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A SOLAR RADIATION ENIGMA.

To the Editor of the Meteorological Magazine.

SIR,—I have often been much surprised by the large amounts of “solar radiation” obtained, even by the comparison of the black bulb thermometer “*in vacuo*” at 4ft. with the ordinary shade temperature at the same height, it being not at all uncommon to have so much as 70° of so-called “solar radiation.” I have myself had the same result with Casella’s thermometers. I have accordingly for some time been thinking that if we wish to ascertain the true amount of radiation, we are scarcely right in comparing, in a direct manner, the “vacuum thermometer” in the sun with the ordinary shade instrument. The former is most sensitive and peculiar in its action, not under at all the same conditions as the latter, being besides protected from rain, moisture, wind, &c., to some extent, and also having a thick coating of lamp-black over its bulb and part of the stem, and appears to be remarkably affected by diffused or radiated light.

Why not compare the black bulb “*in vacuo*,” in the sun, with the black bulb thermometer “*in vacuo*” in the shade? We should then have to start with two thermometers more under the same conditions, and at any rate reduce the amount of “radiation” by this method, as will be seen from the following experiments, which I have just begun. The thermometers used are first-class instruments by Pastorelli. The vacuum instruments are both blackened on the bulbs and one inch of the stems, and have been compared together in shade and sun. They are placed with the bulbs facing the S.E., mounted on posts as shown in *Meteorological Magazine*, Vol. IV., p. 97, fig. 2. Both the solar and shade thermometers are fixed at 4 ft. above the ground, in a clear open space, and in close proximity to one another. The stand used has the double sloping back, in the same manner as the “Glaisher” stand, but does not rotate, and is constructed with sides or “wings.”

It is certainly very surprising to note the wonderful excess of the readings of Casella’s thermometer in sun over Pastorelli’s. The difference in the amounts of “solar radiation” given by the two thermometers “*in vacuo*” ($A + D$), as compared with the ordinary method ($A + C$), is very considerable. I have also given the wind, force and direction,

as bearing on the question. To take an example of the high readings:—On the 12th August Pastorelli's thermometer was $123^{\circ}\cdot 8$, and on the same day Casella's was $140^{\circ}\cdot 7$! Now, as the sun temperature consists of the shade temperature + the amount of solar radiation, the $123^{\circ}\cdot 8$ is made up thus: $85^{\circ}\cdot 2$ vacuum temperature, + $38^{\circ}\cdot 6$ solar radiation = $123^{\circ}\cdot 8$. But comparing the ordinary shade temperature with the vacuum shade, it will be seen that from the nature of the thermometer used, the vacuum temperature is too high by 9 degrees. Therefore, $85^{\circ}\cdot 2 + 38^{\circ}\cdot 6 - 9^{\circ} = 114^{\circ}\cdot 8$ appears to be the sun temperature, and which is certainly rather a different result to $140^{\circ}\cdot 7$, as obtained by Casella's thermometer in the ordinary mode.

Yours very truly,
 FRANCIS NUNES, M.A., F.M.S.
Heathfield Lodge, Chislehurst, Kent, Sept. 1st, 1870.

P.S.—This may be further illustrated by the mean values, which give the following results, viz.:—Pastorelli $109^{\circ}\cdot 4$, Casella, $124^{\circ}\cdot 8$; the $109^{\circ}\cdot 4$ is $77^{\circ}\cdot 7 + 31^{\circ}\cdot 7$, but the vacuum is too high by $8^{\circ}\cdot 5$; therefore $77^{\circ}\cdot 7 + 31^{\circ}\cdot 7 - 8^{\circ}\cdot 5 = 100^{\circ}\cdot 9$, against $124^{\circ}\cdot 8$.

All thermometers 4 ft. above ground.

Reference Letters...	Max. in sun.		Max. in shade		Wind during day.		Rain.
	Blackened Bulb <i>in vacuo.</i>		Pastorelli's.		Direction.	Force 0-12	
	Pastorelli. A	Casella. B	Ordinary max. ther. C	Blk. Bulb <i>in vacuo.</i> D			
1870.	deg.	deg.	deg.	deg.			in.
Aug. 7 ...	87·2	92·5	66·8	74·5	S.	—	0·26
„ 8 ...	110·4	127·0	72·6	83·5	E.N.E.	6	0·02
„ 9 ...	122·8	140·0	76·5	85·7	N.E.	2	0·03
„ 10 ...	114·8	130·0	72·0	78·5	N., N.N.E.	4	0·09
„ 11 ...	116·2	133·0	73·2	82·5	N., N.E.	5	
„ 12 ...	123·8	140·7	76·2	85·2	N., E.N.E.	4	
„ 13 ...	115·2	132·5	73·6	82·5	N.E.	4	
„ 14 ..	116·2	135·0	68·2	76·5	N.E.	3	
„ 15 ...	107·0	120·3	69·8	77·7	N.E.	3	
„ 16 ...	108·0	119·0	68·7	76·7	N.E.	3	
„ 17 ...	113·8	129·0	69·3	77·1	E., N.E.	3	
„ 18 ...	115·1	130·2	77·0	85·2	S.W., N.W.	3	0·01
„ 19 ...	108·5	123·5	64·8	73·8	N.N.E., N.	3	
„ 20 ...	107·0	123·5	67·0	75·3	N.N.W.	3	
„ 21 ...	103·8	119·0	64·2	72·2	N.E., N.W.	3	
„ 22 ...	106·2	120·0	67·8	77·7	S.W.	5	0·71
„ 23 ...	102·5	117·0	65·2	74·5	N.W.	3	0·02
„ 24 ...	112·0	130·0	69·2	79·8	W.N.W.	4	
„ 25 ...	104·8	120·0	66·7	75·0	N.W.	4	
„ 26 ..	102·0	117·0	63·0	70·5	N.W.	5	
„ 27 ...	109·0	123·0	70·7	79·4	W.N.W.	2	0·51
„ 28 ...	111·8	127·2	71·0	78·5	S.W., W.	6	0·17
„ 29 ...	105·7	123·8	64·5	72·5	N.N.W.	5	
„ 30 ...	104·2	120·5	64·0	71·8	N.N.W.	4	
„ 31 ..	108·4	126·0	68·8	77·2	S., W.	3	
Mean.....	109·4	124·8	69·2	77·7	...	..

Reference Letters	Solar Radiation.			Differences.	
	A + C	A + D	B + C	In Sun. B + A	In Shade. D + C
1870.	deg.	deg.	deg.	deg.	deg.
August 7... ..	20·4	12·7	25·7	5·3	7·7
„ 8.....	37·8	26·9	51·4	16·6	10·9
„ 9.....	46·3	37·1	63·5	17·2	9·2
„ 10.....	42·8	36·3	58·0	15·2	6·5
„ 11.....	43·0	33·7	59·8	16·8	9·3
„ 12.....	47·6	38·6	64·5	16·9	9·0
„ 13.....	41·6	32·7	58·9	17·0	8·9
„ 14.....	48·0	39·7	66·8	18·8	8·3
„ 15.....	37·2	29·3	50·5	13·3	7·9
„ 16.....	39·3	31·3	50·3	11·0	8·0
„ 17.....	44·5	36·7	59·7	15·2	7·8
„ 18.....	38·1	29·9	53·2	15·1	8·2
„ 19.....	43·7	34·7	58·7	15·0	9·0
„ 20.....	40·0	31·7	56·5	16·5	8·3
„ 21... ..	39·6	31·6	54·8	15·2	8·0
„ 22.....	38·4	28·5	52·2	13·8	9·9
„ 23.....	37·3	28·0	51·8	14·5	9·3
„ 24.....	42·8	32·2	60·8	18·0	10·6
„ 25.....	38·1	29·8	53·3	15·2	8·3
„ 26.....	39·0	31·5	54·0	15·0	7·5
„ 27.....	38·3	29·6	52·3	14·0	8·7
„ 28.....	40·8	33·3	56·2	15·4	7·5
„ 29.....	41·2	33·2	59·3	18·1	8·0
„ 30... ..	40·2	32·4	56·5	16·3	7·8
„ 31.....	39·6	31·2	57·2	17·6	8·4
Mean	40·2	31·7	55·6	15·4	8·5

[Solar radiation temperatures have long been a source of trouble to meteorologists, and we had only just soothed ourselves with the idea that Mr. Stow had solved all difficulties, and that for the future comparable results were readily obtainable, when we received the above letter from Mr. Nunes. Rude as has been the shock to our mental complacency, we rejoice that it has come thus early in the history of "Comparable Solar Radiation," and we are all indebted to Mr. Nunes for pointing out the remarkable discordances. The letter naturally resolves itself into two parts: (1) The true temperature in the sun; (2) The true shade temperature wherewith to compare it.

Startling as it is to find ourselves again adrift, when we had considered that we were sailing safely under Mr. Stow's pilotage, the only thing now to be done is thoroughly to examine all possible causes of the discordances. First, as to the cause of the enormous mean difference of 15°·4 between the thermometers A and B, both of which are by good makers, which agree when placed in the shade, both of which are dull blackened on the bulb and up the stem. We can only see one point in which they can differ, and it is one on which we are not aware that any experiments have been published—*they may be exhausted to a different extent.* To test this point, we have prevailed on

Mr. Nunes to add to his present staff of thermometers three others, containing different quantities of air—one, of which the exhaustion is as perfect as possible, one, which is partially exhausted, and one, which is not exhausted at all, but in which the air is chemically dried. We regret the necessity for even this precaution, but fear that otherwise the interior of the jacket would frequently be dimmed by condensed vapour. There is evidently a very serious error somewhere, and we trust that it may soon be discovered. Mr. Nunes is evidently suspicious of temperatures in sun above 130° , and yet he lives far from London smoke and nearly 300 ft. above the sea. What will Mr. Stow say to that? We know that Negretti's and Casella's thermometers agree, and now it seems that Pastorelli's are 15° below them; truly this wants looking into.

With the second part of Mr. Nunes' letter we do not quite concur. We consider that the excess of $(D + c)$ the vacuum thermometer in shade over the ordinary thermometer alongside of it, simply proves that the ordinary thermometer stand does not produce perfect shade, and therefore that it virtually resolves itself into a test (and a very good one) of the efficacy of thermometer stands, with which object we shall endeavour to apply it to the experimental ones at Strathfield Turgiss.—Ed.]

THERMOMETER STANDS.

To the Editor of the Meteorological Magazine.

SIR,—In your monthly number for April, 1869, you led your readers to expect information of a high value from the arrangements reported as made for an impartial trial at Strathfield Turgiss, of the various forms of thermometer stands in ordinary use. May I ask you when the observations are likely to come under discussion? If the result should lead to a gradual adoption of an uniform stand, a great service will have been rendered by Mr. Griffith, for observations at different places will then be strictly comparable, which they are not now.

The form of stand I have had in use, abroad and here, for the last six years, is Stevenson's. The comparison of the readings in that stand with those taken in a Glaisher stand at the Royal Observatory, and published in Mr. Glaisher's Quarterly Reports, shows this curious result: that, in the winter months, the mean of the maxima in Stevenson's stand are fractionally *above* those in Glaisher's stand, the mean monthly variation being $0^{\circ}5$ to 1° , whilst in the summer months, the mean of the readings in Stevenson's *below* Glaisher's is from 2° to $2^{\circ}5$, and the absolute maximum registered at Greenwich in the months of June and July usually exceeds that in my stand by from 3° to 4° .

I think it highly probable that the readings at both places would far more nearly approximate if the observations were taken under similar conditions.—Your obedient servant,

D. A. FREEMAN.

Upper Tooting, S. W., 22nd August, 1870.

[We are obliged to Mr. Freeman for recalling attention to this very

important subject. A series of observations, accurate and extensive beyond precedent, were made by Mr. Griffith during part of 1868, the whole of 1869, and part of 1870. They were then discontinued, and the observations (about 50,000) are now being discussed by Mr. Gaster. A "Glaisher" and a "Stevenson" stand were at work within 20 ft. of each other, and from a cursory remembrance of the records we think the differences were very similar to those quoted by Mr. Freeman as subsisting between his and the Greenwich records. But we must wait for Mr. Gaster's analysis before deciding *which* of the two stands, or whether either of them, is correct. As Mr. Gaster has only limited time available for the purpose, we cannot unduly press him, but we can assure our readers that the results shall be laid before them at the earliest possible date.—Ed.]

SEA TEMPERATURES AT BOURNEMOUTH.

To the Editor of the Meteorological Magazine.

SIR,—As no resident member of the Bournemouth Meteorological Society has hitherto replied to your criticisms in the February number of the *Meteorological Magazine*, wherein you ask for explanations as to the "Mean" Sea Temperatures, as published by that Society in its Report for 1868, perhaps you will allow me to say that the "mean" for the month was deduced from one daily observation, made between noon and 1 p.m. The observation was taken by letting down a thermometer from the end of the pier, which extends about 150 yards or thereabouts, beyond ordinary low-water mark. The depth of the water at this hour of the day is probably never less than twelve feet, and the thermometer was let down about 8 or 9 feet below the surface. There can be no doubt that the observations fairly represent the temperature of the "briny" in which the bathers had to "dip."

Although the mean temperature of noon for July, 1868, reached the enormous height of $70^{\circ}1$, it is only what was to be expected from the law which is exhibited in the other months. The excess of the sea temperature over the air temperature in the first six months of the year was $5^{\circ}2$, $3^{\circ}2$, $4^{\circ}5$, $4^{\circ}7$, $4^{\circ}5$, and $4^{\circ}1$ respectively. In the famous hot July of 1868, the difference was $4^{\circ}3$.

That this difference is not solely due to solar heat, is proved by the enormous divergence of $10^{\circ}1$ in October and November; and I think that this phenomenon is worthy of more than passing notice, partly as indicating one of the causes of the prolonged high mean temperature of November and December along the south coast district; partly also in this particular instance, as being a precursor of the unprecedented mildness of December, 1868, to February, 1869.—Yours, &c.,

P. H. NEWNHAM.

[We gladly insert the above note on our criticism; having no object but the ascertainment of truth, we gladly hail any contribution to it. At the same time we retain our personal repugnance to "a dip in the briny at $70^{\circ}1$," and should certainly prefer some locality where the temperature is lower. In February we urged the desirability of further observations; Mr. Newnham's letter seems to us to demonstrate it.—Ed.]

THREE WATERSPOUTS.

To the Editor of the Meteorological Magazine.

SIR,—A gentleman sent me the following description of a curious waterspout which appeared about this locality on the 7th. I beg to forward it to you, to give it a place in your magazine, if you think it sufficiently important.—Yours obediently,

D. O'DOWD.

Doo Castle, co. Sligo, 16th August, 1870.

[Although quaintly written, it is so evidently a faithful account of what the writer saw, and it seems so certain that he did not know enough of the subject to manufacture his description, that we think it worthy of insertion *literatim et verbatim*.—ED.]

“On Sunday evening, the 7th inst., about 7 p.m., in a very still and warm atmosphere; the upper currents excitably attracted towards the north (say, seaside of Knockmarea Mountain, co. Sligo), where two ordinary-looking waterspouts appeared fully engaged with rain thereabouts; a third and to my mind a very unusual sort of spout appeared here the eastern part of Doo Castle, co. of Mayo, about fifteen miles from the others. Its base was in a murky brown, angry-looking cloud, and immediately as it appeared it tossed about like the trunk of a huge elephant, even to the lip and nostril; it then let down a few feet of a small inner tube, which rapidly increased in circumference, when the whole spout began to twist and coil in oblique circles. The whirling of the air in the small tube appeared distinctly and disported itself on the northern side in a chaos of roll, when it again elongated itself by several feet in the same way. As this was four times repeated, each extension being longer, and the cloud not much over 100 feet from the earth, I expected to see some more wonderful phenomenon, but the upper currents moved more rapidly towards the north, where the other two spouts were, and induced our very gorgeous visitor to return in nubibus, after enjoying its freaks, which it did with imposing majesty, and increased tossing in the same order, it descended, and all the smaller coils played or retreated entirely on the opposite or east side of the trunk. There was no water in the locality of this air-borne wonder, its like never having been noticed in this region before. Some stray showers of rain fell very unevenly about an hour after.”

OZONE PAPERS.

To the Editor of the Meteorological Magazine.

SIR,—I take the liberty of troubling you with my experience of ozone test papers. At the end of May last I purchased a box of the papers from Messrs. Negretti and Zambra, and began to test for ozone for the first time. I placed the papers on a hook under my thermometer stand, and read three times daily. I send herewith my results for July. The figures in the “day” column are derived from papers exposed from 9 a.m. to 9 p.m. The “night” column is derived from papers exposed from 9 p.m. to 9 a.m., and the “24 h.” column from papers exposed from 9 a.m. to 9 a.m. of the following day. On refer-

ence to the table it will be seen that the mean of the readings for the 24 hours is *less* than that of the "day" hours. This result I was not prepared for, and am totally at a loss to explain. On several occasions, as a glance at the table will show, the paper which was coloured to the extent of say No. 5 of the scale, as on July 10 in the evening, *lost* its colour during the night, and was as colourless at the end of the 24 hours as when first placed on the hook. My experience, short as it is, has convinced me that papers exposed longer than 12 hours are not to be depended upon, and I now read twice daily only.

Your obedient servant,

JOHN THRUSTANS, F.M.S.

Wolverhampton, August, 1870.

1870.	Day.	Night.	24 hours.	Wind.
July 1	9	9	10	N. W.
" 2.....	7	7	8	"
" 3.....	6	0	0	"
" 4.....	3	6	7	S. W.
" 5.....	0	6	8	"
" 6.....	4	2	3	W.
" 7.....	4	1	1	S. W.
" 8	3	0	0	"
" 9.....	3	5	6	Calm.
" 10.....	5	0	0	W.
" 11.....	6	5	6	N. E.
" 12.. ...	6	0	1	N. W.
" 13.....	4	5	7	"
" 14.....	6	0	3	S. W.
" 15.....	4	4	4	"
" 16.....	6	7	10	W.
" 17.....	5	1	2	"
" 18.....	0	0	0	S.
" 19.....	3	1	3	S. W.
" 20. ...	4	0	0	W.
" 21.....	3	2	2	N. W.
" 22.....	4	0	0	} Easterly.
" 23.....	2	0	0	
" 24.....	2	0	0	
" 25.....	1	7	9	
" 26.....	3	0	0	
" 27... ..	4	8	8	
" 28.....	8	1	3	
" 29.....	4	7	7	
" 30.....	4	9	9	
" 31.....	5	8	7	
Total.....	128	101	124	...
Mean.....	4.13	=3.26	=4.00	...

HERTFORDSHIRE RAINFALL IN JUNE AND JULY, 1870.

To the Editor of the Meteorological Magazine.

SIR,—During the months of June and July last the few storms which visited this part of England were of so partial a nature as to

make them quite remarkable. Black clouds would gather, distant thunder roll around, but no rain would fall on the thirsty ground, and the common remark was, "A storm somewhere but not here."

In order to find out where in this neighbourhood these storms fell, I wrote to different persons in and near this county, and with the information they so kindly gave me, I have drawn up the following table:—

Date.	Hoddesdon.	Hertford.	Great Hadham.	Buntingford.	Stevenage.	Hemel Hempstead.	Gt. Berkhamstead.	St. Albans.	Dunstable.	Hitchin.	Potters' Bar.	Dunmow.	Enfield.
June 1.....	·05	·09	...	...	...	·15	·17	·26	...	...	...	..	·22
" 2.....	...	...	...	...	...	...	...	...	·02	...	...	...	...
" 4.....	...	...	...	...	...	...	·01	...	...	...	...	...	...
" 11.....	...	...	·07	·05	·05	...	...	...	...	·03	...	·09	...
" 12.....	...	...	...	...	...	·01	·03	...	...	...	...	...	...
" 16.....	·30	·66	·42	·98	·48	·40	·47	·62	·12	·57	·53	·16	·33
" 17.....	...	...	...	·38	·17	·02	...	...	...	·17	...	·11	...
" 18.....	...	...	...	...	...	...	·02	...	...	...	...	...	...
" 23.....	...	...	·03	...	...	...	...	...	·20	...	·13	...	...
" 24.....	·05	...	...	·05	·02	·22	·16	·27	...	·01	...	·10	...
" 27.....	...	...	...	·02	...	...	·03	...	...	·01	...	...	...
" 30.....	...	...	...	...	...	...	...	...	...	...	...	·03	...
Total	·40	·75	·52	1·48	·72	·80	·89	1·15	·34	·79	·66	·49	·55
July 1.....	·10	·04	·02	...	·09	·05	·06	·02	·14	·12	...	..	...
" 3.....	·20	·17	·25	·37	·18	·04	...	·06	·11	·15	·12	·40	·07
" 4.....	...	...	·01	...	...	·03	·10	...	...	·02	·05	...	...
" 5.....	·10	·11	·24	·26	·25	·18	·24	·25	...	·26	·11	·17	·17
" 6.....	...	...	...	...	·01	...	...	...	·29	...	...	...	...
" 8.....	...	...	...	...	·01	...	·02	...	·02	...	...	...	...
" 9.....	...	...	·05	...	·43	·07	·09	·21	·26	·52	·09	...	·02
" 10.....	...	...	...	·13	...	...	...	...	...	...	·01	...	...
" 11.....	·30	...	·52	1·18	·03	...	...	·09	...	·01	...	...	·07
" 12.....	...	...	...	...	...	...	·01	...	...	...	...	...	...
" 15.....	·10	...	·16	...	...	...	...	...	...	...	...	·25	*·12
" 17.....	·02	·04	·01	...	·04	·02	·01	·04	...	·02	...	...	·03
" 26.....	·08	...	...	...	...	...	·30	...	·45	...	·03	·02	*·21
" 28.....	...	...	...	...	...	...	·03	...	·05	·02	...	...	...
" 29.....	...	...	·03	·02	·02	...	·02	·03	·03	·03	...	·01	...
" 30.....	...	...	...	...	...	...	...	·26	·02	...	...	...	...
" 31.....	...	...	·20	...	·01	·87	·75	·46	·23	·05	·71	·10	·14
Total	·90	·36	1·49	1·96	1·07	1·26	1·63	1·42	1·60	1·20	1·12	·95	·83
., in 2 months	1·30	1·11	2·01	3·44	1·79	2·06	2·52	2·57	1·94	1·99	1·78	1·44	1·38

* Two days' rainfall unavoidably placed in one; not by the observer, but by me.

N.B. All observations taken at 9 a.m., and entered against *preceding* day. Thousandths of an inch not noticed.

On looking over this table, the following remarks suggest themselves.

In June there was no rain in any quantity (except a shower on the 1st, which was confined mostly to the west of the county), till the thunderstorm on the evening of the 16th, which was very general and heavy; very severe at Buntingford, which place was again visited by a heavy but very partial storm on the 17th; partial thunderstorms visited the W. and N.W. of this county on the 24th. It will be seen that the rainfall at Buntingford is greatly in excess of that at any other station.

July.—Showers very general from 1st to 5th; on the 6th a very local shower appears to have fallen in the Dunstable district only.* On the 9th heavy thunderstorms passed over, but were confined to the N. and W. of the county. On the 11th a violent but limited thunderstorm broke over the E. of the county. The fall of rain at Buntingford was 1.18 in. in this storm. Very partial thunderstorms occurred only in the W. of this county on the 26th and 30th, and again (very heavy) on the 31st. Can these storms have all gone into Bedfordshire? The least rain fell at Hertford, 1.11 in.; the greatest amount at Buntingford, 3.44 in.—an extraordinary difference in two places only 11 miles apart in a direct line.—I am, Sir, yours truly,

W. CLINTON BAKER.

Bayfordbury, Hertford, Aug. 30.

THE DROUGHT OF 1870.

To the Editor of the Meteorological Magazine.

SIR,—In your August number, p. 104, you ask, “Why have lawns suffered more in 1870 than in 1869, and yet the fires produced by sparks from locomotives been less numerous?”

In answer to the first part of the question, I would suggest one reason—viz., that although the months of June and July were dry in both years, yet in May, 1869, upwards of 3 in. fell, which was very beneficial in producing good hay crops, and also in strengthening the growth of lawns, whereas this year the drought has continued from middle of March.

The total monthly amounts for each year to the end of July were as follows:—

	1869.		1870.
January	2.800	.....	1.483
February	2.523	.....	1.083
March.....	1.714	.....	2.169
April	1.223	.....	.409
May	3.369	.....	.702
June	1.321	.....	.419
July .....	.667	.....	2.062
	<hr/>		<hr/>
	13.617		8.327

The second part of your question is not so easily soluble, but I would venture the following as possible: on account of the exceptional

* May not the explanation be that the entry on the 6th really belongs to the 5th, on which none is reported from Dunstable, although from 0.10 to 0.26 fell at every other station?—ED.

calmness of the season, the sparks have not been blown away so much from the locomotives.—I am, Sir, yours truly,

C. O. F. CATOR.

Beckenham, Kent, August 22nd, 1870.

To the Editor of the Meteorological Magazine.

SIR,—The vale district of Gloucestershire appears to have suffered so severely by the drought of 1870, that I am induced to send you a statement of the rainfall here up to the end of July, for the purpose of comparison. On comparing it with the returns from the twenty stations given by you in your number for August, it appears we have had less rain than any, with the exception of Leicester.

Rainfall at Berkeley during the first Seven Months of 1870.

Month.	Depth of Rain. inches.	No. of days. on which not less than 0·01 fell.	Remarks.
January ..	1·83	14	
February ..	0·98	8	
March	1·41	7	
April	·44	4	
May	1·41	6	1·10 fell on 11th
June	·56	2	0·55 „ 16th
July	·79	5	0·48 „ 6th
Total	7·42	46	.....

During the same period of 1869 we had 14·67 in. of rain, which fell on 85 days.

To-day rain has fallen almost without intermission from 1.30 to 8 p.m., accompanied by a thunderstorm during the last hour, and 2·85 in. of rain has fallen in six hours.—Yours faithfully,

J. H. COOKE.

Berkeley, August 22nd, 1870.

To the Editor of the Meteorological Magazine.

SIR,—Possibly you may be able to find a corner in your very valuable magazine for the following statement as to the rainfall at this place during this very remarkable year. The gauge has been tested by Mr. Symons, and is kept in an open situation, about 700 or 800 yards from the sea-shore. Showers have frequently been reported a few miles away, while not a drop has fallen here.

	Average, 1864-70, inclusive.		1870.		Difference from Average.
January	1·96	.....	1·47	.....	—0·49
February	1·74	.....	2·07	.....	+0·33
March	1·85	.....	1·16	.....	—0·69
April	1·85	.....	0·74	.....	—1·11
May	2·17	.....	1·18	.....	—0·99
June	1·52	.....	2·66	.....	+1·14
July	1·68	.....	0·30	.....	—1·38

Deficiency from the average in 1870, January to July inclusive,

3·17 in. In 1868 the defect from the average (1864—70) as above, was 2·48 in. In other words, the rainfall in 1870 is less than in the dry year of 1868 by 0·69 in.

Up to to-day (Aug. 27) the quantity measured for the present month only amounts to 0·48 in. The excess in June is more than accounted for by two heavy thunder-showers. On June 9th, 0·83 in. fell, and on 26th 0·74 in. February was a wet month; rain fell on 18 days, and on the 6th 0·57 in. was measured. Every other month than February and June shows a deficiency in the fall.—Yours, &c.,
R. F. WHEELER.

The Vicarage, Whitley, North Shields, Aug. 27.

RAINFALL AT WORTHING.

To the Editor of the Meteorological Magazine.

SIR,—I beg to forward you the following extract from my journal, relative to the heavy rainfall we had here on August 9th :—“The day broke fine, and a hot wind prevailed from the N. and N.E. throughout the forenoon. After 1 p.m., heavy banks of clouds began to form in the N. and N.E., and about 4 p.m. a heavy shower passed over the immediate neighbourhood, accompanied with lightning, but no thunder was heard. Throughout the afternoon it continued squally and threatening to rain, but little fell in the town till about 6.40 p.m., when two very heavy and dark masses of cloud, one from the N.E. and the other from the N.W., met, with a discharge of electricity in the shape of lightning and thunder, accompanied with a most precipitate downpour of rain, coming down more like a sheet of water for some *sixteen minutes* at the outside. The sea was very much disturbed, and blown about in all directions, and the whole phenomenon partook more of the character of a whirlwind and waterspout together. The total fall of rain gauged in this short space of time was 0·39 inch.” Our rainfall for the past eight months has been only 11·05 inches, as you will perceive by the annexed mem.

January.....	2·15 inches	during 17 days.
February ...	1·78	“ “ 12 “
March	2·30	“ “ 10 “
April.....	0·18	“ “ 3 “
May	0·85	“ “ 6 “
June	0·22	“ “ 2 “
July	1·11	“ “ 9 “
August	2·46	“ “ 11 “

Yours obediently,

W. J. HARRIS, M.R.C.S.E., F.M.S.

Worthing, Sept. 3rd, 1870.

A GUIDE TO SUMMER TEMPERATURE.

To the Editor of the Meteorological Magazine.

SIR,—In the rule referred to by Mr. Freeman in your last number, as in many other rules of the same kind, the converse does not hold good, and your correspondent very properly acknowledges that I did not say that it did.—Yours, &c.,
GEO. D. BRUMHAM.

Barnsbury, Sept. 1st, 1870.

THE ANEMOMETER AT THE ROYAL BOTANIC GARDENS.

To the Editor of the Meteorological Magazine.

SIR,—In your last (p. 103) you refer to the “improved modification of Dr. Robinson’s anemometer,” but you do not explain wherein the improvement consists. The dial is clearer and more handsome than any I have yet seen, and it works at a considerable distance below the cups, but is there anything else novel about it?—Yours truly,

Q.

[Yes, and a full description was given by Mr. Pastorelli, at the last meeting of the Meteorological Society, where the anemometer was exhibited. The following is an abstract of the description given.—ED.]

“This anemometer is based on the measurement of the velocity of the wind by Robinson’s rotatory cups. The velocity is registered on separate dials, indicating on the one dial single miles and fractions, and upon the others are shown 10 : 100 : 1000 : and 10,000 miles, so that a velocity of miles from the time of observation to the next can be read off with the greatest ease and distinctness. In the construction of this apparatus great care has been taken to diminish the friction. The method by which this has been effected will be seen from the following description :—

“The rotatory cups are supported by a vertical axis, resting with its pointed end on a hard steel face, enclosed in a socket. This axis passes through a cylindrical tube, with an upper fitting to keep the axis vertical and steady. Fixed on the lower end of the axis is an endless screw, which drives a wheel with 20 teeth, which has a long axis, and upon the same is another endless screw, which acts upon a wheel of 100 teeth. One revolution of this wheel represents 5 miles. The motion of this wheel is seen by the index in the centre of the dial, which allows the reading off of single miles and fractions. Fixed on the side of the 100-teeth wheel is a pin, which during each revolution comes in contact with a lever having a click attached, with a steel back spring. The click drives a ratchet wheel of 20 teeth. The ratchet wheel has an index on the dial, and registers the miles from 0 to 100 (it is figured tens of miles.) Upon the axis of this ratchet wheel are two arms, opposite to each other. Each of these acts during one revolution of the axis upon a lever. This lever is provided with a similar click as already described, and sets another ratchet wheel of 20 teeth in motion, moving the index on the dial engraved 100ds of miles. By a corresponding arrangement two other dials are set in motion, registering 1000 and 10,000 of miles.

“I consider the chief improvement in the construction of this anemometer to consist in the diminution of friction by the introduction of the levers and ratchet wheel motion, instead of the constant friction caused by the uninterrupted action of the toothed wheels. The arrangement enables an observer to divide his dial in such a way that fractions of miles, as well as 10,000 of miles, are shown most clearly. Another advantage consists in the ease with which each index can be set to 0 ; the rate of the wind can then be read off with greater facility at any moment. The total velocity of wind registered during 24 hours can be seen at first sight, as the extensive range of this instrument would even register the velocity of the greatest hurricane if blowing for 24 hours.

“The instrument has an electrical arrangement, by means of which the velocity of the wind can be recorded in miles in the office or library at any distance ; this will prove a great advantage during a brisk gale or hurricane. It may also be an advantage to apply the same means to several anemometers in different situations to observe the differences in their registration. This might serve as a medium of testing anemometers.”

AUGUST, 1870.

Div.	STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL.					TEMPERATURE.				No. of Nights below 32°	
		Total Fall.	Difference from average 1860-5	Greatest Fall in 24 hours.		Days on which ≥ 0.1 or more fell.	Max.		Min.		In shade	On grass
				Dpth	Date.		Deg.	Date.	Deg.	Date.		
		inches	inches.	in.								
I.	Camden Town	2.69	+ .05	.85	1	8	82.5	12	40.5	31	0	0
II.	Maidstone (Linton Park).....	2.06	- .65	.62	28	7	81.0	6	38.0	30	0	0
	Selborne (The Wakes).....	1.66	- 1.52	.61	22	10	76.0	1, 18	33.7	31	0	1
III.	Hitchin	1.23	- 1.12	.49	28	7	74.0	4, 6	40.0	30	0	0
IV.	Banbury	1.73	- .40	.58	27	9	80.0	1	35.0	31	0	0
V.	Bury St. Edmunds (Culford).....	1.77	- .67	.72	27	8	80.0	1, 6	34.0	30	0	0
VI.	Bridport .....	.82	- 1.77	.29	6	5	79.0	12	41.0	30+	0	0
	Barnstaple	1.35	- 2.84	.54	27	9	83.5	13	42.0	31	0	0
	Bodmin	4.23	+ .37	1.28	22	9	75.0	12	44.0	31	0	0
	Cirencester	2.74	- .10	1.75	22	6	...	...	...	...	...	...
	Shiffnal (Haughton Hall)	2.92	+ .05	.98	22	9	77.0	1, 11	40.0	31	0	0
	Tenbury (Orleton)	2.09	- .79	.90	22	7	81.7	11	36.3	31	0	0
VII.	Leicester (Wigston)	1.89	- .30	.69	23	7	85.0	1, 5, 6	39.0	20	...	...
	Boston	1.45	- .84	.67	27	8	82.0	5	42.7	27	0	0
	Grimsbay (Killingholme)	1.53	..	.63	27	12	77.0	5	43.0	31	0	0
	Derby	1.15	- 1.45	.59	25	4	80.0	1, 12	43.0	30+	0	0
VIII.	Manchester	1.65	- 1.85	1.00	27	8	...	...	...	...	...	...
IX.	York	1.58	- 1.13	.68	27	8	79.0	11	43.5	27	0	0
	Skipton (Arncliffe)	2.24	- 3.70	1.46	28	4	85.0	3*	32.0	27	0	...
X.	North Shields	2.12	- .73	.83	27	10	70.7	6	43.0	30	0	0
	Borrowdale (Seathwaite).....	1.50	-12.58	...	...	...	...	...	...	...	...	...
XI.	Cardiff (Town Hall).....	...	...	...	...	...	...	...	...	...	...	...
	Haverfordwest	2.70	- 2.18	1.26	21	5	78.2	2	36.9	19	0	...
	Rhayader (Cefnfaes).....	2.00	- 2.66	1.00	27	8	79.0	...	36.0	...	...	...
	Llandudno	1.44	- 2.38	.75	27	7	84.2	3	45.5	31	0	0
XII.	Dumfries	1.72	- 2.16	.70	27	12	88.5	12	39.5	30	0	0
	Hawick (Silverbut Hall).....	1.54	..	.40	28	8	...	...	...	...	...	...
XIV.	Ayr (Auchendrane House)	2.06	- 1.91	1.10	4	10	77.0	1, 2	33.0	29	0	1
XV.	Castle Toward	2.03	- 4.27	.73	4	11	80.0	10	38.0	29	0	0
XVI.	Leven (Nookton) .....	.95	- 2.04	.33	27	11	79.0	11	40.0	19	0	...
	Stirling (Deanston) .....	.95	- 3.67	.25	18	11	79.0	10	35.0	29	0	2
	Logierait	2.12	..	.77	2	17	...	...	...	...	...	...
XVII.	Ballater	1.88	..	.42	28	11	82.0	9	40.5	9	0	...
	Aberdeen .....	.84	..	.34	28	11	72.8	9, 11	44.2	16	0	4
XVIII.	Inverness (Culloden) .....	...	...	...	...	...	...	...	...	...	...	...
	Portree	2.12	- 5.33	1.00	21	11	...	...	...	...	...	...
	Loch Broom	2.21	..	.40	25	12	...	...	...	...	...	...
XIX.	Helmsdale	1.27	..	.23	25	13	...	...	...	...	...	...
	Sandwick	1.11	- 2.60	.31	21	13	69.2	6, 8	43.8	28	0	0
XX.	Cork	1.60	..	.85	6	8	...	...	...	...	...	...
	Waterford	2.17	- 1.78	1.21	6	11	82.0	11	49.0	21	§	...
	Killaloe	2.49	- 2.44	.78	21	12	85.0	2	30.0	13	1	0
XXI.	Portarlington	1.61	- 2.89	.56	28	13	79.5	2	39.5	20	0	...
	Monkstown .....	...	...	...	...	...	...	...	...	...	...	...
XXII.	Galway	3.29	..	.68	27	11	87.0	13	43.0	31	0	0
	Bunninadden (Doo Castle) .....	.86	..	...	...	...	...	...	...	...	...	...
XXIII.	Bawnboy (Owendoon) .....	...	..	...	...	...	...	...	...	...	...	...
	Waringstown	1.45	..	.79	27	9	90.0	10	38.0	30	0	1
	Strabane (Leckpatrick)	2.42	..	.94	28	14	80.0	10	31.0	21	1	8

* And 12, 14. † And 31. ‡ And 30. § And 29, 30, 31. || And 12. ¶ And 29.
 + Shows that the fall was above the average; - that it was below it.

METEOROLOGICAL NOTES ON AUGUST.

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

ENGLAND.

CAMDEN TOWN.—TS on 1st; L on 18th and 20th; gale on 27th at night.

LINTON PARK.—A dry fine month, with R only on seven days, on each occasion followed by bright weather, so that its effects soon disappeared; very little T, and no high winds. Bar. generally high; winds mostly from N., N.E., and N.W.; rather heavy fogs on 2nd, 3rd, and 4th; and mornings of the 21st, 30th, and 31st, cool, and in some places approaching a frost.

SELBORNE.—Prevailing winds S.W. till the 7th, then N.E. and N.W. to 21st, then more or less W. T on 8th, 18th at 4 p.m., (when a farm-house near Winchester was struck and burnt down), and on 20th. Fog on 1st, 2nd, 3rd and 8th. Heavy R on the 7th within 2 miles, but none here.

BANBURY.—T and L on 1st and 20th.

CULFORD.—T and L on 1st and 18th. First half of month exceedingly dry. Slight indication of frost on morning of 31st, but the grass thermometer did not quite reach freezing point.

BODMIN.—Average temp. of the month $62^{\circ}8$; max. diff. of wet and dry 9° on the 6th, average diff. $4^{\circ}8$. On the 22nd 1.28 in. of R fell in one hour, and no less than .69 fell in 15 minutes.

CIRENCESTER.—N. and N.E. wind all the month, excepting on three occasions, when there was R. It has been all the year since January the tendency of the wind to cling to the north, which has caused the extreme dryness of the weather and the cold nights, with a great amount of sunshine. The great R of the 22nd, 1.75, commenced about noon, soon becoming steady and exceedingly heavy; at 7 p.m. T came on. One of the finest harvests ever known, was nearly completed before the R came.

SHIFFNAL.—A most acceptable TS from S.W., with .46 in. of R on the 1st, and repeated on the 7th, with .47 in. of R; these, with the plentiful falls on the 22nd and 27th, quite saved our turnips, though with little benefit to the pastures, which are as hard as the road. Fog on the mornings of the 3rd, 4th and 5th. The nights cool throughout, owing to the prevalence of the N. and N.W. winds. Red admiral butterfly first seen on the 17th; few wasps seen till the 22nd, and no earwigs; 26th, peacock butterflies appear, with more red admirals; 28th, hornets from a nest in the roof of a house near, feed on the sap exuding from a large oak, and afterwards on the apricots and plums, with the wasps; sulphur butterfly on 31st.

ORLETON.—The drought, which has been of unexampled duration, continued till the 22nd, when a steady and at intervals very very R set in soon after noon, and continued till 7 p.m., without T or L. Before this the weather was very fine and warm, but afterwards it became much cooler. Much T and L in N.E., with gentle R from 4 to 6 p.m. on the 1st. T and R again on the 7th, and L seen on the 19th. The crops light, but harvested in fine condition. Great wind on the 28th. Temp. rather above the average for the month. Damp fog in morning of 4th.

WIGSTON.—The corn harvest was nearly completed before the 20th, in the more forward districts ten days sooner. The fine R which fell on and after the 20th improved the appearance of the grass land.

GRIMSBY.—Wheat harvest began on the 2nd; grass scarce, and all kind of root crops suffering from the drought. Harvest plentiful and well got in. Very abundant crops of apples, pears and wall fruit. Pleasant weather for harvesting, nearly all finished at the end of the month. Some very welcome R on the 27th. Northerly winds prevailing.

DERBY.—The deficient rainfall of summer has extended over August, the fall less than half the mean; this added to the N.E. winds which prevailed the greater part of the month, has had its effects on the pastures; the fall of R recorded on the 25th has wonderfully changed the aspect; fruit abundant.

MANCHESTER.—Very heavy R on the 27th.

NORTH SHIELDS.—Fog on the 1st and 2nd; T on 6th, 17th, and 29th; clematis, hollyhock, and china-asters in bloom in the first week.

W A L E S.

HAVERFORDWEST.—Splendid summer weather during the first 17 days, temp. each above 70°; a rather sudden change took place on the 19th, temp. falling at night to 36°·9; after which the weather became much cooler; heavy R on the 21st, with considerable fall of temp.; rest of the month fine, air quite autumnal; magnificent harvest weather throughout the month; all the crops good and splendidly harvested; oats heavy.

CEFNFAES.—Nights generally cold during the month, often slight frosts. Days hot, with bright sun. Harvest early, and well got in; wheat good on the average, other grain light and short in straw. Great distress for water and herbage. Prevailing winds N.E. and N.W.

LLANDUDNO.—Barley was cut on the 29th of last month, wheat on the 1st of this, and oats on the 3rd; peas cut and led on the 18th. Very hazy on the 2nd and 3rd, on the former day even the near hills could not be defined, a few T drops at 5.30 p.m.; T on the 4th and 5th at a distance; very heavy shower between 8 and 9 p.m. on 28th.

S C O T L A N D.

DUMFRIES.—The first half of month very dry, except on 4th and 7th. T on 4th; latter part of the month showery; H on 19th; weather on the whole very favourable for harvest, which was nearly completed at the end of the month. The R of incalculable benefit to pastures and turnips. Wheat a good crop; barley excellent, potatoes very good; turnips good, where not attacked with mildew; oats above the average. Mean temp. 61°·3.

SILVERBUT HALL.—A very dry and warm month, and yet there have been very few wasps or caterpillars, but many of the humblest weeds have been attacked by red spiders. Garden peas terribly mildewed, and will soon be over; harvest operations are well forwarded, and potatoes so far have kept clear of disease. T on 2nd and 4th.

AUCHENDRANE.—Bar., evaporation, and diff. between mean temp. and mean dew point above the average for August; bar. range, rainfall, mean temp., elastic force of vapour, dew point, humidity, force of wind, and amount of cloud, were below the mean. With these plus and minus signs of the instruments, the weather was splendid throughout. What was a gain to the harvest was a loss to the rivers, now almost dried up; only one severe T S, on the 4th, when there fell in a few hours more than half the total rainfall of the month. Aurora streamers and meteor seen on the 15th, 21st, and 24th.

CASTLE TOWARD.—A fine harvest month; T and L on the 3rd and 4th; exceedingly bright and warm from the 8th to the 17th; during these 10 days the average max. temp. was 78°, min. 56°, mean 67°. Grain crop above the average, all cut, and much of it secured in fine condition. Foggy on 2nd on the Clyde.

DEANSTON.—The whole month bright, hot, and dry; grain being cut on the 13th; all cut by the end of the month, and some secured in the stackyard.

LOGIERAIT.—Intense heat in the early part of the month; T S on the 2nd; sudden change of temp. on the 18th; that and the four following days cold, with east wind; after which, the cold winds moderated, but we no longer complain of the heat. Crops are being well secured, the bulk is not very great.

ABERDEEN.—A warm, quiet, and unusually dry month; a remarkable continuance of fog in the beginning of the month, lasting till the 8th. Bar. and temp. above the average, rainfall and wind pressure below it.

PORTREE.—A very fine month. Harvest commenced on the 19th, the earliest harvest in this island since 1826; not one shower from the 21st of July to the 18th of August (a very unusual thing for Skye, never happened before in the memory of any one living), and the heat during this dry period was intense, more so than ever remembered for so long a period. Hay all secured; all other crops looking well, but the potatoe disease is appearing.

LOCHBROOM.—Dry and pleasant throughout. The crops are nearly all cut, and

some in the stackyard, events seldom occurring so early in the season in this far northern region. The dried up rills and shallow streams have had some running water for the last two days, but for the previous two months water seemed to have abandoned them.

SANDWICK. -- August has been warmer and drier than the mean, indeed warmer than any August since 1858, and drier than any for the last 30 years, except that of 1852. The ther. stood above 100° in the sun on several days, and on the 11th at $106^{\circ}\cdot5$.

I R E L A N D.

DOO CASTLE.—One of the driest months on record ; ground parched, cattle suffering, and green crops poor.

WARINGSTOWN.—Fine, bright, and hot ; great scarcity of water ; harvest progressed very rapidly, but has ripened rather too fast. Crops in general very good, the best in this district for many years.

LECKPATRICK.—Day temp. of the month much above the average, nearly as warm as in July ; night temp. much below, so that the mean is about the average. Rainfall still deficient ; the amount for the year to the end of August is $19\cdot35$, about $5\frac{1}{2}$ in. below the expected average. Ther. in shade reached 80° on one day only. Rainfall on the 28th the heaviest of the year. Magnificent harvest weather, crops all good.

METEORIC PHENOMENON.

The following account of a meteoric phenomon is extracted from the *Belfast News Letter* of August 16th :—

SIR,—As it is unusual, if not altogether unprecedented, in meteoric displays to find a permanent trace of them, I think this phenomenon is worthy of notice.

On Monday evening, at about 20 minutes to nine o'clock, when the display of fireworks in the Botanic Gardens had just begun, a strange meteoric phenomenon appeared in the north-western heavens. It seemed, at first, like an ordinary "shooting-star," except that it was considerably larger and more of a silver brightness. At the end of its course, which was some fifteen degrees above the horizon, it exploded. The peculiarity of its appearance, however, consisted in the permanent bright trace which it left in the sky. There was a sombre bank of haze hanging over the mountains, and extending about ten degrees above them. The sky beyond this was clear and bright, as is usual in these summer evenings.

It was in this bright sky that the meteor appeared. Its course was from a position somewhat to the south of the tail of Ursa Major in the direction of the head of Leo Minor, extending in all over some 12° . The track left was, at first, of this length, and in the direction of the course of the meteor. The haze, it may be added, seemed to be striated in the same direction. After an interval of about five minutes the straight luminous line became varied, then more curved, until about ten minutes after the occurrence it took the form of a somewhat irregular corona, breaking finally before its evanescence into the figure of a horse shoe. The phenomenon was altogether visible about thirty minutes.

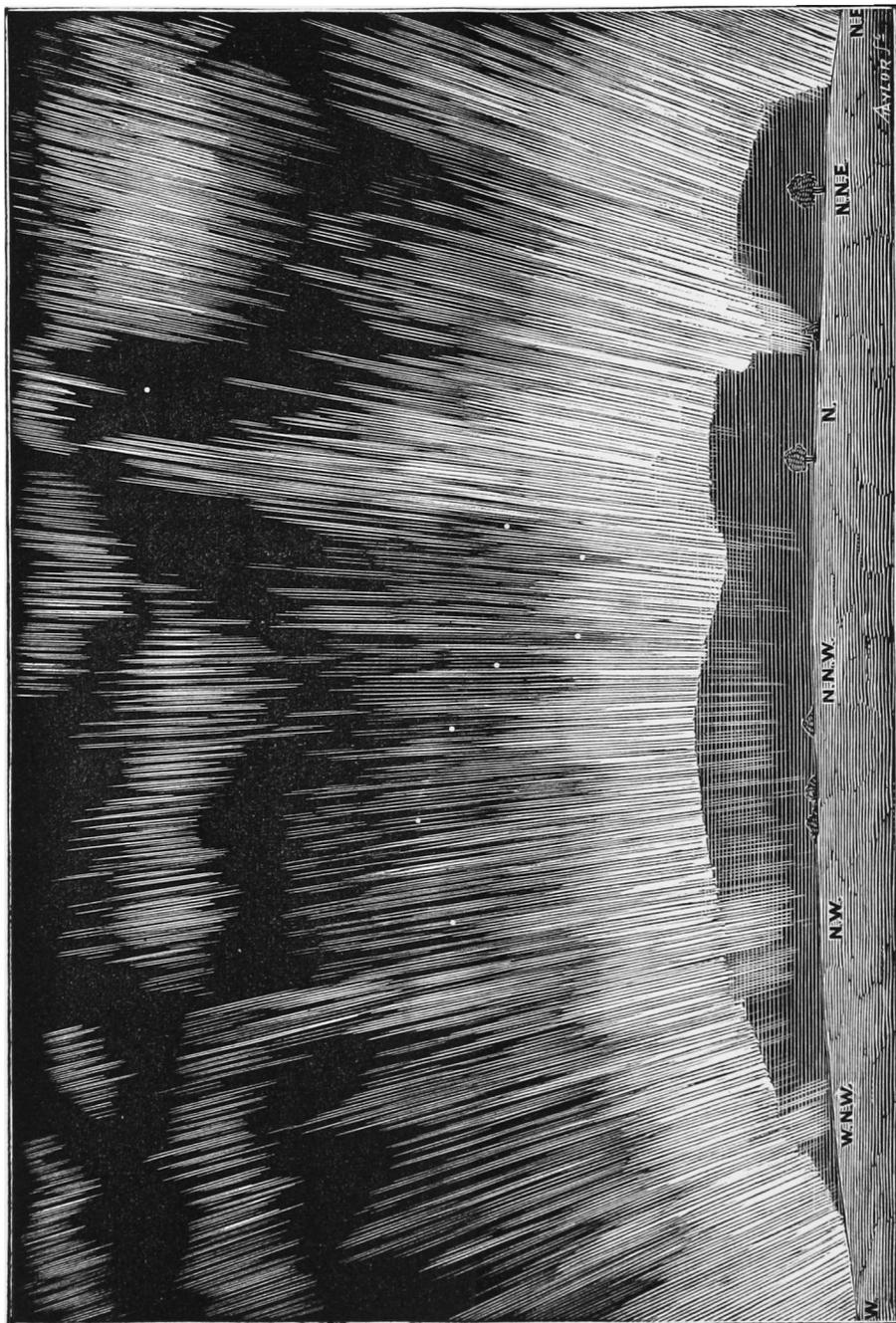
There was little or no wind at the time, and no apparent cause for the curious changes in figure which the luminous line underwent. The northern horizon in the early part of the night had rather an electrical appearance.

EDMUND M'CLURE, Clk.

Belfast, August 16th, 1870.

ERRATUM.

In *Monthly Meteorological Magazine*, August, 1870, p. 115, line 10, for "T never more than," read "T never less than," &c.



AURORA BOREALIS, AS SEEN NEAR WHIRBY, ON SEPTEMBER 24TH, AT 9.30 P.M. (See page 139.)