

Physical Science.

The following communication was received too late to be inserted in its proper place, but as the writer was desirous to have it published in the same volume with the article to which it is a reply, the Committee have judged it better to place it thus out of order, than to postpone it to the next volume.

COM. PUB.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Remarks on Mr. Espy's Theory of Centripetal Storms, including a Refutation of his Positions relative to the Storm of September 3rd, 1821: with some Notice of the Fallacies which appear in his Examinations of other Storms.
By W. C. REDFIELD.

The practical importance of the investigations which relate to the character and courses of our great storms, will be deemed sufficient apology for this communication.

Early in the year 1831, an article on storms appeared in the *American Journal of Science*,* the main objects of which were, to point out the relative or whirling character of the great storms which visit the Atlantic coast, their origin in the intertropical latitudes; the circuitous or semi-elliptical character of their several paths or orbits; the general uniformity of their courses through the tropical and temperate latitudes; and the obvious cause for the continued depression of the barometer which is found in the centrifugal influence of their rotary action.

In drawing up this paper, I deemed it not inappropriate to exhibit the origin of the views or conclusions therein maintained; they having been first suggested by extensive personal observations of the phenomena of the storm of September 3d, 1821, in the states of Connecticut and Massachusetts, and confirmed by numerous personal inquiries, made at that period, of ship masters and other intelligent persons who had observed its action. I also added, in a very condensed form, such marine reports relating to this storm as appeared to afford further information. My statements, as then published, were copied extensively into the newspapers of the day, and had a wide circulation among the intelligent inhabitants of New England, who had witnessed the effects of this storm; and, so far as I know, their general accuracy has never been called in question.

Having shown the origin of my investigations, I proceeded to a more particular statement of the phenomena which were exhibited at various localities by the north-east storm which visited New York on the 17th of August, 1830; showing from an extensive collation of facts, its whirlwind character; its identity with the hurricane which visited certain islands in the West Indies five days before; its course, daily progress, and uniform character during this period; its further progress to the Banks of Newfoundland; and also its absolute identity with the E.N.E. S.E., S., S.W., and north-westerly gale which prevailed off this coast on the 17th, at or near the time when the gale was blowing at N.E. at New York and its vicinity. These results, which, for the most part, appear not to have been previously sus-

* *Silliman's Journal* for April, 1831, vol. xx., p. 17—51.

pected, have been more fully generalized and illustrated in subsequent papers: and are also exhibited, in a most convincing manner, in the highly valuable work of Col. Reid on the Law of Storms, which has lately been published at London.

It appears, that since the results of the above inquiries have been brought before the public, Mr. Espy, of Philadelphia, in considering the laws of aqueous condensation, has been induced to believe that he has discovered the true cause of winds and all the various phenomena of storms which occur in our atmosphere.* This theory, which he has set forth in a series of essays in this journal, appears to have formed the basis of his reports as chairman of a joint meteorological committee of the American Philosophical Society and the Franklin Institute.

The type of this new theory, or of the manner in which it is supposed to be exemplified, it is believed may be found in the movements of the air in a common chimney, or bonfire: but it appears to find little or no support in the facts which have been brought to notice during my inquiries into the phenomena of the Atlantic storms. Encouraged, however, by plausible, but erroneous inductions, made from the phenomena of the New Brunswick tornado in June 1835,† and by friendly, though perhaps injudicious support and announcements from highly respectable sources; and aided also (with few exceptions) by the favour and guardianship of the Philadelphia press, Mr. Espy has continued to labour with assiduity for the establishment of his theory.

In a brief introduction to his essays in April, 1836, Mr. Espy announced that "he had collected such a mass of facts as would place his newly discovered theory on an immovable foundation;" and that his readers would find developed in his essays "a law" which explains at once "all the seven phenomena of rain, hail, and snow, water-spouts, land-spouts, winds, and barometric fluctuations.‡"

Of the manner in which this modest announcement has been sustained, and of the apparent errors or misapprehensions of facts and of the principles of science, which abound in these essays and subsequent papers, I forbear at this time to make inquiry. But in one of these essays, (August, 1836, p. 105—108,) he gives a constructive abstract of my account of the storm of 1821, which abstract is then claimed to be inconsistent with a horizontal whirlwind, and he adduces these constructive phenomena, as "proving with irresistible evidence the existence of an upward vortex in this storm;" meaning here, by a vortex, not a gyrative movement, but a chimney-like motion.§ He also treats as an unwarranted conclusion, the observed fact, that "*along the central portion of the track, the storm was violent from the south-eastern quarter, changing suddenly to an opposite direction.* Disregarding, also, an important portion of the evidence, he then proceeds to assert, without, however, offering any proof, "that it was on the S.E. side of the storm at which the wind set in S. of E.," and further, that he could not find that the wind had changed from the S.E. to the N.W. quarter, as I had represented.

To this effort to set aside the results of my observations and inquiries, I

* Jour. Frank. Inst. vol. xvii., p. 240 vol. xxiii., p. 153, &c.

† Some incidental remarks on this tornado will be published in the June number of this Journal.

‡ Journal Frank. Inst., April, 1836, vol. xvii., p. 240.

§ Ibid, August, 1836, vol. xviii., p. 105.

replied in a communication which appeared in this Journal for February, 1837; (vol. xix., p. 112—127,) to which the reader is now referred.

It must appear obvious, however, to Mr. Espy, that the action of the Atlantic storms, as developed by my own inquiries and those of Col. Reid, cannot be reconciled with his supposed centripetal movement of the winds, *even for hundreds of miles*, in nearly right lines from all sides towards the centre of the storm;* and hence the renewed attempt which we now find in the March number of this Journal, to invalidate the facts which I had adduced, and to obscure or pervert their plain and obvious bearing.

In the freedom and candour of these prefatory remarks, it is by no means intended to impeach the sincerity or integrity of Mr. Espy, in any of his strictures or positions: but the strong bias which has apparently resulted from having preoccupied his mind with the speculations which he connects with his favourite theory, causes him to "suspect" every fact or conclusion which militates with his cherished conceptions, and to press into his service nearly all the heterogeneous phenomena in nature. This seems to disqualify him, at least in a measure, for instituting a rigid and impartial system of inquiry, suited to the present state of knowledge, and to the obvious demands of his assumed position, as a reformer in meteorological science. It appears to have been the misfortune of Mr. E. to have commenced his labours at the very point where, if successful, they should have terminated; viz. in establishing a general theory of atmospheric physics, resting on the basis of observation and strict induction in every class of natural phenomena which are sought to be comprised in his system. The attempt to explain nearly all the physical phenomena of the atmosphere by the theory of aqueous condensation, is not unlike that of him, who, in essaying to climb, should commence at the last and highest step in the ladder. In so diffuse and complex a science as meteorology, it is not by this inverted Baconian process that we can expect to "ascend from effects to their causes."

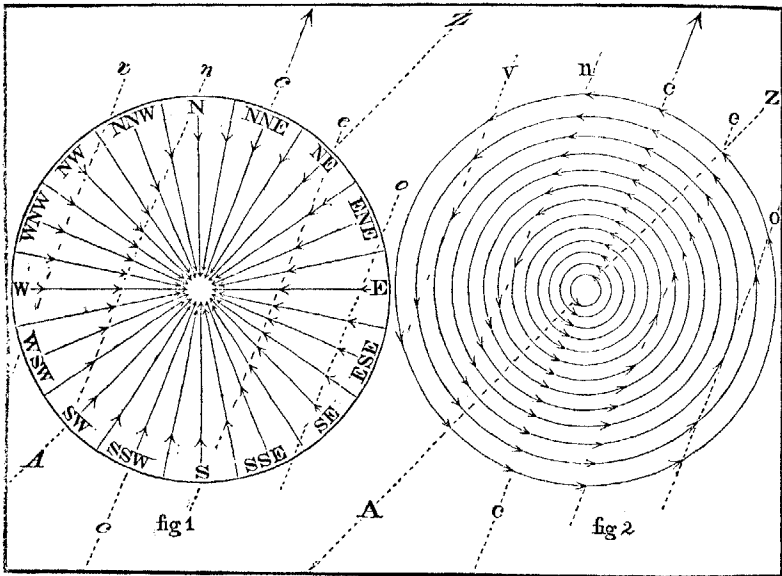
I have already glanced at the physical impracticability of a centripetal movement in the atmosphere, over a surface of several hundred miles in diameter, towards the centre of a storm; where, instead of the accumulation which must inevitably result from this movement in the air, its state of diffusion is known, by the indications of the barometer, to be unusually increased. But, for the purpose of examination, we may assume the theory; and we may then expect that when a storm moves along the coast of the United States, from the tropical latitudes, the wind, *on the centre of its path*, will set in from N.E., and so continue till the centre of the storm itself shall arrive, when, after a short lull, or a very rapid change, it must change to S.W., and blow in this last direction to the end of the storm; while, on the N.W. border of the centripetal storm, it should *commence from nearly N.W.*, and be of comparatively short duration, and showing little change in its direction.

But, on the contrary, if the storm be of a whirlwind character, and revolving to the left around its own central lull, or axis, then, if regularly exhibited, the N.E. wind at its commencement must pertain to the left hand

* It should here be kept in mind, that half of the entire atmosphere lies below the height of three and a half miles. I have also good reasons for believing that the entire masses of our storms lie beneath this comparatively small elevation. What space for the exhibition of a vast centripetal column, whose semi-diameter is even imagined to have extended, in one case, from Iceland to Italy! See Journ. Frank. Inst. Oct. 1836, vol. xviii., p. 241, 242.

portion of the storm, (N. W. of its centre) and, as the storm advances, will change by the N. to the N. W. quarter. While *on the centre of its path*, the wind must set in from near to S. E., *blowing across the track of the storm*, and when the axis, or lull, has passed, the wind will be found in the N. W. quarter, blowing across the track of the storm, in the direction opposite from the commencement: and in places near to which the lull of the storm may pass, the wind will veer round, more or less suddenly, in proportion to the distance, towards the direction which is opposite from its commencement.

For the illustration of these positions, I refer to the annexed figures, the first of which illustrates Mr. Espy's centripetal theory, as applied to the storm of 1821; which, in the latitude of Philadelphia, was moving nearly N. N. E., as indicated by the line and arrow head *c, c*. Fig. 2 illustrates the rotary or whirlwind theory as applied to the same storm; which, in its advance, would be intersected by the several geographical stations, *v, n, c, e, o*, on the several lines of arrow heads which are found in line with these stations on both figures. The direction of the several arrow heads represents the direction, as well as the order of changes, which the wind would present to an observer, at each of these stations, according to the two theories.



A supposed variation of the course of the storm, and of the lines of intersection on the two figures, to N. E., parallel with the lines A, Z, may serve to illustrate the application of the two theories to storms that move in a N. E. direction, which is their more general course in these latitudes.

The foregoing remarks and illustrations are deemed necessary for a right understanding of the subject before us.

The positions of Mr. Espy which I propose at this time to refute, are found in his Examination of Col. Reid's Law of Storms; in a portion thereof

which he states to have been written in his official capacity as meteorologist of the joint committee at Philadelphia, but not accepted by the committee. He here proposes to "demonstrate" that the storm of Sept. 3d, 1821,* was not "exhibited in the form of a whirlwind, but was like the twelve storms which have been investigated [?] by the joint committee of the American Philosophical Society and the Franklin Institute, that is, that the wind blew inwards at its borders." He says, "this conclusion is rendered certain by the following facts, [allegations?] which are deductions from the particulars given below."—We shall see.

First position. "The storm set in every where on the extreme S.E. border from the S.E., and not from the S.W., and changed round to the S.S.W. or S. And on the extreme N.W. border it set in from N.N.E., and blew hardest from the N. and N.W. Now, on the extreme S.E. border, it could not blow from the S.E. at all, on the supposition it was a whirlwind; nor, on the N.W. side, could it blow at all from the N.W. Both facts, however, are not only consistent with a centripetal motion of the air, but absolutely prove it." p. 149, March number of this Journal.

That by the "extreme S.E. border," is here meant the extreme outward limit of the storm in that direction, is evident; for, assuming, as he appears to do, that the course of the storm was N.E., it is only upon "the extreme border," according to his own theory, that the storm could set in at S.E.; and because the position would otherwise be destitute of any discriminating value.

We begin with the two positive allegations: 1st, "The storm set in every where on the extreme S.E. border from the S.E.;" and 2d, "On the extreme N.W. border it set in from N.N.E.;" From the evidence recited as supporting the alleged facts, we find a wide portion of the central track of the storm on which it is reported as beginning at S.E., viz: from the coast of Maryland, and New Jersey, and thence on a line through Bridgeport and Middletown, Conn., on one side, to an unknown point off Cape Hatteras, and a line drawn from thence, at a distance from the coast not well ascertained, but passing perhaps through the towns of Providence and Boston on the other.† Now, what evidence has Mr. Espy adduced, that the easternmost general limit here alluded to, was "the extreme S.E. border of the storm?" On this supposed limit, we find the storm raging with violence, and this wind could not here have sprung instantaneously into action, but must have swept from a greater distance, though doubtless with a diminishing force and modified direction, as it became more remote from the axis of the storm.

But we are not left to this obvious conclusion: for we find in the evidence adduced, that "a vessel from Bermuda experienced the gale from the westward on the inner edge of the Gulf Stream." Probably from the S.W. quarter, i. e. *westward of the meridian*, a colloquialism common with nautical men; and on any construction, this statement alone refutes the position.

We find, 2d, "in lat. 38° 30', on the inner edge of the Gulf Stream, *gale from the westward.*" This also agrees with the foregoing, and disproves the position.

* Journ. Frank. Inst., March, 1839, vol. xxiii., p. 149—158.

† It is my own opinion, that the S.E. wind was not found eastward of a line passing through New London and Worcester, but newspaper reports have given the direction at S.E. in general terms, to the extent here mentioned, where I suppose the storm was S.S.E. nearly, or at best S.E. by S., in the early part of the gale.

3. We have also reported in lat. $38^{\circ} 30'$, lon. $74^{\circ} 30'$, gale S. by E. Whether this longitude be printed correctly or otherwise, this report contradicts the position. It is true also that we find "a ship from Boston to Norfolk [Bristol Trader, three days out,] in lat. $40^{\circ} 19'$; weather foggy, and light winds from S.E.;" but she had met with head winds, and judging from the position of Nantucket shoals, it appears not probable that she was westward of their meridian, and she may have been much further to the eastward;* and to assume a direct connexion and identity of these exterior "light winds from S.E.," with the S.E. gale in Connecticut, is assuming the very point which is necessary to be proved; and such a conclusion, it will be seen, is contravened by other facts.

I now submit further evidence, to show that the border here claimed was not the extreme border, and also, that as we proceed from the centre of the path of the gale towards its eastern border, it was found to commence from a point southward of S.E., which could not happen according to Mr. Espy's theory, as may be seen by referring to fig. 1.

4. We have accounts of the gale eastward of the Bay of Rhode Island, and in Bristol harbour a vessel was driven on shore: probably not by a S. E. wind.

5. The ship *Camillus*, Peck, from Greenock, which arrived at New York on the 7th September, experienced the first part of the gale from S.S.E.

6. Schooner *Juno*, Low, from Aux Cayes, reported at Salem, September 5. On Monday morning, Sept. 3d, saw a dismasted vessel, eight leagues E. of Cape Cod. Had a heavy blow on Monday night, at S.S.E., and a very high sea running.

We thus see, in part from Mr. Espy's own evidence, that his "extreme S.E. border" of the storm is a mistaken assumption, and that his extreme S. E. wind (which, upon his theory, should have been E. S.E., as the course of the storm in this latitude was nearly N.N.E.) has been already traced round to S.S.E., and, could the inquiry be carried out, I have no doubt we might follow it round to the westward of the meridian, as experienced by the vessel from Bermuda.

We proceed now to the supposed "extreme N.W. border," where it is alleged that the storm "set in from N.N.E." I might, however, rest contented with this allegation; for the admission that the storm here set in from N.N.E., i. e. in the direction which is contrary to the progress of the storm, is in strict accordance with the whirlwind theory, and fatal to his own, which would here require the wind at W.N.W., or nearly; while his N.N.E. wind should be confined to the centre of the track, and yet Mr. Espy here makes the unfortunate assertion, that such facts as these are not only consistent with a centripetal motion of the air, but absolutely prove it!

The only places I find mentioned where the gale is said to have set in at N.N.E., is in one of the reports from Norfolk, and another from Bombay Hook, near the head of Delaware Bay, from both which places the other accounts say N.E.; but in one of these points of direction, (N.E.) Mr. E. has fixed the centre of the storm, and the gale was heavy on this line of track: how, then, does he find here "the extreme N.W. border?" But more of this as we proceed.

* This last supposition appears not only probable, but almost certain, from this fact, that the ship *Camillus*, from Greenock for New York, was up with Nantucket about three days before the gale, but was unable to get to the westward if not driven back; so that she took this gale at S.S.E., and did not then arrive till the 7th.

Second position. "Wherever the wind set in from the E., it always changed round by the S., which is consistent with the centripetal, and inconsistent with the centrifugal, theory." p. 149.

The entire want of arrangement in the facts collected by Mr. Espy, somewhat impedes the inquiry; but on examination, I find mention of only three places where the gale is said to have set in at E., viz. off Roanoke; in some of the accounts from New York; and in a letter from on board steamboat Connecticut, which went that day from New York to New Haven. Of these, the report from Roanoke represents the wind not as changing "round by the S." but first at E., and then S.W. At New York also, no mention is made of a change from the E. round by S. The "wherever" would appear, therefore, to be found only at, or near, New Haven. Here, it is true, the wind "changed round," not from E., but from S.E., "by the S.," as it *should do*, (except on the line of lull,) according to both theories, (see figures.) Intelligent friends, (one a ship master,) then on board the Connecticut, assured me that the gale here set in nearly from S.E., and hauled somewhat suddenly to the S. and S.W., (owing, as I suppose, to the near proximity of the lull at that time,) and by this change the Connecticut was driven from her anchors and cast on shore at Morris' Cove, East Haven. It was within my own observation, also, that trees prostrated by the first part of the gale in New Haven and its vicinity, pointed, not to the W., but N.W., or more northerly, showing a S.E. or S.S.E. wind, and numbers of these indubitable records remained in this position for years, some nearly to this day. The observations made at New Haven, for the Connecticut Academy of Arts and Sciences, (and furnished to Mr. Espy by Mr. Rich, now a member of Yale College,) also fix the wind at S.E. Nor does it appear, on any theory, how the wind could have been more eastward at New Haven, than at Bridgeport and Middletown, where the printed reports state it to have been S.E. The position, therefore, fails.

Third position. "There never was a lull mentioned, only where the wind set in from the N.E., which has the same bearing as before, for the centre of the storm only can have a lull." p. 149.

Let us try this allegation by the evidence then before Mr. Espy.

1st. In the marine reports, from localities where the gale set in from S.E. to E., we may rightly infer the presence of the lull from the phenomena which are expressly mentioned. As, off Roanoke, "a dreadful gale at E.,* then S.W.," (p. 153) for we know that the gale seldom shifts to nearly the opposite quarter, without an intervening lull. Again, at sea, 40 miles N. of Cape Henry, severe gale from S.E., *changing to N.W.*" The last remark applies still more strongly to this report. To which I may add as positive evidence, (not, however, then before Mr. Espy) that a shipmaster, whose vessel was driven on shore to the southward of Cape Henlopen, with the wind "right on shore," also described to me the sudden lull, and the ensuing blast from W.N.W. Also, the schooner Mark Time, from Norfolk, (New York Gazette, September 7,) experienced the gale from S.E. off Chincoteague, Md., *was thrown upon her beam ends*, and remained an hour in that position, when *the shift of wind to the westward righted her*. This vessel would hardly have lived so long in this position, except she had fallen into

* It should be noted, that an E. wind in this part of the track, where the course of the storm was nearly N., corresponds, in the character of its changes, to an E.S.E. wind in the latitude of Philadelphia, where the course of the storm, or the curve of its track had changed to nearly N.N.E.

the lull, and being righted by the sudden shifting of the wind, might fairly imply, that after the lull, it had suddenly come out from the opposite quarter.

2d. "At Cape Henlopen, Delaware, the hurricane commenced at half past 11 A. M., from E. S. E.; shifted in 20 minutes to E. N. E., and blew for nearly an hour. *A calm of half an hour succeeded*, and the wind then shifted to W. N. W., and blew, if possible, with still greater violence," p. 154. Here, certainly, is mention of a lull, and no mention of a N. E. wind.

3d. The National Gazette, adduced by Mr. Espy, states: "At Cape May, from 1 P. M. till half past four, the wind blew a violent hurricane from S. E.," p. 158; and my own reports (p. 154) state that the gale here "commenced at N. E. at 2 P. M., and veered to S. E., and blew with great violence,—*after abating 15 minutes*, it again blew with increased violence for two hours, and then abated." The direction of the wind, after the lull, is not stated, but being the close of the storm, it was doubtless from the westward, as at Cape Henlopen, which is distant but 13 miles, and nearly in the line of the storm. Here is the only pretence which I can find for connecting the lull with a N. E. wind, which the collation of accounts shows to be an error, or at best only an incipient wind at Cape May, and not the true easterly wind of the gale. But further:

4th. "This storm, as experienced in the central parts of Connecticut, commenced blowing violently from E. S. E. and S. E. about six o'clock in the evening of the 3d day of September, having been preceded by a fresh wind from the southern quarter, [from S. or S. S. E.,] and flying clouds. It continued blowing in heavy gusts with increasing fury, till about 10 o'clock, P. M., when the wind suddenly subsided. A calm, or *lull*, of perhaps fifteen minutes duration ensued, which was terminated by a violent gust from the N. W., which continued till about 11 P. M., and then [i. e. from that time,] gradually abated." (Silliman's Journal, April, 1831, vol. xx., p. 20.) This (which lay before Mr. Espy) was the testimony of an actual observer, who resided on the ground, was familiar with the points of the compass as connected with the winds, from his boyhood, and had the best possible reasons for knowing the direction and strength of this gale; who had then formed no theories on the subject; who for months, and even years, afterwards, had also before him nature's own records of the direction of the wind, as exhibited in the prostration of the orchards and forest trees; and who is perhaps the only person living who made extensive and careful observations and inquiries on these points at the period of the storm.

Of the surprising character of this allegation, "that there never was a lull mentioned, only where the wind set in from the N. E.," it does not become me to speak; but I infer that Mr. Espy has here drawn mainly upon the centripetal image existing in his own mind, rather than upon the recorded observations which lay before him.

Having thus shown the error of this statement, and that the lull was on or near the line of S. E. wind, and as Mr. Espy also here admits that the centre of the storm only can have a lull, it appears to follow that "this storm was exhibited in the form of a great whirlwind," as I had previously maintained; for the point here discussed, involves the main question between the two theories.

Fourth position. "Where the wind set in from the S. E., there is no lull mentioned previous to a change of wind, and in no instance could I find that it changed round to N. W. Two instances are given by Mr. Redfield, one at Bridgeport, Conn., which I find is incorrectly reported, [?] and instead

of changing round to N.W., it should read S.W.:—the other at sea, 40 miles N. of Cape Henry; this I could not find, and I suspect there is something wrong in it, for 40 miles N. of Cape Henry is not at sea, but in the eastern shore of Virginia. [1] At other places in a right line with this, it set in from the N.E., e. g. at Cape May and Norfolk." p. 149—150.

The first assertion here, that "where the wind set in from the S.E. there is no lull mentioned previous to a change of wind," is refuted by the facts just reviewed; this being a reiteration of the foregoing position in another form. But he here says: "*in no instance* could I find that it [the S.E. wind] changed round to N.W." The value of this extraordinary assertion has also been seen.

Unfortunately, it appears that two of my cases have been "*suspected*" by Mr. Espy as being contrary to his theory.* We have before heard of his finding of the error at Bridgeport, where, by his showing, "the wind commenced blowing hard from S.E. about 6 P. M., and continued to increase in violence *till about 9 P. M.*, [the italics are mine] when the tempest raged with a degree of fury the most awful and destructive. The storm continued with unabated force until near 11 P. M., when the wind hauled round to S.W., and gradually abated."

I see nothing in this account to support Mr. Espy, except the obvious omission to state the direction of the wind from 9 to 11: for we know that the centre, or axis, of the storm, which, from the indications of the barometer, we find to have been opposite to New York at 7h. 30m. P. M.,† must have passed Bridgeport at, or soon after, 9, about the time which my information fixes the change at New Haven, and was at Middletown and Hartford about 10; and immediately after this crisis of the gale, the wind is known to have been blowing from the N.W. quarter on all this line. Neither have we any reason to doubt the account from which my own statement was taken. After 11, i. e. two hours *after* the passage of the centre of the storm, "the wind hauled round [from N.W.?] to S.W., and gradually subsided." My own knowledge, and inquiries made at the time, corroborate this view of the facts.‡

The observations made "at sea, 40 miles N. of Cape Henry," it appears are set aside, because that 40 miles *due* N. of that Cape is on land, "in the eastern shore of Virginia"! This is quite unworthy of Mr. Espy and of his cause; for who did not perceive, that by this phrase was meant, 40 miles from Cape Henry, on the usual route of vessels bound northward. On this subject I find the following:—

Norfolk, Sept. 9th, 1821. Arrived, sloop *Atalanta*, Philips, of Swansey, bound to Charleston. August 26, off Cape Hatteras, close in with the land, experienced a severe gale from S.E., which split her sails to ribbons, and made it necessary to put into the first port. On the 3d instant, about 40 miles N. of Cape Henry, experienced another severe gale from S.E., which hauled round soon after to N.W.; which made the A.'s situation so embarrassing, that it was with difficulty she could be got in.

* Journ. Frank. Inst., August, 1836, p. 105. I quote the italics.

† In the *New York American*, Sept. 4, I find the following facts communicated relating to the state of the barometer in this storm; at 6 A. M. 30.13—2 P. M., 30.05—6 P. M., 29.62—7 30 P. M., 29.38—8 P. M., 29.53—9 P. M.; 29.64—10 P. M., 29.07—the last, evidently a typographical, or a clerical, error.

‡ From the best estimates which I have been able to make of the course of the lull or centre of this storm, it would appear to have crossed Stratford Point and Milford, on the N. shore of L. I. Sound, passing between Bridgeport and New Haven, and perhaps nearly touching one, or both, of these places.

The worthy captain of the *Atalanta*, and his marine reporter at Norfolk, will doubtless be surprised on finding that the reported position of this vessel was "not at sea, but in the eastern shore of Virginia." The reader, however, will here perceive at least one other instance in which the S.E. wind *did* "change round to N.W."

It is strange enough that the "right line" of N.E. wind should have been located through Cape May, where, according to Mr. Espy's own showing, from the *National Gazette* of September 7th. "from 1 P. M. till half past 4, the wind blew a violent hurricane from S.E." p. 158. Instead of this, we find this line to have been through Edenton, Norfolk, Chesapeake Bay, Bombay Hook, and New Castle, Philadelphia, Trenton, and New Brunswick; at all which places, instead of a lull and opposite gale, the storm veered to N.W. I see nothing left, therefore, of this position.

Fifth position. "Along the seaboard, where the wind had been S. and S. E. all day, at the approach of the storm, it backed round towards the E. and E.N.E.; and inland, where the wind had been N.W., it backed round towards the N. and N.E., on the approach of the storm." p. 150.

I cannot perceive any relation which the direction of the wind, *previous* to the arrival of the storm, can have upon the question at issue. Nor do I perceive that this vast generalization of the previous winds, westward of the main line of the storm, is supported by any evidence, except by the single statement of the direction of the wind at Annapolis, at 4 A. M.

Sixth position. "Wherever the wind set in from the N.E., it ought not to have changed at all, according to the centrifugal theory, whereas it did always change round by the N. to N.W. or W., or by the S. to S.W., as it should do by the centrifugal theory." p. 150.

One fact is truly stated in this position, viz. that this gale, wherever it "set in [or continued to blow] from the N.E.," "it did actually" "change round by the N. to N.W. or W." But the alternative fact is not found, of a change [veering] from N.E. "by the S. to S.W., as it should [not] do by the centripetal theory." For this theory (supposing the course of the storm to be N.E.) requires the wind to remain unchanged till the arrival of the central lull, after which the wind should come out, with even greater strength, from the opposite quarter; or, if the point of observation be just without the lull, the change should then be very rapid, as the lull passes, (see figures 1 and 2.) The averment, that "according to the centrifugal theory," meaning, as I suppose, the whirlwind theory, the N.E. wind "ought not to have changed at all," is not only unfounded, but appears as difficult to account for as any which is found in any of these positions; as will appear by the illustrations above referred to.

I object, however, to the term "centrifugal," as here used: for no one, I believe, except Mr. Espy, ever talks of the wind blowing *outwards* from the centre, towards the circumference of a storm. The idea of the wind's blowing directly inward, and thence upward, or downward, and thence outward in all directions, in violent storms, of either large or small extent, I consider as being fanciful, and wholly opposed to all correct observations, as well as to the laws of motion and equilibrium, which pertain to both the ocean and the atmosphere.

Seventh position. "According to the centrifugal [whirlwind] theory, the wind never could change round, on the extreme N.W. boundary, from N. N.E. to N.W., as it did, according to the centripetal theory." p. 150.

All the strength of this position lies in the assumption, here repeated, (see position first) that the points from which the gale was reported at N.

N.E., were "on the extreme N.W. boundary" of the storm, an assumption apparently as gratuitous and unfounded as could well be made. We have already noticed the general line on which the first violence of the gale was experienced from the N.E., and I can find its direction, at this period, mentioned as N.N.E. only as follows, viz. in one of the accounts from Norfolk, (p. 154) one from Bombay Hook, (ibid.) and possibly by constructive inference, at Point Lookout, at the entrance of the Potomac, (p. 156) and one also at Philadelphia, (p. 157.) But at all these places, we find that the same accounts, or others, state the gale to have been N.E., on which line of wind Mr. Espy locates the centre of the storm. The reader will therefore be surprised to find this line, where the wind veered to N., N.N.E., and N.N.W., assumed also as "the extreme N.W. boundary" of the storm, where "the wind never could change round from the N.N.E. to the N.W., as it did," according to *either* theory.

The mere absence of reports from more western localities, would afford no good ground for this position; for the gale raged with destructive fury on the line here mentioned, which could not therefore have been its extreme border. It is true, that we have found it stated in my reports, that there was no *hurricane* felt at Baltimore; but the direction of the wind having been from off the land at that place, as well as less violent, there was no injury received, nor any cause for reporting a remarkable storm. That the storm, however, was experienced at Baltimore, I have never doubted, for the contrary supposition would be of the most incredible kind. Besides, Baltimore is but little out from the line of New Castle, &c. through Chesapeake Bay to Point Lookout; and I find, also, the following accounts which have not improbably met the eye of Mr. Espy, as part of the first is comprised in his details of evidence at page 156.

Baltimore Sept. 6. "The steamboat Norfolk left here on Monday morning, at 9 o'clock, and when she opened the bay, [only twelve miles from Baltimore, and early in the day,] felt the gale severely; but being before [it] proceeded without fear. Off Point Lookout, [N. point of the entrance of the Potomac] fell in with ship Repeater, Maxwell, who had anchored before the gale. During the gale, parted her small anchor, and capsized, and was fast driving on shore, when it was thought advisable to cut away her masts. The Norfolk fell in with her, and towed her to Norfolk."

Another account says, the schooner Alert, Beers, rode out the gale under St. Mary's, Md., i. e. in the Potomac.

I may add also, that Mr. Espy, in admitting that on the extreme N.W. boundary the wind did change from N.N.E. to N.W., has effectually refuted his own theory, as applied to this storm. See figure 1.

Eighth position. "On the extreme S.E. boundary, it could not blow at all from S.E. according to the centrifugal [whirlwind] theory: but it did, according to the centripetal theory, blow in that direction in many places on that border." p. 150.

It is here correctly stated that this storm (if blowing in the form of a regular whirlwind at its extremities) "could not blow at all from S.E. on the extreme S.E. boundary of its path;" for a like reason, that according to Mr. E.'s hypothesis, it could not blow from N.N.E. "on its extreme N.W. boundary;" but in here reiterating the assertion, (see first position) that "*it did*," according to the centripetal theory, blow in that direction in many places on that border, for six or eight hours during the whole strength of the gale," he appears to confute himself; for, 1st. The gale could not have exhibited this duration and "whole strength" upon its extreme border; for this would

be contrary to all our knowledge of this and other great storms; and 2d, we have already seen, that it was in places nearer to the centre of the storm where the gale set in at S.E., and where its duration was not only six or eight hours, but, with vessels drifting before the gale, was eight and ten hours; *the duration of the gale being found greater on the line where it set in from nearly S.E. than on any other portion of its track;* as it should be, according to the whirlwind theory. On no hypothesis, therefore, could these places where the storm set in from S.E. and exhibited such strength and duration, have been at its "extreme S.E. boundary." Other evidence deciding this point has already been considered: (see under first position.)

Ninth position. "On the extreme N.W. border, according to the centrifugal [whirlwind] theory, it could not blow the hardest from the N.W., nor on the extreme S.E. border could it blow the hardest from the S.E., as it did in exact conformity with the centripetal theory." p. 150.

We have been showing that on the "extreme borders" here mentioned, "it could not blow the hardest," on any theory. The error or fallacy of the position, lies in again assuming for the "extreme border," the interior of the storm's path. But, by what process, or evidence, Mr. E. discovers that on these extreme borders, "it did blow the hardest" from S.E. and N.W., and "in conformity with the centripetal theory," I am at a loss to discover. The evidence of the manner in which the gale *did* blow, as we have seen, affords no support to this conclusion. This new fact, that the wind blew "the hardest" at the very point from which it first commences to blow, appears to be a more extraordinary discovery than any yet made.

Tenth position. "At Cape May it changed round from N.E. by E., and at Cape Henlopen it changed round from N.E. by N., in conformity with the centripetal, and entirely contradictory to the centrifugal, [whirlwind] theory." p. 150.

There is much error in this. 1st, A change of wind "round from N.E. by N.," pronounced to be entirely contrary to the centrifugal [whirlwind] theory"! I forbear to comment on such a statement. But, 2d, can Mr. Espy inform us how this change from N.E. *both ways*, at or nearly on the same point or line of advance, can be in conformity with his centripetal theory? especially when we find from the reports that the central lull visited both places. We have seen, that on his hypothesis, the N.E. wind on the central line, supposing the storm moving N.E., should not veer at all, but, at the expiration of the central lull, should come out at S.W. nearly, and this last wind having all the progressive force and velocity of the storm to aid it, should here blow with far greater fury than the previous N.E. wind. We are told, elsewhere, however, that the centre of the gale passed between these two points. But the diameter of the lull was such as to give a duration of half an hour at one place, and fifteen minutes at the other, moving with the velocity of 30 miles an hour. The fact alleged, therefore, cannot be known, and is also improbable; for according to the charts and Coast Pilot, Cape May bears from Cape Henlopen N.E. by N., distant but $12\frac{3}{4}$ miles, and the course of the gale being here N.N.E. nearly, would give a distance, *in the line of advance* between the two places, of less than three miles, while the diameter of the lull would appear, by these accounts, to have been at least fifteen miles.

At Cape Henlopen, "the gale commenced at half past 11 A. M. from E. S.E., and shifted in 20 minutes to E.N.E., blew very hard for nearly an hour, [evidently much longer,] a calm of half an hour then succeeded, and

the wind then shifted to the W.N.W., and blew, if possible, with still greater violence." Now, where do we find the wind, which, it is alleged, "at Cape Henlopen," changed round from N.E. by N., in conformity [?] with the centripetal theory." To show the error of this, I also add the following fact in relation to the direction of the wind at this place, viz. the pilot boat Oscar, Davis, of Wilmington, was driven ashore during the gale, about one mile S. of Cape Henlopen lighthouse, and the crew lost.* How could a *pilot boat* be thus driven on shore by a "N.E. wind changing round by N.?"—or even by an E.N.E. wind. Can Mr. Espy inform us?

The mean of the accounts from these two capes, as before suggested, is probably an approximation to the true state of facts; and that the gale was not N.E. at these places, seems also apparent from the report from Morris River in the lower part of Delaware Bay, (N. J., and not Del., as previously given,) which states the gale there was "from E.S.E." And at Dennis' Creek, in the same vicinity, according to the reports collected by Mr. E., "the wind came on to blow about 2h. from the eastward, and continued to increase till about 5 P. M., when the wind *changed to the westward*, still blowing very heavy," (p. 157.) I also find reported from Mount Holly, in the interior of New Jersey, between the Delaware and the sea coast, a "heavy rain, with violent *east wind*." (N. Y. Gaz., Sept. 8.) These facts serve to show, most conclusively, that the line of N.E. wind was not over the Capes of Delaware, as claimed by Mr. Espy.

The errors here involved have also been shown in the refutations of the third, fourth, and seventh positions.

Eleventh position. "Both in Norfolk and New York, the wind set in from near the N.E., and at the termination blew from S.W., which is the *experimentum crucis* in favour of the centripetal theory, and utterly inconsistent with the other. [?] In like manner at Ocracoke, it set in at E.S.E., and terminated at S.S.W.; and out at sea, on the extreme eastern borders of the storm, the wind blew for eight or ten hours from S.E. and S. by E., with but little change, as it ought to do, if the wind does actually blow towards the centre of the storm." p. 150.

We shall find, that the setting in of the wind "from near N.E." at New York, does not very clearly appear; and it would seem to have been *after* the termination of the gale at the above places that the wind blew from the S.W. The important fact, that at these places the gale veered by the N., and blew its greatest strength before passing the N.W. point, is kept out of view, and appears fatal to the centripetal theory and its "*experimentum crucis*." The wind reported at Ocracoke "from E.S.E. hauling round to S.S.W.," accords with the regular whirlwind action of the storm, provided its centre passed inside of that anchorage, as it probably did, and from thence to sea across Currituck Sound, the line of progress here being N. or westward of that point; although it does not appear whether the phrase *hauling round* is used in its proper sense, or to express a more abrupt and general change of direction. We again find here, also, the singular assumption which has already been disposed of, and which, as now presented, amounts to this; that an undefined point of observation, which would appear to have been moving to the northward and westward before the gale and the Gulf Stream, so as to carry the gale for eight or ten hours with but little change, was actually "*in the extreme eastern border of the storm!*" Infer-

* N. Y. Gazette, Sept. 8.

ences drawn from such positions as these, would seem to require no further refutation.

Twelfth position. "At the time the wind changed round to S.S.W. at Ocracoke, it was blowing at Norfolk a violent gale N.E., nearly towards Ocracoke. Now, as these places are 130 miles apart, and nearly on opposite sides of the storm at that moment, it is utterly impossible, according to the whirlwind theory, that the wind at Ocracoke should be blowing towards Norfolk, and, at the same time, the wind at Norfolk be blowing towards Ocracoke. And this fact is entirely consistent with the centripetal theory."

We have here, if I mistake not, a further specimen of the manner of confounding, or passing over, the essential distinctions of time, place, and direction, for which Mr. Espy's meteorological papers are so remarkable. The evidence laid before us is this: "At Ocracoke, at daylight, wind E.S.E., blowing a gale; *after* hauling round to S.S.W., ceased between 10 and 11 A. M. both at Ocracoke and Portsmouth." At Norfolk, after 10 A. M., the wind *commenced* blowing a gale from N.E.; from 11½ to 12½, it threatened a general demolition; about 12, the wind shifted to N.W., [one other account mentions the wind as changing from N.N.E. to N.N.W.,] and *continued* its fury half an hour longer; and at 4 o'clock, *the storm was over*, and the wind changed to S.W." The italics here are mine.

Now, 1st, as to time: The storm, it appears, ceased at Ocracoke between 10 and 11, and of course it blew from S.S.W. *before* this period, if at all; while at Norfolk the gale *commenced* blowing at N.E. *after* 10 o'clock. So much for the winds of this hurricane blowing at these two places "at the same time." 2, As to place and direction: a N.E. wind moving in a direct course from Norfolk for the distance of 130 miles, as protracted on Blunt's Chart, *would reach a point 120 miles W.N.W. from Ocracoke bar or inlet*; and this is called "blowing at Norfolk nearly towards Ocracoke"! We thus see, that the assumptions which are here made, fail altogether; but it will also be perceived, that there was sufficient time and space for the wind of the N.E. storm at Norfolk to turn towards the left, around the rapidly advancing axis of the whirlwind storm, without sweeping so far south as Ocracoke.

(TO BE CONTINUED.)

Progress of Practical and Theoretical Mechanics and Chemistry.

ARTICLES FROM THE FRENCH JOURNALS. TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE, BY J. GRISCOM.

Salts Arising from Organic Bodies. By M. V. REGNAULT.

In an elaborate memoir entitled "New Researches on the Composition of Organic Alkalies," it is stated by the author, in his conclusion, that "the preceding analyses show very clearly that all salts formed from organic bases with oxacids, include one atom of water necessary to their composition, and of which they cannot be deprived without undergoing decomposition. These bases, therefore, present a complete analogy with ammonia in its mode of action with acids. They combine directly with the hydracids without decomposition, forming hydrochlorates, and not chlorides, like