66
,,	Ross, The Graig	2·60	,,	Fermoy, Gas Works ...	2·78
,,	Wem, Clive Vicarage ...	1·81	,,	Killarney, Woodlawn ...	3·24
,,	Cheadle, The Heath Ho.	2·23	,,	Caher, Duneske	2·03
,,	Worcester, Diglis Lock	1·82	,,	Ballingarry, Hazelfort...	1·75
,,	Coventry, Coundon	2·16	,,	Limerick, Kilcornan ...	1·54
VII.	Ketton Hall [Stamford]	1·26	,,	Ennis.....	3·23
,,	Grantham, Stainby	1·87	,,	Miltown Malbay.....	2·58
,,	Horncastle, Bucknall ...	1·38	XXI.	Gorey, Courtown House	2·12
,,	Worksop, Hodsck Priory	2·18	,,	Athlone, Twyford	1·82
VIII.	Neston, Hinderton	1·78	,,	Mullingar, Belvedere ...	1·45
,,	Preston, Haighton	...	,,	Longford, Currygrane...	1·69
,,	Broughton-in-Furness..	3·47	XXII.	Woodlawn.....	1·35
IX.	Ripon, Mickley	2·22	,,	Crossmolina, Enniscoe..	2·09
,,	Melmerby, Baldersby ...	1·63	,,	Collooney, Markree Obs.	2·54
,,	Scarborough, South Cliff	...	,,	Ballinamore, Lawderdale	...
,,	Middleton, Mickleton..	1·16	XXIII.	Lough Sheelin, Arley ..	1·71
X.	Haltwhistle, Unthank..	1·55	,,	Warrenpoint	3·91
,,	Bamburgh.....	·93	,,	Seaforde	2·61
,,	Keswick, The Beeches...	2·81	,,	Belfast, Springfield	2·18
XI.	Llanfrechfa Grange	3·00	,,	Bushmills, Dundarave...	1·28
,,	Llandovery	2·11	,,	Stewartstown	1·64
,,	Castle Malgwyn	4·16	,,	Buncrana	1·70
,,	Builth, Abergwessin Vic.	3·68	,,	LoughSwilly, Carrablagh	1·71
,,	Rhayader, Nantgwillt..	3·21			

APRIL, 1895.

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	Greatest Fall in 24 hours. Date	Days on which ·01 or more fell.	TEMPERATURE. Max. Deg.	Max. Date	Min. Deg.	Min. Date.	No. of Night below 32°. In shade.	No. of Night below 32°. On grass.
			inches.	inches.	in.								
I.	ENGLAND.	London (Camden Square) ...	1·34	— ·40	·61	25	13	67·1	29	29·1	1	1	8
II.		Maidstone (Hunton Court)...	1·21	— ·44	·45	25	13	...	...	...	...	...	...
,,		Strathfield Turgiss	1·71	+ ·11	·61	24	9	65·5	19	26·4	1	3	8
III.		Hitchin	1·08	— ·71	·48	25	13	63·0	11*b*	28·0	13*i*	4	...
,,		Winslow (Addington)	1·45	— ·47	·56	25	12	63·0	6 dys	28·0	1	6	9
IV.		Bury St. Edmunds (Westley)	1·33	— ·33	·64	25	9	64·0	17	30·0	15	2	...
,,		Norwich (Brundall)	1·20	...	·18	1*a*	11	65·8	20	29·0	5	2	10
V.		Weymouth(LangtonHerring)	2·36	+ ·48	·88	24	13	61·0	17*c*	33·0	1, 14	0	...
,,		Torquay (Cary Green)	2·43	...	·70	22	13	60·3	10	33·6	1	0	4
,,		Polapit Tamar [Launceston]..	2·42	+ ·20	·45	22	16	62·5	17	29·0	13	2	6
VI.		Stroud (Upfield)	2·99	+ ·84	·68	24	14	64·0	17*d*	34·0	12	0	...
,,		ChurchStretton(Woolstaston)	2·24	— ·10	·93	25	17	69·0	30	28·0	5	6	10
,,		Tenbury (Orleton)	2·14	+ ·06	·51	25	14	62·7	21	28·0	5	6	9
VII.		Leicester (Barkby)	1·72	— ·38	·47	25	13	67·0	29	25·0	12*i*	11	19
,,		Boston	1·49	— ·22	·56	25	10	70·0	28	29·0	13	2	...
,,		Hesley Hall [Tickhill].....	1·66	— ·05	·57	25	10	66·0	21	29·0	5*k*	5	...
VIII.		Manchester(PlymouthGrove)	1 36	— ·35	·50	25	10	65·0	30	29·0	4,7	4	7
IX.		Wetherby (Ribston Hall) ..	1·20	— ·65	·56	26	5	...	...	...	...	...	...
,,		Skipton (Arncliffe)	3·41	— ·02	·99	22	12	...	...	...	...	...	...
,,		Hull (PearsonPark)	1·19	— ·73	·30	22	12	65·0	20*f*	28·0	8	8	10
X.		Newcastle (Town Moor)	1·31	— ·52	71	25	11	...	...	...	...	...	...
,,		Borrowdale (Seathwaite).....	8·30	+ 1·16	2·61	5	15	...	...	...	...	...	...
XI.	WALES.	Cardiff (Ely).....	2·32	— ·09	·42	22	14	..	...	...	...	...	...
,,		Haverfordwest	3·69	+ 1·06	1·07	22	16	64·0	17	26·0	5	2	11
,,		Aberystwith (Gogerddan) ...	2·45	— ·11	·77	26	8	68·0	17	20·0	4	11	...
,,		Llandudno.....	2·39	+ ·58	1 08	25	15	63·8	20	32·4	5	0	...
XII.	SCOTLAND.	Cargen [Dumfries]	2·47	+ ·24	·76	22	10	62·4	17	27·0	5	6	...
,,		Jedburgh (Sunnyside).....	1·52	— ·18	·47	25	11	63·0	30	26·0	14	6	...
XIV.		Colmonell	2·89	...	·84	25	10	65·0	15	27·0	4, 13	8	...
XV.		Lochgilphead (Kilmory)	3·24	+ ·43	·65	5	17	...	...	23·0	6	10	...
,,		Mull (Quinish).....	2·96	— ·02	·87	6	15	...	...	...	...	...	...
XVI.		Loch Leven Sluices	1·80	— ·42	·40	23	9	...	...	...	...	...	...
,,		Dundee (Eastern Necropolis)	1·15	— ·90	·25	25	12	63·1	22	27·4	4	7	...
XVII.		Braemar	1·34	— 1·08	·36	25	15	59·0	18	25 0	4	14	19
,,		Aberdeen (Cranford)	1·37	...	·29	25	15	57·0	21*g*	29·0	15	5	...
XVIII		Strathconan [Beauly]	3·01	+ ·20	·70	26	7	...	...	...	...	...	...
,,		Glencarron Lodge.....	5 89	...	1·40	5	23	66 0	18	26·5	7	7	...
,,		Cawdor [Nairn]	1·74	+ ·22	·88	26	12	...	...	..	...	..	...
XIX.		Dunrobin	1·62	— ·11	·29	26	13	61·0	23	32·0	3	1	...
,,		S. Ronaldsay (Roeberry).....	2·80	+ 1·19	·71	5	17	...	...	29·0	3	2	...
XX.	IRELAND.	Darrynane Abbey.....	2 78	...	·38	22	18	...	...	...	...	...	...
,,		Waterford (Brook Lodge) ...	2·46	— ·01	·81	22	12	59·0	18	29·0	3	4	...
,,		O'Briensbridge (Ross)	1·62	...	·38	5	16	..	...	...	...	...	...
XXI.		Carlow (Browne's Hill)	1·87	— ·41	·41	22	15	...	..	...	...	...	...
,,		Dublin (FitzWilliam Square)	1·15	— ·97	·25	26	13	64 0	21	32·9	4	0	5
XXII.		Ballinasloe	1·19	— 1·15	·19	20	15	61·0	21	29 0	2	7	...
,,		Clifden (Kylemore)	6·53	...	1·62	20	21	...	...	...	...	..	...
XXIII		Waringstown	1·70	— ·72	·30	29	19	67·0	22	28·0	1,5	7	12
,,		Londonderry (Creggan Res.)	2·04	— ·20	·52	23	19	...	...	...	...	...	...
,,		Omagh (Edenfel)	2·04	— ·19	·27	18	17	60·0	15*h*	33 0	1, 27	0	10

a And 19, 26. *b* And 20. *c* And 19. *d* And 23. *e* And 29. *f* And 21. *g* And 25. *h* And 16. *i* And 14. *k* And 12, 13, 15.

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

METEOROLOGICAL NOTES ON APRIL, 1895.

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.—The first part of the month was cold and rough; from the 7th to the 21st the weather was beautifully fine and dry, but with cold winds; the month closed with showery unsettled weather. The nesting of the birds singularly late. Horse chestnut in leaf on 17th. Blackthorn in flower on 20th.

ADDINGTON.—A rather sharp frost on the 1st, followed by a few days of low max. temp. and slight frosts from the 13th to the 15th. Altogether a favourable month. Distant thunder on 17th and 27th. Plum trees in full blossom at the end, quite a fortnight later than last year. Summer visitors rather early. Swallows seen on the 10th, cuckoo on the 17th, and nightingale on the 25th.

BURY ST. EDMUNDS, WESTLEY.—A fine month, with frost only on the 5th and 15th. Foreign birds arrived at the usual time. Vegetation as forward as the average. Swallow seen on 11th, Cuckoo on 12th, and Nightingale on the 14th. Thunder on 17th and 25th.

NORWICH, BRUNDALL.—A fine growing month; mean temp. 47°·3. Cold and bleak from 1st to 7th; dry and warm from 8th to 12th; warm, with R at times, from 19th to 27th.

LANGTON HERRING.—The weather was fine from the beginning of the month to the 16th, but unsettled from the 17th to the end. L on the 17th. Mean temp. at 9 a.m. 47°·5, 0°·2 above the average. Fogs were frequent, those on the 8th, 9th, and 30th being thick. Cuckoo heard on the 10th. Blackthorn in blossom on the 16th. Foliage of trees four weeks later than the average.

TORQUAY, CARY GREEN.—Rainfall ·26 in. below the average. Mean temp. 47°·8, or 1°·3 above the average. Duration of sunshine 167 hours, being 23 hours below the average; two sunless days.

POLAPIT TAMAR.—The month was rather wetter on the whole than usual. The first three weeks were dry and very favourable for agricultural work; the last ten days very wet.

STROUD, UPFIELD.—Slight TS from S.E. from 6 p.m. to 7 p.m. on 17th; T all the afternoon, and sheet L at night.

WOOLSTASTON.—The first half of the month was cold and backward, with sharp frosts on the ground on most nights. The latter part was warmer and more genial. The first swallow was seen on the 16th; the Cuckoo heard on the 18th. Mean temp. of the month 47°·3. H on the 1st.

TENBURY, ORLETON.—The first half of the month was very dry, but from the 16th to the end there was R nearly every day. The temp. of the month was about the average of 34 years. T on the 17th, 18th and 24th; L on 17th; cuckoo heard on the 12th, a week earlier than usual. Damson, cherry and plum trees in full blossom on the 30th. Sharp frosts on 5 days.

LEICESTER, BARKBY.—Some fine days, but often chilly, and even chillier nights in proportion. First swallow seen on the 9th, first cuckoo on the 19th. T on 1st. Meam temp. 46°·9.

MANCHESTER, PLYMOUTH GROVE.—A very fine month upon the whole. Summer weather from 9th to 17th, and generally fine to the end. Mean temp. 47°·8.

WALES.

HAVERFORDWEST.—Excepting the 17th, there really was not one day of warm shade-temp. in April. The temp. was about the average and the weather showery in the first week. Fine bright weather with north-easterly wind and keen ground frosts set in on the 11th, lasting to the 16th, when the conditions

gradually altered, the air became much milder, the wind southerly, and the weather fine but damp. The wind reached the force of a gale on the 21st, and R fell in large quantities up to the 27th; temp. again decreased, and the month ended cold but fine. Horse chestnuts in leaf on the 17th, currants and gooseberries also in about the same stage of advancement; blackthorn in blossom only on 27th, and not generally even then. Oak swelling, but ash making no sign. Grass lands looking remarkably well, and general appearance of the country promising. Cuckoo heard on 11th, and swallow seen on the 14th.

GOGERDDAN.—Dry and cold with N.E. winds during the first half of the month; the last fortnight showery, with wind S.W.

SCOTLAND.

CARGEN.—The chief characteristic of the month is the low sunshine record—only 121 hours; 46 hours less than the average for April during 36 years. The continuance of southerly winds for 8 days (18th to 25th) is quite exceptional, while east winds were much less prevalent than usual. The favourable winds, combined with a slight increase in the rainfall, and a more equable day and night temp. than usual, had a very marked effect on vegetation during the latter portion of the month, and pasture and corn crops more than made up their leeway occasioned by the unfavourable character of February and March. On the 9th the ground was still frozen 9 inches below the surface. T and L on 24th, and T on 25th.

JEDBURGH.—During the first two weeks the weather was cold, but towards the end, particularly the last ten days, it became much milder, and vegetation advanced rapidly. Most of the cereals were sown in good condition. Swallow seen on 23rd, cuckoo heard on 25th.

COLMONELL.—Rainfall ·59 in. above the average of 19 years.

ROEBERRY.—A wet, cold month. Mean temp. 44°·4.

IRELAND.

DARRYNANE ABBEY.—The first week was rather cold; the middle of the month fine and warm. The second half was unsettled, but mild, and vegetation made much progress.

WATERFORD, BROOK LODGE.—Swallows about the house on the 19th; Cuckoo heard on 25th, and Corncrake on 26th.

O'BRIENSBRIDGE, ROSS.—Moderate rain and rather low temp. up to the 20th. All vegetation three weeks later than the average, and fully a month later than in April, 1894

DUBLIN.—Speaking generally, April, 1895, was a favourable and an average month. The wind was singularly variable, blowing from all points of the compass in nearly equal proportion. The mean temp. (48°·1) was 0°·4 above the average. High winds were noted on nine days. Sleet and H fell on 1st, and H on 11th. The temp. exceeded 50° in the screen on every day except six. Aurora borealis on the 11th.

WARINGSTOWN.—Everything fully a month late.

EDENFEL.—On the whole a favourable and seasonable month, sufficiently fine in the early part for the prosecution of farm labour, and rainy in the latter half for purposes of vegetation. No appreciable frost.