XXVII. On the barometer

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that used to saturate an equal weight of the same acid diluted with water, and I find them to agree exactly.

M. Vogel*, in his remarks on this subject, seems to think that increasing the quantity of acid hastened the formation of the sugar. He only obtained the syrup; time did not permit him to go further: we are therefore, for the present, deprived of that able chemist's remarks on this subject. Should my future experiments on this subject prove sufficiently interesting, I shall have great pleasure in making them public, and I will take the liberty of asking indulgence for these, as I am but a pupil in that science in which there are at present so many able proficient. If these remarks should induce some able investigator to pursue the subject, and thereby benefit science and the arts, I shall consider myself as very fortunate.

XXVII. *On the Barometer.* By RICHARD WALKER, Esq.
Oxford. Communicated by the Author!

To Mr. Tilloch.

SIR, SHOULD the following observations, forming the conclusion of a subject, viz. "Observations on the Barometer," which you did me the favour to communicate, through the channel of the Philosophical Magazine for October 1810, and the two following numbers, be deemed not unworthy of a place in your next number, I request you will have the goodness to insert them.

I am, sir, your obedient servant,

Oxford, August 17, 1812.

RICHARD WALKER.

P. S.—I have judged it expedient, in the course of these observations, to descend occasionally to particulars which, to the generality of your readers, must be totally unnecessary, but which to some persons, who may not before have given much attention to this subject, may not prove unacceptable.

The reason of the long interval between this and my former communications on the same subject, is in consequence of my attention having been engaged in a small work of a different nature, which I hope soon to have it in my power to announce.

The barometer, *stationary*, with a *concave surface* of the mercury at the top, is an almost infallible indication of

* *Journal de Physique* Mars 1812, Notice sur la transmutation de secula de frument en matière sucrée, par M. Vogel.

rain,

rain, at the place of observation, or in its vicinity ; especially if the barometer be *at* or *below* CHANGEABLE.

The barometer, *stationary*, with a *convex* surface of the mercury at the top, is a strong indication of *fair weather*, at the place of observation, or in its vicinity ; especially if the barometer be *at* or *above* CHANGEABLE.

In the first instance, I would account for this circumstance, by the natural spring or elasticity of the air being *suspended* or *diminished* (the density or weight of the atmosphere remaining the same) by the *intervention of vapour* collecting into a mass ; and in the latter instance, from the *dispersion* of the interposed vapour, by which the natural spring or elasticity of the air is restored.

For the same reason it is, I presume, that during a steady fall of *rain*, the barometer is commonly *stationary*, with a *concave* surface at the top ; and as soon as the weather begins to clear up, the top of the mercury in the barometer assumes a *convex* surface.

The quick *ascent* into the atmosphere, of *smoke*, *vapour*, &c. indicates *fair-weather* ; and the slow ascent, and particularly the *descent* of them, indicates *rain*. The former, in consequence of an influx of *denser* or *heavier* air, into the lower stratum of the atmosphere, commonly from the *north* and *east* points ; and the latter, in consequence of an influx of *rarer* or *lighter* air, into the lower stratum of the atmosphere, commonly from the *south* and *west* points.

Upon the whole there is more *wet weather*, whilst the barometer is *above* CHANGEABLE ; than there is *dry weather*, whilst the barometer is *below* CHANGEABLE. Hence it follows that, *cæteris paribus*, the former state of the barometer is not so strong an indication of *fair weather*, as the latter is of *rainy weather*.

The barometer *rising*, especially if it be progressive, whilst the wind is in the *south* or *south-west* points, indicates a change of the wind to the *north* or *east* points ; and conversely, the barometer *sinking*, whilst the wind is in the *opposite* points, indicates a change to the *south* or *west* points.

In the *spring*, and as *summer* advances, *rain* brings successively *warmer weather* after it ; and in *autumn*, and as *winter* approaches, *rain* brings successively *colder weather* after it. Hence, successive showers gradually change, as it were, *spring* into *summer*, and *autumn* into *winter*.

The reason of this seems to be, that during *fair weather* *alone*, the true character of each season, with respect to temperature,

temperature, is exhibited; whereas it is in some degree obscured, or suspended, during *cloudy weather*.

The mercury in the barometer is usually *fixed*, at whatever height it may happen to be, with a *concave surface*, during *settled rain*; and *fixed* with a *convex surface*, during *settled fair weather*. It is essential, in order to make accurate observations on the barometer, that it be viewed with a magnifier, which is best when *fixed* to the moveable index.

Fogs in the *morning* are more visible over *land* than over *water*, because the *greater coldness* of the land *condenses the vapour most*; but in the evening, over the *water*, because *water* is then the *coldest*.

The *mean height* of the clouds above the earth's surface is about three quarters of a mile;—the *greatest height*, somewhat more than a mile—and the *least height*, about three furlongs, and sometimes in *thunder storms*, even less.

In order to make the most accurate observations on the state of the weather, and to predict the various changes which are about to take place in it, the observer should be provided with a *barometer*, *thermometer*, and *hygrometer*, each of the best construction. De Luc's hygrometer, I think, is the best;—and in order, at all times, to be able to notice the changes in the direction of the wind, which are taking place, and which is extremely essential, it would be expedient that a wind-vane be so constructed, as to exhibit the direction of the wind within the room appropriated for meteorological observations; which, in defect of any better means, might be contrived, by the axis of the *wind-vane*, without being continued so as to reach within the room, having an *index* affixed to it.

The *rising* of the barometer is a more certain indication of *fair weather*, than its *sinking* is of *rainy weather*; because it sinks for wind, as well as rain. If therefore, whilst the barometer is sinking, the atmosphere still remain clear, *wind* may be expected.

In *winter*, *spring*, and *autumn*, a sudden falling of the mercury presages *high winds* and *storms*; but in *summer*, *heavy showers*, and sometimes *thunder*.

The principal changes in the atmosphere take place about the time of the *vernal equinox*, viz. from the 16th to the 28th of *March*.

Rain or *snow* may come during a *north* and *easterly* wind, whilst the barometer stands higher, than when the wind is in the *south* or *west* points; because in the former instance

instance the clouds come from a *denser* to a *rarer medium*, and in the latter case, from a *rarer* into a *denser medium*.

The *maximum* and *minimum* heights of the barometer, in this and every other country, are limited, by nature, thus : When the atmosphere is charged with as much *water* in a state of *chemical combination*, under the most favourable circumstances for absorbing it, as the atmosphere can sustain, it is then *heaviest*, and the barometer is at its *maximum* ;—and when the air is most free from, or contains the least quantity of, *water* in a state of *chemical combination*, other circumstances concurring, the atmosphere is then *lightest*, and the barometer is at its *minimum* of height. Hence, *cæteris paribus*, the absorption of water, by air, renders the atmosphere *heavier*, and its parting with it renders it *lighter**.

During many successive years of observation on the barometer in England, it may be found, that its *greatest height* will not exceed one inch and a quarter *above CHANGEABLE* ; nor its *least height*, the same distance *below CHANGEABLE*.

The variations in the barometer are *greatest* towards the *poles* ; less, in *temperate latitudes* ; and *least*, between the *tropics*.

The barometer was observed, some years ago, at Oxford, as low as 28 inches, within two hundredths, at which time the weather was perfectly fair and calm ; but it appeared afterwards that an earthquake had happened at the time, at a distant part of the world. This circumstance puzzled ordinary observers, and injured the reputation of the *weather-glass* ; but the intelligence afterwards of the event which had happened restored its character.

The *moisture* on the ground and in other situations *freezes*, as is well known, when the atmosphere is *warmer* than 32°, the freezing point, in consequence of the cold produced by *evaporation*. Under the most favourable circumstances, viz. a *dry air* and a *brisk wind*, this may happen, when the air is eight or ten degrees above the *freezing point*. The *rise* or *fall* of one-tenth of an inch, in the barometer, is usually accompanied, or followed, by a very perceptible change in the weather.

* Among other circumstances, which show the power of air for absorbing water or vapour, the following is a very curious as well as satisfactory one : if a small cloud, or fragment of a cloud, in a loose or rare state, insulated from others, in a clear part of the atmosphere, especially when the air is warm and calm, be observed, it will be found to melt, or dissolve, as it were, in the atmosphere, gradually, and at length to vanish entirely.

Rain

Rain happens, among other causes before mentioned, in consequence of a subtraction of the *electric fluid*, which, when the air abounds with vapour, is easily conducted to the earth; hence arises the *velocity* of rain in *thunder showers*.

In this climate, the *hottest* time of the day is about three in the afternoon, in consequence of the *continued influence* of the sun, whilst near *its greatest height* from the horizon; and the *coldest* is a *short time before sun-rise*, viz. that time at which our part of the earth has been *longest* without the influence of the sun.

The *hottest month* is *July*; and the *coldest month* is *January*; the former, in consequence of the continued strongest influence of the sun, whilst near *its greatest elevation* from the horizon; and the latter, in consequence of the *continued weakest influence* of the sun, whilst near its *least elevation* from the horizon. The *driest months* are *July* and *August*, and the *wettest* are *October* and *November*; the former, in consequence of the small quantity of water which has been raised into the atmosphere previously, and the powerful influence of the sun, during these months, in dissipating the vapours which are raised; and the latter, in consequence of the *inverse effects* of those two causes.

In like manner, as the *annual* influence of the sun operates upon the weather, producing different seasons, respecting wet and dry weather, before stated; it is not improbable, that its *diurnal influence*, being a kind of *epitome* of the former, may, in a smaller degree, have the same effect in producing an *effect* for fair weather, whilst the sun is nearest its *greatest diurnal altitude*, in consequence of its greater power, at that time, of dissipating vapours, or dispersing clouds.

The greater or less avidity with which the mercury appears to *rise* or *sink*, as exhibited by the greater or less *convexity* or *concavity* of the mercury at the time of observation, the stronger or weaker will be the indication in each instance.

The surface of the mercury in a barometer is best seen when the tube, at the part to be observed, is exposed to the light behind, that is, constructed without an opaque substance at the back of it.

The *convex* or *concave* surface of the mercury arises, of course, from the adhesion of the mercury to the tube, in *rising* or *sinking*: at each observation of the barometer, therefore, after noticing the variation in height, the *index* should

should be first accurately placed, the barometer then smartly rapped, in order to reduce the mercury to a level, and the *index* again accurately adjusted.

The principle of a barometer is so perfectly uniform in its effect, that although, for want of precision in their construction, any two of them may not, under similar circumstances, respecting the state of the atmosphere, and the elevation in which they are placed, stand precisely at the same height; yet all will agree in this—they will rise or sink at the same time.

The ordinary upright barometer is the only one in use, among scientific persons, of which there are two kinds, viz. the cistern or bason barometer, and the syphon barometer: the former of these requires a *floating gage*, with an adjusting screw, in order to show the precise length or height of the column of mercury in the tube; which is essential in accurate observations, and particularly in the measurement of altitudes by the barometer; but which may be dispensed with in ordinary observations.

The only objectionable circumstance in the *perpendicular barometer* is the shortness of its scale; but, since there are no means of extending the scale of a barometer without, in some degree, injuring its principle, this defect is supplied by a *nonius* or *vernier*.

Barometers intended for the purpose of *measuring altitudes*, are fitted up in a peculiar manner adapted to that intention.

The attractive power of the *sun* upon the earth's surface, is to that of the *moon*, as 2 to 5.

With respect to the direction of the wind, it is tolerably uniform within the *tropics*, being more immediately under the influence of the two principal causes of currents of air, viz. first the *sun*, which, in its course heating the places it successively passes over, causes a very considerable rarefaction of the air there, which is constantly followed by a current of air, to restore the equilibrium;—and secondly, the current of wind, which is produced by the *attractive* influence of the *sun* and *moon* on the atmosphere, as the different places pass under them.

Near the *poles*, the wind is probably more uniform than it is in the middle or temperate climates; the lower portions of the air being constantly inclined towards the *equator*, in consequence of the *increasing heat* in that direction; and the upper portions being renewed, from the more elevated regions of the *inter-tropical* currents.

Whereas, in the middle or *temperate* climates, besides other causes unknown to us, the direction of the wind becomes

comes more complicated, in consequence of its situation between the two former ; being occasionally influenced by each of them, separately or conjointly.

There seems to be a kind of habit in the weather, as in other cases : thus, towards the close of a series of *dry weather*, several efforts are apparently made towards a series of *rainy weather*, before it actually sets in ; and *inversely*.

With respect to the difference of the weather, which I have presumed *takes* place during the *increase* and *wane* of the moon ; I would account for it on a supposition that at each conjunction of the moon with the sun, or the time of the *new moon*, as it is called, there may be a kind of disposition, as it were, for *clarifying* the atmosphere, or *renovation* of fair weather ; and *vice versâ*, at the moon's opposition, or *full moon* ; and the reason why this change does not actually take place until about the third or fourth day after each change of the moon, because, as I have stated before, the former habit of the weather is not till then entirely conquered.

The atmosphere becoming *drier*, as indicated by the *hygrometer*, indicates a *disposition* for *fair weather*, and *vice versâ*.

A cold, dry, and serene state of the atmosphere is most favourable for barometrical measurements.

The limit, or boundary of the atmosphere, terminates where the expansive force or power of the air, *upwards*, or from the earth's surface, is completely overcome by the force or power of gravitation *downwards*, or towards the earth's surface, which is estimated at about 44 or 45 miles*.

A pint measure of air, when the barometer is at $29\frac{1}{2}$ in ENGLAND, weighs eight grains, or a gallon 64 grains ; but near the POLES somewhat more ; and at THE EQUATOR somewhat less. This variation in the weight of the air, in the different parts of the world, is ascribed to a difference in the height of the atmosphere ; by which it happens, that the air near the surface of the earth, at different places, differs in *density* ; the pressure or weight of the incumbent atmosphere being the same. The atmosphere is presumed to extend *highest* at the equator, and to be *lowest* at the poles ; in consequence of a greater degree of *centrifugal force* and *heat* at the equator.

The barometer, *cæteris paribus*, stands *higher* in winter than in summer, in consequence of the greater condensation of the air, from cold, at that season.

* The atmosphere, it is computed, would extend only to about $5\frac{1}{2}$ miles in height, if it were so compressed, that its density throughout should equal its degree of density near the surface of the earth.

The barometer unquestionably has been observed, in England, to rise *above* 31, and to sink *below* 28; viz. to exceed those limits, each way, by the *tenth* of an inch.

The lowest point at which I have observed the barometer is $28\frac{1}{4}$ inches, viz. on November 9th, 1810; which was accompanied by a remarkably high wind, and torrent of rain.

The ordinary range, or variation, in the barometer, differs according to the latitude of the place:—thus, at the *equator* (except during the hurricane season) it is scarcely any thing;—and at the *poles*, it is probably not less than four inches; varying in an *increasing ratio*, from the *equator*, to each pole*.

The column of mercury in the tube of a barometer, as most persons know, is sustained by the counter-pressure of a column of air, of the same base, extending to the top of the atmosphere; which, when at its mean state of gravity, that is, when the barometer is at $29\frac{1}{2}$ inches, presses on the base of the mercury, with a weight which is equal to, or after the rate of, fifteen pounds upon each square inch of surface.

In a comparison of barometers placed in different situations, with respect to elevation; an allowance must be made, at a mean rate, of 100th of an inch on the barometer for each complement of nine feet measure in height; that quantity being *added* to the higher barometer, or *subtracted* from the lower one, in order to make the comparison equal†. (See Table I. &c. page 279, of *Philosophical Magazine*, for October 1810.)

It has been confidently asserted by respectable authors, that the barometer is affected by the *atmospherical tides*; it does not appear, however, that any observations have actually proved the fact.

With respect to the periodical *rise* and *fall* of the barometer noticed at *Calcutta*; in the first place, the variation appears to have been very small; and *secondly*, it does not correspond in point of time with the *attractive influence* either of the sun or moon.

That the atmosphere is influenced by the *attractive power* of the sun and moon, there can be no question; but it seems

* The barometer at PERU, under the EQUATOR, varies ordinarily, only to the extent of two or three-tenths of an inch; but at PETERSBURGH, to the extent of three inches.

† The difference in the height of two barometers equally well constructed, one being in the ground floor, and the other in the attic, will of course amount to several hundredths of an inch.

contrary

contrary to reason, that the barometer should be affected by it; since, in proportion as the atmosphere is *rarefied*, from this cause; in the same proportion, from the same cause, likewise, is the atmosphere *accumulated* there; and hence the *gravity*, or *pressure* of the atmosphere upon the surface of the earth, remains the same in each instance.

I might add, that if an alteration in the barometer actually took place from such a cause, it could scarcely have escaped my notice.

P.S. I have noticed with considerable sensations of surprise and satisfaction, the progress of Professor Leslie, in his experiments *on the production of cold by means of the air-pump*, in which it is stated that that gentleman has already reached a cold of 70° below 0. At the time I was pursuing my experiments on *artificial cold* by frigorific mixtures, the means of producing *artificial cold* by means of the air-pump naturally presented itself, and to which I was more particularly stimulated by an experiment related by Mr. *Nairne*, in which it is said, by the evaporation of ether, under the air-pump, a cold of 49° below 0 was produced, the temperature of the air in the room being 55° . *Philosophical Transactions* 1777.

I made several attempts at producing an extraordinary degree of cold by this means, but without success; owing chiefly, as I presumed, to the imperfection of the best air-pump I was able to procure. Conceiving that the *Torricellian vacuum*, as it is called, might be the best method of effecting the most sudden and complete evaporation of ether, upon which the success of the experiment depends, I had projected in my mind to put this method to the test; but the difficulty of obtaining a fit apparatus for the purpose prevented me.

Perceiving that Professor Leslie's experiments, in which he has succeeded to a most extraordinary degree, have been conducted upon the principle alone of *rarefying the air*, without any auxiliary means excepting his ingenious method of absorbing the vapour, the existence of which necessarily diminishes the success of the experiment; I have been induced to take this opportunity of mentioning these circumstances, fully trusting that, should these observations furnish no hint to the learned and ingenious Professor, they will not be deemed an improper interference*.

* By means of evaporation in the open air, from purified *sulphuric ether*, (as mentioned in my *Treatise on the Production of Cold*, pages 80, 81,) I sunk the thermometer from 71° , the temperature of the air at the time, to 12° ; and by *water* used in a similar manner, to 56° .