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ON CERTAIN VARIATIONS OF TEMPERATURE DURING  
THE SOLAR ECLIPSE OF DECEMBER 22ND, 1870.

THE observations described in the following paper were conducted in the neighbourhood of Barnstaple, North Devon ; where, in consequence of the fineness of the weather, the eclipse was seen to the greatest possible advantage.

During the night of December 21-22 there was a severe frost, and when my usual meteorological observations were taken at 10 a.m. on the 22nd, the wind was E.S.E. and the barometer (corrected for sea level) stood at 30.16. The sun was shining brightly, and, with the exception of a few cumuli along the eastern horizon, no clouds were visible in any part of the sky. During the whole of the day it was freezing in the shade.

As the wind was blowing in occasional gusts, I found that any thermometrical observations made in the open air, would be comparatively useless for the purpose of showing the actual variation of temperature produced by the eclipse, whilst the erection of any shelter between the instrument and the wind would have been objectionable from its tendency to cause side draughts. The thermometer was therefore placed in a large room on the ground floor, with a southern aspect, where it was perfectly free from the influence of any currents of air, which might cause an undue depression. It was attached in a slightly inclined position to an oak board, placed 2 feet from the window, which was a large one, opening down to the ground, and having a superficial area of 36 square feet. Every care was taken to insure the accuracy of the observations ; but, if any error exists in them, it would tend, as far as I can see, to show an excess instead of a diminution in the several readings. Such error might arise from one of two sources. Either from the refraction of the glass of the intervening window ; or, secondly, from the occasional presence of the observer in the room. Neither of these causes would, however, materially affect the observations ; and the latter I especially guarded against, by entering the room only at each interval of five minutes, and remaining no longer than the few seconds requisite to examine the thermometer. No fire had been lighted in the room for several days previously.

The thermometer was put in position, and fully exposed to the sun, some time before the commencement of the eclipse, when the tempera-

ture marked 69°. The first contact took place at 11h. 1m., Greenwich time, but no perceptible difference was indicated during the succeeding 40 minutes. Between 11.40 and 11.45 the temperature fell 1°, and from that time there was a rapid and regular depression until 12.30, when the *minimum* of 49° was reached. This was immediately followed by a steady rise, and at 1.35 the atmosphere had regained its normal temperature.

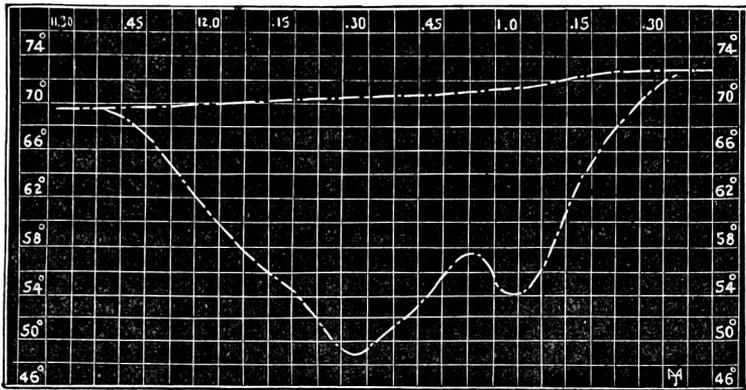
In the accompanying table I have given, in the second column, the temperature in the sun for each interval of five minutes during the period of variation, that is to say from 11.40 to 1.40. In the next column, taking the difference between the mean temperature before and after the eclipse, and considering, from former observations made under ordinary circumstances, that the temperature steadily increases from sunrise till nearly 2 p.m., I have estimated the exact ratio in which it would have progressed during the two hours under normal conditions. From these corrected temperatures I have subtracted the observed temperatures, and formed from them the accompanying diagram, as well as the results shown in the column headed "difference from mean." The last line of figures gives the difference between each successive interval of five minutes.

*Summary of Thermometrical Observations taken at Pilton Parsonage, near Barnstaple, during the Solar Eclipse of December 22, 1870.*

| Hour. | Temperature in the sun. | Estimated normal temperature. | Difference from mean. | Difference between each interval. |
|-------|-------------------------|-------------------------------|-----------------------|-----------------------------------|
|       | deg.                    | deg.                          | deg.                  | deg.                              |
| 11.30 | 69·0                    | ...                           | ...                   | ...                               |
| 11.35 | 69·5                    | ...                           | ...                   | 0·5                               |
| 11.40 | 69·5                    | 69·5                          | 0·0                   | ...                               |
| 11.45 | 68·5                    | 69·625                        | 1·125                 | ...                               |
| 11.50 | 66·25                   | 69·75                         | 3·5                   | 2·375                             |
| 11.55 | 63·5                    | 69·875                        | 6·375                 | 2·875                             |
| 12    | 61·25                   | 70·0                          | 8·75                  | 2·375                             |
| 12.5  | 59·0                    | 70·125                        | 11·125                | 2·375                             |
| 12.10 | 56·75                   | 70·25                         | 13·5                  | 2·375                             |
| 12.15 | 55·25                   | 70·375                        | 15·125                | 1·625                             |
| 12.20 | 53·75                   | 70·5                          | 16·75                 | 1·625                             |
| 12.25 | 50·0                    | 70·625                        | 20·625                | 3·875                             |
| 12.30 | 49·0                    | 70·75                         | 21·75                 | 1·125                             |
| 12.35 | 50·25                   | 70·875                        | 20·625                | 1·125                             |
| 12.40 | 52·0                    | 71·0                          | 19·0                  | 1·625                             |
| 12.45 | 54·25                   | 71·125                        | 16·875                | 2·125                             |
| 12.50 | 56·75                   | 71·25                         | 14·5                  | 2·375                             |
| 12.55 | 57·25                   | 71·375                        | 14·125                | 0·375                             |
| 1     | 54·0                    | 71·5                          | 17·5                  | +3·375                            |
| 1.5   | 54·75                   | 71·625                        | 16·875                | 0·625                             |
| 1.10  | 58·0                    | 71·75                         | 13·75                 | 3·125                             |
| 1.15  | 64·0                    | 71·875                        | 7·875                 | 5·875                             |
| 1.20  | 67·25                   | 72·0                          | 4·75                  | 3·125                             |
| 1.25  | 69·75                   | 72·125                        | 2·375                 | 2·375                             |
| 1.30  | 71·75                   | 72·25                         | 0·50                  | 1·875                             |
| 1.35  | 72·25                   | 72·375                        | 0·125                 | 0·375                             |
| 1.40  | 72·50                   | 72·50                         | 0·0                   | 0·125                             |

Commencement, 11h. 1m. ; greatest phase, 12h. 19m. ; termination, 1h. 37m.

*Diagram showing the variations of temperature during the Solar Eclipse, December 22nd, 1870.*



*Notes.*—From 12h. 21m. 0s. to 12h. 27m. 30s. a few small detached clouds passed rapidly over the sun, but they were not of sufficient density at any time, to obscure it. A series of bright white rays, diverging upwards from above the clouds, contrasted strongly in colour with the deep indigo blue of the whole sky. At 12.25 three stars faintly visible in the north. 12.54 a narrow broken belt of clouds beginning to pass over the sun, continuing till 12.57, when a thicker cloud completely obscured it till 1.2, causing a fall in the thermometer of 3°·25. At 1·4 all the remaining portions of the cloud had disappeared.

*Results.*—In the foregoing observations I have endeavoured to show the extent to which the atmosphere is affected by a partial eclipse during the middle of winter. It will be seen that the total amount of depression at the time of the greatest obscuration was 21°·75, and I would submit that these figures represent more exactly the influence of an eclipse, than if the observations had been taken at any other period of the year.

During the summer months both the atmosphere and the earth are so charged with heat, that a partial darkening over of the sun for so short a time loses, to a certain degree, its effect—the diminution of warmth being partially neutralised, before it can reach the earth, by reason of its passage through the intervening atmosphere. It is to be hoped that similar observations will have been made at some point along the line of total obscuration; whilst, on a future occasion, it will remain an interesting question to be determined by meteorologists, how far the thermal depression varies with the season of the year and the climate of the locality.

*Pilton, Barnstaple.*

TOWNSHEND M. HALL, F.G.S.

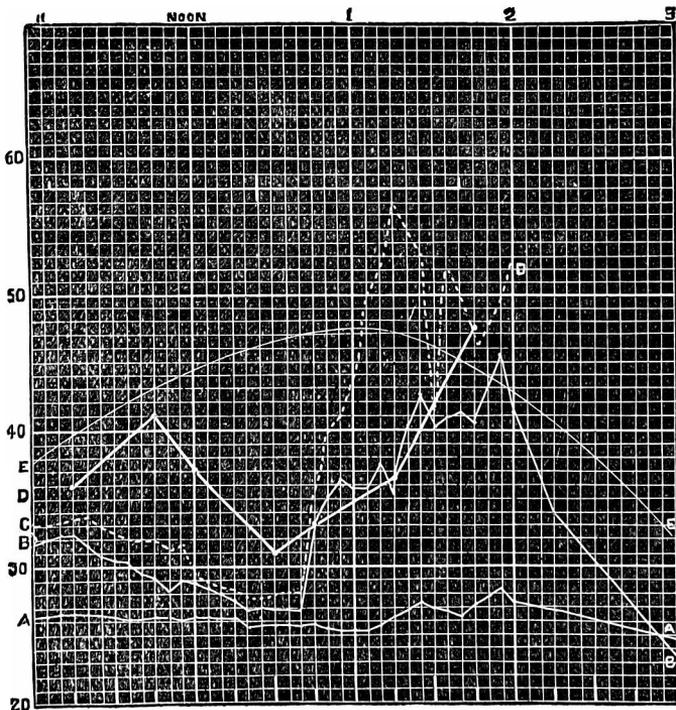
*To the Editor of the Meteorological Magazine.*

SIR,—The season of the year and the variable character of the weather during the eclipse rendered its effect upon the temperature less marked than is usual. I have no report from any station where the

sun was unclouded during the whole of the eclipse, and this renders any exact determination of the diminution of this heat by obscuration impossible. It will be best simply to place, side by side, an abstract of the observations which have been placed at my disposal, leaving it to your judgment to make any additions to the figures or comments on them that may be desirable.—I am, Sir, your obedient servant,  
F. W. STOW.

P.S.—The thermometers used for determining the sun's heat are the "dull black bulb in vacuo," and have the bulb and 1 inch of the stem blackened. The others are the ordinary dry bulb mercurial thermometer (except where otherwise stated). \* indicates a minimum, † the maximum for the day.

[In order to throw a little further light on the information afforded by Mr. Stow's tables, we add the following diagram, wherein A is the shade temperature at Camden Square, B the vacuum black bulb readings at the same station, C and D the readings of similar instruments at Holloway and Hawsker respectively, and E represents approximately the normal curve of the vacuum black bulb thermometer at Camden Square for a cloudless midwinter day. The period of the eclipse is denoted by the thick horizontal line, and the epoch of maximum obscuration by the short transverse mark in its centre.—ED.]



| Time.  | CAMDEN SQUARE.<br>G. J. Symons, Esq. |       |                              | HOLLOWAY.<br>Leighton Kenteven, Esq. |          |                              | HAWSKER, WHITEY.<br>Rev. F. W. Stow. |           |                              | SUNDERLAND.<br>T. W. Backhouse, Esq. |          |                              | HALIFAX.<br>J. Gledhill, Esq., F.G.S. |          |                              |
|--------|--------------------------------------|-------|------------------------------|--------------------------------------|----------|------------------------------|--------------------------------------|-----------|------------------------------|--------------------------------------|----------|------------------------------|---------------------------------------|----------|------------------------------|
|        | Thermometers at 4 ft.                |       | Decrease (-) or Increase (+) | Thermometers at 4 ft.                |          | Decrease (-) or Increase (+) | Thermometers at 4 ft.                |           | Decrease (-) or Increase (+) | Thermometers at 4 ft.                |          | Decrease (-) or Increase (+) | Thermometers at 4 ft.                 |          | Decrease (-) or Increase (+) |
|        | Shade.                               | Sun.  | Shade.                       | Sun.                                 | Shade.   | Sun.                         | Shade.                               | Sun.      | Shade.                       | Sun.                                 | Shade.   | Sun.                         | Shade.                                | Sun.     | Shade.                       |
| 9 a.m. | deg. 25.1                            | ...   | deg. ...                     | deg. ...                             | deg. ... | deg. ...                     | deg. ...                             | deg. 28.0 | ...                          | deg. ...                             | deg. ... | deg. 25.0                    | deg. 24.7                             | deg. ... | deg. ...                     |
| 11     | 26.2                                 | 31.9  | +1.1                         | ...                                  | 30.0     | 33.0                         | ...                                  | 28.5      | 28.0                         | ...                                  | ...      | 23.4                         | 22.3                                  | -1.6     | -2.4                         |
| 11.15  | 26.4                                 | 32.2  | +1.3                         | +0.3                                 | 29.0     | 33.6                         | +1.0                                 | 29.8+     | 36.0                         | +8.0                                 | ...      | ...                          | ...                                   | ...      | ...                          |
| 11.30  | 26.3                                 | 30.4  | -0.1                         | -1.8                                 | 28.0     | 32.5                         | -2.0                                 | ...       | ...                          | ...                                  | 29.0     | 24.0                         | 23.0                                  | -1.0     | -1.7                         |
| 11.45  | 26.2                                 | 29.1  | -0.2                         | -3.1                                 | 28.0     | 32.0                         | -2.0                                 | 28.7      | 41.0                         | +13.0                                | ...      | ...                          | ...                                   | ...      | ...                          |
| noon   | 26.1                                 | 28.8  | -0.3                         | -3.4                                 | 27.0     | 29.5                         | -3.0                                 | 28.2      | 37.0                         | -4.0                                 | 30.0     | 24.0                         | 23.0                                  | -1.0     | -1.7                         |
| 12.15  | 26.1                                 | 27.5  | -0.3                         | -4.7                                 | 26.8     | 23.5                         | -3.2                                 | ...       | ...                          | ...                                  | 29.5     | ...                          | ...                                   | ...      | ...                          |
| 12.20  | 25.7                                 | 26.8  | -0.7                         | -5.4                                 | 26.8     | 27.8*                        | -3.2                                 | ...       | ...                          | ...                                  | 30.3     | ...                          | ...                                   | ...      | ...                          |
| 12.25  | 25.8                                 | 26.9* | -0.6                         | -5.3                                 | 26.8     | 27.8*                        | -3.2                                 | ...       | ...                          | ...                                  | ...      | ...                          | ...                                   | ...      | ...                          |
| 12.30  | 25.8                                 | 26.8* | -0.6                         | -5.4                                 | 27.0     | 28.0                         | -3.0                                 | 28.0*     | 31.0                         | -10.0                                | 31.0     | 23.7                         | 22.2                                  | -1.3     | -2.5                         |
| 12.35  | 25.8                                 | 26.8* | -0.6                         | -5.4                                 | 27.0     | 28.0                         | -3.0                                 | ...       | ...                          | ...                                  | 28.0*    | ...                          | ...                                   | ...      | ...                          |
| 12.40  | 25.7                                 | 26.8* | -0.7                         | -5.4                                 | 26.5     | 28.0                         | -3.5                                 | ...       | ...                          | ...                                  | ...      | ...                          | ...                                   | ...      | ...                          |
| 12.45  | 25.8                                 | 30.0  | -0.6                         | +3.2                                 | 26.5     | 35.0                         | -3.5                                 | 28.0*     | 33.0                         | +2.0                                 | ...      | ...                          | ...                                   | ...      | ...                          |
| 12.50  | 25.5                                 | 35.3  | -0.9                         | +8.5                                 | 26.0*    | 40.0                         | -4.0                                 | ...       | ...                          | ...                                  | ...      | ...                          | ...                                   | ...      | ...                          |
| 1      | 25.4*                                | 35.8  | -1.0                         | +9.0                                 | 26.5     | 44.0                         | +0.5                                 | ...       | ...                          | ...                                  | ...      | 23.7                         | 22.4                                  | -1.3     | -2.3                         |
| 1.15   | 26.3                                 | 35.5  | +0.9                         | +8.7                                 | 28.5     | 57.0                         | +2.5                                 | 29.8+     | 36.5                         | +5.5                                 | 30.0     | ...                          | ...                                   | ...      | ...                          |
| 1.30   | 26.8                                 | 40.2  | +1.4                         | +13.4                                | 28.5     | 41.0                         | +2.5                                 | ...       | ...                          | ...                                  | 30.5     | 24.8                         | 23.4                                  | +1.1     | +1.0                         |
| 1.45   | 27.2                                 | 40.8  | +1.8                         | +14.0                                | 29.0     | 46.0                         | +3.0                                 | 29.8+     | 47.5+                        | +16.5                                | 31.0     | ...                          | ...                                   | ...      | ...                          |
| 2      | 27.2                                 | 41.4  | +1.8                         | +14.6                                | 30.0     | 52.5                         | +4.0                                 | ...       | ...                          | ...                                  | 31.0     | 24.4                         | 23.1                                  | -0.4     | -0.3                         |
| 2.30   | ...                                  | ...   | ...                          | ...                                  | ...      | ...                          | ...                                  | ...       | ...                          | ...                                  | ...      | 24.4                         | 23.0                                  | -0.4     | -0.4                         |
| 3      | 24.8                                 | 23.8  | -2.4                         | -17.6                                | ...      | ...                          | ...                                  | ...       | ...                          | ...                                  | 31.0     | 24.8                         | 22.8                                  | +0.4     | -0.61                        |

*Amount of Solar Radiation (=sun, —shade). Thermometers at 4 feet.*

| Time. | Camden Square. | Holloway. | Hawsker. |
|-------|----------------|-----------|----------|
|       | deg.           | deg.      | deg.     |
| 11    | 5·7            | 3·0       | ...      |
| 11.15 | 5·8            | 4·6       | 6·2      |
| 11.30 | 3·9            | 4·5       | ..       |
| 11.45 | 2·9            | 4·0       | 12·3     |
| noon  | 2·7            | 2·5       | 8·8      |
| 12.15 | 1·4            | 1·7       | ...      |
| 12.20 | 0·9            | 1·0       | ...      |
| 12.30 | 1·0            | 1·0       | 3·0      |
| 12.45 | 4·2            | 8·5       | 5·0      |
| 1     | 10·4           | 17·5      | ...      |
| 1.15  | 9·2            | 28·5      | 6·7      |
| 1.30  | 13·4           | 12·5      | ...      |
| 1.45  | 13·6           | 17·0      | 17·7     |
| 2     | 14·2           | 22·5      | ...      |

*To the Editor of the Meteorological Magazine.*

*Temperature during the latter half of the Solar Eclipse, 22nd December, 1870, observed at Sidmouth.*

| Chronometer showing Greenwich time. |    |     | Thermometers        |       |       |       |
|-------------------------------------|----|-----|---------------------|-------|-------|-------|
|                                     |    |     | A.                  | B.    | C.    |       |
| h.                                  | m. | s.  |                     |       |       |       |
| 12                                  | 19 | 43, | middle of eclipse   | ...   | —     | —     |
| „                                   | 24 | ... | bright sun          | 31°·3 | ...   | —     |
| „                                   | 25 | ... | „                   | 31°·0 | ...   | 29°·5 |
| „                                   | 29 | 30  | „                   | 32°·0 | 36°·0 | ...   |
| „                                   | 32 | ... | cloud               | 31°·1 | ...   | —     |
| „                                   | 36 | ... | sun                 | 32°·5 | ...   | —     |
| „                                   | 38 | ... | „                   | 33°·5 | ...   | —     |
| „                                   | 39 | ... | „                   | 34°·0 | ...   | —     |
| „                                   | 41 | ... | cloud               | 33°·4 | ...   | —     |
| „                                   | 45 | ... | sun                 | 35°·0 | ...   | —     |
| „                                   | 46 | 30  | „                   | 36°·0 | ...   | —     |
| „                                   | 48 | ... | „                   | 37°·0 | ...   | —     |
| „                                   | 50 | ... | „                   | 38°·0 | 45°·0 | ...   |
| „                                   | 58 | ... | „                   | 40°·0 | 53°·0 | ...   |
| 1                                   | 0  | ... | „                   | 41°·5 | 55°·0 | ...   |
| „                                   | 3  | ... | „                   | 43°·0 | 57°·0 | ...   |
| „                                   | 9  | ... | „                   | 44°·0 | 62°·0 | ...   |
| „                                   | 10 | ... | „                   | 45°·5 | ...   | —     |
| „                                   | 13 | ... | „                   | 46°·5 | 64°·0 | ...   |
| „                                   | 20 | ... | „                   | 48°·8 | 67°·0 | ...   |
| „                                   | 27 | ... | „                   | 50°·5 | 71°·0 | ...   |
| „                                   | 37 | ... | clouds              | 50°·5 | 73°·0 | 81°·0 |
| 1                                   | 37 | 57, | end of the eclipse. |       |       |       |

N.B.—The time was mostly taken at the moment the mercury in rising touched the line marking the whole degrees. During the longer intervals the sun was more or less clouded. As long as the sun shone the mercury rose visibly and continuously, but the slightest film of cloud, almost invisible, caused a check and then a fall.

Thermometer A was laid on the side of a window facing south, so

that it could be observed with a magnifier through the glass. This thermometer is extremely sensitive, having a spiral bulb of 20 turns, a very fine bore, and being divided to the tenth of a degree ( $10^\circ = 3\frac{1}{2}$  in.) It has been verified at Kew, the correction only twice amounting to  $0^\circ\cdot 1$ ; mounted on box wood scale.

Thermometer B has an exhausted jacket and black glass bulb; it is fixed parallel to A. Owing to reflected heat its readings are considerably higher than they would be if it were in a proper position. (On May 26, 1870, it stood at  $168^\circ$ .) When the white linen blind is drawn down inside the closed window, in full sunshine, it rises  $2^\circ$ . No lamp black. It rose to  $97^\circ$  on the 23rd of December.

Thermometer C, in a wooden box (like a sentry box), outside same window.

Sidmouth.

R.

*To the Editor of the Meteorological Magazine.*

SIR,—I beg to enclose a few observations made during the late solar eclipse. As I was unable to leave the equatorial room, L. J. Crossley, Esq., F.M.S., of Willow Hall, very kindly instructed his assistant to read the thermometers. The remarks on the clouds, &c., are mine.—I am, dear Sir, yours very truly,

JOSEPH GLEDHILL, F.G.S., F.M.S.

*Park Road Observatory, Halifax, Dec. 22nd, 1870.*

*Readings of Hygrometer in Shade, 4 feet from ground.*

| Time.          | Dry Bulb. | Wet Bulb. | Time.       | Dry Bulb. | Wet Bulb. |
|----------------|-----------|-----------|-------------|-----------|-----------|
| 9 a.m. ...     | 25°·0     | 24°·7     | 1 p.m. ...  | 23°·7     | 22°·4     |
| 11 ,, ...      | 23·4      | 22·3      | 1.30 ,, ... | 24·8      | 23·4      |
| 11.30 ,, ...   | 24·0      | 23·0      | 2 ,, ...    | 24·4      | 23·1      |
| noon ...       | 24·0      | 23·0      | 2.30 ,, ... | 24·4      | 23·0      |
| 12.30 p.m. ... | 23·7      | 22·2      | 3 ,, ...    | 24·8      | 22·8      |

*Remarks on Cloud, &c.*—6 a.m. Some detached clouds pass slowly from N.E.—7 a.m. More cloud.—8 a.m. Cloudless zenith, sun rising in dark beds of cloud.—9 a.m. as at 8 a.m., with warm haze in S.E.—10.30 a.m. White clouds gather about sun, soon free from them. From this time until noon clouds often gathered near the sun.—11.45 a.m. The wind rose a little.—12.15 p.m. Dark clouds pass.—12.20 p.m. The southern sky now put on a stormy appearance, a dull haze covering the sky and cutting off the sun's light considerably; then a well defined glory surrounded the sun; the zenith was cloudless. From this time until 2 p.m. the sky was clear. At 1.30 the coloured fringes were well seen on the detached white clouds near the sun.

ADDITIONAL NOTES ON THE SQUALL OF OCT. 19, 1870.

The number of additional observations of this squall which we have received appearing to us insufficient to throw much further light upon its character, we think that the wisest course is to chronicle the additional reports which we have received, to point out that the longitude

of Chepstow was entered wrongly in our first table (Vol. V., p. 149), and to give in a second table the correct figures for Chepstow, and those for the additional returns received since November :—

| Station,              | County.      | Longitude. | Time of occurrence. |           |             |
|-----------------------|--------------|------------|---------------------|-----------|-------------|
|                       |              |            | Reported.           | Computed. | Difference. |
| St. Anne's .....      | Pembroke..   | 5° 8' W.   | 10.15               | 9.38      | —37 min.    |
| Ilminster.....        | Somerset ... | 2 54       | about noon          | 11.30     | —30 „       |
| Chepstow .....        | Monmouth.    | 2 41       | 11.15               | 11.41     | +26 „       |
| Frome Vanchurch ..... | Dorset ..... | 2 33       | 11.42               | 11.47     | +5 „        |
| Birmingham .....      | Warwick...   | 1 54       | 11.55               | 0.20      | +25 „       |
| Halifax .....         | York .....   | 1 54       | 0.30                | 0.20      | —10 „       |
| Lymington .....       | Hants .....  | 1 34       | noon                | 0.37      | +37 „       |
| Banbury .....         | Oxford.....  | 1 20       | 0.30                | 0.48      | +18 „       |
| Swyncombe.....        | „ .....      | 1 0        | 0.40                | 1.5       | +25 „       |
| Winchmore Hill... ..  | Middlesex..  | 0 6 W.     | 1.45                | 1.50      | +5 „        |
| Audley End .....      | Essex .....  | 0 13 E.    | 2.3                 | 2.6       | +3 „        |
| Eridge .....          | Sussex ..... | 0 16 E.    | 1.55                | 2.7       | +12 „       |

From the combined results of the two tables it appears that the rate of progress originally assumed was very nearly correct, if anything about three miles per hour too slow ; 53 miles per hour would apparently agree better with the recorded times than 50 miles, but the error is not serious.

ST. ANNE'S, MILFORD, SOUTH WALES.—October 19th, 8 a.m., bar. 29.11 ; ther., 58° ; wind, S.W. ; force, 8 ; rain during preceding 24 hours, 0.51. *Note.*—A gale from S.W. at 2 p.m. on the 18th until 10.30 a.m. on the 19th, with a very severe squall at 10.15 a.m. on the 19th.—*T. L. Marriott.*

ILMINSTER.—On the 19th, about noon, there was a violent hailstorm, which did not last beyond half-an-hour, and tore down some trees. During this storm the thermometer fell to 45° from 56°.5 at 9 a.m. On this day, also, was the greatest fall of rain (.87 in.).—*J. Knott.*

SIR,—I enclose tracings from our instruments, which will give you the variations of wind and of barometric pressure for the time you name.



The actual corrected reading of the standard barometer at 9 a.m. on October 19th was 28.928 in., so that, as you see, the barograph readings are somewhat higher than the standard. The following

pressures of wind on the square foot occurred at the times named, October 19th, 1870 :—

|                     |                         |
|---------------------|-------------------------|
| 9·0 a.m. ... 2 lbs. | 11·0 a.m. ... 5·5 lbs.  |
| 9·5 " ... 3·5 "     | 11·5 " ... 6·2 " (max.) |
| 9·6 " ... 4·0 "     | 12·0 " ... 5·8 "        |
| 10·3 " ... 2·0 "    | 1·0 p.m. ... 0·8 "      |

The record is imperfect after this hour.—Yours truly,

C. J. WOODWARD.

Midland Institute, Birmingham, Dec. 23rd, 1870.

*Willow Hall Observatory, Halifax.*

Lat. 53° 43' 7" N. Lon. 1° 53' 56" W. 630 feet above sea level.

| Time.           | Bar.   | Temp. | Direction of Wind. | Velocity | Remarks.  |
|-----------------|--------|-------|--------------------|----------|---|
| Oct. 19, 1 a.m. | ...    | ...   | S.S.W.             | 19       | Rain ·004.  |
| 2 "             | ...    | ...   | W.S.W.             | 17       | { "·005, veering suddenly towards the west.   |
| 3 "             | ...    | ...   | W.E.S.             | 22       |   |
| 4 "             | ...    | ...   | W.S.W.             | 23       |   |
| 5 "             | ...    | ...   | S.S.W.             | 22       |   |
| 6 "             | ...    | ...   | S.S.W.             | 10       |   |
| 7 "             | ...    | ...   | S.S.W.             | 7        |   |
| 8 "             | ...    | ...   | S.S.W.             | 6        |   |
| 9 "             | 29·362 | 50·48 | S.E.W.             | 9        | { Rain for previous 24 hours, ·105.   |
| 10 "            | ...    | ...   | S.E.W.             | 9        |   |
| 11 "            | ...    | ...   | S.                 | 12       |   |
| Noon.           | 29·195 | 52·50 | S.                 | 16       | { At 12.30 the wind changed suddenly into the S.W.  |
| 1 p.m.          | ...    | ...   | S.W.               | 22       |   |
| 2 "             | ...    | ...   | S.S.W.             | 12       |   |
| 3 "             | 29·160 | 51·47 | S.W.               | 15       |   |
| 4 "             | ...    | ...   | S.W.               | 13       | { At 6.30, 6.50, and 7.10 there were peculiar puffs of wind from the S.W.   |
| 5 "             | ...    | ...   | S.W., E.S.         | 11       |   |
| 6 "             | ...    | ...   | S.S.W.             | 12       |   |
| 7 "             | ...    | ...   | S.S.W.             | 17       |   |
| 8 "             | ...    | ...   | S.W., E.W.         | 18       |   |
| 9 "             | 29·029 | ...   | S.W., E.W.         | 20       | { A sudden change here at 9·55 into the W.N.W.  |
| 10 "            | ...    | ...   | W.N.W.             | 20       |   |
| 11 "            | ...    | ...   | W.                 | 19       |   |
| Midnight.       | ...    | ...   | W.                 | 21       |   |
| Oct. 20, 1 a.m. | ...    | ...   | W.E.S.             | 19       | { Heavy squalls from N.W. to W.S.W.   |
| 2 "             | ...    | ...   | W.E.N.             | 21       |   |
| 3 "             | ...    | ...   | W.S.W.             | 19       | { The wind here became more steady, but backing gradually into the S.W.   |
| 4 "             | ...    | ...   | W.S.W.             | 20       |   |
| 5 "             | ...    | ...   | W.S.W.             | 21       | { Rain previous 24 hours ·485; the wind here became squally, and at 11.40 veered suddenly from S.W. into N.W., in which quarter it remained throughout the whole day, the velocity averaging about 15 miles per hour. |
| 6 "             | ...    | ...   | S.W., E.W.         | 22       |   |
| 7 "             | ...    | ...   | S.W., E.W.         | 21       |   |
| 8 "             | ...    | ...   | S.W.               | 21       |   |
| 9 "             | 29·128 | 43·42 | W.S.W.             | 29       |   |
| 10 "            | ...    | ...   | ...                | 14       |   |

L. J. Crossley.

WAINSFORD, LYMINGTON, HANTS.—I give you an extract from my register of the gale of 19th October last, and also the readings of my

barometer the day previous and two days after. You will observe the gale began at night on the 18th from S.W., thence round to N.N.W., ending in a flat calm.

|         | 10 A.M.  |                 | 10 P.M. |                    |  |
|---------|----------|-----------------|---------|--------------------|--|
|         | Bar.     | Wind and Force. | Bar.    | Wind and Force.    |  |
| 18th... | 29·83... | W.S.W., IV.     | .....   | 29·54 ..S.W., IX.  | Strong gale at night.                          |
| 19th... | 29·49... | W.S.W., VIII.   | ....    | 29·36...W., IX.    | } Fresh to a strong gale; heavy squall midday. |
| 20th... | 29·51... | N.W. V.         | ....    | 29·53...N.W., VII. |  |
| 21st... | 29·85... | N.N.W., III.    | .....   | 29·95...Z. O.      | Fine.  |

Rainfall:—18th, 0·18 in.; 19th, 0·44 in.; 20th, 0·15 in.; 21st, 0·0 in.—*H. Fawcett.*

BANBURY.—Extracts from Meteorological Register at 5, High Street. October 18th, 9 a.m.:—Bar. at 32°, 29·543; dry ther., 45·0; wet ther., 44·5; wind, N.W. 3 p.m.:—Bar. at 32°, 29·405; dry ther., 55°; wet ther., 51·0; wind, S.; max. temp., 55·0; min. temp., 38·0; rain, 0·21. October 19th, 9 a.m.:—Bar. at 32°, 29·136; dry ther., 50·9; wet ther., 49·0. 3 p.m.:—Bar. at 32°, 28·977; dry ther., 48·5; wet ther., 47·0; max. temp., 56°·0; min. temp., 44°·0; rain, 0·37.—*T. Beesley.*—*Erratum.*—In the account of the storm of Oct. 19th, in last month's *Meteorological Magazine*, "Burton Danete" should have been "Burton Dassett."

WINCHMORE HILL.—A violent storm of wind, hail, and rain passed over here at 1.45 on the 19th of October. The wind at the time was strong from S.W., but suddenly shifted to N.W. during the storm. The storm lasted for about ten minutes, during which time the rainfall was ·30 inch. Another, though less violent, passed over at 4.30, accompanied with hail and distant thunder.—*Thos. Paulin.*

| DATE.         | Bar. reduced to 32° and sea level. |         | Wind.  |        |        | Rain. | Mean Temp. |
|---------------|------------------------------------|---------|--------|--------|--------|-------|------------|
|               | 9 a.m.                             | 10 p.m. | 9 a.m. | 1 p.m. | 4 p.m. |       |            |
| Oct. 18th ... | 29·861                             | 29·702  | S.W.   | S.S.W. | S.S.W. | 0·14  | 47·6       |
| „ 19th ...    | 29·630                             | 29·392  | S.W.   | S.W.   | S.W.   | 0·29  | 52·1       |
| „ 20th ...    | 29·503                             | 29·500  | W.S.W. | W.     | S.W.   | 0·17  | 46·2       |
| „ 21st ...    | 29·884                             | 30·029  | N.W.   | N.W.   | W.N.W. | ...   | 48·9       |

Weather on 19th—Unsettled, gusty, rainy afternoon.

*Francis Nunes, Chislehurst.*

AUDLEY END GARDENS, SAFFRON WALDEN.—In my letter to you of November 23rd, respecting the squall of October 19th, and published by you this month, I find there is an error respecting the temperature, which should have been 57° instead of 67°.—*J. Bryan.*

KILLINGHOLME, NEAR ULCOBY.—In compliance with the request made in your last number for notes of the weather on October 19th, I send you an extract from my log-book for that day. Ther.: min. 48°,

max.  $56^{\circ}$ ; bar. at 9 a.m., 29.55; wind S.W., squalls, with rain; rainfall, .21. A telegram of this date from Washington, reports—"severe storm on Lakes Erie and Ontario." October 20th:—wind, W.S.W.; force, 5; heavy showers; rainfall, .21. An earthquake in Canada.—*J. Byron, M.A.*

## HOW OUGHT THE TEMPERATURE AND RAINFALL TO BE ENTERED ?

*To the Editor of the Meteorological Magazine.*

DEAR SIR,—You will, I have no doubt, recollect that some few years since the observers of rainfall were not all of the same opinion as to the entry of the same,—some entering to the day on which it was measured, while others entered to the day on which it fell. They are, I believe, now quite agreed in very properly entering to the day on which the rain actually fell. And as regards the temperature, I was surprised to read as follows, at p. 205, in the *Meteorological Magazine* for January, 1871:—"The minimum temperature indicated by the thermometer, when read at 9 a.m., is the minimum of that day, and is always to be so entered." Now, without the gift of prophecy, I cannot understand how the minimum or maximum temperature of any given day can be ascertained at 9 a.m. of that day. Surely the day must have closed before its history can be written, and the day does not, I suppose, close until 12 p.m. But as this is an inconvenient time to make observations, and 9 a.m. is admitted to be the most convenient to do so, is it not advisable to consider the day, as far as meteorological observations are concerned, to commence at 9 a.m.; and to enter the maximum and minimum temperature, as well as the rainfall, then read to the preceding day ?

Such has always been my practice, and the indices of maximum as well as minimum thermometers are never moved except at that time.

It does not follow that the greatest depression should always take place during the night. Indeed, during the winter, 9 a.m. is not unfrequently the coldest period during the 24 hours, and the exact time of the minimum temperature of two consecutive days occurs sometimes at the same moment. Thus, on any given day—say January 20th, at 9 a.m.—the temperature we will suppose to be  $32^{\circ}$ , and the index or float close to the top of the spirit column, showing that there could have been no greater depression during the preceding 24 hours,  $32^{\circ}$  would be consequently entered as the minimum temperature of January 19th; and the index, being at the extremity of the spirit, could not, and would not, require to be moved. And should it so happen that no greater depression of temperature occurred during the succeeding 24 hours,  $32^{\circ}$  would again be read, on the morning of the 21st, at 9 a.m., as the minimum temperature of January 20th.

If my practice is wrong, I am quite willing to endeavour to reform it, but we certainly ought to have something like uniformity in the matter.—I am, yours, &c.,

P. GRIEVE.

*Culford, Bury St. Edmunds, Jan. 23rd, 1871.*

*To the Editor of the Meteorological Magazine.*

SIR,—Nothing can be more useful in the way of conducing to accuracy of observation in meteorology than the discussion of matters of detail, for which your Magazine supplies the only available medium. In the number for this month, at p. 205, you quote with approval the remark of a correspondent, to the effect that the minimum thermometer should be read and set at 9 a.m., and the reading assigned to the day on which it is taken. Now I fully agree with your correspondent, that if the reading of the minimum thermometer is to be taken at 9 a.m., it should be set down to the day on which it is taken rather than to the previous day; but I wish to state the grounds upon which I hold that the reading of the minimum thermometer should *not* be taken at 9 a.m.

To read the minimum thermometer at 9 a.m. in winter, or to read the maximum thermometer at 3 p.m. in summer, is to give to every exceptional extreme double its proper value. That is to say, every very low minimum will count as two very low minima, and every very high maximum will count as two very high maxima. Undoubtedly, the minimum recorded should be the minimum of 24 hours, and the maximum recorded should be the maximum of 24 hours; but the 24 hours for the minimum should be the 24 hours of which the normal minimum is the centre, as nearly as may consist with the general scheme of observations; and, similarly, the 24 hours for the maximum should be the 24 hours of which the normal maximum is the centre, as nearly as may be. In other words, if the observations are taken at 9 a.m. and 3 p.m., the minimum should be read and set at 3 p.m. and the maximum at 9 a.m. Strictly, both instruments should be *read* at both times, and all the readings should be entered in the rough memorandum book. An excellent check will thus be obtained. If the readings agree, each will confirm the other. If they differ, then the case must be investigated, in order to ascertain whether one of the readings was erroneous, or whether the index has actually moved in the interval. If it be found, for example, at 9 a.m. that the minimum is 30°, and at 3 p.m. that it is 28°, and the known circumstances of the weather of the day do not forbid the supposition that both readings are true, then 28° must be set down in the permanent record as the minimum of that day, and a note may be appended in the following form—"min. to 9 a.m. 30°."

It appears to me that this is the correct method, whether we regard index readings as data for the calculation of mean temperatures, or whether we regard them as observations having an interest *per se*. Under the former aspect, I have already referred to the impropriety of cutting each extreme reading into two by selecting an hour likely to coincide very nearly with the occurrence of such extreme. Under the latter aspect, the adoption of 9 a.m. readings for the minimum, or of 3 p.m. readings for the maximum, must involve hopeless confusion in the investigation of any particular wave of heat or cold. Suppose, for example, that on a certain morning—say the 24th of December—an

intense frost prevailed throughout the country, followed in the latter part of the day by a rapid rise of temperature, except in a few places where severe frost continued through the next night. It is desired to ascertain the area within which the frost persisted. But the observations are taken and the instruments set at 9 a.m., about which hour the minimum would very likely have occurred in most places, while in some the temperature might have continued falling until after 9. Accordingly, the minimum of the 25th will be everywhere nearly as low as that of the 24th, and in some places, even where the change had occurred, it will be the lower of the two. Under these circumstances, it would be evidently impossible, by an inspection of the records, to distinguish those places in which severe frost prevailed in the night between the 24th and 25th from those in which that night was comparatively warm.

If it be said, in reply, that for such a purpose special observations must be taken, I answer that there is no occasion. The ordinary observations, conducted in the way I suggest, representing, as they would, something more real and true than when taken in the other method, would not only be the best possible for the calculation of means, but would also be readily available for the purpose of any special inquiry.

Yours truly,

GEORGE F. BURDER, M.D.

Clifton, 24th January, 1871.

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*To the Editor of the Meteorological Magazine.*

SIR,—Will you allow me to make some remarks on a passage in your last number, on page 205—“when the minimum of the thermometer is noted at 9 a.m., *as it should be?*” Surely 9 a.m. is a very bad time, as in winter it is very near the ordinary time of minimum, so that it will frequently happen that one occurrence of cold will be entered on two days. This will make a great difference in estimating the average minimum temperature. I should have thought the usual time of greatest heat to be the proper time to record the minimum; so I always record it at 2 p.m.—I am, yours truly,

T. W. BACKHOUSE.

Sunderland, Jan. 25th, 1871.

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*To the Editor of the Meteorological Magazine.*

SIR,—I shall be much obliged if you will put me right in this matter. I understand, from p. 205 of your *Meteorological Magazine*, that the temperature of the minimum thermometer read at 9 a.m., say on the 2nd of February, is the minimum temp. of the 2nd not the 1st of that month. Am I right in this? If so, take this case:—On the 1st of February, at 9 a.m., the temp. is at the minimum of that day, say 30°; then, on setting the thermometer, the minimum cannot be higher for the 2nd inst. than 30°, although the temp. may considerably increase after the morning of the 1st inst.; so that the minimum, on the 2nd of February, would be as low as that of the 1st inst., though

the temp. since 9 a.m. of the 1st had risen considerably. I hope I make myself understood. The minimum temperature, I believe, is, *as a rule*, just before sunrise, so that that temp. would be the minimum of the same day, not of that before. With many apologies for this muddle, yours very truly,

W. D. NASH.

*Buckingham Villas, Clifton, January 31st, 1871.*

### SOLAR RADIATION.

*To the Editor of the Meteorological Magazine.*

SIR,—I read with much interest Mr. Procter's letter on solar thermometers in your December number. That the thermometer *in vacuo* is a kind of "heat-trap" is in substance what I have always maintained, and I have often combated the notion that it or any other thermometer can give an absolute measure of solar radiation. It is only a convenient means of measuring the variations in the amount of radiation, and the more of a heat-trap it is, the more easily is it affected by the slightest change in the intensity of the sun's rays.

With reference to Mr. Nunes' letter, in which he reminds me that one of his two solar thermometers by Casella reads 3° higher than the other, I need only say that I do not consider 3° a very extraordinary difference, but I believe it is more than the average. I have very recently had four to test for a friend; and when compared with mine, there was on sunny days an average difference of 2°·3 between the highest and the lowest of the five on each day, and the average readings of the five on 14 such days were 78°·4, 77°·7, 77°·3, 77°·3, 76°·4.

I can assure Mr. Pastorelli I have not the least wish or intention to impugn the well-known accuracy of his instruments. Still the evidence against A seemed to me conclusive. But if A, after being re-exhausted with all possible care, behaves no better, we must look for some other reason. His quotations, however, are not to the point. He first referred to the utmost difference I had observed between thermometers *in vacuo* blackened both on bulb and stem and those blackened only on the bulb. The second proved not the badness of the instruments used in your experiments, but the folly of expecting exact results from thermometers *in vacuo* placed on the grass. When placed on the uniform surface of a tray, you found them, if I remember rightly, to agree very closely.—I remain, Sir, your obedient servant,  
FENWICK W. STOW.

### ANEROID BAROMETERS.

*To the Editor of the Meteorological Magazine.*

SIR,—The correspondence which has recently appeared in your columns on the subject of aneroid barometers induced me to retest one which I bought some eight years ago from Messrs. Negretti and Zambra. At 2 p.m. to-day the instrument read 29·782 in. in a room having a temperature of 40°. I placed it in another room where a thermometer near it showed a temperature of 64°. Having remained there for a full half hour, it read 29·784 in., showing an increase of ·002 in. I

then removed the aneroid out of doors, where the temperature was 33°. In half an hour I again read it and found it stood at 29·786 in., showing still an increase of ·002 in. This increase of ·004 in. in the hour could not be due to imperfect compensation, as it occurred both with an increased and diminished temperature. It was, in fact, a natural increase of atmospheric pressure, which continued at the same rate for some hours afterwards. I may add, that on former occasions I have tested the aneroid much more severely with similar results. It has had very hard work, too, as I have used it for taking altitudes on some two or three hundred occasions, a purpose for which I find it admirably adapted. I have not compared its readings with the mercurial standard daily, but have only had occasion to alter it two or three times since I bought it. I have great faith in well-made aneroids, and consider them superior, even for scientific purposes, to many so-called "standard" instruments.—Yours truly,

JOHN THRUSTANS, F.M.S.

*Merridale, Wolverhampton, Jan. 27th, 1871.*

### A LUNAR RAINBOW.

*To the Editor of the Meteorological Magazine.*

SIR,—Last night a beautiful lunar rainbow was seen to the W.N.W. of this place. I first saw it at 10.35 p.m., and it lasted after that for ten minutes, finally dying away at 10.45 p.m. Faint colours were distinctly visible, but the arc was apparently narrower than that of a solar rainbow. The night was tolerably calm and mild for the season (the temperature being 45°), with a slight sea fog, and thick drizzling rain; and the moon shone with a pale light through the misty atmosphere.—I remain, Sir, yours very truly,

ARCHDALL E. BUTTEMER.

*Burnham, Somerset, Feb. 8th, 1871.*

### BEST GUIDE TO AIR TEMPERATURE.

*To the Editor of the Meteorological Magazine.*

SIR,—Your correspondent, Mr. Ffolkes, is disposed to come to the conclusion, "that the plan of affixing a thermometer to an exposed wall or a bare board is the most accurate index of the cold."

I shall be glad if you will allow me to say a few words in arrest of this judgment.

As Englishmen are great sticklers for authority, I will first of all appeal to the law as laid down by one whose opinion ought to carry as much weight as that of any living man on every subject to which he has given his attention, Astronomy, Meteorology, or Optics.

Sir John Herschell insists (*Admiralty Manual*, 3rd Ed., p. 131) that the external thermometer "should be especially guarded from rain and from spray, so that the bulb should never be wetted;" "it should be *completely screened from the sky*, so as to annihilate all loss of heat by upward radiation."

It is very well known that on clear nights the temperature of the

ground falls much lower than that of the air immediately above it, and every meteorologist is aware that the reason of the difference lies in the fact that the earth radiates its heat to the sky, and receives no heat in return. Now, just as the earth radiates, the bulb of the thermometer must radiate too, "*pro viribus suis*." And that the radiating powers of glass are by no means contemptible every astronomer knows to his cost. If, on a damp night, the dew cap of his refractor be forgotten, the object glass is soon obscured by dew. Now what does this prove? It proves that the temperature of the object glass has fallen not only below the temperature of the air but below the temperature of the dew point, yet the object glass is mounted in a brass cell, and has only one surface exposed to the air. Can any reason be assigned why the bulb of an exposed thermometer should not do the same? And the mischief does not end here. The dew once deposited may evaporate again; the evaporation demands a certain amount of heat, and this heat must either be abstracted from the bulb of the thermometer, or intercepted on the way to it. If the bulb of the thermometer be wetted with snow, it falls to the freezing point at once, though the air may still be some degrees above it; if wetted with rain at or near the time when the temperature is lowest, we have the minimum of the wet bulb instead of the minimum of the dry one.

As Mr. Ffolkes overlooks the influence of radiation on the minimum thermometer, he probably makes less account of the influence of reflection on the maximum. Here, again, I quote from Sir John Herschell: "An exposure should be chosen perfectly shaded both from direct sunshine and that reflected from the sea [ground] or radiated from any hot object." Perhaps in their anxiety to secure free exposure to the air, meteorologists may sometimes be inclined to neglect precautions which are scarcely less essential.

One day last week, by way of experiment, I threw the light of the sun, reflected from a small piece of window glass, on the bulb of a sensitive thermometer about 14 feet distant. In one minute the mercury rose  $1^{\circ}$ ; in five minutes,  $2^{\circ}$ ; in ten minutes,  $3^{\circ}$ . When the sun was turned off, the mercury fell rather more rapidly than it rose. During the whole time the sun was more or less obscured by haze, and his rays passed obliquely through a window. The thermometer, which is divided to tenths of a degree, was observed through a telescope. In this case the heat rays were also, in part at least, luminous; but, as the larger portion of the heat rays reflected or radiated upon the bulb of an exposed thermometer from the surrounding objects are mostly obscure, their action may be quite invisible. But whenever such objects are heated by the sun above the temperature of the air, the bulb of an exposed thermometer *must* receive more heat than it gives, *i. e.*, must stand higher *pro tanto* than it ought to do. It has been remarked that the temperatures registered at Greenwich, on the hottest days of the year, are considerably higher than the maxima at Kew. Perhaps the difference in the thermometer stands respectively employed may go far to account for the difference.

JANUARY, 1871.

| Div.   | STATIONS.<br>[The Roman numerals denote the division of the Annual Tables to which each station belongs.] | RAINFALL.      |  |                                  |       |      | Days on which<br>41 or more fell. | TEMPERATURE. |      |       |      | No. of<br>Nights<br>belc<br>32° |          |          |
|--------|---|----------------|--|----------------------------------|-------|------|-----------------------------------|--------------|------|-------|------|---------------------------------|----------|----------|
|        |   | Total<br>Fall. | Differ-<br>ence<br>from<br>average<br>1860-5 | Greatest<br>Fall in<br>24 hours. |       | Deg. |                                   | Date.        | Max. |       | Min. |                                 | In shade | On grass |
|        |   |                |  | Dpth                             | Date. |      |                                   |              | Deg. | Date. | Deg. | Date.                           |          |          |
| I.     | Camden Town .....   | 1.99           | + .04  | .42                              | 22    | 17   | 45.2                              | 7            | 19.7 | 13    | 23   | 27                              |          |          |
| II.    | Maidstone (Linton Park).....  | 3.50           | + 1.44                                       | .48                              | 25    | 22   | 47.0                              | 17           | 15.0 | 5     | 26   | ...                             |          |          |
| III.   | Selborne (The Wakes).....   | 3.12           | — .15  | .54                              | 16    | 18   | 45.0                              | 7            | 3.0  | 1     | 24   | 26                              |          |          |
| III.   | Hitchen .....   | 1.17           | — .97  | .23                              | 15    | 16   | 44.0                              | 6            | 12.0 | 1     | 31   | ...                             |          |          |
| IV.    | Banbury .....   | 1.13           | — .96  | .45                              | 15    | 12   | 44.0                              | 6            | 11.0 | 1     | 28   | ...                             |          |          |
| V.     | Bury St. Edmunds (Culford).....   | 1.08           | — .79  | .20                              | 6     | 13   | 43.0                              | 6            | 14.0 | 1     | 25   | 31                              |          |          |
| V.     | Bridport .....  | 2.99           | — .20  | .59                              | 21    | 14   | 47.0                              | 6            | 15.0 | 5     | 21   | ...                             |          |          |
| V.     | Barnstaple.....   | 3.78           | + .26  | .75                              | 15    | 16   | 50.0                              | 15           | 14.0 | 1     | 5    | ...                             |          |          |
| VI.    | Bodmin .....  | 5.06           | — .13  | 1.02                             | 15    | 22   | 47.0                              | 13           | 23.0 | 1     | 7    | 23                              |          |          |
| VI.    | Cirencester .....   | 1.86           | — 1.14                                       | .57                              | 9     | 6    | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| VI.    | Shiffnal (Haughton Hall) .....  | 1.78           | — .12  | .65                              | 9     | 11   | 40.0                              | 5, 15        | 9.0  | 1     | 30   | ...                             |          |          |
| VII.   | Tenbury (Orleton) .....   | 2.82           | + .29  | .68                              | 15    | 15   | 48.0                              | 6            | 5.5  | 1     | 23   | 27                              |          |          |
| VII.   | Leicester (Wigston).....  | 0.96           | — 1.02                                       | .33                              | 16    | 10   | 44.0                              | 6            | 16.0 | 1     | 27   | ...                             |          |          |
| VII.   | Boston .....  | 0.89           | — .82  | .35                              | 15    | 14   | 48.0                              | 6            | 4.0  | 1     | 25   | 29                              |          |          |
| VII.   | Grimsby (Killingholme) .....  | 0.97           | ...  | .20                              | 15    | 17   | 43.0                              | 14*          | 11.0 | 1     | 20   | ...                             |          |          |
| VIII.  | Derby.....  | 0.82           | — .97  | .27                              | 15    | 12   | 45.0                              | 6            | 10.0 | 1     | 22   | ...                             |          |          |
| VIII.  | Manchester .....  | 3.30           | + .78  | ...                              | ...   | 13   | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| IX.    | York .....  | 0.70           | — .88  | .46                              | 15    | 7    | 46.0                              | 6            | 10.0 | 1     | 21   | ...                             |          |          |
| IX.    | Skipton (Arncliffe) .....   | 2.65           | — 2.99                                       | .95                              | 5     | 11   | 44.0                              | 7            | 2.0  | 1     | 26   | ...                             |          |          |
| X.     | North Shields .....   | 1.13           | — .98  | .28                              | 22    | 17   | 47.0                              | 14           | 12.0 | 1     | 20   | 28                              |          |          |
| X.     | Borrowdale (Seathwaite).....  | 11.95          | — 4.41                                       | 3.63                             | 7     | 11   | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| XI.    | Cardiff (Town Hall).....  | ...            | ...  | ...                              | ...   | ...  | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| XI.    | Haverfordwest .....   | 6.05           | + 1.00                                       | .93                              | 16    | 16   | 49.0                              | 6            | 18.0 | 28    | 20   | 26                              |          |          |
| XI.    | Rhayader (Cefnfaes).....  | 3.19           | — 1.33                                       | 1.00                             | 6     | 9    | 53.0                              | ...          | 5.0  | 4     | 28   | ...                             |          |          |
| XI.    | Llandudno.....  | 1.87           | — .67  | .29                              | 15    | 16   | 51.4                              | 14           | 23.0 | 1     | 14   | ...                             |          |          |
| XI.    | Dumfries .....  | 2.58           | — 2.02                                       | .54                              | 4     | 10   | 48.5                              | 6            | 12.5 | 28    | 22   | ...                             |          |          |
| XII.   | Hawick (Silverbut Hall).....  | 1.81           | ...  | .44                              | 6     | 9    | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| XIV.   | Ayr (Auchendrane House) .....   | 3.99           | — .53  | .74                              | 7     | 12   | 53.0                              | 16           | 17.0 | 25    | 16   | 28                              |          |          |
| XV.    | Castle Toward .....   | 3.39           | — 2.90                                       | .76                              | 1     | 19   | 49.0                              | 6            | 21.0 | 24    | 22   | 26                              |          |          |
| XVI.   | Leven (Nookton) .....   | 1.31           | — 1.56                                       | .25                              | 4, 6  | 15   | 46.0                              | 14           | 13.0 | 28    | 26   | 30                              |          |          |
| XVI.   | Stirling (Deanston) .....   | 2.93           | — 1.79                                       | .76                              | 6     | 17   | 46.0                              | 14           | 16.8 | 28    | 28   | 29                              |          |          |
| XVI.   | Logierait .....   | 1.67           | ...  | .42                              | 6     | 14   | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| XVII.  | Ballater .....  | 1.74           | ...  | .75                              | 15    | 6    | 46.0                              | 6            | 7.5  | 24    | 25   | ...                             |          |          |
| XVII.  | Aberdeen .....  | 1.53           | ...  | .45                              | 15    | 17   | 44.9                              | 14           | 21.4 | 3     | 19   | 31                              |          |          |
| XVII.  | Inverness (Culloden) .....  | 1.74           | ...  | .80                              | 14    | 14   | 46.1                              | 6            | 25.7 | 24    | 14   | 29                              |          |          |
| XVII.  | Portree .....   | 8.26           | — 4.83                                       | 1.58                             | 16    | 24   | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| XVIII. | Loch Broom .....  | 4.11           | ...  | .90                              | 15    | 12   | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| XIX.   | Helmsdale .....   | 1.85           | ...  | .46                              | 6     | 18   | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| XIX.   | Sandwick .....  | 1.65           | — 1.64                                       | .22                              | 9, 10 | 18   | 48.0                              | 6            | 27.7 | 21    | 8    | 21                              |          |          |
| XX.    | Cork .....  | 4.92           | ...  | .58                              | 15    | 24   | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| XX.    | Waterford .....   | 4.81           | — .05  | .64                              | 31    | 26   | 50.0                              | 6            | 27.0 | 22    | 12   | ...                             |          |          |
| XX.    | Killaloe .....  | 4.96           | + .10  | .63                              | 5     | 24   | 50.0                              | 5, 6         | 22.0 | 26    | 13   | ...                             |          |          |
| XXI.   | Portarlington .....   | 3.43           | — .58  | .44                              | 11    | 29   | 55.0                              | 6            | 26.0 | 1     | 20   | ...                             |          |          |
| XXI.   | Monkstown .....   | 2.90           | — .49  | .61                              | 10    | 18   | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| XXII.  | Galway .....  | 6.44           | ...  | .87                              | 14    | 26   | 50.0                              | 20           | 29.0 | 24    | 9    | ...                             |          |          |
| XXII.  | Bunninadden (Doo Castle) .....  | 4.57           | ...  | .31                              | 9     | 20   | 48.0                              | 13           | 21.0 | 25    | 13   | ...                             |          |          |
| XXIII. | Bawnboy (Owendoon) .....  | ...            | ...  | ...                              | ...   | ...  | ...                               | ...          | ...  | ...   | ...  | ...                             |          |          |
| XXIII. | Waringstown .....   | 3.10           | ...  | .74                              | 1     | 20   | 52.0                              | 6            | 22.0 | 26    | 22   | 28                              |          |          |
| XXIII. | Strabane (Leckpatrick) .....  | 4.37           | ...  | .43                              | 15    | 24   | 47.0                              | 5            | 20.0 | 25    | 30   | 31                              |          |          |

\* And 15.

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

## METEOROLOGICAL NOTES ON JANUARY.

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.—The severe frost that commenced on the 21st of December continued with only a partial cessation of one day till the 13th of January, when a cold thaw, with occasional heavy falls of R and sleet, set in till the 24th, when more S fell, accompanied with frost, which continued to the end; the whole being an exceedingly wintry month, S being on the ground nearly the whole of it.

SELBORNE.—Intense cold, ther.  $3^{\circ}$  on the 1st. A wretchedly gloomy month, scarcely a ray of sunshine to enliven the prospect. Max. ther. down to  $32^{\circ}$  on eight days; much dense fog the latter end of the month, much illness and distress from want of work amongst the labouring class; thaw on 14th, ther.  $40^{\circ}$  at 9 a.m.; on 15th, ther.  $39^{\circ}$  at 11 a.m., fell to  $35^{\circ}$  by 12.30; most tempestuous night on 16th, R at night, H and S in morning; faint aurora on 17th.

CULFORD.—This has been the coldest January that I have recorded, even the max. temp. of five days was below the freezing point, and the mean temp. of the month was only  $32^{\circ}$ ; S has fallen slightly on five days; on 16th T was heard at intervals from 12.30 p.m. until about 2 p.m.

BRIDPORT.—S nearly 5 inches deep on the 2nd; heavy south-westerly gales on 15th and 16th; frosty weather the last week and good skating.

BODMIN.—A very heavy S.S.E. gale on the 15th; mean temp. of the month,  $37^{\circ}\cdot 2$ .

HAUGHTON HALL, SHIFNAL.—A severe month, fully justifying Mr. Brumham's calculations; the min. ther. only averaged  $25^{\circ}\cdot 75$ , the max. do.  $34^{\circ}$ , and only one night above  $32^{\circ}$ . The month opened with a severe frost ( $9^{\circ}$ ), with a beautiful rime and bright sun; S fell on 4th, 11th, 25th and 29th; a rapid thaw set in on 15th with R and sleet, but the frost returned on 17th with a S.W. wind and very low bar. ( $28\cdot 47$ ), and lasted through the month. The sun was visible only on six days. The winds came chiefly from the S. and S.W. up to the 23rd, and from N.W. and N.E. to the close; a remarkable absence of gales; the ice was  $7\frac{1}{4}$  inches thick on the pools, and bore skaters throughout the month; the roads a continual sheet of ice.

ORLETON.—A remarkably cold month, with severe and continuous frost, a great prevalence of fog and cloud, and very little clear sky; ther. on 1st fell to  $5^{\circ}\cdot 5$  in shade (protected) and to  $1^{\circ}\cdot 5$  on grass plot; temp. of month about  $6^{\circ}$  below the average, and  $0^{\circ}\cdot 6$  lower than that of January, 1861; all the rivers frozen over at the beginning of the month; S on the 9th 12 inches deep on the high lands; bar. very low on the 16th.

BOSTON.—Very severe frost in the first week; on the 1st the ther. registered the min. reading of the month, viz.  $4^{\circ}$  at 4 feet above the ground, while the grass min. fell to  $-4^{\circ}$ ; very severe gale from the S.W. on the 16th; the latter part of the month was cold and foggy, with frequent S showers.

GRIMSBY, KILLINGHOLME.—A month of frost and cloudy skies, with scarce any intermission.

MANCHESTER.—We have not had so long a season of continuous frost for many years.

SEATHWAITE.—Two days on which more than 3 inches of rain fell.

## WALES.

HAVERFORDWEST.—Very wet and cold month; the last fortnight the frost was severe, the E. wind rising to a gale during the last two days of the month. Very severe gale on 16th and 17th; great depression of the mercury, which continued below  $29\cdot 00$  from the 16th to the afternoon of the 18th; lowest depression  $28\cdot 597$  at 3 a.m. on the 16th.

CEFNFAES.—An extremely cold month, wind generally N.E. or S.E., temp. low, S at intervals, and on the night of the 21st a heavy fall from 7 to 9 inches deep, which continued on the ground to the end of the month; great loss of sheep on the hills, and general want of fodder.

LLANDUDNO.—S on the hills from the 18th to 31st.

## SCOTLAND.

**DUMFRIES.**—R fell on three days in the first week, and from the 12th to the 17th, during which time the weather was stormy; the rest of the month frosty, with falls of S; the plough has been stopped for six weeks; mean temp. of the month  $32^{\circ}\cdot69$  or  $3^{\circ}\cdot66$  below the corresponding month of last year and  $9^{\circ}\cdot1$  below January of 1869.

**HAWICK.**—The frost throughout the month has been most severe—nothing like it since 1861.

**AUCHENDRANE.**—A low mean temp., with even its small capacity for vapour not fully saturated, prevailed during the month, along with bar. pressure and range slightly differing from the January means; also a small rainfall, small elastic force of vapour, low dew point and weak evaporation. There was likewise an unusual number of ice days, with a few slight snowfalls and a rather low force of wind and amount of cloud. Gales occurred on the 1st, 6th, 7th, 14th and 16th, all equatorial, and the month closes with a strong polar breeze from the E. on the 30th and 31st; the gale of the 16th was well marked by the lowest bar. and highest ther. in shade in the month. The exposed ther. on grass during the calm night and early morning of the 25th had fallen to  $11^{\circ}$ ; according to the self-registering thermometer in shade, the nights were from  $8^{\circ}$  to  $15^{\circ}$  colder than the days; rivers generally large and filled with fixed and loose ice. The month has been throughout very wintry, ploughing and out-door labour has been much interrupted, horizon frequently hazy, but few dense fogs.

**CASTLE TOWARD.**—A cold, cloudy and wintry month, with frequent frosts, wet days, and small amount of sunshine; gales on the 1st and 16th from the S.W., but the prevailing winds were N., N.E. and N.W.; about 1 inch of S on the 26th and 27th, which still lies close to the salt water edge. During the last eight days the max. has not been above  $39^{\circ}$ , nor the min. below  $29^{\circ}$ ; bar. steady and high since the 21st; it has not been below  $30\cdot20$  since the 24th.

**DEANSTON.**—On the 2nd 3 inches of S; 4th and 5th thaw and R, S all gone, high wind; on the 7th and 9th 1 inch of S, with strong N.W. winds; then bright, calm and frosty till the 13th; great fall of bar. from the 12th to the 16th, from  $30\cdot67$  to  $28\cdot25$ ; gale of wind on the 16th, after which the bar. rose gradually, and on the 31st was  $30\cdot10$ ; latter half of month very dull, hazy, frosty, and cold E. winds.

**LOGIERAIT.**—First half of the month changeable; continued frost, with occasional showers of S, from the 17th; rainfall small, being  $2\cdot78$  inches less than the average for the five preceding years.

**BALLATER.**—A month of very severe weather, the ground remaining covered with S throughout, the frost never relapsing, all out-door work completely suspended, the last few days dull, with indications of a change of weather, which was greatly desired.

**ABERDEEN.**—Bar., mean temp. and rainfall all below the average; winds from S.E., S. and S.W., in excess of frequency above the average; pressure of wind little more than half the average; a cold, dry, hard month; 3 inches below the surface the ground never softened during the month; frequent S and sleet, several auroræ, but all faint; lunar halo during the eclipse.

**PORTREE.**—Gale from the S. on the 16th and 17th; S, H, sleet, and frost from the 1st to the 22nd; black frost from latter date to the end of the month; T and L on evenings of 5th and 6th; have not had such severe frost in January during the memory of the oldest inhabitant.

**LOCHBROOM.**—The first half of the month was very wet and stormy, and the last half has been remarkable for the keenness of its frost, blighting everything green, and destroying turnips and all exposed vegetables.

**SANDWICK.**—This has been one of the driest and coldest Januaries during the whole period of observation, there having been only two drier, viz. 1847 and 1864, and four colder, viz. 1827, 1838, 1841 and 1867. The rainfall, however, at Balfour was  $3\cdot3$  inches, and at Hoy High Lighthouse  $5\cdot45$  inches. The bar. was lower on the 16th than for many years, except in December, 1869, when it was  $28\cdot094$  instead of  $28\cdot170$ . Aurora on the 4th, corruscating to zenith; T and L on the 6th.

## I R E L A N D.

DOO CASTLE.—A cold and ungenial month.

WARINGSTOWN.—Rainfall about the average, and the month, although the weather was extremely disagreeable and unfavourable to labour in consequence of frequent frosts, was not colder than the average here, though it seems to have been so at other stations.

LECKPATRICK.—Very cold month; great fall of bar. from the 12th to the 16th from 30·243 to 28·307 corrected, on morning of 16th, at 9 a.m., mercury rising fast, so that probably this was not the min.; moderate gale blowing from S.W.; mean min. temp. of month 33°·16; coldest of last seven years, except 1867, when it was 31°·5.

## OZONE OBSERVATIONS.

*To the Editor of the Meteorological Magazine.*

SIR,—I think Mr. Gledhill is rather hard on me in respect to ozone observations. When I first took ozone observations, I did so at 9 a.m. only; and finding sometimes (for it is very seldom I am at home in the daytime) that all colour had disappeared from a previously coloured paper, I thought I would look at these papers every twelve hours. Similar results occurred—as I knew for certain, when being at home in the daytime, I had an opportunity of looking at the papers every three hours. Now, as I can only see the papers (as a rule) twice a day, and I know that a paper, which has been coloured, does lose all its colour sometimes before I can see it; and as I cannot tell how deep a colour a paper may have been during the day, as it is quite white at night, I did not see what use I could make of it. I could not put down in my register “No ozone,” as for anything I knew to the contrary, there might have been a great deal. When a person can see his ozone papers at any time of the day, then Mr. Gledhill is right in insisting a record should be kept, and that ozone should not be regarded as a delusion or a snare.

In regard to determining the amount of discoloration, I found considerable difficulty in comparing the papers with the ozonometer at night, and I never yet got the colours represented at p. 31 of Sir Henry James' book on “Instructions for taking Meteorological Observations.” London: G. E. Eyre and William Spottiswoode. 1861.

Your obedient servant,

HARRY CHICHESTER, F.M.S.

*Furtoyn, Huddersfeld, Jan. 22nd, 1871.*

## AURORAL LIGHT.

*To the Editor of the Meteorological Magazine.*

SIR,—On Saturday evening, December 17, 1870, at 6 p.m., two rather considerable masses of auroral light were seen here, Lat. 51° 35' N., Long. 1 second West of Greenwich; they met near the zenith, and as I pretty well determined the position of the southern boundary amongst the stars, a notice may probably contribute to a determination of their altitude, should the same masses have been observed at other stations. Colour red or crimson north of the constellations mentioned below; boundary well defined, grazing  $\beta$  Aurigæ,  $\epsilon$ ,  $\gamma$  and  $\beta$  Cassiopeiæ,  $\alpha$  Cygni and  $\alpha$  Lyrae. These masses remained more or less steadily in view for about ten minutes; they were ill-defined towards the north.

W. R. BIRT.

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