METEOROLOGICAL OBSERVATIONS,

MADE IN THE TOWNSHIP OF CRUMPSALL,
FROM 1821 TO 1828, INCLUSIVE,

WITH

REMARKS.

BY JOHN BLACKWALL, F.L.S.

(Read October 20th, 1826.*)

CONSIDERING the greatly increased attention which of late years has been bestowed upon atmospherical phenomena, it is mortifying to reflect how little has been done, the important discoveries of one or two distinguished indivi-

* It may be proper to state, that when this paper was read before the society, it comprised a series of meteorological observations made during a period of five years, commencing with 1821, and terminating with 1825. In its present form, the series, with the exception of the observations on the temperature of spring-water, and on the dew-point, which were discontinued, is, with the permission of the society, extended to the close of 1828. This circumstance will serve to explain the apparent incongruity, into which it might be supposed I had been led, of having announced facts previously to the date of their occurrence.

duals excepted, to promote the progress of meteorological science. The facilities afforded by the publication of numerous literary and philosophical journals have induced a multitude of observers, at regular periods, to lay before the public the results of their researches; but, although much ingenuity has been displayed in tabular arrangements and in the construction of diagrams, the tendency of their labours towards the establishment of sound theory has been very slight indeed. Whether this arises from any inefficiency in the ordinary modes of investigation; from discordancies occasioned by unavoidable differences in the instruments employed; or from a want of uniformity in the time and manner of taking the observations, which are thus rendered of small value comparatively; or whether it is to be attributed to some other cause, I will not take upon me to determine. That so much minute and elaborate investigation should have been productive of no greater advantage to this branch of science, is certainly a discouraging reflection: still, however, a large number of facts has been accumulated, which, when collected and carefully examined, may yield to some acute and comprehensive intellect, valuable results which may have escaped the notice of those who have only considered them partially or in detail. Under this impression,

and with the desire of contributing something to the general stock, I have drawn up the following tables and remarks; leaving the task of collecting, arranging, and comparing what has been done by others, and of extracting useful information from it, to those who have more leisure and are better qualified for the undertaking.

Before we proceed to the results obtained from the observations, it should be stated, that the place of observation is situated in the township of Crumpsall, about two miles and a quarter north from Manchester, and is in most respects favourable for meteorological pursuits.

The tables do not require any explanation.

Observations on the Barometer.

TABLE OF THE MEAN HEIGHT OF THE BAROMETER,

AT CRUMPSALL.

Months.	1821.	1822.	1823.	1824.	1825.	1826.	1827.	1828.	Means.
January . .	29.51	29.73	29.35	29.64	29.78	29.65	29.43	29.55	29.58
February .	29.87	29.58	29.04	29.44	29.72	29.45	29.67	29.45	29.52
March. . .	29.23	29.56	29.41	29.44	29.72	29.62	29.23	29.54	29.46
April . . .	29.28	29.57	29.50	29.51	29.65	29.59	29.57	29.38	29.50
May. . . .	29.50	29.66	29.53	29.64	29.62	29.73	29.43	29.53	29.58
June. . . .	29.75	29.75	29.57	29.58	29.62	29.92	29.59	29.64	29.67
July. . . .	29.58	29.43	29.44	29.66	29.81	29.63	29.73	29.33	29.57
August . .	29.59	29.52	29.51	29.59	29.56	29.61	29.70	29.50	29.57
September.	29.48	29.62	29.61	29.54	29.52	29.56	29.66	29.60	29.57
October . .	29.52	29.28	29.35	29.27	29.55	29.51	29.42	29.69	29.44
November.	29.36	29.28	29.71	29.18	29.28	29.46	29.63	29.49	29.42
December.	29.05	29.65	29.26	29.37	29.18	29.46	29.36	29.52	29.35
Means. . .	29.47	29.55	29.44	29.48	29.58	29.59	29.53	29.51	29.51

The barometer, which is an upright one of the usual construction, has a tube 32 inches long, with a capacious bulb at its lower extremity; its internal diameter is .22 of an inch, and it was carefully filled with dry mercury. No allowance having been made on the scale for the rise and fall of the mercury in the bulb, the variations, as registered, are somewhat too small: to be strictly accurate, they should be increased by one-fortieth part.

The height of the instrument above the level of the sea, I have reason to believe, is about 292 feet. From barometrical measurements, I find its elevation above the Duke of Bridgewater's canal, at Manchester, to be 212 feet, and the canal is represented to be nearly 80 feet above the sea,* making a total of 292 feet.

Many observations were taken each day during the foregoing period of eight years, but the highest and lowest only, with the mean obtained from them, were regularly noted down in the journal. Previously to any observation being made, a few gentle vibrations were invariably given to the mercury for the purpose of overcoming its adhesion to the tube.

* Society's Memoirs, New Series, Vol. III. p. 486.

From the time of Torricelli to the present day, the variations of the barometer have continued to attract the notice of men of science, and numerous hypotheses have been formed to account for those fluctuations in the weight of the atmosphere by which they are occasioned. As a minute inquiry, however, into the merits of the various opinions which have been broached on this subject would far exceed the limits of a paper, I shall confine my remarks to such particulars as are more immediately suggested by my own observations.

On attentively looking over my journal, I find that great and sudden depressions of the barometer, which generally happen in the winter months, are, for the most part, accompanied with high wind from the south, or some of the intermediate points between that and the west; and that with a northerly wind, whatever may be its force, the mercury usually rises; but that it attains its greatest elevation in calm, frosty weather: moreover, it appears that a rapid rise frequently follows a sudden depression of the mercury in the barometer, especially on a quick transition of the wind from south to north of the west.

Subjoined are a few examples selected from

an extensive collection of observations illustrative of the accuracy of the above results.

On the 5th of December, 1822, there was a slight frost in the morning, with a gentle breeze from the W., the barometer at 10h. A.M. being at 29.31, and the thermometer at 37°. About noon the wind shifted to the S.W., and soon after passing to the S., gradually increased in strength till midnight, when it blew a complete hurricane. The effect on the barometer was remarkable: at 10h. P.M. it had gone down to 28.27, which is rather more than an inch in twelve hours; the thermometer at the same time standing at 43°. Early on the 6th, the wind, which had got up to the W. by N., still blew with unabated violence, and did not wholly subside till after the break of day; yet, at 8h. A.M. the barometer had risen to 29.02, and at 10h. P.M. it was at 29.40, the mercury having moved through a space of 2.17 inches in 36 hours; that is, from 10h. A.M. on the 5th, to 10h. P.M. on the 6th.

An extremely high wind from the S.W. occurred on the evening of the 3rd of December, 1823. The barometer, which, at 10h. A.M., was at 29.10, at 12h. 30m. A.M. on the 4th, had fallen to 28.32; the thermometer, during the

same interval, having moved from 40° to 52°.5, where it remained till the storm began to abate. Between 2 and 3h. A.M. on the 4th, the wind, which had previously changed to the W., blew with its greatest violence, and continued very boisterous till noon; nevertheless, the barometer began to rise about 1h. 15m. A.M., and, at 10h. P.M., when the thermometer was at 39°.5, had got up to 29.20.

The barometer, on the 14th of February, 1824, went regularly up from 28.67 to 29.10. The wind was N.E., and in the afternoon it blew very hard.

Again there was a strong gale from the N.E. on the morning of the 2nd of April, 1824, during which the barometer rose rapidly; moving, in the course of the day, from 28.75 to 29.58.

A tempestuous S. wind on the 23rd of November, 1824, reduced the barometer from 28.64 to 27.82, which is the lowest observation recorded in the eight years.

With a high wind from the N.W., the barometer, on the 2nd of January, 1825, got up from 29.30 to 29.70.

On the 10th of January, 1825, the barometer was at 30.48, which is the highest observation for the eight years. The weather, for several days preceding, had been still and frosty.

From these facts we may fairly infer, that heat and currents of air are the principal agents in producing the fluctuations of the barometer. It is well known that bodies become dilated, or have their volume increased, by their union with heat; and that they undergo a degree of contraction, or condensation, when a portion of their caloric is abstracted: now, this being pre-eminently the case with aëriform fluids, it follows, that in winter, strong northerly winds will bring cold air from higher latitudes, of greater specific gravity than that which it displaces in its passage south; and that high southerly winds, in the same season, will bring warm air from lower latitudes, of less specific gravity than that which it displaces in its progress north; consequently, the barometer will rise or fall as a current from one or the other quarter prevails. When the atmosphere over any part of the globe is reduced in volume by severe and long-continued frost, the contiguous air flows in to preserve the equilibrium, and an accumulation of matter ensues which occasions a corresponding rise of the barometer at that place.

What powerfully tends to confirm the opinion, that heat and currents of air are the chief causes of vicissitudes in the weight of the atmosphere, is the fact, that the fluctuations of the barometer are much smaller in summer than in winter, and it will not be denied that heat is more equally distributed over the northern hemisphere, and that the atmosphere is more rarely disturbed by tempestuous winds in the former than in the latter season.

I am aware, it may be objected to the explanation of some of the more remarkable phenomena of the barometer here insisted upon, that the changes of the air in temperature, as shewn by the thermometer, are seldom proportionate to its contemporaneous variations in weight; but it should be recollected, that the capacity of elastic fluids for heat varies with their density, and that every increase of capacity is attended with an absorption of caloric which then ceases to affect the thermometer.*

* For a more complete developement of the causes of the variation of the barometer, see Mr. Dalton's Meteorological Observations and Essays, part second, essay third.

Observations on the Thermometer.

TABLE OF THE MEAN HEIGHT OF THE THERMOMETER,

AT CRUMPSALL.

Months.	1821.	1822	1823.	1824.	1825.	1826.	1827.	1828.	Means.
	°	°	°	°	°	°	°	°	°
January . .	38.2	40.3	31.7	39.7	38.6	32.0	34.2	40.6	36.9
February .	36.1	42.8	36.7	40.5	38.7	42.9	32.6	41.3	38.9
March. . .	42.1	45.2	40.8	40.3	41.4	42.9	41.4	43.8	42.2
April . . .	48.5	46.5	44.0	45.6	47.8	47.2	47.4	46.4	46.6
May. . . .	48.1	54.5	53.0	50.3	52.7	52.5	53.3	53.4	52.2
June. . . .	54.3	62.2	53.2	56.2	56.9	63.6	56.8	58.0	57.6
July. . . .	57.6	58.9	57.0	60.6	62.7	64.4	61.3	59.6	60.2
August . .	60.2	58.4	57.0	58.7	60.4	63.2	58.0	59.2	59.3
September.	58.5	54.4	53.8	57.0	59.6	56.7	56.2	57.8	56.7
October . .	50.5	51.0	47.2	48.4	51.5	52.4	52.8	50.2	50.5
November.	47.1	46.6	44.3	43.7	40.9	40.1	43.9	44.6	43.9
December.	42.8	34.9	40.0	40.0	39.3	42.3	44.4	45.3	41.1
Means. . .	48.6	49.6	46.5	48.4	49.2	50.0	48.5	50.0	48.8

I obtain the daily mean temperature from the extremes indicated by a pair of Rutherford's horizontal self-registering thermometers, placed 15 feet above the ground, out of the window of a room on the second floor, having a northern aspect. The situation is airy and out of the direct influence of the sun. The mean annual temperature, which, on the average of the eight years' observations, is 48°.8, in all probability is nearly correct, as it accords exactly with that deduced from the following series of observations on the temperature of spring-water.

Observations on the Temperature of Spring-water.

TABLE OF THE MEAN TEMPERATURE OF SPRING-WATER,

AT CRUMPSALL.

Months.	1821.	1822.	1823.	1824.	1825.	Means.
	°	°	°	°	°	°
January . .	42.4	43.8	40.9	43.8	44.3	43.0
February .	41.6	44.0	39.0	43.0	43.4	42.2
March. . .	41.4	44.4	40.7	42.6	43.0	42.4
April . . .	44.2	46.0	43.9	43.6	45.0	44.5
May. . . .	48.0	49.9	47.6	47.6	48.5	48.3
June. . . .	50.4	54.8	51.0	51.8	51.9	51.9
July. . . .	53.5	56.1	53.3	53.6	55.0	54.3
August . .	55.4	56.0	54.3	55.5	57.5	55.7
September.	56.2	55.6	54.6	56.0	57.5	55.9
October . .	52.9	52.9	51.0	53.1	55.6	53.1
November.	49.8	50.8	48.1	48.6	49.6	49.3
December.	46.7	45.4	45.3	45.6	46.4	45.8
Means. . .	48.5	49.9	47.4	48.7	49.8	48.8

The observations were made once a week, and the general annual mean found from them is 48°.8, being .4 of a degree higher than that determined by means of Rutherford's thermometers, for the same period. The surface of the water in the well, below that of the ground, varies from about 3 to 5 feet.

Account of Rain.

TABLE OF THE FALL OF RAIN,

AT CRUMPSALL.

Months.	1821.	1822.	1823.	1824.	1825.	1826.	1827.	1828.	Means.
January . .	1.70	2.39	1.29	1.44	1.72	.69	2.60	2.90	1.84
February .	.53	2.93	3.28	.62	1.86	2.22	.93	1.82	1.77
March. . .	3.88	4.31	2.38	2.85	1.02	.77	4.44	1.60	2.65
April . . .	3.52	.75	1.49	1.54	1.76	1.73	1.01	3.17	1.87
May. . . .	2.88	1.81	2.62	1.55	4.12	.17	1.69	.79	1.95
June. . . .	1.20	1.45	2.87	3.29	3.06	.19	2.03	2.03	2.01
July. . . .	1.87	8.14	5.21	.98	.52	3.04	2.00	10.10	3.98
August . .	3.28	3.98	5.92	1.79	4.10	2.22	4.08	3.45	3.60
September.	4.28	1.56	4.58	4.51	1.77	2.34	3.12	2.92	3.13
October . .	3.32	3.35	3.66	6.64	4.21	3.60	4.42	2.54	3.96
November.	4.44	4.19	1.90	4.95	6.21	2.00	2.44	2.21	3.54
December.	3.86	1.44	4.30	6.25	2.58	2.87	3.77	4.57	3.70
Total. . . .	34.76	36.30	39.50	36.41	32.93	21.84	32.53	38.10	34.00

My rain-gage is placed on the garden wall, at a sufficient distance from any higher object, and is about 12 feet above the ground. The funnel, which is six inches in diameter, is of sheet copper, with a perpendicular rim three inches high. On the mean of the eight years, the annual fall of rain in this township is 34.00 inches; but this amount is probably somewhat too small, as Mr. Dalton invariably makes the annual fall for Manchester greater than I make it for Crumpsall: the difference, which sometimes exceeds six inches, may, in part, be attributed to the circumstance of my gage being considerably more elevated than Mr. Dalton's: so great a discrepance, however, can hardly be referred to this cause alone. Mr. Dalton has suggested, that in stormy, wet weather, high winds, by impinging against the wall on which the gage is fixed, may have their direction altered in such a manner as to diminish the quantity of rain that falls into the funnel; and in this opinion I entirely coincide. It appears, on inspecting the monthly means, that in the first six months of the year, much less rain falls, on an average, than in the last six; every month in the former period producing a smaller quantity than any one in the latter; and that, in the township of Crumpsall, February is the driest, and July the wettest month in the year. The

number of days on which rain fell, and the number of distinct falls of rain, hail and snow observed in each year, are given in the following table.

Years.	Number of Wet Days.	Number of Distinct Showers.
1821	225	433
1822	234	537
1823	234	701
1824	242	746
1825	209	636
1826	196	402
1827	231	674
1828	237	765
Total.	1808	4894
Mean.	226	611

In the interval comprised between the commencement of 1821 and the termination of 1828, it is worthy of remark, that the atmosphere did not, in a single instance, remain completely cloudless for the space of twenty-four hours, or during the term of the natural day.

It has been the fashion to ascribe the formation of clouds, rain, and other aqueous meteors to the agency of electricity; and this fanciful hypothesis is not even yet entirely exploded: we may, however, reasonably expect, that ere long

it will be wholly superseded by a more philosophical doctrine, founded on sound inferences deduced from exact experiments, and a careful examination of facts; I allude to the theory of rain, originally advanced by Dr. Hutton, of Edinburgh, and subsequently illustrated and established by Mr. Dalton, which requires no comment; it is perfectly satisfactory and quite incontrovertible.

Observations on the Winds.

TABLE OF OBSERVATIONS ON THE DIRECTION OF THE WIND,

AT CRUMPSALL.

Winds.	1821.	1822.	1823.	1824.	1825.	1826.	1827.	1828.	Total.
N.	31	29	21	40	43	25	33	20	242
N. E.	80	91	80	101	81	87	91	74	685
E.	61	69	54	50	48	40	70	59	451
S. E.	60	80	59	41	66	45	40	80	471
S.	115	102	80	75	67	73	77	80	669
S.W.	168	176	169	156	174	126	145	131	1245
W.	169	164	178	157	142	135	148	137	1230
N.W.	89	98	82	106	126	92	73	87	753
Number of Observations.	773	809	723	726	747	623	677	668	5746

I generally ascertain the direction of the wind, by observing that of the smoke which issues from a lofty chimney, favourably situated for the purpose; and my practice is to register every change observed, whose duration is not merely momentary. The prevailing currents in this neighbourhood, it will be seen, are the S.W., W., N.W., N.E., and S.; those of more rare occurrence being the N., E., and S.E. As I possess no instrument for determining the force of the wind with precision, I have contented myself with rudely estimating it from its general effects. On the present occasion, I shall only give the number of high winds recorded, with the months in which they occurred.

High Winds.	Jan.	Feb.	Mar.	April.	May.	June.
	36	54	45	38	6	1
	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	3	10	31	36	44	61

From the observations thus collected and arranged, it is obvious, that the winter months are much more subject to boisterous winds, and, consequently, to those atmospherical phenomena which are dependent upon them, than the summer months.

A few remarks on the distance to which spray from the sea is sometimes carried inland by

storms of wind, may not, perhaps, be deemed altogether irrelevant to the subject we are treating upon.

Sea-water is brought into the immediate neighbourhood of Manchester, which is at least thirty miles from the nearest coast, by every violent and long-continued gale from the west; and the exact proportion in given quantities of rain-water, collected on several occasions of this kind, has been determined chemically.*

That the sea is the principal source whence the salt is derived, with which the rain that falls in this town and its vicinity is occasionally impregnated, cannot, I think, be doubted; as I have clearly ascertained, by direct experiment, that its excess or deficiency depends entirely on the direction, force, and duration of the wind. Rain collected in clean glass vessels, a few miles to the north of Manchester, when the wind blows moderately from the N. or N. E., scarcely ever exhibits the slightest trace of muriatic acid, on the application of the most delicate test, (nitrate of silver,) even when reduced two-thirds or three-fourths by spontaneous evaporation;

* Society's Memoirs, New Series, vol. IV.—Essay on the Saline Impregnation of Rain, &c, and Appendix.

though samples collected in the town, precisely at the same time, on being subjected to the test, generally have their transparency more or less impaired. This fact seems to prove, that, notwithstanding muriate of soda is never raised into the atmosphere by evaporation, yet the air over large towns usually contains a very minute portion of muriatic acid, which, as Mr. Dalton observes,* is probably supplied by the sublimation of muriate of ammonia during the combustion of fuel. A considerable increase of muriatic acid takes place in the rain which falls in Manchester, when accompanied with a brisk breeze from the west, of several hours duration; as is evident from the greater degree of opacity observed in samples caught under such circumstances, when treated with a few drops of the solution of nitrate of silver; and that which falls in the adjacent country, then manifests a sensible trace also: indeed, the direction of the wind remaining the same, its force and duration seem almost entirely to regulate the quantity of muriatic acid in the atmosphere; which completely establishes the fact, that it is brought from the sea by the mechanical action of powerful currents of air.

* Society's Memoirs, New Series, vol. IV. p. 370.

The utmost distance to which sea-water is conveyed by tempestuous winds is not easily determined. Sir H. Davy, in his Elements of Agricultural Chemistry, p. 295, states, that "in great storms the spray of the sea has been carried more than 50 miles from the shore," but he does not give his authority. Being at Blackwall, in Derbyshire, the residence of my relative, John Blackwall, Esq., on the 23rd of November, 1824, when a violent hurricane occurred which did extensive damage on the southern coast, I took several opportunities of examining the rain which fell at intervals on that occasion, and uniformly found that it became extremely turbid on application of the test, evidently containing much more muriatic acid than rain collected in large towns, during calm weather, is ever found to contain. The storm commenced on the night of the 22nd of November, and continued, with little abatement, till after noon on the 23rd. The wind blew from the south all the time, and the place of observation is 140 or 150 miles from the sea in that direction. This is, perhaps, the greatest distance on record, to which sea-water has been clearly ascertained to be conveyed by the wind; and that it extended much further is highly probable.

Observations on the Dew-point.

TABLE OF THE MEAN TEMPERATURE AT WHICH THE AQUEOUS VAPOUR IN THE ATMOSPHERE BEGINS TO BE CONDENSED INTO WATER,

AT CRUMPSALL.

Months.	1821.	1822.	1823.	1824	1825.	Means.
	°	°	°	°	°	°
January. .	34.8	37.1	27.2	37.4	34.7	34.2
February .	32.4	39.3	32.2	36.7	35.4	35.2
March. . .	38.1	40.4	35.3	35.0	36.2	37.0
April . . .	42.8	41.5	37.2	39.0	41.8	40.4
May . . .	41.7	46.5	45.8	44.0	45.9	44.7
June . . .	45.8	54.7	47.2	51.0	49.8	49.7
July. . . .	50.0	53.9	51.4	54.9	55.1	53.0
August . .	54.8	52.5	52.2	53.9	54.9	53.6
September	53.3	48.1	48.9	52.6	53.7	51.3
October. .	46.3	45.8	43.2	44.9	47.3	45.5
November	41.8	43.3	42.1	41.0	37.4	41.1
December	39.3	30.4	37.7	36.6	36.4	36.0
Means. . .	43.4	44.4	41.7	43.9	44.0	43.4

In finding the dew-point, or that degree of temperature at which the aqueous vapour in the atmosphere begins to be condensed into water, I employ the method introduced by Le Roi, and recommended by Mr. Dalton. An observation was made every day, in the open air, usually between nine and ten in the evening, but as this hour is rather too late, except in summer, to give the true daily mean, the monthly means obtained from the observations are a little lower than they should be, especially in the winter months. It will be perceived, that on the average of the five years, the quantity of aqueous vapour in the atmosphere is at a minimum in January, and that it goes on progressively increasing till August, when it arrives at the maximum; it then begins to diminish gradually, and continues decreasing till the month of February. The mean annual point of deposition is 43°.4, which is 5° lower than the mean annual temperature for the same period. The lowest state of vapour in the atmosphere, observed in the course of the five years, took place on the 18th of January, 1823; when the dew-point was 13°, corresponding to .1 of an inch of mercury in force, which is equal to 1.4 inches of water, the temperature of the air, at the time, being 17°; and the highest state occurred on the 18th of July, 1825; when the dew-point was 68°.5,

corresponding to .69 of an inch of mercury, or 9.6 inches of water, the temperature of the air, at the time, being 73°.5. The difference between the quantities of water contained in a vertical column of the atmosphere, in these particular instances, is 8.2 inches.

It was my intention to introduce, in this place, a series of observations on the evaporation from water, but my gage was so unfavourably situated, and I experienced so much difficulty in protecting it sufficiently from rain, frost, and birds, without, at the same time, impeding, in a great measure, the free admission of air and sunshine, that the results were considered too incorrect to be admissible here; they are, therefore, withheld; and I the less regret this circumstance, because the quantity of water evaporated each month throughout the year, may always be found from the mean monthly temperature and point of deposition.*

* See the second part of the 5th volume of the First Series of the Society's Memoirs, p. 588.

Observations

ON

THUNDER STORMS AND LUMINOUS METEORS.

Intimately connected with the state of the aqueous vapour in the atmosphere, are the electrical phenomena of thunder and lightning. By evaporation the electric fluid is silently raised and accumulated in the air, and by condensation, or the conversion of steam into water, its intensity is increased; till, under favourable circumstances, it manifests itself in those energetic and sublime displays which are witnessed in thunder storms. From the annexed comparative view, founded on the experience of the five years, commencing with 1821, and terminating with 1825, it is plain, that those months in which the dew-point is highest are most liable to thunder and lightning.

Mean Monthly Point of Deposition.

Jan.	Feb.	Mar.	April.	May.	June.
34°.2	35°.1	36°.9	40°.4	44°.7	49°.6

Number of Thunder Storms observed.

0	0	4	10	15	16

Mean Monthly Point of Deposition.

July.	Aug.	Sept.	Oct.	Nov.	Dec.
53°.0	53°.6	51°.3	45°.4	41°.0	36°.0

Number of Thunder Storms observed.

26	27	8	6	5	3

On the evening of the 10th of June, 1822, this neighbourhood was visited by one of the most remarkable thunder storms I remember to have seen: numerous and vivid electrical discharges, from almost every point of the compass, illuminated the sky; indeed, for the space of more than an hour, there were, on an average, sixteen distinct flashes of lightning in a minute. The point of deposition, at the time, was 57°.5, and, on the evening of the preceding day, it was 61°. When the dew-point is unusually high for the season of the year, but more especially in summer, thunder frequently ensues on the same or following day.

Of eighteen appearances of the aurora borealis, which have been registered from 1821 to 1828, inclusive, one occurred in 1821, one in 1826, seven in 1827, and nine in 1828; it is evident, therefore, that this interesting phenomenon has been visible much more frequently, in England, during the last two years of the series, than for a considerable period antecedent to them. On

three occasions, namely, December the 27th, 1827, and December the 1st and 26th, 1828, the aurora, in the form of a rainbow-like arch, was seen to cross the magnetic meridian, by the plane of which it was bisected, at right angles. That the true height of the luminous arches of the aurora must be great, is certain from contemporaneous observations which have been made upon them, by persons situated in distant parallels of latitude. According to Mr. Dalton, who has recently determined their altitude trigonometrically, it is about one hundred miles above the surface of the earth.* The periodical occurrence of this splendid meteor, and the motion from north to south, which the luminous arches are usually perceived to have, well deserve the attention of the scientific meteorologist.

With regard to the meteors known by the appellation of shooting stars, I have little to observe, except that their motions do not appear to be influenced either by currents of air, or by the earth's magnetism; and that their elevation is probably considerable. The great velocity with which they pass through that portion of their path in which they are visible, and the various and opposite directions they pursue on the same

* Transactions of the Royal Society for 1828, Part II.

night, and even at the same moment of time, sufficiently establish the accuracy of the first remark; and the fact that they must have an elevation of at least several miles, is proved by their never being seen within the region of the clouds. Of more than 260 shooting stars, above the medium size, observed in the course of the eight years, not one was perceived to pass beneath a cloud; it is desirable, however, that the altitude of these meteors should be correctly ascertained by exact measurements.

On the 7th of September, 1828, at half-past eight, P.M., a large meteor appeared which was visible over a great extent of country. According to numerous accounts of this phenomenon, which, with the assistance of Mr. Peter Barrow, I collected from newspapers and other periodical publications, it was seen at Glasgow and Dumfries, in Scotland; at Newcastle-on-Tyne, Carlisle, the village of Bolton in the north riding of Yorkshire, Whitby, Scarborough, York, Hull, Preston, Horton in Ribblesdale, Blackpool, Manchester, Matlock, Northampton, Chelmsford, Bristol, Brighton, and Plymouth, in England; at several of which places it is remarked, that its altitude above the horizon was very considerable; it was seen also by a passenger on board a steam-boat a few miles to the north of the Isle of Man.

Some individuals describe this meteor as having a diameter equal to that of the sun or moon, but they must have greatly overrated its apparent size, misled, in all probability, by the extreme brilliancy of its light; for a very intelligent lady of my acquaintance, who saw it at Manchester, informs me, that it appeared to her somewhat larger than the planet venus when at its greatest elongation.

Observers at York, and to the north of that city, state, that the direction in which the meteor moved was south-easterly; while those at Manchester, and to the south of that town, remark that it was north-easterly.

This difference of opinion was occasioned, no doubt, by mere optical illusion; due allowance for which being made, it is very probable that the true path of the meteor was nearly from west to east, and that it was vertical somewhere between York and Manchester.

Though these observations do not supply data from which the exact height and magnitude of this meteor may be determined, yet they clearly establish the fact, that its true altitude and size must have been very considerable; and taken in conjunction with former observations upon

similar phenomena, powerfully support the opinion, that the luminous meteors, denominated shooting stars and fire-balls, occur in a very elevated region of the earth's atmosphere.