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THE

PRINCIPLES OF

METEOROLOGY.

BY

THE REV. THOMAS TROTTER, ANTIGONISH.

READ AT THE MEETING OF THE

LITERARY AND SCIENTIFIC SOCIETY

OF PICTOU,

4TH JANUARY, 1837.

[*Bee Office, Pictou.*]

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The Author of the following imperfect sketch, consented to its publication, not because he thinks it possesses merit, sufficient to entitle it to that distinction ; but because he wished, to gratify those who paid him the compliment, to request it. For every thing which he has stated as a fact, he can give respectable authority ; which he has withheld only for the sake of brevity ; but for the conclusions drawn from them, he generally holds himself accountable. He has collected the information here brought together, from a considerable variety of sources, several of which are but little known to the public at large, in this Province ; but had he known any one publication, in which the whole or even the greater part of that information is to be found, he would have most readily given the the name of it.

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PRINCIPLES OF METEOROLOGY.

METEOROLOGY is that branch of physical Science, which treats of the properties, and phenomena of the atmosphere. It was long neglected, and may still be regarded as in a state of infancy. This may be imputed in some degree, to the signal success which has rewarded the researches of scientific men, in other departments, and to the deep and general interest, which their splendid discoveries, in these departments, have naturally excited. But it may be also owing in part, to the difficulties attendant on meteorological investigations, and the impossibility of placing some of the most important conclusions to which they lead, in that clear and convincing light, in which it is possible to exhibit the principles of other Sciences. While the doctrines of Chemistry, may be subjected to the infallible test of experiment ; and the problems of Mathematics admit of demonstration, the Meteorologist has to be guided by the light of observation, and to infer one fact from the existence of another. The very useful and important discovery of the Barometer, and Thermometer, &c. has been of singular advantage to him in conducting his enquiries, and of leading him to the knowledge of a great number, and variety of facts, connected with different departments of his subject. Nevertheless, much still remains to be accomplished, before the necessary means be provided, of solving all the problems of the Science, and of forming a theory of wind and weather that will not admit of correction, or amendment.

The atmosphere is that subtle, invisible, and elastic fluid, by which our globe is on all sides surrounded, and which acts as a powerful, and very frequently as a principal agent, in those changes, which are continually going on on its surface, but more especially, among its various animal, and vegetable productions. In treating of the principles of the Science in question, it will be proper to begin, with a very slight and general account, of the composition of the atmosphere; and then to take a more full, and extended view, of the several properties, on which its agency in the economy of nature, and its many interesting phenomena depend. The chief of these are its Gravity, Temperature, Mobility, and Moisture; and to these I mean to confine my attention.

To enter into a minute, and lengthened account, of the composition of the atmosphere, would only be a useless waste of time; as it would afford us little, or no assistance, in the investigations, on which we are about to enter. Its principal ingredients, are Nitrogen Gas, and Oxygen Gas, and these are in common atmospheric air, more properly speaking mixed, than combined. It is by the quantity of Oxygen existing in the atmosphere, that it supports animal life, and combustion. When the Oxygen is separated from the Nitrogen, the latter if breathed alone would be fatal; and if blown into a fire, it would serve to extinguish it. Such is the structure of the lungs in animals, that the Oxygen which is drawn into them in breathing, combines with the superabundant carbon of the venous blood, which it has collected in its passage through the system; and is expelled in respiration, in the form of carbonic acid gas. The air which we respire, in breathing, is not then precisely the same as that which we inhale. Every time it is breathed, it is deprived of a given portion of its Oxygen, and becomes less fit to be breathed again; and when a number of people are met, in a close apartment, which is artificially lighted, the oxygen is consumed in two ways. Namely, by being repeatedly breathed, and by supporting the flame, or burning of the lights; and its diminution under such circumstances, is also indicated in two ways; namely, by the increased difficulty of breathing, and by the dimness with which the lights burn.

I. The first property in atmospheric air, to which it is necessary to pay particular attention, in order to account for its various phenomena, and extensive agency in the system of nature, is its gravity, or weight. The weight of any given measure of air, depends in a great degree on its density; and as a change in its density may take place in an instant, and be brought about by a variety of causes, it would serve no useful purpose, to give the weight of different measures, at different degrees of density, or compactness. The atmosphere is supposed to rise to the height of forty five miles, above the surface of the earth; but whether this be the case, or not, there can be no doubt, that it rises to a very great height, and that altogether, the weight of it resting on the surface of the globe, amounts to a fraction less than 15 lbs. to the square inch. A man of an ordinary size, supports a load of from 14 to 15 tons on his person, and a young lady, when moving with such a light and elastic step, as to make it appear uncertain whether she touches the earth, or not, is carrying a burden of eight or ten tons, on her slender and delicate form. This may to some appear impossible, and it would certainly be so, were it not that the pressure from without meets with an equal or correspondent resistance, from the air that is within. Every limb, and muscle of our bodies, is so completely filled with air, and air in a sufficiently compact state, to resist, or neutralize, the pressure on the surface. Indeed we would require to be differently constituted, in order to live, and move in a different element, for the pressure of the air is not only no inconvenience to us, but it is actually necessary to our comfort, and even to our existence. When Humboldt, and Bompland, ascended the Andes, to the height of 19,000 feet, the air became so much rarified, and attenuated, that the smaller blood vessels about their noses, mouths, and eyes, &c. being deprived of their customary support from the air without, and unable to restrain the elasticity, or expansive force of the air within, suddenly gave way, and the blood trickled from them in many places. Whoever has witnessed the operation of cupping, which is performed by scarifying or puncturing a particular part of the skin, and placing over it a cup or glass, from which the air has been in a great measure previously expelled, and the air within is consequently left without resistance, to repress, or restrain it; has had an opportunity of seeing the consequences that would attend our being deprived of the external pressure of the air. Were it possible for the lady who moves with so much grace, and ease, under a load of nine tons avoirdupois, to subsist in a vacuum, she would require for the time to be corsetted in mail, and laced with chains, to prevent her from expanding into such dimensions, as would certainly ruin her prospects for life, if they did not altogether prove fatal.

Any person may satisfy himself that the weight of the atmosphere, cannot be greatly below what has been stated, by placing his hand on the mouth of an exhausted receiver, or of any vessel, from which the air is removed, and all support from below withdrawn; but the Barometer is the surest and best instrument, and the one most frequently employed in ascertaining this point. A tube of three feet in length, having its upper end hermetically sealed, is filled with mercury to the very top, which is for that reason turned downwards, and then brought again to its proper position; when the mercury falls down into the cup, or ball at the bottom, leaving a vacuum at the top, till no more remains in the tube, but what is balanced, and supported by the air, and though this varies according to the state of the air, its mean height is from 29, to 30 inches, at the level of the sea. The level of the sea, being the lowest situation on the surface of the earth, at which an observation can be taken, the weight of a column of air at that level, extending from the earth to the upper boundary of the atmosphere, is found to be equal in weight to a column of mercury, of the same diameter, and rising to 29, or 30 inches in height. Now the weight of mercury being to that of common atmospheric air, as 1, is to 11,040, and this multiplied by 29¾ inches, will give 334,880 inches or 27,906 feet. Again it is known, that water can be raised in a pump at the level of the sea, to a height of 34¼ feet; and that being done by the pressure of the air, on the surface of the water in the well, forcing it up into the vacuum created by the raising of the piston, a column of air extending to the upper boundary of the atmosphere, must be equal in weight to a column of water having the same diameter, and extending in height to 34¼ feet. Now as water is 13½ lighter than mercury, and 816 times heavier than air, this latter number multiplied by 34¼ feet will give 27,948, making no more than a difference of 42 feet between the two methods of calculating its amount. This coincidence between the two methods makes them tests of each other's accuracy, and they respectively prove that the weight of the air at the level of the sea amounts to from 14 to 15 lbs. to every superficial, or square inch of the earth's surface, for such is the weight of 30 solid inches of mercury, or 411 of water.

When I say that the water in the pump, and the mercury in the Barometer, respectively prove, that the atmosphere rises to the height of 27,900 feet, above the level of the sea; I must be understood to mean, that this would be its actual height, provided its density were precisely the same, from its lowest to its highest boundaries. But this cannot be the case, for it is necessarily far more condensed at the level of the sea, where it undergoes the pressure of the whole superincumbent mass, than it is in the higher regions, where a great part of that pressure is taken off. Air being a highly elastic fluid naturally becomes more expanded, or dilated, in proportion as it becomes less confined; and the consequence is, that one solid foot of it, at the level of the sea, where it is pressed together on all sides, would expand into many feet, were it raised to the upper regions, where a great part of that pressure is removed.

At the level of the sea, the medium height of the mercury in the Barometer, is not more than 29 inches, and at the Convent of St. Bernard's, which is only 8,040 feet above that level, its medium height is only 14 inches. And Saussure ascertained, that between Geneva, at the height of 1324, and the Col du Gean, at 11,275, it had lost upwards of one third of its density. If the Barometer stands at 14 inches, at the height of 8,040 feet above the level of the sea, it is evident that more than one half of the whole mass of air, by which our globe is surrounded, is contained within that space. And we have no more than the other half to fill up the 229,760 feet, which remain to be occupied.

Some have supposed that this diminution in the density of the atmosphere, takes place according to the following ratio. At the height of 3½ miles, it is diminished twice as much, as at the level of the sea, at the height of 7 miles four times as much; at 14 miles, sixteen times as much; at 28 miles, two hundred and fifty six times as much; and that if the air had risen to the height of 500 miles, instead of 45, one solid inch at the common density, at the earth's surface, would become so exceedingly attenuated, and expanded, as to be sufficient to fill a hollow sphere, equal in circumference to the orbit of Saturn. But this idea is too sublime to be seriously discussed on such an occasion as this, and I therefore return to the consideration of facts, which if less calculated to dazzle, and surprise, are so much the more open to investigation, and better calculated when fully understood, to lead us to an acquaintance with the mysteries of nature.

Though the atmosphere may be more condensed in one latitude, and more expanded in another, it is very equally apportioned, or divided among all the different latitudes, from the

Equator to the Poles; for the observations of Mr. Bouguer, on the coast of Peru; those of Sir George Suckburgh, in the Mediterranean; and those of Lord Mulgrave, in the Arctic seas, gave all very nearly the same results. In all of them the highest range of the Barometer was found to be from $29\frac{1}{2}$ to 30 inches, which is equal to a pressure of from $14\frac{1}{2}$ lbs. to 15 lbs. to a square inch of the surface of the globe; and from this it has been calculated that the weight of the atmosphere altogether, amounts to 1, 911, 163, 227, 258, 181, 818 lbs. avoirdupois.

There is then the same weight of air on every part of the earth's surface; but in the warm latitudes, this is far more expanded, and occupies a much larger space, than those that are colder. If the Barometer fall a given measure, for every 200 feet that we rise above the level of the sea, in the temperate regions; it will fall nearly twice as much, for the same ascent in the arctic, and only about one half in the torrid zone. So that a stratum of air of 400 feet in thickness, at the Equator, is equal only to one of 200 feet in the temperate, and one of 100 feet in the frozen zones: all the three being taken at the same proportion above the level of the sea. The consequence is, that man, and all other animated beings, can exist in far more elevated situations, near the Equator, than in the frozen, or even the temperate zones. On the Andes, and the mountains of Central Asia, men have established themselves in considerable communities, at an elevation of 11,000 feet and upwards; but this would be impossible in Europe, and still more so in the arctic regions. Humboldt and Bompland ascended to a height of more than 19,000 feet on the Andes; but the top of Mount Blanc is as high as any man could ascend in Europe, had he even the means and opportunity of going far beyond it; and yet Mount Blanc is less in height by 3,600 feet than the point in the Chimborazo attained to by the travellers.

Though then the same weight of air rests upon every part of the earth, it is far more rarified, and expanded, in the warmer, than in the colder regions; and must of course rise to a far greater height in the one, than in the other; and this fact ought to be kept in mind, as it accounts for some very interesting phenomena, to which we shall have occasion to advert in the sequel.

The weight of the air, is not precisely the same in the same place at all times, and the variations are indicated by the range of the Barometer; which in the temperate regions, extends even to a number of inches. This shows, that the air is considerably lighter at one time, in the same place, than it is at another; which must be occasioned by a reduction in its quantity; and this may arise, either from the circumstance, that a portion of it is temporarily withdrawn from one place, and accumulated in another, or that a part of it is decomposed, and abstracted from the general mass, to be restored to it at another time. The range of the Barometer is less within, than without the tropics, which is easily accounted for, and also in North America, than in the same latitudes in Europe, the reason of which is perhaps unknown. It is also greater in winter, than in summer, which may be partly owing to the fact, that during the former we have a greater amount of air in our northern hemisphere, than during the latter. In the winter the air is more condensed in the Northern, and more rarified and expanded in the Southern hemisphere. And being raised to a greater height above the earth, in the warmer than in the colder hemisphere, a proportion of it naturally falls over to the lower side. This extra quantity of air which we have in the winter, is restored in the very same way to the Southern hemisphere, during the summer; when the states of the two hemispheres are reversed. This is partly the reason, why we have so much heavier gales in winter, than in summer; and it is also one of the reasons why the Barometer takes a wider range in that season of the year.

II. The second point to be considered, is, the temperature of the air, together with the means by which it is equalised. It does not belong to the Meteorologist, to discuss the merits of the conflicting theories, respecting the nature and origin of heat; or, to determine, whether it is a material substance, or only a vibration among the particles of matter, originating in friction, percussion, &c.; and on this ground I shall not enter. The heat of the atmosphere is either derived from the sun, or is set in motion by his agency; but his influence is modified by a number of circumstances, which should be kept in view, in all our calculations on this subject. It does not appear that the rays of the sun, have any sensible effect upon the air, till they first come into contact with the earth, and are reflected by its surface; for the higher we ascend above the earth, the colder does the air become, till we at last attain to the region, or domain of everlasting frost. The more that air is rarified, and expanded, it has the greater capacity for absorbing heat, or of reducing it to a fixed and latent state. And the higher we ascend above the level of the sea, the air having the less weight to compress it, becomes the more expanded through its own elasticity; and the heat that reaches the higher regions, is of course more rapidly absorbed, and reduced to a state of complete inactivity. Under the Equator, the Thermometer falls about 1° in the scale of Fahrenheit, for every 300 feet above the level of the sea; and in proportion as we advance near to the Poles, the fall becomes more rapid; and after we reach a certain elevation, we come to a point in every latitude, where the Thermometer never exceeds 32°, and where ice, and snow are never melted. This is called the line of perpetual congelation.

The line of perpetual congelation is sometimes spoken of as an inclined plane, extending from the Equator to the Poles, and by others it is represented as the companion of the cycloid; but neither the one nor the other of these is correct. It is a curved line, but its curvature is not the same with that of the hemisphere; for it is raised a great way above the earth, at the Equator, and comes into contact with it, long before it reaches the Pole. The following account of it, is from the Edinburgh Review, No. 59, in an article on the Polar ice, and North West passage, which is said to have been from the pen of a distinguished writer. "Under the Equator the mean height of eternal frost, is, 15,207 feet; in lat. 30° it is 11,484; in 60° 3,818; and it comes into contact with the earth at the Pole." If this be correct the line of perpetual congelation, comes nearer to the earth at the mean rate of 145 feet, for every degree of latitude, within the tropics; at 283 feet, for every degree between 30° and 60°, and at 227 feet, for every degree between 60° and the Pole, which cannot be correct. It was perhaps a slip to say, as the writer does, that the line of perpetual congelation touched the earth at the Pole. If he had given the 65th degree of N. lat. his statement would not in the last part of it have been far from the truth. But I would take the liberty of saying that as it stands, no part of the statement is correct. M. Bouguer determined by actual observation under the Equator, that the line of perpetual congelation, is as high as 15,730 feet. Burnes again ascertained, that the base of the Koh i Baba, in the Hindoo Koosh in lat. 35 °, is 13,000 feet above the level of the sea; and yet the frost and snow leave it in May. The peak itself, which he estimates at 18,000 feet is for ever covered with snow, not only at its summit, but a considerable way downwards, yet the line of perpetual congelation cannot be lower there than 13,500 feet; and from Burnes's account it is probably considerably higher than this. This gives a descent for the first 35 degrees of lat. of 64 feet, instead of 145 to a degree. Again, it is known that the height of the line in question, does not exceed 10,000 feet, in lat. 45 °, which gives a descent between 35 °, and 45 °, of 350 feet to a degree. Between 45 ° and 60 ° the descent is 450 feet to a degree; the line of congelation at the latter parallel being 3,800. And in 65 ° it comes in contact with the earth, which gives a descent in the last space of 700 feet to a degree.

The air, like every other fluid, becomes more rarified, and lighter, when its temperature is increased, and denser and heavier when its temperature is diminished; and in consequence of this, the lowest stratum of the air, very often changes places with the stratum which rests immediately over it; and the temperatures of the two, are kept more nearly the same, than would otherwise be. When water is heated to 212 ° at the bottom of a pot, it becomes so much lighter as to rise up to the surface, while the cooler water at the surface falls down into its place, and thus occasions the phenomenon of boiling; so the air when heated at the surface of the earth, by the reflection and condensation of the rays of the sun, immediately ascends to the place of the second or third stratum, while the latter descends and takes its place.

If the temperature of the atmosphere, decreases, in proportion as we ascend to greater elevations above the earth; it is also diminished, in proportion as we recede from the Equator, and advance towards the Poles. We have first the torrid, then the temperate, and last of all the frigid zones. This diminution of the heat of the air, according as we advance into higher latitudes, may be imputed to the increased distance of the sun from these latitudes; but this would have no sensible effect, were all other circumstances precisely the same. The power of the sun, depends not on his nearness, or distance from the earth; but on the angle of the coincidence of his rays with the earth. If we throw a ball at right angles against a tree, or any other object, it will strike it with a far greater force, than if its direction were so oblique that it merely grazed on the surface of the object, and started off on another course. The sun is more than two millions of miles nearer to us in December, than in June, and yet his power is far greater in June, than in December; because in the latter, his rays fall on the earth much more obliquely, and consequently with a greatly diminished force. And not only do the rays which actually strike the earth, strike it with a greatly diminished force; but a far smaller number of them actually comes into contact with the earth. It has been calculated that one fifth of the rays of the sun do not reach the earth at all, even when they are vertical; that little more than two-thirds of them, reach it at an angle of fifty degrees; that about one fifth only reach it at an angle of seventy degrees; and that when their direction is horizontal, or parallel to the earth's surface, there is no more than one ray out of two thousand, that comes into contact with the earth at all; so as to produce any effect. Under the Equator the mean direction of the sun's rays is vertical or perpendicular; and in that place they have their greatest effect; but for every parallel of latitude towards the North, or South, their direction becomes more oblique, and their force is diminished in the same proportion.

As the temperature of the air depends primarily, on the action of the sun, it is natural to suppose, that any two, or more places in the same parallel, and at the same elevation, should enjoy or suffer the same climate; because they receive the rays of the sun at the same angle, and in equal numbers; and this opinion is entertained by many, who have not paid due attention to the subject. Mr. Young has asserted it as an indisputable truth, in his 'Letters of Agricola;' with a view to encourage the Farmers of this Province, to cut down their forests and cultivate their land. According to him nothing more than this is necessary, to transfer the delightful climate of Italy, to Nova Scotia; and make the shores of the St. Lawrence, and the Bay of Fundy, like the flowery banks of the Loïre, and the Po. The object of this representation is certainly praiseworthy in the highest degree, yet we have reason to suspect that the representation itself, is little more than a delightful dream. The severity of our climate is the effect of an established, and permanent law of nature; and that law will be but little affected, by the influence of the axe, the mattock, or the plough.

The difference between the climates of Europe, and America, was observed at a very early period, and different ways were taken to account for it. It was most frequently imputed to the magnitude, and height of the mountains of America, and the number and extent of its lakes, and capacious inlets of the sea. These reasons may satisfy those who are disposed to be satisfied, but they will never satisfy men of well-informed, and inquisitive minds; for if there are elevated ridges in the new world, there are still more elevated ridges in the old. High as Chimborazo raises its summit, it will not for a moment bear a comparison, with the more majestic and towering heights of the Dhawalagiri, and Jewahir; and if the Andes, and the stony mountains of America, affect its climate, why should not the Himmalaya, and the Altai, the Hindoo Koosh, and other elevated ridges of Central Asia, and Europe, have an equally unfavourable effect upon the climate of the old world. And as for the lakes, and arms of the sea, in North America, they should on the known and acknowledged laws of nature, have the opposite effect of what is imputed to them. The melting of the ice which is formed on them in the winter season will no doubt have the effect of keeping the spring cold, and making the summer later; but they should also delay the approach of winter, and mitigate its severity when it does come. During the summer these lakes, and arms of the sea, take in a vast store of heat, which is slowly returned to the air, after it begins to cool by the shortening of the days, and the departure of the sun to the southern hemisphere.

Humboldt was the first who, discarding conjecture and fanciful theorising, made the clear, and steady light of science, to bear on the point under consideration; yet he did little more than to point out the path, which in due time will conduct others, to a full, and satisfactory solution, of all the difficulties by which it is beset. From a cautious, and minute comparison, of a great number and variety of observations, partly made by himself, in different parts of the world, and partly communicated to him by others, on whose accuracy, he could fully depend, he formed a system of Isothermal Lines, or lines where the mean temperature is the same, although they run through different parallels; and from these it appears, that the line of 32° the freezing point, commences in Lapland, in lat. 66°, and taking a course so many points to the southward, passes through Table Bay in Labrador, in lat. 54°, and continuing nearly the same course, through a considerable part of the continent of North America, it again takes a North West course, till it at last reaches the latitude of its commencement, somewhere on the Western side of that continent. The line of mean Temperature 41° begins at Stockholm, the capital of Sweden in lat. 60°, and running in a direction a very little less southerly than the former, passes through St. George's Bay in Newfoundland, and Rustigouche in New Brunswick, in lat. 48° 30' and following nearly the course of the former, comes again to the lat. of 60°. The line of mean Temperature 50°, commencing in Belgium in lat. 50°, runs through Massachussets, in lat. 42° 30', and the line of mean Temperature 39°, commencing in Italy, in lat. 43°, runs through North Carolina. in lat. 36°. These lines are not then altogether segments of circles, but are more properly speaking parts of ellipses, and become more inclined to straight lines, as they become more southerly. The higher the latitude, the greater is the difference between the temperatures of Europe, and the eastern parts of North America; and the nearer the Equator, it is proportionally less. The greatest difference in the lat. of 30°, is only 3°, in lat. 40°, it is increased to 8°, in lat. 50°, to 12°, and in lat. 60°, to 16°.

These differences in temperature, are found only to exist between the western parts of the old world, and the eastern parts of the new; for the temperatures of Europe, and the western coasts of N. America, are nearly the same in the same parallels. On the other hand, the eastern parts of the old world, correspond as nearly in regard to climate, as the eastern parts of the new. Thus, for instance, the climate of Pekin, is as near as possible the climate of Philadelphia, which is in the same degree of lat. with it; and the climate of Kamschatka, is not milder than that of Labrador. These facts led Humboldt to the hasty conclusion, that the eastern sides of all great continents, are colder than their western sides; but into the causes of a fact so incautiously assumed, that distinguished philosopher does not venture to enquire. His authority however has been deemed sufficient, by the majority of writers on physical Geography, while those who have had the courage to dissent from an authority so respectable, or perhaps differed from it without knowing it, have continued to insist on the influence of mountains, lakes, and woods, as sufficient in themselves to account for the whole.

It would appear, that the attention of the scientific world, has been drawn anew to this very interesting and important inquiry, in consequence of the discoveries which have lately been made, through the recent expeditions into the Arctic regions; and it appears to me that these discoveries, at least in so far as Magnetism is concerned, may be so exhibited, as to place the matter under consideration, both in a new, and most interesting light.

It has been fully ascertained, that instead of there being but one Magnetic Pole, or centre of Magnetic attraction, there are two in each of the hemispheres; that they are placed in opposite sides of the globe, and consequently at the distance of 180 degrees on each hand, from one another. The two in the Northern hemisphere have been found to be placed in the 71° North lat. and the probability is, that the two in the Southern hemisphere are in the corresponding degree of Southern lat. We can form a correct idea of their true, and also of their relative positions, by taking a ball of worsted, to represent the earth, and running a piece of wire, or knitting needle through its centre, to represent its axis; then take other two knitting needles, and run them also as nearly as possible through the centre, but in rather opposite directions, or nearly in the form of a St. Andrew's Cross; having the needle that represents the axis of the earth, fair between them at both ends; and they at such distances from it, as may be supposed to correspond, with the 71st degrees of N. and S. latitudes; and we will have a representation in the ends of the two diagonal needles, of the position of the four Magnetic Poles. Let it farther be considered, that these Poles are not stationary, like the Poles of the earth, but are continually moving at a given rate, from East, to West, and keeping at the same distances from one another. And let it be observed moreover, that each of these Poles, forms, by itself, a separate or distinct axis, of Magnetic currents, which move around it at right angles, or in a plane that is perpendicular with its direction: and that these currents form lines on the surface of the Globe, which are called Isodynamic lines, or lines, in which their intensity, or power is found to be the same. Now the centres of these Magnetic currents, or the axis round which they respectively move, being placed obliquely to the axis of the earth, and the currents themselves moving at right angles with them, must approach the Equator more nearly, at the one side than they do at the other. By putting a circular piece of paper upon one of the needles, representing the Magnetic Poles, and bringing it to right angles with it, we will both see that this must be the case, and also the reason why it must be so. It is not I believe known as yet, what disturbing causes may exist, to prevent the Isodynamic lines of Magnetism, to describe perfect circles around their centres, and consequently to form parallels, like the degrees of latitude; excepting this, that the intensity of magnetism, is sensibly effected by heat, and cold. It is known to be augmented by every augmentation of cold, to the utmost degree that can be artificially produced; and to be diminished by every increase of heat, till the Thermometer rises at least to 100°. If we suppose then that the Isodynamic lines, are acted upon in the usual way by an increase of heat, they cannot preserve the circular form, but must take the elliptical, in their lower sides, and come to a correspondence with the Isothermal lines of physical geography. This it must be allowed, is only stating what ought to be the case, and not what is actually proved to be so; for we have not sufficient information on this subject to enable us to lay down the precise direction of the Isodynamic lines. Professor Hansteen of Christiana, who has already done a great deal to solve many of the problems of the science, has been engaged for some years, in making observations in Asiatic Russia, and when he has completed these, the public may expect a full and authentic account of the matter.

The above discussion may appear to be quite foreign to my purpose, or at least very little connected with it; but I shall be able to show, that this is not the case. After a certain progress had been made in the discoveries just referred to, it became perfectly clear, that there is some connection between the intensity of cold, and that of Magnetism, and it began to be suspected that the maximum points of the two, might be found to be at no great distance from one another; and the following observations are made on this subject in the Edinburgh Review, No. 124, p. 447, 448—"In perusing Commander Ross's narrative respecting the Magnetic Pole, we have been much surprised to find that neither he nor Captain Ross, has made the slightest reference to the Pole of maximum cold, which is placed in or near the regions which they visited, and which is supposed to be coincident with the Magnetic Pole. Our readers may not perhaps have heard, that it has been proved, by numerous observations, that the Pole of the Equator is not the Pole of greatest cold, as had always been believed, till it was shown by Sir David Brewster that there were two Poles of maximum cold in each hemisphere. This singular distribution of heat was deduced from observations made by Mr. Scoresby, in the East of Greenland; and from those of Sir Charles Giesecké and the Governors of the Danish Settlements in West Greenland, extending over a period of nearly seven years. It was confirmed by all the Meteorological observations made by Captain Parry and Captain Franklin, and may be considered to be as well established as any other physical fact.

"The position assigned to the Pole of maximum cold in North America was 73° N. lat. and 100° of West long.,—a point little more than two degrees to the North of the Magnetic Pole." This the Reviewer considers as strikingly confirmed by a fact which Captain Ross has mentioned incidentally, but of which he made himself fully certain, and from which it appears that the Thermometer fell very rapidly as they approached the position of the Magnetic Pole.

"These facts," adds the Reviewer "approximate more closely than had been done before, the Magnetic and the Northern Poles." (Does he not mean the Magnetic and the *cold* Poles?) "And it is highly probable that they will be found to have some higher and closer connexion than that of accidental locality. If this shall prove to be the case, the cold Pole will make the circuit of the earth in 1890 years, and we shall thus obtain a satisfactory explanation of those remarkable revolutions which are indicated not only in the climate, but in the animal and vegetable productions of the Globe."

It has been already stated, that there are but 3 degrees of difference, between the temperature of the old world, and that of the new in lat. 30°; and that the difference continues to increase till in lat. 60° it amounts to 16°; and also that the intensity of Magnets, has been found to increase with an increase of cold; and to decrease with an increase of heat; and it has also been noticed, that Commander Ross found from observations made "with such care that he could not have been deceived," that the Thermometer fell rapidly as they approached very near to the position of the Magnetic Pole; and from these facts it seems but fair to conclude, that there is some intimate connection between cold, and Magnetism; and that they act reciprocally on one another.

If the cold, and Magnetic Poles, then coincide, and be connected with one another, they must move in company, and if the opinion of Professor Hansteen be but confirmed, they move at the mean annual rate of 11' 4", and perform the circuit of the Globe in the period of 1890 years. But there are two Magnetic Poles in each hemisphere; and they move at the same rate, and preserve the same distance from one another; so that every meridian, must have a visit either of the one, or the other in the half of the time, or in 945 years. Their Orbit or course is in the 71° N. lat. and the present position of the one, is in the 100° W. long. while that of the other is in 80 E. long. or about the mouth of the Lena, in the country of the Samoiedes, to the North of Siberia.

Here a question may naturally arise; if the cold Pole be moving in connection with the Magnetic Pole, or if in other words they be one and the same, and are visiting every meridian in their turns, with their chilling influence; does history preserve no trace of their passage through the North of Europe? or of the effects which could not fail to attend upon it? If the one Pole is now in the 100° W. long., and moving at the mean annual rate of 11' 4", it must have been in the meridian of Europe in the eleventh and twelfth centuries.—Now though we are not to expect, a set of Meteorological observations for that period, it was a period of great and memorable deeds, and in the annals in which these deeds are recorded, we are warranted to expect that some indirect notice would be found of the state of the climate. The historians of Charles the tenth, of Sweden, inform us that the ice was so strong on the Little Belt, in 1058, that he marched his whole army over it, with all his baggage, and heavy artillery; and there are various other ways, in which the state of the climate, or the weather, may come to be noticed in the annals of nations. It appears that there are such notices in the chronicles of the times; and they are said to have been collected with great industry, and attention to the subject, by Toaldo and Pilgram, of a part of whose work in German, a very interesting abstract is given in No. 59 of the Edin. Rev., p. 23 to 50. The following statements are copied from it. "In 1133, it was extremely cold in Italy; the Po was frozen from Cremona to the sea; the roads were impassable from the quantity of snow; the wine casks burst, and the trees split, by the action of the frost, with immense noise." "In 1216, the Po froze 15 ells deep; in 1234 the Po was again frozen, and heavy teams and loaded waggons crossed the Adriatic on the ice. In 1236 the deep and majestic river of the Danube was arrested in its course, and converted into a solid mass of ice from the top to the bottom". It is evident, that the cold was the most severe, in the centuries from which these years are taken; but there were cold winters before these centuries, and also after them; and the cold appears to have been greater in the East of Europe, before these periods, and in the West after them; for in 763, the Hellespont itself was covered with ice, and in 1269 the Categat was frozen so as to be passable all the way from Norway to Jutland.

It is but little that we know of the climate of North America in those days, but the little that we do know, gives countenance to the opinion that it must have been equal, if not superior to the climate of Europe. Greenland was discovered in 982, by Eric Rande or the Red, a turbulent and plundering Norwegian chief, who had been banished to Iceland some time before on account of his misdeeds. He wintered in the new country, and had therefore a very fair opportunity of becoming acquainted with its climate; and he not only bestowed on it the name of Greenland, on account of its verdure, but gave such a flattering account of it generally, as induced a number of emigrants to repair to it, from different countries, among whom were some from Orkney and Shetland, and other Northern parts of Scotland. In 1062, Lief the son of Eric, explored the country so far to the South, that he wintered in a place, where the shortest day was 8 hours long; and that must of course, have been in the 52° or 53° N. lat., and consequently on the coast of Labrador, or Newfoundland. And he represented the climate as mild and agreeable, and the country as being in many respects inviting, its woods abounding with delicious fruit, in the summer season, and its rivers with the finest kind of fish, &c. Moreover, it is known, that the Danes, formed the settlements or Colonies of Oestre Bygd, and Vestre Bygd, in East, and Western Greenland, sometime in the eleventh century; and that they continued to increase, and in some measure to prosper, till the fourteenth century, when they began to languish, and were finally either completely ruined, or shut in by the ice in the fifteenth century, and excluded from all further intercourse with the rest of the world. The Edinburgh Review, No. 59, endeavours to discredit this account, but allows that the Court of Denmark has from time to time, made repeated efforts to restore the communication; which shows that the account is seriously believed, in the very quarter where the best means are possessed of ascertaining whether it is true, or false.

If we go back again till near the commencement of the Christian era, when another of the cold, or Magnetic Poles, should have been passing over the North of Europe, we will find the writers of that age, representing the climate in the East, and North, as uncommonly rigorous, in the winter season. Every body knows, that the Poet Ovid was banished to Pontus, on the Asiatic shore of the Euxine, or Black Sea, by the Emperor Augustus, where he remained for eight, or ten years, and he represents that sea, as being passable on the ice, in the winter season, and as having in his own view, been traversed by loaded teams of oxen. And Virgil represents the inhabitants about the Northern shores of the Black sea, and the banks of the Danube, as living under ground in the winter, "Vessels of brass," says he "are frequently burst asunder; their clothes grow stiff on their backs; they divide their wine with axes; whole pools are suddenly congealed; and icicles dangle from their uncombed beards." Many other accounts could be produced, were it necessary, of the extreme severity of the climate of the East, and North of Europe, in that age. Columella, who wrote in the days of Claudian, represents it as beginning to improve, in his time, and it would appear as I have already shown, to have deteriorated again in the middle ages.

Such are the grounds on which I suppose, that the Magnetic or cold Poles visit every meridian of the Globe, in regular periods, of nearly ten centuries. It is not improbable that the periods may be somewhat longer than has been supposed; for though Hansteen has calculated the mean annual motion of the Magnetic Pole to be 11 min. and 4 sec., as has been already stated, there are others who consider this point as not yet fully settled. I have been the more full, and particular, in the discussion of this point, of the cause of the difference between the climate of Europe, and that of America, because the view given of it is new, because so far as I know, the reasoning now used in support of it, is also new, and on these accounts it should have been rendered as full and clear as possible.

If the position of the cold Pole be moveable, and if it be the same, as is supposed, with the Magnetic Pole; milder seasons than we have hitherto experienced, will again be enjoyed in this country; and it is not impossible, that the lateness of our springs, and coldness of our summers, for some years past, may be connected with the commencement of their return. The first symptoms of a change to the better, will be winters a very little milder, followed by late springs, and colder and wetter summers: for if the mean temperature of our climate be raised, it will have the effect in the first instance of detaching from its moorings, a great mass of that ice,which has been accumulating for ages in the arctic regions; and this reaching our latitudes before it is melted, a great proportion of our heat will necessarily be expended in the process; and the temperature both of the waters, and the atmosphere, will be lowered accordingly. But this effect will only be temporary; for the more moveable masses of ice in the arctic seas, will soon be disengaged, and the consumption of heat occasioned by them, will soon be at an end.

The actual amelioration of the climate, however, does not keep pace with the causes in which it originates. Winter does not set in as the days shorten, nor does summer return as their length is increased. During the summer, the earth and sea, have been taking in a store of the surplus heat, which they gradually return in the decline of the year, and by so doing keep off the approach of winter for a time. On the other hand, in the beginning of the year, though the days become longer, the power of the sun is counteracted, and his heat wasted, in the melting of the ice, and snow of the winter; and the spring is kept back till these are gone. And although we were at present nearer than we really are, to the division line between the operation of the two Magnetic Poles, we might not be so close on that amelioration of the climate, to which it may be reasonably expected to lead.

There are many important changes in the temperature of the air, which are local, and temporary. The lower strata of the atmosphere, are, generally speaking, proportionally warmer than the higher; but this order is occasionally reversed. A Thermometer placed on the top of Arthur's seat, near Edinburgh, was sometimes observed in the winter season, to indicate a greater degree of heat, than another which was placed about 700 feet below it. And we not unfrequently observe fogs, and other symptoms of mildness, on the tops of our mountains in this country, while the frost continues very intense in the plane below. There is at the surface of the earth, a regular current of air, from each of the Poles, towards the the Equator; where being heated, and rarified, it mounts up to the higher regions, from whence it is returned again to the Poles, to perform the same circuit anew. And though its temperature is reduced in the upper regions, it sometimes remains higher than the state to which it is reduced in cold weather at the surface of the earth.

The temperature of the air may sometimes appear to us to have been reduced, when it has actually been raised, and that to a very considerable degree. It is no uncommon thing to hear complaints of the chilliness of the air, at the commencement of a thaw. Now when the snow is beginning to melt around us, it cannot possibly be becoming colder. But there is nothing attended with a greater waste, or consumption of heat, than the melting of ice. The heat that would raise 135 lbs. of water, one degree, would do no more than melt a single pound of ice, which had been already heated to the melting point or 32° of Fahrenheit. When the melting of ice therefore, is going on, there is a very great absorption of heat going on along with it, and the capacity of the air for the reception of heat, is constantly increasing during the process, and the consequence is, that the heat which is generated in our bodies, radiates more rapidly and more copiously from their surfaces, and this is attended with a sensation of cold. On the other hand, when it is freezing moderately, there is not the same absorption of heat going on around us, and that which is generated within our systems, not being withdrawn so rapidly from them, serves to keep us in a more comfortable state.

The great waste, or consumption of heat, attendant on the melting of ice, snd snow, is a wise and benevolent arrangement of nature. All sudden and great transitions, from cold to heat, and *vice versa*, are injurious to every thing possessing vitality; and it is of the utmost importance, both to animal, and vegetable existence, to have these moderated, and kept within bounds. Besides, were ice, and snow, as easily melted, as air or even water is heated, a thaw, after a heavy fall of snow, would produce such a sudden and excessive rise, in all running streams of water, as could not fail, to be attended with the most distastrous consoquences to many.

It only remains, on this department of the subject, to point out the means by which the temperature of the atmosphere is preserved, and equalised. The earth is not a good conductor of heat, and for that reason it penetrates but a short way into it; and were there no other means of transmitting it from one place to another, it would soon accumulate to such a degree, within the tropics, as to ruin every living thing. While at the same time, the arctic and even the temperate zones, would not have enough to carry on the various and important processes, for which it is required. A powerful heat, produces no sensible effect through a very few feet of mason work, and it would be long before it penetrated through the earth, from the 30° to the 60° of latitude. The surface of the earth receives and reflects the rays of the sun, and by so doing renders them a great deal more powerful, than they would otherwise be; but when it has accomplished this it goes little farther, and leaves it as it were to other agents to distribute that heat which it has evolved, or put in motion, more equally over its whole extent.

The sea is the great agent employed by nature, in accomplishing this important object. From the transparency of water, it is easily penetrated by light, and heat, and the rays of the sun do not only enter it with facility, but they descend to the very bottom, and are equally diffused through the whole mass. The waters of the ocean do not only receive those rays of the sun, which fall upon themselves, but they are so distributed over the surface of the Globe as to take off from the land any excess of heat which may exist upon it. In this way the superabundant heat of the equatorial regions, is regularly withdrawn, and transmitted to those regions where a deficiency is felt, for water is not only a good conductor of heat, but its conducting power is greatly assisted by the action of its currents. Thus where the heat is inclined to become superabundant, it is kept down, and the excess of one region, is employed to supply the deficiency of another.

But besides equalising the temperature of the air in the way, that has just now been pointed out, the sea serves the purpose of a great reservoir, or storehouse of heat, in which all that is unnecessary at one time, is collected and laid up for the use of another. What is sent down to the very bottom, in the heat of summer, is kept in reserve for the cold of winter, and is again gradually restored to the air, during the latter period. It is the property of all fluids to increase in density as their temperature diminishes, and no sooner has the water on the surface of the ocean been deprived of its heat, by the air which rests upon, or moves over it, than it settles down and is replaced by a warmer stratum from beneath; and these successive changes go on, till the whole mass is reduced from top to bottom to the temperature of 40°, and here the process stops; for whenever water is reduced below 40°, it immediately becomes lighter, and more buoyant, and consequently keeps its place on the surface. This prevents the waters of the ocean from being ever cooled down to such a degree, as to endanger the existence of its numerous tribes of inhabitants, and it likewise serves to keep the temperature of the air higher than it might otherwise be. When the whole mass from top to bottom is reduced to 40°, every stratum keeps its own place, and there is no more rising and falling. What is uppermost continues to cool till it comes to 32°, the freezing point, and is converted into ice. The stratum that is next to it continues also to give out its heat, till it is likewise turned into ice; and every succeeding stratum in its order, till the season changes and puts an end to the process. By this means the severity of the cold is moderated, wherever there are large collections of water, and for this very reason, the numerous and extensive lakes, and bays, in North America, cannot be the cause of the severity of its climate, as many eminent men have alleged.

When we consider the immense superficial extent of the sea, amounting to more than two thirds of the surface of the Globe, and add to it the vast depth of its waters, which according to Laplace must be 12 miles, at an average, in order to account for the usual rise and fall of the tides, and taking its mean temperature at 55°, we will see what a store of heat it must have in reserve, and what the air may receive from it before that store is exhausted.

III. The next point to be considered, is the motion of the air, and the means by which it is occasioned. The air is very often either in appearance, or in reality, in a state of rest; but it is easily agitated, and put in motion, and is at all times subject to changes, which have this effect upon it. To its motions we give the name of breezes, and winds, &c.; and these may be divided into three classes; namely, those that are constant in their motion, and unchanging in their direction; those that are constant in their motion, but changeable in their direction; and those that are inconstant, or changeable in both.

With regard to the first of these classes of winds, namely, those that are constant both in regard to their motion, and direction; the heat of the sun is the grand agent by which they are first put in motion, and also by which their motions are regulated, and maintained. When the temperature of any particular place is increased, be the cause what it may, the air in that place becomes rarified, and lighter, and yielding to the law of all fluids, it gives way to the pressure of the colder, and denser air in its neighbourhood, which consequently rushes in, and displaces it. The air within the torrid zone, being continually exposed to the powerful action of a vertical sun, is necessarily heated to a great degree beyond that of the temperate, and frigid zones, and is consequently pressed upon, by the denser air, of these regions, in both hemispheres, and forced upwards to a great height above the surface of the earth. It is so rarified, even under the Equator, at an elevation of 20,000 feet, as to be totally unfit for the purposes of respiration, yet it rises many times higher, and still carries up a proportion of aqueous vapour with it, for the Himmalaya ridge which rises in the 35° N. lat. to the gigantic height of 28,000 feet, is covered with snow to its very summit.

Were the atmosphere subject as many have alleged, to the full influence of the centrifugal force, I do not see what could prevent it from accumulating within the tropics, and being in a great measure withdrawn from the higher latitudes; for there is, from the rarifaction of the air within the tropics, a continual current towards the Equator, in both hemispheres; and the rarified air mounting to the upper regions, and not being detained there by the centrifugal force, falls back again towards the Poles, to perform the said course anew.

The Equator of the atmosphere does not coincide with the Equator of the Globe, but is placed between the 3° and 4° of N. lat. Owing as it is supposed, to the greater extent of land in the Northern hemisphere, than in the Southern, and the consequent greater rarefaction of the air in the former. Here the currents, from the opposite Poles, would come into collision, were it not that they change their course, long before they reach the point of actual contact. In the higher latitudes, where the rotatory motion of the earth is less, the atmosphere appears to keep pace with it, but it is necessarily much increased at the tropics, on account of the increased diameter of the earth, and the atmosphere, either from its own incapability of receiving the increased motion of the earth within the tropics, or that motion being counteracted by some antagonist force, is as it were left behind the earth, in its rapid sweep from West to East, and appears to be moving in an opposite direction.

But be the case as it may, the current from the North Pole, by the time it reaches the 32° N. lat. begins to take a South-Westerly direction; and the current from the South Pole, by the time it reaches the 27° S. lat. takes a North-Westerly direction; and both continue to come the more round the nearer they approach the Equator, till at last their course becomes due West; and they then receive the name of the trade winds, on account of the advantage which is taken of them in commerce. Were there an open sea all round the globe, within the tropics, there can be little doubt that the trade winds would perform the whole circuit of the Globe; but their progress round it, is intercepted by the intervention of the extensive continents of Africa, and South America; and in their passage over these burning districts, they become so heated and rarified as to rise to the higher regions of the atmosphere, from whence they are returned again to the Poles. And this return to the Poles, it is no hard matter to explain. If we take the axis of the earth from the Equator to the Poles, for the base of a triangle, and erect a perpendicular upon it at the centre of the earth, the perpendicular rising to the surface of the earth at the Equator, will exceed the length of the base by 35 miles, the earth being 70 miles less from Pole to Pole, through the centre, than when measured through the centre at the Equator. Then add to this the 25 or 30 miles more, that the atmosphere rises above the earth at the Equator than at the Poles, and the perpendicular will be 60 miles longer than the base, which facilitates the descent of the air from the Equator to the Poles. Being elevated to a height of 45 or 50 miles above the surface of the earth at the Equator, and not being subjected to the full influence of the centrifugal force, it naturally falls down the very steep descent towards the Poles, and performs the same circuit anew.

This continued circulation of the air, between the Equator, and the Poles, serves many important purposes in the economy of nature. Among others it contributes to a more equal distribution of heat over the Globe, and what is of no less importance it tends to preserve the purity, and salubrity of the air. As the blood when returned to the lungs by the veins, is no longer fit to be sent back into the system through the functions of the arteries, till it has been previously relieved of its superabundant carbon, and has perhaps received a proportion of oxygen, so the air in its passage over the earth, towards the Equator, becomes in different respects deteriorated, and impregnated with a variety of noxious qualities, but its return to the Poles through the higher regions, and subjection to the action of the Polar frosts, purify and refine it, and prepare it anew for those important purposes which it is intended to serve, both in the animal, and vegetable economy of nature.

The second class of Winds which I proposed to account for, are those that are constant in their motion, but changeable, and periodical in regard to their direction. The chief of these are the Indian Monsoons, which blow one half of the year from the North-West, and the other half from the South-East. They are only a part of the Trade Winds already mentioned, but subject to the control of local influences. I observed in regard to the Trade Winds, that they come from opposite quarters, and meet between the 3° and 4° N. lat., and in like manner the Monsoons come from opposite quarters, and meet about the 3° S. lat. They blow from the S. E. to N. W. from April, till October, when they change their course, and blow from N. W. to S. E. from October again till April.—The reason of this is, that after the vernal equinox, when the sun crosses the line, and the extent between the Equator, and the tropic of Cancer, is placed under his vertical rays, the air over India and the adjacent countries, becomes so much rarified as to be unable to resist the pressure of the denser air of the sea. The former therefore ascends to the higher regions, and the latter rushes in to take its place; and after the sun has re-crossed the line, at the autumnal equinox, and is placed between the Equator, and the tropic of Capricorn, India, and the adjacent countries cool, and the opposite continent of New Holland, becomes warm, and the wind takes the direction of the warmer country, and continues in that direction for six months, or till the sun again returns to the Northern hemisphere.

The extent of the Monsoons, is much more limited, than that of the Trade Winds. The latter extend over 60 degrees of latitude, or from the 27° S. to the 32° N. lat. whereas the Monsoons do not reach beyond the 10° S. latitude, while their Northern boundary is variable and not well defined. There are a kind of Monsoons in the Red sea; the Mozambique channel; the Bay of Panama; and on the coast of Brazil, between Cape St. Augustine, and the Island of St. Catharines; and they are all to be accounted for in the same way, namely, by the heating of the land towards which they blow, while the quarter in which they originate becomes colder.

It is in the same way, that we are to account for the alternation in land, and sea breezes. When the land becomes heated in the forenoon, a refreshing breeze from the sea sets in, and continues till the afternoon, when the sun declines, and the land begins again to cool; and about the beginning of the night the land breeze springs up, and continues till morning, because the land is during the night colder than the sea. All these motions of the atmosphere, are occasioned by an increase of temperature in one place, while it either continues the same or is diminished in another.

The third class of Winds which I proposed to account for, are those which are both inconstant in their motion, and changeable in their direction. Nothing is more inconstant or more changeable than the wind in the temperate regions. Sometimes it is a perfect calm, and at other times it blows a hurricane, and we have winds of all degrees of violence, and velocity, from one, to a hundred miles in the hour. And they are not less changeable in their direction, than in their velocity, for they blow from all points of the compass, and may change from one, to another, in a very short time. There can be no doubt, that many of these changes have an electric origin, and it is not improbable that the greater part, if not the whole of them, may yet be traced to the influence of electricity. When an electric, or thunder cloud rises in any quarter of the heavens, the wind blows towards it, in a very short time after its commencement. Electricity contributes to this motion in two ways, which although distinct, are connected with one another. In the first place it decomposes a part of the atmosphere, and creates a vacuum, which must be filled up by the surrounding air; and in the second place, it evolves a portion of fixed, or latent caloric, and consequently raises the temperature of the surrounding air for a time, and from both these causes, a rush is created from all quarters towards the place where the changes have happened.

Should the electric cloud, rise between us and an atmosphere that is naturally warmer, and lighter, than that about us; its extremeties may come nearer to us, by means of its increase; yet the body of the cloud will generally speaking be moving to a greater distance from us; because the lighter breeze which has a tendency to bring it our way, is counteracted and overcome, by the denser, and stronger current, which carries it from us. When an electric cloud is formed, it commonly extends itself for a time in all directions, for as soon as the light breeze which blows towards it, in the first instance, from all directions, comes within the range of the electric action, it undergoes the same change, which that which had come before it has undergone, and an addition is made on all sides to the extent of the cloud; yet the density and strength of the wind from the colder quarter, will increase more rapidly than those of the wind from the warmer, and the latter will of course be resisted from the beginning, by the former, and be at last entirely overcome by it. Should the cloud, therefore, rise between us and a quarter that is naturally colder, the denser, and stronger atmosphere, of that quarter, will overcome the lighter, or more rarified wind, that is opposed to it, and bring the cloud our way. Should a thunder cloud rise to the Southward, or Eastward, of the town of Pictou, it will very seldom come much nearer to it; but if it rise to the Northward, or Westward of the Town, it will generally come over it, or pass it at no great distance, on the one side or the other.

It sometimes happens, particularly in autumn, or about the beginning of winter, that after a warm and strong breeze from the Southward, the wind comes suddenly round to the North, or Northwest, and brings a complete change in the weather. The cause of such a phenomenon is this, some local change has taken place in the state of the atmosphere, at a distance from us, to the North or Northwest; and the wind continuing to blow towards it, both from the Southward, and Northward at the same time; and the former being the lighter, and less powerful of the two, is forced back by the stronger, from the opposite direction; till at last the place of meeting between the two, reaches, and passes over us, and we come within the action of the colder, and denser current.

All fluids are subject to nearly the same laws, and there is a striking resemblance between the motion of water, and that of air. If we take a bucket-full of water out of one end of a trough, the whole mass will move forward from the other end, till the vacancy is filled up, and all comes to a level; but if the bucket-full be taken out of the middle of the trough, there will be a correspondent movement from the opposite sides, at the same time; and in both cases, the motion will begin nearest to the place where the water is taken out. The water that is next to the vacuum, being deprived of support on that side, will fall in, and leave what is next to it unsupported, and in this way the motion will extend to the farthest extremities. In like manner when a part of the atmosphere has been removed, whether by decomposition, or otherwise, the surrounding air presses in to fill up its place, and what is behind that, must follow it in its turn, and so on till the whole is set in motion to a great distance. Were a certain portion of the atmosphere removed, and nothing more, its place would soon be filled up, and the whole coming to a level would be again in a state of rest; but the same influence, which in the first instance, produced the motion, very often continues it for a time, for electricity continues to be elicited either, by the collision and friction of the opposite currents, or by some other cause; and the air as it rushes forward, is either decomposed, or rarified, so that the deficiency is still kept up, and the current towards it continues to follow.

We often observe in a thunder storm, that one stratum of air moves in one direction, and another immediately above, or below it, in an opposite one; for the clouds cross, and recross one another, and appear to be in the greatest confusion, and disorder. Now it is known, that on such occasions, the same cloud will suddenly change from a negative, to a positive state of electricity, and back again to a negative; and these changes must have correspondent effects on the state, and consequently on the motions of the air.

The winds are a great deal more changeable in the temperate regions, than within the tropics; and in well cultivated, and thickly inhabited countries, than in barren and desert plains. The constancy of the winds within the tropics, is well known, and Burnes informs us in his travels to Bokhara, that in the elevated, and barren plains of Turkistan, the wind seldom or never changes; but continues Northerly through the whole year. This may perhaps be owing to the circumstance, that in warmer climates, the region of positive electricity is removed to a greater distance from the earth. As we ascend from the lower, to the higher regions of the atmosphere, its positive electricity becomes more intense, and if this depend on the mean density of the air, the region of electricity must be nearer to the earth, in the temperate, than the torrid zone; and its discharges, with their consequences, may be more frequent in the former, than in the latter.

There are however electric changes in the state of the air, in the warmer, as well as in the colder regions; but they are both less frequent, and less extensive. Hurricanes, and Tornadoes, are visitations from which the colder regions are exempted; and the phenomenon of the whirlwind, is most frequently seen in extensive deserts. This is occasioned by a sudden, and great change, in the state of the atmosphere, but confined to a very limited space. Powerful currents are brought into collision, from opposite quarters, and presenting a balanced resistance to one another, they are formed into a rapid eddy, or spiral motion. It is probable, that by their powerful action on one another, heat is evolved, and that they are rapidly and greatly rarified, for they ascend with great force from the earth, and carry up a variety of substances along with them. When opposite currents thus encounter and turn upon a centre; any cloud, or other body which comes within its range, is drawn into the vortex, and if light enough to be lifted up by it it is rolled more closely together, and carried upwards in a rapid whirl. When this takes place at sea, it forms the water-spout; and if it happens, as it very frequently does on extensive sandy plains, it raises lofty columns of sand, which move to and fro, over the desert, according as the different currents preponderate, and when at last it dies away, a large pile of sand is formed, which has been known in some instances, to bury a whole caravan in its fall.

Of the variable winds, one from the South, is the most common in the Northern hemisphere, and one from the North, in the Southern hemisphere. In Europe the wind blows from the Southwest, about 126 days, or one third of the year; and different hypothesis have been formed for the purpose of accounting for the circumstance. If I may venture to give an opinion of my own, upon a subject on which men of the highest respectability have speculated, it is this; that Southerly winds are occasioned by the Aurora Borealis, or Northern Lights. Different theories have been formed respecting this remarkable meteor, but that of Dr. Trail appears to be the most probable, namely; that while different processes are going on, on the earth, a proportion of Hydrogen gas is disengaged, which being very considerably lighter than common atmospheric air, ascends through its own buoyancy to the upper surface of the atmosphere, from whence it descends towards the Poles, where it is collected in such quantities as to be ignited by electricity, as it comes in contact with the oxygen of the upper regions. Supposing this to be the fact, there will on every appearance of the meteor be a vacuum created in the atmosphere, by the condensation, and burning of a portion of the gases; and that will give rise to a Southerly wind. Now it is a well known fact that the Aurora Borealis is generally followed by a Southerly wind, at least in the higher latitudes, and that the farther North, this is so much the more common. When the meteor is brilliant, and rises to a great height in the heavens, it has a less effect on the lower strata of the atmosphere, being removed to a greater distance from them; but when it is low and faint, yet pretty well defined in its upper extremeties, it is usually followed by a Southerly wind, and rain. The time of the change of the wind depends on the distance of the meteor from us. Sometimes it takes place within 24 hours; at other times it is 36; and not unfrequently 48; or even longer. The wind always moves first, in the immediate vicinity of the cause of the change, and latest at the greatest distance from it; just as the water in a canal is moved first, in the neighbourhood of a lock, when the gate is opened, and after that, what is next to it, and so on in succession, till the motion at last reaches to the farthest extremity. When the Aurora Borealis is brighter, and consequently nearer to us, the change in the wind will reach us the sooner, but when it is fainter and lower, and consequently more distant, if the change reaches our latitude at all, it will be proportionally later.

If this account be well founded, the Aurora Borealis will be a part of the complicated machinery of nature, by which a balance is preserved, between the atmosphere of one region, and that of another; and by which a more equal distribution of heat is made, than would otherwise take place.

It is very common in this country in the winter season, for the wind to blow from the Northwest, for three days in succession, and that with a constantly increasing severity; till at last it settles into a calm, and a very intense frost; which is followed in its turn by a Southerly wind. It is easy to account for the gradual diminution of temperature. The floating or active heat, has been carried off by the cold wind from the frozen region; and till that has been restored, or its place supplied, the temperature must continue low. For the calm in which the blow terminates, two different reasons may be assigned; one is, that the vacuum to the Southward, which gave rise to the current from the North, must be filled up, and the rush towards it will stop of course: and the other is, that the denser air in the Northern regions, has been diminished in quantity, and the whole brought to an equilibrium. But it still remains, to account for the change of wind to the Southward. The greater the blow towards the South, the more rapidly is the rarified atmosphere of the Equatorial latitudes, forced upwards to the higher regions; and its greater accumulation there, will hasten its descent again to the Poles; while the cold air from the Poles, has been precipitated on the South, and diminished the temperature of the warmer regions, the air from within the tropics has taken its place; and though cooled in its passage through the upper regions, it is still warmer than the air about the latitudes of the Magnetic Poles, and even to a considerable distance to the Southward of them.

I have thus pointed out the principal causes, by which the equilibrium of the air is disturbed, and currents of it are put in motion; and in so far as these are known, they are ascertained to be, an increase of the temperature, or a diminution of the quantity, in one place and not in another.

IV. It will now be proper to pay some attention to the Moisture of the atmosphere, or the quantity of aqueous vapour contained in it; together with the manner in which it receives it, and afterwards returns it again to the earth. That the atmosphere contains a proportion of water, is universally admitted; but different opinions are entertained, respecting the state in which it exists in it. Some maintain, that it is held in a state of solution in the air, as sugar, and salt, &c. are held in water; and others, that it mixes or combines with the air, in the state of steam. It would be going out of my way, to enter into this controversy, and I shall therefore take the latter opinion for granted; as it is certainly the most common, and appears to me to be the best supported, and most probable of the two.

When a quantity of water is exposed to the air, its volume, or bulk, is gradually diminished, till it entirely disappears; and this process is continued under different degrees of temperature, or whether the air be warm or cold. Indeed it may be a question whether water is most rapidly dried up, in an intense heat, or in an intense frost. The atmosphere then, is continually receiving a supply of water from the earth, in the form of vapour; but there are times when the process of evaporation goes on with more activity than at others. It was ascertained by the experiments of Halley, that water exposed to a summer heat, loses by evaporation in the course of twelve hours, one cubic inch for every ten square inches of its surface, and consequently that every square mile of water, loses 6,914 tons, and every square degree 33 millions of tons in the same time. Allowing seven tenths of the surface of the Globe, to be covered with water, we may form an idea of the vast quantity that is elevated into the air, by means of evaporation, in a summer day. And it is perhaps still greater in the winter season, in the colder climates, for in severe frosts, water dries up as much, if not more in the night, than in the day.

Not only do the extremes of heat, and cold, give greater activity to the process of evaporation, but it is also promoted by the rarefaction, or tenuity of the air. Saussure ascertained, that the atmosphere lost one third of its density, between Geneva, and the summit of the Col du Geant ; and that at the latter place, the rate of evaporation as compared with that at the former, was no less than as 7, to 3 ; and from this he concluded, that the capacity of the air for receiving vapour, is rapidly increased, as its density is diminished. This will account for the very active evaporation which is often known to take place, after an electric or thunder shower. On such occasions, the surface of the earth is often covered with vapour, which rises a little above it, and disappears. This is a benevolent provision of nature, and tends to preserve the salubrity of the air. All sudden, and extensive changes in the temperature of the air, are pregnant with danger, both to animal, and vegetable life ; but there are established checks upon all these, which serve as it were, the purpose of safety valves, and protect us from the consequences of an over action, in any part of the system. When the state of the air is greatly changed, by an electric discharge, it very commonly produces rain, and the copious evaporation which immediately follows it, takes off the excess of heat that may be engendered, for there are few changes attended with a greater absorption of caloric, than that of water into a gaseous state.

The rate of evaporation, depends in some measure on the difference between the temperature of the water, and that of the atmosphere. When they are nearly the same, the process is very slow ; but the greater the temperature of the air, above that of the water, the more abundant is the evaporation. In the temperate regions, where the mean or average temperature is $52\frac{1}{2}$ of Fahrenheit, the annual evaporation is 37 inches, but in 10° N. lat. where the mean temperature is 82°, the annual evaporation is more than 100 inches.

When water has been converted into vapour, its volume, or bulk is increased no less than 1800 times, by the change, and in consequence of this extraordinary expansion, it becomes proportionally lighter than air, and rises to the higher regions of the atmosphere. The vapour sometimes appears from the top of the Andes, to be suspended over the pacific ocean, at the height of 10,000 or 11,000 feet; but at other times, clouds are seen floating, at an elevation of several thousands of feet, above their highest summits; and it is well known, that the most lofty peaks of the Himmalayan ridge, are crowned with everlasting frost, and snow. This rise of aqueous vapour to the higher regions of the atmosphere, is necessary for the supply of brooks, and rivers, which have generally their sources in the higher grounds, and which are of essential service to man and all the inferior animals.

So far as I know, no theory has yet been proposed, that will account in a clear and satisfactory manner, for all the phenomena, attending the condensation of vapour, into clouds, and its descent to the earth in the form of rain. Sometimes the heavens are overcast with clouds during the night, and clear through the day; and at other times, it is the very reverse.— One thing is certain, that it never begins to rain till the firmament is either partially, or generally overcast, and the invisible moisture with which the air is saturated, has become vesicular. Moreover, it seldom, or never happens, that the atmosphere becomes gradually dark, or that the change commences with a light, and general haze, which gradually thickens, and becomes closer, till the rain commences. When those changes in the state of the air, which are followed by rain, have an electric origin, they evidently commence in a particular place, where a cloud makes its appearance, which is gradually increased, sometimes by its own extension, but more frequently by the addition of other clouds, which start up around it, and one after another, become connected with it. But when the change which leads to rain has not an electric origin, the clouds do not arise in the quarter towards which the wind blows, but rather in the quarter from which it comes. This is more especially the case, when the wind is Southerly.

On such occasions, there is usually a darkness in the southern quarter of the heavens, which rests on the horizon, and rises to a greater or less height, according as it is nearer or more distant from us. When it approaches nearer us, a number of small, and distinct clouds, appear to arise over the face of it, and take their flight in rapid succession, towards the north; in the course of which they frequently increase, and form larger masses, by uniting with one another. While this is going on in the lower regions of the atmosphere, but still at a considerable distance from the earth, the upper strata are overspread with a haze, which is at first lighter, but gradually thickens, and continues to descend, till it falls to the region of the flying clouds, and when all are formed into one mass the whole heavens are quickly overspread, down to the horizon, and the rain soon begins to fall. These phenomena may be observed by every one, but they take place at too great a distance from us, to be narrowly examined, and all that we can do, is to form what may be considered as probable conjectures, concerning their causes.

We can attain to a greater degree of certainty, respecting the amount of aqueous vapour contained in the air, and the quantity of rain which it can yield at any given time. I have already stated, that at the level of the sea, a column of water of 34 feet in height, is equal in weight to a column of air, of the same dimensions in other respects, but extending in height to its highest boundaries. Were the whole of the atmosphere then convertible into water, and did the vapour contained in it constitute the whole of its weight, it would contain just as much water as would cover the whole surface of the globe to the depth of 34 feet. But it is only a small proportion of the air, that is convertible into water, and that proportion can be ascertained to a nearness. Water is a compound of $\frac{1}{3}$ of oxygen, and $\frac{2}{3}$ of hydrogen, combined with a certain proportion of heat, which being imponderable, adds nothing to its weight. Now as air contains no more than 21 parts in the 100 of oxygen, it can only afford materials for the formation of 63 parts in the 100 of water; supposing that the whole of its oxygen were so appropriated, and that hydrogen could be found in sufficient quantity to make up the compound. But as such an arrangement as this, were it possible, would be instantly fatal, to every thing possessing a principle of vitality, it is out of the question. But we are under no necessity of reasoning in this way, for the air like every other compound with which we are acquainted, can be subjected, and has been subjected to a chemical analysis ; and there is no known process, by which a greater amount of water could be separated from, or formed out of it, than would be sufficient to cover the surface of the Globe, to the depth of 34 or 35 inches ; and even this could not be done without decomposing it, and rendering it unfit, for the support of animal and vegetable life.

Now it has been fully established, by observations made and often repeated in different parts of the world, and by many different individuals, that not more than 34 or 35 inches of rain, at an average, fall upon the earth in the course of the year, in the temperate zone. It appears then, that the rain which falls in the temperate zone, in the course of the year, is the same in amount with the quantity of water contained in the air, at any given time, or which could be separated from it, by decomposition, and that it is two or three inches less, than the water which it receives in the same region in the course of the year, by the process of evaporation. This is a curious fact, and I do not know that it has hitherto been noticed, or that any one has thought of enquiring into its cause.

The quantity of rain that falls in some parts of the torrid, is much greater than that which falls in the temperate zone ; and it is not a difficult matter to discover, both the cause of this, and also its design. I have already shown, that owing to the greater heat, and rarefaction of the air in the Equatorial regions, the annual evaporation there, is 100 inches, or upwards, while it is only 36, or 37, in the temperate regions. And within the tropics the average quantity of rain, that falls within the year, amounts accordingly, to 100, or 110 inches. The rate of evaporation, and the quantity of rain in the different zones, thus appear to correspond nearly with one another. In the temperate zones, the rate of evaporation has been given at 36, or 37 inches, in the year ; while the quantity of rain has been stated to be only 34 inches. But the difference is easily accounted for, by the fogs, and dews, and drizzly rains, which cannot be ascertained by the Pluviometer. It may perhaps be thought, that the excess of evaporation over the rain that falls in the temperate regions, goes to make up the more abundant rain. But this cannot be the case, for the moisture that falls within the tropics, must be equal to that which is taken from the earth, otherwise it would in time be entirely dried up ; but two or three inches in the year, do not seem to be an overallowance, for the fogs, and dews, &c. of the temperate regions.

The greater heats of the Equatorial regions, render a greater quantity of rain necessary, for the support of vegetation, and other important objects for which water is required; and the fall of rain, must always bear a near proportion to the rate of evaporation, otherwise the earth might be burnt up while the atmosphere was altogether overloaded with moisture. Accordingly we find, that all other things being equal, there is a near correspondence between the mean heat, of any parallel and the quantity of rain, that falls in it. In the Island of Grenada for instance in 12° N. lat. the annual rain amounts to 112 inches; at Rome in 42° to 36 inches, and at St. Petersburgh in 60° to 16 inches.

Moreover, a greater quantity of rain falls on the higher grounds, than on those that are nearer to the level of the sea. While 34 inches fall at Liverpool, 60 fall at Rendal, in the mountains of Westmoreland. The obvious reason of this is, that clouds are attracted by mountains, and settle on their summits, where they fall out in rain, while the air continues dry in the plains below. This arrangement, like every thing else in nature, has its use; for as I have already observed, it is in the higher grounds that springs, and running streams, originate; and it would be a waste of time, to show the importance of providing for their constant, and regular supply.

Within the tropics, rain is in a great measure confined to one season of the year, while the other is dry. This is owing to the situation of the sun. When he is in the Northern hemisphere, or between the Equator and the tropic of Cancer, the rainy season is in the same quarter, and to the South of the Equator it is dry; and when he crosses the line, and is between it and the tropic of Capricorn, the rainy season is to the South of the line; and to the North it is dry. Between April, and October, is therefore the rainy season in the Northern hemisphere, and between October, and April, in the Southern. The cause of this most probably is, that while the sun is on the one side of the line, his rays have more effect there, and less on the other, and while the current from the Pole, in the former, is diminished by the increased temperature of the whole hemisphere, it is in the latter increased by the diminished temperature. We know that the air is denser, and drier, in the winter, than in the summer season; and it presses on, with a proportionally greater rapidity and force, towards the Equatorial regions; and throws the rarified air of that quarter into an elevation above the earth, where vapour is seldom formed into rain.

On the outside of the tropics, but at no great distance from them, there are four seasons of the year, two rainy, and two dry. In the sacred Scriptures, we repeatedly read, of the early, and the latter rains. The one is in the month of October, which softens the ground, and prepares it for the seed, after it has been hardened and dried up, by the long and severe drought, which usually prevails during the summer; and the other is in April, which fills the grain, and brings it to maturity. It is evident that these are connected with the passage of the sun over the line, and are brought about by the change which everywhere takes place in the state of the weather, about the time of the equinoxes. Besides these there are frequently showers during the winter, in Barbary, and the Levant; and they are in these countries, of very great service to vegetation. But they are always light, when compared with the more abundant rains of the equinoxial seasons. The writer of the book of Job, speaks of the two kinds of rain as follows, "For he saith to the snow, Be thou on the earth; likewise to the small rain, and to the great rain of his strength." Chap. 37. 6.

I have now finished what I intended; but had the limits to which I must have been understood to be confined, permitted me to take a more extended view, of this very interesting branch of Science, I should have now proceeded to give a detailed account, of the following subjects: the Aurora Borealis: Thunder and Lightning: Igneous Meteors, and Meteoric Stones, or Aerolites; for though these are not now understood, to form the most important departments of Meteorology, they are certainly very intimately connected with it, and they present us with a number, and variety, of phenomena, which are, in every respect, deserving of our attention. But as the matter stands, I shall only add, a few of the most interesting particulars respecting them.

Of the Aurora Borealis, I have already spoken, and I shall only observe, in proof of its connection with electricity, which has been already assumed, that it is known to disturb the position of the compass, and to have a very sensible effect, upon a delicately suspended Magnetic needle. This has been observed on many occasions, and the following are given as particular instances of it. On the night of the 11th September, 1814, a very brilliant appearance of the meteor, was seen in Scotland; and Colonel Beaufoy of London, who was then engaged in making observations, and was in possession of the finest needle in Britain at the time, noted down the following on the 12th, without knowing any thing of the appearance: "Variation remarkable, and the morning observation greater than the noon, for which no reason can be assigned." On the 26th September, 1815, there was a similar appearance, and the Colonel again without knowing it, observed a similar effect on his needles.*

* There is a vulgar error, which has been propagated and kept up by some inferior publications, into which it has found its way; namely, that the Aurora Borealis was never seen, till little more than a hundred years ago. In the South of Scotland, the common people, connect its first appearance, with the rebellion under the Earl of Mar, in 1715; probably, from the circumstance, that an uncommonly brilliant appearance of it was seen in the spring of 1716. Halley watched this appearance, and gave a particular account of it; and afterwards informs us, that the first account of similar phenomena, recorded in the annals of Britain, was on the 30th Jan'y, 1560. An account of which, under the name of "burning spears," is given in an anonymous publication of that time. According to Stow, another occurred 7th October, 1564, and a third on the 14th or 15th Nov'r, 1574. But Halley is mistaken in making that of Jan'y, 1560 the first; for we have an account of a similar appearance, in the Saxon Chronicle, for An. 1131, which I shall transcribe:

"This year aefter Cristes Messe on an Mone niht aet the forme slaep waes se heouene othe north-half ealswilc hit waer baerarende fir. Swa that ealle the hit saeyon waer on swa of-faered swa hi naefre aer ne waeron. That waes on III Idas Januar. Thaes ilces yeares waes swa micel orf-cwalm swa hit maefre aer ne waes on manne yeminde ofre eall Engle-land thaet waes on naet & on swin swa thaet on tha tun tha waes ten ploges other twelfe gangende ne belaef noht an. & se man tha haefde twa hundred oththe thre hundred swin ne beleaf him noht an Thaer aefter swulten the henne fuyeles tha scyrte the fleso-mete & se cease & se buetor." Translation:—

"This year after Christmas, on a clear moonlight night, at the first sleep, the northern parts of the heaven, were all as it were

That Lightning is an electric explosion, has been fully established, and is universally admitted. When two clouds, at no great distance from one another, are in opposite states of electricity, a discharge will take place; and the electricity of the one, will strike into the other, and a flash of lightning will be emitted. When this happens, the lightning passes from the one to the other, for the most part in a waving line; but when the discharge is to the earth, it commonly takes a zigzag direction towards some elevated, or pointed object; as the top of a mountain, or of a tree, &c. When lightning strikes a house, it fixes on the best conductor of electricity in it, as a bell-wire, &c. and follows it to its termination. The most dangerous place in a house, in a thunder storm, is therefore in the neighbourhood of a bell-wire; and the safest posture and position, is, to lie down on a feather bed, laid upon chairs, in the middle of the largest apartment in the house. And the safest place, in the open air, is at the foot of a high, and steep bank; or at a short distance from a lofty tree, in the opposite direction of the cloud.

Thunder is the agitation of the air, occasioned by an electric discharge. The electric spark passing through the air, decomposes a part of it, and creates a vacuum, and the rush which ensues from all sides, to fill up the vacuum, disturbs the air and occasions the peal. Whenever the sound is heard, the danger of the discharge which causes it is passed; and we may calculate the distance of the thunder from us, by the time that intervenes between the flash, and the peal. Sound travels through the air, at the rate of 1,142 feet in a second; and if four seconds intervene, the discharge took place, at the distance of a mile. And the danger depends on the direction

a burning fire; so that all who saw it were so frightened, as they never were before. And this was on the third of the Ides of January. The same year, there was such a loss of live stock all over England, as has never happened in the memory of man.—This was more especially the case in regard to cattle, and swine; so that in a town which had ten, or twelve ploughs going, not one remained; and he who had two, or three hundred swine, had not one left. After this the poultry died, and there was a famine in butcher meat, cheese, and butter."

The connection of this Meteor with the calamities of the times, shows both the ignorance, and superstition of the age, and also that the meteor had been less common than it is now.

in which the cloud is moving; or whether it is coming nearer, or going farther from us. When the explosion is near, the peal is more sharp, and of shorter continuance, and when it is at a considerable distance, it appears more heavy, and is more protracted. This is owing to the circumstance, that it is reverberated, or re-echoed from different quarters, and we hear it repeated a number of times.

Though the true cause of those electric discharges, which occasion thunder, and lightning, is not perhaps fully ascertained, it is supposed to depend on the friction created, by the meeting of opposite currents of air, and their passing closely upon one another. And if we observe the clouds, not only during a thunder storm, but before it commences, we will often see them passing, and repassing, one another; which shows that the air is in a disturbed condition, and that there are different currents coming into contact, and collision with one another. But whatever be the primary cause of thunder, or the degree of danger attending upon it; it is often beneficial, by bringing rain in dry weather, and otherwise ameliorating the state of the air, which previously feels sultry, and oppressive, and afterwards agreeable and refreshing.

Igneous Meteors, or fire-balls, are moveable luminous bodies, of different sizes, and brightness, which appear occasionally in the air; but by what means they are formed, or put in motion, has never yet been satisfactorily explained. One of the most remarkable, appeared in 1783; and another in 1805. The former was calculated to be about 3,000 feet in diameter, and about 60 miles from the earth. The velocity of the latter was so great, that no calculation could be made, either of its size or height. The motion of both, was attended by a sound, like distant thunder, and both terminated in a loud explosion.

The most remarkable fact, connected with the appearance of Igneous Meteors, that has been fully ascertained, is, that in some instances, stones of a peculiar composition, and an immense size, have been discharged from them, towards the earth, at the time of their explosion. It was the opinion of Laplace, that these stones are thrown with such force from the volcanoes of the moon, as to come within the attraction of the earth, and consequently to gravitate towards it, as their centre; and this view of the subject has been supported by others, since his time. Their horizontal motion, till the explosion takes place, militates strongly against this opinion; and others therefore think, that they are concretions formed in the air itself. Numbers of the stones thus obtained, have been subjected to a careful chemical analysis, and have all been found to possess the same properties, and are all different from any other stones that are known. They are enclosed in a coat of rust, or oxide of iron; and they contain proportions of different earths, and metals; but how these have been collected in the air, or by what means they have been consolidated and put in motion, are points about which, no one has ever ventured to conjecture; and nothing, as Dr. Thomson well observes, can be a more complete proof, of the imperfect state of the Science of Meteorology.

Imperfect however, as the state of the Science, confessedly is, enough is known of it, to invite the attention, of those who desire to extend the boundaries of human knowledge. Though it is a field which is in a great measure unoccupied, it will abundantly repay the labour of cultivation. It is not indeed permitted us to hope, that by any possible improvement, or discovery, we shall succeed in bringing the elements under our controul; but if we ascertain the laws by which they are regulated, and learn to read the signs of approaching changes, we will be in a better condition to take advantage of them; and we will discover more of the unsearchable wisdom, and boundless power, of Him "who hath his way in the whirlwind and in the storm, and the clouds are the dust of his feet."