A SHORT DISSERTATION ON THE BAROMETER, THERMOMETER, AND OTHER METEOROLOGICAL INSTRUMENTS:

TOGETHER WITH AN

ACCOUNT

OF THE

PROGNOSTIC SIGNS OF THE WEATHER

By GEORGE ADAMS,

MATHEMATICAL INSTRUMENT MAKER TO HIS MAJESTY, AND OPTICIAN TO HIS ROYAL HIGHNESS THE PRINCE OF WALES

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PREFACE.

I HAVE, for ſome time paſt, thought of publiſhing a regular digeſt of what is at preſent known in Meteorology, a work which ſhould contain an arranged abſtract of the ſeveral treatiſes written on the ſubject by Meſſrs De Luc, De Sauſſure, Van Swinden, La Cotte, Jones, Kirwan, &c. together with an account of the various inſtruments invented for exploring the ſtate of the atmoſphere, and a hiſtory of their improvements. But, as it would be ſome time before it could be prepared for public inſpection, as well from the nature of the work itſelf, as from my preſent engagements, I conceived a ſhort Diſſertation on the Barometer and Thermometer, with an account of the Prognoſtic Signs of the Weather, would be an acceptable preſent to my cuſtomers To this idea, they are indebted for the following haſtily written tract Of it's various imperfections, I am fully ſenſible, but I could not, conſiſtently with my other avocations, ſpare time to render it more perfect, or even to copy it fairly for the preſs imperfect as it is, I have no doubt of it's being uſeful, that it will make many attentive to a ſubject which they have hitherto diſregarded, and that while it furniſhes a new fund of uſeful employment, it will tend alſo to advance the boundaries of ſcience No branch of philoſophy is more intereſting than that which immediately concerns the conſtruction of that fluid which ſurrounds our globe, and is a principal agent in the most striking operations of nature.

There are many, indeed, among the pretenders to sagacity, who treat all prognostic signs of the weather with contempt, as fit only for the attention of rude and uncultivated minds. They may, however, be told, that the processes continually carrying on by nature, on every side, and which are obvious to every eye, are as much the instruments of knowledge, as the more refined apparatus of the experimental philosopher; that among the observers of signs and seasons, men * are to be reckoned, who have given proofs of genius, that have not been equalled by all the efforts and wisdom of succeeding ages. These not only noted the phenomena of nature, but they attended also to the various prognostics of the weather, described them with accuracy, pointed out those they thought most determinate, and recommended it to others to compare the signs with the events, and correct one remark by another.

Meteorology is intimately connected with every branch of natural history, but more closely so with botany and agriculture. It is certain that much of the good qualities of plants, of grasses, corn, fruit, &c. depend on the temperature of seasons. The knowledge, therefore, of the effects of particular states of the atmosphere on vegetables, might probably lead us insensibly to account for some of the principal phenomena of vegetation; at least, by enabling us, in some degree, to foresee events, it would prevent many accidents, and remove much anxiety. To the observations on plants, should be joined others on the appear-

* Aristotle, Pliny, Virgil, &c.

appearance, departure, &c of birds and insects: for there is no insulated fact in nature, they are all relative, systematic, or mechanical, having a double reference, as effects to their causes, and as causes to their effects. The material world is an immense body, composed of an infinite number of parts, so interwoven together, as to unite in one common center It is the business of philosophy to point out what apparently separates these parts, and how they are connected, and to trace these connections to the principle of unity, which harmonizes and connects all the works of creation

It is much to be regretted, that mankind, in endeavouring to avoid one error, are so prone to fall into the opposite extreme: this has been the fatal source of numerous errors Thus, in order to avoid the hypothetical ideas of former philosophers, those of the present day are continually labouring to accumulate unconnected facts, remarks on links detached from nature's chains: these disjointed links, they twist and torture in ten thousand different ways, and think every new form, or every new appearance, an important discovery, seldom endeavouring to trace out it's connection with superior and inferior causes, on which alone all it's real powers and activities depend Experiments are undoubtedly the sure way of proving or disproving any hypothesis, and all hypotheses should be examined by them but if we stop at them, without proceeding any further, we shall never come at any causes, and if they be wholly relied upon, without some better guide, we shall come at none but false ones, because the principal agent in nature is so subtle as to elude both sense and experiments, so that they can never discover it to us, though, when we have been told of it, they will serve to demonstrate it's operations. The science of nature has been too long improperly treated, it is now high time for us to return to plain and sound observations on the phenomena which surround us, it is high time for us to consider the agency of the elements. it is this agency which performs all the wonders in the theatre of nature, by it the universal system, the life of individuals, the growth of plants, &c are preserved and supported.

The importance of this subject is so great, that I cannot refrain from subjoining the testimonies of two able writers in confirmation of the foregoing sentiments "It answers no purpose to consider the motion of any single body abstractedly, as a thing by itself. If there is in fact no such motion to be discovered, speculations which carry us out of the world, can never teach us how things are conducted in the world. Nature is a system of parts connected and related, and every particular part of it should be considered under this relation, without which, neither the nature, nor design of it, can be understood. Matter, subsisting as a part of the created world, has motion, but if separated from the rest, would have no more motion than a limb divided from the body: so that he who would understand the nature of motion, by taking matter abstractedly, is studying motion from that which has no motion belonging to it. If we proceed thus, we shall not only deceive ourselves, but be great sufferers, by losing sight of the true construction of nature. and if we build a system upon matter so independently considered,

ſidered, we ſhall raiſe ſuch a world as never did, or can exiſt, as empty and abſurd as it is arbitrary."*

"Men are generally ſolicitous to know the nature and cauſe of diſeaſes, of blemiſhes, of preternatural appearances in the body, but indifferent as to the proceedings of the healthy œconomy: we have an hundred diſſertations on fevers, for one upon life. The action of ſtimuli, and the irritability of the living fibre, have been the ſubjects of many ingenious diſcuſſions, the regular and uniform action of the fibre but of few.—It is the ſame in philoſophy: we have treatiſes on light, as ſeparated and divided by the priſm; on heat as meaſured by the thermometer: but none on that ocean of the ſolar fluid, in which all bodies are as it were immerſed, none upon the various influences of the ſun, upon which the life and activity of all things in this natural world depend. In the preſent mode of philoſophizing, what hope have we but of ſeeing new facts continually multiplied, by the indefatigable experimentaliſt: but no advance towards the knowledge of cauſes."†

* Jones's Phyſiological Diſquiſitions.

† Young's Eſſay on the Powers and Mechaniſm of Nature

WORKS

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A SHORT

A SHORT DISSERTATION ON THE BAROMETER AND THERMOMETER,

AS MADE BY

GEORGE ADAMS,

MATHEMATICAL INSTRUMENT MAKER TO HIS MAJESTY, AND OPTICIAN TO HIS ROYAL HIGHNESS THE PRINCE OF WALES,

No. 60, FLEET-STREET, LONDON.

THERE is ſcarce any ſubject in which mankind feel themſelves more intereſted than in the weather, the temperature of the air, and the influences of wind and rain, which is evident, from its conſtantly forming a principal topic of their converſation. The traveller endeavours to regulate his motions, and the farmer his operations, by the weather by it, plenty or famine is diſpenſed, and millions are furniſhed with the neceſſaries of life.

Notwithſtanding it's importance, our actual knowledge of the atmoſphere is blended with much uncertainty, and, in many inſtances, enveloped in obſcurity, yet enough is even now known, to enable us to obviate danger, and avoid inconvenience. The ſpeculative philoſopher contemplates with pleaſure the changes in the weather, changes that preſent the mind with ſome of the moſt wonderful among natural effects, all working with boundleſs variety, for the good of the world and it's inhabitants.

Among the various conſiderations that tend to mortify pride, and humble arrogance, there is perhaps none more ſtriking than the reflection that the moſt brilliant labours of men are ſeldom the moſt uſeful, but, on the contrary, are often of great diſ-ſervice, both to the preſent and future generations; yet theſe are admired, while the humble labours of thoſe, by whom ſcience is advanced, and civilization gradually diffuſed, are looked upon with contempt by the ſlave of ambition and the man of genius.

It is, however, only by aſſiduous obſervation, and patient inveſtigation of the conſtitution of the air, the variations in the weight of the atmoſphere, a regular hiſtory of the winds, of the rain, and the changes of heat and cold, that we can ever expect to diſcover the connection of thoſe phænomena in the atmoſphere, which now appear to be unconnected and without order. Furniſhed with theſe data, we might, perhaps, be enabled to follow the courſe, and predict the changes of the elements, with as much certainty as we now do thoſe of the planetary bodies.

If

If every one, who is in poſſeſſion of meteorological inſtruments, would keep a diurnal regiſter of the ſtate and of the correſponding phænomena of the atmoſphere, and tranſmit the reſult of his obſervations to the public, he would contribute more to the advancement of this branch of ſcience, than he might at firſt imagine. While he was amuſing himſelf, and only gratifying curioſity; he would be promoting knowledge, and probably procuring benefits for poſterity. Let no one ſuffer the apparent improbability of ſucceſs, to diſcourage him from the attempt Let him remember that ſcience advances by ſlow and gradual ſteps, that it's progreſs depends on the cultivation of the mind, the removal of obſtacles, and the exertions of individuals, that the preſent is ever pregnant with the future, but the connections between them can only be found by long attention and diligent obſervation.

There is great reaſon to hope that meteorology will ſoon be very much improved, from the zeal with which it is now cultivated, the more ſo, as Charles Theodore, Elector Palatine of the Rhine, has erected an academy, ſolely dedicated to meteorological inquiries, and has ſent inſtruments, fabricated at his own expence, to all the academies and univerſities of Europe, willing or able to undertake the taſk of employing them.

Meteorological phænomena, like all the durable motions of the world, depend upon A CIRCULATION of matter.— Here it is carried on by a changing of water into a new, and a regeneration of it into it's primitive form again. It goes off from the ſurface of the earth in the form of a rare, invisible, expanded vapour, perfectly dissolved in the air as a menstruum, being suspended for some time in this state, it is afterwards condensed into mist and clouds, then gathered into drops, when it falls, and in this form it returns to the place from whence it came, to take it's turn once more in the common course of evaporation, and be again, and again, circulated to the great promptuary of the world.

The principal objects of inquiry are, therefore, 1st, In what manner the atmosphere is supplied with HUMIDITY? The 2d, WHAT CAUSES and WHAT PREVENTS this invisible humidity from being formed into visible clouds? And 3dly, WHAT PREVENTS and WHAT CAUSES the visible clouds to be precipitated in rain? To know the BALANCINGS OF THE CLOUDS? How such ponderous bodies are suspended in the fluid ether? And how THE WATERS ARE BOUND UP IN THE THICK CLOUD?

Meteorological instruments are, 1. A Barometer. 2. A Thermometer. 3. A Hygrometer. 4. A Rain Guage. 5. An Electrometer. 6. An Anemometer. 7. An Evaporation Guage.

OF THE BAROMETER.

In 1643, Torricellius, by one happy and decisive experiment, discovered the barometer, and proved the pressure of the atmosphere. For on filling a tube of glass 36 inches long, and hermetically sealed at one end with quicksilver, and then plunging the lower and unsealed end into a bason of the same fluid, he observed that a column of quicksilver of about 30 inches remained in the tube

tube He compared this to the height to which water is elevated in pumps, and found that the heights were in an inverse ratio of the specific gravities of water and mercury, which led him to think they were supported by the same counterweight, and on examining the several circumstances, he found this counterweight was the air: hence this instrument was called a barometer To this instrument philosophy is indebted for the greater part of what is known concerning the weight and elasticity of the air for though mankind had been always pressed and acted upon by this weight, and a thousand phænomena bore witness to it's existence, yet it's power was not known, nor it s influence acknowledged, till the last century

GENERAL IDEA OF A BAROMETER

Take a clean glass tube about 33 inches long, sealed at one end, and open at the other, fill it perfectly with pure quicksilver, then stopping the open end with the finger, invert the tube, and plunge the open end into a cistern of quicksilver, after which, elevate the tube till it be perpendicular, and the mercury will descend, and subside at a certain distance from the top, more or less, according to the state of the air at the time of making the experiment

The space vacated by the mercury at the top of the tube having no air in it, the external air presses upon the quicksilver in the cistern, and sustains, by a pressure in a contrary direction, a column equal in weight to itself. For it is evident that the mercury endeavours to descend with

with a force equal to that by which it's descent is prevented. In other words, the pressure of the atmosphere on a given surface is equal to the weight of a column of mercury, whose base is the given surface, and height that which it stands at in the barometer, but the pressure of the atmosphere is the weight of a column of air, whose base is the given surface, and height equal to that of the atmosphere. The height of the mercury is therefore an adequate measure of the weight or pressure of the air, upon a surface equal to that of the base of the tube containing the mercury.

Such was the first barometer as invented by Toricellius. since his time, the mode of filling it, so as perfectly to exclude the air from the upper part, and many other necessary circumstances for constituting a good barometer, have been explored with diligence by some of the most eminent modern philosophers Various methods have been contrived for enlarging the scale of the barometer, they are, however, all of them replete with error, and though, in point of form, some among them may appear more elegant than the plain barometer, yet they cannot be depended on for keeping an accurate register of the weather, or for observing the extent of the variation in any given situation, or comparing the different changes at one place with corresponding ones at another.

OF SOME OF THE PRINCIPAL REQUISITES OF A GOOD BAROMETER.

The limits to which I have confined myself in this tract, will preclude me from entering minutely into this subject,

subject, I mean to consider it fully in my Meteorological Essays, touching here only on one or two of the more essential circumstances.

1. It is requisite that the height of the column of mercury be altered by no other causes but the changes that arise from the pressure of the air, and that these changes be truly indicated.

2. That the variations in the height of the column be ascertained by a known measure.

3 That the column of mercury be susceptible of the smallest alterations in the weight of the air.

In order that the column of mercury, in the tube, may be affected by no other cause than the pressure of the air, it is absolutely requisite, that the upper part of the tube, and the mercury itself, be entirely freed from air, for if there be any air between the upper surface of the column of mercury and the sealed end of the tube, it will be the source of many errors and much irregularity. The included air will act as a counterpoise against the weight of the atmosphere, and to a certain degree counteract it's pressure, and, therefore, render the indication of the instrument uncertain and erroneous. This included air, being also often combined with humidity, expanded by heat, or contracted by cold, acts differently at different times, the only method of preventing these errors, and perfectly excluding the air from the barometer, is by boiling the mercury in the tube. an operation which is carefully performed in all the best instruments

That the changes in the height of the mercurial column may be truly ascertained, it is necessary to know at all

 times

times the exact distance of the surface of the mercury in the tube, from the surface in the reservoir or cistern.

The first point of the measure must commence from the surface of the mercury in the cistern; but this surface is variable, for when the mercury descends, a quantity of it falls into the basin and raises the surface thereof; and on the contrary, when it rises, a quantity is taken out of the cistern, and the surface thereof is lowered. The scale of inches to the barometer is fixed, but the surface of the mercury in the cistern from which it originates is continually varying. To remedy this evil, it is necessary that the lower surface should be always kept at the same height from the divisions on the scale affixed to the instrument. This is effected by means of a floating guage, which was first applied to the barometer by MY FATHER, though others have, since his time, assumed the merit to themselves. By means of the floating guage, the same screw that renders the barometer portable, regulates the surface of the mercury in the cistern, so that it is always at the place from whence the divisions on the scale commence. This guage is never applied to the common portable barometers, but only to those of the best kind. The method of using this guage will be described in a subsequent part of this tract.

Another circumstance necessary to be attended to in very accurate observations, is the effect of heat and cold on the barometer, as by these the mercurial column is either dilated or contracted; for as all bodies expand and occupy larger spaces when their temperature is increased, the mercury in the barometer will, when heated, be

specifically

ſpecifically lighter, and will conſequently aſcend from that cauſe, though the preſſure of the air ſhould remain unchanged, and that, therefore, in order to know accurately the effect of the air's preſſure on the barometer, it is neceſſary to correct the height by the addition, or ſubtraction of a quantity equal to the influence of the temperature of the air thereon for this purpoſe, a table is ſubjoined to this deſcription. In ſome caſes a ſcale of correction is applied to the thermometer accompanying the barometer, and which is indeed a neceſſary companion to it

2d Condition That the ſcale ſhould be of ſome known meaſure. It would have been totally unneceſſary to have mentioned this condition, had it not been to prevent thoſe, into whoſe hands this tract may fall, from being impoſed upon by venders of imperfect inſtruments. Some of theſe inſtruments have no determinate ſcale affixed to them, and thoſe which have a ſcale, have one that is in general ill graduated and erroneouſly placed, ſo that no comparative obſervations can be made with them, and often, indeed, no obſervation at all, as from the ſmall bore of the tube, they act as a thermometer, as well as a barometer We have already obſerved, that by enlarging the ſcale, error is multiplied, and uncertainty produced

3d Condition That the ſmalleſt changes in the height of the column of mercury may be diſcerned.

To meaſure the ſmalleſt changes, a nonius diviſion moves with the index, by which each inch is ſubdivided into 100 parts, and the height of the mercury is accurately obtained without any danger from parallax, by the peculiar construction of the index

OF THE NONIUS.

The scale of inches is affixed to the right side of the tube, the zero or beginning of the scale being at the surface of the mercury in the cistern, the index and it's nonius plate slide up and down in a groove, which is parallel to the line of inches, that the index may be set at any time to the upper surface of the column of mercury

Each inch, or line of inches is divided into ten parts, which are again subdivided into ten, by means of the nonius scale, the whole inch being thereby divided into 100 equal parts

TO READ OFF, OR ESTIMATE THE DIVISIONS OF THE NONIUS SCALE.

1. If that edge of the nonius scale, which is in a line with the index, coincides exactly with any division on the line of inches, that division expresses the height of the index from the surface of the mercury in the cistern, in inches and tenths of inches. But 2dly, If the foregoing edge does not coincide with any division, you must look for that division of the nonius, which coincides with a division in the line of inches, and the number on the nonius shews how many tenth parts of the tenth, the index or edge has passed the last decimal division. Thus for example, suppose the edge of the nonius was at a point somewhere between 29 inches 8 tenths, and 29 inches 9 tenths; then if by looking at the nonius, you observe the

the coincidence at 5, it ſhews the altitude to be 29 inches 8 tenths, and 5 parts of another tenth, or 29, 85.

Accurate obſervers do not eſtimate the height of the mercurial column by the edge of the mercury that is in contact with the interior part of the glaſs tube,* becauſe the attraction of the glaſs prevents, in ſome meaſure, that part of the mercury which is in contact with it from obeying immediately the preſſure of the atmoſphere, while the middle part of the column being but little, if at all affected by this attraction, is undoubtedly the trueſt meaſure, and is, at the ſame time, the moſt ſenſible of every change in the preſſure of the atmoſphere. In order to aſcertain the exact height of the upper part of this convex ſurface, beſides the index on one ſide of the glaſs tube, there is another placed directly oppoſite thereto behind the glaſs tube, in ſuch manner, that if a plane was to join the lower edges of theſe indices, it would be at right angles to the direction of the glaſs tube, and the eye being placed in this plane, the index is to be raiſed or lowered, till it's lower edge, and alſo that of the index behind the tube, appear to touch the top of the convex ſurface of the mercury in the glaſs tube, or in other words, that an imaginary plane joining the lower edges of the indices, may appear as a tangent to the convex ſurface of the mercury, and the nonius will give the height of the mercurial column. This improvement of the indexes is one, among many, for which ſcience is indebted to Mr Ramſden

* Deſaguliers

OF THE COMMON PORTABLE BAROMETER.

This instrument, when made with care, will anſwer for general and domeſtic obſervation, but is not ſufficiently accurate for philoſophical purpoſes. It conſiſts of a tube, of a proper length, accurately filled with mercury; the lower end of the tube is glued to a wooden reſervoir, the bottom of which is formed of leather; into this reſervoir the ſuperfluous mercury deſcends, and the air, by preſſing upon the flexible leather at the bottom of the reſervoir, keeps the mercury ſuſpended at it's proper height. This reſervoir is concealed from the eye by a neat mahogany cover, or box. This tube and reſervoir are placed in a frame, on the upper part of which is a ſilvered braſs plate; on the right-hand ſide of this plate is a ſcale of inches, reckoned from the ſurface of the mercury in the ciſtern; each inch is divided into ten parts. Cloſe to the line of inches there is a ſlit, or groove, for conveniently ſliding the nonius ſcale and index up and down. The upper edge of the index and nonius ſcale are in a line. It is the upper edge of the index that is to be ſet to the upper ſurface of the mercury. On the left-hand ſide of the plate, the words FAIR, CHANGEABLE, RAIN, are engraved. At the bottom of the frame there is a ſcrew paſſing through the mahogany box which covers the reſervoir; a flat round plate is placed upon the end of the ſcrew within the box; this end is deſigned to preſs upon the leather bag, and force the mercury up to the top of the tube, and thus prevent it from ſhaking, or violently ſtriking againſt the top of the tube when tranſported from one place to another.

To

TO USE THE PORTABLE BAROMETER.

1 Suſpend it againſt a wall, or wainſcot, ſo that the tube may be perpendicular to the horizon.

2 Unſcrew the ſcrew at the bottom of the frame as low as it will go, and the mercury will fall to it's proper height, and be obedient to the changes in the weight of the air.

3 Set the upper edge of the index, ſo as to coincide with the ſurface of the mercury in the tube, and the nonius ſcale will point out the height of the column

4. Before every obſervation, ſtrike the frame gently with the knuckles, to diſengage the quickſilver from the tube.

5 If the barometer is to be moved from one place to another, turn the ſcrew, till the mercury is preſſed by it againſt the top of the tube.

DEFECTS OF THE COMMON PORTABLE BAROMETER.

It is neceſſary here juſt to mention ſome of the defects of this kind of barometer, in order to render the advantages of the better kind more conſpicuous.

1 It cannot be ſo adjuſted as to be ſure that the diviſions on the ſcale are at that height from the mercury in the ciſtern, which is expreſſed by the numbers affixed to them.

2. As when the mercury falls in the tube, it riſes in the reſervoir, and when it riſes in the tube, it falls in the reſervoir it's diſtance is perpetually varying from the diviſions of the ſcale.

3. The

3. The tension of the leather forms a considerable resistance to the pressure of the atmosphere

OF THE BEST PORTABLE BAROMETER

This barometer, like the preceding, consists of a glass tube, properly filled with mercury, having the lower end fixed to a wooden cistern, with a leather bottom, and this tube and cistern placed in a mahogany frame

On the upper part of the frame a brass plate is placed, on the right-hand side of the tube a scale of inches is graduated on the plate, the beginning of the scale being at the surface of the mercury in the cistern each inch is divided into ten parts, which are again subdivided into tenths by the nonius scale.

The nonius plate carries two indexes, exactly similar to each other, one placed before the tube, the other behind it The indexes may be raised or depressed, by turning the key, which fits into a small hole in the frame, directly under the groove of the nonius plate

On the left-hand of the tube a small thermometer is placed, with Fahrenheit's scale, there is an index to the thermometer, which may be set by the same key as the barometer, only putting it into the small hole under the thermometer, and turning it round till the index points to the mercury in the thermometer A scale for correcting the expansion of the mercury in the barometer, is often graduated close to the scale of the thermometer

The upper part of the barometer is covered with a glass plate, to prevent the silvering of the plate from being injured by dirt, or being corroded by the action of the air

OF

OF THE LOWER PART OF THE BAROMETER.

The lower end of the tube is immerſed in the ciſtern which contains the mercury, the ciſtern is covered with a mahogany box, at the bottom of the frame is a ſcrew, to raiſe or lower the ſurface of the mercury, at the top of the ciſtern is a hole, which is fitted with an ivory ſcrew, to be placed there occaſionally for the conveniency of tranſporting the inſtrument ſafely from one place to another.

The guage conſiſts of a ſmall ſtem of ivory, ariſing from a float of the ſame ſubſtance, a circular diviſion is cut round this ſtem, the ſtem paſſes through a ſhort cylinder of ivory, which is cut open in front, on this front two ſmall diviſions are cut, at the bottom of this cylinder is a male ſcrew, to fit the female ſcrew of the ciſtern, the upper part of the guage is protected by a tube of glaſs perforated at top

TO USE THIS BAROMETER.

1. The barometer being fixed in a perpendicular poſition, unſcrew the ſcrew at bottom as far as it will go without forcing it.

2 Take out the ivory ſcrew at the top of the ciſtern, and place it between the ſcroles on the upper part of the frame.

3 Screw the guage into the place from whence the ivory ſcrew was taken.

4 Screw up that ſcrew which is at the bottom of the frame, until the line on the float exactly coincides with the two lines on the front of the ivory cylinder.

5 Strike the barometer gently with the knuckles, and then so set the lower edge of the front index to the convex surface of the mercury, that it may be at the same time in a line with the edge of the index behind the tube, and the nonius will then give the true height of the mercurial column, from the surface of the mercury in the cistern

6. The preceding rule for setting the guage must be complied with, previous to every observation.

7. If the barometer is to be transported from one place to another, the guage must be removed, and the solid *ivory screw inserted in it's place, after which, the mercury in the tube may be forced gently up to the top* thereof, by the screw at the bottom of the frame.

OF THE SCALE OF CORRECTION.

This scale is placed close to that of the thermometer, but on the right-hand side, the zero, or 0 degree of this scale, corresponds to the 55th degree of the thermometer.

1. If the barometer is at 30 inches, and the thermometer at 55 degrees, no correction is necessary

2. But if the thermometer be under 55, and the barometer at 30 inches, you must add to the height of the barometer as many of the 100ths of inches as are on the scale of correction opposite to the degree of the thermometer.

3. If the thermometer be above 55, and the barometer at 30 inches, you must subtract as many 100ths as are indicated by the given degree of the thermometer on the scale of correction.

4. The scale applied to the thermometer answers for the general range of *meteorological observations*, but if the

the height of the barometer be very far diſtant from 30 inches, it will be neceſſary to make uſe of the rule of three, in order to obtain the true correction· for inſtance, let the barometer be at 26 inches, which we will call P, c the correction indicated by the thermometer, x the true correction then as $30 : P . c \; x$, or $\frac{pc}{30} = x$, which is to be added to the height of the barometer whenever the thermometer is under 55 degrees, but to be ſubtracted when it is above 55.

OF THE THERMOMETER.

HEAT and COLD are perceptions of which we acquire our ideas from the ſenſes. though, properly ſpeaking, theſe ideas only indicate a certain ſtate, in which we find ourſelves independent of any exterior object.

But as theſe ſenſations are, for the moſt part, produced by ſome of the bodies which ſurround us, and as they are generally accompanied in theſe bodies by an augmentation or diminution of what we call FIRE, we consider them as an effect of fire, and judging by appearances, we apply the names hot and cold to the substances themselves, calling those hot which produce in us the sensation of heat, and those cold which communicate the sensation of cold to us. Whatever be the nature of that quality in bodies which we call heat, we are assured that it does not resemble the sensation of heat. It is no less absurd, to suppose a likeness between the sensation and the quality, than it would be to suppose that the pain of the gout resembles a square or a triangle. The simplest man, with common sense, never imagines the sensation of heat, or any thing that resembles it, to be in the fire. he only imagines that there is something in the fire which makes him feel heat But as the name heat more frequently signifies this unknown something in the fire, than the sensation occasioned by it, he justly laughs at the philosopher who denies that there is any heat in the fire.

But the contradiction between the philosopher and the vulgar is more apparent than real, and is owing to an abuse of language on the part of the philosopher, and to indistinct notions on the part of the vulgar. The philosopher says there is no heat in fire, meaning that the fire has not the sensation of heat. his meaning is just, but his language is improper, for there is really a quality in fire, of which the proper name is heat, a name given to this quality both by the philosopher and the vulgar, more frequently than to the sensation of heat; and when he explains himself, and says that the fire does not feel heat, the difficulty vanishes, and the vulgar will agree with him.

But

But our ſenſations depend not only on the ſubſtances which excite them, but on the actual ſtate of our bodies at that time: we cannot, therefore, conclude the exact identity or ſimilarity of the cauſe, from the ſameneſs of the ſenſations, unleſs we can be aſſured that our bodies are in the ſame ſtate: if they be not, the ſame objects will produce very different ſenſations. Thus, if the hand be plunged into lukewarm water, this water will appear cold if the hand be warm, but if the hand be cold, the water will appear to be warm, though in both caſes it poſſeſſes the ſame temperature.

Our ſenſes are, therefore, both imperfect and deceitful meaſures of heat; and we cannot aſcertain, by their means only, the ſtate of the ſurrounding bodies with reſpect to heat or cold. This occaſioned philoſophers to ſeek for ſome method by which they might determine the temperature of bodies with more certainty. This they found in the property of heat, to dilate and expand all bodies, whether ſolid or fluid, and of cold, to contract or condenſe them. This expanſion and contraction is conſidered as a meaſure infinitely more certain of the degrees of heat and cold, than the ſenſes.

It would appear from this expanſion, that fire, when it is agitated by that motion which we call heat, always acted as if it wanted more room, and this in ſuch a wonderful manner, as if every particle of ſpace in which it exiſts were a radiant point or center, from whence it ſpreads forcibly outwards in every direction, and conſequently when fire, thus acting, is admitted into the pores of bodies, their parts muſt be ſtretched out, and their dimenſions every way increaſed, according to the degree

 of

of fire by which they are acted on. Some idea of the force of this expanſion may be gained by conſidering how vaſt a weight may be ſuſpended from a bar of iron, or braſs, in a vertical poſition, without ſeparating the parts of the metal, or overcoming the force with which they cohere. Now this, fire eaſily executes, ſo far relaxing the texture of braſs and iron, that their parts will fall aſunder with nothing but the force of gravity.

Thermometers are inſtruments which meaſure the degree of heat by the expanſion of bodies. Fluids are thoſe generally uſed, becauſe they are dilated more readily than ſolids; and quickſilver is preferred to other fluids, becauſe it's expanſibility is not affected by the different circumſtances in which it is placed, it does not ſoil the tube like many other fluids, and at the ſame time affords an extenſive ſcale of diviſions.

A thermometer is a tube of glaſs, the end of which is blown into a ball or cylinder; the ball, and part of the tube, is filled with mercury. The fluid in the ball dilates by the heat, and contracts with the cold, which occaſions the fluid in the tube to riſe and fall; and the ſmaller the bore of the tube is in proportion to the ball, the more viſible will be the riſe of the fluid by a ſmall expanſion. We may, therefore, conſider this inſtrument as a convenient meaſure of the changes of heat and cold, which is ſhewn by the ſcale to which the tube is affixed.

But it is not ſufficient to have found a meaſure of heat, it muſt be univerſal, always ſpeaking the ſame language, and awaking the ſame ideas in the mind, in all places, and at all times.

To

To this end it is neceſſary, 1 That this meaſure ſhould begin from a known and determinate point. And, 2. That another point, equally certain as the firſt, but at ſome diſtance from it, be fixed upon And, 3. That the ſpace between them may be divided into a certain number of parts, which in all inſtruments will have a conſtant proportion.

It has been fully proved that the temperature of freezing water, or melting ice, is conſtantly the ſame in all places, and at all times The ſame may be ſaid of boiling water, under a given preſſure of the atmoſphere. If, therefore, the ball of a thermometer be plunged into melting ice, and afterwards into boiling water, and left in each till it acquires their temperature, and marks are made at the reſpective heights at which the mercury ſtands in each, two fixed points will be obtained.

Fahrenheit's ſcale is that which is uſed in England. the freezing point is called 32, the boiling water point 212, ſo that there are 180 degrees, or diviſions, between them, which may be extended upwards and downwards, as far as is neceſſary

Foreigners uſe Reaumur's, or rather De Luc's ſcale, where the freezing point is called 0, and the boiling water point 80.

In a good thermometer it is neceſſary, 1 That the ſpace between the mercury and the ſealed end of the tube be free from air 2 The fixed points muſt be accurately aſcertained. 3. The ſcale ſhould be divided according to the capacity of the tube.

Two thermometers are neceſſary for accurate obſervation, one to be ſuſpended within doors, near the barometer,

barometer, the other out of doors. That without doors should be placed at the north side of the house, or where it will be sheltered from the rays of the sun.

OF THE HYGROMETER.

THE hygrometer is an instrument intended to discover the state of the air with respect to humidity, or dryness.

Had we indeed an hygrometer which would shew with accuracy the moisture of the air at different altitudes, we should be forward in our way towards prognostication.

The author of nature has, however, kindly furnished us with natural hygrometers, namely, the rising and setting luminaries, and even when they have risen to a considerable altitude, an attentive observer may consider them as hygrometers. Perhaps a bright scorching sun, a lucid moon with sharp horns, and lively twinkling stars, denote a dry air; while a faint sun and stars, and the moon blunt, as also the lunar and solar rings, may indicate a moist air.

As the whole atmoſpheric œconomy, as far, at leaſt, as relates to the weather, depends upon, or is connected with the ſtate of the vapour it contains, it is rather ſurprizing that we find ſo few hygrometrical obſervations among the many meteorological diaries that have been publiſhed. From time immemorial, the effects of moiſture have been conſidered as prognoſtic of the weather, as is evident by the confidence the houſewife places in her ſalt-box, the carter in his whit-leather thong, and the ſailor in his ſhrouds

But whether the hygrometer be a prognoſtic or not of the weather, it is certainly of the utmoſt importance to the natural philoſopher, and would probably prove a valuable oracle to the farmer, which is fully evinced by the following obſervation of Mr. Marſhall, in his minutes of agriculture. "Yeſterday morning, (ſays he) while the hygrometer ſtood at 2 degrees moiſt, the peas were by no means fit for carrying, the halm was green, and the peas ſoft. About ten o'clock the hygrometer fell to 1 degree dry; before one the peas were in good order: I went up into the field, merely on the WORD of the hygrometer, and found the peas fit to be carried" It is plain, therefore, that on a ſcattered farm, in hay-time and harveſt, an hygrometer muſt be peculiarly uſeful.

Within theſe few years, Meſſ De Luc and De Sauſſure have conſidered, with great attention, the ſubject of hygrometry, and have publiſhed three volumes on hygrometers, and the phænomena connected with them. they have alſo, each of them, contrived inſtruments for the purpoſe of aſcertaining the moiſture of the air. That of Mr. De Sauſſure is probably the beſt; the moving principle

ciple is a human hair· they have not been made in England, 1. On account of the trouble attending the necessary preparation of the hair. 2 On account of it's fragility Mr De Luc's, though more defective in construction, is made with more ease, and is less liable to accidents. In my meteorological essays I mean to give a full account of these instruments, and the substance of the works of their respective inventors

There are two other hygrometers in use, one made of the beard of a wild oat, the other of hatters paper

OF THE

UDOMETER,

OR

RAIN GUAGE.

IT is as necessary towards forming a systematic idea of the weather and it's various changes, to measure the quantity of rain which falls upon the earth, as to know the different degrees of heat and cold, or the variations in the pressure of the atmosphere.

The

The rain guage is a very ſimple inſtrument, conſiſting of a tin funnel of twelve inches diameter, communicating with a tube or cylinder of tin, into which the rain is conveyed by the funnel The heighth of the water is meaſured by a rule fixed to a float, this rule paſſes through the center of the funnel.

To uſe the rain guage, ſo much water ſhould be firſt poured in as will raiſe the float, ſo that the zero, on the rule, may exactly coincide with the aperture of the funnel. The funnel is ſo contrived, as to prevent the water from evaporating.

This guage ſhould be fixed down firmly in a place where, whatever wind blows, the fall of the rain may not be intercepted by the houſe, or any other impediment

ELECTROMETER.

For a deſcription of this, I muſt refer to my eſſay on electricity.

OF THE ATMIDOMETER.

THE atmidometer is an inſtrument for meaſuring the abſolute quantity of water raiſed in vapour, at different ſeaſons, and in different years: or to know from evaporation, at any given time, the diſſolving power of the air at that time, or the quantity of water exhaled and absorbed by the atmosphere.

The atmidometer consists of a cylindrical vessel, of 12 inches diameter, with a glass tube of four or five feet, proceeding from the bottom in a diagonal direction, the top of the tube being level with the top of the vessel; by this contrivance the smallest variations in the surface of the water are readily discovered.

There is a cover to the guage, at some distance from the surface, to prevent rain falling into it.

OF THE
ANEMOMETER,
OR
WIND GUAGE.

AS no accurate instrument has been contrived for measuring the force of the wind, the purposes of meteorology will be answered, by registering the quarter it blows from by a common vane, with the following distinctions, gentle air, brisk wind, fresh gale, hard gale, a storm, violent storm, hurricane.

When

When there are detachments of clouds, with a mixture of sun-shine, the velocity of the wind may be traced by their shadows along the ground. In storms, if the wind rages by violent gusts at intervals, a grove of trees may be seen to bend under the force, and if it's course be attended to, other trees, at a sufficient distance, may be seen to bend under the same blast, so that the space run over in a given time may be nearly discovered.

ON PROGNOSTIC SIGNS OF THE WEATHER.

By the weather we mean the various circumstances and phenomena attendant upon vapours, mists, clouds, rain, hail, snow, frost, thunder and lightning, the aurora borealis, and the winds.

The state of the atmosphere is influenced and modified by the variations in it's density or weight, by the quantity of aqueous particles, or it's humidity, by it's transparency, or the invisibility of the aqueous particles; by the visible collection of them in clouds, by their precipitation in rain, by the wind, by the agency of electricity, and the action of heat and cold.

There is no part of meteorology which interests mankind so much, as the predictions it furnishes of the change of weather. The theory of it only engages the attention, by animating us with the hopes of thereby bringing the knowledge of their predictions to perfection.

And the far greater part of those who purchase meteorological instruments, buy them, not so much to know the actual state of the elements, as to foresee the changes thereof.

thereof. This ſcience is, however, very imperfect; for it is but of late years that we began to make obſervations on the changes of the weather, and that it's progreſs has been rapid and ſucceſsful, may be ſeen in the works of De Luc, De Sauſſure, Jones, Marſhall, and Kirwan. But theſe obſervations will be ſtill more valuable to poſterity, for we can ſcarce expect them in ſufficient number in our own age, to deduce from them a general and perfect theory.

To attain this end, it will be neceſſary to multiply obſervations on as great a number of ſigns as poſſible, for it is only by their combination and concurrence that we can expect to remove the uncertainty, inſeparable from each in itſelf. Thus the barometer is not always a certain ſign, the ſame may be ſaid of the thermometer, the hygrometer, and the action of winds But if they all concur together, there is but little chance of being deceived, and there would be ſtill leſs, if to theſe were joined other ſigns, which are eaſy to obſerve, and which by their combination would render our prediction certain

No ſign, nor any inſtrument of obſervation, ſhould therefore be neglected, either from a love of ideal perfection, or fears of inaccuracy Thus though the hygrometer be at preſent a very imperfect inſtrument, yet one certain ſign has already been obtained from it's indicators, and more may be reaſonably expected. Even the words very dry, very moiſt, moderately dry, moderately moiſt, though of vague determination, may throw much light on the ſtate of the atmoſphere.

It is neceſſary that the obſerver ſhould enter into a preciſe detail of the various ſtates of the ſky, and the clouds. What can we learn from the words covered,

and

and cloudy, or half covered ſky, &c? Nothing, ſince it is well known, that a covered ſky, in one caſe, is almoſt as certain an indication of fine weather, as in another, it is an indubitable preſage of rain. The accurate obſerver piques himſelf on a thermometer, with which he can obſerve within a degree, and a barometer that he can depend upon to leſs than the 100dth of an inch, but is ſilent on the tranſparency of the air, on dews, on the elevation, the form, the ſign, the diſpoſition, the colour, and the denſity of the clouds, things that may be obſerved with eaſe, and deſcribed without trouble, being attended with no other inconvenience than that of extending the ſize of our meteorological tables

There is a phenomenon, which has not been ſufficiently attended to, namely, the undulating motion of the firmament, or that diurnal tumult in the air, which is kept up by the heat of the ſun. What the ſun raiſes from the earth by the heat of the day, is ſuſtained in the atmoſphere by it's heat, and the agitation, or expanſive undulation of the air. This motion is often viſible to the naked eye, but in the field of a powerful teleſcope it is very conſpicuous, all objects appear in violent agitation, and the line of the ſenſible horizon, which ought to be clear and well defined, is waved like a field of corn in the wind, or the ſurface of the ſea in a ſtorm. So long as this agitation continues, the vapours ſtay in the air, but when it ſubſides, and the ſun departs, they are condenſed and fall down to the earth in the night as dew.

In the preſent ſtate of this part of ſcience, when we are unacquainted with ſo many phenomena, and ſtill more ignorant of their cauſes, general rules will often be found to fail, and particular ones will, without much circumſpection, prove to be a ſource of error. amongſt the variety of means for predicting the changes of the weather, the barometer is undoubtedly one of the beſt, and is in this, as well as many other reſpects, one of the greateſt acquiſitions to natural philoſophy.

The uſual ranges of the mercurial column in this latitude, are comprized between 28 and 31 inches, of which the middle, or 29½ is conſidered as the variable I think it ſhould be placed ſomewhat higher. Near the pole, the variations of the barometer are much greater; between the tropics, much leſs.

PROGNOSTICS FROM THE BAROMETER.

1. In general, when the barometer falls, the air being lighter, will let fall it's vapour, and give us rain. But when the mercury riſes, the air being heavier, will ſupport the vapours, and be productive of fine weather

2. If the mercury falls in a froſt, we may expect ſnow, or a thaw, but if it riſes in winter with a north or eaſt wind, it generally portends a froſt

3. In order, however, to deduce any obſervations with certainty, we muſt attend to the progreſs of the riſe or fall thus, if it ſinks ſlowly and gradually, we may expect that the rain will be of ſome continuance But if the riſe be gradual, we may judge, that the fine weather will be laſting

4. If the barometer fluctuates much, riſing and falling ſuddenly, the weather is unſettled and changeable

5 If it falls very low, there will be much rain.

6. But if it's fall be low and ſudden, a high wind generally enſues.

7. When

7. When exceeding low, ſtorms and tempeſtuous weather may be expected: but if an extraordinary fall happens, without any remarkable change near at hand, it is probable that there is a ſtorm at a diſtance.

8. The deſcent of the barometer is not, however, always an indication of rain, for it will often fall for wind, nor is it's riſe a certain ſign of fair weather, particularly if the wind be northerly or eaſterly

9 If the fine weather be laſting, with a weſterly wind, the barometer generally reſts a little above changeable, but ſomewhat below 30 inches.

10. In the ſummer months the barometer does not vary ſo much as in winter

11. The French writers ſay, that the greateſt elevations of the barometer are in a froſt with a north or eaſt wind.

12. The greateſt variations in the barometer are in the two firſt, and the two laſt months of the year, but particularly in the firſt and laſt.

13. A north-eaſt wind generally makes the barometer in this country riſe, and it is generally loweſt with a ſouth-weſterly wind.

Beighton's Rules.

If the mercury continues to fall while it rains, it will be likely to rain the next day.

When the mercury is pretty high, and has fallen to foretel rain, and yet riſes before the rain falls, it is an indication that there will be but little of it

In ſerene and hot weather, when the mercury is high and riſing, and you have all poſſible certainty of fair weather

ther the next day, and yet there should happen to fall very heavy showers, it is probable they have been driven upon you by the effect of distant thunder.

In fair weather, when the mercury has continued high and rising, if it falls about noon, and rises again towards the evening, a single shower may be expected on the evening or noon of the next day, and then fair weather.

When the mercury rises gradually about half a 10th, and continues to do so for many days, the fair weather may be expected to continue for some time, unless wind intervenes, particularly from the S W by S.

PROGNOSTIC FROM BAROMETER AND THERMOMETER.

If the air in foggy weather becomes hotter by the action of the sun alone, the fog generally dissipates, and the air remains serene but if the barometer falls, and the change of temperature be from a south or south-west wind, the fog rises and forms itself into clouds, and it's ascension is generally a sign of rain.

FROM BAROMETER, HYGROMETER, WIND, AND STATE OF THE SKY

The barometer being high and stationary, the natural and factitious hygrometers indicating dry air, the canopy of the sky lofty, and the wind north-easterly, are the surest signs of SETTLED FAIR, while a light and moist atmosphere, the canopy of the sky low, and a south-west wind, certainly portend a wet season

FROM

FROM VAPOURS.

A shepherd in Essex had a doctrine which he said was confirmed by long observation, that after the sky had taken up five or six fogs, it was pretty sure to send them down again in rain so he made it a practice to keep a register of the fogs upon a stick, and according as the numbers stood, he predicted when the rain was to follow. There might be some foundation for this as a local observation, but it cannot be extended, as fogs depend not only upon the state of the air, but also upon the situation of the place. We have at present no data from observations, whereby to form certain conclusions relative to fogs, and their connections with rain.

SIGNS FROM THE THERMOMETER ONLY.

In winter, if the cold diminishes suddenly, it in general portends rain In summer, a sudden augmentation of heat is a forerunner also of rain.

PROGNOSTIC FROM THE HYGROMETER AND THERMOMETER.

It is in most cases a certain sign of fair weather, when the march of the hygrometer from it's greatest extreme of humidity in the morning, to the greatest degree of dryness in the afternoon, is greater than it generally makes with the same temperature, while the reverse is one of the most certain indications of rain.

PROGNOSTICS FROM THE CLOUDS

There are so many signs by which it is supposed that we may foretel the approaching weather, that Virgil was bold enough to affirm, that no shower ever did damage to any man without giving him proper warning: amongst these the signs from the clouds are many and important; for from the clouds the rain proceeds, and it is the state of the air with respect to the water they contain, that either prevents or hastens it's fall into rain. "They are continually travelling over all the terrestrial globe, and by a proper communication of moisture, render fruitful the spacious pastures of the wealthy, and gladden the cottager's little spot. Nay, they SATISFY THE DESOLATE AND WASTE GROUND, AND CAUSE THE BUD OF THE TENDER HERB TO SPRING FORTH: that the natives of the lonely desert, the herds which know no master's stall, may nevertheless experience the care of an all-supporting Parent."

The formation and solution of clouds in the sky are often manifest to the sight, if they are watched attentively for some time together, particularly in a summer's evening, we shall see them lessen by degrees, and be at last so totally dissolved in the air as to be no longer visible. The Rev. Mr. Jones, in his admirable disquisitions, to which I am principally indebted for the account of the prognostic signs of the weather, says, that when in company with another observer, he has been taking the angles of a cloud at two stations, to find their height at different seasons, the cloud fixed upon for his purpose has often wasted away and disappeared entirely

5 before

before it reached the intended place of obſervation. This reſolution of the clouds into air, and their diſappearance from the ſight, may be conſidered as a ſtrong ſymptom of fair weather.

But on the other hand, when they are collected out of it, and manifeſtly increaſe both in denſity and magnitude, it is a ſtrong prognoſtic of rain Thus when the ſky, which has been long ſerene and blue, becomes fretted and ſpotted with innumerable ſmall clouds, bearing ſome reſemblance to the waves of the ſea, or the party-coloured back of a mackerel at firſt they are thin, white, and fleecy, but by degrees grow dark and black, and are in general generated at about the height of three quarters of a mile

Againſt heavy rain, every cloud riſes bigger than the preceding, and all are in a growing ſtate this is moſt remarkable on the approach of a thunder-ſtorm, when ſmall fragments of clouds increaſe and aſſemble together, till in a ſhort ſpace of time they cover the ſky. Thus, after a great drought in the days of Elijah, a cloud ſeemed to ariſe out of the ſea (that is, from the horizon of the ſea) no bigger than a man's hand, which ſoon overſpread and blackened the whole heaven.

When the clouds are formed like fleeces, deep and denſe towards the middle, and very white at the edges, with a bright blue ſky about them, they generally ſoon fall in hail, ſnow, or in haſty ſhowers of rain.

If clouds are ſeen to breed high in the air, in thin white trains, like locks of wool or the tails of horſes, they ſhew that the vapour is ſpread and ſcattered by contrary winds above while it is collecting, from which wind will soon be produced below, and probably rain with it.

Mr Jones says, that from the complexion of a single cloud, with white edges and dark diverging lines from it, he ventured to predict a high wind forty hours before it began, when there was a storm of the first magnitude, which lasted for two days and two nights.

If the clouds, as they come forward, seem to diverge from a point in the horizon, a wind may be expected from that or the opposite quarter.

When a general cloudiness covers the sky above, and there are small black fragments of clouds like smoke flying underneath, rain is seldom far off, and is generally lasting.

There is no sign of rain more certain than two different currents of clouds, especially if the undermost flies fast before the wind: two such currents, in hot weather, portend a thunder-storm.

The transparency of the air is to the inhabitants of the Alps one of the most certain prognostics of rain; there, when the distant objects appear distinct and well defined, when the sky is of a deep blue, they consider rain as near at hand, though no other signs appear. How far this observation may hold, with respect to this country, I have had no opportunity of observing since I began to consider the subject: so far, however, may be said, even with respect to us, that the clearest sky contains a great quantity of vapour, which is the occasion of its blue colour.

Another circumstance which seems to have escaped the attention of most observers, is, the colours which may

may be ſometimes obſerved in the white clouds immediately under the ſun By obſerving carefully theſe clouds, we may now and then ſee decided tints of the rainbow, without rain or rainbow, the colours are lively and ſcattered, without any order, about the moſt enlightened or brighteſt part of the cloud This in Swiſſerland is reckoned to be an infallible ſign of rain.

FROM THE DEW.

If the dew lies plentifully upon the graſs after a fair day, another fair day may be expected, but if after ſuch a fair day there is no dew upon the ground, and no wind ſtirring, it is a ſign that the vapours go upward, and that there will be an accumulation above, which muſt terminate in rain

If the dew, or hoar froſt, are very abundant at a ſeaſon when they are not generally produced, and the barometer is low, it is in general a ſign of rain.

FROM THE FACE OF THE SKY.

The colour of the ſky is an index to the weather, becauſe it ſhews the ſtate of the vapours which reſide in the atmoſphere.

If the red vapours of the evening are precipitated, the morning ſky is clear, but if they remain in the air, the morning is red, and rain is in general the conſequence.

If a lowring redneſs ſpreads far upwards from the horizon, either in the morning or the evening, it is ſucceeded either by rain or wind, frequently by both.

If ſuch a fiery redneſs extends towards the zenith in an evening, the wind will be high from the weſt, or ſouth

weſt,

weſt, attended with rain, and ſometimes ſucceeded by a flood.

When the ſky in a rainy ſeaſon is tinged with a ſea-green colour near the horizon, when it ought to be blue, the rain will continue and increaſe. If it be of a deep dead blue, it will be ſhowery.

The loftineſs of the canopy, is perhaps one of the trueſt prognoſtics of fine weather.

FROM THE SUN, MOON, AND STARS.

The appearance of the ſun, moon, and ſtars, give notice of approaching changes in the weather, as the rays which come from them to us, muſt paſs through the vapour in the atmoſphere, and indicate it's ſtate.

The ſun riſing gaudy, (the clouds in the eaſt being tinged with an orange colour) is generally eſteemed to be a ſign of rain.

When there is a hazineſs high in the air, the light of the ſun fading by degrees, and his orb looks whitiſh and ill defined, it is in general a ſign of rain

If the rays of the ſun breaking through the clouds are viſible in the air, and appear like the horns of irradiation which painters place on the head of Moſes, it ſhews the air to be filled with vapour, and if other ſigns concur, is a proof that rain is at hand.

Virgil ſays, that a pale moon is a ſign of rain, that a red one predicts wind, and a white one, and of her natural colour, with a ſerene ſky, fair weather.

If the moon and ſtars grow dim at night, with a hazineſs in the air and a ring, or halo round the moon, it is a ſign of rain. This is not, however, a bad ſign, if if it happen in an evening, when the dew is forming; but if they appear at any other time, they prove a general disposition in the air and clouds, to let go their vapours under that form which we denominate rain

Mr Jones gives us the following observation with respect to the moon's monthly course.

If the moon be rainy throughout, it will clear up at the ensuing change, and the rain will probably commence again in a few days, and continue. but on the contrary, if it has been fair throughout, and it rains at the change, the fair weather will probably be restored about the fourth or fifth day of the moon, and continue as before. By this rule, he says, he has made hay these twenty years, without having once had the mortification to see it damaged by the rain A farmer who has much work to do, cannot contract it in so small a compass as to reap much benefit by this observation, but a gentleman who cuts hay for his own consumption, will seldom fail to find his account in it

Dr. Horsley attacks this opinion concerning the moon, and though it's influence has attracted the general notice of men in all ages, yet he peremptorily asserts, that it is a notion in itself improbable, destitute of all foundation in physical theory, and but little supported by any plausible analogy. But the Doctor himself does not deny that the observant husbandman will find a variety of useful prognostics in the appearances of the moon, but then he says, they will be symptoms destitute of all efficient powers they will shew the present state of the air as that on which they depend, not as that which

they

they govern, and may furnish probable conjectures for two or three days to come.

FROM THE WINDS.

Among the causes which affect the weather, there is none whose influence is more demonstrable than that of the winds; these, though uncertain in appearance, are, like all other phenomena of nature, governed by fixed and determinate laws, and deserve a most serious investigation.

When the wind veers about uncertainly to several points of the compass, rain generally follows. By some it has been asserted, that if the wind in veering about follows the course of the sun from east to west, it brings fair weather, but if it's course is from west to east, foul.

A whistling, howling wind is almost an infallible sign of rain, it is a sign that does not seem to be confined to any climate for in the sacred history we find Elijah saying, GET THEE UP, EAT AND DRINK, FOR THERE IS A SOUND OF ABUNDANCE OF RAIN

SIGNS FROM ANIMALS.

Those who pay attention to the animal creation, will find in their habitudes, many prognostics of the changes of the weather In the nature of their labours, by the uneasiness they testify, by the peculiar tone of their voice, or by the precautions they take to shelter themselves, their feelings are probably more acute, and their senses more awake to the delicate impressions of natural causes, than our's, where the mind by it's continual

tinual action diminiſhes the force of all external impreſſions.

OF THE SOURCES OF HEAT AND COLD.

If the changes of the weather depended on the courſe of the year, and the temperature of climates were governed by their ſituation with reſpect to the ſun, that is, by their latitude, then the weather might be reduced to ſome regular theory. But this is ſo far from being the caſe, that the latitude of a place cannot be conſidered as an index to the temperature of the climate: for we find the hotteſt days in the coldeſt climates, and the coldeſt weather, and even perpetual ſnow, are found in countries bordering on and immediately under the equator, ſo that we muſt recur to ſome other cauſes beſides the immediate influence of the ſolar rays.

1. But though the ſun is not the only cauſe, it's preſence is undoubtedly the principal ſource of heat as well as light, and it's abſence the primary cauſe of cold. It is indeed the great ſpirit of the world: all things revive at his approach, winter and froſt lay behind him.

2. The ſecond ſource of heat is the earth. Nobody has yet been found ſo abſurd as to ſuppoſe that human perſpiration was owing to the air that ſurrounds the ſkin, it originates in an internal cauſe. it is occaſioned by a heat within, not the air without. It is the ſame with reſpect to the earth, which by imparting it's heat to the atmoſphere, moderates the rigour of the winter's cold. Whether we ſuppoſe that this heat ariſes from a central ſource, or that the globe from it's firſt creation was endued with a heat ſufficient for all the purpoſes it

was intended to anſwer, yet it is evident that it is renewed and preſerved by the influence of the ſun, and that there is always a ſilent and imperceptible heat proceeding from the earth

3 The next great ſource of heat is the condenſation of vapour Vapour contains a quantity of fire it is this fire which cauſes it to aſſume, and ſupports it in an aerial expanded ſtate when condenſed into a liquid form, it lets go this fire, which warms the ſurrounding atmoſphere hence the ſultrineſs frequently experienced before rain.

OF THE SOURCES OF COLD

1. As the earth is one of the principal ſources of heat in the atmoſphere that ſurrounds it, ſo is diſtance from the earth a ſource of cold · the greateſt cold prevailing in the higheſt regions of the atmoſphere for where the reaction is wanting that is occaſioned by a ſuperficial preſſure, but little effect can be received from the rays of the ſun, and it is further proved by experiments with the burning-glaſs, that a clear unclouded air receives no heat from theſe rays Hence when we aſcend to a lighter air, at a diſtance from the ſurface, the heat is not ſufficient to melt the ſnow, and we find the higheſt mountains, even under the equinoctial, perpetually covered therewith · thus the mean height of the lower term of congelation in winter, in this latitude, may be conſidered in general to be at 6260 feet from the ſurface, and the mean height of the upper term at 1125 feet. We cannot in this ſhort tract conſider any of the minute exceptions.

2. The

2. The next great fource of cold is evaporation. The fame caufe which makes the condenfation of vapour a fource of heat, makes evaporation productive of cold; as it abforbs the fire in the latter inftance, which it gives out in the former it is this which gives the particles of vapour their aerial form. When fire paffes from fluids which it has heated, it's courfe is upwards, and it always carries with it a thin ftratum of the fluid in the form of vapour thus evaporation not only tempers the heat occafioned by the fun's rays, but is one great fource of cold.

Of Evaporation.

Of evaporation it may be obferved, 1. That in our climates the quantity of it is four times greater from the 21ft of March to the 21ft of September, than it is from the 21ft of September to the 21ft of March.

2 That it is greater in proportion as the difference in temperature between the air and evaporating furface is greater, though if the air be 15 degrees colder than the evaporating furface, there is no evaporation but a depofit of moifture from the air

3. The degree of cold produced by evaporation is always much greater when the air is warmer than the evaporating furface, than that which is produced when this furface is warmer than the air. Hence warm winds, as the Serocco and Harmatan are more deficcative than cold winds.

4. Evaporation is more copious when the air is lefs loaded with vapours, and is confequently powerfully promoted by cold winds flowing into warmer countries.

5. That it is greatly increased by a current of air, or wind flowing over the evaporating surface, not only because the evaporating surface is thereby increased, but also because unsaturated air is constantly brought into contact with it: hence it is generally remarked, that calm days are the hottest.

6. Tracts of land covered with trees, or vegetables, emit more vapour than the same space covered with water: on this principle it is, that the air about a wood or forest, is made colder by the evaporation from trees and shrubs, while the plants themselves are kept in a more moderate heat, and secured from the burning heat of the sun by the vapour perspired from their leaves. Thus we find the shade of vegetables more effectual to cool us, as well as more agreeable, than that from rocks and buildings.

7. The heat and cold of different countries are transmitted from one country to the other by the medium of winds.

OF ANNUAL TEMPERATURE

Within 10 degrees of the pole there is very little difference in the annual temperature, nor is there much within 10 degrees of the equator.

The temperature of different years differs very little near the equator, but they differ more and more as their latitudes approach the pole.

It scarce ever freezes, unless in very elevated situations, in latitudes under 35°, and it scarce ever hails in latitudes higher than 60°.

Between the latitudes of 35 and 60, in places adjacent to to the ſea, it generally thaws when the ſun's altitude is 40°, and ſeldom begins to freeze until the ſun's meridian altitude is below 40°

The greateſt cold in all latitudes in our hemiſphere, is generally about half an hour before ſun-riſe. the greateſt heat in all latitudes between 60° and 45°, is found to be about half paſt two o'clock in the afternoon.

The coldeſt weather in all climates generally prevails about the middle of January, the warmeſt in July.

The temperature of a climate depends on many circumſtances, particularly on the diſpoſition of the land; as it's elevation, its expoſure to the winds, and the courſe of the mountains that are found in it Thus the writer of Anſon's Voyage informs us, that while they coaſted near the land of South America, which has thoſe vaſt ridges of mountains, the Andes and Cordilleras, the air was rendered temperate by the wind that blew over them, but when they had paſſed beyond this tract of land, and ſailed by the iſthmus of Darien, where the country is flatter, the air became inſupportably cloſe and ſultry

All countries lying to the windward of high mountains, or extenſive foreſts, are warmer than thoſe to the leeward in the ſame latitude

The vicinity to the ſea is another circumſtance which affects the temperature of a climate, as it moderates the heats from the land, and brings the atmoſphere down to a ſtandard beſt fitted to the human conſtitution: this is probably the reaſon why there is ſo great a proportion of ſea on the terraqueous globe, and particularly why it is ſo largely diſtributed about the middle region of the earth.

earth. In our hemisphere, countries that lie southward of any sea are warmer than those that have that sea to the south of them because the winds that should cool them in winter are mitigated by passing over the sea, whereas those that are northward of the sea, are cooled in summer by the breezes from it A northern, or southern bearing of the sea, renders a country warmer than an eastern or western bearing

Islands participate more of temperature arising from the sea, and are therefore warmer than continents. Most large islands have their greatest extent from north to south With us, the southern parts are proportionably colder than the northern. A ridge of mountains generally traverses islands in the direction of their length.

The soil of large tracts of land has it's share in influencing the temperature of the weather thus stones, or sand, heat and cool more readily, and to a greater degree, than the earth or vegetable mould: hence the violent heats of the most sandy desarts of Arabia and Africa, and the burning heat and blasting qualities of the wind that passes over them hence also the intense cold of Terra del Fuego, and other stony countries in cold latitudes.

Living vegetables have a considerable effect in altering climates and affecting the weather Wooded countries are much colder than those that are open and cultivated thus part of Guiana has only been cleared from wood since the beginning of this century, and the heat in that part is already excessive, whereas in the wooded parts the inhabitants are obliged to light a fire every night.

Sir William Young gives a remarkable instance of the effect of hills in arresting vapour, and producing rain; while the exhalations from the trees on it's surface cool and temper the air: observing, that the smooth polished Barbadoes and our Leeward islands are parched up, whilst the towering and rugged Dominica, St Vincent, Grenada, and Tobago, enjoy incessant rains, and delicious verdure.

It is generally agreed, that the clearing away of wood in time lessens the vapours, and consequently the rain of a country. Several fine parishes in Jamaica, which used to produce large crops of sugar canes, and were once the richest spots in the island, are now dry for nine months in the year, and are turned into cattle pens, through the clearing away of the neighbouring woods.

The following observations on the same subject were communicated to me by a very ingenious friend.

Water is very plentiful in those countries where woods and forests abound, and the purest springs are generally found beneath the friendly shelter of a grove.

The natural history of every country shews, that in proportion as the woodlands are cleared, the water courses diminish.

In America, unfortunately for the inhabitants, this truth is too well known. For since the woods in the vicinity of their towns have been cut down, many long established mill races have become dry, and others have been reduced so low as to cause very great interruptions to the miller, who must wait a considerable time for the dams to fill between every few hours work.

Hence

Hence we may learn the important neceſſity of preſerving the trees, from beneath whoſe humid ſhades a water ſpring diſcharges it's ſtreams and hence too we may learn, that the ſmalleſt ſprings may be improved *by planting around them a grove of trees*, particularly the oak, ſo highly valued by the Greeks, the Romans, and our ancient Druids who, conſidering the health of man, and the fertility of the ſoil to be abſolutely dependent upon plenteous ſtreams of water, CONSECRATED THEIR GROVES *to preſerve their ſprings*

It were much to be wiſhed that ſome expedient could now be formed to anſwer the ſame valuable purpoſe

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I ſhall finiſh this little tract with an extract on the connection between the human body and the weather from Mr Jones's Phyſiological Diſquiſitions.

The air affects the human frame, by it's weight, it's moiſture, it's dryneſs, it's heat, and it's cold There are two forces which act upon the animal frame, and they are both equally neceſſary to the keeping up of vital heat and vital motion The one force is that of the atmoſphere preſſing without upon the ſurface of the body, the other is that of the air expanding it within, and theſe two ought to be a counterbalance to each other When the barometer is high, the ſuperficial preſſure is in force on the outſide of the body, by which the fibres are ſtrengthened, the coats of the veſſels react upon their contents, the blood is propelled, ſecretions are promoted, the body feels active, and the mind is in vigour, athletic conſtitutions, inured to the inclemency of the weather, feel little or no inconvenience from any change, but when the frame is tender, or ſickly, it is ſenſible of depreſſion

preſſion and relaxation, when the weight of the air is leſſened the force within is not ſufficiently counterbalanced, the reaction of the ſolids upon the fluids is weaker, the coats of the veſſels are diſtended, the muſcular parts inflated the body leſs active, and the faculties leſs vigorous than uſual.

When the air is too moiſt it draws off the vital heat, occaſions a ſenſation of cold and chilneſs over the ſkin, checks perſpiration impoveriſhes the blood, and by increaſing the ſerous fluids, brings on agues, intermittents, dropſies, putrid ſore throats &c. While air which is too dry, as is ſometimes the caſe with a north or north eaſt wind, by carrying off the finer parts of the animal fluids in perſpiration, occaſions a viſcidity of the blood, and a variety of diſtempers, according to the different conſtitutions of the body.

Of ſituations, perhaps, the moſt promiſing for the enjoyment of health, life, and every convenience, is near the bottom of an high hill, that has a ſoutherly aſpect, with woods and plantations about the head of it, a dry ſoil of ſand or gravel with a mixture of loam, and running water, with green meadows before it to the ſea, with a ſteep and clean ſhore of gravel or beach. There may Health fix her ſeat, but let no man think that his ſituation will preſerve him, unleſs he has the prudence to preſerve himſelf. All the varieties of the weather, all the ſeaſons, and all the elements, are at war with the indolent and the intemperate.

The General State of the Weather when the Mercury in the Barometer remains stationary on any of the undermentioned Degrees, 12 of which are equal to an English Inch

The outer numbers are the correſponding inches and parts.

31 inch.	16.	Settled, fine clear ſky.
.92	15	Summer, very warm, winter, hard froſt.
.83	14.	Great drought.
.75	13	Pleaſant ſerene weather.
.67	12.	Settled.
.58	11.	Summer, cloſe and rainy, winter, ſnow, and foggy.
.50	10.	Clear.
.42	9.	Rain or wind; winter, ſnow or miſt.
.33	8	Fine weather.
.25	7.	Rain or wind.
.17	6.	Good but uncertain weather.
.08	5.	Generally miſty when the thermometer is under 60 deg · otherwiſe, thick, rain or wind; but in ſummer with an eaſterly-wind, clear.
30 inch.	4.	Good weather.
.92	3.	Stormy with a north-weſterly wind, otherwiſe, raw, hazy, cloudy weather; in ſummer, thunder.
.83	2.	Moderate weather.

.75	1. Rain, thunder, wind; in winter, with a northerly wind, raw, cold, ſnow, or miſt.
.67	0. Variable.
.58	1. Moderate, if the wind be ſoutherly, rain.
.50	2. Rain, wind, thunder, hail, ſnow, &c.
.42	3. Calm, but generally with heavy clouds.
.33	4. Rain, wind, thunder, hail, ſnow.
.25	5. Tolerably calm.
.17	6. Heavy rain, or wind, thunder, hail, ſnow, &c.
.08	7 Serene, though ſometimes fogs or miſt.
29 inch.	8. Stormy, in winter, miſt.
.92	9. Calm, in winter, thick fog.
.83	10. Heavy Storms.
.75	11 Calm.
.67	12. Stormy.
.58	13. Calm, but heavy clouds.
.50	14. Half a hurricane.
.42	15. Calm, with a great drift of ſcudding clouds.
28 33	16. Violent hurricane.

Thus the barometer ſtood, 12th December 1747.

Theſe obſervations were made when the barometer was placed 25 feet above the level of the ſea or river waters.

Before each obſervation, it will be requiſite to rap the caſe with the knucles, to remove the friction of the mercury, thence you may be certain whether the mercury has been ſtationary on any degree.

When the mercury rests at $\frac{1}{2}$ a degree, expect variable, or a mixture of that weather expressed by the degree above and below it.

It is most adviseable to observe the alteration in the rise and fall of the mercury every three hours; as at 6, 9, 12, &c.

I found this state of the weather among my Father's papers.

A SCALE OF HEAT.

	Fahrenheit's Degrees
Iron in fusion about	3000
Iron with the white sparkling heat of a smith's forge	2780
Iron with a heat almost white	2080
The heat of live coals without blowing, perhaps about	1650
Iron with a glowing red by day light	1600
Iron just red hot by day light	1120
Iron just red hot in the dark	1000
Greatest heat of lead in fusion	820

	Fahrenheit's Degrees.
Colours of iron are burned off	800
Mercury boils, by ſome placed at 600, by Jones	700
Poliſhed iron takes a full blue	700
Poliſhed iron takes a purple	660
Linſeed oil boils	620
Lead melts	610
Poliſhed iron takes a ſtraw colour	605
Oil of vitriol boils	546
Braſs takes a blue colour	500
Tin melts	490
Tin foil and biſmuth	450
Braſs takes a copper colour	415
Poliſhed braſs takes a gold colour	340
Spirit of nitre boils	242
Water boils at a mean ſtate of the atmoſphere	212
Freſh human urine boils	206
Brandy boils	190
Alcohol boils	176
One pound of water of 52°, to $\frac{1}{2}$ a ℔ of freſh chalk lime	182
1 oz. of water of 54°, to $\frac{1}{2}$ oz. of oil of vitriol	170
Serum of blood and white of eggs harden	156
Bees wax melts	145
Greateſt heat of a bath which the hand can well bear	114
Heat of the Serocco wind at Palermo in Sicily	112
Heat of a hen hatching eggs, from 92, to	108
Heat of the ſkin in ducks, geeſe, hens, pidgeons	107
Heat of the human ſkin in an ague, fever	106

Heat

	Fahrenheit's Degrees.
Heat of the ſkin in dogs, cats, ſheep, and other quadrupeds ——	103
Heat of the human ſkin in health ——	98
Heat of a hive of bees ——	97
Heat of the air in the ſhade in very hot weather	80
Butter begins to melt ——	74
Temperate —— ——	55
Oil of olives begins to ſtiffen ——	43
Water juſt freezing, or ice juſt melting ——	32
Milk freezes ——	30
Urine and common vinegar freeze ——	28
Good burgundy, claret, and madeira, freeze	20
One part of ſpirit of wine, with 3 of brandy, freezes —— ——	7
A mixture of ſnow and ſalt ——	0
Mercury freezes ——	39

With reſpect to the formation of this table, ſee Jones's Phyſiological Diſquiſitions.

OF

Of measuring Heights by the Barometer.

The barometer is the only inſtrument that can be conveniently uſed for this purpoſe in great and diſtant tracts of country. The method of uſing it is eaſy, only requiring a little habit, and ſome attention; while few will go to the expence, or attend to the adjuſtments neceſſary for an accurate geometrical menſuration of heights; and there are few ſituations in mountainous countries that afford a proper baſe. The barometrical obſervations require no peculiarly favorable circumſtances in the figure or ſituation of the mountain to be meaſured; it is ſufficient that both ſituations be acceſſible.

In order to meaſure heights accurately by the barometer, it is neceſſary to be provided with two barometers, made for that purpoſe, of the beſt conſtruction, with a nonius, by which the length of the mercurial column is aſcertained to the 500dth part of an inch. There ſhould be four thermometers, one attached to each barometer, and two detached therefrom.

1. Place one of the barometers, with it's attached and detached thermometer, on the given eminence in the ſhade, while the other is in the valley, or plain, at the bottom of the hill. Here they muſt remain a ſufficient time for the detached thermometer to acquire the temperature of the air.

2. As ſoon as the thermometer is fixed, obſerve the height of the mercurial column, and the temperature of the two thermometers. Similar obſervations ſhould be made, at the ſame time, by the obſerver on the plain. It is adviſeable to take three or four ſets of obſervations at ſhort intervals of time, at each ſtation, and to uſe the mean of the whole as the true obſervation.

3. To

3. To reduce the temperature of the mercury in each barometer to the mean height of 55°, take the difference between the two attached thermometers, and seek in table 1, the degrees of heat in the column on the left hand, and take out the number in the same line with this, but under the height of the barometer, in inches, in the horizontal line at top. The number thus found is the correction for the expansion of the quicksilver, by heat expressed in thousandth parts of an inch, to be added to the coldest barometer, or subtracted from the hottest, will give the height of the two barometers, such as would have obtained had both been exposed to the same temperature.

4. Take the difference of the logarithms of these corrected heights of the barometers, and the four first figures on the left will be the logarithmic elevations in fathoms, the remaining figures being a decimal. this may be reduced to feet by multiplying it by six, and the number found will be the true elevation, if the mean temperature was 31° ¼.

5. To find the mean temperature, add together the degrees of the two detached thermometers, and divide their sum by two, the quotient will be an intermediate to be taken for the mean temperature of the vertical column of air intercepted between the two places of observation. If it be 31° ¼, no correction is required, but if not, take it's difference from 31° ¼, and with this difference seek the correction in table 2.

Look for the number of degrees in the left hand column, and the height found to the nearest thousand of feet in the horizontal line at top. For the hundred feet

strike

off one cypher to the right hand, for the tens strike off two, for the units three. The sum of these numbers is to be added to the height, if the temperature be greater than 31° $\frac{1}{4}$; but subtracted if less, which will give the correct height in English feet.

EXAMPLE.

Barometer	Therm attached	Diff.	Therm.	Mean heat
Lower 29 400	50	4	45	42¼
Higher 25.190	46		39½	

Log of lower Br. 29 400	is	4683473
Log. of upper Br. 25 200	is	4014005
Difference		669.,68
		6
Approximate height		4016 708
		+ 107 474
Correct height		4124.108

Correc. for the diff between the 2 attached Ther 4° gives 10 to be added to the col-dest.

	25.190
	+ 10
	25 200

31¼ Standard heat from 42¼ gives 11 for 2d correction.

11 on 4000 feet	106 9
16	5
	107 4

TABLE I.

For the EXPANSION of QUICKSILVER by HEAT.

By Sir GEORGE SHUCKBURGH

Degrees of Therm.	Height of the Barometer in Inches.												
	[illegible]	[illegible]	[illegible]2	[illegible]3	2[illegible]	[illegible]	26	2[illegible]	28	29	30	31	32
1	2	2	[illegible]	2 [illegible]	2 [illegible]	2	2 6	2 [illegible]	2 8	2 9	3 0	3 1	3 2
2	[illegible]	[illegible]	[illegible] 5	[illegible]	4 9	5 1	5 3	5 5	5 7	5 9	6 1	6 3	6 5
3	6 1	6 [illegible]	6 [illegible]	7 [illegible]	7 3	7	7 9	8 2	8 5	8 8	9 1	9 4	9 7
4	8	[illegible]	[illegible]	9 [illegible]	9 [illegible]	1[illegible]	10 5	11 0	11 4	11 8	12 2	12 6	13 0
5	10 1	[illegible]	1[illegible] 1	11 6	[illegible]2 1	1[illegible]	[illegible]3 2	13 [illegible]	14 2	14 [illegible]	15 2	15 7	16 2
6	[illegible]2 2	[illegible]	[illegible]3 [illegible]	[illegible]	1[illegible] 6	1[illegible]	[illegible] 8	16 [illegible]	17 0	17 6	18 2	18 8	19 [illegible]
7	1[illegible] 2	[illegible]	15 6	1[illegible] 3	17 [illegible]	[illegible]	18 [illegible]	19 2	19 8	20 6	21 3	22 0	22 7
8	[illegible]	[illegible]	1[illegible] [illegible]	[illegible]	19 [illegible]	20 2	21 0	21 9	22 [illegible]	23 5	24 3	25 2	25 9
9	[illegible]	19 [illegible]	20 [illegible]	[illegible]	[illegible]	22 8	23 7	24 6	2[illegible] 6	2[illegible] 5	27 4	28 3	29 2
10	[illegible]	[illegible]	22 [illegible]	[illegible]	[illegible]	2[illegible]	26 [illegible]	2[illegible] 4	28 [illegible]	29 4	30 4	31 [illegible]	32 4
11	[illegible]	23 [illegible]	[illegible]	[illegible]5 [illegible]	[illegible]6	2[illegible] [illegible]	28 9	[illegible]0 1	31 2	32 3	33 4	3[illegible] 5	35 6
12	[illegible]	[illegible]	[illegible]0 [illegible]	[illegible]	[illegible]	30 [illegible]	31 6	32 9	3[illegible] 1	3[illegible]	36 5	37 6	38 9
13	[illegible]	[illegible]7	[illegible]9	[illegible]0 3	[illegible]1 6	[illegible]2 [illegible]	3[illegible] 2	3[illegible] 6	36 [illegible]	38 2	39 [illegible]	[illegible]0 8	[illegible]2 1
14	[illegible]	[illegible]	[illegible]	[illegible]2	[illegible]	[illegible]	3[illegible]	3[illegible]	39 [illegible]	41 2	[illegible]2 6	[illegible]3 [illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39 [illegible]	41 1	42 6	[illegible] 1	45 6	47 1	48 6
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]8 8	[illegible]0	[illegible]2 [illegible]	[illegible] 8	4[illegible]	[illegible]	48 6	50 3	5[illegible] 8
17	[illegible]	[illegible]	[illegible]	[illegible] 6	[illegible]1 3	[illegible]3 [illegible]	[illegible]	[illegible]6 6	48 3	[illegible]0 [illegible]	[illegible]1 [illegible]	53 1	55 1
18	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]	[illegible]9 3	[illegible]1 1	52 9	[illegible]	[illegible]6 [illegible]	58 3
19	[illegible]	[illegible]	[illegible]	[illegible] 2	6 [illegible]	[illegible]	4[illegible] 9	52 1	54 0	55 9	[illegible]7 [illegible]	[illegible]	61 6
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 6	[illegible]	[illegible]2 6	[illegible] 8	[illegible]6 [illegible]	[illegible]8 8	60 [illegible]	62 [illegible]	64 9
21	[illegible]2 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]1 [illegible]	[illegible]3 2	[illegible] 2	[illegible] 5	59 6	61 7	63 [illegible]	[illegible]5 9	68 1
22	[illegible] 6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 9	[illegible]	62 [illegible]	6[illegible]	66 9	[illegible]9 [illegible]	[illegible]1 4
23	[illegible]0 [illegible]	9 [illegible]	[illegible]1 3	[illegible] 6	[illegible] 9	[illegible]8 [illegible]	[illegible] 5	63 0	65 3	6[illegible] 6	[illegible]9 [illegible]	72 2	74 6
24	[illegible]	[illegible]1	[illegible]	[illegible]	[illegible]	[illegible]0 [illegible]	6[illegible] 1	6[illegible] 8	68 2	[illegible]0 [illegible]	[illegible]3	[illegible]5	77 8
25	[illegible]	[illegible]	[illegible]	[illegible] 2	[illegible]	[illegible] 2	6[illegible]	6[illegible] 3	71 [illegible]	7[illegible]	[illegible]6 [illegible]	[illegible] 5	81 1
26	[illegible]	[illegible]	[illegible]	[illegible]	1 6	[illegible]	68 3	[illegible]1 2	73 8	76 [illegible]	[illegible]9 [illegible]	81 [illegible]	84 [illegible]
27	[illegible]	[illegible]	[illegible]	[illegible]2 [illegible]	[illegible] 5	[illegible]	[illegible]1 0	[illegible]	76 [illegible]	79 [illegible]	82 [illegible]	[illegible]4 8	87 [illegible]
28	6 [illegible]	[illegible]	[illegible]	[illegible] 2	[illegible]8 0	[illegible]	[illegible] 0	[illegible]6 7	79 5	82 [illegible]	85 1	8[illegible] 9	90 7
29	[illegible]	1	[illegible]	[illegible]	[illegible]	73 [illegible]	[illegible]6 2	79 5	82 4	85 3	88 2	91 1	94 1
30	[illegible]	[illegible]	[illegible]	[illegible]	2 3	[illegible]6 [illegible]	[illegible]8 9	82 2	85 [illegible]	8[illegible] 2	91 2	94 1	97 3
31	[illegible]2	[illegible]6 [illegible]	[illegible] 1	[illegible]2 [illegible]	[illegible] 2	[illegible]8 4	81 5	8[illegible] 9	88 0	91 1	94 2	97 4	100 5
32	[illegible]	[illegible]	[illegible]1	[illegible] 6	7	8 [illegible]	8[illegible] 2	8[illegible] 7	90 9	94 1	97 [illegible]	10[illegible]	103 8
33	[illegible]	[illegible]	[illegible]	[illegible]6	[illegible] 1	83 [illegible]	8[illegible] 8	90 4	93 [illegible]	97 0	100 3	103 6	107 0
34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]6 1	89 [illegible]	93 2	96 6	1[illegible]0 0	[illegible]03 4	[illegible]06 7	110 3
35	[illegible]	[illegible]	[illegible]	8 [illegible] 1	[illegible]8 0	88 6	92 0	9[illegible] 9	99 4	102 9	106 4	109 9	113 [illegible]
36	[illegible]	[illegible]6	[illegible]	[illegible]8	[illegible]6 4	91 1	[illegible]	98 [illegible]	[illegible]2 2	1[illegible] 8	[illegible]09 4	113 1	[illegible]16 8
37	[illegible]	6	[illegible]	[illegible]3 2	[illegible]8 9	9[illegible] 6	9[illegible]	101 4	1[illegible]5 1	108 [illegible]	1[illegible]	116 2	120 0
38	[illegible]	[illegible]	[illegible]	8	[illegible]	96 2	99 9	10[illegible] 1	107 9	111 [illegible]	1[illegible]5 [illegible]	119 3	123 2
39	[illegible]	3	[illegible]	[illegible]	[illegible]3	[illegible]8 [illegible]	1[illegible]2 [illegible]	106 0	110 8	11[illegible] 7	11[illegible]	122 5	126 5
40	81 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]2	[illegible]01 2	10[illegible] [illegible]	[illegible]	113 6	11[illegible] 6	121 6	12[illegible]	[illegible]29 7

TABLE II.

For the EXPANSION of the AIR, or CORRECTING of the UPPERMOST HEIGHT

By Sir GEORGE SHUCKBURGH

Deg	Approximate Height in Feet.								
0	1000	2000	3000	4000	5000	6000	7000	8000	9000
1	2.4	4.9	7.3	9.7	12.1	14.6	17.0	19.4	21.9
2	4.9	9.7	14.6	19.4	24.3	29.2	34.0	38.9	43.7
3	7.3	14.6	21.9	29.2	36.1	43.7	51.0	58.3	65.6
4	9.7	19.4	29.2	38.9	48.6	58.3	68.0	77.8	87.5
5	12.1	24.3	36.4	48.6	60.7	72.9	85.0	97.2	109.3
6	14.6	29.2	43.7	58.3	72.8	87.5	102.0	116.6	131.2
7	17.0	34.0	51.0	68.0	85.0	102.1	119.0	136.1	153.0
8	19.4	38.9	58.3	77.8	97.1	116.6	136.0	155.5	174.9
9	21.9	43.7	65.6	87.5	109.3	131.2	153.0	175.0	196.8
10	24.3	48.6	72.9	97.2	121.5	145.8	170.1	91.4	218.7
11	26.7	53.5	80.2	106.9	133.6	160.4	187.1	213.8	240.6
12	29.2	58.3	87.5	116.6	145.8	175.0	204.1	233.3	262.4
13	31.6	63.2	94.8	126.4	157.9	189.5	221.1	252.7	284.3
14	34.0	68.0	102.1	136.1	170.1	20[illegible]	238.1	272.2	306.2
15	36.4	72.9	109.3	145.8	182.2	218.[illegible]	255.1	291.6	328.0
16	38.8	77.8	116.6	155.5	194.3	233.3	272.1	311.0	349.9
17	41.3	82.6	123.9	165.2	206.5	247.9	289.1	330.5	371.7
18	43.7	87.5	131.2	175.0	218.6	262.4	306.1	349.9	393.6
19	46.1	92.3	138.5	184.7	230.8	277.0	323.1	369.4	415.5
20	48.6	97.2	145.8	194.4	243.0	291.6	340.2	388.8	437.4
21	51.0	102.1	153.1	204.1	255.1	306.2	357.2	408.2	459.3
22	53.5	106.9	160.4	213.8	267.3	320.8	374.2	427.[illegible]	481.1
23	55.9	111.8	167.7	223.6	279.4	335.3	391.2	447.1	503.0
24	58.3	116.6	175.0	233.3	291.6	349.9	408.2	466.6	[illegible]
25	60.7	121.5	182.2	243.0	303.7	364.5	425.2	486.0	546.[illegible]

TABLE II. continued.

D.	Approximate Height in Feet								
o	1000	2000	3000	4000	5000	6000	7000	8000	9000
26	63 1	126 4	189 5	252 7	315 8	379 1	442 2	505 4	568 6
27	65 0	131 2	196 8	262 4	328 0	393 7	459 2	524 9	590 4
28	68 0	136 1	204 1	272 2	340 1	408 2	476 2	544 3	612 3
29	70 4	140 9	211 4	281 9	352 3	422 8	493 2	563 8	634 2
30	72 9	145 8	218 7	291 6	364 5	437 4	510 3	583 2	656 1
31	75 3	150 7	226 0	301 3	376 6	452 0	527 3	602 6	678 0
32	[illegible]	155 5	233 3	311 0	388 8	466 6	544 3	622 1	699 8
33	80 2	160 4	240 6	320 8	400 9	481 1	561 3	641 5	721 7
34	82 6	165 2	247 9	330 5	413 1	495 7	578 3	661 0	743 6
35	85 0	170 1	255 1	340 2	425 2	510 2	595 3	680 4	765 4
36	87 4	175 0	262 4	349 9	437 3	524 8	612 3	699 8	787 3
37	89 9	179 8	269 7	359 6	449 5	539 4	629 3	719 3	809 1
38	92 3	184 7	277 0	369 4	461 6	553 9	646 3	738 7	831 0
39	[illegible]	189 5	284 3	379 1	473 8	568 5	663 3	758 2	852 9
40	97 2	194 4	291 6	388 8	486 0	583 2	680 4	777 6	874 8
41	99 6	199 3	298 9	398 5	498 1	597 8	697 4	797 0	896 7
42	102 1	204 1	306 2	408 2	510 3	612 4	714 4	816 5	918 5
43	104 5	209 0	313 5	418 0	522 4	626 9	731 4	835 9	940 4
44	106 9	213 8	320 8	427 7	534 6	641 5	748 4	855 4	962 3
45	109 3	218 7	328 0	437 4	546 7	656 1	765 4	874 8	984 1
46	111 7	223 6	335 3	447 1	558 8	670 6	782 4	894 2	1006 0
47	114	228 4	342 6	456 8	571 0	685 3	799 4	913 7	1027 8
48	116 6	233 3	349 9	466 6	583 1	699 8	816 4	933 1	1049 7
49	119 0	238 1	357 2	476 2	595 3	714 4	833 4	952 6	1071 6
50	121 5	243 0	364 5	486 0	607 5	729 0	850 5	972 0	1093 5

A LIST

A LIST

OF

METEOROLOGICAL INSTRUMENTS

MADE AND SOLD BY

GEORGE ADAMS,

Mathematical Inſtrument-maker to HIS MAJESTY, and Optician to HIS ROYAL HIGHNESS the PRINCE of WALES.

A Plain portable barometer —	2	2	0
Ditto with a thermometer — —	3	3	0
A plain barometer, covered frame and glaſs door	2	12	6
Ditto with a thermometer —	3	13	6
A barometer with a long cylindric thermometer	4	4	0
A ditto with ditto, and De Luc's hygrometer	7	7	0
A barometer and thermometer, with a guage, the indexes moving by rack-work —	5	15	6
Ditto neater — —	6	16	6
A barometer for meaſuring the altitude of mountains, &c. — —	9	9	0
Marine barometers			
Diagonal, wheel, and ſtatical barometers			
Fahrenheit's thermometers, from 1l. 1s to	2	12	6
Ditto for botanic purpoſes —	0	18	0
Ditto for the brewery — — —	1	1	0
De Luc's hygrometer, theſe are the only inſtruments by which comparative obſervations can be made on the dryneſs and moiſture of the air, from 3l. 3s to — —	7	7	0
Rain guages — — —	0	18	0
Dr. Lind's wind guage			
Hygrometers with the head of the wild oat	0	10	6
Fontana's eudiometer for aſcertaining the purity of the air — —	2	5	0