TENTH NUMBER

OF

METEOROLOGICAL PAPERS,

COMPILED BY R. ADMIRAL FITZROY, F.R.S.,

PUBLISHED BY AUTHORITY OF

THE BOARD OF TRADE.

STORMS OF THE BRITISH ISLANDS.

LONDON:
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J. D. POTTER, *Agent for the Admiralty Charts*, 31, POULTRY,
AND 11, KING STREET, TOWER HILL.

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CONTENTS.

PREFATORY REMARK.

A critical investigation of the principal facts, stated on reliable authorities, respecting some remarkable storms in the British Islands, having been desired; an attempt has been made, in the following pages, and in the charts to which they refer, to express the results of a partial enquiry, which may be considerably extended in a second edition.

R. F.

September 1861.

BRITISH STORMS.

Chapter I.

Outline notices of remarkable instances. Royal Charter, and other recent storms.

It is well known that no year passes in which the British Islands are not visited by storms, and that they vary in degree of force from what is usually called a gale, to a hurricane almost irresistible in violence. Only of late years, however, has it been supposed, and but recently proved, that nearly all, if not indeed the whole, of these remarkable tempests, by which such excessive injury has been done, have been so much alike in character and have been preceded by such similar warnings, as to warrant our reasoning inductively from their well-ascertained facts, and thence deducing laws. Every one looks back to some extraordinary storms as exceeding all others in a lifetime; but a tempest that is severely felt in one part of a country is not always extensive, it is usually the reverse, more or less limited in area, varying in range, direction and force. It would be inexpedient to advert to many of even the most devastating tempests in much detail; therefore I propose to mention only a few, and glance but summarily over their most marked features. From this merely superficial view I would except those to which these pages and the series of wind charts by Mr. Babington have especial reference.

The first storm to which I would advert is that so well and so fully described by De Foe, in 1703.* He calls it "the greatest, "the longest in duration, the widest in extent of all the tempests "and storms that history gives any account of since the be- "ginning of time." "Our barometers," he continues, "informed "us that the night would be very tempestuous; the mercury "sank lower than ever I had observed it on any occasion;" it fell to 28·47.† This storm began at south and veered through the west towards the north, round to the south, and continued (chiefly between south-west and north-west) with more or less strength, for a whole week! Very remarkable it is that not only did De Foe suppose this storm began near the southern coast of North America, but that it traversed England, Denmark, and the Baltic, to lose itself in the Arctic regions. He recurs afterwards to its shifting from south-west to north-west, and coming from the west *like other storms in the south of England*, but does not advert to any corresponding north-easterly wind, nor had he evidently any idea of a rotatory or circulating atmospheric current. Pro-

* The "Storm," 1704. A most striking collection of the then recorded tempests in England.

† In the Orkneys, Mr. Clouston has recorded 27·45. Perhaps De Foe's mercury could not fall more for want of space in the cistern,—a defect common in the earlier barometers, and not unknown now, occasionally.

bably, accounts from the north of England were less enquired for then: it is noted, however, that the north of England escaped the violence of that storm, which, evidently, was one of a succession of cyclones. See p. 10.

I will not take more from De Foe, but may venture to say that his graphic accounts of many storms, and the more comprehensive views of Dampier, are well worth the notice of any scientific meteorologists. To them and to Franklin, Capper, Horsburgh, Redfield, Reid, Piddington, and Dové, besides other authorities, seamen may well be grateful for their works on storms: the facts and inferences compiled by them having been demonstrated to be generally true.

Among other storms to be noticed in a more detailed manner, two alone will probably suffice as types shown in synchronous charts. The *Royal Charter* gale, so remarkable in its features, and so complete in its illustrations, I may say, from the fact of its having been noted at so many parts of our coast, and because the storm passed over the middle of the country, is one of the very best to examine which has occurred for some length of time. I would, therefore, ask for attention to this particular instance. It occurred on the 25th and 26th of October 1859. The lowest barometer and a corresponding or simultaneous central *lull* prevailed over areas of ten or twenty miles successively. But at the time that this comparative lull existed, there were violent winds around this central space (by some called a vortex, but which can hardly be thus *appropriately* termed, because there was no central disturbance), while there were only variable winds or calms in the middle of the area, which was from ten to twenty miles across. The wind attained a *maximum* velocity of from sixty to one hundred miles an hour, at a distance of twenty to fifty miles from this comparatively quiet space, and in successive spiral eddyings seemed to cross England towards the north-east, the wind blowing from all points of the compass consecutively around the lull; so that while at Anglesea the storm came from the north-north-east, in the Irish Channel it was northerly, and on the east of Ireland it was from the north-west; in the Straits of Dover it was from the south-west; and on the east coast it was easterly —at the *same minute*.

Thus there was an apparent circulation, or cyclonic commotion, passing northwards from the 25th to the 27th, being two complete days from its first appearance near the "chops" of the Channel; while outside of this circuit the wind became less and less violent; and it is very remarkable that, even so near us on the west coast of Ireland, there was fine weather, with light winds, while in the Bristol Channel it blew a northerly and westerly gale. At Galway and at Limerick, on that occasion, there were light winds only, while over England the wind was passing in a tempest, blowing from all points of the compass in irregular succession around a central variable area.*

* See Note A, in page 32.

Another storm, that occurred a few days after, was similar in its nature, though it came from a slightly different direction. This one was on the 1st and 2nd of November, and its character was in most respects like that just described. Its centre came more from the westward, passed across the north of Ireland, the Isle of Man, and the north of England; then went over the North Sea towards Denmark. Further than that distance facts have not yet been collected; but, no doubt, in the course of time they may be obtained and added to a future collection, for which this may be preparatory.

The general effect of these storms was felt unequally on our islands, and less, inland, than on the coasts. Lord Wrottesley has shown, by the anemometer at his Observatory in Staffordshire, that the wind is diminished or checked by its passage over land; and looking to the mountain ranges of Wales and Scotland, rising two to four thousand feet above the ocean level, we see they must have great power to alter the direction, and probably the velocity of wind, independently of alterations caused by changes of temperature.

Very remarkable were the similarities of the storms of the 1st and 2nd of November, and the 25th and 26th of October, the series of storms investigated by Dr. Lloyd during ten years, and the observations of Mr. William Stevenson in Berwickshire,* (requiring especial notice.) There is no discrepancy between the results of ten years' investigations published by Dr. Lloyd in Transactions of the Royal Irish Academy, the three years' enquiries published by Mr. W. Stevenson, and other investigations which have been brought together during the last few years. They all tell the same story. Dr. Lloyd found, in ten years, only one instance of a storm which differed; namely, one that came from the north, apparently, in the first instance.† Gales from the south-west are followed by sudden and dangerous storms from the north and east; and these from the north and east do most damage on our coasts. By tracing the facts, it is shown that storms which come from the west and south come on gradually; but that those from the north and east begin suddenly, and often with extraordinary force. The barometer, with these north-eastern storms, does not give direct warning upon this coast, because it ranges higher than with the wind from the opposite quarter. But though the barometer does not give much indication of a north-east storm, the thermometer does; and the known average temperature of every morning in the year affords the means (from the temperature being much above or below the average of the time of the year) of knowing, by comparisons, whether the wind will be northerly or southerly (thanks to Mr. Glaisher's deductions from more than eighty years Greenwich observations).‡

For a few days before the "*Royal Charter* Gale" came on, the thermometer was exceedingly low in most parts of the country:

* On the storms which pass over the British Isles, 1853.

† A doubtful instance.

‡ Besides electrical indications.

there were northerly winds in some places, with a good deal of snow; with low barometers. There had been a great deal of exceedingly dry and hot weather previously, which made the sudden change to remarkably cold weather, with snow, more remarkable (for the season). In the north of Ireland, especially, at that time (on the 22nd and 23rd of October), thermometers were very low. Many days preceding the *Royal Charter* storm an extraordinary clearness in the atmosphere was noticed in the north of Ireland—the mountains of Scotland were never seen more prominently than they were in the few days preceding those on which it took place. The summer was remarkable for its warmth; it was exceedingly dry and hot. All over the world, not only in the Arctic but in the Antarctic regions, in Australia, South America, in the West Indies, Bermuda, and elsewhere, auroras and meteors were unusually prevalent, and they were more remarkable in their features and appearances than had been noticed for many years. There were also extraordinary disturbances of the currents along telegraphic wires; which were so disturbed at times that it was evident there were great electric or magnetic commotions in the atmosphere which could then be traced to no apparent cause. Lord Wrottesley* has since adverted to some

* *Lord Wrottesley's Address to the British Association*, 1860.

In the progress of science it often happens that a particular class of observations, all at once, and owing to some peculiar circumstance, attracts very general attention and becomes deeply interesting. This has been the case within the last few years in reference to observations of the sun's disc, which were at one time made by very few individuals, and were indeed very much neglected both by professional and amateur astronomers. During this season of comparative neglect, there were not, however, wanting some enthusiastic individuals, who were in silence and seclusion obtaining data of great importance.

On the 1st September 1859, at 11·18 a.m., a distinguished astronomer, Mr. Carrington, had directed his telescope to the sun, and was engaged in observing his spots, when suddenly two intensely luminous bodies burst into view on its surface. They moved side by side through a space of about 35,000 miles, first increasing in brightness, then fading away; in five minutes they had vanished. They did not alter the shape of a group of large black spots which lay directly in their paths. Momentary as this remarkable phenomenon was, it was fortunately witnessed and confirmed, as to one of the bright lights, by another observer, Mr. Hodgson, at Highgate, who, by a happy coincidence, had also his telescope directed to the great luminary at the same instant. It may be, therefore, that these two gentlemen have actually witnessed the process of feeding the Sun, by the fall of meteoric matter; but however this may be, it is a remarkable circumstance, that the observations at Kew show that on the very day, and at the very hour and minute of this unexpected and curious phenomenon, a moderate but marked magnetic disturbance took place; and a storm or great disturbance of the magnetic elements occurred four hours after midnight, extending to the southern hemisphere. Thus is exhibited a seeming connexion between magnetic phenomena and certain actions taking place on the sun's disc—a connexion, which the observations of Schwabe, compared with the magnetical records of our Colonial Observatories, had already rendered nearly certain.

We may derive an important lesson from the facts above alluded to. Here are striking instances in which independent observations of natural phenomena have been strangely and quite unexpectedly connected together: this tends powerfully to prove, if proof were necessary, that if we are really ever to attain to a satisfactory knowledge of Nature's laws, it must be accomplished by an assiduous watching of all her phenomena, in every department into which Natural Science is divided. Experience shows that such observations, if made with all those precautions which long practice, combined with natural acuteness, teaches, often lead to discoveries, which cannot be at all foreseen by the observers, though many years may elapse before the whole harvest is reaped.

extraordinary facts respecting various circulating substances apparently absorbed by the sun. Perhaps, these electric disturbances were connected with a peculiar action of the sun upon our atmosphere. Certainly electrical wires above ground, and also submarine wires, were greatly disturbed, and these disturbances were followed within a few days by great commotions in the atmosphere, and by some remarkable change of weather.*

Instances of remarkable exceptions to the force of these particular storms occurred. At some places there was little or no wind; the barometer fell much, but there was no storm; the wind apparently circulating around those districts did not affect them, while at other places, a few miles off, the tempest was tremendous.

A very remarkable storm has been lately traced, and its description published, by Mr. Rowell, of Oxford. This blast occurred near Calne, in Wiltshire, cutting through fields and high trees. It actually lifted an empty waggon *from the road, over a hedge, into the next field!* The violence of the wind was confined to a limited line. The downward and onward pressure of the wind was so great in that locality that it acquired such elasticity as to lift opposing weights and carry them on. (I have myself known wind lift a boat into the air and shake it to pieces.) We have all heard of houses being unroofed; of great trees being torn up or broken by the force of the wind; but this is the first authenticated instance of a *heavy waggon* being lifted up and hurled over a hedge.

Before proceeding to describe and analyze the storms of October and November 1859, which are so amply illustrated by Mr. Babington's series of thirty charts, accompanying this introduction, I think that a perusal of Extracts from Mr. Stevenson's paper, (published in 1853, but yet little known,) will prepare and tend to clear the way. His explanation of the interference of following or consecutive cyclones is so frequently corroborated by practical observations, that no person who has not met with the original will object, I think, to its reprint in these pages, as much of its subject-matter is specially relevant to the discussion of British storms.

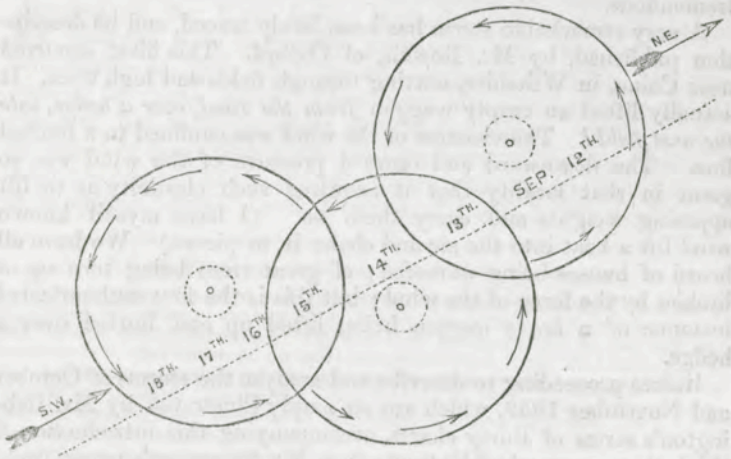
By W. Stevenson, Esq., of Dunse. 1853.

In this paper I propose to state, as concisely as possible, some of the more important general conclusions regarding storms, to which I have been led by long-continued observations, made in the Merse of Berwickshire, compared with observations made in other localities; and then to offer a few practical suggestions which have occurred to me while reflecting upon the subject.

The storms which pass over the British Isles are found generally to act in strict accordance with the "cyclonic" theory. In many cases, however, this accordance is not so obvious, and the phenomena become highly complicated. This is a result which often

* See Note B, in page 32.

happens when two or more cyclones interfere—an event of very frequent occurrence. When interferences of this description take place we have squalls, calms (often accompanied by heavy rains), thunder storms, great variations in the direction and force of the wind, and much irregularity in the barometric oscillations. These complex results are, however, completely explicable by the cyclonic theory, as I have tested in several instances. A very beautiful and striking example of a compound cyclonic disturbance of the atmosphere, at this place, was investigated by me in September, 1840, and found to be due to the interference of three storms, in the manner shown in the subjoined diagram :—



The dotted line and the dates show the progress of the storms over this locality, and the curved arrows the vertical or cyclonic movement, from right to left, which is found to hold with regard to the storms of the northern atmosphere. A glance will suffice to indicate the nature of the meteorological changes which might be expected to occur at any point upon the dotted line, or on parallel lines, during the passage of the storms in question. The complicated veerings of the wind, the risings and fallings of the barometer, the calms, irregular gusts and occasional heavy showers, which prevailed for about a week, while this system of cyclones passed over this locality, appeared at first quite anomalous; and it was with no small pleasure that I found the varied phenomena explained in the most satisfactory manner, and agreeing beautifully with the received laws of storms, on the hypothesis of a combination similar to that shown in the diagram.

Another striking instance of cyclonic interference was presented by a storm which passed over the North of Ireland on the 19th November 1850, and reached this place early on the following morning. On the 18th November, about noon, a storm

commenced here from S.E., and continued till the afternoon of the 19th, at which time the wind had veered to S.W., showing that the centre of this storm had passed to northward. The completion of the veering of the wind was prevented by the arrival of the other storm above referred to, and the wind backed to S.E. A very great quantity of rain fell during the night and next day, the wind veering by N.E., and N. to N.N.W. The centre of this storm must therefore have passed to southward of this locality. The 21st was fine, wind light from S.W.

A third example of the interference referred to, was exhibited by a series of storms which passed over Britain in a direction nearly N.W. to S.E., between the 18th and 27th of February, in the present year. The first storm commenced on the 18th, and had completed its course by mid-day of the 21st, the veering of the wind having been confined to points between W.N.W. and N.N.E., and the centre having passed to eastward. On the evening of the 21st, symptons of a second storm began to appear. This storm also moved in the same direction, its centre likewise passing to eastward. Its course was regular until the forenoon of the 24th, when it was interfered with by a third storm of quite the same character as the two preceding, but more nearly central here. The barometer fell until nine p.m. when it attained its lowest point, the wind being from S.W. At twelve p.m. the wind had veered to N., and the barometer had risen ·05. The wind continued northerly, with a rising barometer, till about three p.m. of the next day, when the wind was backed to S.W. by a fourth storm coming over in the same direction. This storm was nearly central here, and caused a great depression of the barometer. The 26th was very stormy, wind N.N.E. This storm, the last of the series, was permitted to complete its course with regularity, and by three p.m. of the 27th the atmosphere had become settled. During the passage of these storms, heavy snow and hail squalls, with high winds, occasionally interrupted by calms, were very prevalent.

Numerous other instances of cyclonic interference might be cited, but those now given will, it is hoped, be sufficient to serve as examples of their general character. It not unfrequently happens that a series of cyclones follow hard upon each other for several weeks, the preceding members of the series being often overtaken and interfered with by those succeeding. It is, however, important to remark, that amidst all the complexity necessarily occasioned by such combinations—the greater and more violent storms, and particularly that portion of them which is most dangerous and destructive, exhibit almost invariably the simple cyclonic character. It is thus with the "Law of Storms" as with the "Law of Gravitation;" the grand results of both are exceedingly simple, but the minor details become more and more complicated in proportion to their minuteness.

The direction of the *progressive motion* of the storms which pass over Britain is most frequently from about S.W. to N.E., but occasionally from other points, including it would appear all

points from S.E. round by S. and W. to N. They seem very rarely to come over from any point between N. (round by E.) and S.E. About ten years ago, I was led to form the opinion, that *the direction of the progressive motion of any storm coincides with that of the upper current of the atmosphere prevailing at the time, at the ordinary altitude of cirrus clouds.* Since then, I have met with no instance adverse to this view, but, on the contrary, many highly confirmatory of it. The point cannot, however, be considered as determined, until placed beyond doubt by the concurrent testimony of other observers, and I would beg to impress upon meteorologists the importance of giving the subject their close attention. It is obviously of very great consequence that this point should be ascertained, since if found to hold universally or even generally true, the movements of cirrus clouds, at the time when a cyclone is approaching or passing over, would be of greater utility in indicating the direction of its progressive motion, which being known, a little attention to the state of the barometer and the wind, will suffice to enable an observer to predicate with confidence the general characters or elements of the storm, such as its probable violence, the manner in which the veering will take place, and the point from which the wind will blow with the greatest force.

From observations made at this place during the years 1840 to 1847 inclusive, I find that the directions of the atmospheric currents at the surface have been:—

		Days.
From points N.W. to N.N.E.	inclusive	660
„ N.E. to E.S.E	„	471⅔
„ S.E. to S.S.W.	„	402
„ S.W. to W.N.W.	„	1244⅔
		2778⅓

During the same period I find that the directions of the upper currents, at the ordinary elevation of cirri, as indicated by the motions of these clouds, may be represented by the following figures:—

		No. of Observations.
From points N.W. to N.N.E.	inclusive	267
„ N.E. to E.S.E.	„	8
„ S.E. to S.S.W.	„	187
„ S.W. to W.NW.	„	496
		958

It thus appears, that in this part of the world, the instances in which the upper currents of the atmosphere move from the easterly points are exceedingly rare and exceptional, being under one per cent., and even the eight instances noted are open to objection, as in nearly the whole of them the clouds observed, though of the cirrus type, appeared to move at an elevation considerably inferior to that which such clouds usually occupy. So far as I have observed, the instances of cyclones coming over

from these points are equally rare; indeed, I have not as yet found a single example.

Our heaviest storms generally have a progressive motion from S.W. to N.E., and the most frequent track of their centres, is a line passing in that direction across the North of Ireland, and the South of Scotland. A great number of these storms are central in the Merse of Berwickshire, hence the barometric range is greater in general here than at places situated to northward or southward. The damage done by such storms is much greater at places situated within the range of the Southern semicircle of the whirl, at a certain distance from the centre, than at places within the northern semicircle, or even in the course of the central line. A remarkable instance of this was afforded by the memorable storm of 7th January 1839. The centre of this storm passed in a S.W. to N.E. direction, by Belfast, Dumfries, and the Merse. The barometer here fell rapidly with the wind at S.E., and rose with the wind from N.W., the wind in passing through the westerly points having been comparatively light. In the southern semicircle of the storm, particularly at Dublin, Liverpool, &c., the violence of the wind was much greater than at this place, and was most furious from S.W. In the northern semicircle, embracing the central and northern districts of Scotland, the wind blew from the easterly and northerly points, and caused comparatively little damage. The greater force of the wind in the southern semicircle is readily explained by the consideration, that in it the maximum force of the wind is composed of the vortical force *plus* the progressive, whereas in the northern it consists of the vortical *minus* the progressive. If we suppose the vortical or rotatory velocity of the wind, in a storm such as that referred to, to be 60 miles an hour, and the rate of the progressive motion of the storm to be 15 miles an hour, the greatest velocity of the wind across the central line, or axis, would be 60 miles, at certain points in the northern semicircle 45 miles (60–15), and at others in the southern semicircle 75 miles an hour.*

If the views stated above, relative to the motions of the upper currents of the atmosphere at the elevation of the cirri, be found to be correct, they may prove to be of utility, in indicating at sea, or where there are no means of comparing observations, the directions of the progressive motion of any storm, and this is a point of essential importance to a thorough understanding of its other conditions.

I have undertaken a discussion of my meteorological registers for the years 1840 to 1847, inclusive, with the view of testing the correctness of the opinion which I have long held,—that the directions of the progressive motions of cyclones are the same as

* It should be remarked, that although cyclones may practically be regarded as funnel-shaped, or as sweeping over areas approximately circular at any given moment,—they are, in reality, to a certain extent, spiral, or irregular in their movements.

those of the upper currents at the time, as indicated by the motions of cirri. The result is shown in the following table:—

Year.	No. of Cyclones.	Directions of the Motions of Cyclones.												Comparison with Motions of Cirri.					
		S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	N.	Unascertained.	A.	B.	C.	D.	E.	Sums.
*1840	12	–	–	1	–	2	3	4	2	–	–	–	–	4	3	–	–	5	12
1841	15	–	1	–	2	6	–	4	–	2	–	–	–	8	2	–	3	2	15
†1842	8	–	–	–	3	2	2	–	–	1	–	–	–	3	–	–	3	2	8
1843	10	–	–	–	–	2	–	4	1	1	–	–	2	6	2	–	1	1	10
1844	8	–	–	–	–	1	1	4	1	1	–	–	–	5	–	1	2	–	8
1845	11	–	–	–	2	1	2	4	–	1	–	–	1	5	4	–	–	2	11
1846	11	–	–	–	2	4	1	2	–	–	–	–	2	5	3	–	–	3	11
1847	15	–	–	–	1	4	1	4	2	1	1	–	1	5	3	–	2	5	15
Sum.	90	–	1	1	10	22	10	26	6	7	1	–	6	41	17	1	11	20	90

* Nine months, April to December, inclusive. † Six months. viz., Jan., Feb., Sept., Oct., Nov., and Dec.

Column A. contains the number of instances in which the agreement of the motions of the cyclones with those of the upper currents at the time appeared complete.

B. cases in which the difference did not exceed one principal point (reckoning 16 to the compass card), or 22½°.

C. cases in which the difference appeared to exceed the same.

D. cases in which the directions of the motions of the cirri or of the cyclones were doubtful.

E. cases in which the motions of the cirri were not observable during the passage of the cyclones.

It thus appears that in 58 cases, or nearly two-thirds of these quoted, the agreement is as close as could be expected; in 31 cases satisfactory grounds of comparison were not attainable; leaving only *one* instance out of 90 in which any considerable disagreement was apparent. In constructing this table, all the decided storms which passed over this part of the country during the period to which it refers were selected, and the directions of their progressive motions ascertained as nearly as possible,—in accordance with the principles of the cyclonic theory. The motions of the cirri, at the time of the passage of each storm, were then extracted from the register, arranged in a column adjoining that in which the motions of the cyclones were entered, and a comparison instituted between them. In some instances where cirri were not observed on the day of the passages of a cyclone, observations made on the preceding or following day were employed, but only where it was obvious that the motions of the upper currents were steady, or the amount of their veering known. This veering of the upper currents, it may be remarked, appears to follow the same law as the veering of the currents nearer the surface. It is often rather sudden. "Backings" also

are occasionally observed, and generally it would appear that the upper currents are affected by cyclonic (or rather perhaps *cyclonoidal*) movements similar in character to those which prevail in the lower regions of the atmosphere.

The following table shows the results of a comparison of the cyclonic movements, greater and less, observed during part of the period embraced in the preceding table, drawn up according to the same method:—

Year.	No. of Cyclonic movement.	Directions of the Motions of Cyclones.											Comparison with Motions of Cirri.					
		S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.N.	N.W.	N.N.W.	N.	Unascertained.	A.	B.	C.	D.	E.	Sums.
*1840	37	2	1	1	–	4	8	9	2	–	–	–	10	11	4	1	2	19	37
1841	72	1	3	3	6	13	2	11	8	3	–	1	21	20	13	–	11	28	72
†1842	27	–	–	3	6	4	2	2	2	2	–	–	6	8	3	–	7	9	27
Sum.	136	3	4	7	12	21	12	22	12	5	–	1	37	39	20	1	20	56	136

† Nine months, April to December, inclusive.
Six months, viz., Jan., Feb., Sept., Oct., Nov., and Dec.

Chapter II.

Preparations for simultaneous, or synchronous observations. Occurrence of remarkable storms. Means of investigation. Astronomer Royal's assistance.

In my report to the then President of the Board of Trade, Lord Stanley of Alderley, in March 1857, was the following passage:—

"As one illustration of what might be speedily effected by "combination, a portion of a plan is submitted, which, if fully "executed, would throw a light on the atmospheric changes over "the British islands and their vicinity, which has been unattainable hitherto. I refer to ascertaining the simultaneous states "of the atmosphere at certain times, remarkable for their extreme "and sudden changes, at very numerous stations, on land as well "as at sea, within an area comprised between the parallels of 40 "and 70 degrees north, and the meridians of 10 degrees east "longitude and 30 west.*

"For each selected time (referred to one meridian) a chart "should be compiled of the atmosphere within these limits; and "from such charts a great amount of information, practically as "well as scientifically useful, might be derived. Their intercomparison might tend to show the course, progress, and nature "of those changes, which now seem so uncertain, and cause so "much anxiety to farmers and travellers, as well as to those most "interested, who are concerned in navigation or fishery. Scientific men would obtain facts immediately applicable to theories "of wind and weather, and to a more distinct elucidation of the "nature and progress of atmospheric waves. The meteorological "history of three months of winter, and perhaps three of summer, "by such a combination, would be the object aimed at if approved.

"When Sir John Herschel proposed "term days" for general "use in the great combination of magnetical and meteorological "observers, which was instituted in 1838, that great philosopher "recommended united efforts to be made at *definite limited times.* "(Those meteorological observations being for purely scientific "objects rather than for those of navigation, however related to "them, were not specially referred to at the commencement of "this report.) The principle of observing at certain terms rather "than constantly, if adopted generally, might induce many persons "to co-operate who now cannot undertake to observe continuously,—besides being otherwise advantageous."

The plan submitted is sketched in the circular annexed, which might be widely distributed, not only in the British islands but around the coasts adjacent to the North Atlantic Ocean, in the temperate zone.

* Besides nearly one hundred places of regular observation within the British Islands, registers are kept at the lighthouses, now very numerous.

Simultaneous Observations.

"It has been desired that a great many observations should be "compared throughout the British Islands (with their neighbouring coasts and seas,) at certain remarkable periods, to obtain the "means of delineating or mapping the atmosphere at successive "times; and thence to deduce the order of those changes of wind "and weather which affect navigation and fisheries especially, "besides agriculture, health, and all outdoor occupations.

"Such maps or charts might show the various horizontal or "other currents of wind (existing within such an area) at one "time, to which all other corresponding times should be reduced "by allowing for the difference of longitude.

"They might show the pressure and temperature of those currents, and other facts, such as the presence of clouds, rain, lightning, &c. at their respective localities.

"A sequence of such maps, compiled for special periods when "changes have been most marked, would enable meteorologists to "trace atmospheric waves as well as currents, both in plan and "section, and would throw much light on meteorology.

"Means might be taken, by circular letters, or otherwise, to "request copies of such particular observations made between "certain limits and dates, as might be specified in a general manner, and accompanied by a form for details."

Circular.

"Probably all persons who are interested in meteorology as a "science, or in changes of wind and weather as practical matters "affecting every-day life, have more or less noticed the remarkable changes of particular seasons.

"The meteorological department of the Board of Trade is collecting facts in connection with such changes of weather and "violent winds, with the view of ascertaining exactly where and "when they occurred throughout a considerable area, including "the British islands and adjacent localities.

"This last winter has been selected as a portion of time within "which certain sequences of simultaneous observations at a great "many places may be collected, and their results arranged for "publication, with particular advantage.

"The direction and force of wind, nature and changes of "weather, height of barometer, temperature of air, and moisture, "are particularly desired, at whatever time actually observed, at "sea or on land, between the meridians of thirty degrees west "and thirty of east longitude, and between the parallels of forty "degrees and sixty-seven of north latitude.

"Such information is requested relating to any time between "November last and the end of February.

"In all cases, the peculiarities and errors or corrections of instruments should be given, with the known or estimated height

" (saying which) of the barometer above the mean level of the " sea, besides expressing whether the observations are given " exactly as made, or whether any and what corrections have been " applied towards their reduction.

" The more numerous the exact observations and details " that may be transmitted, the more valuable will be the com- " munication.

" Captains of ships within the specified area, during the months " selected, are particularly requested to send in as many obser- " vations as their logs or registers contain, for comparison made " with those at lighthouses, and with the numerous records now " kept by private gentlemen, besides those of established obser- " vatories."

In accordance with this proposal, which was approved, communications were organized, and—from the information willingly sent by private gentlemen, and by others in public service, especially the Corporation of Trinity House, the Commissioners of Northern Lights, and the Irish Ballast Board,—a series of synchronous charts was commenced, and had extended to nearly four hundred sheets before those were begun which are the principal subject of these pages.

The Royal Society and British Association having requested Government to institute a series of regular and continuous observations at specific points on the Atlantic, two of Osler's self-registering anemometers, one for Bermuda, the other for Halifax, were conveyed to their destinations and fixed early in 1859.

Soon afterwards the following circulars were distributed extensively, and an encouraging correspondence was opened.

Board of Trade (and Admiralty),
Meteorological Department.

MEMORANDUM.

Much interest having been caused by developments of the laws of storms, of winds of all kinds, and of the general circulation or changes of our atmosphere, the Royal Society, and the British Association for the Advancement of Science, requested Government to institute a series of regular and continuous observations in the Atlantic Ocean, and to place anemometers at a few eligible stations. Such instruments* are now in position at Halifax and Bermuda; arrangements being in progress for collecting a series of wind and weather observations, over and around the North Atlantic, during the next twelve or fourteen months consecutively.

In connexion with this subject, a series of wind charts is in progress, and will be extended to show the simultaneous states of atmosphere over the ocean and its boundaries, once a day (at least) during certain selected periods in the twelve or fourteen months of special observation.

During this limited interval of time, a collection of various meteorological information will be gathered from every available source—from ships at sea, as well as from observers on land.

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* Osler's self-registering, with Robinson's cups.

It would seem to be only necessary to make known the object in view, to say from whence it originated and how it is supported, —to secure the countenance and often the co-operation of all whose opportunities and tastes may combine to encourage a share in this extensive undertaking—the resulting value of which will chiefly depend on the extent of operations, and their subsequent discussion.

When once a sufficient store of facts is accurately recorded and arranged, their discussion may be variously effected by those who have particularly studied meteorology.

It is therefore earnestly requested that such information, particularly respecting wind and weather, may be obtained, and transmitted to this office during the next fourteen months.

Commencing as near the present date as may be convenient,* and continuing till October 1860,—or during as much of the time as it may be found practicable to do so,—the observations specially noted, and from time to time transmitted, should be as follows:—

About nine† o'clock, by Greenwich, each day, the direction and character of wind and the kind of weather prevailing at that hour should be recorded.

When there are the means it would be very desirable that temperature and pressure of air, with other meteorological facts, should likewise be noted, though *wind* and *weather* are *principally* sought, for the special objects at present contemplated.

Simple and few as these requisitions seem, they may produce much useful knowledge if acted on extensively and simultaneously.

The direction of the wind should be given, as most convenient to the observer, either by magnetic or by true bearing, *stating which* (whether by *magnetic-needle*, or by the world, sun, or pole star).

Winds, or currents of air near the earth's surface, being affected so much by inequalities, it is advisable to notice the lower and upper clouds, as well as smoke or vanes and weathercocks.

Strength or force of wind, may be estimated in common terms, where no better method is available.

Next to an anemometric scale, in value, is the Beaufort, and, in default of either, the words usually employed, such as strong, fresh, moderate, &c. should be adopted.

With this Memorandum are forms‡ suitable for rather extended observations daily—but for the record or registry of wind and weather *only*, no specific form will be required; as the direction and character of wind, with the description of weather, may follow successively, as noted thus;

June 22d, 8 A.M. N.W. Fresh, (5). Cloudy.
(with any further remarks that may seem useful).

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* The sooner the better.

† Greenwich mean time, allowing the longitude or difference of time.

‡ These forms are intended for use at sea or on land; for one, two, or three daily observations, the hours of nine A.M. and three P.M. being preferable, in addition to the Greenwich Nine or its equivalent in time.

From time to time, monthly or quarterly, such records as may be made should be transmitted to the Station from which these papers were received, whence they will be forwarded to the Board of Trade; or they may be sent direct, addressed to

The Secretary of the
Board of Trade,
LONDON, S.W.

The word "Meteorological" being in the lower left-hand corner.

June 22d, 1859.

Observatory, Washington,
June 18, 1859.

Lord Lyons sent up to me your letter of the 30th, with a packet of papers "intended to facilitate a collection of limited meteorological information in and around the North Atlantic Ocean."

As the best means of seconding this excellent move, I immediately addressed a letter to the President of the Lighthouse Board, of which I enclose you a copy.

I also made a circular to observers on the weather, of which I enclose you a printed copy. This was sent for publication to all the leading newspapers, from Maine to Louisiana.

I presume that these steps will secure you the desired co-operation in this country, for as soon as the responses begin to come in, I shall ask to have your circular published in the newspapers, for the information of co-operators. Is there anything more I can do to help on the good work?

M. F. MAURY.

"Observatory, Washington,
"July 16, 1859.

"SIR,

"I have the honour to enclose herewith for your information, and that of the Lighthouse Board, a circular from the Meteorological Department, Board of Trade (and Admiralty), London, and to ask the friendly co-operation of your Board with regard to the same.

"You will observe that the object in view is the collection of meteorological information, in and around the North Atlantic Ocean, during the next 12 or 14 months; that the British Government has taken up the subject with especial reference to the law of storms and other atmospherical phenomena, which concern alike all who use the sea; that the observations required are few and simple. Indeed, when instrumental observations cannot be had, observations with the eye alone, and just such observations as every one is accustomed to make on the weather, are very desirable.

"The assistance, therefore, which the Lighthouses and Light-boats, along the Atlantic and Gulf coasts of the United States

may lend to this undertaking is very important; and I hope that it will be in the power, as I am sure it would be the pleasure of the Board, to cause such assistance to be rendered, by commanding those keepers who have instruments to keep a journal, according to the printed form herewith enclosed, and by requiring those who have no instruments to keep a journal simply according to this form:—

Meteorological Journal for the Board of Trade, kept by Light Keeper at Lat. Long.

Date.	Wind.	Weather.	Remarks.
June 22.	N.W. Fresh. (5)	Cloudy.	——

"If desired by the Board, it will give me pleasure to place at its disposal a number of the forms and circulars prepared by Admiral FitzRoy.

"Respectfully, &c.,
"M. F. MAURY,
"Superintendent.

"Flag Officer W. B. Shubrick,
"President of the Lighthouse Board,
"Washington."

"Observatory, Washington,
"July 22, 1859.

"SIR,

"WITH regard to the blank forms for meteorological observations, in furtherance of the plan which the British Government has set on foot, and in reply to your letter of the 20th, I have the honour to state that this plan calls for observations with the eye alone, in case instruments cannot be had, and that it is not contemplated that the lighthouses would be furnished with instruments in order to afford the co-operation solicited in my letter of the 16th instant. Should any of them happen to possess a thermometer, a barometer, a rain-gauge, and the like, any or all, it would be very desirable that readings from such should be recorded, in addition to the observations with the eye alone.

"I enclose herewith, as a specimen, a suitable blank form—stouter paper would be better. You will observe that one single sheet of paper about the size of this will answer each keeper a month.

"Supposing the observations to commence on the 1st proximo, and to be continued till September 1860, 13 sheets will make a set, which should last each observer the whole term (13 months).

"Forms of this sort, on good stout paper, about 14 × 17 inches, will cost for paper, ruling, presswork, and composition $21 the

thousand. The expense, therefore, will be at the rate of two cents and one mil for each lighthouse per month.

" Respectfully, &c.,
" M. F. MAURY.

" Commander R. Semmes, U.S.N.,
" Secretary of the Lighthouse Board,
" Washington."

To Observers of the Weather in the Atlantic and Gulf States.

" At the instance of the Royal Society, and the British Association for the Advancement of Science, the British Government is just now commencing a series of observations in and around the North Atlantic Ocean, for the purpose of investigating the law of storms and other phenomena concerning the weather in and about the ocean.

" The matter has been placed in charge of Admiral FitzRoy, of the Meteorological Department of the Board of Trade (and Admiralty), London, who calls on ships at sea as well as persons on shore for co-operation. The observations are to commence forthwith, and to continue until September 1860; and they relate principally to wind and weather.

" Therefore, though observations with instruments in addition to those of the eye on the direction and force of the wind, and the character of the weather, are also desirable, yet the assistance to be rendered by those who will keep a journal, giving simply the force and direction of the wind, and the character of the weather twice a day, thus:—June 22. N.W. fresh, (5) cloudy (with any further remarks that may seem needful), will be highly important, and thankfully received. The hours of observation being about 9 A.M. and P.M. of mean time at Greenwich, will be for Texas about 2.30 A.M. and P.M.; for New Orleans about 3; for Georgia and Florida about 3.30; for Philadelphia 4; and for Eastport, Maine, about 4.30 A.M. and P.M.

" It is hoped that the masters of our coasting vessels will furnish at least *eye* observations on wind and weather; also, that the fishermen will do the same; and last, though not least, the farmers.

" Admiral FitzRoy has furnished me with a number of circulars and blank forms, containing full particulars, and giving detailed instructions to those who wish to observe; a copy of which I shall be happy to furnish to any one who will apply.

" This is a beneficent undertaking, fraught with advantages alike to all on both sides of the Atlantic; and I hope my fellow citizens will give it the encouragement and support it deserves, and that the press generally will second this appeal by publishing the above, and oblige,

" Respectfully, &c.
" M. F. MAURY.

" Observatory, July 16, 1859."

Observatory, Washington,
23 July 1859.

I REPORTED to you on the 18th the steps that I had taken to procure co-operators for you in this country.

Yesterday, in answer to a call from the Treasury Department through the Lighthouse Board, I submitted a form (with estimates) to be used by the observers in light-boats and at light houses.

There are along the Atlantic and Gulf coasts, 363 Lighthouses and Light-boats. If all of these be ordered to co-operate, forms for the whole period, say thirteen months, would cost about $95. I hope that the Treasury Department will order them. I send you a press copy of my reply.

I hope I have been fortunate enough to comprehend fairly your wants, and that the form is such as you would have it. The hours of observations should be filled in at the Lighthouse Board, for each station, and I suppose will be.

I am receiving from amateurs applications for the blank forms which you had the kindness to send me. My stock in hand will soon be exhausted, and at the end of August co-operators will be in want of more. I mail you a batch of these applications in order to bring you in direct communication with co-operators; so that you may not only supply them for the rest of the term, but be in position to avail yourself of other advantages.

I shall continue to transmit these applications to you, first having sent to the applicant a copy of the forms and circulars received from you.

M. F. MAURY.

Rear-Admiral Robert FitzRoy.

N.B. I suppose that few or none of the lighthouses have meteorological instruments.

28th July 1859.

I HAVE the pleasure to inform you that the Secretary of the Treasury has authorized the blanks to be prepared, and that the Lighthouse Board will give you the naked eye co-operation of the light keepers.

M. F. MAURY.

" Treasury Department,
" Office Lighthouse Board,
" July 26, 1859.

" SIR,

" THE Hon. Secretary of the Treasury having authorized the expenditure of the necessary funds to enable the Lighthouse Board to co-operate with the Board of Trade (and Admiralty), London, in making the meteorological observations described in your letters of the 16th and 22d instant, I have the honour to

inform you that the system of observations contemplated will be undertaken with as little delay as practicable.

"In consequence, however, of the remoteness from the seat of government, and of the difficulty of access to many of the light-houses of the United States, it is scarcely to be expected that the system can be fairly put in operation before the 1st day of September next.

"Very respectfully,
"Your obedient servant,
"R. SEMMES,
"Secretary.

"Commander M. F. Maury,
"Superintendent of the National
"Observatory, Washington."

Very remarkable it was, that these arrangements had only just reached maturity,—and were in satisfactory operation,—when two storms, in close succession, of a most marked and memorable character, passed directly over the British islands.

These were the violent and apparently rotatory gales of October the 25th, and November the 1st.

It then immediately occurred to me that, having a large collection of facts—in connection with these gales—the first of which is but too well known as the *Royal Charter* Storm, such a collection as never could have been accumulated on any former occasion of even the most remarkable storm, and having means of adding to them *largely*, though *gradually*, I ought to treat this one, so evidently cyclonic, in full detail, with the belief that a better *type*, for illustrating the subject, might not occur soon.

A series of simultaneous, synoptic, or *synchronous* charts would show *successive* views of wind directions, weather states, air pressures, temperatures, rains, clouds, &c., throughout the space or region known to have been connected with or affected by that great but very limited disturbance.

With these charts (seen as from above, or in plan,) there might be sectional views—in *diagonal* as well as rectangular lines.

By such *sections* it would be seen how far, and in what directions, *areas* of depression or elevation, *peculiarities* of *temperature*, clouds, rain, &c. extended, and how they moved, onward or otherwise.

Many of the points in doubt among meteorological observers and writers might be settled by a thorough synopsis, such as is thus sketched, if fully worked out, and duly treated *afterwards* by competent authorities.

In furtherance of these views, a series of such charts has been most carefully executed. They have principally engaged Mr. Babington's time and thought, and are as reliable as the numerical data from which he constructed them, with mathematical accuracy.

Full explanations are on the charts themselves; but a fair estimate of the relative value of barometrical data employed may here be offered, before referring to the charts in detail, and successively.

The PROBABLE LIMITS of ERROR of the BAROMETRIC CURVES on the SYNCHRONOUS CHARTS, 21st October to 2d November 1859.

1st. Observatories, quite correct.

THE observations at the regular observatories, such as Greenwich, Oxford, Cambridge, Kew, Highfield House, &c., have had all corrections applied, and have been reduced to sea-level, at the temperature of 32°.

2nd. Observers (1st Class). Error probably very small, less, certainly, than ½ a tenth.

The returns from members of the British and Scottish Meteorological Societies (nearly ninety in number) have *nearly* all been corrected for the exact height above sea-level, and all within a few feet. The corrections due to instrumental errors, and reduction to 32°, have (in most cases,) been applied by the observers themselves.

Continental observations. Probably within a very few hundredths of an inch.

The Continental observations have been collected partly from the Utrecht papers, and partly from the "Moniteur."

Those from the former have been corrected for instrumental errors, and have been reduced to 32°.

The heights of some foreign stations are known, and the corrections due to those heights have been applied: others are known to be very little above the sea-level.

Any error in laying down a curve from such data, can scarcely exceed two or three hundredths, on an average.

3rd. Observers (2nd Class) and ships. Error less than the tenth of an inch.

The heights of the stations of ordinary observers are known, for the most part, pretty nearly; and corrections for such heights have been applied to the returns. Other corrections have only been applied in a few cases; the observations, sometimes recorded only to the nearest tenth, not being deemed minutely accurate enough for any further correction.

Those returns in which the barometrical observations are evidently erroneous, (from comparison with other more reliable, neighbouring and contemporaneous, observations,) have been rejected altogether.

On the whole, we may safely assume that the observations laid down are less than a tenth in error anywhere.

4th. Lighthouses. Error probably not greater than the tenth of an inch.

The heights of the lantern above the sea-level, and of the tower, from the base to the vane, being known, the probable height of the barometer can be ascertained in all these cases.

The proper corrections for the heights thus estimated have been applied, and all returns seeming to be erroneous have been rejected.

The following Scales have been used :—

Sea Scale.		Wind.		Land Scale.
0 to 3	=	Light	=	0 to 1
3 „ 5	=	Moderate	=	1 „ 2
5 „ 7	=	Fresh	=	2 „ 3
7 „ 8	=	Strong	=	3 „ 4
8 „ 10	=	Heavy	=	4 „ 5
10 „ 12	=	Violent	=	5 „ 6

Pressure in Pounds (Avoirdupois.)		(Land Scale.)		Velocity in Miles (Hourly.)
½	=	1	=	10
5	=	2	=	32
10	=	3	=	45
21	=	4	=	65
26	=	5	=	72
32	=	6	=	80

As a basis of reference for all observations used in constructing the charts, and as a check on them throughout, the following tables are here placed. Mr. Airy kindly compared the Oxford Observations with those of Greenwich. Their accordance is remarkable.

Diagrams are appended.

The observations of Professor Challis, at Cambridge, are so *nearly* similar to those of Greenwich and Oxford, that their insertion, on the same diagram, would have caused some confusion.

Meteorological Observations made at the Royal Observatory, Greenwich, from October 20 to November 10 inclusive, 1859.

Height above the sea, 159 feet, allowed for in the charts, but not in these pages.

(Astronomical Time.)

Day.	Hour.	Reading of Barometer.	Direction of Wind.	Rain.	Day.	Hour.	Reading of Barometer.	Direction of Wind.	Rain.
		in.		in.			in.		in.
Oct. 20	0	29·375	W.		Oct. 24	0	29·325	S.	
	2	·340	W.			2	·310	S.	
	4	·280	W.			4	·295	S.	
	6	·280	N.E.			6	·300	S.W.	
	8	·232	N.N.E.	0·03		8	·310	S.W.	0·11
	10	·208	N.N.E.			10	·342	S.W.	
	12	·185	N.N.E.			12	·345	S.W.	
	14	·160	N.N.E.			14	·350	S.W.	
	16	·126	N.N.E.			16	·347	S.W.	
	18	·140	N.N.E.			18	·360	S.W.	
	20	·142	N.			20	·374	E.S.E.	
	22	·164	N.			22	·371	E.S.E.	
Oct. 21	0	29·160	N.		Oct. 25	0	29·342	E.S.E.	
	2	·160	N.			2	·289	E.S.E.	
	4	·125	N.W.			4	·210	E.S.E.	
	6	·170	N.W.			6	·105	E.S.E.	
	8	·197	W.N.W.	0·00		8	28·990	S.E.	0·69
	10	·230	W.N.W.			10	·960	S.S.E.	
	12	·236	W.N.W.			12	·945	S.	
	14	·275	W.N.W.			14	·920	S.S.W.	
	16	·296	W.			16	·920	S.S.W.	
	18	·320	W.			18	·960	S.W.	
	20	·374	W.S.W.			20	29·025	S.W.	
	22	·390	W.S.W.			22	·107	S.W.	
Oct. 22	0	29·404	W.S.W.		Oct. 26	0	29·147	S.W.	
	2	·385	W.			2	·248	W.S.W.	
	4	·385	W.			4	·360	W.S.W.	
	6	·405	W.N.W.			6	·463	W.S.W.	
	8	·420	S.W.	0·00		8	·526	W.S.W.	0·00
	10	·420	S.W.			10	·586	W.S.W.	
	12	·397	S.S.W.			12	·590	SW.	
	14	·364	S.S.W.			14	·565	SW.	
	16	·340	S.S.W.			16	·567	SW.	
	18	·306	S.S.W.			18	·627	SW.	
	20	·303	E.S.E.			20	·630	SW.	
	22	·290	E.S.E.			22	·680	S.W.	
Oct. 23	0	29·295	S.E.		Oct. 27	0	29·755	S.W.	
	2	·252	E.S.E.			2	·750	S.W.	
	4	·248	E.S.E.			4	·750	S.W.	
	6	·245	N.E.			6	·775	S.W.	
	8	·260	N.N.E.	0·00		8	·778	S.S.W.	0·01
	10	·270	N.W.			10	·780	S.S.W.	
	12	·270	W.			12	·766	S.	
	14	·270	W.			14	·736	S.	
	16	·270	W.S.W.			16	·720	S.	
	18	·270	S.W.			18	·680	S.	
	20	·295	S.W.			20	·670	S.	
	22	·318	S.W.			22	·625	S.	

Meteorological Observations, &c.—*continued.*

Day.	Hour.	Reading of Barometer.	Direction of Wind.	Rain.	Day.	Hour.	Reading of Barometer.	Direction of Wind.	Rain.
		in.		in.			in.		in.
Oct. 28	0	29·590	S.S.W.			12	29·138	W.S.W.	
	2	·525	S.S.W.			14	·208	W.S.W.	
	4	·470	S.S.W.			16	·316	W.	
	6	·410	S.S.W.			18	·425	W.S.W.	
	8	·335	S.S.W.	0·15		20	·508	W.S.W.	
	10	·315	S.W.			22	·626	W.	
	12	·293	S.W.						
	14	·293	S.W.		Nov. 2	0	29·676	W.	
	16	·260	S.W.			2	·695	W.S.W.	
	18	·218	S.W.			4	·685	S.W.	
	20	·220	S.W.			6	·680	S.S.W.	
	22	·225	W.S.W.			8	·685	S.S.W.	0·25
						10	·632	S.S.W.	
Oct. 29	0	29·204	W.S.W.			12	·620	S.S.W.	
	2	·215	W.S.W.			14	·597	S.S.W.	
	4	·223	W.N.W.			16	·590	S.W.	
	6	·268	W.N.W.			18	·590	S.W.	
	8	·297	W.	0·00		20	·597	S.W.	
	10	·333	W.			22	·610	S.W.	
	12	·373	W.						
	14	·393	W.		Nov. 3	0	29·616	W.S.W.	
	16	·398	W.S.W.			2	·605	W.S.W.	
	18	·398	W.S.W.			4	·600	S.W.	
	20	·399	S.W.			6	·600	S.S.W.	
	22	·382	S.W.			8	·590	S.	0·01
						10	·510	S.	
Oct. 30	0	29·340	S.S.E.			12	·440	S.E.	
	2	·240	S.E.			14	·375	S.E.	
	4	·134	S.E.			16	·295	S.E.	
	6	28·975	S.E.			18	·200	S.E.	
	8	·905	S.W.	0·16		20	·115	S.E.	
	10	·893	W.			22	·075	S.E.	
	12	·917	N.W.						
	14	·975	N.W.		Nov. 4	0	29·004	S.S.E.	
	16	29·030	N.W.			2	28·970	S.	
	18	·095	N.W.			4	·950	S.W.	
	20	·180	N.W.			6	·965	S.W.	
	22	·200	N.			8	·964	S.W.	0·26
						10	·960	S.W.	
Oct. 31	0	29·190	N.			12	·960	S.W.	
	2	·143	N.			14	·991	W.S.W.	
	4	·115	S.E.			16	29·130	W.N.W.	
	6	28·990	S.S.E.			18	·220	W.S.W.	
	8	·833	S.S.E.	0·02		20	·307	W.S.W.	
	10	·722	W.S.W.			22	·355	W.S.W.	
	12	·720	S.W.						
	14	·750	S.W.		Nov. 5	0	29·346	S.W.	
	16	·745	S.W.			2	·330	S.W.	
	18	·715	S.W.			4	·217	S.W.	
	20	·709	S.W.			6	·200	S.W.	
	22	·680	S.W.			8	·228	S.W.	0·21
						10	·263	W.S.W.	
Nov. 1	0	28·655	S.W.			12	·305	W.S.W.	
	2	·665	S.W.			14	·279	W.S.W.	
	4	·735	W.S.W.			16	·215	W.S.W.	
	6	·864	W.S.W.			18	·182	W.S.W.	
	8	·995	W.S.W.			20	·205	W.	
	10	29·096	W.S.W.	0·06		22	·295	W.N.W.	

Meteorological Observations, &c.—*continued.*

Day.	Hour.	Reading of Barometer.	Direction of Wind.	Rain.	Day.	Hour.	Reading of Barometer.	Direction of Wind.	Rain.
		in.		in.			in.		in.
Nov. 6	0	29·330	S.W.			12	29·940	N.W.	
	2	·380	S.W.			14	·990	N.W.	
	4	·405	S.W.			16	30·047	N.W.	
	6	·432	S.W.			18	·080	N.W.	
	8	·430	S.W.	0·47		20	·170	N.	
	10	·428	S.W.			22	·195	N.N.E.	
	12	·410	S.W.						
	14	·384	S.W.		Nov. 9	0	30·203	N.	
	16	·395	S.W.			2	·250	N.	
	18	·408	S.W.			4	·293	N.	
	20	·470	S.W.			6	·344	N.	
	22	·522	S.W.			8	·372	N.	0·00
						10	·400	N.	
Nov. 7	0	29·563	W.S.W.			12	·425	N.	
	2	·585	W.S.W.			14	·440	N.	
	4	·599	W.S.W.			16	·470	N.	
	6	·597	W.S.W.			18	·485	N.	
	8	·595	S.W.	0·05		20	·520	N.	
	10	·596	S.W.			22	·540	N.	
	12	·596	W.						
	14	·611	W.		Nov. 10	0	30·557	N.	
	16	·610	W.S.W.			2	·550	N.	
	18	·620	W.S.W.			4	·567	E.N.E.	
	20	·625	W.S.W.			6	·573	E.	
	22	·620	W.S.W.			8	·579	E.	0·00
						10	·605	E.	
Nov. 8	0	29·591	W.S.W.			12	·595	E.S.E.	
	2	·555	W.S.W.			14	·582	E.S.E.	
	4	·578	W.S.W.			16	·575	E.S.E.	
	6	·715	W.S.W.			18	·570	S.E.	
	8	·810	N.W.	0·00		20	·580	S.E.	
	10	·895	N.W.			22	·568	S.E.	

The Barometer readings are taken from the photographic records, and need no correction.
The amount of rain, which is collected on the ground, is read at 9h. P.M.
The direction of the wind is taken from the sheets of the Anemometer.

G. B. AIRY,
November 30, 1859.

In order to show how very general, gradual, and uniform were the barometrical indications of atmospheric pressure, or tension, two other contemporary records, made by careful and reliable observers, are offered for comparison with the standard ones of Greenwich and Oxford.

Observations at Camden Town, London, October 20th—to November 10th, 1859.

The following table gives the original readings of a standard barometer (by Negretti and Zambra) as read off, with the attached thermometer reading;—and reduced to 32°, corrected for capillarity and index-error;—also with the pressure reduced to sea level.

The correction for capillarity, the mercury having been boiled in the tube, is + ·007, the diameter being 0·4 inch.

The index-error as determined at Greenwich is — ·016 inch.*

The reduction from 125 ft. to sea level has been made by the addition of ·139, which invariably produces an accordance between indications of this instrument and the recorded pressure at the Royal Observatory within ·003 of an inch.

G. J. Symons.

* Probably caused by capillarity.—R. F.

Date.	Time.	125 Feet. Attached Thermometer.	125 Feet. Uncorrected Reading.	125 Feet. Reduced to 32°, and Corrected.	Sea Level. ——
	h. m.	°	in.	in.	in.
October 20th	1 0 A.M.	57	29·726	29·641	29·780
	9 0 „	59	29·580	29·491	29·630
	0 10 P.M.	57	29·488	29·404	29·543
	5 20 „	56	29·367	29·286	29·425
	9 0 „	57	29·331	29·248	29·387
	10 15 „	55	29·316	29·237	29·376
„ 21st	0 15 A.M.	53	29·296	29·222	29·361
	8 50 „	57	29·298	29·214	29·353
	9 20 „	54	29·283	29·208	29·347
	9 0 P.M.	50	29·340	29·275	29·414
	11 0 „	46	29·352	29·297	29·436
„ 22d	9 0 A.M.	47	29·500	29·443	29·582
	9 5 P.M.	44	29·498	29·448	29·587
„ 23d	9 10 A.M.	45	29·404	29·351	29·490
	2 50 P.M.	44	29·336	29·286	29·425
	8 45 „	43	29·358	29·311	29·450
„ 24th	8 40 A.M.	42	29·400	29·355	29·494
	3 0 P.M.	42	29·387	29·342	29·481
	9 10 „	43	29·456	29·409	29·548
„ 25th	9 0 A.M.	40	29·468	29·429	29·568
	5 0 P.M.	43	29·206	29·159	29·298
	6 35 „	43	29·094	29·047	29·186
	9 0 „	43	29·015	28·968	29·107
	9 40 „	42	28·999	28·955	29·094
	10 25 „	46	28·996	28·942	29·081

Barometrical Observations—*continued.*

Date.	Time.	125 Feet. Attached Thermometer.	125 Feet. Uncorrected Reading.	125 Feet. Reduced to 32°, and corrected.	Sea Level. ——
	h. m.	°	in.	in.	in.
October 26th	0 35 A.M.	46	28·983	28·929	29·068
	9 10 „	47	29·126	29·069	29·208
	1 15 P.M.	47	29·294	29·237	29·376
	9 10 „	46	29·683	29·628	29·767
„ 27th	9 0 A.M.	45	29·836	29·783	29·922
	9 0 P.M.	47	29·876	29·818	29·957
„ 28th	9 0 A.M.	47	29·787	29·729	29·868
	2 0 P.M.	48	29·623	29·562	29·701
	8 15 „	48	29·397	29·336	29·475
	9 0 „	47	29·380	29·323	29·462
	10 5 „	47	29·353	29·296	29·435
„ 29th	0 20 A.M.	48	29·364	29·303	29·442
	9 0 „	51	29·309	29·241	29·380
	9 25 P.M.	50	29·437	29·372	29·511
„ 30th	9 15 A.M.	52	29·514	29·443	29·582
	1 0 P.M.	52	29·404	29·333	29·472
	4 30 „	49	29·187	29·125	29·264
	6 45 „	49	29·052	28·992	29·131
	8 45 „	49	29·013	28·951	29·090
	9 0 „	49	29·012	28·950	29·089
	10 0 „	49	29·016	28·954	29·093
„ 31st	8 30 A.M.	49	29·306	29·243	29·382
	9 0 „	50	29·304	29·239	29·378
	7 15 P.M.	50	28·991	28·926	29·065
	8 25 „	51	28·896	28·829	28·968
	9 0 „	51	28·841	28·774	28·913
	9 37 „	51	28·824	28·757	28·896
	10 21 „	53	28·803	28·730	28·869
	11 16 „	53	28·816	28·743	28·882
November 1st	0 55 A.M.	52	28·851	28·781	28·920
	8 30 „	55	28·787	28·709	28·848
	9 0 „	55	28·780	28·702	28·841
	9 33 „	55	28·772	28·694	28·833
	11 17 „	57	28·768	28·685	28·824
	11 45 „	58	28·750	28·665	28·804
	0 45 P.M.	56	28·737	28·657	28·796
	1 15 „	56	28·731	28·651	28·790
	2 5 „	58	28·748	28·663	28·802
	2 55 „	56	28·768	28·688	28·827
	3 45 „	56	28·812	28·732	28·871
	5 45 „	54	28·937	28·862	29·001
	7 37 „	55	29·051	28·973	29·112
	9 0 „	57	29·136	29·053	29·192
„ 2d	8 45 A.M.	56	29·716	29·633	29·772
	9 0 „	55	29·712	29·633	29·772
	7 45 P.M.	54	29·734	29·657	29·796
	9 0 „	54	29·723	29·646	29·785
	9 30 „	54	29·718	29·641	29·780
„ 3d	8 45 A.M.	55	29·702	29·622	29·761
	9 20 P.M.	54	29·627	29·551	29·690
„ 4th	8 0 A.M.	52	29·239	29·169	29·308
	9 0 „	53	29·222	29·149	29·288
	2 0 P.M.	54	29·071	28·996	29·135
	9 0 „	55	29·049	28·971	29·110
„ 5th	7 30 A.M.	53	29·412	29·338	29·477
	9 0 „	57	29·460	29·376	29·515
	8 50 P.M.	57	29·310	29·226	29·365

Barometrical Observations—*continued.*

Date.	Time.	125 Feet.			Sea Level.
		Attached Thermometer.	Uncorrected Reading.	Reduced to 32°, and corrected.	——
	h. m.	°	in.	in.	in.
November 6th	9 20 A.M.	59	29·398	29·309	29·448
	8 50 P.M.	59	29·525	29·436	29·575
„ 7th	8 40 A.M.	59	29·550	29·461	29·600
	9 0 P.M.	56	29·724	29·641	29·780
„ 8th	8 55 A.M.	57	29·763	29·678	29·817
	9 15 P.M.	53	29·886	29·811	29·950
„ 9th	9 0 A.M.	53	30·237	30·162	30·301
	9 0 P.M.	47	30·508	30·449	30·588
„ 10th	9 0 A.M.	46	30·646	30·589	30·728
	11 45 „	47	30·653	30·593	30·732
	6 40 P.M.	46	30·656	30·599	30·738
	9 0 „	47	30·684	30·624	30·763
	11 40 „	47	30·658	30·595	30·734

Note A.

As it is the *north-west* half (from north-east to south-west, true), which seems to be principally influenced by the cold, dry, heavy, and positively electrified polar current; and the south-east half of the cyclone that apparently shows effects of equatorial air,—(*warm, moist, light, and negatively, or not sensibly electrified,*) places over which one half of a cyclone passes, are affected differently from others over which the other part of the very same atmospheric eddy passes, the eddy itself being caused by the meeting of very extensive bodies of atmosphere moving in nearly, but not exactly opposite, directions, one of which gradually overpowers, or combines with the other.

On the polar side of a cyclone, continually supplied from that side, the sensible effects are chilling, drying up, and clearing the air—with a rising barometer and falling thermometer; while on the tropical or equatorial side, overpowering quantities of warm, moist air, rushing from comparatively inexhaustible supplies, push towards the north-east as long as their impetus lasts, and are successively chilled, dried, and intermingled with the conflicting polar currents.

Note B.

"Moorgate Street, London, March 28, 1860.

"*Last autumn* we had very remarkable weather. The changes on that occasion were preceded by tremendous "magnetic storms." Very powerful electric currents flew about the earth, and frequently paralyzed our circuits, submarine, and land.

"*To-day* we have had notable deflections, but not nearly so strong as those of last autumn.

"As these probably indicate a change, I have thought it would be interesting to you to be informed.

"C. F. Varley.

Chapter III.

Character and effects of seasons immediately preceding Autumn 1859. Connection of electrical or magnetic actions with storms. General Sabine and Professor Loomis on Auroras. Synchronous Charts.

The summer of 1859 was hot and dry, the two previous years were similar, and the intervening winters comparatively mild. In 1858 a severe drought prevailed in Africa, America, the West Indies, and Australia:—and a mild winter followed in Western Europe, but without a sufficiency of rain, so that during spring and summer of 1859, drought was severely felt, especially in England.

Some violent local thunderstorms occurred, in summer, but not till September was there any important rainfall.

In Africa, however, at this time, the rains were excessive, and the rivers swollen greatly: so much that in even the sea entrance of the Bonny there were three feet more water than usual, and other rivers were similarly flooded by heavy rains in the interior of the country.*

Turning to the Arctic Regions, as affecting our temperate zone, on one side, while influenced by varying tropical conditions on the other, it was found that in 1860 great quantities of icebergs had accumulated on the coasts of Greenland, to an extent unknown for about thirty years †.

Those masses of ice must have been moved by some abnormal cause, perhaps by the successive heats of 1857-8 and 1859.

Such immense quantities of ice, displaced from more northerly localities, indicated an unusual action in the arctic zone, near Iceland and Greenland, if not around the polar region.

To such natural and recurring events, of which the range is not limited to a small space of earth's surface, but extends through wider zones of atmosphere surrounding the globe, perhaps our remarkable variations of climate may be partly referred, rather than to any of those fanciful conjunctions, or relative planetary positions, so whimsically yet gravely described by "Astro-meteorologists."

The connexion of these great changes with electrical tension, magnetic action, the earth's rotation, and their great *visible* cause, the sun, is sufficiently demonstrated by philosophers; though hard to trace, in detail, through special instances, where many facts, of importance to the issue, may be overlooked, if not altogether unknown.

Some eminent men of the first authority on such subjects, do not think that magnetic "storms,"—or even auroras, are directly connected with atmospheric currents, or have any special relation to storms of wind.

General Sabine said to me (November 16, 1860), "When "at home this evening I turned for curiosity to the Toronto "Meteorological Journal for September 1841, vol. 1, page 174.

* W. Laird, Esq., of Liverpool. † Sir Leopold M'Clintock, R.N.

" Pray refer to it. You are aware, I dare say, that September 25, " 1841, was the greatest magnetic disturbance on record before " the one at the close of last August and beginning of September. " It was accompanied in all parts of the globe by brilliant " auroras, and obtained public notices printed at almost all " Meteorological and Magnetical observatories. Well, I observe " that for one week before until the end of one week after, the " six-hourly record of the weather is *without interruption* of the " most tranquil kind. *Calm, light, very light,* constitute 44 of " the entries, with *four moderates,* and *no* stronger entry. And " further, that the same description of weather prevailed without " interruption from the *beginning* of the month of September to " the 9th of October, when at 9 P.M. *brisk* is recorded.

" Turning then to the Hobarton record of the direction and " force of the wind, noted at every second hour of the 24, the " greater part of the entries for the week before and the week " after the 25th September 1841, are either calm or very low " figures. There are only three *sevens* entered, viz., on the " 30th September at 3 h., 5 h., and 9 h., but at all other hours of " the same day from one to four. (Beaufort scale).

" The same fortnight was distinguished at Greenwich by pretty " nearly the same weather, except that on the 28th September " the wind blew fresh in gusts for six or eight hours, during " which the pressure plate is recorded to have showed (in gusts) " in one instance 8 lbs., and in another 12 lbs, on the square foot. " It would be rare to find a fortnight in September in the par- " ticular localities with so little that can approach a violent " storm."

These valuable facts seem to show want of connection, as General Sabine implies; but, while feeling that my own mere doubts are of little value, I cannot eradicate the impression, *previously* amounting to conviction, that in so elastic, changeable, and laterally extensive a mass of air and gases, a certain *time,* and that, perhaps, more than a few days, may be requisite before any magnetic or general electric cause operates sensibly on our surrounding atmosphere.*

At the end of this Tenth Number will be found a reprint of a valuable paper on Auroras, sent to me by Professor Loomis, and exhaustive, it may be said, of the " Auroral Exhibition," for such it truly was, in the later summer of 1859.

The principal display recorded by him, on the 28th of August, was witnessed by M. Blandowski, a pupil of Professor Dove, then off Mauritius, on his return from nine years' travelling as a philosophic naturalist in Australia; and it was described by a friend at Halifax in the following letter:—

Royal Engineer Office, Halifax, U.S.
9th September 1859.

(I am much obliged to you for your kind letter and its enclosure.

The anemometer here has been a source of great interest to

* See Mr. Cromwell Varley's letter in page 32.

me, so that in fact I have been more than repaid for any trouble I may have taken about it.)

We have had some splendid auroras here. They commenced on the 28th ultimo; the weather up to that time, having been very sultry; since then, cool, with north-west winds.

The aurora on the 29th showed some curious phenomena, which I never remarked before. The arc of light, from which the coruscations take their origin, instead of being, as is usually the case here, an arc of a great circle, extending from north-west to south-east, appeared to be a small circle, having its plane dipping towards the south, at an angle (as well as I could make it with a sextant) of about 15°; the southern portion being much the highest, with a well-marked haze under it, the corona being apparently some 12° south of the zenith, the barometer standing at 29·78, and the mean thermometer for the week before being 73°.

After the aurora, during the following week, the barometer rose and the thermometer fell to a mean of 50°, accompanied with strong north-westerly winds.* The light was so strong, that when visiting the sentries about 12 o'clock, I could read writing. Altogether it was a most beautiful display.

The telegraph clerks tell me it affected their instruments in a great degree, and I hear the same from Toronto.

R. Home,
Lieutenant, R.E.

I have adverted to these auroral exhibitions as preliminary to those sensibly felt changes which occurred subsequently, because, whether really connected or not, their approximate coincidence seems to many persons at least deserving of record. Let me add here, before mentioning other signs noticed before the *Charter* storm, that among the more experienced seamen who have visited many climates, an opinion prevails that lightning,—the aurora, meteors, and shooting stars,—are indicative of disturbance in the air,—of wind or rain, if not both, in no long interval of days.

But as this *may be* like faith in change of weather at the moon's quartering, a mere illusory deduction from coincidences, many of which must occur within a day or two of limits, bounding only one week, I mention it now, with the view of eliciting further information.

Lightning in *high* latitudes, antarctic or arctic, is a certain indication of marked atmospheric commotion.

Besides several auroral, and some meteoric, occurrences observed during September and October, 1659, the following are worthy of notice, as having been witnessed at Holyhead and near Athlone, the evening of the *Charter* storm.

* Electricity and polar current?—R. F.

Sir W. Snow Harris, writing from Plymouth (10th November 1859), said to me:—

"My son, who is on the Holyhead works as a civil engineer, under Mr. Hawkshaw, observed, on the evening of the late great storm, a very interesting phenomenon, which should, I think, be noticed. Here is an extract from his letter:—'Since Wednesday, 19th October, heavy breezes N.N.E. to N.N.W., with bitter storms of hail, sleet, and rain. In the evenings, brilliant lightning, with distant thunder; Welsh hills covered with snow. Monday, 24th October, this weather seemed breaking up; wind moderated; weather becoming mild. Tuesday morning, 25th, preceding the gale, fine, with sunshine; light easterly wind, with a thick dirty-looking sky to leeward, as if working up against the wind. The wind freshening a little, but not very much, by-and-by, during the forenoon, the sky became overcast, with a uniform dull mass of vapour; at 6 P.M. very heavy and dark; wind had freshened to a strong breeze. At 7, a strong gale from east; night *very dark. I was then walking into the town*' (he has a house on the works), '*when I was startled by what appeared to be a bright ball of fire directly over my head; the light of it was intense; it pierced* through the heavy mass of vapour which obscured the heavens, and illuminated the whole bay and land with the light of day. This meteor lasted from two to three seconds. *Very soon after* this appearance, the *wind increased to a hurricane*, and the rain came down like a deluge.' This was the evening and night previously to the wreck of the *Royal Charter*. When we consider that for a week or two previously to this northern hurricane we have had *blood-red streamers* of aurora crossing the sky, and other electrical exhibitions, such a phenomenon is important, and should be recorded.

"I observed on the 12th, within a fortnight of the storm, blood-red streamers reaching quite across the zenith, from the western to the eastern horizon, about 7 to 9 P.M., most magnificent. It is worthy of remark all this, as connecting electrical action with the source of such a storm.

"W. Snow Harris."

"Holyhead Harbour Works,
"20th November 1859.

"It is with much pleasure that I send you a slight account of the occurrence of a meteor of great brilliancy on the evening of Tuesday, 25th October, understanding that a description of the circumstances attending this phenomenon will be acceptable to you. I have heard of other meteors having been seen, both in this country and on the other side of the channel, at about the time of the late heavy gale on 25th and 26th October; but having been much engaged lately, I have not been able to make proper enquiries respecting their appearance.

"On Tuesday evening, October 25th, at about 7.15 P.M., my attention was suddenly arrested by the appearance, directly over

head, of a bright ball of fire, the light of which rapidly diffused itself and illumined the dense mass of vapour then filling the sky to such an extent that objects for a considerable distance around me became visible as by day. At this time it was blowing a pretty fresh gale from east, but the wind now began to increase so very swiftly that by 9 P.M. a perfect hurricane was raging, accompanied by a deluge of rain; the wind went on gradually increasing until it appears to have reached its climax some time between 2 and 3 A.M. of October 26th, flying then into N.E., soon after sunrise going to N., and by 10 A.M. to N.N.W., from which point it blew, if possible, harder than ever until 11 A.M., when the weather began to moderate, the wind by the afternoon getting round to N.W. For about a week previous to the gale we had very heavy cold winds varying from N.N.E. to N.N.W., attended by bitter squalls of sleet, hail, and rain, varied in the evenings by displays of most dazzling lightning, although the thunder was slight. On Monday, 24th October, this weather seemed to be breaking up; the day was fine, with light breezes, and much warmer. The morning of Tuesday, 25th, was also fine, with sunshine, and a light breeze from east; but by noon the sky was completely overcast; the wind then gradually freshened, but not much until 6 P.M., when the sky became very dense, and it began to blow fresh, the night setting in pitchy dark. About an hour from this time I observed the meteor I have mentioned.

"Thos. Harris."

That this meteor may have been seen, at the same time, in Ireland, the following interesting letter shows:—

"Dublin, November 9, 1859.

"As I understand that any information respecting the storm of the 25th and 26th ultimo is acceptable to the Board of Trade, I beg to offer the following:—

"I was at Belmullet, in the north-west part of the county of Mayo, in October. There had been several days of beautifully mild weather up to Wednesday, the 19th; on the 20th, there was a change in the weather,—some cold showers, and in the evening hail and snow storms, with wind, of short duration. This state of things continued getting worse, the mountains in the neighbourhood being covered with snow; and on Sunday night the roads were two inches deep in snow as they pass through the Erris mountains. On that evening I saw two balls of fire fall to the earth from one of the snow-clouds. I left that part of the county on the 24th, Monday, and proceeded to Castlebar and Ballinrobe, where, though there had been, as I was informed, some snow, there was none on the ground, but the air was very cold. On Tuesday, 25th, I could perceive nothing at all unusual in the appearance of the weather, till, at half-past seven, when in the neighbourhood of Ballinamar and Ballyporeen, about, I should say, 12 or 14 English miles west of Athlone, the sky being free from clouds, I saw, in the direction of the Pleiades, a meteor. At first,

when I saw it, it was about the size of a star of the first magnitude; it advanced swiftly towards me for about four or five seconds, rapidly increasing in size, and appeared to be coming so straight towards where I was that it created alarm; the colour was an intense white light, similar to the electric spark. At the end of the first four or five seconds it changed colour to a bright ruby red, and it seemed (but of this I could not speak positively) then both to change its course and to lose its velocity; while the red colour remained was not more than one-and-a-half to two seconds. It then burst into about, I should suppose, 15 or 16 bright emerald green particles, which, after remaining visible for about two more seconds, disappeared altogether. I saw nothing more that night. I arrived at Athlone about 12 o'clock, and up to that period the sky was quite clear and calm, and there was not the slightest appearance of storm. I was much astonished to hear, on my arrival in Dublin, on the night of Wednesday, 26th, of the violent storm that had taken place on the coast of Wales.

"From the fact of the meteor appearing to come so directly towards me at first, I should find great difficulty in giving a correct sketch of it. I think after it changed its colour it seemed to have decreased in diameter, and to have taken more the form of a current than a solid substance. I am sure the whole duration was not more than ten seconds, or less than seven.

"I should say the direction from where I was,—say 12 English miles, as a crow would fly, west of Athlone,—was about north-west or north-north-west.

"Of course it is impossible for me to say at what distance it was from me; but if any other of your correspondents observed it, some idea of its distance from the earth might be arrived at. It was the most beautiful meteor I ever saw, and, with the exception of one I witnessed in the day-time, a few years ago, in Oxfordshire, which passed south over Southampton, and I believe the whole of France, I have never seen one so large as it appeared towards the end of the period of white light.

"I could not but think that the fall of the meteor had some connexion with the storm.

"Thos. T. Carter."

Numerous other instances of a similar kind have been mentioned; but none so marked and definitely recorded have as yet reached the compiler of these papers.

One fact more, of a magnetic character, should be noted, before changing the subject. In a note (B) at page 32, it is said that Mr. Cromwell Varley, the well-known electrician, informed me he had observed high winds, or rain, follow disturbances of electric currents along the telegraphic wires.

On one occasion, *very marked*, he kindly wrote to me; and two days afterwards there was a *particularly* heavy gale of wind.

Few Londoners have yet forgotten the state of the Thames in 1859. Deficiency of water supply during 1858 and 1859, and great evaporation, (often to fourteen degrees of thermometrical difference in Mason's hygrometer,) caused a condition of its liquid excessively disagreeable to eye and nose, if not actually pestiferous.

Everywhere a want of water was felt, and this had been of considerable duration. In August the heat reached 92° (in places where usually summer heat is not above 80°), and the temperature of evaporation was 78°, by Mason's hygrometer.

About the middle of October the barometer began to fall, and at the same time the temperature diminished sensibly. By the twentieth of the month, all barometers (at or reduced to sea level) showed a pressure or tension of atmosphere not exceeding twenty-nine inches and eight-tenths in the north of England, nor 29·5 (nearly) in the southern counties. With this pressure, after a gradual fall, continuing, a southerly wind might have been expected of some duration, had not the temperature been low for the season, namely, below 50° in the morning, between eight o'clock and nine, when the temperature is most nearly the average of the twenty-four hours; and also of that time of day.

This comparative coldness, with a barometer for some days previously below par, or the normal level, (which in the middle of England is about 29·95 inches,) indicated northerly wind, or polar current, the wind which passes over the British Islands, from northern regions, being between north-west and north-east true (N.N.W. and E.N.E. magnetic), inclining more from the west, or from eastward, according to circumstances and conditions of which an explanation will be offered in the latter part of this paper. At present it will be more convenient to keep closely to our record of facts.

In the accompanying twenty-six synchronous wind charts, with four sections deduced from them, and in the small diagrams annexed to this introductory paper, will be found ample details of atmospheric changes or states over the British Islands, and parts of sea and land near them, from the 20th of October to the 10th of November, inclusive.

But the collection of facts is still far from completeness. Details in north-west Europe, the North Sea, the Færoe Isles, Iceland, the North Atlantic, North America, Portugal, and in part of Spain, besides Madeira and Bermuda, are still earnestly desired; and it is hoped that the circulation of these papers will induce many persons to transmit additional notes or records of these twenty days, or some part of them, to this department of the Board of Trade, for incorporation with the present work in another edition.

The simplest form that has been distributed, for collecting facts from ships, is the following; which seems to be *generally* suitable.

Place and Date.	Readings 9 A.M. Barometer.	Ther-mometer.	Wind. Direction by Compass.	Wind. Force.	Remarks.	Readings P.M. Barometer.	Ther-mometer.	Wind. Direction by Compass.	Wind. Force.	Remarks.
October & November, 1859.					The *more* times, readings, and notes are added the better. This form is only as a skeleton schedule.					The form ruled for use may be of any size, and have any number of lines or entries, intermediate.
21										
22										
23										
24										
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Having glanced at the small diagrams, only to be aware of their nature, so as afterwards to know when to revert to them, the first of the synchronous charts (No. 1, October 21st,) is suggested to the reader's attention. (Detached from its guard-cover?)

All explanation necessary is in the lower right-hand corner; but as in this, and in the following charts there is not a scale so available for reference as will be found under the respective *titles* on most of them, it will be convenient to have a scale of inches, decimally divided, at hand, with a pair of compasses.

That every detail on the charts has been laid down, or plotted, with mathematical exactness, and correctly as far as the data permitted, I am quite satisfied.

In the first chart, a *general* polar current of wind is shown, at a glance, by the wind lines (like pendants, or streamers, or gossamer threads, stretching away from their points of suspension or stations)—in length, according to the recorded force of wind, by *exact scale*, though the force itself, being only an estimation, except at the few established observatories, can only be trusted as relative, and as being checked by numerous inter-comparisons, as well as occasional reference to an observatory anemometer. On noticing the dark lines showing pressure, and measuring (inches and decimals) from their respective base lines of 28 inches, a generally low barometer is evident, though the wind is polar, which usually raises the mercurial column.

The temperature lines are exceedingly irregular, it will be seen: for instance, those passing near Hull, Liverpool, and Dundalk; or Sunderland and Tory Island; Galway, London, and Amsterdam; or Aberdeen and Skye. Hail and snow in the north, clouds and rain in the south are shown; and this winter weather, on the 21st of October, seems the more remarkable as so rapidly following very warm if not hot weather.

It happened that Mr. Laird, who made several useful notes of this and following days, was in the North of Ireland, near Garron Tower, on the 21st. It was exceedingly cold, the air remarkably transparent, and the Scotch mountains so distinct that every one noticed their extraordinary visibility.* There was lightning to the southward.

Writing about these days, the lamented Captain Boyd said to me,—"On the 19th I was at Belfast, oppressed with heat, in close "weather, with small rain. It was like a muggy May day. The "next three days I was travelling along the east coast, cut to the "vitals by a piercing north wind, with snow and hail squalls."

The barometer continued to fall. Near London that night the temperature was only 22°,† a degree of cold not often exceeded during a whole winter, and, on this occasion, the more remarkable, from its sudden succession to very mild, if not warm weather.

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* Beaufort Scale V. ‡ At my house in Onslow Square.

On the 22d (Chart 2.) there were northerly, mixed with westerly winds—great variations of temperature—within narrow geographical limits, and barometers still low.

On this day a friend (at the Board of Trade), told me his barometer had fallen very much, and asked what it could be for, as the weather seemed fine. I replied, "We shall hear of much "wind and snow in the north, the thermometer is so low." Afterwards, but that very evening, I met some relations, just arrived from Yorkshire, whose journey had been delayed on the railway by a heavy fall of snow, with a north-east gale.

On the 23d (Chart 3.) much mixture, or contest of air currents is evident, the temperature even lower (being 18° only that night near London), and the barometer remaining low, but unsteady.

The differences of temperature between the east and west coasts are remarkable, on these days, and the much less strength of wind exhibited inland, as compared with that on adjacent coasts at the same time.

These charts will be again referred to, after this preliminary inspection of the series, when various suggestions will be submitted to the reader.

In No. 4 (October 24th), it will be seen that with a low barometer and excessive differences of temperature (in very limited spaces) there was not much wind, or horizontal movement of air currents. The barometer was low, and almost equally low, therefore generally expressive of an extensive "area of depression," a *comparative* vacuity, or diminution of tension, necessarily to be filled, or equilibrated, by supplies, or by pressure, from other regions. If this were considered as an extensive, but shallow basin, a lagoon, as it were, on a vast scale, into which two streams are admitted from opposite directions—one having the start of the other—their effects and motions might be rather analogous to the following recorded movements of the *fluid*, however elastic, air.

On this day, the 24th, it blew hard along the coast of Portugal, from the southward, but no evidence has been obtained of any storm, or cyclonic commotion in the Atlantic, to the southward or westward of the British Islands, no proof of a cyclone having originated considerably to the southwestward, and having travelled across much of the Atlantic.

On the contrary, so far as hitherto ascertained, the gale of October 25 and 26, appears to have had its commencement near the Bay of Biscay, and its conclusion about Norway. But much light may yet be thrown, on these mere *appearances*, by *facts* still attainable.

It was blowing strongly, from the northward, to the west of Ireland, on that same day (24th), but no ship reported a storm, on that or the previous two days.

During the night of the 24th and in the morning of October 25th (Charts 1 to 5 and 5a), there was no evidence of a storm moving towards England. During the previous days there was a preponderance of northerly wind (polar currents) over and near the British Islands. There was no cyclonic commotion of any kind to the westward or southward. It is very important to mark this fact,—because ideas have prevailed that cyclones crossing our islands, have travelled far—even across the Atlantic, from the south-west. Plausible theories, and elaborate diagrams have been published,—intended to show how cyclones had travelled—not only across the Atlantic Ocean from near the West Indies, but (having there altered their course, or recurved,) actually all the way from the coast of Africa.*

That such storms do travel, like eddies, a considerable distance, during two, three, or four days, has been demonstrated, but any further extension of their progress has not hitherto been satisfactorily proved.

Consecutive storms, at the meetings of main currents, in zones of latitude, at certain periods, have had appearances of continuity. The familiar instance of the *Charles Heddle* has so often been adduced as proof of continuing circuitous action, or gyration, that it may seem injudicious to doubt the *evidence;* but knowing how frequently circuits, or cyclones, succeed each other, *rapidly;* and how uncertain are logs or journals of events in a storm, written after its cessation, especially respecting directions of wind and courses steered, when waves and storm blasts were the guides, not the oscillating compass, (if indeed *that* had not been washed away, as in the *Charles Heddle's* case); it does not appear accordant to experience, and enlarged acquaintance with the subject, to imagine that such atmospheric eddies are, *sui generis*, erratic, and considerably independent.

At midnight of the 24th and very early on the 25th, a ship named *Alipore*† was between 46° and 47° N. lat., 13° and 14° W. long. crossing the Bay of Biscay, and, therefore, to the south-west of the British Channel. She had the barometer *then* at 28·98 with the wind at N.N.E. (true) blowing hard. On the chart (5a) her place is marked for nine A.M. Clearly (by the chart) there was no storm then to the westward of her. It was on the other side, but near. Its central part was at the entrance of the channel, not far from the Land's End. The *Alipore* had come from the south-west. No cyclone or strong wind had passed her from the southward. She *met* a north-east gale. The *Alipore* could not have overtaken a cyclone, supposing it moving only fifteen miles an hour to the north-eastward, bodily. Had it travelled from far westward, or south-westward, it must have overtaken, and passed that ship. Another ship, the *Neikar*, passed down channel, to sea, on the days immediately preceding the 25th. She met no

* Redfield's track of the storm of September 1853, and other tracks shown by Sir William Reid, in his admirable works.

† Belonging to Mr. Lindsay, M.P.

storm. Mr. Laird's ship met none. More "crucial" instances could not be desired.*

In the morning of the 25th, there was a strong gale from south-west to south-east, over Portugal, Spain, France, and England. This was warm, and very wet wind, which did not raise the low barometer. Fog, dense clouds, or heavy rain prevailed. (*See* Chart 5.) At this time a northerly and cold wind was prevailing in the Atlantic, and soon it contended against the warm, wet, southerly wind, from which its chilling influence caused the precipitation, or deposit, of vapour in fog, or rain. Both these winds were then blowing towards (and afterwards around) that area, of the region near, in which the barometrical depression was greatest.

At this time, in Ireland, at Kingstown, there was a very dense fog,—so dense that (said Captain Boyd) "although I fired full "charges from guns on the seaward side, the packet (for whose "guidance into port I intended them) though not more than a "mile distant, only heard a few. The fog-bell was heard by her, "only as the fog 'lifted' for a time, when she was about half "a mile from the bell. In the afternoon it cleared to a fresh "north-east wind. Not till near midnight had we the gale, fierce "and startling, at the ship." "The tide was unusually high. "The weather had been singularly ominous and threatening for "some days; so baffling also as to perplex the oldest and most "weatherwise pilots." † ‡ ‖

The Channel squadron, under Admiral Elliot, not far from the Eddystone, had a strong south-east gale all the earlier part of the 25th, but about three in the afternoon the wind ceased, and the sun shone, though the sea continued "towering up and breaking." The barometer, on board, was then 28·50. Suddenly, in less than half an hour, (the barometer having begun to rise) a blast swept furiously over the ships, from north-west; and during the next three hours it blew with the force of a hurricane. There then, at three o'clock, was a lull, or vortex, of the storm, occasioned by an opposition of contrary currents of wind. At half-past five that afternoon, Mr. Laird was in a railway train near Reigate, that was struck so forcibly by a violent squall from *south-east*

* See page 47, and logs in Appendix.

† Captain Boyd adverts to a very dense fog. Sir W. Snow Harris says,

"When morning mists come *from* the hills,
And the huntsman's horn is free,
Fine weather reigns:—but, woe the time,
When the mists are *from the sea*."

‡ Pressure of westerly winds, and a low barometer, raise the sea level, temporarily, round the British Islands. North-easterly winds, and high barometer, have a contrary effect, driving the surface water, bodily, seaward, towards the ocean, from comparatively shallow "soundings."

‖ Before a gale is felt, its advent is often signified on the shore, or at Light-ships, (such as those of the Kish, Cockle Gat, &c.,) by the undulation or swell that sets in, caused by the then distant gale.

that he "thought the train would be capsized." It was so very sudden, and heavy, that every one was alarmed.

According to the most reliable accounts the centrical area, where the barometer fell lowest, and towards which the winds blew, while distant, and around when near, was over Cornwall at about three o'clock in the afternoon of the 25th, and over Lincolnshire at nine next morning, having thus advanced about 250 miles towards the north-east (true) in eighteen hours, *averaging*, therefore, 14 miles an hour *over land*. This is demonstrated by the sectional charts even more than by those showing the circumstances horizontally.

During the advance of the centrical area (a varying space, in which there was heavy rain but very little wind,) from Cornwall to Lincolnshire, all places south-eastward of the line between them (axial line of the progression shown by the charts, or axis of the cyclone), had a storm veering from south-eastward, through the south to south-west, west, and north-west; while all those places north-westward of the axial line of progress found the same storm veer round from south-eastward, through east, north-east, north, and to the north-westward.

This is beautifully proved by the charts (Nos. 5 to 10, including the oceanic and sectional supplementary ones,) as to general limits and direction; but no proof is given of the contour outline of that area, which, probably, varied considerably as it passed over Cornwall, near the Welsh Mountains, or across the Midland Counties. Excessive quantities of rain fell on the south-east side of, and within the area, as it progressed north-eastward. Comparatively little or none on the north-west side of that *centrical space*. (*See* Charts, also Note A., p. 32, and s. 5. in p. 58.)

So limited was the actual gyration, that it only extended to Kingstown, hardly to Dublin, and did not affect France, beyond a few miles inland. Thus its diameter scarcely reached 400 miles at the utmost, but often was nearer 300, as the charts show.

While there was a storm from every point of the compass, around the progressive vortex above mentioned (Charts 5 to 10), the greater part of Ireland, especially its west coast, and the west of Scotland, had but little wind or rain, and cloudy fine weather.*

Reference to Charts 3, 4, 5, and 5 a will show that, while there was an area of extreme barometrical depression about Cornwall, the "chops" of the Channel, and the "edge of sound-"ings" towards the Bay of Biscay, there were two strong currents of wind advancing towards that place, one from the northward, and another, then strongest, along Portugal and across France from southward. Their encounter occurred near the channel entrance, and from that time, on the 25th, the two bodies of atmosphere that had been drawn towards the same place, to restore due equilibrium, mutually pressed on to maintain advance, while their place of gyration, an immense eddy, was forced north-

* See particularly, Mr. Carter's letter, in pages 37 and 38.

eastward by the overpowering mass and momentum of the southerly (or tropical) current. But this eddy, or cyclone, commenced on the 25th, and had almost expended its energy on the 27th, near the coast of Norway (Charts 14 and 15), having lasted between two and three days, as a definite and mathematically proved continuous circulation, or cyclone. While the centrical area was moving north-eastward, from 10 to 20 miles an hour, the sensible velocity of wind, estimated, by comparisons with measured pressures and *practical experience*, (not only then but at other times,) could not have been less than 60 nor more than 100 miles an hour. Probably at the strongest part, on the south-east side of the circuit, the velocity was about 80 miles, added to near 20 for the cyclone's advance, making 100, while on the other side about 60 was the utmost.*

It may be again observed that places in Scotland had no remarkable wind during the night of the 25th. When it blew hardest on the northern coasts of Britain, from the eastward, on the 26th, there was but little wind in the British Channel or Ireland. This shows, in connection with the facts immediately preceding, the circular or gyratory movement that commenced near Cornwall, that the nearest quantities of air were drawn by ordinary dynamical laws towards the place of deficiency, and that the two great normal movements of atmosphere, from and towards the pole, were immediately affected by, and drawn in towards, the local and temporary disturbance of equilibrium.

* With many *exceptions*, caused by local circumstances, and by the very *varying* effect of heavy gales; owing to the great *elasticity* of air, to its eddyings, and to numerous obstacles to the wind's swift advance horizontally. Remarkable streams, or rather thread-lines of force have been noticed at Observatories, especially by Dr. Robinson, of Armagh.

Chapter IV.

Progress of Royal Charter Storm. Charts 15 to 17. Mr. Hartnup. Mr. Moffat. Colonel Austen. Mr. Andrews.

While imagining the progress of this storm as described in the previous chapter, it may be useful to refer to the condition and circumstances of surrounding regions.

It has been already noted that the west coast of Ireland, and a large proportion of that island, were not affected at all. Scotland was not reached on the 25th, but was so subsequently. Neither the *Alipore*, nor a ship sailing *from* the channel*, (on the 23d,) nor any other vessel, felt its influence, *before* the 25th.

As the *Neikar* left Channel soundings on the 23d, having been off Scilly on the 21st, she must have crossed any cyclone advancing from south-west.†

One of Mr. Laird's African vessels sailed from Liverpool on the 24th. No storm was encountered. Only strong northerly winds were found, as she went to the westward, with southing. But the barometer was generally low, over at least a thousand square miles of sea and land, and had become so gradually during many previous days.

The *lowest* division then reached, however, was not nearly so low as has been *known*, nor was it equal, in depression, to that caused by the subsequent storm, of November 1st.‡

This may have been caused by the rapid shift to the *northward*, and by so much polar current resisting the southerly mass.

On board the *Alipore* 28·98 inches was the lowest registered pressure. Admiral Elliot's squadron noted 28·50. In London, at my house, the mercury was rather below 29 inches, reduced to sea level and 32°, rain being incessantly heavy, and wind violent from southward all the earlier part of the night.

At this time the *Royal Charter* was making way round Anglesea, close in shore, to her fatal anchorage, on the north side of that island; where the full force of next day's tempest, from the northward, was felt, and that *doubly* powered ship, of iron, which had circumnavigated the globe, was destroyed, with nearly all on board, in one short hour, towards seven in the morning. With her power of steam, in addition to that of sails in perfect order, a few hours on the starboard tack, with but little way, would have saved her. So much, at such a time, hangs on individual judgment. Another ship but a few miles off, a wooden sailing ship, not a steamer, the *Cumming* §, and several smaller vessels, acted thus, stood to the westward, and not one was wrecked, nor even injured materially.

* Neikar, of Hamburgh, Captain Brolin. † Extract from log in Appendix.
‡ Piddington, India, 26·47 inches? Clouston, Orkneys, 27·45 inches. Howard, London, 27·73 inches. Reid, West Indies, 28·00 inches. Daniell, Chiswick, 28·60 inches.
§ *See* letter in Appendix.

Unfortunately many cases might be cited of a similar nature, in other storms, where accidents, heavy expenses, or great losses, have been traced to similar errors in judgment.

It has been supposed by many persons, and asserted authoritatively in public prints, that if warnings had been given from Lighthouses, or salient points on the coast, the *Royal Charter* might have been saved.

Now, it is extremely desirable to separate what is practicable, and may be accomplished, under any or some conditions, from that which is only supposed to be so, yet so much wished for, that the means of effecting the object are over estimated.

The *Royal Charter* could not have made (seen) the land in time, or sufficiently plain, to make out a signal. It was raining and dark on that afternoon and evening. Holyhead, the high mass of land behind it, and bright lighthouse lights, were distinguishable, but nothing more.

No warning signal from the land could *then* have averted the consequences of erroneous management.

That ship had excellent instruments on board when she left her last port—they *would* have given sufficient notice—but had they not been there, or had their indications been unheeded, those of the heavens should not have been disregarded—overlooked they *could* could not have been from any ship—and were not by the *Cumming*, or by numerous coasters.

While the storm was most violent against Anglesea Island, its force was not excessive at Liverpool. The strongest part of the north-west side of the cyclonic circulation did not sweep over that town till shortly before noon of the 26th. Mr. Hartnup wrote to me, "The storm on the 25th and 26th of October did not reach "Liverpool till about 12 hours subsequent to the wreck of the "*Royal Charter*."

"We had at the observatory, Liverpool, light winds until 9 A.M. "on the 26th, when the gale first reached us. At 11.45 A.M. the "extreme pressure was 28 lbs. on a square foot, and the greatest "horizontal motion, measured hourly, was 57 miles between noon "and one P.M. The direction of the wind being N.N.W." (true*).

The greatest force recorded at Liverpool, was 42 lbs. to the square foot, in December 1852, when the velocity was 70 miles an hour. At Lloyd's, a pressure of 38 has been noted by a similar instrument (in February 1860), and during the St. Kilda storm of October 1860, the force was 28 lbs. At Lord Wrottesley's observatory, on the summit of a rising ground in Staffordshire, no pressure has been noted exceeding 16 lbs. on the square foot, since his lordship first placed an anemometer there; being a remarkable instance of the modifying effect of certain local circumstances, or an inland position. That, generally speaking, (allowing such *exceptions* as those of local storms or whirlwinds,

* At the Liverpool Observatory, on one of the northern quays of the Mersey, there are local circumstances common to vallies or low places near heights, influencing the direction as well as strength of wind.

as, for example, those of Calne, and Clifton,* in 1859), there is much less strength of wind, continuously, in inland places, is shown by the full regular growth and foliage of trees, in contrast to the stunted, inclined, and half foliaged trees of a sea coast, exposed to prevailing winds.

A letter from Dublin† said, "In England you have had this "tremendous gale (October 25–26.) Here it was not felt. The "barometer fell much, but nothing followed."

Captain McKillop, R.N., informed me that "during the gale "which swept the coast of England and Wales, when the *Royal* "*Charter* was lost, a dead calm, and a sharp frost of unusual "severity for the country (Ireland), was experienced along the "coast, from Westport to Galway, the wind going round from "north-east to south-east;—when the frost ceased, and a most "unusual quantity of rain fell, with light variable winds from "south to west."

Mr. Saxby, whose interesting diagram is annexed, remarked, that "at Liverpool the barometer scarcely varied in height during "the 24th, 25th, and 26th, while a complete hurricane blew off "Anglesea, and at Sheerness." He, however, appears to have undervalued the fact, (shown by the charts, &c.) that on those days the barometer was unusually low *everywhere*, and had been so for some time previously. Also, that before a gale from the *northward*, then impending, the faithful monitor would not be so low, by half an inch probably, as if a storm were coming from the southward *only*, and it would not begin to rise till near the crisis, or shift from southward to northward, from which time it would rise faster, as the wind blew harder.

Mr. Moffat, then residing in Cheshire, obligingly wrote to me: "At Hawarden, a distance of 100 miles from the scene of the "wreck, the storm, a compound of the polar and equatorial cur-"rents, raged with unabated fury from an early hour until six "o'clock in the morning. From this hour the wind gradually "abated, but continued at a mean force of 4 for the day. "*During the storm* 0·7 in. of rain fell, and there were occasional "showers of hail, snow, and sleet. The tide in the river Dee "rose to an unusual height. From the 20th to the 26th October, "(the date of the storm,) there were two beautiful auroral "displays. There was lightning at night, and thunder and "lightning during the day. Hail, snow, or sleet fell every day, "at one time to the depth of 2 in.; there was frost, with ice $\frac{1}{4}$ of "an inch in thickness, and the temperature was extremely low for "the season. For seven days before the 20th, ozone was but "twice perceived, and the electrometer gave but once a week "positive indications. From the 20th to the 26th ozone increased "to 4; and both electricities were indicated with varying degrees "of tension. On the 22d the negative tension (during a hail "storm) was greater than I had ever seen it. Two days "previous to the storm of the 1st November a similar negative

* Mr. Burder's account. † Colonel Smyth, C.B., 76th Regiment.

" tension was observed, and ozone during the gale was 10.
" It is worthy of remark that on the 26th February 1853 a simi-
" lar storm prevailed on the west coast, also accompanied by a
" very high tide. This tide was so unusually high, that a stone was
" erected at Queensferry on the Dee, bearing an inscription record-
" ingits unusual height. During the late storm, the tide in the
" Dee rose to 7 inches higher than on the former occasion.

" On the 26th February 1853, the fall of the
" barometer was - - - - 0·804 inches.
" Mean temperature - - - 37·0 „
" Ozone - - - - - 4·0 „
" Wind North-west uniform.
" Hail, snow, and sleet. Unusually high tide.

" 26th October 1859 fall of barometer - 0·466 „
" Mean temperature - - - 38·7 „
" Ozone - - - - - 3·5 „
" Wind north-west - - - 4· „
" Hail, rain, and sleet.
" High tide, 7 inches higher than on 26th February 1853."

The remarks of so good an authority (and respecting ozone in particular), must be specially valuable. The relation of ozone to particular currents of wind, irrespective of land or sea, to sea winds especially, from whatever direction, and to electrical tension, is very curious,* and deserves strict investigation.

A vessel returning from Iceland † had heavy gales from N.N.E. (true) between October 23d and 28th. This was in latitude 64° to 61°, and longitude 28° to 23°.

On the 24th, 25th, and 26th, the wind's force was stated at 10 to 11. During the *whole* of the time, when variable or southerly winds prevailed, eastward of Ireland, as well as while the polar current alone was felt between Ireland and the Baltic,

* On this subject a valuable series of observations has been made during the last few years by Lieut. Chimmo, R.N., formerly a passenger with Dr. Scoresby in an earlier long voyage of the *Royal Charter*, and latterly commanding a surveying vessel in the Hebrides, under the Admiralty.

† The *Wyman*, Captain E. Baker.

Bark "WYMAN," Captain E. BAKER, with Colonel SHAFFNER;

Stations and October.	Date. 1859.	Actual Readings, 9 A.M.				Wind.		Readings at P.M.			
		Barr.	Therr.	Thermomrs.		Direction.	Force.	Barr.	Therr.	Thermrs.	
				Dry.	Water.					Dry.	Water.
° ′ ° ′		in.	°	°	°			in.	°	°	°
63 38 30 40	21	30·40	53	41	46	E.S.E.	5	30·45	56	41	46
63 48 28 32	22	·35	60	42	41	N.W.	5	·30	51	41	45
64 3 28 25	23	·30	60	38	45	E.N.E.	8	·30	56	38	46
63 14 26 44	24	·30	60	38	47	N.E.	10	·20	56	37	46
63 33 27 20	25	·15	46	34	45	E.N.E.	11	·10	50	33	46
62 28 26 16	26	30·15	58	40	47	E.N.E.	11	30·10	60	40	46
61 36 26 0	27	29·90	58	38	46	E.N.E.	11	29·90	55	45	48
60 54 23 0	28	30·00	66	41	47	E.N.E.	5	·85	64	42	48
60 3 20 20	29	29·70	66	43	50	N.W.	4	29·55	56	42	49

across France to Spain, and in the eastern Atlantic,—during the whole of this time, the expeditionary vessel *Wyman*, employed by Colonel Shaffner to explore a submarine track for his intended telegraphic communication, was in northerly (or polar) winds, on four days extremely strong, with a high barometer.*

Colonel Austen, at Bognor, took great pains with the investigation of this storm, and traced it, independently of other than his own and published observations, from the Land's End to Lynn Wash, or, in other words, from Cornwall to Lincolnshire. Colonel Austen's own words should be quoted, in justice to himself, and for comparison with others :—

" A most valuable illustration, practically, of the operation of
" the cyclonic law of storms, as they affect Europe, and our own
" Islands more immediately, has just occurred.
" Lines on a diagram, representing severally the times at which
" the south-east gale first began at separate places, mark the pro-
" gression of the cyclone from south-west to north-east.
" One may readily verify, approximately, the influence of such
" a storm, by placing a paper compass on a map, and making it
" revolve from north to south by west, and so by east to north
" again, when the rhumb lines will indicate the several directions
" of the wind, as it blew at their respective localities on the 25th
" and 26th.
" All places situated to the south-east of this axial route, expe-
" rienced the gale varying from south-east, south, and south-west
" with an increasing force; and when the vortex had passed,
" winds from the west and north-west, in a decreasing ratio of
" violence, whilst persons to the north-west of the axial line felt
" the gale increasingly from south-east, east, and north-east points,
" and then decreasingly from the north-west and north points,
" agreeably to the laws of cyclones.

* In reading this extract from the well-kept and reliable log, one of Maury's (which Colonel Shaffner kindly entrusted to me for some time), it should not be forgotten to allow nearly four points variation to the left : E.N.E. apparent, or magnetic, being N.N.E., true bearing.

Gales of October 25–6, and November 1, 1859.

Wind.		Variation. West.		Remarks.
Direction.	Force.	A.*	P.*	
E.S.E.	5	° 47	° 50	Light winds; cloudy; rainy. Fresh breeze; cloudy.
N.W.	7	55	—	Fresh breeze; cloudy.
S.S.E.	9	54	—	Strong gale; rainy. Strong gale; cloudy.
E.N.E.	10	—	—	Strong gale; cloudy. Cloudy; heavy gale.
E.N.E.	11	45	—	Heavy gale; cloudy. Violent squalls; snow; hail.
E.N.E.	10	45	45	Heavy gale; violent squalls; snow; hail. Heavy gale; snow; hail; lying-to.
E.N.E.	5	—	—	Heavy gale; squally; lying-to. Heavy gale; squally.
N.	6	39	39	Heavy gale; cloudy. Moderate wind; cloudy.
N.W.	3	—	39	Fresh breezes; cloudy. Light winds; passing clouds.

* A = Actual. P = Probable.

" As the storm of the 25th began to affect Plymouth from the " south-east at 6 A.M., and Dover only at 6 P.M., the vortex moved " over about 250 miles in 12 hours, and that, also, was its radial " sweep; but we may consider its rotatory velocity about 80 miles " an hour! Dover, Plymouth, and Liverpool, form on the map " nearly an equilateral triangle; and the same cyclone was, in " this instance, blowing a south-east storm at Dover, and from " N.N.W. at Liverpool, having just been blowing from the " south-west, at Plymouth, under the influence of the self-same " whirlwind. A diagram will indicate the cause of such con- " trariety of effect, resulting from the gyration of all cyclones in " the northern hemisphere, against watch-hands."

On the 28th (Chart 15), this cyclonic commotion appeared to be still between Norway and the Shetland Isles, having crossed the North Sea, towards Norway, but not further (as far as yet known here).

Chart 16, the 29th, shows an increased or successive action in that locality, connected with another, and a strong polar current affecting Scotland, and the Irish channel. This should be closely noticed. If not a *recoil*, and temporary increase of the previously diminishing cyclone, it must have been a fresh local gyration, closely following that which has been traced in these papers; but *originating* in the North Sea.

On the 30th (Chart 17) that cyclone has gone off towards the northward, rather easterly, and indications of another great storm are evident.*

* Mr. Andrews, at Sidmouth, wrote the following valuable letter to the Editor of the *Shipping and Mercantile Gazette*:—

Sir,—It is painful to read the serious loss of life and property recorded in your pages of yesterday's publication. I have carefully read them over with a view of ascertaining the commencement, direction, and changes of the wind during this remarkable storm, which has been evidently of a circular character, and thereby tracing its course, direction, and velocity; but from the very imperfect reports, some not even stating the direction of the wind or the time of the commencement of the gale, it is impossible to form any accurate data to direct this research. But as the first of the gale was felt at Dunmore, in Ireland, on the 25th, and the direction N.E., and the first of the gale at St. Andrew's, in Scotland, came on in the same direction on the 26th, these places must both have been in the course of the northern verge of the circle. The centre of the gale appears to have passed in a N.E. direction from the coast of Wales and Bristol Channel to Flamborough Head and the Yorkshire coast. Devon and the south coast were evidently in the southern verge, from the fact of the gale being from S.E. to S.W. It may not be too late now to trace the progress and character of this remarkable storm, if your various correspondents at the places that came under its influence will kindly send in for publication the following facts in a tabular form :—

Name of Place.	Time of commencement of the Gale.	Direction and Force of the Wind.	Time of Changes.	Direction and Force.

Trusting the interest attached to this subject in a scientific view may be an excuse for the trouble given,

I remain, Sir, your obedient servant.

Salcombe Mount, Sidmouth, Oct. 28, 1859. W. S. ANDREWS.

CHAPTER V.

Storm of November 1st. Charts 15 to 26. General remarks. Conclusions. New application.

ON the 28th the barometer had risen considerably in general, but not to its normal or par height.* Winds were variable, and temperatures extremely so. Much rain fell (Chart 15).

On the 29th there was a local cyclone apparently at the meeting of northerly and southerly currents of wind, near the east coast of Scotland in the North Sea. This had not travelled. It grew and then diminished in one locality. (Charts 15, 16, and 17.) There was much variation in the temperatures of even neighbouring places, showing great mixture of air currents. Chart 17 shows little wind, and that very variable; in many places from the *land to the sea*, the land having been considerably chilled by previous northerly winds, by rain and evaporation, while the sea retained nearly uniform, and, at that time of year, rather high comparative temperature (October 30).† With barometers everywhere low, and falling, ominous skies and increasing warmth, with south-easterly winds encroaching towards the north-east, it was seen that another gale might be expected immediately; and next day, 31st, it commenced in Ireland, having been felt heavily in the Atlantic, at a considerable distance. (*See* Charts 18 and 18a.)

On the 1st of November, this storm's centre crossed Ireland, the north of England, and then, on the 2d of November, appeared to diminish rapidly in its strength as it overspread the North Sea, progressing towards Denmark.‡ A more distinctly marked cyclone than this as it appears demonstrated on these charts, it is hard to imagine. That it existed three days is proved, and that its centrical area progressed eastwards about fifteen miles an hour, on an average, cannot be far from the truth. The barometer fell before this storm, considerably lower than it did before its more generally remarked precursor, and the thermometer was much higher. These indications showed preponderance of the southerly (tropical) element over that from the polar direction; and that the meeting, place of gyration, or node, was therefore further toward the north.

That its direction of progress should have been nearer eastward, across the British Isles, instead of more northerly (in consequence of such southern predominance) may have been a consequence of the Scottish mountains, three to four thousand feet high, impeding such a course as would have been taken across open sea.

At the Board of Trade, at Kew, and at Brompton, the lowest barometrical reading in the night of the 31st October and morn-

* Near thirty inches (29·94 to 30·00).

† Air averaging then 48°.

‡ *See* Charts 22, 22a, 26, and the two sectional charts of this storm. Between 18a, and 26, the sequence of charts is continued *here* in manuscript, but does not express much more than these, except by repetition.

ing of November 1st, was 28·80,* the thermometer in open air being then 50. It has been stated already that the lowest on the night of the 25th was 29·00 (sea level and 32°), and the temperature then 25°. Two aneroid barometers, considered to be good instruments, near Lake Windermere, the night of the 31st fell to 28·09 and 27·70 (approximately reduced to sea level). The first of these showed 28·80, nearly (reduced) the night of the 25th of October.*

On the 29th, Colonel Rogers' barometer had fallen to 28·42, and at 11 P.M. on the 31st to 28·27; but nothing of consequence followed besides rain; no strong wind. At eight next morning his barometer showed 28·09, and at 3 P.M. the sky had cleared, the glass was rising; Windermere had felt no storm, and did not experience any strength of wind afterwards. This is by no means a singular case, but is quoted here as one of the well-marked exceptional anomalies that occurred during this storm of November 1st as well as that of the 25th October, on which occasion, also, Lake Windermere escaped undisturbed. Colonel Rogers said of that time (Tuesday night 25th October):—"My aneroid fell " to 28·60† at night. Rain fell, but no remarkable wind " occurred. It was fresh and gusty, but at no time severe." Similar exceptions occurred in Ireland, Wales, and Scotland; in some degree resulting, probably, from the sheltering or deflecting effects of high land, but chiefly from the very diversified action of violent winds, expanding and expended, in some places, and so, extremely compressed (as it were) and elastic at others, that heavy weights are lifted, large trees snapped asunder, or laid prostrate, and strong buildings unroofed.

On the 31st October, charts 18 and 18a show that there was a circulation of wind around a place about two hundred miles west of Ireland; barometers indicating very diminished pressure everywhere, but particularly to the south-westward of Ireland, and thermometers showing great differences of temperature. Extreme cloudiness, much fog, and a good deal of rain prevailed during the 30th and 31st. It became evident that a southerly gale was impending. Barometers near London fell to 28·76 at midnight of the 31st, the thermometer, exposed, being then 50°. (Near Lake Windermere 28·09 was the reduced height, soon after that time). A steamer, the *Adler*, was in the Channel, on her passage to Cork, during this night (31st), and the following day. Her master thus describes the weather:—

Cork, November 4th 1859, Friday.

On the passage from London to Cork Monday (31st) and Tuesday last (1st November), I experienced a very severe gale in the English Channel, and I now submit the following remarks on wind and weather to the Meteorological Department of the Board of Trade:—Monday,

* From Captain Hemming, H.I.C.S., Colonel Rogers, and Captain Crowe. 156 and 200 feet, having been estimated as their elevations.

† 28·77 reduced to mean sea-level, or *half-tide* height.

noon, October 31st, wind S.E. fresh, dark gloomy weather, barometer 29·0° inclining to fall. At 4 h. P.M. increasing wind with rain at times. Barometer falling, dark and cloudy weather at 9 h. P.M. In a heavy arched squall of both wind and rain, attended with vivid flashes of lightning, the wind changed to W.N.W. Midnight, blowing severe gale from west, with low, white haze, over which showed a clear sky. At 1 h. 30 m. A.M., the appearance of the western horizon was like thick smoke, the stars visible to the eye like balls of fire through the black haze, very vivid lightning from the same quarter.

Barometer then down to 28·50°. I perceived at this moment a lull and the wind felt quite warm; (I have felt a heated wind similar in the West India hurricanes, also in the tropical belt of calms during heavy squalls, more particularly when accompanied by lightning, near the line;) a fierce gale then commenced, the ship could not be steered, and fell off broadside to wind and sea (the latter running very high), and rolling the lee paddlebox nearly under water; the gale so continued unabated till daylight of Tuesday, November 1st, with fierce gusts. On the horizon a white haze was visible about masthead high, partly composed of drift or water blown up from the surface. With this appearance the gale lasted the entire day. At 4 h. P.M. I perceived a lull, and found the barometer inclined to rise. At 6 h. P.M. between fierce squalls, and lulls at intervals, the gale moderated to a strong wind, with sea decreasing.

WM. L. TOOKER,
P. Adler, S. Ship.

A letter from Bute Docks, Cardiff, stated:—"The gale of the " 1st of November began here at noon of the 31st. The wind " was then East, (magnetic). It veered round to the S.S.W. " blowing heavily. At midnight it was W.S.W. (S.W. true), " with loud thunder and lightning, and terrific squalls, with heavy " rain; and so it continued till after noon of the 1st, when the " gale abated *here*. The heaviest of it was from W.S.W. " (S.W. true)."

To Dr. Vachell. JAMES FRASER.

At Dublin and at Kingstown at 10 A.M. on the 31st, it was blowing strong from the north-east, at sunset a gale from E.S.E. with rain, at 11 P.M. from north-west, with a great deal of lightning, and at 10 A.M. on the 1st from west.

It blew hard all the morning of the 1st; a good barometer in Dublin fell to 28·010, at 8 A.M. while the wind was west.*

At Liverpool the extreme pressure shown by the Observatory wind plate was only 14 lbs. on a square foot. This was at 8 A.M., the wind being W.S.W. true, (west magnetic.) The utmost hourly horizontal motion that day was but forty miles, showing that the greatest force of that gale did not reach the entrance of the Mersey.

At this time the vessel chartered by Colonel Shaffner for exploring a northern submarine line, was near 62° latitude, and

* Colonel Smyth, C.B., 76th Regiment. If a hundred feet above the sea level, this would be about 28·10 inches.

18° longitude, in a very heavy south-easterly gale. An extract from the log is subjoined, being extremely relevant to this subject.*

The justly esteemed Captain Boyd told me that the night of the 29th was fine at Kingstown; on the 30th the weather was gloomy and threatening, on the 31st a strong gale was blowing from north-east, while at Cork he heard it was south-east (magnetic.) Between 3 and 4 P.M. on that day the barometer fell, at Kingstown, from 29·30 to 29·00 in less than one hour, the wind being south-westward—the tides much affected.

On November 1st at 2 A.M. the barometer at Kingstown shewed 28·50 afloat. Heavy north-west gales followed at Cork, likewise, thunder, with lightning and rain.† The chart numbered 22, shows a very remarkable rotation of wind around the Solway Firth, and the "Merse" of Berwick. That circuit or gyration had progressed across the North of Ireland from at least two hundred miles to the westward (as several ships' logs prove) and diminished, or dispersed, towards the Baltic, apparently (see Chart 26); but its exact direction and condition, after reaching the North Sea, facts are yet wanting to demonstrate accurately.

The charts omitted in this publication, 19, 20, 21, 23, 25, and 27, do not contain any particulars sufficiently important to warrant their addition to this series, at present. Further information, especially from France, Denmark, Norway, Sweden, Holland, and Prussia, may assist much.

After inspection of these published charts, many persons may be induced to co-operate, by sending such facts, as they can then see will be useful, to the Board of Trade,‡ where they will be carefully combined with previous acquisitions, and made available for the public with as little delay as there can be in such subjects.

In thus summarily glancing over these *indisputable* charts, such a series as it would have been impossible to execute, without extensive and cordial assistance (in addition to that of the Board of Trade, the Post Office, the Admiralty, the Foreign Office and other Departments of Her Majesty's Government), the

* Bark "Wyman," Captain E. Baker, with Colonel Shaffner.

Stations and October.	Date. 1859.	Actual readings, 9 A.M. Barr.	Therr.	Thermomrs. Dry.	Water.	Wind. Direction.	Force.	Readings at P.M. Barr.	Therr.	Thermomrs. Dry.	Water.
° ′ ° ′		in.	°	°				in.			
60 19 18 39	30	29·15	60	42	48	S.	4	29·00	55	44	48
61 4 17 30	31	28·80	57	43	48	S.	11	28·80	56	45	48
61 38 17 59	1	29·15	60	45	48	S.S.E.	10	29·15	62	45	48
62 12 19 30	2	29·25	50	46	48	S.S.E.	9	·35	60	44	47
60 51 17 56	3	·50	50	46	48	E.	10	·60	55	42	48

† Mr. Saxby states that on the 2d November, at Sheerness (*see* diagram), the barometer rose 0·45 of an inch, while off Beachy Head, on board H.M.S. *Locust*, it was steady throughout the day.

‡ The word "Meteorological" being on the envelope, at the left-hand lower corner.

insufficiency of so cursory an inspection will be quite understood by the real meteorologist. But the limits of this paper, already exceeded, oblige me now to leave further examination of details to other occasions.

Able authors, such as Espy, Russell, and Hopkins,* and a few nautical men, have written and spoken against the views of Dové, Humboldt, Herschel, Reid, and the legion of their followers, with respect to the law of storms, especially cyclones.

Some of Mr. Russell's and Captain Jinman's latest published views are in the appendix.

The Author of the "Physical Geography of the Sea," the instigator of the Brussels Conference of 1853, and the cause of immense practical benefits to seamen, was himself a decided opponent of the rotatory theory. He visited England in November 1859, met and passed a few days with his friend (and former colleague at Brussels), Captain Jansen, Controller of the Royal Danish Navy. They examined Mr. Babington, as well as his charts, inquisitively, during several hours of successive days. And Captain Maury was converted by the evidence; as he has stated in the preface to his last edition of that popular work, the Physical Geography of the Sea.

The general impressions caused here, after this investigation, are:

1. The gyratory movements of wind, usually called cyclones, are consequences of the meeting of great air currents.
2. When so caused, in any part of the world, they rotate, as eddies, during a certain time, more or less limited, not exceeding four complete days and nights without interruption, but usually a much shorter period.
3. That cyclones originate on one side of the Atlantic, and traverse to the other, is a fallacy arising out of an *insufficiency of facts*, and consequent erroneous combination of the details of consecutive gyrations, *since* proved to be *frequent*.

* Of Manchester.

Gales of October 25–6, and November 1, 1859.

Wind. Direction.	Force.	Variation. West. A.†	P.†	Remarks.
S.	8	39	—	Light winds. Snow; heavy gale.
S.	11	—	—	Heavy gale; cloudy. Terrific gale; cloudy.
S.S.E.	9	45	—	Violent gale; cloudy. Gale; cloudy.
S.E.	10	—	—	Gale with rain. Heavy gale; cloudy.
E.N.E.	8	—	45	Heavy gale; cloudy. Moderate; cloudy.

† A = Actually observed. P = Probable.

4. When such an atmospheric commotion happens, it is not usually an isolated occurrence, but one of many such, similar in nature and origin, though unequal in extent, duration, and force; not taking place at exactly the same time, necessarily, but prevalent in a certain zone or region of the world during a few days, or weeks, or a season.

5. The conflicting action of two currents opposed in many peculiarities as well as in *direction* (a feature connected with electricity?) not only originates a cyclone, but tends to continue its striking qualities of a wet warm side, and a dry cold one, owing to the continued access and addition of air from each of the currents (between which is the eddy), as place is made by immense precipitation of vapour, in rain, hail or snow;—thus supplied from the vaporous side, as speedily as precipitated, or absorbed by the chilling and drying influence of the antagonistic current from a polar direction.

6. These cyclones originating in *opposition* of currents otherwise caused, are different from local whirlwinds, occasioned by rarefaction or *electrical* action ("trombs,") from sand columns (of the desert)* and water-spouts.

It would be mere repetition now, to advert, however briefly, to the general movements of those principal currents, so intermingled *generally*, so different in specific character when entirely separate, (as during a prolonged north-easterly or south-westerly wind,) and always co-existing, laterally or superposed. Too much has been said already in other numbers,—the *Ninth* more particularly; but one very peculiar feature may here be noticed, because it is as new as I believe it to be practically important.

The researches and investigations of Beccaria, Quételet, De Saussure, Faraday, Crosse, Delmann, Thomson, and others, showed, some time ago, that during the prevalence of northerly (polar) current of air, electricity (positive or vitreous), was more or less active, or developed. That in the contrary, southerly (tropical) current, there was no such action, no electricity in *excess*, no positive or vitreous, and but little, if any, (negative, or resinous) minus electrical evidence.

Having often noticed effects on certain instruments, used as weather glasses, that did not seem to be caused by pressure, or solely by temperature, by dryness, or by moisture; having found that these alterations happened with electrical atmospheric changes that were not always preceded or accompanied by movement of mercury in a barometer, and that, among other peculiarities, increase or diminution of wind in the very "heart of the trades," caused effects, while the mercurial column remained unaltered, or showing only the slight intertropical diurnal change (as regular

* Baddeley's Whirlwinds and Dust-storms of India, &c.

there as a clock.*) I have long felt sure that *another* agent might be traced further, not to say discovered.

Some forty years ago an Italian, named Malacredi, introduced what was called a "storm glass" into this country. He was then with Mr. Troughton, the well-known optician.†

Since 1825 I have generally had one or more of these glasses, as curiosities rather than otherwise, for nothing certain could be made of their variations until lately, when it has been proved, to my own satisfaction, that if fixed, undisturbed, in free air, not exposed to radiation, fire, or sun, but in the ordinary light of a room, or outer air, the mixture or chemical compound in a so-called storm glass varies in character with the *direction* of the wind, not its force, *specially* (though it *may* so vary, in *appearance* only) from *another* cause, its *electrical* tension.

As the atmospheric current veers toward, comes from, or is *approaching* only from the polar direction, this chemical mixture (microscopically watched) grows like fir or fern leaves, hoar frost, or crystallizations.

As it tends to the opposite quarter, the lines or spikes,—each regular, hard, or crisp feature gradually vanishes. Before and in a continued southerly wind the mixture sinks into a shapeless mass, at the bottom of the vial, like melted sugar.

Before, or during the continuance of a northerly wind (polar current) the crystallizations are beautiful (if the mixture is correct, the glass a *fixture*, and duly *placed*); but the least motion of the liquid disturbs them.

While *any hard* or *crisp* features are visible below, above, or at the top of the liquid (where they form for much north wind) there is plus electricity; a *mixture* of polar current existing in that locality. When nothing but soft, melting, sugary substance is seen, the atmospheric current (feeble or strong, as it may be,) is southerly, unmixed with, and uninfluenced by the contrary wind.

By repeated trials with a delicate galvanometer, applied to measure electrical tension in the air, I have proved these facts, and now find them invaluable for aiding, with the barometer and thermometers, in forecasting weather.‡

* Humboldt's "Personal Narrative."

† Well remembered by the agent for Admiralty and Board of Trade Publications, Mr. Potter, 31, Poultry, London.

‡ According to the principles stated in the Ninth Number.

APPENDIX.

THE GREAT AURORAL EXHIBITION OF AUGUST 28TH TO SEPTEMBER 4TH, 1859.

SEVENTH ARTICLE.

By ELIAS LOOMIS,
Professor of Natural Philosophy and Astronomy in Yale College.

Since the publication of my last auroral article I have obtained some additional information, chiefly collected during a recent visit to Europe.

1. *Observations at Highland, Illinois,* (lat. 38° 43′, long. 89° 48′ W.), *by* A. F. Bandelier, Jr.

At 9 P.M. Aug. 28, 1859, I was struck by the appearance of a broad purple ray extending lengthwise across the seven stars of Ursa Major to 80° of height. This ray remained for about half an hour, rapidly changing. Then appeared three rays in the east inclining to the south, which ascended from a bright yellow circle resting upon a segment of a brown misty appearance. Both arch and segment were gradually rising, the former illuminated as by the faint lightning of a distant tempest. The segment greatly agitated near its upper border, tossing and rolling its cloudy particles over each other in heavy undulations. No more rays appeared, but the yellow arch and the segment rose slowly. Through the latter I saw plainly α Aurigae rise without much diminution of brightness.

At 1 o'clock a quantity of rays shot upwards from the lucid arch, purple at the base and middle, brilliant yellow at the top. A little S.E. from the zenith they united, forming a small semicircle of the most dazzling beauty, from which rays now shot downwards. The corona lasted only a few minutes, then broke up and vanished. Some rays continued after it, but the great movement of the arch and segment ceased gradually.

At 4 A.M. both still stood on the northern horizon. The greatest height of the arch during the whole apparition was 60°, that of the segment was 20° to 25°.

Sept. 2d, at 9 P.M., I observed a dark segment in the north, looking very much like a fog, of an irregular circular form, the upper borders broken up, and 5° or 6° above the horizon at its greatest elevation. Behind it a faint light broke out, not unlike a distant prairie fire. The whole ranged from 10° west to 40° east. At $9^h\ 20^m$ four rays darted out directly north. They were of a pale milky colour. They seemed to descend into the segment below, and then suddenly prolonged themselves into the true ray or flame. The same lightning-like illumination of the arch was visible as in the aurora of Aug. 28th.

At 9h 30m a strong ray appeared N. 20° E.
At 9h 35m light diminishing east.
At 9h 45m strong decrease. Segment almost without motion ; its borders were now completely regular ; continued to decrease and fall below the horizon.
At 10h 30m only feebly visible.
At 11h 2m segment only a small stripe of 2° in breadth, a faint lighted border.
At 3h 30m A.M. all had entirely vanished. Clouds were gathering from the south.

2. *Observations at Greenwich, England,* (lat. 51° 28′), *communicated by* Prof. G. B. Airy, Astronomer Royal of Great Britain.

Greenwich Mean Time.	Western Declination.	Greenwich Mean Time.	Horizontal Force.	Greenwich Mean Time	Vertical Force.
h. m.	° ′ ″	*h. m.*		*h. m.*	
August 28th.		August 28th.		August 28th.	
0 0	21 31 30	0 0	·0897	0 0	·02143
5 23	21 12 30	2 15	·0953	3 15	·02170
8 15	21 17 15	3 30	·0890	6 40	·01969
11 15	21 52 10	5 0	·0926	9 4	·01880
11 20	20 57 30	5 25	·0935	10 39	·02019
11 38	21 52 10	7 45	·0904	11 46	·01510
12 46	20 47 10	8 19	·0897	12 37	·00260
14 4	21 53 5	9 15	·0916	13 2	·01561
14 45	21 16 50	9 51	·0929	13 21	·00263
16 5	22 1 50	21 0	·0832	14 9	·01836
17 11	21 3 0			14 27	·01340
18 9	21 23 30			16 49	·02263
18 55	21 5 30			18 10	·00840
19 6	21 55 40			22 6	·02251
21 15	21 4 10			22 43	·02120
August 29th.		August 29th.		August 29th.	
0 0	21 34 10	0 0	·0845	0 0	·02143
2 39	21 27 10	3 13	·0933	2 30	·01989
5 28	21 7 10	3 50	·0958	5 10	·01556
5 50	21 24 20	4 9	·0809	5 26	·01580
7 20	21 16 30	5 30	·0895	7 22	·01352
14 26	28 0	18 27	·0865	12 28	·01464
19 46	12 0	19 39	·0832	14 58	·01654
23 45	29 30	21 56	·0844	19 20	·02229
August 30th.		August 30th.		August 30th.	
0 0	21 28 20	0 0	·0861	0 0	·01882
5 20	20 25	2 39	·0886	9 18	·01349
12 52	27 50	7 45	·0880	18 47	·01963
19 3	15 0	14 14	·0893	23 15	·01730
21 37	20 30	21 45	·0854	23 59	·01481
August 31st.		August 31st.		August 31st.	
0 0	21 46 10	0 0	·0867	0 0	·01481
7 6	18 40	7 18	·0900	5 15	·00950
9 22	9 30	9 20	·0909	16 40	·01563
14 10	23 40	12 45	·0883	17 30	·00301
16 17	22 5 20	15 53	·0930	17 45	·04158
19 45	20 57 45	18 47	·0839	17 56	·02297
20 12	20 31 10	19 30	·1027	18 20	·04261
20 14	21 7 10	20 10	·0763	18 30	·02722
20 16	20 55 10	20 15	·0940	18 41	·04139
20 18	21 22 20	20 41	·0841	19 6	·02228
20 24	20 56 25	20 50	·0938	19 15	·02817

Observations at Greenwich—continued.

Greenwich Mean Time.	Western Declination.	Greenwich Mean Time.	Horizontal Force.	Greenwich Mean Time.	Vertical Force.
h. m.	° ′ ″	*h. m.*		*h. m.*	
August 31st.		August 31st.		August 31st.	
20 27	21 24 10	21 19	·0787	20 15	·02031
21 40	21 1 30	21 44	·0947	20 33	·02166
22 10	21 26 10	22 15	·0777	21 37	·02097
22 42	21 10 0	23 10	·0888	23 20	·01730
September 1st.		September 1st.		September 1st.	
0 0	21 33 35	0 0	·0885	0 0	·01719
1 56	42 35	1 57	·0906	8 33	·01051
8 20	15 0	4 28	·0885	21 0	·01658
14 10	25 35	9 21	·0900	23 30	·01563
20 0	12 30	13 0	·0905	23 43	·01438
23 42	35 40	20 55	·0873	23 56	·02043
23 54	8 45	22 40	·0869		
September 2d.		September 2d.		September 2d.	
0 0	21 18 0	0 0	·0940	0 0	·01978
0 16	4 10	1 33	·1069	1 22	·02556
1 4	53 10	1 39	·0817	1 36	·01963
1 13	11 5	1 59	·1065	1 53	·02437
1 18	52 15	2 27	·0778	2 17	·02197
1 40	21 10	2 52	·1120	2 48	·02769
1 54	58 50	3 23	·1003	3 13	·02203
2 13	11 15	3 37	·1078	3 30	·02400
2 30	51 40	5 43	·0930	5 47	·01988
2 43	13 10	6 30	·0964	6 3	·02142
3 40	51 25	8 40	·0850	8 37	·01602
3 57	23 10	9 25	·0937	9 5	·01670
5 50	40 0	11 29	·0802	10 47	·01200
6 15	0 30	12 43	·0945	11 17	·01329
7 0	24 10	12 54	·0816	11 32	·01063
8 51	20 53 0	14 48	·0884	12 37	·01293
9 40	21 32 0	16 13	·0816	12 56	·01142
11 4	21 6 25	18 25	·0848	14 40	·01290
11 43	21 42 20	21 35	·0812	14 57	·01221
14 15	21 5 30	23 12	·0833	15 50	·01320
15 52	27 20			16 6	·01281
20 15	15 30			18 48	·01556
September 3d.		September 3d.		September 3d.	
0 12	21 27 20	0 0	·0889	0 0	·01739
3 3	58 45	0 31	·0940	3 30	·01620
5 53	21 10	3 15	·0837	4 40	·01946
6 12	20 50 5	5 9	·1075	5 32	·01683
6 53	21 28 15	6 27	·0887	6 4	·01936
7 30	0 30	6 31	·0930	6 58	·01300
7 58	21 28 30	8 5	·0835	7 26	·01405
8 15	11 30	10 44	·0891	8 4	·01347
11 50	36 0	12 39	·0811	8 15	·01425
13 8	15 10	13 45	·0850	12 36	·00900
16 7	25 0	15 15	·0822	15 7	·01510
21 6	13 0	19 21	·0861	19 38	·01923
September 4th.		September 4th.		September 4th.	
0 0	21 33 0	0 0	·0830	0 0	·01809
1 20	41 45	2 15	·0936	2 4	·01763
2 37	22 30	3 22	·0845	2 36	·01846
3 30	30 20	3 52	·0912	3 37	·01682
10 54	12 10	5 19	·0837	3 56	·01701
12 4	30 30	12 55	·0877	14 4	·01102
19 23	3 30	13 54	·0827	21 53	·01732
23 15	37 10	19 32	·0883	23 59	·01739
		23 12	·0790		

3. *Deflections of the Needles of the Vertical Galvanometers of Cooke and Wheatstone's Telegraph Instruments, observed at Ramsgate Station in the County of Kent, England, upon three distinct Lines of Telegraph; namely, Ashford and Margate, distant in a direct line 27½ miles; Ashford and Ramsgate, distant 27½ miles; Ramsgate and Margate, 3 miles; furnished by* Mr. CHARLES V. WALKER.

Note.—The direction in which the current moves is indicated by the letters N. and S.; N. means that the current is from the more northerly to the more southerly station of the two; S. means the reverse. The direction of Ashford from Ramsgate is S. 60° W., and that of Margate from Ramsgate N., 22° W.

In the "value column," "strong" means 30° or 40°; "hard over," 45; horizontal, from 70° to 80°. Ordinary strong telegraph signals produce about 60°.

Date.	Time.		Telegraph Line.	Direction.	Value.
1859.					
Aug. 29th	7·10 A.M.	7·25 A.M.	Ashford and Margate	S.	Strong.
"	7·36 "	7·45 "	" " "	S.	Hard over.
"	7·46 "	7·49 "	" " Ramsgate	N.	Strong.
"	7·50 "	8· 0 "	" " "	S.	Hard over.
"	9·45 "	10· 0 "	" " "	N.	"
"	10·20 "	10·27 "	" " "	N.	Strong.
"	10·27 "	10·28 "	" " "	S.	Hard over.
"	10·28 "	10·36 "	" " "	N.	Strong.
"	10·37 "	10·40 "	" " "	S.	Hard over.
"	10·40 "	10·45 "	" " Margate,	N.	"
"	10·45 "	10·49 "	Margate and Ashford	S.	"
"	10·50 "	10·53 "	" " "	N.	"
"	10·53 "	11· 0 "	" " "	S.	Horizontal.
"	11· 2 "	11·25 "	" " "	N.	"
"	11·25 "	11·40 "	" " "	N.	Hard over.
"	11·45 "	12·20 P.M.	" " "	N.	"
"	12·30 P.M.	12·45 "	" " "	N.	Strong.
"	12·48 "	1· 3 "	" " "	S.	"
"	1· 5 "	1·40 "	" " "	N.	"
"	2·40 "	2·53 "	" " "	N.	Very strong.
"	3·40 "	3·50 "	" " "	S.	"
"	3·52 "	4· 5 "	" " "	S.	Horizontal.
"	3·52 "	4· 5 "	Ashford and Ramsgate	N.	Very strong.
"	4·15 "	4·50 "	" " Margate	N.	"
"	5· 0 "	5·20 "	" " "	N.	"
"	" "	" "	" " Ramsgate	N.	"
"	5·25 "	5·48 "	" " Margate	N.	"
"	6·10 "	6·23 "	" " "	S.	"
"	6·50 "	7·20 "	" " "	S.	"
"	7·53 "	8·10 "	" " "	S.	Slight.
"	11·20 A.M.	11·26 A.M.	" " "	S.	Strong.
Sept. 1st	11·28 "	11·35 "	" " "	N.	Slight.
"	7·10 "	7·42 "	" " "	N.	Horizontal.
Sept. 2d	7·10 "	7·50 "	Ramsgate and Margate	N.	"
"	7·10 "	7·42 "	Ashford and Ramsgate	N.	"
"	7·43 "	7·48 "	" " Margate	S.	Strong.
"	" "	" "	" " Ramsgate	S.	"
"	7·49 "	7·51 "	" " Margate	N.	Hard over.
"	" "	" "	" " Ramsgate	N.	"
"	7·51 "	7·56 "	" " Margate	S.	"
"	" "	" "	" " Ramsgate	S.	"
"	7·56 "	8· 0 "	" " Margate	N.	"
"	" "	" "	" " Ramsgate	N.	"
"	" "	" "	Ramsgate and Margate	N.	"
"	8· 0 "	8· 7 "	Ashford and "	S.	Strong.

Date.	Time.		Telegraph Line.	Direction.	Value.
1859.					
Sept. 2d	8· 0 A.M.	8· 7 A.M.	Ashford and Ramsgate	S.	Strong.
"	" "	" "	Ramsgate and Margate	S.	"
"	8· 8 "	8·12 "	Ashford and "	S.	"
"	" "	" "	" " Ramsgate	S.	"
"	" "	8·17 "	Ramsgate and Margate	S.	"
"	8·12 "	" "	Ashford and Ramsgate	S.	Hard over.
"	" "	" "	" " Margate	S.	"
"	8·20 "	8·30 "	" " Ramsgate	N.	"
"	" "	" "	" " Margate	N.	"
"	8·31 "	8·46 "	" " "	S.	"
"	" "	8·40 "	" " Ramsgate	S.	"
"	8·41 "	8·46 "	" " "	N.	"
"	" "	" "	" " Margate	N.	"
"	8·47 "	8·54 "	" " "	S.	"
"	" "	" "	" " Ramsgate	S.	"
"	8·54 "	9· 0 "	" " "	N.	Strong.
"	" "	" "	" " Margate	N.	"
"	9·22 "	9·25 "	" " "	N.	"
"	9·26 "	9·28 "	" " "	S.	"
"	9·29 "	9·40 "	" " "	N.	"
"	9·40 "	9·52 "	" " "	S.	"
"	9·55 "	10·32 "	" " "	N.	"
"	" "	" "	" " Ramsgate	N.	"
"	10·35 "	10·38 "	" " Margate	S.	"
"	10·38 "	10·40 "	" " "	N.	"
"	10·41 "	10·46 "	" " "	S.	"
"	10·55 "	11· 0 "	" " "	S.	"
"	11· 2 "	11·15 "	" " "	N.	"
"	" "	" "	" " Ramsgate	N.	"
"	11·16 "	11·27 "	" " Margate	S.	"
"	11·20 "	11·32 "	" " Ramsgate	S.	"
"	11·38 "	11·40 "	" " Margate	N.	"
"	11·40 "	11·45 "	" " "	S.	"
"	11·45 "	11·49 "	" " "	N.	"
"	" "	" "	" " Ramsgate	N.	"
"	" "	11·50 "	Ramsgate and Margate	N.	"
"	11·50 "	11·51 "	Ashford and "	S.	"
"	" "	" "	" " Ramsgate	S.	"
"	" "	" "	Ramsgate and Margate	S.	"
"	11·52 "	11·54 "	Ashford and Ramsgate	N.	"
"	11·52 "	11·54 "	Ramsgate and Margate	N.	"
"	" "	" "	Ashford and "	N.	"
"	11·59 "	12· 3 P.M.	" " Ramsgate	N.	"
"	" "	" "	" " Margate	N.	"
"	12· 4 P.M.	12·14 "	Ramsgate and "	N.	"
"	" "	" "	Ashford and Ramsgate	S.	Horizontal.
"	12·15 "	12·30 "	" " Margate	S.	Strong.
"	" "	" "	" " "	N.	Horizontal.
"	12·30 "	12·35 "	" " Ramsgate	N.	Strong.
"	" "	" "	" " Margate	N.	"
"	12·36 "	12·57 "	Ramsgate and Margate	N.	"
"	" "	" "	Ashford and "	N.	"
"	12·57 "	1·18 "	" " Ramsgate	N.	"
"	" "	" "	" " Margate	S.	"
"	1·20 "	1·44 "	" " Ramsgate	S.	"
"	" "	" "	Ramsgate and Margate	N.	"
"	1·44 "	1·47 "	Ashford and Ramsgate	N.	"

Date.	Time.		Telegraph Line.	Direction.	Value.
1859.					
Sept. 2d	1·44 P.M.	1·47 P.M.	Ashford and Margate	S.	Strong.
,,	1·47 ,,	1·54 ,,	,, ,, ,,	N.	,,
,,	,, ,,	,, ,,	,, ,, Ramsgate	N.	,,
,,	2· 0 ,,	2·15 ,,	,, ,, Margate	N.	,,
,,	,, ,,	,, ,,	,, ,, Ramsgate	N.	,,
,,	2·15 ,,	2·18 ,,	,, ,, Margate	S.	,,
,,	,, ,,	,, ,,	,, ,, Ramsgate	S.	,,
,,	2·21 ,,	2·31 ,,	,, ,, Margate	S.	Horizontal.
,,	,, ,,	2·37 ,,	,, ,, Ramsgate	S.	,,
,,	2·38 ,,	2.52 ,,	Ramsgate and Margate	N.	Strong.
,,	,, ,,	,, ,,	Ashford and Ramsgate	N.	,,
,,	,, ,,	,, ,,	,, ,, Margate	N.	,,
,,	2·52 ,,	2·55 ,,	Ramsgate and ,,	S.	,,
,,	,, ,,	,, ,,	Ashford and Ramsgate	S.	,,
,,	,, ,,	,, ,,	,, ,, Margate	S.	,,
,,	2·55 ,,	3· 2 ,,	Ramsgate and ,,	N.	,,
,,	,, ,,	,, ,,	Ashford and Ramsgate	N.	,,
,,	,, ,,	,, ,,	,, ,, Margate	N.	,,

4. *Auroral Observations made at Sea; furnished by* Rear-Admiral Robert FitzRoy, of the British Navy.

A. Lat. 50° 47′ N., long. 10° 12′ W.

Aug. 28th. About 11h 30m P.M. the sky being cloudy, it brightened up like daybreak; remained so for twenty minutes, then turned a dark red, and soon after darkened in again as before.

B. Lat. 29° 48′ N., long. 45° 26′ W.

Aug. 28th. The aurora seen from 9 P.M. till 4 A.M. the next morning, of a rose colour. Streamers about 30° high.

C. Lat. 26° 48′ N., long. 45° 40′ W.

Aug. 28th. Sky in the S.S.E. of a lurid fiery colour; a vivid bright streak from the middle.

D. Lat. 25° 45′ N., long. 27° 4′ W.

Aug. 28th. From 11h 15m P.M. till midnight the N.W. portion of the sky of a deep red colour, resembling an angry sunrise.

E. Lat. 33° 55′ N., long. 44° 13′ W.

Sept. 2d. The aurora faintly visible in the north about 4 A.M.

F. Lat. 33° 33′ N., long. 33° 2′ W.

Sept. 2d. At 3 A.M. a low bank of straw-coloured aurora on the northern horizon; it became a beautiful rose colour, covering about four-tenths of the sky, and gradually disappeared as the day broke.

G. Lat. 24° 10′ N., long. 35° 50′ W.

Sept. 2d. Aurora seen in the morning from N.W. to E.N.E. of a bright red colour, interspersed with streaks of white, converging to a centre nearly over the ship.

5. *State of the Weather at the Russian Magnetic Observatories, during the Auroral Display of August 28th to September 2d, 1859; furnished by* A. T. Kupffer, Director of the Central Physical Observatory.

Hour.	St. Petersburg.	Catherinburg.	Barnaoul.	Nertchinsk.
		August 28th, 1859.		
0	Overcast	Cloudy	Scattered clouds	Overcast
1	Overcast	Overcast	Scattered clouds	Overcast
2	Cloudy	Overcast	Scattered clouds	Overcast
3	Cloudy	Overcast	Scattered clouds	Overcast
4	Cloudy	Cloudy	Scattered clouds	Overcast
5	Cloudy	Cloudy	Clouds in horizon	Overcast
6	Cloudy	Cloudy	Clouds in horizon	Overcast
7	Cloudy	Cloudy	Clouds in horizon	Clouds in horizon
8	Cloudy	Cloudy	Clear	Clouds in horizon
9	Cloudy	Cloudy	Clear	Cloudy
10	Light clouds	Cloudy	Clear	Cloudy
11	Light clouds	Clouds in horizon	Clear	Cloudy
12	Light clouds	Clear	Clear	Cloudy
13	Cloudy	Clear	Clear	Overcast
14	Cloudy	Clear	Clear	Overcast
15	Cloudy	Clear	Clear	Overcast
16	Cloudy	Clear	Clouds in horizon	Overcast
17	Cloudy	Clouds in horizon	Clouds in horizon	Overcast
18	Cloudy	Clouds in horizon	Clouds in horizon	Overcast
19	Cloudy	Clouds in horizon	Clouds in horizon	Overcast
20	Cloudy	Clouds in horizon	Clouds in horizon	Clouds in horizon
21	Cloudy	Cloudy	Scattered clouds	Clouds in horizon
22	Cloudy	Cloudy	Scattered clouds	Cloudy
23	Cloudy	Cloudy	Scattered clouds	Cloudy
		September 2d, 1859.		
0	Scat. clouds	Cloudy	Cloudy	Cloudy
1	Scat. clouds	Cloudy	Scattered clouds	Cloudy
2	Scat. clouds	Cloudy	Cloudy	Cloudy
3	Light clouds	Cloudy	Cloudy	Overcast
4	Light clouds	Cloudy	Cloudy	Cloudy
5	Light clouds	Cloudy	Cloudy	Overcast
6	Light clouds	Cloudy	Cloudy	Overcast
7	Light clouds	Clouds in horizon	Cloudy	Cloudy
8	Scat. clouds	Clouds in horizon	Cloudy	Clouds in horizon
9	Scat. clouds	Clouds in horizon	Cloudy	Clear
10	Light clouds	Cloudy	Cloudy	Clear
11	Scat. clouds	Cloudy	Cloudy	Clouds in horizon
12	Scat. clouds	Clouds in horizon	Scattered clouds	Clouds in horizon
13	Scat. clouds	Clouds in horizon	Scattered clouds	Clouds in horizon
14	Scat. clouds	Clouds in horizon	Clouds in horizon	Clouds in horizon
15	Scat. clouds	Clouds in horizon	Clouds in horizon	Clouds in horizon
16	Scat. clouds	Clouds in horizon	Clouds in horizon	Clouds in horizon
17	Light clouds	Clouds in horizon	Clouds in horizon	Cloudy
18	Light clouds	Clouds in horizon	Scattered clouds	Cloudy
19	Light clouds	Clouds in horizon	Scattered clouds	Cloudy
20	Light clouds	Clouds in horizon	Scattered clouds	Overcast
21	Light clouds	Scattered clouds	Scattered clouds	Overcast
22	Light clouds	Cloudy	Scattered clouds	Cloudy
23	Light clouds	Cloudy	Scattered clouds	Overcast

In vol. xxx., pp. 80–82, of this Journal, observations are published showing an unusual disturbance of the magnetic instruments throughout the whole of the Russian empire, but no mention is made of any aurora. The preceding observations show that during this period the sky was generally overcast at each of the Russian stations.

6. *Observations of the Aurora of August 28th and 29th, 1859, made in Australia; furnished by* Mr. James Glaisher, of the Greenwich Observatory.

A. Observations at Hobarton, lat. 42° 52′ S., long. 147° 27′ E.

Aug. 29th, from 6h 55m to 7h 25m P.M., there appeared a most brilliant aurora extending from W. by N. to the eastern part of the horizon in one continuous arc of about 190°, and shooting up to the zenith. The eastern and western extremities of the conoid were of a pale ruby and deep red colour, intermixed through the whole vault with bands of pale yellow and shades of dark and light green, and with here and there a small dark cloud jutting in; elsewhere the circumpolar stars glittered like diamonds set in an emerald and ruby ground. The phenomenon had for 30 minutes a most magnificent appearance, the bands being in complete repose, forming a truncated cone of glory, the apex of which, if projected, would have terminated in the zenith. This brilliant storm appeared again about 9h 30m P.M., flickering in brisk coruscations of most beautiful colour from the horizon to the zenith.

A second display of the aurora appeared on the night of Sept. 2d, equally brilliant and extensive, and less transitory. From midnight to 1 A.M. the aurora broke out into flickering streamers and coruscations, forming in the zenith a well-defined corona, which shortly after became diffused, and then dispersed.

B. Observations at Cape Otway, lat. 30° 51′ S., long. 143° 50′ E.

Aug. 29th. Aurora most magnificent at 6h 30m P.M., and continued visible until after 2 A.M., displaying itself in the form of a rainbow, the arc extending to about 60° or 70°. First colour above the horizon, a light blue with a tint of green, blending into, second, a very light yellow, again blending into, third, a deep red.

C. Observations at Portland, lat. 38° 20′ S., long. 141° 55′ E.

Aug. 29th. Aurora visible at 6h 40m P.M. At 7 P.M. a bright band partly tinged with blue and pink, extending E. and W., pink rays converging to a centre on the band, a little to the W. of the Milky Way. Gradually faded, and all disappeared by 8 P.M.

D. Observations at Melbourne Observatory, lat. 37° 49′ S., long. 145° 9′ E., by George Neumayer.

On the evening of Aug. 28th great disturbances made themselves manifest in all the three magnetic elements, which became less violent during the early part of the morning of the 29th. At 4 A.M. Aug. 29th, the horizontal intensity was 0·0020 below the mean for the previous ten days, and then increased until 8h 50m A.M., when the disturbances assumed so violent a character that the intensity at times, and the inclination very frequently, could not be registered, the scales being out of the field of the telescope. At 8h 57m A.M. the horizontal intensity was 0·0284 below the mean above referred to, showing a decrease of 0·0264 in the space of one hour. The variation of the needle underwent similar changes, decreasing rapidly until 9h 35m, when it was 36 minutes below the mean for the ten days mentioned above. After 8 A.M. the magnetic instruments were registered every minute. The following table contains the means for declination and horizontal intensity:—

	Declination.	Horizontal Intensity.
Between 7h and 8h A.M.	8°24′·20	2·36264
„ 8 „ 9 „	8 22 ·23	2·33677
„ 9 „ 10 „	8 8 ·52	2·35072
„ 10 „ 11 „	8 13 ·00	2·34711
„ 11 „ 12 „	8 22 ·86	2·34983
„ 12 „ 1 P.M.	8 34 ·33	2·35160
„ 1 „ 2 „	8 37 ·54	2·35539
„ 2 „ 3 „	8 37 ·40	2·35755
„ 3 „ 4 „	8 38 ·46	2·34353
„ 4 „ 5 „	8 35 ·83	2·35479
„ 5 „ 6 „	8 34 ·21	2·35412

The above figures do not give the greatest range; that for declination being 1° 8′·8; and for intensity 0·03197 of the absolute unit.

At 6h 10m P.M. the first traces of an aurora were observed towards S.E. by S. The luminous appearance increased rapidly, spreading towards S.W.

6h 40m P.M. A rosy colour appearing on the clouds in S.E. and S.W. by W.

6h 50m. Splendid aurora. Red streamers very bright, S.E., S.W., and W. by S. visible to an altitude of 50° or 90°. One very bright whitish streamer in S.W. by S. looking as if there were a thin red curtain before a beautiful white luminous curtain. Lower edge about 12° above the horizon. Well defined in S. by W. and S.S.W.; upper portion scarce visible at 45°. The folds of the luminous curtain and the red streamers, if produced, would probably meet one another about 10° S. of the zenith.

7h 15m P.M. Aurora fading away. Red patch in S.

7h 20m P.M. Red colour disappearing from S. to S.W., giving place to white; at the same time the white in S.S.E. becoming reddish.

7h 21m P.M. Sky in S. becoming very bright and white. Low bank of well-defined cumulo-stratus 5° to 6° above the horizon.

7h 23m P.M. A well-defined arch of white light 10° to 12° high above the bank of cloud before mentioned, extending from S.S.E. to W.S.W., being brightest in W.S.W.

7h 30m P.M. Very faintly red in S.E. Two pink streamers. Two whitish streamers, one in the zodiac, and the other through the cross.

7h 34m P.M. Faint rosy light in E.S.E. nearly as high as the zenith.

7h 43m P.M. White streamers in S.W. by W.

7h 49m P.M. A large patch of very bright light in S.E., white below, reddish above.

7h 50m P.M. A white luminous cloud appearing in S.W. About 30° high, below the southern cross, a rosy streamer in S.E. by E. very faint.

7h 55m P.M. The white and red light in S.E. increasing in brightness, yellowish white below, and red above. Top 40° high.

8h 3m P.M. Luminosity in S.E. almost gone, especially the red.

8h 20m P.M. Rosy arc from E.S.E. to W. by N., passing nearly through the zenith.

9h 50m P.M. Three red streamers in S.E. very bright, and several white ones in S.W.

12h 15m A.M. Bright broad streamers S.S.W. to S.W., partly covered with clouds.

12h 40m A.M. Luminosity in S. and S.W. 25° high.

2h 15m A.M. Luminosity from S.S.E. to W., brightest in S.S.W.

The magnetic disturbances continued with more or less intensity until 4 A.M., August 30th.

During the whole of the 29th the instruments of the electric telegraph were disturbed to such a degree as to interfere with the working of the lines extending over New South Wales, Adelaide, and Victoria. This effect was similar to that produced by atmospheric electricity.

E. Observations at Ballarat, lat. 37° 36′ S., long. 143° 51′ E.

Aurora visible August 29th at $6^h\ 45^m$ P.M. It gradually spread to the E., and formed a magnificent arch, the colours of which were red, green, and violet. The rays of light were distinct and beautiful. The southern portion of the sky was illuminated until $7^h\ 30^m$ sufficiently to cast a shadow.

F. Observations at Longwood, lat. 36° 54′ S., long. 145° 41′ E.

At $6^h\ 10^m$ P.M. August 29th, an aurora appeared from a dusky line in the S.W. part of the horizon, which gradually ascended with a tremulous motion towards the zenith, assuming all shapes and varieties of colour, from a pale red or yellow, to a deep vermilion, and extending to the N.E., serving to illuminate the earth, until its disappearance at $7^h\ 15^m$ P.M.

G. Observations at Sandhurst, lat. 36° 48′ S., long. 144° 24′ E.

Aurora very brilliant from 7 P.M., August 29th, until a little after midnight.

H. Observations at Beechworth, lat. 36° 22′ S., long. 146° 52′ E.

August 29th. Aurora visible for nearly an hour and a half, commencing about $5^h\ 45^m$ P.M., gradually increasing in beauty and brilliancy of tint until shortly before 7^h, when the rays became gradually indistinct, disappearing at about $7^h\ 15^m$ P.M. During the whole day the telegraph wires were strongly affected.

I. Observations at Sydney Observatory, lat. 33° 52′ S., long. 151° 12′ E., made by W. Scott.

The aurora was first noticed August 29th, at $7^h\ 20^m$ P.M., and continued visible for about half an hour, when it gradually faded away, and the sky became rapidly covered with clouds. I was in the act of observing a transit of the pole star, when I was struck with the redness of the southern sky. On looking out I was surprised to find a considerable portion of the southern sky in a glow of red light, similar to that which sometimes precedes the rising of the sun. This red light formed a tolerably regular arch from E.S.E. to W.S.W., extending in depth from the south pole to within a few degrees of the horizon. There was a partial break to the S.S.W., and in some places there were radiating streams of light brighter and of a lighter red than the rest.

About 10 A.M., Aug. 29th, the wires of the electric telegraph were seized with an unaccountable fit of restiveness. They did not altogether refuse to work, but acted irregularly, the adjustment of the instrument altering so frequently that it was almost impossible to get any continuous message through. This state lasted until the evening, when the wires began to work better.

From the preceding observations, and from those which have been heretofore published in this journal, it appears that the remarkable auroral display which prevailed throughout a large portion of the northern hemisphere from Aug. 28th to Sept. 4th, 1859, was accompanied by a display about equally remarkable in the southern hemisphere; and the periods of greatest brilliancy were nearly cotemporaneous in both hemispheres. In order to determine whether such a coincidence is a common occurrence, I have sought for some long and continuous record of the aurora in the southern hemisphere.

The most complete record of this kind which I have found is that made at the British magnetic observatory at Hobarton, on Van Dieman's Island, during the years 1841–48. These observations have been published by the British Government, and the first part of the following table contains all the instances of auroral exhibitions which I have been able to find in these volumes.

The second part of the table contains the corresponding observations made at New Haven by Mr. E. C. Herrick, who kept a careful record (negative as well as positive,) of all auroral phenomena from 1837 to 1853, except from March to Sept. 1851.

The third part of the table contains auroral notices from the State of New York, as published in the annual Regent's Reports; and the fourth part of the table contains auroral notices from the Toronto Meteorological Observations.

I. *Observations of the Aurora at Hobarton, Van Dieman's Island,* lat. 42° 52′ S. long. 147 27 E.
Magnetic Dip in 1845 . . . . 70° 35′·6.

Hobarton Mean Time, Astronomical Reckoning.		Notices of Auroras.
Day.	Hour.	
1841. March 16	17^h	Slight appearance of Aurora.
March 22	15	Faint appearance of Aurora.
May 17	13	Slight appearance of Aurora.
July 20	9	Aurora very brilliant in S.E.
Dec. 17	11	Slight Aurora in S.
1842. Jan. 1	11	Appearance of Aurora to the S.
Feb. 2	9	Slight appearance of Aurora in S.W.
Feb. 18	9	Appearance of Aurora in the S.
April 11	9	Slight appearance of Aurora in the S.
April 13	13–15	Aurora in the S.
April 14	9	Aurora in the S.
April 15	9	Aurora in the S.
May 16	9–15	Aurora from S.E. to S.
June 13	11	Faint Aurora in the S.
July 2	7–11	Slight Aurora in the S.
Sept. 2	13	Steady bright light in the S.
Dec. 31	9	Slight Aurora in the S.
1844. April 16		Aurora in the evening and night.
April 25	9	Faint appearance of the Aurora.
1846. Sept. 22		Aurora very brilliant throughout the night.
1847. April 20		Aurora very distinct during the night.
April 21		Aurora visible.
Sept. 24		Aurora very bright.
Sept. 25		Aurora visible.
Sept. 26		Aurora visible.
Oct. 22		Aurora visible and very brilliant.
Oct. 23		Aurora visible.
Oct. 24		Aurora still visible.
Dec. 20		Aurora visible.
1848. March 24		Aurora very distinct at night.
April 6		Aurora very distinct at night.
Oct. 18		Aurora visible.
Nov. 19		Aurora visible.
Dec. 21	10	Slight signs of Aurora to the S.

II. *Observations of the Aurora at New Haven*, lat. 41° 18′ N., long. 72° 55′ W.
Magnetic Dip in 1844 . . . . 73° 21′.

Date.	Notices.
1841. March 16	Snowing.
March 21	10·45 P.M., faint Aurora ; 22d, cloudy.
March 23	10 P.M., Aurora with streamers.
May 17	Clear. No Aurora seen up to $10^h\ 15^m$.
July 19	10 P.M., Aurora with streamers ; 20th, clear. No Aurora.—$10^h\ 15^m$.
July 21	10 P.M., Aurora.
Dec. 17	Overcast.
1842. Jan. 1	Clear. No Aurora up to 10^h.
Feb. 2	Somewhat hazy. No Aurora up to $10^h\ 30^m$.
Feb. 18	Overcast.
April 11	Aurora with streamers.
April 13	Raining.
April 14	10 P.M., Aurora reaching 20° altitude.
April 15	3 A.M., Aurora reaching 45° altitude.
May 16	Hazy ; moonshine ; no Aurora up to 10^h.
June 13	Raining.
July 2	Overcast.
Sept. 2	8·30 P.M., Aurora with streamers.
Dec. 31	Clear. No Aurora up to 11^h.
1844. April 16	Overcast.
April 25	Overcast.
1846. Sept. 21	Aurora ; 22d, 8 P.M., Aurora.
1847. April 20	Overcast.
April 21	Overcast.
Sept. 24	Raining.
Sept. 25	Raining.
Sept. 26	Raining.
Oct. 22	Overcast.
Oct. 23	Overcast.
Oct. 24	Raining.
Dec. 20	5 A.M., grand Auroral display.
1848. March 24	8 P.M., Aurora with streamers
April 6	9·30 P.M., Aurora with streamers.
Oct. 18	Raining.
Nov. 19	8 P.M. Aurora.
Dec. 21	Snowing.

III. *Observations of the Aurora at the Academies in the State of New York.*
Magnetic Dip from 73° to 75°.

Date.	Notices.
1841. March 16	Aurora seen at Fredonia.
March 22	Aurora at Newbury, Vt.
July 20	Aurora seen at St. Lawrence.
1842. Feb. 1	Aurora seen at Cortland.
April 11	Aurora at Albany, Rochester, and many other places.
April 12	Aurora at Malone.
April 14	Aurora at Albany, and many other places.
April 15	Aurora at Rochester, and many other places.
June 13	Aurora at Ellisburgh.
July 2	10 P.M., Bright Aurora at several places.
Sept. 2	Aurora at North Salem.
1844. April 17	Aurora at Onondaga.
1846. Sept. 21	Aurora at North Salem, and several other places.
Sept. 22	Aurora at Onondaga.
1847. Oct. 23	Aurora at Rochester and Casanovia.
Oct. 24	3 A.M., Brilliant Aurora at Rochester.
Dec. 20	Aurora at Hamilton and Mexico.
1848. March 24	Aurora at New York, Fredonia, and many other places.
April 6	Brilliant Aurora at Albany, Rochester, and many other places.
Nov. 18	Morning, Splendid Aurora at New York.

IV. *Observations of the Aurora at Toronto*, lat. 43° 40′ N., long. 79° 23′ W.
Magnetic Dip in 1845 - - - 75° 15′.

Date.	Notices.
1841. July 19	Aurora from 9^h to 13^h.
Dec. 17	14^h. Faint auroral light in north.
1842. Feb. 18	Rain and snow.
April 10	14^h. Bright bank of auroral light in N.
April 14	14^h. Brilliant Aurora.
April 15	8^h. Aurora visible from 8^h to 14^h.
July 3	14^h. Brilliant Aurora.
Sept. 2	9^h. Faint auroral light at 9^h and 10^h.
Dec. 31	Snow.
1844. April 16	Auroral light.
April 25	Rain.
1846. Sept. 21	From 9^h to 17^h brilliant Aurora.
1847. April 19	From 13^h to 16^h auroral light in N.
April 21	Rain.
Sept. 24	Rain.
Sept. 25	Rain.
Sept. 26	Rain.
Oct. 22	16^h. Remarkable appearance of Aurora.
Dec. 19	17^h. Aurora. Great magnetic disturbance.
1848. March 24	From 9^h to 12^h Aurora.
April 5	From 10^h to 15^h Aurora.
Oct. 18	Auroral light through the clouds.
Nov. 19	Slight auroral light.
Dec. 21	Snow.

Part first of the preceding table contains a list of 34 auroras observed at Hobarton. Part second of the table shows that in 11 of these cases an aurora was seen on the same day at New Haven. These observations were not strictly cotemporaneous, for Hobarton and New Haven being in nearly opposite longitudes, when an aurora was seen at Hobarton it could not be seen at New Haven on account of the presence of the sun. Moreover, the New Haven observations were chiefly made in the early part of the night; but in 11 cases an aurora was seen within about 12 hours of its appearance at Hobarton. In several cases when an aurora was seen at Hobarton it was cloudy at New Haven, and there were eight other corresponding cases in which an aurora was seen at some one of the academies in New York, although not noticed at New Haven. In four additional cases an aurora was seen at Toronto, when none was recorded at New Haven, or in the State of New York.

There remain then only 11 cases of auroras at Hobarton for which we do not find corresponding observations from one of these three sources in the northern hemisphere, and in eight of these cases the sky was overcast from New Haven to Toronto. The following are the dates of these auroras, and opposite to the dates I have placed notices of auroral or magnetic phenomena from some station in the northern hemisphere:—

Date.			——
1841.	May	17	Unusual magnetic disturbance at Greenwich, England.
1842.	Jan.	1	Unusual magnetic disturbance at Greenwich.
	Feb.	18	Unusual magnetic disturbance at Greenwich. Aurora at Christiana, Norway.
	May	16	Unusual magnetic disturbance at Toronto and Greenwich.
	Dec.	31	Magnetic disturbance at Greenwich.
1844.	April	25	Unusual magnetic disturbance at Philadelphia and Toronto.
1847.	April	21	Unusual magnetic disturbance at Greenwich.
	Sept.	24	Aurora 9^h to 10^h at Greenwich.
	Sept.	25	Unusual magnetic disturbance at Greenwich.
	Sept.	26	Unusual magnetic disturbance at Greenwich. Aurora at Carlisle, England.
1848.	Dec.	21	Aurora in Newfoundland.

It thus appears that in every instance when an aurora was observed at Hobarton, an aurora was seen on the same day in the northern hemisphere; or there were observed unusual disturbances of the magnetic instruments, indicating the existence of an aurora at no very remote station. So far then as a conclusion is authorized from so small a number of observations, we should infer that whenever an aurora is seen at Hobarton, where the magnetic dip is $-70°$, an aurora occurs at some place in the northern hemisphere as far south as where the magnetic dip does not much exceed 75°; in other words, an unusual auroral display in the southern hemisphere is *always* accompanied by an unusual display in the northern hemisphere. As any cause which affects the intensity of the magnetism at one pole of a magnet, usually affects the other pole, so an exhibition of auroral light about one magnetic pole of the earth, is uniformly attended by a simultaneous exhibition of auroral light about the opposite magnetic pole.

New Haven, May, 1861.

St. John's, Newfoundland,
27th December 1858.

To the Mercantile Marine Association, London.

Gentlemen,

For several years past the Law of Storms has attracted considerable attention, so much so, that several scientific men on shore have devoted a considerable portion of their time in endeavouring to develope its true principles.

Meteorological observatories have been established in nearly all parts of the world, and books and instruments placed on board many of our finest ships, yet, notwithstanding all these exertions they have failed to discover the missing link,—that there was a link missing, I believe has been admitted by many, notwithstanding the successful application of the law, as generally understood in many instances. Of course the authors of the different works on the Law of Storms will not admit that their theory is fallacious, but that if it fails in any instance it must be through the ignorance of those who endeavour to put it in practice; and several of the supporters of their theory have gone so far as to censure shipmasters for not doing this or that; but I beg leave to tell them that they had no right to do so, for I will prove that were masters to act according to their ideas, in many instances it would lead them into danger instead of out of it. They say that all cyclones are circular, and by consequence, that the vortex always bears eight points from the point from whence the wind blows; thus, in the northern hemisphere, if you have the wind west, the vortex should bear north; and in the southern hemisphere, if the wind is west, it should bear south; but I assert that it is not so in all cases, and what is more, I will prove it.

I have discovered that every gale which blows (trades and monsoons excepted) are cyclones, but that there is not one out of fifty that forms a perfect circle; the form is oblong, the two ends are semicircles, joined together by two long parallel sides, or nearly so; these sides are parallel to the line of progression, and with the vortex nearest the advancing end. Now, we will suppose a gale to be travelling due east, and a ship steering west, she will of course take the wind at south, and as she advances the barometer will fall and the gale increase very rapidly, and, of course, will answer every expectation of those who adopt the present theory. But we will suppose another ship to be steering north; she will take the wind at west or west by north; the barometer will fall slightly when entering the verge, and as she advances to the northward it may fall a very little, but the gale will increase rapidly until she is reduced to a close-reefed topsail, and yet the barometer has not fallen above two-tenths of an inch. Hence, one ship may have a gale with a high barometer, while another may have a moderate breeze, or even a calm, with a low one. If a ship were to enter steering north, she may be 300 miles behind the storm or the centre line and have a heavy gale, while a ship at 200 miles east of the gale will have only a moderate breeze or calm; it is the vortex which causes the barometer to fall, or rather the heavy rains which surround it, and hence the barometer will only indicate the distance from it and not the force of wind; this is the cause of complaint against barometers by those who have been collecting evidence on the subject. Because the heights, as noted in the different logs, did not agree with their ideas, they have put them down as useless; and again, because the bearings of the wind as noted did not agree, they have put those down who noted them as being something worse; in fact, they have been firing away pretty roundly on us poor ignorant merchant commanders; but

let them look to the security of their own camp, lest instead of a return "shot" they find a shell dropping in amongst them. I have said that if commanders were to act according to the rules laid down in most works, it would frequently lead them into danger instead of out. We will suppose a gale travelling to the eastward at the rate of four or five miles an hour, which happens very frequently, and a vessel enters the gale; as she goes to the northward, the gale increases until she is forced to heave to; now let her heave to on either tack, she will drive very nearly with the gale and very nearly as fast, and consequently she would take a long time to get out of it.

Now the commander takes a look at the Law of Storms, and he sees by the rules that as he has the wind at west the vortex should bear north, and as the gale is travelling so slowly, if he were to put her before the wind and run to the north-east, he might easily run round the front of the storm and get the wind from the south-east or east, and thus enable him to proceed on his voyage; the ship is accordingly put before the wind, and what is the consequence? the barometer begins to fall rapidly, and if the vessel is steered anything to the northward of east, in a few hours she is involved in the centre line of the gale, which is nearly as destructive as the vortex itself, and which has often been taken for the vortex, for it has every appearance of it. Instead of the wind blowing round in circles, as has hitherto been asserted, it blows parallel with the sides behind the vortex, leaving an oblong space down the centre, of the same width as it is from the inside of the rain zone across the vortex, and which varies from 20 to perhaps 100 miles. Across this space the wind rushes with fearful velocity, and nearly at right angles with the two sides, and hence the sudden shifts of wind so often mentioned; the lengths of the sides vary considerably; sometimes they are very short, and consequently the gale is nearly circular, whilst at other times they extend over hundreds of miles. During one of my voyages from Portugal to this island, and when a little to the westward of the Azores, I took the wind at south, and as I ran to the northward it veered to south-east; when I shaped my course direct for St. John's, and ran with it till within 30 miles of my port, when it veered to north-east, and I ran into the harbour with it, having ran altogether about 950 miles in the same gale; and as I calculated that the gale was travelling to the south-east, at the rate of about four miles per hour, its whole length must have been at least 1,500 miles, but its breadth I am certain did not exceed 400. This, I think, will account for the two atmospheric waves which have been spoken of, for the two sides of a gale form two distinct waves blowing parallel, but in opposite directions to each other. Some persons may say that these ideas may suit Atlantic gales, but would not do for cyclones in the Indian Ocean or China Seas; but I have been in them, both the Indian and Pacific Oceans, and I cannot discover one particle of difference with regard to the law that governs them and those which blow in the Atlantic, with the exception that perhaps the force of wind is greater in the former than in the latter; but then, on the other hand, where you meet with one cyclone in either of those seas, you meet with 50 in the Atlantic, and the same may be said with regard to the damage done to our shipping by them. In support of my theory I will take the remarks made by S. P. Hall, on the abstract log of the "Water Witch," during a cyclone in the China Sea, as published in the Mercantile Marine Magazine for February 1858. It says, "the long continuance of the "gale at south, from midnight to 10 A.M., may be accounted for by "the ship being on the port tack and heading westward, thus advanc- "ing with the storm, while the lee way she was making, partly assisted

"by the storm current, drifted her to the north-east verge of the "meteor about 10 A.M." Now, I will ask any man who has the least knowledge of nautical affairs, how much westing a ship would make with the wind at south, blowing a hurricane, the ship on her beam ends, without a stitch of canvas set; it is perfectly absurd to suppose that the vessel made more than a mile or two of westing during the 10 hours; I doubt whether she made even this much; she lay like a log upon the water, and was, consequently, driven dead to leeward. The fact is, the "Water Witch," after passing through the vortex entered upon the centre line of the gale, nearly the whole of which passed over her, until she drove into the right hand side of the gale where the wind was east; but the wind being east is no proof that the vortex bore south,—far from it; it is very probable that at this time the vortex bore W. or even W.N.W., for I am well satisfied that gales, when recurving, frequently form a crescent. Let it be understood that I do not speak from imagination, for I speak from dear bought experience. For some time past I have watched them night and day; I have not picked out any particular gale or gales, but I have taken them as they came, large and small. I have experienced as many as nine consecutive gales in 25 days, not one of which deceived me. I could go into them or out of them just as I pleased.

Now the next consideration is, what are these gales and what is their mission? I will make an assertion and challenge the whole world to disprove it.

Every gale or hurricane that blows is a comet sent to purify the atmosphere in the absence of the natural currents, which are the trade winds; were it not for these meteors, the air would become stagnant and impure, and no creature could breathe it and live. The vortex is an immense reservoir of electricity, towards which the impure air rushes to partake of a sufficient amount to purify it; it rushes in on the right hand side, and is delivered out on the left, in the northern hemisphere, and *vice versâ*. But as it does not always obtain a sufficient amount during its first revolution, it rushes across from the left side to the right; hence the violence of the wind all down the centre line. The exact shape of a cyclone is that of a comet seen in the heavens; some are nearly circular, whilst others have very long tails. The body of a comet seen in the heavens is electricity, the tail is the disturbed air through which it passes. Some astronomers have said that the atmosphere does not extend beyond 40 or 50 miles above the surface of the earth. Let them look again and see if they have not made a mistake; let them see if it does not extend throughout the whole solar system, but that the attraction of the earth near its surface disturbs the component parts, extracting the one and leaving the others visible to the eye to the distance they have said the atmosphere extends.

In conclusion, let those who have been collecting evidence look carefully over that which they have hitherto rejected as irrelevant, and see if it does not prove my opinions on the subject to be correct.

I remain, Gentlemen,

Your obedient servant,

GEORGE JINMAN,

Commander of the Barque "Tasso,"

of London.

ON STORMS AND CIRCLE SAILING.

At the ordinary meeting of the Liverpool Literary and Philosophical Society, last week, the Rev. H. H. Higgins, president, in the chair, Mr. Thomas Dobson, B.A., head master of the school frigate Conway, read the following paper on some results of the storm encountered by the Royal Charter :—

"In examining the results of the bad weather in the months of October and November 1859, I shall notice very briefly the effects on shipping of the excessive motion of the air, and direct my attention chiefly to some of the less known consequences of the extreme changes in the air's pressure and temperature during the great atmospheric paroxysm of which the Royal Charter storm was only a portion. I have constructed the curves of the pressure, and of the maximum and minimum temperature of the air, from continuous observations made every six hours, during the months of October and part of November, at Kew, at Wakefield Prison, at Stoneyhurst College, Lancashire, and at the Bishop's Rock Lighthouse, Scilly Islands. The character of these curves is so nearly identical that I have selected the Wakefield curves as exhibiting a fair type of the state of the atmosphere as to pressure and temperature over the whole of England at that time. The dark line in the diagram represents the vertical fluctuations of the barometric column of their actual dimensions; the upper boundary of the coloured zone denotes the maximum temperature, and the lower boundary the minimum temperature, as determined by self-registering thermometers. An inch of vertical space is here equivalent to 20° Fahrenheit, and one-tenth of an inch of horizontal space to 24 hours. The Admiralty Register of Shipwrecks on the coasts of the United Kingdom in 1859 gives a comprehensive view of the effects of the storms of wind of that year on shipping; and the reports of the Government Inspectors of Mines supply the dates of the fatal explosions of inflammable gas in these mines for the same period. To these dates I have added those of eight fatal cases of suffocation in coal mines by fire-damp and choke-damp, as such cases are as significant as explosions are of the unusual presence of gas in the mine at the time of their occurrence. The marked coincidence in time of the greatest atmospheric distance during the year, and the occurrence of the greatest number of fatal accidents from gas in coal mines, is striking and instructive. In the year 1859 there were 139 vessels totally lost on our coasts, and of these wrecks 77 took place between the 21st of October and the 9th of November. If this period of nearly three weeks be omitted, the total losses during the remaining 49 weeks of the year amount to 62, giving a weekly average of less than two total losses, whereas the weekly average is 26 for the three weeks just mentioned. The number of lives lost by shipwreck on our coasts in 1859 was 1,645, of which 877, or more than one-half, were lost in the same three weeks. The number of fatal accidents in British coal mines, by accumulation of noxious gas, also arises far above the average in the month of October, 1859. There were in all 81 fatal accidents, of which 18 happened in October, leaving an average of less than six for each of the other months of the year. The diagram shows that from the 1st to the 19th of October the atmospheric pressure did not vary greatly, but the temperature of the air was far above the average (49° Fahrenheit) of October. The effect of such a long sequence of very warm days and nights in checking the ventilation of mines is shown by the occurrence, within 18 consecutive days, of 12 fatal accidents in 11 different localities. These were :—On the 3d of October, at Bilston, explosion ; 5th, Seacroft, Leeds, explosion ; 7th, Dudley, suffocation by choke-damp ; 8th, Pendlebury, Lancashire, explosion ; 8th, Prescot, St. Helen's, explosion ; 8th, Robart's Town, Leeds, explosion ; 12th, Newport, Shropshire, explosion ; 14th, Aberdare, South Wales, explosion; 14th, Heaton, Northumberland, suffocation by choke-damp; 17th, Rowley Regis, Staffordshire, suffocation by sulphur ; 18th, Rowley Regis, Staffordshire, explosion ; 20th, Hampstead, Staffordshire, suffocation. No shipwrecks in British seas are recorded between the 1st and the 21st of October. On the 20th the temperature falls suddenly as much below the monthly mean as it had previously been above it. Much snow fell in North Wales, in the North of England, and in Scotland on that day. On the 21st several waterspouts were seen at the Isle of Man ; and on the 22d there was a very severe storm of thunder, lightning, and hail at Liverpool; several distinct shocks of earthquake were felt in Cornwall and in the West of England ; and the barometrical column fell three-quarters of an inch. Such were some of the premonitory symptoms of one of the most remarkable disturbances of the atmosphere in our time, which, beginning on the 19th of October, did not subside until about the 12th of November. Having copied, early in November of last year, the sheets on which the direction and force of the wind, during the 25th and 26th of the preceding month, had been traced by the anemometer at the Liverpool Observatory, I concluded

from these data alone that the storm which has now acquired a painful historical interest in connection with the loss of the Royal Charter steamship, was a revolving whirlwind, or cyclone, travelling to the north-eastward, an opinion fully confirmed both by my own researches and those of others. The anemometer shows that the wind began here at noon of the 25th, from the eastward, veering continuously from east to north, up to 6 A.M. of the 26th, when there was a dead calm for an hour ; after which the wind rose again at north, and veered rapidly to the north-west, increasing in force until 11 A.M., when it blew hardest here, the anemometer registering a pressure of 28 lbs. average on the square foot. These shifts of wind prove the storm to have travelled to the eastward of north, and the central track to have been to the eastward of Liverpool. The mercurial column at Wakefield fell to 28·83 inches about the time that the wind was strongest here. It may conduce to a just appreciation of the fluctuations of the barometric curve to state, that the sharp vertical depression in this curve, on the 26th of October, is the barometrical exponent of 69 shipwrecks, involving a loss of 796 lives, and of three fatal colliery explosions, induced, in all probability, by the sudden overflow of inflammable gas released from the coal by the greatly diminished atmospheric pressure. On the 31st of October the mercurial column again fell below 29 inches, and at 9 A.M. of the next day reaches a minimum height of 28·39 inches. The corresponding depression in the curve symbolises one fatal colliery explosion and 14 shipwrecks. The localities and dates of the fatal explosions of gas in mines, from the 20th of October until the end of this remarkable period of stormy weather, are :—October 22d, at Washington, Durham ; 22d, at Dean Hall, Leeds ; 24th, at Crook, Durham ; 26th, at Longton, Staffordshire ; 26th, at Tipton, Staffordshire ; 26th, at Tollcross, West of Scotland ; November 2d, at Royton, Lancashire ; 11th, at Donnington, Shropshire ; 14th, Duckingfield, Cheshire."

At the conclusion of this paper, Mr. Dobson made some oral remarks (illustrated by diagrams) upon Sir John Herschel's "Theory of Cyclones," as described in the "Outlines of Astronomy." Mr. Dobson pointed out the chief features of cyclones, which a true theory was bound to account for ; and he explained the principle by the operation of which the trade winds are caused. Sir John Herschel's theory was, that cyclones are formed by an extension of the same principle which he called the law of gyration. But, inasmuch as this principle is least efficient at the equator, where almost all the great hurricanes are first formed, and where they are most violent, it did not appear to Mr. Dobson to afford any satisfactory explanation ; and, moreover, it fails altogether to account for the progressive motion of cyclones.

Many interesting points were elicited in a conversational discussion.

Mr. Dobson having announced that he had brought with him Captain G. Jinman, a gentleman of much practical experience, who was an opponent of the circular theory of storms, the President invited him to state his views, which he did with much clearness.

Captain Jinman said :—

"As it would occupy too much time to detail all the circumstances which led me to doubt the truth of the circular theory of storms, I shall be as brief as possible. Having frequently to pass over those parts of the globe where they are most frequently met with, I made myself thoroughly acquainted with all that had been written on the law of storms. And, previous to meeting a hurricane, I conceived that I was thoroughly posted up in the matter, and that I could manœuvre in one with all the ease imaginable. Practical experience, however, soon dispelled this idea, and convinced me that either I had yet much to learn, or else that the principles laid down by Redfield, Sir William Reid, Piddington, and others were far from being correct. The principles laid down by those gentlemen, as you are no doubt aware, are, that hurricanes, typhoons, &c. are nothing more nor less than great whirlwinds, winds blowing in circles round a calm centre ; and, consequently, that this centre always bears about eight points from the direction of the wind ; that near it will be found the greatest force of wind ; that the centre is the principal part to be avoided on account of its being the most dangerous, from the sudden shifts of wind, or calm, and heavy cross sea to be met with at that point. The analysis of data obtained from ships which had been involved in storms from time to time tended somewhat to confirm these views ; and, consequently, the 'circular law of storms' became, apparently, an established fact. On these principles rules were laid down for the guidance of shipmasters, by which, it was said, we might easily avoid the most dangerous part of a storm. To those whose avocations did not require them to put it in practice, the

circular law appeared feasible enough; whilst the rules were so simple that a person of the most ordinary capacity, it was argued, might understand, and be able to apply them when necessary. As I have before observed, I made myself acquainted with these rules; and, as opportunities offered, I endeavoured to put them in practice. But the results were anything but satisfactory, for not unfrequently I appeared to meet with the centre (sudden shift of wind or calm) when I imagined myself to be far away from it. Feeling satisfied that there was something wrong, I resolved to examine carefully the various logs and other data which had been published. I was quite prepared to find a few discrepancies and anomalies; but I was certainly not prepared to find in the details of every storm the most glaring proofs of the fallacy of the circular law. Judge of my surprise when, on examining the works of Sir William Reid, I found that there was scarcely a track laid down on his charts which agreed with the shifts of the wind experienced by the ships, or at places involved. For instance, in the Barbadoes hurricane of 1831, the wind is reported to have blown for a time, at Barbadoes, from the N.E., shifting suddenly to N.W., and veering to W.S.W., S., and finally to S.E. and E.S.E.; yet the track on the chart is about W.N.W. Whereas, according to the rules laid down, the shift from N.E. to N.W. should give a due north track; from N.W. to S.W., a due west one; and the final shifts from S.W. to S.S.E. and E.S.E., about S. by E. If similar discrepancies or anomalies were to be found in a few cases only, I should have thought but little of the matter; but, as I have before observed, they are to be found in the details of every storm. Yet, notwithstanding those glaring proofs of the fallacy of the principles advocated, we have been told that we may easily ascertain the track of and avoid a storm by adopting them. The most unqualified abuse has been poured forth on shipmasters in general, and those in particular who have had their ships damaged by storms. Mr. Piddington, the great cyclonist, has even gone so far as to imply that shipmasters are in the habit of running their ships wantonly into hurricanes. Seeing those glaring proofs of its fallacy, I threw the circular theory aside, and scarcely rested night or day until I had got hold of what I believe to be the right clue. And I now assert, and am prepared to prove, that there never has been such a thing as a really circular storm, or one which bore out the principles laid down by Redfield, Sir William Reid, Piddington, and others. Every hurricane or gale is formed by the joint action of two distinct currents of air flowing in opposite directions, and crossing each other at two points—one on each side of the centre. The two sides are distinct, seldom equally developed at the earth's surface, and seldom blow with equal force. The centre is not the most dangerous part of a storm; the greatest force of wind is invariably at some distance from the centre under the points of crossing, or where one current forces its way under the other. Sudden shifts of wind and calms are met with at the points of confluence as well as at the centre; and the greater portion of those ships which have been reported to have run into the centre never were near it. A ship may stand into the centre of a storm, from one side, carrying topgallantsails, and yet be reduced to bare poles in passing out on the other. The consequence is, that lives and property are being sacrificed, almost daily, by being plunged headlong into the most destructive parts of hurricanes, through those in charge being misled by the absurd and dangerous circular theory of storms. In proof of this, I have but to refer to the case of the Royal Charter. The anemometrical records of the Liverpool Observatory clearly show, that previous to the calm, between 6 and 7 A.M. of the 26th, the greatest pressure was only 5 lbs. to the square foot; whereas, at noon, five hours after the calm, the greatest pressure was about 28 lbs. Consequently, a ship might have stood into the centre of that storm with a pressure of only 5 lbs. on one side, and have met with a pressure of 28 lbs. in coming out of it. If a storm is formed by one continuous current of air flowing round a centre, and if the sudden shifts so often reported occur only at the centre, how is it that the temperature and general appearance of the weather changes so suddenly, as it often does, when a shift of wind occurs? I have known the thermometer to fall 20° in less than so many minutes when a shift of wind has occurred in the Atlantic. Is it reasonable to suppose the cool current entered was the same as the one left, and that it had changed its temper whilst passing round the centre, or in the space of a few minutes? Surely not. The temperature, appearance of the weather, and force of wind, are seldom the same after the shift as before it; clearly proving, as I maintain, that a hurricane, or gale, is formed by the joint action of two distinct currents of air, and not by one continuous one. It may be said that ships have escaped by adopting the rules laid down. True; but it can easily be shown how two ships may be overtaken by the same storm; both follow those rules, and one escapes by so doing, whilst the other is plunged headlong into the heaviest part of it."

Captain Mortimer agreed with much that Captain Jinman had said. He once thought that it would be very easy to sail out of a gale by the directions contained in the various works upon cyclones, and formerly had a great respect for Piddington's Horn-book; but experience had made him gradually lay them on the shelf. He believed that the spiral direction given to the wind arose in a great measure from the backing up of clouds, and from the form of the coast line against which the wind impinged.

Thanks having been voted to Mr. Dobson and Captain Jinman, the discussion ceased.

TO THE EDITOR OF THE "SCOTSMAN."

SIR, January 14, 1860.

WILL you honour me by allowing this short letter to appear in your columns, with reference to the really important article on Meteorology which has just appeared in the "*Scotsman*"?

Being mentioned by name in that article is my excuse for observing that my having treated "difficult and disputed topics within too "limited a compass, leaving matters little better than I found them," was unavoidable, because my object in the paper quoted by "R." was to elicit discussion of those very difficulties, as I stated to the section (A.) at Aberdeen, for which my hastily written paper was intended.

It is not to be supposed that a compilation of meteorological views can, in this infancy of the science, be free from opinions "*more than doubtful.*" Professor Espy pointed out those great elevations and depressions of the barometer that occur simultaneously over extensive areas; so did Daniell and others. But proof is still wanting of the dimensions, or limits, and figures of such areas, as well as of their course of progression.

Simultaneous observations in *more directions* are required to prove the extent, figure, and connection or correspondence of these areas of elevation and depression—I venture to submit to meteorologists;—after a very careful study of Espy's last great work, and comparison with numerous observations made in Europe.

My own humble opinion at present inclines to the belief that the changes progress in nearly the direction of the polar and equatorial currents (or north-east and south-west), but, that being measured at successive intervals of *time*—considerably apart—the *apparent* result is a more or less direct west and east progress. "In *justice* to Espy," or *any one*, indeed, I *should* "have acknowledged the sources of illustration," had they not been my own, deduced from independent reasoning (as some friends here happen to remember) at least two years before I knew of Espy's works.

My description of the action of the trade-winds is stated by me to be taken from Herschel, Dove, and others. My own authority would indeed be light.

But that the "trade-winds *do* become more easterly as you get nearer the equator," I appeal for proof to the numerous modern wind-charts of the Atlantic and Pacific Oceans, recently published by the Board of Trade. Captain Basil Hall had not the assistance of *accumulated facts* on this subject when he wrote; and as I had the advantage of listening to him respecting this matter in 1820, in the Pacific, my belief is that he judged too much from winds *near Africa*, when ships made passages eastward of 20° west longitude, and was not aware of the *union* of trade-winds near Brazil: or of the *easterly* winds prevailing across the wide Pacific (tropical) Ocean (with *very* slight interruption) except during two, or at most three, months of more or less westerly monsoon *near* the equator.

With the help of Dove's "*law of gyration*" and *electrical* action, I shall be prepared, Sir, to discuss these subjects further at a future time with your respected and well known correspondent, "R."

I am, &c.

ROBERT FITZROY.

A communication from Admiral FitzRoy, in answer to some of our recent criticisms of his "Notes on Meteorology," affords an opportunity for further examination.

It is surprising to find that Admiral FitzRoy, after having perused Espy's great work, should still have any doubts of the direction in which the fluctuations of the barometer travel over the United States. Whatever may be the cause of the phenomena, this is certain, that instead of it being from *south-west to north-east*, it is from a little to the *north of west* to the *south of east*. Out of several hundreds of storms that have been examined, no exceptions have been found to this rule. The advocates of rotatory storms, of course, attempt to deny this fact, as it entirely undermines the foundation of this once favourite theory. Admiral FitzRoy has just sent us his translation of Dové's latest views on the subject of storms, and he may be said to endorse the old fallacies which are once more put forth. Dové cites the observations of Franklin on this head, which were quite correct, though the inferences he drew from them were by no means so. Franklin found that storms were sooner felt at Savannah than at Boston, and he naturally thought that they travelled up the coast of the United States. So the rotatory theorists always quote Franklin's opinions in support of their own. It is quite true that all storms in the United States are sooner felt in the south on the east coast than in the north. But this is now explained by the fact that storms are from three to four times of greater length than breadth, and travel from *west* to *east*. The storms reach Savannah sooner than they do Boston, *not because it is further to the south, but because it is further to the west*. If the American coast had run due north and south, instead of from south-west to north-east, the rise and the fall of the barometer, and the attendant phenomena, would have occurred at once over its whole length. If this had been the case, in all probability we should never have had such a thing as the rotatory theory applied to the winds of the temperate latitudes.

It may be stated that, although the theory of rotatory storms was at first founded on the atmospheric phenomena of the United States, it has now scarcely an advocate of any eminence in science there. The Academy of Sciences in Philadelphia has long since discarded it. One popular writer, Lieutenant Maury, no doubt gives a sort of tacit assent to it; but his opinions on this matter will not go far, seeing that he admits that storms travel from the north of west to south of east. We readily accept Admiral FitzRoy's statement of his having arrived at clear views as to the fallacy which so many entertain of the fluctuations of the barometer being caused by atmospheric waves, from independent reasoning of his own; and, thankful to him for having expressed himself so plainly on the matter, trust that others will reflect before making use of this term, even on the authority of Herschel. At the same time it is singular how long the truth, as enunciated by Espy, has been unregarded and literally despised in consequence of the deference paid to great "authorities."

We have much less faith than Admiral FitzRoy in Dové as an authority in meteorology. He has never written with any clearness on the subject—nay, his views have hitherto been so ambiguous that you will scarcely find two individuals who quote him and give the same version of his meaning. He has been constantly changing his views, but he has some chance at arriving at more fixed ones at last. Having now abandoned his famous parallel-current theory, he has alternatively adopted some of Espy's views. The first diagram, with its illustrations, as published by the Board of Trade, is nothing else than a plagiarism from Espy, though it is like a body without the spirit. Dové there speaks of "centripetal aërial currents" as things having an existence; but these he formerly ignored, and Sir John Herschel, at the meeting of the British Association in 1838, maintained they could not occur. Now, however, Dové adopts Espy's theory of the veerings of the wind as his own, without one word of comment. Espy had formerly good reason to complain of the treatment he received from Dové, who, unable to grapple with him on strictly scientific grounds, used to pass over his accurate deductions by adding a few marks of interjection! About twenty years ago, he "sneered" at Espy's theory; now he seems ready to embrace it. This, no doubt, indicates progress; but in justice an acknowledgment ought to have been made of the claims of a rival explorer in the same field.

In regard to our statement that the trade-winds were more northerly at their southern verge, Admiral FitzRoy so far admits all that we intended to argue. Our remarks, of course, referred to the eastern Atlantic. We were quite aware that the phenomena were abnormal in the proximity of the American continent, where the south and north trades form one current. This is not owing to the rotation of the earth, but to the heating of the continent, causing the trades to flow over it as a vast sea-breeze, or, as better understood, as a *monsoon*. Why, in the Caribbean Sea and Gulf of Mexico these winds are reversed by similar agents, and form south winds. The same south winds in summer usually blow from Vera Cruz straight north for nearly 2,000 miles, without being converted into south-west winds, as Dové would insist. The same thing happens in the western Pacific, as the trade-winds are again reversed and flow over the empire of China. So also with the monsoons of Hindostan. It ought to be borne in mind that it is only those localities on the borders of the torrid zone, in which the trades are abnormal, that are blessed with fertility, but at the same time are devastated by hurricanes. But the rotation of the earth does not enter as an agent in the production of these phenomena.

Along with many others, we do not believe in cyclones or rotatory storms, considering that such ideas are founded upon a very limited view of the whole phenomena. One authority has been merely re-echoing the mistakes of the other on this question. Let Admiral FitzRoy fully analyse the storm which wrecked the *Royal Charter*, on the 25th October last, and he will confer a great benefit on meteorology. Indeed, he has already been nibbling at this storm and pronouncing it to be a true "cyclone," moving from the south-west of England along a north-easterly track. This may possibly be the case. But with all respect we would beg Admiral FitzRoy to beware of again committing a mistake similar to that which has so frequently been committed in the United States from the time of Benjamin Franklin to the present. Let him trace the atmospheric changes along lines towards the *south-east and east*, as well as towards the *north-east*. For once let us all take a more enlarged view of the area over which the atmosphere is disturbed in such cases than Dové, Lloyd, or other rotatory theorists have ever done. Indicate the directions of the wind by arrows on

charts, and every one will be enabled to see whether the winds during their greatest fury blow towards a central space or *circulate* around it. This is surely a simple proposal for arriving at the truth. It is no more than Espy has been calling upon the Board of Trade and British Association for some years to do, but hitherto in vain. As a comprehensive examination of a single storm will do more to throw light on the question than volumes of theorising, we hope that Admiral FitzRoy will set to work in earnest, and show us the nature of the storm that wrecked the *Royal Charter*.

R.

Copied from the Meteorological Journal of the American Ship *William Cumming*, by Robert P. J. Simpson, R.N., June 16, 1860. Received June 19, 1860.

Extract.

Having had many threatenings of bad weather for several days past, I began to apply your views as to storms. Not having much sea room, I considered them more closely. For three or four days before the 26th of October, we had squally weather with very sharp quick flashes of lightning from east to north-east. During the night of the 25th, I stood on the northern board, and so, to the northward, till noon, with the wind strong from E.N.E. At noon I tacked ship, thinking that if the gale should come on then, I should have the *off-shore tack* in the night, and the *vortex* of the gale to the southward. I stood in till half-past 5 P.M., then wore ship under short sail, when I was in a line with Holyhead and Bardsey, about 10 miles or so, as near as I could judge (it being thick and dark) from Holyhead. Gale increasing, at 8 P.M., took in close-reefed main topsail and fore topmast staysail, having nothing then set but the main spencer and a small storm mizen. It blew a complete West India hurricane ; but, as I drove *off shore*, I thought the force of the storm did not increase, and I now think from what other ships suffered, which were to the southward of me at the same time, that further south it blew harder.

I did not suffer *any damage whatever;* none more than usual in ordinary *blows*,—only a little chafe, and some spray.

The lightning alluded to above was very unnatural in its appearance, being of such a sharp flashing glare, without leaving off. Unless looking at the exact place of its flash, you could not tell from whence the light actually came.

Wm. J. Johns,
Commanding the Ship *William Cumming*.

To Lieut. Maury, U.S. Navy,
Washington Observatory.

Ship "Alipore," Messrs. W. S. Lindsay & Co.

Date.	Days out.	Hour.	Thermometer.	Barometer.	Strength, 0 to 12.	Winds. (Magnetic.)	Strength, 1 to 6.	Latitude.	Longitude.	Course. (Magnetic.)	Distance.	Remarks.
1859.			°					° ′	° ′		miles.	
October 21		Noon	62	29·52	9	N.W.	4	44 16 N.	18 44 W.	N.E. b. E. ½ E.	180	q. c. b. Variation two points, left or westerly.
,,		Mid.	56	29·57	4	E.N.E.	2	— —	— —	—	—	b. c. Wind took a turn from N.W. to N.E., head sea.
,,	22	Noon	56	29·68	4	N.E.	2	45 19 N.	18 14 W.	N. b. E. ¾ E.	66	q. c. swell from north.
,,	,,	Mid.	53	29·69	9	N.N.E.	4	— —	— —	—	—	q. c. heavy swell from east.
,,	23	Noon	50	29·64	9	N.N.E.	4	46 0 N.	16 53 W.	N.E. b. E.	71	q. b. c. swell from eastward.
,,	,,	Mid.	50	29·54	10	N.	5	— —	— —	—	—	Q. h. r. heavy confused swell.
,,	24	Noon	49	29·40	6	N.N.W.	3	46 50 N.	14 22 W.	N.E. b. E. ¾ E.	120	q. r. heavy confused swell.
,,	,,	4 PM	50	29·28	2	N.N.W.-ly.	1	— —	— —	—	—	g. c. u. o., p.
,,	,,	6 PM	50	29·21	2	N.W.-ly.	1	— —	— —	—	—	g. u. o. all round, small rain.
,,	,,	8 PM	50	29·15	2	N.E.	1	— —	— —	—	—	g. o. r. phosphorescent sea.
,,	,,	10 PM	50	29·11	2	E.N.E.	1	— —	— —	—	—	g. o. wind variable E.N.E. and E.
,,	25	Mid.	49	29·03	6	N.E.	3	— —	— —	—	—	q. o. g. c. r.
,,	,,	2 AM	50	28·98	6	N.E.	3	— —	— —	—	—	q. g. u. m. r.
,,	,,	4 AM	50	28·98	9	N.E.	4	— —	— —	—	—	q. p. of h., weather clearing up.
,,	,,	6 AM	50	29·02	10	N.N.E.	5	— —	— —	—	—	Q. h. c. Aurora borealis.
,,	,,	8 AM	50	29·08	9	N.E.	4	— —	— —	—	—	q. weather brightening up.
,,	,,	Noon	52	29·16	6	N.N.E.	3	46 45 N.	13 0 W.	E. ½ S.	61	cloudy, bright sunny weather, high sea.
,,	,,	6 PM	50	29·27	9	N.	4	— —	— —	—	—	Q. h. high confused sea.
,,	,,	Mid.	50	29·37	9	N. by W.	4	— —	— —	—	—	Q. h. high confused sea from east and north.
,,	26	Noon	52	29·44	6	Vble. N.W.	3	47 36 N.	10 47 W.	N.E. b. E. ½ E.	110	Q. h. high sea from east and north.
,,	,,	Mid.	52	29·62	9	N.N.W.	4	— —	— —	—	—	q. b. c.
,,	27	Noon	54	29·69	4	N.W.	2	49 16 N.	7 43 W.	N.E. ¾ E.	170	m. c. but fine pleasant weather.
,,	,,	Mid.	53	29·67	4	S.W.-ly.	2	St. Agnes and Lizard Lights.			—	m. o.
,,	28	8 AM	—	29·51	6	S.S.W.-ly.	3	— —	— —	—	—	q. m. o.
,,	,,	Noon	57	29·44	9	S.W.	4	50 2 N.	3 11 W.	E. b. N. ¼ N.	181	q. m. o.
,,	,,	6 PM	—	29·28	10	W.S.W.	5	— —	— —	—	—	g. o. m. r.
,,	,,	Mid.	—	29·23	9	S.W.	4	— —	— —	—	—	g. o. m.
,,	29	4 AM	53	29·18	9	N.W.-ly.	4	— —	— —	—	—	m. g., but fine weather.
,,	,,	Noon	51	29·11	6	N.W.	3	Off Dungeness.		—	—	m. g.
,,	,,	7 PM	42	29·14	6	W.-ly.	3	—	—	—	—	b. c.
,,	,,	Mid.	41	29·23	9	W.	4	In the Downs—anchored.			—	q. b. c.

Barque "Edward," Captain Weeting.—New York to Bremen.

Place and Date.		Readings, 4 a.m.		Wind.		Readings, Noon.			Readings, 8 p.m.		Wind.		Remarks.
		Barom^{r}.	Ther^{r}.	Direction by Compass.	Force. 1–12	Baro^{r}.	Wind.	Force.	Barom^{r}.	Ther^{r}.	Direction by Compass.	Force. 1–12	
	1859. Oct.												
Lat. N. 42° 20'—54° 38' W. -	21	29·70	—	S.W.	5	29·66	N.E.	4	—	—	Variable.	3	——
42·33—52·39 -	22	—	—	Calm.	—	29·95	N.E.	3	29·95	—	E.	2	——
42·30—50·06 -	23	30·08	—	N.	9	30·33	N.W.	5	30·40	—	W.	3	——
43·03—47·15 -	24	30·30	—	S.W.	3	30·29	S.S.W.	5	—	—	S.S.W.	6	——
43·52—42·51 -	25	30·00	—	S.	4	29·90	S.S.E.	6	—	—	S.S.E.	6	——
45·36—38·12 -	26	29·80	—	—	—	29·80	N.W.	6	—	—	—	—	——
46·01—35·03 -	27	29·80	—	Variable.	4	29·90	S.W.	3	—	—	S.S.W.	6	——
46·39—30·34 -	28	—	—	S.W.	5	30·13	N.W.	3	—	—	Calm.	—	——
46·57—27·04 -	29	—	—	W.	7	29·90	W.	9	29·70	—	W.	7	Strong gale.
47·12—22·21 -	30	29·60	—	W.	9	29·50	W.	9	29·48	—	W.	8	Strong wind and much rain.
47·41—17·05 -	31	29·37	—	W.S.W.	9	29·20	W.S.W.	10	—	—	W.N.W.	10	Strong storm from W.S.W. and then W.N.W.
	Nov.												
48· 4—10·54 -	1	29·38	—	W.N.W.	10	29·56	N.W.	9	—	—	—	—	More moderate.

Ship "Neibar," Captain Brolin.—Hamburg to Mobile.

Place and Date.		Readings, 9 a.m.		Wind.		Remarks.	Readings, 8 p.m.		Wind.		Remarks.
		Barom^{r}.	Ther^{r}.	Direction by Compass.	Force. 1–12		Barom^{r}.	Ther^{r}.	Direction by Compass.	Force. 1–12	
	1859. Oct.										
Lat. N. 48° 55'— 6°·26' W.	21	29·58	53	N.N.W.	3 to 8	Squalls very heavy; sea short.	29·48	56	W.N.W. to N.	4 to 9	Hail squalls; sea turbulent; unsettled.
48·25— 6·52 -	22	29·42	55	W. to N.	8 to 4	Terrific aspect; waterspouts.	29·45	50	N. to N.W.	4 to 6	Squally.
47·11— 7·24 -	23	29·44	55	N. to W.	6	More moderate.	29·50	56	W.N.W.	3 to 6	Gusts of wind with heavy rain.
46·15— 9·35 -	24	28·98	54	N.W.	4 to 8	Moderate gale with squalls.	29·45	55	N. to N.W.	4 to 6	Strong squalls.
43·49—11·36 -	25	29·80	58	N.N.W. to N.W.	7	Moderating.	29·97	58	N.W. to W.N.W.	3	Light winds and calm.
42·23—12·07 -	26	29·97	59	W. to S.	0 to 5	——	29·63	62	S. to E.	8	Fresh gales; easterly swell.
39·40—15·50 -	27	29·97	62	N.N.W.	7	Wind growing light.					

Barque "Zephyr," Captain Lane.—New York to Malaga.

Lat. N. 40·11—57·40 W. -	25	29·40	70	W.N.N.	8	Rain.	29·40	70	S.S.W.	6	Rain.
41· 0—54·10 -	26	29·55	73	S.W.	7	Do.	29·80	70	S.S.W.	6	Do.
41·40—49·40 -	27	29·72	70	S.S.W.	8	Do.	29·80	70	S.S.W.	4	Do. strong gales and large seas.
39·42—48·58 -	28	29·85	70	S.W.	4	—	29·70	72	W.	6	Do.
41·30—44·12 -	29	29·50	70	N. to W.N.W.	8	Heavy swell from West.	29·52	70	N.N.W.	9	—
41·45—39·50 -	30	29·90	70	N.W.-ly.	9	Strong gales and tremendous sea.	29·95	71	N.W.	7	—
41·48—36·14 -	31	30·30	72	N.W.	7	Hazy.	30·30	70	W.N.W.	8	Moderate gales.
	Nov.										
41·30—33· 0 -	1	30·05	74	S.S.W.	7	Strong breezes.	29·70	71	S.S.W.	5	Fine.
41·02—28·32 -	2	29·85	74	S.S.W.	7	Overcast.	29·90	68	N.W.	10	Terrific gale and high sea.
39·54—23·58 -	3	29·95	72	N.W.	11	Terrific gales.	29·95	70	N.W.	8	Moderating.

SHIP "ESCORT," CAPTAIN HUSSEY.—LIVERPOOL TO NEW YORK.

Place and Date.		Readings, 9 a.m.		Wind.		Remarks.	Readings, 8 p.m.		Wind.		Remarks.
		Barom^{r}.	Ther^{r}.	Direction by Compass.	Force. 1–12		Barom^{r}.	Ther^{r}.	Direction by Compass.	Force. 1–12	
	1859. Oct.										
Lat. N. 49° 37′—29° 0′ W.	23	30·10	56	Nly.	4	—	29·50	56	S.S.W.	7	Rain.
48° 08—32° 15	24	29·40	54	N.W. to E.	8	—	29·70	56	E.	7	Strong gales with heavy sea from westward.
48° 41—36° 40	25	29·88	60	E.S.E.	5	—	29·68	60	S.S.W.	5	Fresh gales.
48° 18—40° 15	26	29·50	60	S.W. to N.W.	9–10	5 a.m., wind suddenly veered from S.W. to N.W., blowing heavily.	29·80	56	N.W.	5	—
47° 27—42° 28	27	29·54	58	S.W.	7	Strong gales; severe squalls.	29·78	56	W.N.W.	5	Do.
46° 45—43° 20	28	29·50	58	N.W. to S.S.W.	2 to 8	Strong gales, moderating towards noon.	29·70	56	W.N.W.	6	Do.
45° 20—43° 45	29	29·65	62	W.N.W.	4	Rain; heavy sea from westward.	29·50	62	W.	1	Rain.
45° 40—44° 34	30	29·30	61	W. to S.W.	1 to 7	Fresh gales.	29·40	54	N.W. by N.	10	Strong gales and heavy sea from westward.
43° 56—44° 10	31	29·87	52	N.W. by N.	9	Sea going down.	30·10	56	W.N.W.	4	Heavy sea from N.W.
42° 0—46° 45	Nov. 1	30·20	60	W.N.W. to S.S.W	1–3	—	29·60	66	S.S.W.	5	Fresh breeze, increasing.
41° 22—48° 00	2	29·98	—	N.N.W.	9	—	30·17	—	N.	4	—

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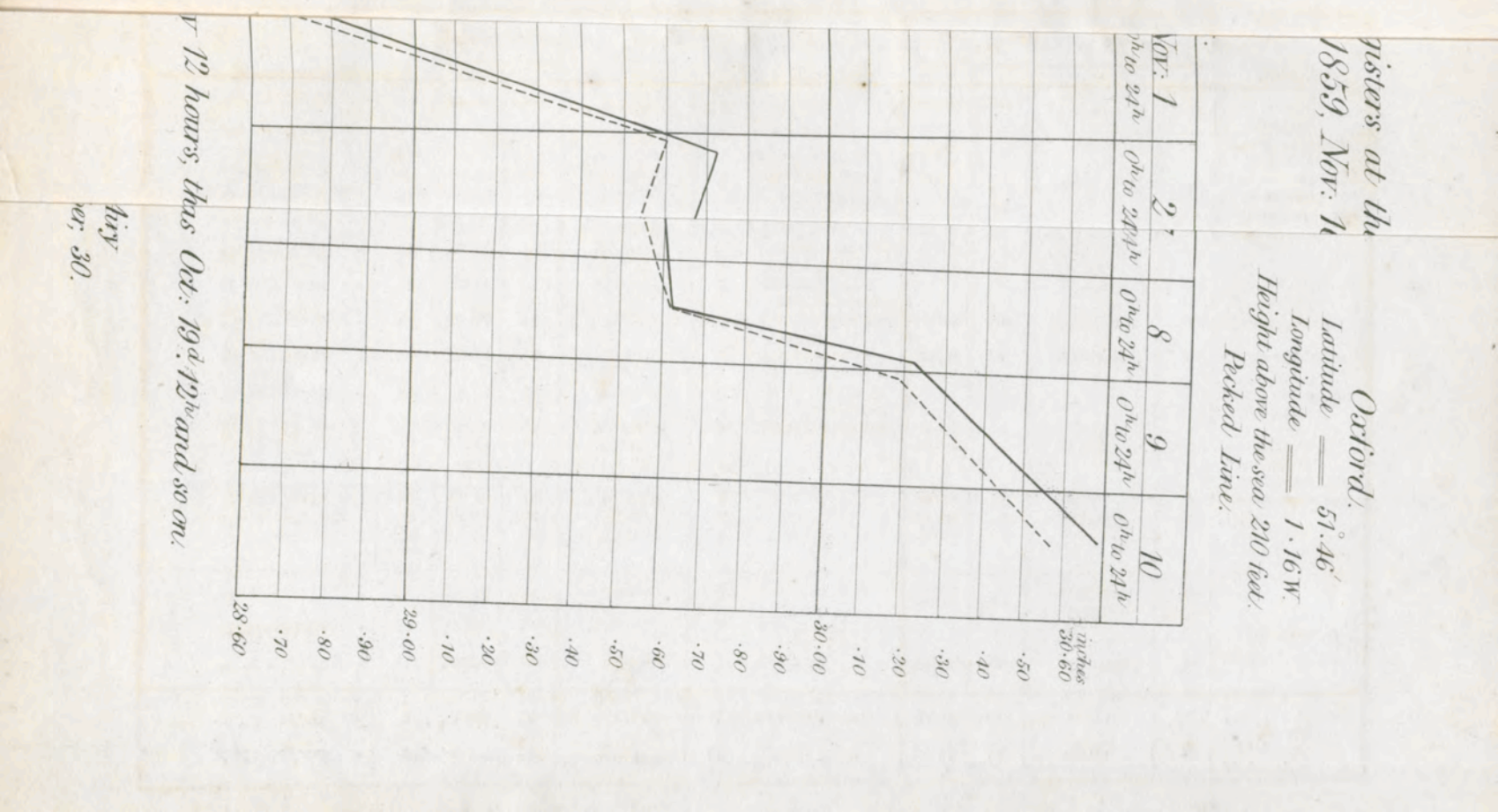

SHIP "ESCORT," CAPTAIN HUSSEY.—LIVERPOOL TO NEW YORK.

Place and Date.	Readings, 9 a.m. Barom'.	Ther'.	Wind. Direction by Compass.	Force. 1–12	Remarks.	Readings, 8 p.m. Barom'.	Ther'.	Wind. Direction by Compass.	Force. 1–12	Remarks.
	1859.									
Lat. N. 49° 37'—29° 6' W.—	Oct. 23	30·10	56	Nly.	4	—	29·50	56	S.S.W.	7	Rain.
48° 08'—32° 15' —	24	29·40	54	N.W. to E.	8	—	29·70	56	E.	7	Strong gales with heavy sea from westward.
	25	29·88	60	E.S.E.	5	—	29·68	60	S.S.W.	5	
48° 41'—36° 40' —	26	29·50	60	S.W. to N.W.	9–10	5 a.m., wind suddenly veered from S.W. to N.W., blowing heavily.	29·80	56	N.W.	5	Fresh gales.
48° 18'—40° 15'						—					—
						Strong gales; severe squalls.	29·78	56	W.N.W.	5	Do.
47° 27'—42° 28' -	27	29·54	58	S.W.	7						
						Strong gales, moderating towards noon.	29·70	56	W.N.W.	6	Do.
46° 45'—43° 20' -	28	29·50	58	N.W. to S.S.W.	2 to 8						
						Rain; heavy sea from westward.	29·50	62	W.	1	Rain.
45° 20'—43° 45' -	29	29·65	62	W.N.W.	4	Fresh gales.	29·40	54	N.W. by N.	10	Strong gales and heavy sea from westward.
45° 40'—44° 34' -	30	29·30	61	W. to S.W.	1 to 7						
						Sea going down.	30·10	56	W.N.W.	4	Heavy sea from N.W.
45° 56'—44° 10' -	31	29·87	52	N.W. by N.	9						
	Nov.					—	29·60	66	S.S.W.	5	Fresh breeze, increasing.
42° 0'—46° 45' -	1	30·20	60	W.N.W. to S.S.W.	1–3						—
						—	30·17	—	N.	4	
41° 22'—48° 00' -	2	29·98	—	N.N.W.	9						

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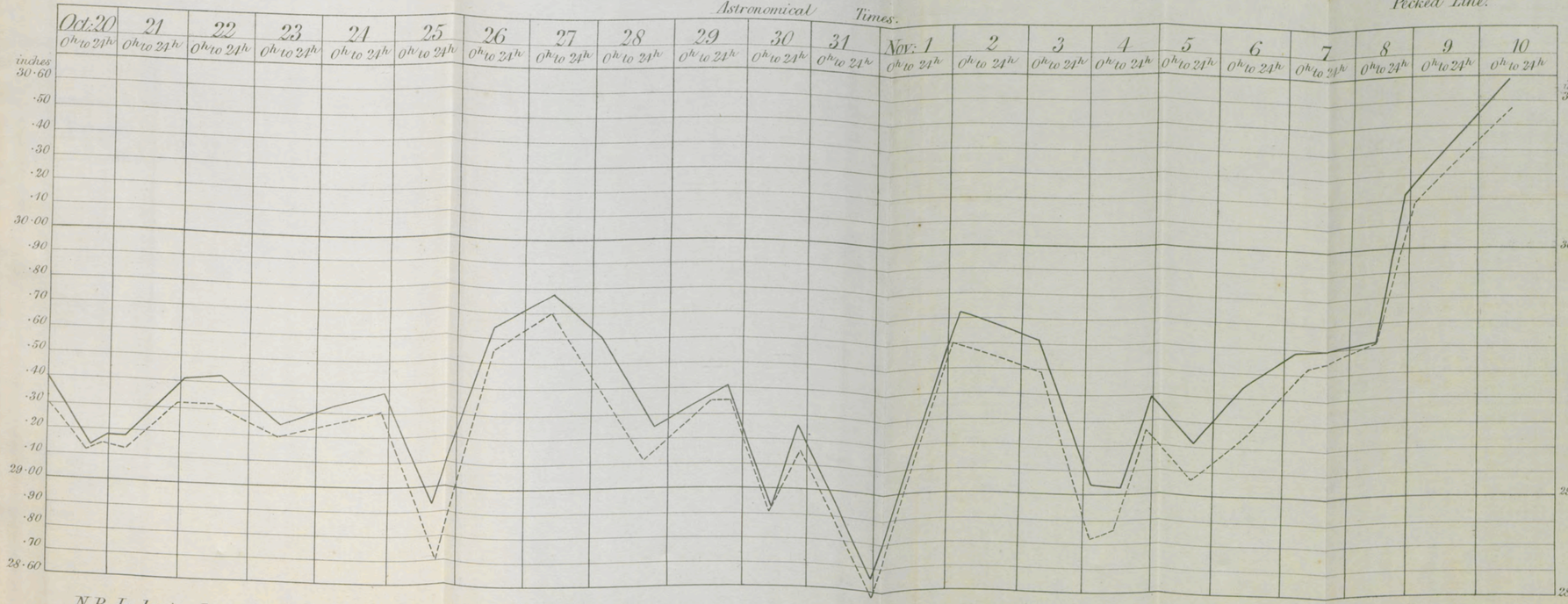
Greenwich.
Latitude = 51°. 29'
Longitude = ——
Height above the sea 159 feet.
Black line.

Barometric Curves laid down from the Photographic Registers at the Royal Observatory, Greenwich, and at the Oxford Observatory, from 1859, Oct: 20 to 1859, Nov: 10.

Oxford.
Latitude = 51°.46'
Longitude = 1·16 W.
Height above the sea 210 feet.
Pecked Line.

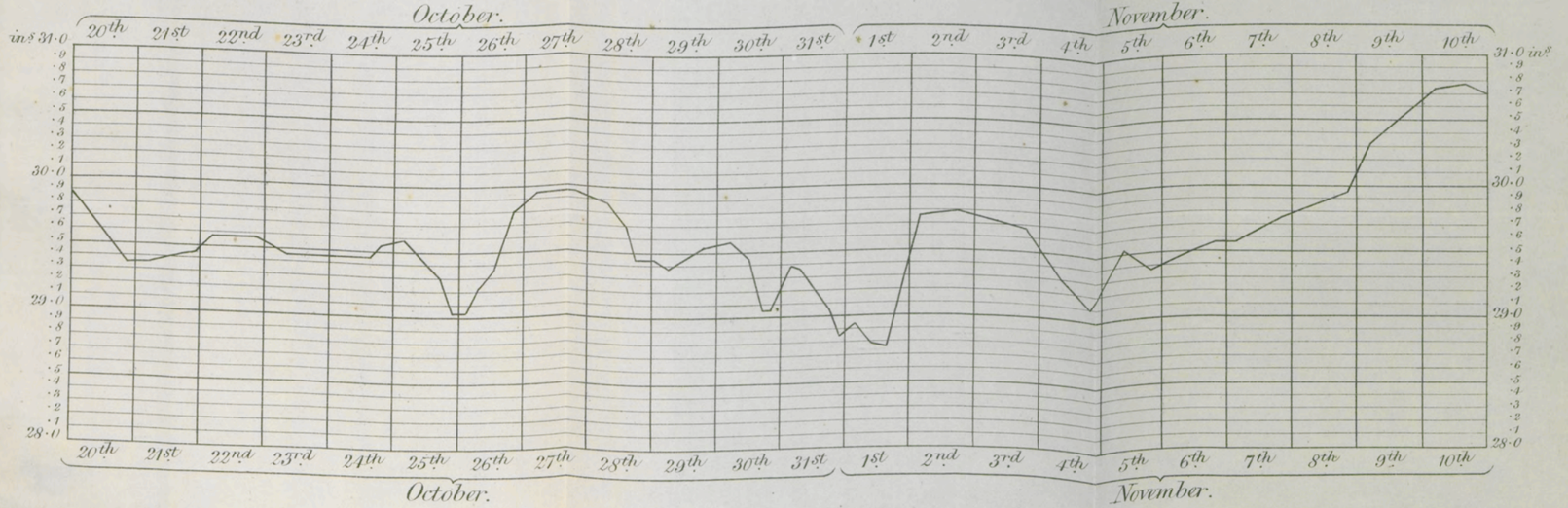


N.B. In laying down the Oxford Curve, the times given with the observations have been altered by 12 hours, that stated as Oct: 20d. 0h has been used as Oct: 19d. 12h and so on.

G. B. Airy
1859 November, 30.

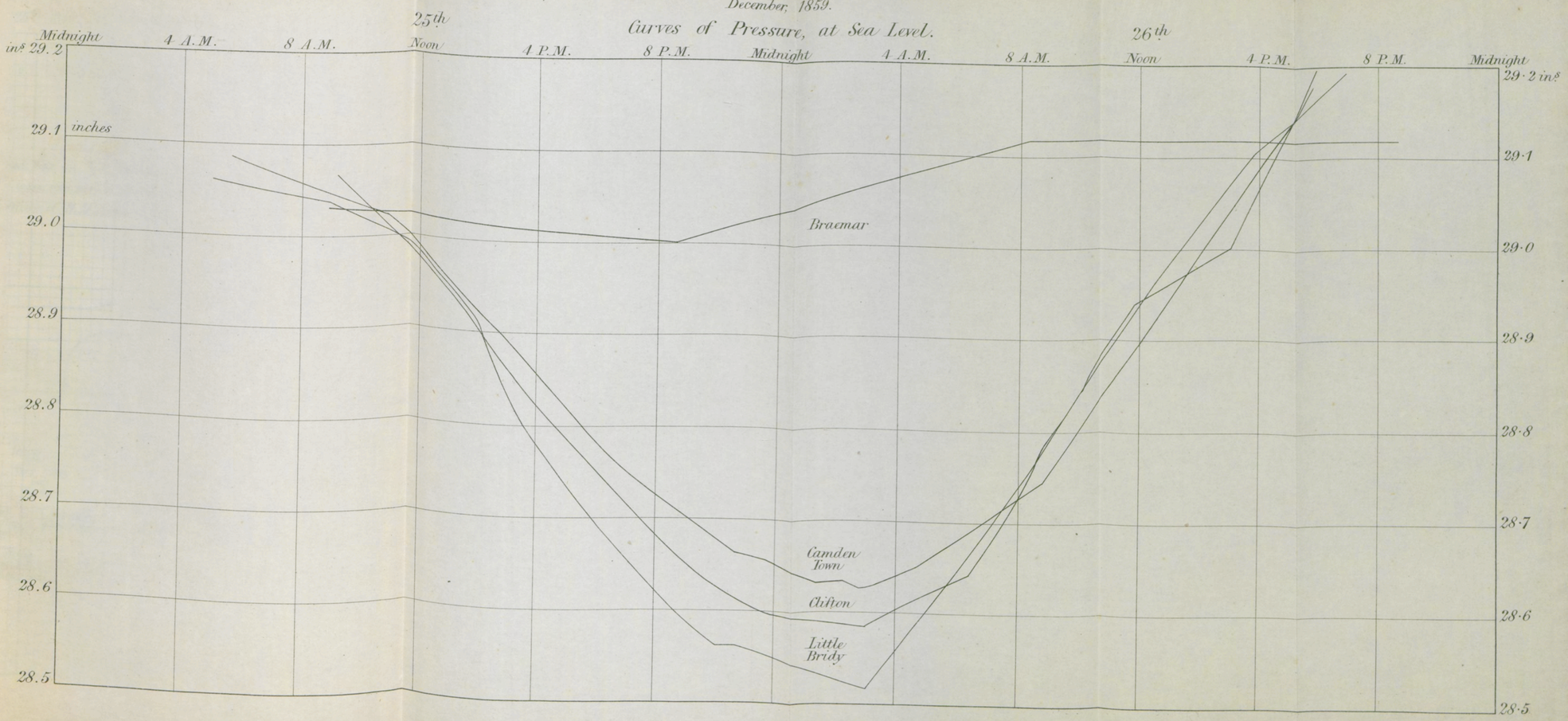
Curve of Atmospheric Pressure at Sea Level.

Deduced from Observations made at Camden Town, London, at an altitude of 125 feet above mean level of the sea at Liverpool.



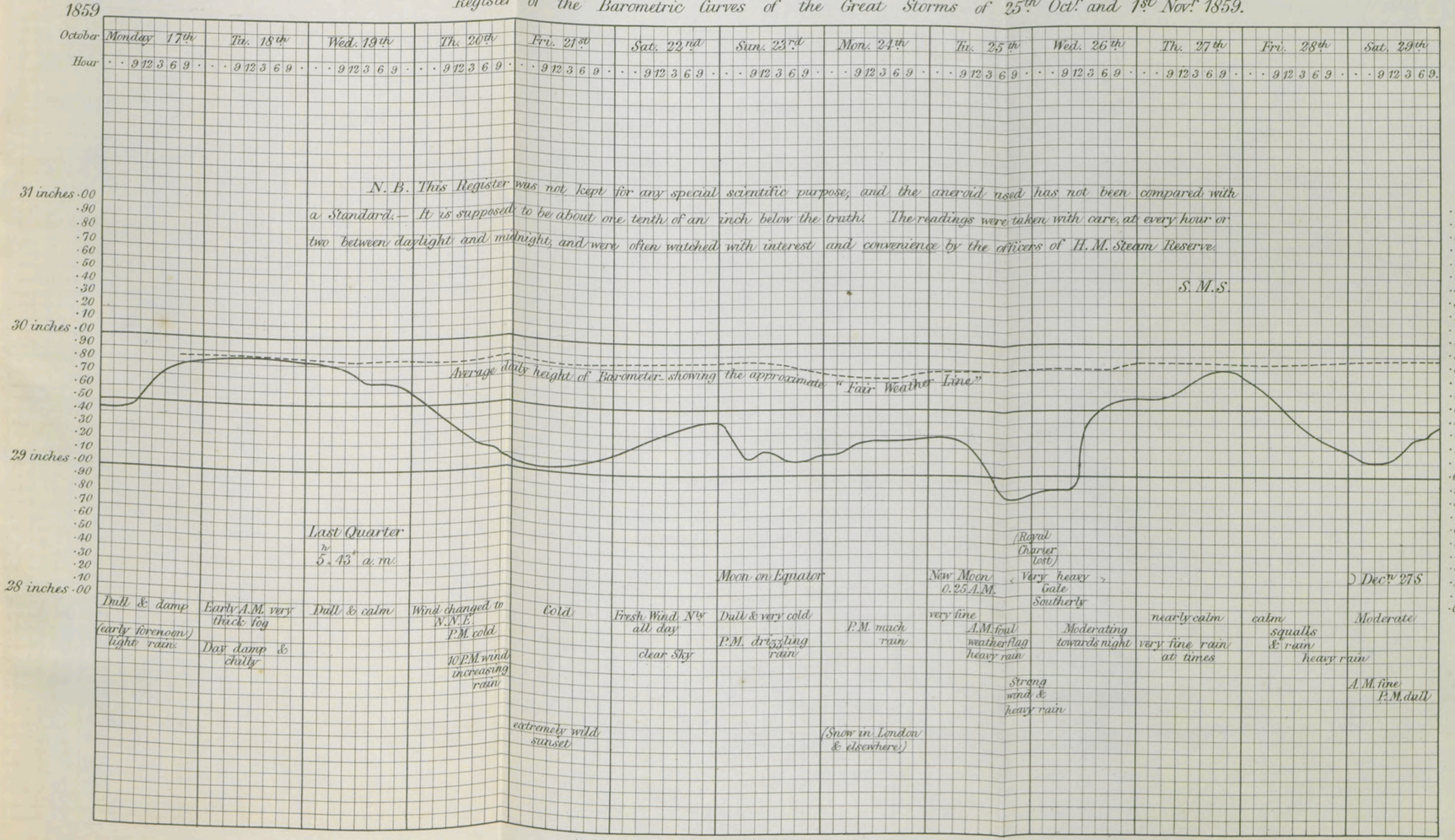
December, 1859.

Curves of Pressure, at Sea Level.



H. M. Ship Devonshire, Sheerness.

Register of the Barometric Curves of the Great Storms of 25th Octr. and 1st Novr. 1859.



1859

Observed and Registered by S.M. Saxby, R.N. (H.M. Steam Reserve,) Esq.re