

SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE.

LXIII.]

APRIL, 1871.

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EARTHQUAKE ON MARCH 17TH.

IN our last number we had the pleasure of inserting two letters descriptive of the recent slight earthquake shock ; in the present we complete the narrative by the insertion of an abstract of the published accounts, and of the following sketch map, which shows by dots all the spots at which we have heard of the shock being felt. The area may be roughly described as being the whole of England north of the Mersey and the Trent, but, as will be seen from page 50, it was felt in Dumfriesshire, so that Scotland was not entirely exempt. Moreover, it will be noticed that it was reported from many more stations in the west than in the east, and that the mechanical effects, although in no case of any importance, are uniformly reported as greater in Lancashire and the Lake District than elsewhere.



The velocity of transit of earthquake shocks is approximately known ; hence if the various reports had given us the *real* time at which the shocks were felt in the different districts, much more light could have been thrown upon the subject, and possibly the position and depth of the centre of disturbance computed.

Probably many of our readers noticed that the two letters in our last, assigned times differing by ten minutes, and very likely they set this down as another illustration of bad time-keeping. Inconsistent as

are several of the entries in the following table, and discreditable as they are to a country with the thousands of miles of telegraph wires which England has, it is nevertheless possible to extract some general system from them, and it seems to us clear that the 11 o'clock shock was felt between 11.0 and 11.5 in the north-western counties, but not till 11.10 or 11.15 in the north-eastern—thus supporting *both* our correspondents.

6.0	Ulverstone	11.5	Singleton Brook, Manchester
6.20	Kendal	11.5	St. Asaph
6.30	Manchester	11.5	Burton, Westmoreland
6.30	Ambleside	11.5 to 11.10	Stonyhurst
6.40	Grasmere	11.5	Ulverstone
6.45	Askrigg	11.10	Doncaster
7.00	Coniston	11.10	North Shields
10.54	Singleton Brook, Manchester	11.15	Dumfries
11.0	Grasmere	11.15	Blencowe, Penrith
11.0	Coniston	11.15	Kendal
11.0	Nent Head, Alston	11.15	Darlington
11.0	Llandudno	11.15	Hexham
11.0	Lingen Presteign	11.15	Scarborough
11.3	Ambleside	11.15	Leeds
11.4	Preston	11.15	Liverpool
11.4	Bowden, Manchester	11.30	Tyneside
11.4	Penrith	11.30	Newcastle

CARLISLE.—On Friday night an earthquake was distinctly felt in the northern counties of England. Our correspondent writes that the accounts from various parts of the country agree that there were more shocks than one. The first was much less severe than the second, which occurred a few minutes afterwards. At Silloth and Aspatria, twenty miles west and north-west of Carlisle, the windows of houses were shaken with alarming violence. A gentleman who resides near Aspatria states that he felt the floor of the room in which he was sitting heave, the piano was perceptibly moved, and a statuette upon it was rocked so much that it was nearly overturned. At Castle Canock, on the eastern side of the county, the windows were severely shaken, and the experiences of inhabitants of the southern districts about Penrith were of a similar nature. In Carlisle the trembling of the earth was distinctly felt in various parts of the city, preceded or accompanied by a loud rumbling noise resembling the sound of distant thunder or of a cart rattling over a stony street. It was noticed in several places that cage birds were much alarmed, and at Hutton Hall, near Penrith, the pheasants in the adjoining preserves made so much commotion that their unusual movements attracted the notice of the inmates of the hall. No damage has been reported.

THE LAKE DISTRICT.—About three or four minutes past eleven on Friday night a smart shock was experienced over this district. The effect was sudden and the agitation powerful, but of short duration. It was accompanied by a sound as if a heavy goods train passed at express speed, and the shock was followed by a rushing wind which quickly died away. Articles of furniture rocked fearfully, and many persons who had retired to rest sprung out of bed in the greatest alarm, expecting the houses they occupied to fall. The recent gunpowder explosions suggested an accident at one or other of these manufactories, and one man actually ran two miles partially dressed to satisfy himself that the works in which he was interested were not destroyed. The shock lasted fifteen or twenty seconds, and appears to have extended over a wide area. Lancaster Castle is said to have been damaged so much as to need repairs. Opinions differ as to the course taken by the wave, but those who were sufficiently calm and self-possessed to be observant, and feel a scientific interest in the phenomenon, consider the earthquake travelled from east to west. The vibration was so powerful that beds were lifted, and persons standing were thrown on the floor. On Friday it is asserted by several persons that shocks were felt about noon, and again in the evening, about six o'clock. It was difficult to

account for these sounds and vibrations until after the more severe shaking at eleven, but the experience of the latter convinced these persons that the sensations of the earlier part of the day were due to the same mysterious cause. Cries of the pheasants in the woods were heard for some time after the event, and dogs gave unmistakable evidence of alarm.

KENDAL.—A correspondent writes that the first shock occurred about twenty minutes past six in the evening. It was accompanied by a low rumbling noise like what might be produced by the passing of a heavily-laden waggon, but there was not much vibration, and, generally, the occurrence did not attract much notice. About a quarter past eleven, however, a most severe shock was experienced, throwing down in two or three cases flower-pots on window-sills, and this time the violent vibration of the earth occasioned great alarm—so much so that numbers of people started from their beds and rushed half-dressed into the streets to ascertain what was the cause of the concussion. At first it was attributed to a supposed explosion of some of the powder-works in the neighbourhood, and the telegraph was at once set in motion to ascertain if anything of the kind had happened; but, as nothing could be learnt of any explosion having occurred, people forthwith concluded that it was a shock of earthquake.

GRASMERE.—Mr. R. Farquhar writes to us that the inhabitants were disturbed on Saturday evening by two shocks of earthquake. The first occurred at about twenty minutes to seven p.m., the second at about eleven p.m. Each was accompanied by sounds and motion of similar kinds, but the last was much the more severe of the two. A loud boom, as if an immense explosion had occurred at a distance of, say, five miles, preceded the first shock, which moved apparently from east to west; the same phenomena, though far more decided, occurring on the second occasion, with a great jingling of crockery, shaking of windows, and barking of dogs. Another shock subsequently occurred.

ULVERSTONE.—About 11.5 an alarming earthquake was experienced in this town. The writer of this communication had just retired for the night, and was composing himself for rest when a slight tremor was felt. It was like the approach of a carriage, but in the space of a second or two the vibration had increased to so great an extent that the walls of the house rocked, the window frames rattled, and the bedstead shook as though grasped by the arm of a strong man. The quaking continued from ten to fifteen seconds. The police on their beat distinctly-experienced the sensation. The evening was, for the season of the year, peculiarly still and warm, though the thermometer stood at 42 degrees.

BLACKPOOL.—In this town and neighbourhood the action of the earthquake was noticed by numerous persons. It was very violent in some parts,—glass and crockery having been thrown off shelves and broken.

MANCHESTER.—The oscillations are described as producing only a slight, though perceptible, tremor. At Singleton Brook, near the city, the first shock was felt at precisely six minutes to eleven. A resident says that the windows of his house were violently shaken, as though a heavy vehicle was passing along the road. Several inmates of the house remarked the effect as peculiar, but it did not then suggest the idea of an earthquake, and had nothing further occurred the impression produced would have been forgotten. About five minutes past eleven, however, the noise was again heard, accompanied, as before, by a tremulous motion. This time the effect was much more marked and continuous. All the inmates of the house (nine in number) were in bed, and each felt the shock. At first the impression produced was merely that of trembling, which lasted for, perhaps, two seconds. This was succeeded by a slight pause of about half a second, and then the beds were distinctly felt to roll from side to side, exactly like the heaving of a ship at anchor, and with the same sharp and sudden check to the motion. The time occupied by the second shock was about four seconds.

BOWDEN.—A correspondent at Bowden, near Manchester, says that he had just retired to bed when, exactly at 11 4 p.m., Greenwich time, he experienced the tremulous motion peculiar to an earthquake. He adds that the shock lasted as nearly as possible twelve seconds, and that the course of the earthquake was from north-east to south-west.

LIVERPOOL.—About 11.15 a very perceptible shock of an earthquake was felt

in Liverpool and the neighbourhood. About Brook and Seaforth, and along the coast to Southport, the movement was very plainly felt, and on Breeze Hill, Walton, the furniture in some of the houses rocked to and fro. The shocks, of which there were two, lasting about three or four seconds, appeared to travel from west to east.

TYNESIDE.—On the Tyne, west of Newcastle, the earthquake, about half-past eleven o'clock on Friday night, shook the windows and doors of many of the houses. It was very distinctly felt in the large manufacturing village of Blaydon, and, indeed, all up Tyneside. Several families jumped out of bed in great alarm through the noise occasioned by the rattling of the lighter articles of furniture. The shock was felt in Newcastle and Sunderland, but less distinctly than in the neighbouring villages. The weather on Saturday afternoon became suddenly warm in Newcastle, and more resembled that of June than March. It had been cold and bleak during the week, with occasional snow showers.

ASKRIGG, YORKS, 17th.—A slight shock of earthquake at 6.45; the duration about four seconds; another very violent one at 11.15, duration about six seconds. The weather was very fine at the time, and has been so to the end of the month, except a slight shower on the 25th. There have been several shocks since the 17th.

SCARBOROUGH—The shock was felt here about 11.15: the effects are variously described by several parties who felt it; and it is somewhat singular that while it was felt more or less in every quarter of the town, it was not generally noticed. Thus, a lady residing at Westborough very distinctly felt the tremor, and one side of her bed was disturbed, so that she was on the point of raising an alarm, feeling sure that thieves had entered the house; while her neighbours, a few yards off, felt nothing whatever. It was felt in St. Nicholas-street and the Crescent, while the intermediate neighbourhood was not affected. The shock was experienced on the South Cliff, the glass and china in some of the houses responding to the mysterious force exerted upon them. No injury to person or property has been reported.

YORK.—Some persons were awoken by the rattling of doors and windows and crockery, and several who had not retired to rest rushed into the street, fearing that some catastrophe had occurred.

LEEDS.—At about 11.15 p.m. on Friday a slight tremor of the earth was perceived—so slight that it would not have attracted notice had it not been almost immediately succeeded by a more unmistakable agitation or vibration of the ground.

DONCASTER.—The earthquake was felt in this neighbourhood on Friday night about 10.10 p.m. [11.10 ?]. The vibrations lasted a few seconds, and were strong enough to shake the windows, beds, and other articles of furniture.

To the Editor of the Meteorological Magazine.

SIR,—The earthquake of March 17th was felt very distinctly here. My house was shaken very violently, the motion, which was accompanied by a loud rumbling noise, lasting nearly ten seconds. The time was about 11.5 p.m. The air was very calm, the temperature (4 feet above ground), 42°; and the barometer (corrected) 30.21 in. A slight shock was also perceived in this neighbourhood at 6.20 p.m. on the same day, and one of my servants noticed another at 10.30 p.m. The movement was from W. to E. There was a small auroral display on the evening of the 16th.

T. B. ARMITSTEAD, B.A., F.M.S.

Hutton House, Burton, Westmoreland, March 21st, 1871.

AURORA OF DECEMBER 17TH, 1870.

To the Editor of the Meteorological Magazine.

SIR,—Mr. Birt's description, in your February number, of the aurora of December 17th, does not agree with my observations of it at 6 p.m.,

but it agrees very well with mine a few minutes earlier, as the following extracts from my notes will show :—

5.50 to 5.53 p.m. (Greenwich time).—There is a beautiful red band from N.E. to W.N.W., but passing about 15° S. of the zenith, where it is bright red. It is 10° or 15° wide.

5.56 p.m.—The red very faint, visible only in the W., and the aurora is little but diffused light, covering the greater part of the sky. No part is particularly bright.

6.4 p.m.—There are a good many flashing rays, but not bright ones; they are chiefly near the corona.

6.6 p.m.—The aurora much the same as at 5.56, but there is no red, and it is brighter in the N. It covers all the sky faintly.

From the above account, the southern boundary of the red band would be 21° S. of the zenith, instead of, as with Mr. Birt, 7° N. of it. Assuming that we both saw the same band, the distance between the magnetic parallels of latitude on which Sunderland and Walthamstow are situated being 234 miles, the height of the band would be between 450 and 580 miles.—Yours truly,

T. W. BACKHOUSE.

West Hendon House, March 23rd, 1871.

P.S.—The heights of auroræ seem to be very imperfectly known. I do not see why it should be so; if a systematic series of observations were made in distant places, I have no doubt our knowledge on the subject would soon be greatly increased. I, for one, should be very willing to co-operate in such an undertaking.

[A capital suggestion, which we will gladly aid in any way that we can.—ED.]

AURORA OF APRIL 9TH, 1871.

To the Editor of the Meteorological Magazine.

SIR,—On the night of Easter-day, the 9th April, between 10.20 and 11 p.m., there was a very magnificent display of aurora borealis, nearly equal to that of the 24th and 25th October last year. The colour was principally a brilliant carmine, and twice was the light so suddenly shot upwards and so bright as to resemble a flash of lightning. The base of the auroral light extended from E.N.E. to S.S.W., and the rays converged in a bright crimson fan on Cor Caroli, which was then about in the zenith of this place.—Yours truly,

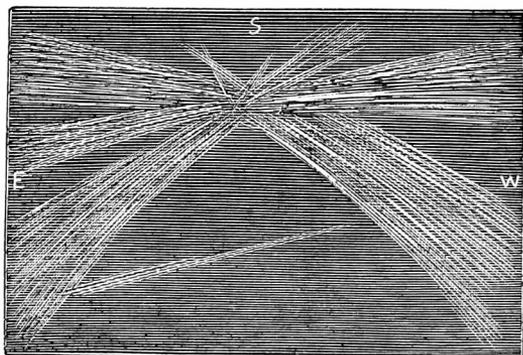
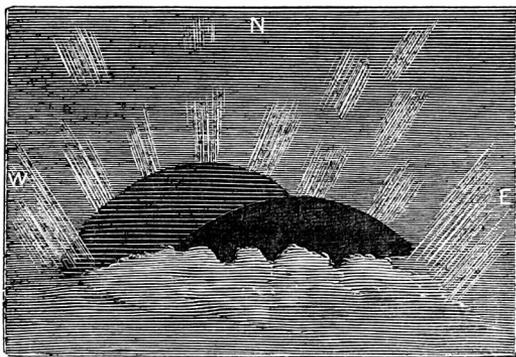
J. M. DU PORT.

Mattishall, Norfolk, April 10th, 1871.

To the Editor of the Meteorological Magazine.

SIR,—The sky was illuminated last night between 10 and 11 o'clock with a magnificent aurora borealis. It was far more brilliant than the most splendid display that I have ever witnessed. I send you a sketch of the N. and S. heavens made by me. The great peculiarity about these northern lights observable here last night consisted in the absence of all streamers and of any luminous appearance in a triangular space

in the south, whilst all the rest of the heavens were a-blaze with light. The apex of this triangular dark space was about 70° from the southern horizon. The streamers seemed to be collected together at this angle, as if tied in a knot, or as if they emanated from this spot, which was, as intimated before, some little distance south of the zenith.



The streamers were most brilliant in the west. Pale green streamers were occasionally intermingled with the crimson. Lightning was said to have been noticed. I here subjoin the state of the meteorological instruments during the display:—Bar. 29.914; dry bulb, 40.9; wet bulb, 38.8; wind, E.; force, 3 (scale 6); clouds, 2 (scale 10).

Yours faithfully,

CORNELIUS B. FOX, M.D., F.M.S.

South Cliff, Scarborough, April 10th, 1871.

To the Editor of the Meteorological Magazine.

SIR,—A most magnificent display of aurora borealis was observed here last night, surpassing in brilliancy and duration the displays of last October.

At 8 p.m. the whole northern sky became lit up with brilliant white light; at 8.45 bright red streamers appeared in N.E., which faded away at 9 p.m., the sky in the north and west remaining very brilliant.

Distant lightning was seen in N.E. from 8.45 to 9 p.m. At 10.30 a body of intensely vivid light appeared in the W., with streamers and waves passing right across the sky to the E. horizon, blending with a hazy cloud which obscured the sky in that quarter and in the N. and N.E. ; the light near the horizon in W. was brilliant green, but as it neared the zenith, became a deep blood red. At 11 p.m. the sky, with the exception of a small portion of the S. horizon, was completely covered with pale streamers, passing from W. to E. At 11.30 a dark cloud, through which the stars could be distinctly seen, partially obscured the light in the W., and bright streamers passed from the N. at right angles to the main body. At midnight the streamers in the W. and near the zenith faded considerably, but the phenomenon continued till near daybreak in the N. and E.—Yours truly,

THOS. PAULIN.

Winchmore Hill, April 10th, 1871.

RAINFALL RULES.

To the Editor of the Meteorological Magazine.

SIR,—I am glad to hear that the rules for observing rainfall are not (with perhaps one exception) the laws of the Medes and Persians, and that *our* government *does* consult its supporters. May I then make a few criticisms?

Rule I.—It is hard to choose among evils. Different parts of the country have different rainy quarters. At Tunbridge Wells it used to pour with S.W. gales; here I find S.E. and N.N.W. the most rainy and windy. Would it not be better, then, to omit the last sentence of this rule?

Rule V. is all very well; but I should say, “Have a copper or zinc funnel put in instead.”

Rule XII. involves a distinction between .005 and .004, which with nine glasses out of ten I am unable to make, owing to the irregularities of the bottom. Besides, since this rule was made, who knows what is the least fall to constitute a “day of rain?” Is it the real .01 or the regulation .01 which may be .005? I quite agree with Mr. Cator.

Rule XV.—I would have every gauge made with an upright rim, 3 or more inches high, or else a cylinder should be used. (3) should be struck out as delusive; sometimes it would not give results right to the nearest inch of rain! (2) does very well when the ground is frozen underneath, and there has been no wind to drift the snow. For melting snow perhaps Mr. Cator's proposal is best. I have tried it, sometimes by pouring in a measured quantity of warm brine. But it is hazardous to put hot water into frosty glasses, and I generally put funnel and bottle before the fire, and the water runs down into the bottle as fast as the snow melts. If the bottle has ice in it, put it in a pan half full of cold water upon the fire; as the water gets hot, the ice will melt rapidly without danger to the bottle.

I ought to have added to my paper in *British Rainfall* an explana-

tion of the column headed "Deduced Velocity." The figures are the velocities which I have found by observation with the anemometer to correspond approximately to the figures at which the force is estimated on the Beaufort scale, and differ slightly from the values given by the Meteorological Office. They are—force 1, 5 miles; 2, 10; 3, 13; 4, 18; 5, 25; 6, 31; 7, 37; 8, 43; 9, 50; for forces 10, 11, and 12 I have no observations, and all are liable to correction from more experience.—I remain, Sir, your obedient Servant,

FENWICK W. STOW.

Hawsker, March 29th, 1871.

To the Editor of the Meteorological Magazine.

SIR,—From the discussion, which has been going on in your valuable magazine, on the present rules laid down for taking meteorological observations, it is evident they are not considered, "according to the laws of the Medes and Persians," for they seem likely to be subject to the same variableness as the various and varying phenomena of our atmosphere which they are intended to record. In your last number, Mr. Bicknell enters a protest against Rules XII. and XV. for "Rainfall Observers." Now, with reference to the former, he states, that "there is no more difficulty in reading 0.001 of rain than 0.001 of the barometer scale." A standard barometer is furnished with a vernier to show 1.500th of an inch, but glass measures are only graduated to hundredths of an inch, with a gauge having a receiving surface of eight inches; in many instances, the graduation of a measure for a 5 inch gauge begins with 0.02 in. after which, they are 0.01 in. Now 50 drops of water, as determined by a minimum measure, is equivalent to 0.01 in. in a measure for a 5 in. gauge, so that a gauge of that dimensions would yield 5 drops for 0.001 in. of rain; such a measurement appears to me simply absurd, and if it is necessary to be exact with small quantities, it is equally so with extraordinary falls. It may look a simple thing to those with only one gauge, but when they exceed half-a-dozen, I doubt whether any special advantage would be obtained, especially if rain were falling heavily at the time of reading. When a beginner I measured with nicety, but I soon found it was not measured in such small quantities in our principal observatories, and came to the conclusion that I was more nice than wise.

With reference to Rule XV., for measuring snow, that gentleman states that it is a bad one. Admitting it to be so, what he proposed would only make bad worse. Whatever method is adopted it should be with the least possible delay, as it is generally accompanied by a rough wind, but I certainly am surprised at the last suggestion, that is, to allow 12 in. of snow to remain until a thaw for half the snow to evaporate. Supposing it fell on the 1st January, it would take until the end of February to lose half of it by evaporation.—Yours obediently,

JNO. ARNOLD.

Aldershot, 8th April, 1871.

BRITISH RAINFALL, 1870.

To the Editor of the Meteorological Magazine.

SIR,—I have just got through *British Rainfall*, 1870, and I wish to make a few remarks. In the first place it is satisfactory to find that my investigation of the results from the Rotherham experimental rain-gauges falls in so consistently with the deductions of the Rev. F. W. Stow, the Rev. C. H. Griffith, Sergeant Arnold's observations, and your own conclusions. Unfortunately, on page 28, line 21, the sign for multiplication has been printed instead of that for addition; and the same mistake exists in line 27. These errors were not in the manuscript, as I find by the press copy which I kept.* However, you have I think made a more important mistake; at p. 45, line 3, "a less angle, such as 35 or 30°," should have been "a greater angle, such as 50 or 60°"; because, if the vertical gauge collected *more* rain, the inference would be that the showers were more nearly horizontal, or the angle from the vertical was greater.

You may well be congratulated on having arrived so nearly to the solution of the problem, which, as you say, "has baffled observers for more than a century" namely, the cause of diminution of rainfall, with elevation above the ground. It would seem that a vertical rotating gauge must henceforth be used conjointly with a horizontal gauge by all observers who desire to ascertain the correct amount of rain, and have a good position for exposure of the instruments. From the lucid exposition of Mr. Stow, meteorologists will perceive the necessity of taking into consideration the nature of the exposure of the gauges before making deductions from rainfall statistics. Mr. Stow's instrument, figured on page 15, seems a very good model for a vertical and a horizontal gauge combined.

At page 19 Mr. Stow gives, against the "estimated force of wind," the "deduced velocity per hour." I should like to know how it is deduced.† I find the following inconsistent relations between the force of wind, as estimated by the Beaufort scale, and the corresponding velocity in miles per hour, and of pressure in pounds on the square foot. Columns A and E are derived from Sir H. James' *Instructions for taking Meteorological Observations*, appendix, pp. 31 and 32; B and F are inferred from a table accompanying Sir W. S. Harris's account of a modification of Lind's anemometer, in the *Nautical Magazine* for 1858; C is given by J. K. Laughton in his *Physical Geography in relation to Winds and Currents*, p. 4; and D is the result of experiments, as stated in the *Quarterly Weather Report*, No. 1, for 1869, issued by the Meteorological Committee.

* Unfortunately true, but it is only fair to mention that the errors of \times for $+$ occurred in the proof, which was submitted to Mr. Strachan, so that the Editor can hardly be considered to be solely responsible for that which escaped the notice of both of them—as to the other it is a mistake, pure, simple, and unmitigated.—ED.

† Singularly enough Mr. Stow has, in his letter of March 29th, p. 44, supplied the particulars requested.—ED.

Beaufort's Scale.	Velocity (miles).				Pressure (lbs.)	
	A	B	C	D	E	F
0	0	0	0	...	0	0
1	7	3	2	...	0·20	0·04
2	14	6	4	...	1·00	0·16
3	21	10	8	...	2·25	0·45
4	28	14	16	...	4·00	0·91
5	35	17	24	...	6·25	1·40
6	42	19	32	36	9·00	1·60
7	49	22	40	44	12·25	2·10
8	56	30	50	...	16·00	4·10
9	63	48	62	...	20·25	10·40
10	70	76	78	...	25·00	26·00
11	77	90	96	...	30·25	36·00
12	84	114	120	...	36·00	57·00

Now, the question is which set of values is the most correct for converting estimated force of wind into velocity, or into pressure? If no one of the above is satisfactory, cannot a relation be agreed upon? It would not so much matter about it being absolutely correct, provided it was an approximation to truth, and received general sanction. It is absolutely necessary to settle upon a basis for converting the Beaufort Scale into velocity, or pressure, because, although nominally a unit scale, it is not founded upon any unit of definite value. As regards velocity Sir H. James gives it a unit value, but the other authorities are far from recognizing this principle. The nominal units have so deceived meteorologists that they are in the habit of averaging the estimates by the Beaufort Scale, although it is evident that if the grades of the scales are of unequal values, they cannot be averaged by simply taking the arithmetical mean. The correct method seems to be to convert them into velocity first, and then to average the velocities. Perhaps you may think it worth while to ventilate this subject in the *Meteorological Magazine*.—Yours faithfully, R. STRACHAN.

11, *Offord-road, N.*, 6th April, 1871.

[Our opinion as to the importance of this subject, enunciated in an article on "Equivalent Expressions of Wind Force," in the *Meteorological Magazine*, Vol. I., p. 19, remains unchanged, except, perhaps, that it has gathered additional strength from the experience of the five years which have passed since it was penned.—ED.]

GALE IN THE CHANNEL, MARCH 16TH.

RECORD OF OSLER'S ANEMOMETER.

To the Editor of the Meteorological Magazine.

Wednesday, March 15th, 9 a.m., strong breeze N.W., pressure 6lbs. on the square foot, moderating during the day to a light breeze at 8 p.m., the wind backing through S.W. as far as S. at midnight.

9 p.m., S.S.W., barometer 29·992, (sea level corrected). A furious gale now set in, the pressure reading from 11 p.m. to 3 a.m., 14lbs. on the square foot, velocity 53 miles an hour. Thunder and lightning, with heavy squalls of hail and rain.

Thursday, 16th, 5 a.m., S.W., pressure moderated to 6lbs., velocity

35 miles. 6 a.m., gale again rapidly rising, wind W., veering to W.N.W. at 8 a.m., when the storm culminated, the pressure reading 21lbs., and 25lbs. in the gusts, velocity 65 to 70 miles an hour, until 10 a.m.

9 a.m., barometer (sea level corrected) 29.421, a fall of nearly six-tenths in twelve hours. Rainfall 0.50 inch.

1 p.m., the gale still continues from N.N.W., with a force of 12 to 15lbs., velocity 50 to 53 miles. Barometer has risen $1\frac{1}{2}$ -tenth.

☛ This gale is, I believe, the outskirts of a cyclone, the axis of which has proceeded N.E., many miles to the north of this island, and we shall probably hear of much worse weather along the English coast.

Yours truly,

TH. L. MANSELL.

Guernsey, March 16th, 1871.

PERIODICAL RETURN OF THE SEASONS.

To the Editor of the Meteorological Magazine.

SIR,—I perceive that several of your staff of monthly observers include in their observations notices of the appearances of insects, and other natural historical details; as these remarks are of great importance in marking the periodical return of the seasons, may I suggest that they would be more comparable and interesting if separated from the general meteorological notices, and tabulated by themselves.

Yours truly,

C. H. GRIFFITH.

Strathfield-Turgiss, Winchfield, Hants.

[We are not sure that the notices of the above class are sufficiently numerous to warrant separate tabulation, but we should gladly devote the requisite space, if Mr. Griffith would undertake it, and a few additional observers would supply him with the requisite information.—ED.]

REVIEWS.

Quarterly Weather Report of the Meteorological Office. Part III., July to October, 1869. 4to, 80 pages, 36 plates.

Barometer Manual, Board of Trade. Compiled by R. H. SCOTT, M.A., F.R.S. 8vo, 76 pages, 4 plates.

THE first of these works is sufficiently noticed by its title, whence it will be seen to be the continuation of the serial, the two previous numbers of which have been fully noticed in these pages.

The barometer manual is a rewritten and considerably improved edition of that prepared by the late Admiral FitzRoy, and contains much useful information at (of course) a moderate price. There are a few points which we think require consideration when another edition is prepared, but they are mostly of minor importance.

We do not agree with Mr. Scott when (on page 10), speaking of the wet bulb thermometer as a hygrometer, he says—"The moisture is usually measured by the pressure or tension of its vapour."

Captain Toynbee, F.R.A.S., contributes a paper on the use of the barometer to seamen, which appears to us of extreme utility. Mr. Strachan's paper on the construction and management of barometers contains many useful hints, and with some reduction tables appropriately closes a very excellent manual.

MARCH, 1871.

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.			
				Dpth.	Date.		Deg.	Date.	Deg.	Date.		
I.	Camden Town	1.19	-.89	.38	15	12	68.7	26	29.0	15	7	12
II.	Maidstone (Linton Park).....	1.44	- 1.05	.40	16	10	71.0	23+	30.0	2	...	...
III.	Selborne (The Wakes).....	2.04	- .56	.68	15	10	63.5	24	26.5	3, 22	11	15
III.	Hitchen	1.40	- .77	.62	15	13	63.0	26	27.0	24+	6	...
IV.	Banbury	1.33	- .87	.56	15	9	65.0	26	27.5	2, 17	8	...
IV.	Bury St. Edmunds (Culford).....	1.47	- .73	.30	14*	12	65.0	25+	26.0	14	9	17
V.	Bridport	1.77	- 1.10	.39	9	11	64.0	24	28.0	17	5	...
V.	Barnstaple	1.66	- 1.49	.32	9	12	67.5	25	32.0	17	...	...
V.	Bodmin	1.91	- 1.84	.62	9	13	63.0	24	31.0	30	1	10
VI.	Cirencester	1.65	- .95	.63	9	8	...	...	...	...	...	...
VI.	Shiffnal (Haughton Hall) .....	.84	- 1.10	.19	15	11	62.0	25	26.0	15	9	...
VI.	Tenbury (Orleton)	1.76	- .66	.43	15	15	66.5	26	27.0	17	9	19
VII.	Leicester (Wigston) .....	.94	- 1.17	.43	16	8	70.0	24||	...	...	10	...
VII.	Boston	1.02	- .77	.45	15	9	66.4	25	29.3	17	2	11
VII.	Grimsby (Killingholme) .....	.88	...	.29	15	10	61.0	25	28.0	15	3	...
VII.	Derby	1.15	- 1.09	.53	15	13	66.0	25	27.0	15	5	...
VIII.	Manchester	1.56	- 1.13	...	...	8	71.2	25	31.0	28	...	...
IX.	York	1.21	- .78	.39	15	12	64.5	24+	29.0	15	2	...
IX.	Skipton (Arncliffe)	4.67	- .14	1.24	10	11	69.0	26	20.0	16	14	...
X.	North Shields .....	.69	- 1.66	.16	9	13	57.6	3	21.3	15	5	8
X.	Borrowdale (Seathwaite).....	10.26	- 3.14	1.80	10	15	...	...	...	...	...	...
XI.	Cardiff (Town Hall).....	...	...	...	...	...	...	...	...	...	...	...
XI.	Haverfordwest	2.24	- 1.21	.64	9	10	65.0	26	30.0	15	3	5
XI.	Rhayader (Cefnfaes).....	1.48	- 2.36	.50	9	9	64.0	...	25.0	...	3	...
XI.	Llandudno.....	.77	- 1.49	.16	12	9	67.6	24	32.5	15	...	...
XII.	Dumfries	2.09	- .89	.73	9	13	69.5	24	13.0	15	6	...
XII.	Hawick (Silverbut Hall).....	2.00	...	.59	9	11	...	...	...	...	...	...
XIV.	Ayr (Auchendrane House) ...	4.04	+ .31	.70	15	17	68.0	24	15.0	15	6	14
XV.	Castle Toward	4.04	- .55	.62	15	19	64.0	25	20.0	15	7	10
XVI.	Leven (Nookton)	1.06	- 1.01	.38	9	15	64.0	25	21.0	15	9	23
XVI.	Stirling (Deanston)	3.49	- .04	.91	11	16	64.5	25	19.2	15	6	16
XVI.	Logierait	2.03	...	.49	6	15	...	...	...	...	...	...
XVII.	Ballater	1.00	...	.28	12	8	66.0	25	18.5	15	11	...
XVII.	Aberdeen .....	.53	...	.12	9	10	60.5	25	25.3	15	5	18
XVIII.	Inverness (Culloden)	1.72	...	.68	13	15	59.1	24	27.1	15	3	16
XVIII.	Portree	8.16	- .88	1.32	11	24	...	...	...	...	...	...
XVIII.	Loch Broom	3.95	...	.48	10	25	...	...	...	...	...	...
XIX.	Helmsdale	1.27	...	...	...	...	...	...	...	...	...	...
XIX.	Sandwick	2.30	- 1.03	.30	8	21	57.0	3	28.5	14	6	9
XX.	Cork	2.64	...	.68	8	11	...	...	...	...	...	...
XX.	Waterford	2.18	- .71	.37	9	15	62.0	...	31.0	15§	3	...
XX.	Killaloe	2.52	- 1.80	.60	10	14	67.0	24	27.0	29	6	...
XXI.	Portarlinton	1.46	- 1.85	.29	9	19	64.0	24	28.0	14	5	...
XXI.	Monkstown .....	.71	- 1.87	.21	6	10	...	...	...	...	2	...
XXII.	Galway	2.21	...	.36	15	15	60.0	25	30.0	28	2	...
XXII.	Bunninadden (Doo Castle) ...	3.06	...	.60	12	14	61.0	22	24.0	24-	6	...
XXIII.	Bawnboy (Owendoon) .....	...	...	...	...	...	...	...	...	...	...	...
XXIII.	Waringstown	1.63	...	.25	8	14	69.0	25	20.0	28	8	19
XXIII.	Strabane (Leckpatrick)	2.87	...	.44	9	16	65.0	...	...	...	...	...

* And 16. † And 25. ‡ And 26. § And 25, 26. § And 30.
 + Shows that the fall was above the average ; - that it was below it.

METEOROLOGICAL NOTES ON MARCH.

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.

LINTON PARK.—A very fine month, scarcely any frosts, while the temp. of the 23rd and three following days resembled June rather than March. Fogs on 20th, 21st, and 22nd; no high winds; wind mostly S. and S.W., but often changeable. S fell unexpectedly on the 16th, accompanied by but little frost, ther. falling only to 31°. Max. bar. 30·17 on 1st; min. bar. 29·13 on 16th. Winds S. and compounds of S., on 18 days; N. and compounds of N., 9; W., 3; and E., 1.

SELBORNE.—Violent wind from S.W., with R, at 10 p.m. on 5th; bar. fell 4 between 9 a.m. and noon on 9th; a most violent storm of wind, R, H, and some S, from 2 p.m., lasting three hours; wind W. Very rough, high wind, much S with R, early on the morning of the 16th; white frost on 20th; fog on 22nd; very dense fog with white frost on 23rd, and another dense fog on 24th, when the wind changed from N.E. to S.W. Sudden rise of bar. on 27th, when the wind changed from S.W. to N.E. Prevailing winds first three days E., then S.W. mostly for 10 days, and N.E. for the remainder of the month. Max. bar. 29·9 on 1st; bar. min. 28·79 on 16th; latter part of the month favourable for gardening and agricultural work, but a bleak and unhealthy month.

HITCHEN.—Tremendous gale and R on 9th; the heaviest fall of S on the 16th since January, 1866. Splendid meteor seen at 6.30 on 23rd. The highest temp. (63°), recorded so early in the year since March, 1858.

BANBURY.—High winds on 7th, 9th, and three following days; S on 14th, 15th, and 16th; T on 26th. Hedges leafing at the end of the third week.

CULFORD.—A month of very seasonable weather, with frequent slight morning frosts at the commencement of fine days. An almost summer temp. and aspect was experienced from the 23rd to the 27th, when a sudden change took place, as may be inferred from the fact of the max. temp. of the 25th and 26th being 65°, while those of the 28th and 29th were 44° and 48° respectively; the mean temp. of the month was 44°·3; high wind on 9th; S on 15th, 16th and 28th.

BRIDPORT.—Latter part of the month fine, and some days very mild, the temp. of the month being rather above the average.

BODMIN.—Bar. average of the month 30·000, average temp. 47°·2, being 3°·2 above the average for March.

SHIFNAL.—Great and sudden changes of wind and temp. This month opened pleasantly with S. and S.E. winds; on 15th it changed to N.W., and then went round by W., S.W., S. to S.E. on 22nd, and then by E. to N.E. on 24th, where it continued till the close of the month. A heavy storm all day on the 9th from S., veering round by S.W. to N.W. A severe frost with S on night of 18th; S with R on the following night; T without R in the N.E. on 26th at 4.30 p.m.; temp. that day 61°, following day 51°, and next day 41°,—20° difference in 48 hours. A dry month, suiting the lambing time and the resowing of the wheat, which had perished on strong lands. Crocus began to flower on 2nd; hawthorn to bud on 4th; apricot to blossom on 11th, willow on 13th; celandine to flower on 20th, wild daffodil on 24th; gooseberry bushes to blossom on 25th. First appearance of large humble bee on 18th; sulphur butterfly first seen on 24th; fog on 19th.

ORLETON.—A dry month, with a temp. 3° above the average, although more than half the nights were frosty. Much R from 5th to 16th, then very dry, generally fine till the end. Temp. at midday on 23rd, 24th, 25th, and 26th, was very high; a sudden change occurred on the evening of the 27th, and the remainder of the month was cold. Apricot in bloom about the 12th, and peach trees about the 24th. Distant T heard on the 26th, and L seen at night on 25th.

WIGSTON.—The unusual high temp. of the early and latter part of the month stimulated vegetation very much, so that the aspect of the country was very

different from that which it usually is in March. A heavy fall of S on the night of 15th. T on 26th.

GRIMSBY.—The month drier than usual, vegetation forward, and many pleasant days. High winds from the 6th to 13th. Max. temp. 61° on 25th, a clap of T at 5.45 p.m. Rooks began to build on the 1st; queen wasp seen on 3rd; gossamer web across funnel of gauge on 4th; apricot began to flower on 11th, and peach on 18th. Shock of earthquake felt at Barrow-in-Furnace and Ravensdale on 17th.

DERBY.—General character of the weather magnificent, many days more like June than March. Temp. about 3° above the mean, rainfall considerably below it.

ARNCLIFFE.—S on 16th.

NORTH SHIELDS.—Lunar halos on 1st and 4th; aurora on 17th, on which night a shock, which was said to be an earthquake, was felt about 11.10 p.m.; we were moving about at the time, and thus did not feel the motion, but the noise was as if the windows rattled. My sister living in Newcastle, 8 miles distant, was awakened by the shaking of her bed; two of our clerks living at Newcastle felt the shaking of their houses very clearly, and another living at Gateshead was awakened by all the bells ringing, and a small glass ornament was thrown down and broken.

SEATHWAITE.—S on 6 days; H on 4, and T on 8th and 26th.

W A L E S.

HAVERFORDWEST.—A mild month; wet from the 6th to the 16th, and at times very stormy; rainfall and frost below the average; a cowslip observed in full flower on the 5th.

CEFNFVAES.—The month has been cold; prevailing winds N.E. and S.E., and the nights more or less frosty. Lambs doing well, although there is but little food for the ewes.

LLANDUDNO.—Primroses gathered in the hedges on the 4th; S on the distant hills on the 6th and 7th. The month has been most changeable, from great heat to cold—March weather. The wind generally W., only E. on 10 days during the month; an earthquake felt on Friday, the 17th, at 11 p.m., rousing many from their beds by the shaking of windows and doors, as if some heavy thing had fallen in the house; a peculiar lurid light for a few moments whilst the earthquake lasted.

S C O T L A N D.

DUMFRIES.—The first half of the month wet and stormy, with occasional showers of S and sleet. On the morning of 15th the most intense frost known in the month of March for upwards of 20 years, the protected ther. being 19° below freezing point, only twice lower during the winter. The latter half of the month dry and generally cold, except from 23rd to 25th, when it was very warm. T on 23rd. A slight shock of earthquake was felt here between 11 and 11.30 p.m. on 17th; in some cases doors and windows rattled, as well as the slates on the roofs; in some houses articles of furniture were thrown down; people in bed felt as if the bed was raised up by some person beneath; at Kirkbean, in the neighbourhood of Criffel Mountain, the shock was experienced throughout the whole parish, a deep rumbling noise was heard, and a violent motion, followed by a sound as if of air rushing to fill up a vacuum.

SILVERBUT HALL.—Violent gales on 5th, 6th, 7th, 20th and 21st. Snowstorms on 13th and 14th. The month has been favourable for getting in seeds; sowing has been actively prosecuted, and has been concluded on most farms, and on all is far advanced. The lambs have made their appearance on the low grounds, and there is a good proportion of twins, but the chill air has not been in their favour. The pastures were rapidly getting fresh and green till checked by the very severe frosts of the last five days.

AUCHENDRANE.—This month the diminished amount of cloud, the high temp., and strong winds, chiefly equinoctial, did not lower the bar. pressure much below the mean, though they narrowed somewhat the extremes of bar. range, and raised the rainfall and evaporation considerably above the mean, producing at some

times a humidity of 83. R slightly intermitted out-door work till the 21st, afterwards March dust and dew on grass appeared. The north of England earthquake was not felt here. Rivers still amply supplied with water.

CASTLE TOWARD.—The first half of the month was wet and occasionally stormy, but free of frost up to the 14th; the latter half generally fine, mild and clear; early spring plants are quite gay, and fruit trees promise an abundant crop.

DEANSTON.—First week changeable, without much R; second week wet and stormy; on 8th T and L, with wind and sleet, and a fall of S on 9th; gale with R on 12th; from 15th to the end but little R; bright sun, E. wind, and sharp frost with ice a quarter of an inch thick, on 29th.

LOGIERAIT.—Frost, with H and S showers on 13th and 15th; frost on the night of 27th. Lapwing seen on 22nd. The month closed cold, with E. wind.

BALLATER.—High winds prevailed throughout the month, but weather open, and out-door work but little interrupted; rainfall under the average; occasional S showers; ground cold and white at the end of the month.

ABERDEEN.—S on six days, auroræ on seven days. A month of mild dry weather; since the 14th of February not one inch of R has fallen. Frequent strong winds; mean bar. (reduced) 29·860, or 0·128 above mean of 14 years; mean temp. 42°·9, or 3°·8 above mean; rainfall 1·87 less than the average. S.W. winds greatly in excess, N.W. also in excess. Estimated pressure a little under the average.

PORTREE.—A cold, wet, and stormy month; from 13th to 17th heavy fall of S, 13 inches deep all over; heavy gale from W.S.W. all day on 12th; the month throughout has been very squally and cold.

LOCHBROOM.—The R during the month has been very constant, but so gradual and uniform that it has not much retarded agricultural operations, and on account of the continual moisture and freedom from frost, vegetation is in an unusual state of forwardness.

SANDWICK.—Temp. of March 2°·3 above the average of last 44 years, and the rainfall below it. Gales on 7th, 8th, 12th, 30th, and 31st, from 40 to 50 miles an hour; auroræ on four nights.

I R E L A N D.

MONKSTOWN.—The month unusually dry; frost occurred on the nights of 13th and 16th. Prevailing winds in the early part of the month were S.E., S., and S.W., in the latter part N.E., N., and N.W.

DOO CASTLE.—Beginning of month rough and stormy, middle to end fine; tillage fairly advanced.

LECKPATRICK.—Constant R the first half of the month, the latter half very dry and favourable for sowing seeds. S on the 16th.

WHAT ARE THE CAUSES OF FROST BEING SO MUCH MORE SEVERE AT ONE PLACE THAN ANOTHER?

To the Editor of the Meteorological Magazine.

SIR,—Amongst the many questions raised in your useful periodical, there is one to which I have never seen a satisfactory solution given, and that is the cause of the wide differences in the readings of min. thers.; in other words, how are we to account for one place being visited with 10 or 15 degrees more frost than another one less than half-a-dozen miles off. I expect to be told that elevation has something to do with it, and undoubtedly it exercises some influence that way, but not sufficient to make up the discrepancies, neither do I attribute errors in the instruments used as blameable for the whole of it, for there are other tokens

of a severe frost besides those which the readings of a thermometer give, and they are its effects on vegetation, the thickness of ice and other natural results of extreme cold, not the less to be regarded because they cannot well be reduced to figures ; and the past winter has given us several examples this way which require explanation ; for instance, the lowest point attained by our thermometer here was 13° , or 19° of frost, on the morning of 24th of December, which I believe was also the coldest at other places in the neighbourhood. While at some places not more than 4 or 5 miles off, the readings were down to 3° , and one or two places at zero, and some are said to have been even below that. An error in the instruments used might have been thought the cause of this, were the effects on vegetation not so apparent as to justify the belief that the thermometers are not much in fault, for while our shrubs and trees have scarcely been injured, others are killed to the ground ; and I could point to one or two situations of nearly the same elevation as Linton, that were visited with 6° or 7° more frost, and that only a very few miles from us, while as much as 8° difference existed in a situation not more than half a mile from us, but some 100 feet lower. Assuredly there must be causes for this, which have never been sufficiently explained. The only conclusion I can come to on the matter is, that the cold air descends in waves or volumes, and not in a compact uniform body, and has to depend on the wind mixing it with the surface atmosphere, and as there was scarcely any wind at all the night in question, the mixing was only imperfectly effected, and probably cold may have an affinity for cold, and consequently an accumulation of it might visit one place to a greater degree than another. Certain it is we never experience the same disparity in heat. The hottest day in summer rarely presents above 1° or 2° of difference in those places where 8° or 10° have been read the past winter, and I can only attribute it to the greater circulation during the daytime ; be this as it may, the matter requires investigating, and I have been looking for each issue of your magazine, the present year, containing some articles upon it ; thus I have put forward the above theory, rather as an inducement for others to inform us of the actual cause ; at the same time, I may repeat that erroneous instruments are not the only one, for I am not sure but a careful examination of them would make the discrepancy still larger, and assuredly an elevation of some 60 or 70 feet ought not to account for 6° or 7° more or less of frost, and yet this has been exceeded, when the situation in other respects seemed much the same, and I am not sure but 15° or 18° difference has not been recorded in this county within a stretch of less than that number of miles, the injury done to trees and shrubs proving that a great difference did exist, and possibly quite to the extent the instrument pointed it to be. Might I ask for some further explanation on this ?

JOHN ROBSON.

Linton Park, Maidstone.